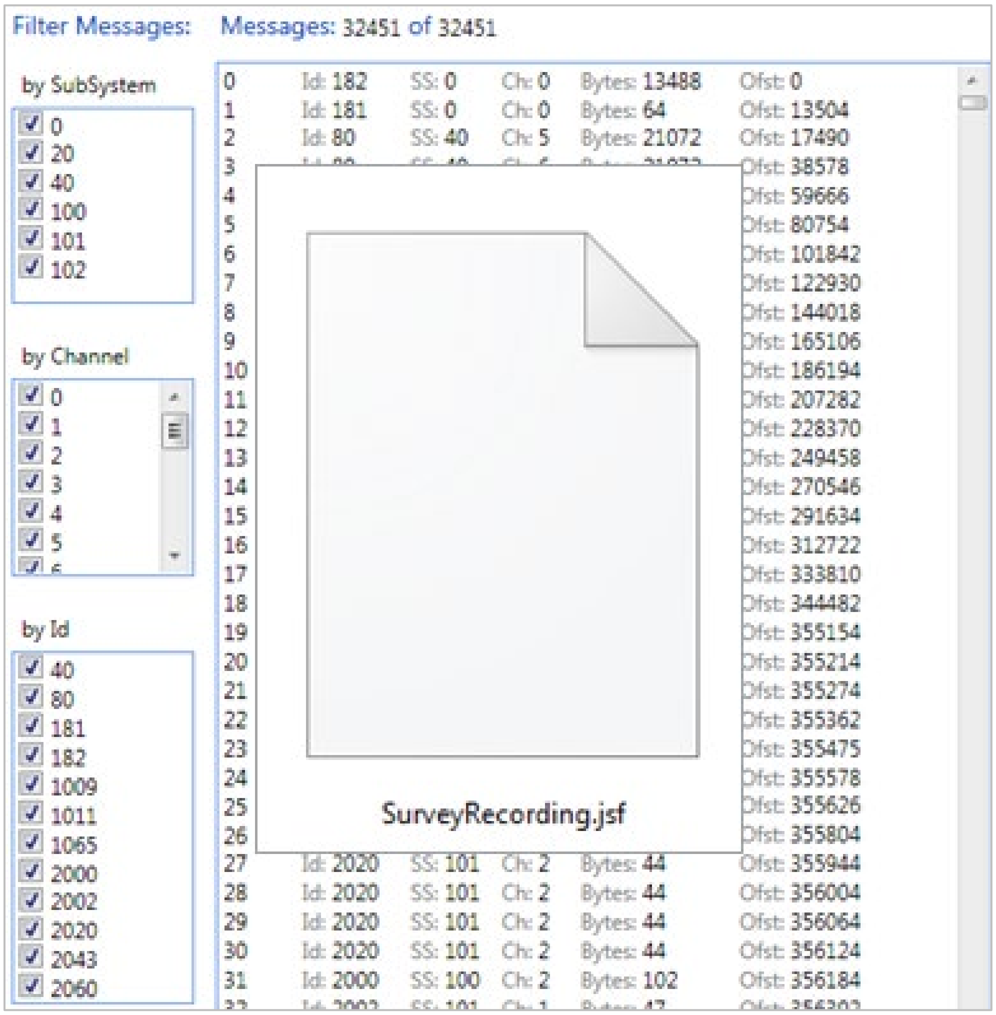
JSF FILE AND MESSAGE DESCRIPTIONS

0023492_REV_D

July 30, 2021



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ABOUT THIS DOCUMENT

Purpose of this Document

The purpose of this document is to describe the messages of common interest to those reading and processing JSF files. Although this document discusses the latest messages, some components may be periodically upgraded or updated. Therefore, the information in this document is subject to change and should be used for reference only.

