Bathyswath Parsed File Format

ETD_2011

1 Introduction

1.1 Document Change Record

Version	Date	Changes
1.0	04/06/15	Parsed file format data extracted from “Bathyswath File Formats” version 7.06

1.2 Scope

This document describes the format and interpretation of the “Parsed Data” data files and data streams written by the Bathyswath and SWATHplus sonar systems.

For a full set of all the data written by Bathyswath and SWATHplus systems, see “Bathyswath File Formats”.

1.3 Context

Bathyswath is a swath bathymetry sonar system. It is derived from the SWATHplus sonar system, and uses the same file formats. In turn, SWATHplus was derived from the Submetrix sonars, built by Submetrix Ltd.

1.4 Glossary

Bathyswath	A seabed mapping sonar system. Also the name of the organisation that builds and sells it
Swath	The Bathyswath Swath Processor software application
SWATHplus	The forerunner of the Bathyswath system

1.5 Table of Contents

2 File Types

The following file types are described in detail in this document. They all use the Bathyswath block-orientated format.
The Parsed Data can be read from ".sxi" files, or from TCP/IP sockets.

Type	Format	Suffix	Contains	Notes	See Section
Parsed data	binary	.sxi	Raw data, but parsed into a format that is easier for third-party code to interpret.	These files have none of the above corrections applied. Parsed data files can be created from raw data files, but not the other way around.	5

3 Data Storage and Transmission

3.1 Disk Format

The data files are written using a Microsoft Windows operating system and therefore follow the conventions of that system in terms of file naming and low-level disk format.

3.2 File Names

The file name is specified by the user during the operation of the real-time sonar software. The extension is supplied by the software according to the file type (see the table above).

3.3 Endianness

All Bathyswath and SWATHplus data is little-endian, i.e. in the natural 80x86 format with the least significant byte at the lower address.

3.4 Real-Time TCP/IP Data Transmission

Bathyswath software can output data in real time, and be controlled, over a TCP/IP interface (for example, using an Ethernet wired or wireless LAN). This interface uses the same block-orientated structure as the data files.
The Bathyswath Swath Processor application can output the Parsed Data format (section 5) and the Raw Data format by TCP/IP in real time.

4 Block-Orientated Data Format

4.1 General

All of the files listed in the first table of section 2 use the same block-orientated data format. They can be read using the same software code, and the blocks that they contain may be included in any of the files. The difference between these file types is therefore simply the types of data block that they tend to contain.
Each file contains a file header block, followed by a series of data blocks.
Every block contains a header that identifies the block, followed by the length of the block. Therefore, the reading software can identify the blocks that it wishes to read, and ignore and skip over any other block type that it encounters. In this way, new blocks can be added to a file without necessarily having to update the reading software.

4.2 File Header

A file header is used to identify each file type. It is formatted in the same way as data blocks, but with a "magic number" as the block type. Each file type uses a different magic number. See the table below.
However, the file header may not be present in some circumstances, and the file may start immediately with data blocks.
This magic number appears in the file as the sequence of bytes. The second 32-bit integer is the block length, which is currently set to a value of 8 bytes. The content of the header block is two 32-bit integers representing the software version number and the file format version number.
The software version number is encoded as an integer, as follows: (Major version- Minor version- Release- Build). For example, a version number of 3065601 means: Major version 3, Minor version 06, Release 56, Build 01.
The file format version number is now obsolete: use the data block identifiers as a way of checking file versions. For example, Swath version 3.7 writes "`SONAR_DATA3`" in its raw data files, and version 3.6 writes "`SONAR_DATA2`" blocks. To allow an application to read both kinds of file, add parsing code for both block types.

4.2.1 Magic Numbers

The file type magic numbers are:

File type	Magic number identifier	Magic number (hexadecimal)
Raw sonar data	SXR_HEADER_DATA	0xbad0bad0
Configuration data	SXC_HEADER_DATA	0xf1c0f1c0
Coverage maps	SWC_HEADER_DATA	0xc311c311
Processed sonar data	SXP_HEADER_DATA	0x01df01df
Grid data	SXG_HEADER_DATA	0xd1edede0
Parsed data	SXI_HEADER_DATA	0x521d52d1

4.3 Data Blocks

Data is stored in blocks; each block has a header consisting of type and length. Block types are 32-bit integer values encoded as follows.
These data blocks can occur in any Bathyswath block-encoded data files. They are also used in TCP/IP communications between applications. However, blocks of a certain type are most commonly found in particular files, and these file types are listed in the table below.