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Revision History

REV	DESCRIPTION	DATE	APPROVAL
1.20	Updated to include latest messages and reformatted for easier reading	03/08/2016	LB
2.0	Updated to include latest message	07/06/2018	HS
3.0	Updated to add Heave field message 80	06/03/2020	HS
A	Document merged with Bathymetric Data Messages_0014932_REV_E	06/12/2020	MM
B	3000 Message Update- Bin Size Field Added	08/13/2020	HS
C	Updated to include Reflection Coefficient Message	04/06/2021	HS
D	RC Message Update	7/30/2021	CC

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1.0 OVERVIEW

EdgeTech's native file format is stored to a binary file with the extension ***.jsf**. The JSF file has been in use for over ten years and is recorded by default by most EdgeTech topsides running the *Discover* and *JStar* acquisition programs.

This document describes the most common messages found in EdgeTech's JSF files and is not intended to be a complete description of all messages contained within. This document should also be used in conjunction with the **JSFdefs.h** header file to read, store, and process JSF files properly.

1.1 The JSF File

Sonar data is recorded to a JSF file on a per-channel basis. A single frequency side scan system has two messages per ping–one for the port (channel 0) and one for the starboard (channel 1). Other data types, such as those coming from a motion reference unit (MRU), providing pitch, roll, and heave, have their own specific message and similarly have a single message per reading set. Different types of data will have different message numbers as identified by the Message Type field. A typical file might contain the following messages, as depicted in EdgeTech's JSF File Viewer Utility (**FIGURE 1-1**) below.

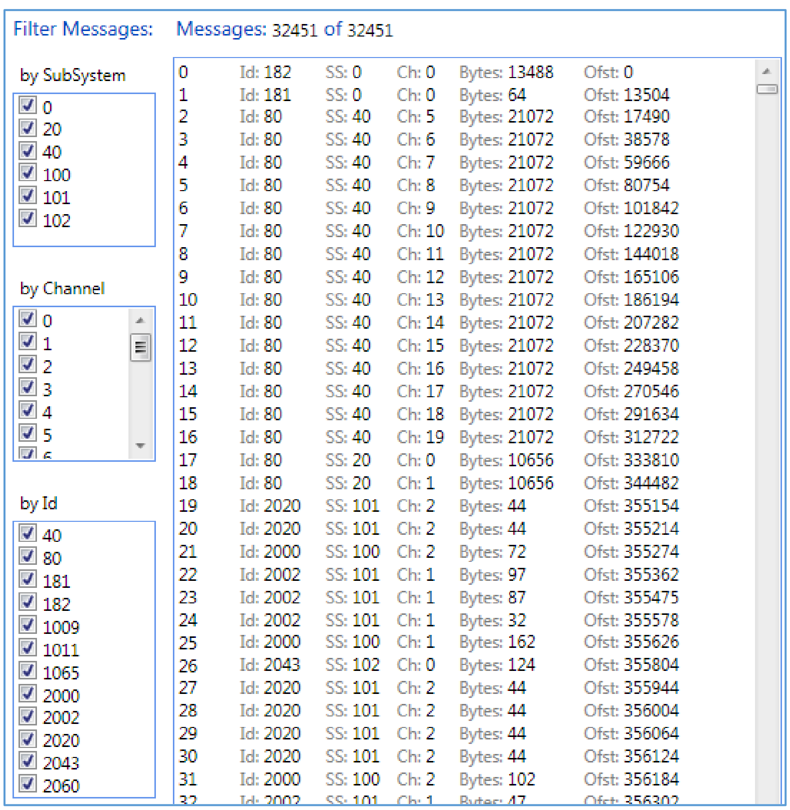

Figure 1-1: Utility Showing Typical Messages Contained within a JSF File

1.2 Byte Ordering

The byte ordering of 16-bit and 32-bit values is important since the JSF format is stored using little endian (Intel) format for binary data, where the least significant bytes are stored first. This is the native format for Intel x86 computers and compatibles. If data is read on a big endian machine (such as most Sun Workstations), the user should byte reverse the data so that the 2 bytes of a 16-bit value are flipped, and the 4 bytes of a 32-bit value are flipped (i.e., bytes 0, 1, 2, 3 become bytes 3, 2, 1, 0).

2.0 JSF FILE FORMAT DEFINITION

The JSF file is made up of several types of messages, each beginning with a 16-byte header indicating the type of data to follow and its size. This section describes the message header along with some of the potential messages contained within a single JSF file.

2.1 Message Header

The header identifies the type and size of the message and the originating subsystem and channel. The header format is given below in **TABLE 2-1**.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 1	Marker for the Sync/Start of Header (always 0x1601) This serves as a sanity check during file processing.	UINT16
2	Protocol Version (e.g.0xD). The protocol level indicates which revision of this specification was used to write that message. Messages of differing protocol levels may be interspersed in the same file. Protocol level changes may involve additional messages or changes to the non-public portion of the interface.	UINT8
3	Session Identifier The session identifier is used for internal routing and can be ignored.	UINT8
4 – 5	Message Type (e.g. 80 = Acoustic Return Data) This field defines the type of data to follow. Some data formats of interest are detailed in the following sections. If this field contains an unwanted or unknown (i.e., not defined) type, use the Size of the Message (bytes 12– 15) to skip over the data to the next message header. The message protocol is used for command and control, as well as data.	UINT16
6	Command Type 2 = Normal data source The command type field can typically be ignored when reading JSF files as this parameter may only be of interest during real-time operation.	UINT8

BYTE OFFSETS	DESCRIPTION	SIZE
7	Subsystem Number The subsystem number determines the source of data; common subsystem assignments are: Sub-Bottom (SB) = 0 Low frequency data of a dual frequency side scan = 20 High frequency data of a dual frequency side scan = 21 Very High frequency data of a tri-frequency side scan = 22 Bathymetric low frequency data of a dual side scan=40 Bathymetric high frequency data of a dual side scan=41 Bathymetric very high frequency of a tri-frequency=42 Bathymetric motion tolerant, low frequency dual side scan=70 Bathymetric motion tolerant high frequency dual side scan=71 Bathymetric motion tolerant very high frequency tri-frequency=72 Raw Serial/UDP/TCP data =100 Parsed Serial/UDP/TCP data =101 Standard side scan systems are single or dual frequency. When more than two side scan frequencies are present, the subsystem number begins at 20 and increases with increasing acoustic center frequencies.	UINT8
8	Channel for a Multi-Channel Subsystem For Side Scan Subsystems: 0 = Port 1 = Starboard For Serial Ports: this will be the logical port number, which often differs from the physical COM port in use. The single-channel sub-bottom systems channel is 0.	UINT8
9	Sequence Number	UINT8
10 – 11	Reserved	UINT16
12 – 15	Size of the following message in bytes The byte count is the number of bytes until the start of the next message header. This is the amount of additional data to read if processing the current message or the amount of data to skip over if the current message is not of interest.	INT32

Table 2-1: 16-byte Message Header Template

2.2 Acoustic Message

The Sonar Data Message (Type 80) is the acoustic data message.

2.2.1 Message Type 80: Sonar Data Message (jsfdefs.h)

The Sonar Data Message consists of a single channel ping of data (receiver sounding period) for a single channel (e.g., port side of low frequency side scan subsystem). Most side scan subsystems have two data channels: port and starboard. Most sub-bottom subsystems have a single data channel. Which fields have data present depends on the system used and data acquisition procedures. In addition, this message may contain data from multiple non-acoustic sensors. Non-acoustic data contained in this message normally is not time interpolated.

EdgeTech strongly recommends that if high positional or situational accuracy is required, the individual sensor messages should be processed instead (see sub-section **2.4 AUXILIARY MESSAGES**). Otherwise, this may be the only message that needs to be interpreted in a JSF file if the level of accuracy is sufficient. The Validity Flag field (byte 30-31) indicates which auxiliary fields are populated. By convention, if a value is not present, the field is set to 0.