Type	Value	Notes	Usual File Type
`TIME_SYNCH_DATA`	`0x13`	Time synchronisation between systems	TCP/IP
`PARSED_PING_DATA`	`0x29`	Sonar data in parsed data	sxi & TCP/IP
`PARSED_ATTITUDE`	`0x2b`	Attitude data in parsed data	sxi & TCP/IP
`PARSED_POSITION_LL`	`0x2C`	Lat-long position data in parsed data	sxi & TCP/IP
`PARSED_POSITION_EN`	`0x2d`	Easting-Northing position in parsed data	sxi & TCP/IP
`PARSED_SVP`	`0x2e`	Speed of sound data in parsed data	sxi & TCP/IP
`PARSED_ECHOSOUNDER`	`0x2f`	Echosounder data in parsed data	sxi & TCP/IP

Type	Value	Notes	Usual File Type
PARSED_TIDE	0x30	Tide data in parsed data	sxi & TCP/IP
PARSED_AGDS	0x31	AGDS data in parsed data	sxi & TCP/IP
Reserved	0x100 – 0x1ff	Reserved for client use; contact Bathyswath for details	

At present, only some of these block types are used. All other possible block types are reserved for future expansion. Data blocks are concatenated with no further padding and in no particular order (the header record is, however, always the first record in the file).

4.3.1 Block Length

Immediately following the block type is the block length, again as a 32-bit integer. The block length is the number of bytes in the block, not including the header.

5 Parsed Data File Blocks

5.1 General

Parsed data files are written with the file extension “SXI”. Parsed Data is also sent to other programs over TCP/IP sockets. Both data flows contain the following data blocks.

5.2 Common Parsed Data Codes

The parsed data blocks encode time and data channel the same way, as follows.

5.2.1 Time Codes

Eight-byte timestamps are organised as two four-byte integers. The first integer represents seconds since 1970, and the second integer represents microseconds since that second.

5.2.2 Channel Number

Channel number identifies a transducer. The software that reads the data will need to store, and account for the location and pointing angle of each transducer, in three dimensions, relative to the attitude and position system data. There are usually, but not always, two channels. Channel 1 is usually port, and channel 2 is usually starboard, but that is not guaranteed. Transducers may fire alternately (port-starboard-port-starboard …), simultaneously, or singly (port-port-port … or starboard-starboard-starboard).

5.3 PARSED_PING_DATA

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	unsigned char	Channel	Identifies the transducer
9	4	unsigned long int	Ping number	Starts from when program starts 1 and increments. Simultaneous pings are numbered separately.
13	4	float	Sonar frequency	Frequency of the transducer, in Hz
17	4	float	Sample period	Time period between sonar data samples, in seconds.
21	2	unsigned short int	Number of samples	Number of samples following
23	4	float	Sound speed	Speed of sound used to calculate angles, m/s
27	2	short int	Tx pulse	Transmit pulse length, in sonar cycles
29	1	char bit field	Data options	Allows options in data encoding. See §5.3.1.
30	1	unsigned char	Ping state	Records the status of pinging: single/alternating/simultaneous etc. See §5.3.3
31	2	unsigned short int	Max count	Maximum data count before filtering
33	2	To be determined	Reserved	Reserved for other ping information

Byte num	Num bytes	Encoding	Item	Notes
				The header information is followed by "Number of samples" examples of the following sample data
35 +(n×7)	2	unsigned short int	Number	Sample number. Calculate range from this value: see §5.3.5. Sample number may not be sequential or increasing.
37 +(n×7)	2	signed short int	Angle	Angle coded +15 bits = 180° up, -15 bits = 180° down, relative to the transducer pointing angle. See §5.3.5.
39 +(n×7)	2	unsigned short int	Amplitude	Scaled so that 16 bits is the full scale of the ADC
41 +(n×7)	1	Unsigned char	Quality	As set by "Data options". See §5.3.1.

5.3.1 Sonar Data Options

The "Data Options" byte in the header part of the PARSED_PING_DATA block allows for options in the encoding of data, encoded as follows:
Bit codes:

7	6	5	4	3	2	1	0
Not currently used					Meaning of quality byte		

Bits 0-2 are used to encode the meaning of the quality byte. The remaining bits are currently not used.

Value	Name	Meaning The quality byte in each sample is …
0	PARSED_ QUALITY_MERGED_CALC	Generated from a combination of quality factors. A measure of relative quality. 255 = maximum quality, 0 is a rejected item.
1	PARSED_ QUALITY_PHASE_QUAL	Generated from phase decode quality. The SWATHplus transducers have several stave pairs to use: this value is a measure of how well the decodes for each pair agree
2	PARSED_ QUALITY_FILTER_ACCEPTANCE	A bit-wise set of accept-reject flags for a set of up to 8 filters. If a filter rejects a sample, then the bit corresponding to that filter is set to 1. If the data point is accepted, or that bit is not used (there isn't a filter assigned to the bit), then it is left zero. Accepted data points therefore have all bits set zero.

5.3.2 Quality Filters

If working in "PARSED_ QUALITY_FILTER_ACCEPTANCE" mode, the meaning of the bits in the quality flag is as follows:

Bit	Name	Meaning
0	FILTER_FLAG_PHASE	Phase coherence filter: checks that the angle decodes for various combinations of transducer stave pairs agree
1	FILTER_FLAG_ANGLE_CONFIDENCE	A moving-window filter in angle, checking that angles are within some set limit
2	FILTER_FLAG_AMPLITUDE	Checks that amplitude is greater than the base noise level
3	FILTER_FLAG_ZER0_ANGLE	Flags items that have an angle of exactly zero, or are within some user-defined angle of the transducer boresight

Bit	Name	Meaning
4	FILTER_FLAG_RANGE	Flags items that are outside user-defined minimum and maximum angles
5	FILTER_FLAG_WATERCOL	Flags items that either have a slant range less than an average nadir depth, or are within 30° of the nadir and are greater than the average nadir depth. In both cases, a percentage threshold margin is allowed either side of the nadir depth.
6	FILTER_FLAG_DEPTH	Flags items that are outside user-defined minimum and maximum depth

The user may choose not to output any points that have any filter flags set, in which case all filter bytes in the output will be zero.

5.3.3 Status of Pinging

This byte records the sonar activation options.
If the byte is set zero, then this byte has no meaning. This allows for successful decoding of previous versions of the data file.

7	6	5	4	3	2	1	0
Not currently used				Port-starboard (set 1 for stbd)	Tx on (otherwise receive only)	Ping mode	

Ping Mode:

Value	Name	Meaning
0	SONAR_SEL_OFF	Not used
1	SONAR_SEL_SINGLE	Single-sided pinging
2	SONAR_SEL_ALT	Alternating pinging
3	SONAR_SEL_SIM	Simultaneous pinging

Port-starboard flag is set using the transducer position data. There is no guarantee that the user has set this data, so the validity of this field is not guaranteed.

5.3.4 Sonar Data Angle

Sonar data angle is relative to the transducer pointing angle. For SWATHplus, the pointing angle is usually 30° down and -90° azimuth for port and +90° for starboard, but any configuration is theoretically possible. Angular measurement is only for the semicircle in front of the transducers.
The sign convention is positive up. On a flat seabed, samples will start negative and change to positive when the returns sweep through the boresight of the transducer.
The conversion factor into radians is (pi/ 32768), and (180/32768) for degrees.
If SWATHplus is not configured with the true speed of sound at the transducer head, then the angles need to be corrected for this speed of sound in the program that consumes this data.
The correction is as follows:

True angle = arcsin(sin(angle) * (true sound speed) / (nominal sound speed))

5.3.5 Sonar Data Range

Range is calculated by:

range = (sample number) * (sample period) * (speed of sound) / 2;

Range is always in front of the transducer, in a line along the transducer “boresight”.

Note that the speed of sound used is likely to be a default value, not taken from a measurement. Therefore, the range should be corrected by multiplying by the ratio between measured speed of sound and the speed of sound in the PARSED_PING_DATA sample.
A possible refinement is to modify range to the mid-point of the sonar pulse, using “Tx pulse” and the sonar frequency.

5.3.6 Sonar Data Time

The precise time of a sonar data sample is calculated by:

(PARSED_PING_DATA time) + ((PARSED_PING_DATA sample period) * (sample number)

5.3.7 Height

Height could be:

- An absolute height, from a combined attitude and position system that is capable of reading GPS height to sufficient accuracy
- A height relative to the water surface: in this case a tide table will be needed
- A heave value: that is, relative to a local average height

It is up to the processing application that uses this data to make the distinction for each case and deal with the data appropriately.

5.4 PARSED_ATTITUDE

Byte num	Num bytes	Encoding	Item	Notes
0	8	See below	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	Unsigned char	Channel	Identifies the data source
9	4	Float	Roll	Positive for starboard down
13	4	Float	Pitch	Positive for nose up
17	4	Float	Heading	Positive clockwise, looking down
21	4	Float	Height	Positive for down

Attitude information can come from a mix of sensors. The Swath system builds combined attitude and heading packets from whatever comes into the system, using user-entered “attitude derivation” selections. Data packets are provided at the same rate as whatever is providing roll (which needs to be at the highest frequency, and so should not be sub-sampled). If heading is at a lower rate, it would be repeated in attitude packets until a new item comes in.
See §6.1 for notes on sign conventions.

5.5 PARSED_POSITION_LL

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same.
8	1	Unsigned char	Channel	Identifies the data source
9	8	double	Latitude	Degrees
17	8	double	Longitude	Degrees

5.5.1 Position Latitude-Longitude and Easting-Northing

Position systems can provide position data either in latitude and longitude or easting and northing.

- If the positioning system provides latitude and longitude, then PARSED_POSITION_LL packets are provided. The system will also probably provide PARSED_POSITION_EN packets, using the conversion factors selected by the SWATHplus operator. However, this converted EN packet is not guaranteed in this case.
- If the positioning system only provides easting and northing, then PARSED_POSITION_EN packets only are supplied: no conversion to LL is provided.

5.6 PARSED_POSITION_EN

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same.
8	1	Unsigned char	Channel	Identifies the data source
9	8	double	Easting	Metres
17	8	double	Northing	Metres

5.7 PARSED_SVP

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	Unsigned char	Channel	Identifies the data source
9	4	float	Speed of sound	Metres per second

5.8 PARSED_ECHOSOUNDER

This is only sent out if a separate single-beam echosounder is fitted to the SWATHplus system.

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	Unsigned char	Channel	Identifies the data source
9	4	float	Altitude	Height above seabed; Metres

5.9 PARSED_TIDE

This is only sent out if tide data is provided to the SWATHplus system in real-time.

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	Unsigned char	Channel	Identifies the data source
9	4	float	Tide height	Metres

5.10 PARSED_AGDS

This is only sent out if a separate Acoustic Ground Discrimination System (e.g. SEA's ECHOplus) is connected to the SWATHplus system.

Byte num	Num bytes	Encoding	Item	Notes
0	8	See §5.2.1.	Time	Start of ping time code. All 8-byte time codes are encoded the same: see §5.2.1.
8	1	Unsigned char	Channel	Identifies the data source
9	4	float	Hardness	
13	4	float	Roughness	

6 Notes

6.1 Axis Conventions

All angles obey the right-hand screw rule about the appropriate axis. Headings obey this rule about the z-axis, whilst at the same time maintaining the usual geographic convention, that is, positive going clockwise, measured from North.
Depth is positive for *down*.
This means that:

- Heading is positive clockwise, looking down.
- Roll is positive for starboard down.
- Pitch is positive for nose up.

The SWATHplus software uses the Euler angle convention for roll and pitch, rather than the horizontal-plane convention. This means that roll is measured about the body's own forward-aft axis, rather than relative to the horizontal plane.
Tide values are given in the usual marine convention, positive up.