A Sonar Data Message consists of a 240-byte header followed by the actual acoustic sample data. This 240-byte header is described in the table below.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	TimeSince1970 Ping Time in seconds since the start of time-based time function (midnight 1/1/1970) The time of the start of the ping of data represented by the following trace data is the Ping Time. This timestamp is only valid for data recorded in Protocol Revision 8 and above. This field is zero in prior protocol versions.	INT32
4 – 7	Starting Depth (window offset) in Samples	UINT32
8 – 11	Ping Number (increases with each ping)	UINT32
12 – 15	Reserved	2 x INT16

BYTE OFFSETS	DESCRIPTION	SIZE
16 – 17	MSBs – Most Significant Bits – High order bits to extend 16 bits unsigned short values to 20 bits. The 4MSB bits become the most significant portion of the new 20-bit value. Bits 0 – 3: Start Frequency Bits 4 – 7: End Frequency Bits 8 – 11: Samples in this Packet Bits 12 – 15: Mark Number (added in protocol version 0xA) The Most Significant Bits fields are used to extend 16-bit integers to 20 bits. These are added as needed when the range of possible values exceeds what can be stored in a 16-bit integer. The simplest way to use these additional bits is to treat the value as a 32 bit integer, the existing value becomes the least significant 16 bits, and the MSB field becomes the next most significant 4 bits with the most significant 12 bits set to zeros.	UINT16
18 – 19	LSB – Extended precision Low order bits for fields requiring greater precision. Bits 0-7: Sample Interval- - Sample interval fractional component Bits 8-15: Course- - fractional portion of course (Added in protocol version 0xB)	UINT16
20 – 21	LBS2 – Extended precision Low order bits for fields requiring greater precision. Bits 0 – 3: Speed - sub fractional speed component (added in protocol version 0xC). Bits 4 – 13: Sweep Length in Microsecond, from 0 - 999 (added in protocol version 0xD). Bits 14 – 15: Reserved	UINT16
22 – 27	Reserved	3 x INT16
28 – 29	ID Code (always 1) 1 = Seismic Data	INT16

BYTE OFFSETS	DESCRIPTION	SIZE
30 – 31	Validity Flag Validity flags bitmap: Bit 0: Lat Lon or XY valid Bit 1: Course valid Bit 2: Speed valid Bit 3: Heading valid Bit 4: Pressure valid Bit 5: Pitch roll valid Bit 6: Altitude valid Bit 7: Heave Bit 8: Water temperature valid Bit 9: Depth valid Bit 10: Annotation valid Bit 11: Cable counter valid Bit 12: KP valid Bit 13: Position interpolated Bit 14: Water sound speed valid	UINT16
32 – 33	Reserved	UINT16
34 – 35	Data Format 0 = one short per sample - envelope data. The total number of bytes of data to follow is 2 * samples. 1 = two shorts per sample - stored as real (one short), imaginary (one short). The total number of bytes of data to follow is 4 * samples. 2 = one short per sample - before the matched filter. The total number of bytes of data to follow is 2 * samples. 9 = two shorts per sample - stored as real (one short), imaginary (one short) - before matched filtering. This is the code for unmatched filtered analytic data, whereas value 1 is intended for match filtered analytic data. The total number of bytes of data to follow is 4 * samples. **NOTE:** Values greater than 255 indicate that the data to follow is compressed and must be decompressed before use. For more detail, refer to the *JSF Decompression Description Document* for more information.	INT16
36 – 37	Distance from Antenna to Tow point in Centimeters. Sonar Aft is Positive	INT16

BYTE OFFSETS	DESCRIPTION	SIZE
38 – 39	Distance from the antenna to tow point in centimeters. Sonar to Starboard is Positive.	INT16
40 – 43	Reserved	2 x INT16

Table 2-2: Message Type 80 Data Format Block

BYTE OFFSETS	DESCRIPTION	SIZE
44 – 47	Kilometers of Pipe See **VALIDITY FLAG** (bytes 30 – 31).	FLOAT
48 – 51	Heave in meter Positive value: Direction is down See **VALIDITY FLAG** (bytes 30 – 31).	FLOAT
52 – 79	Reserved	14 x INT16
80 – 83	Longitude in 10000 * (Minutes of Arc) or X in Millimeters or Decimeters. See Validity Flag (bytes 30 – 31) and Coordinate Units (bytes 88 - 89). **NOTE:** Unless the Validity Flag Bit 13 “Position Interpolated” is set, the position stored in message 80 is the value recorded by Discover and is not the sonar’s position. It is the last navigation position received before pinging, and Layback is not applied.	INT32
84 – 87	Latitude in 10000 * (Minutes of Arc) or Y in Millimeters or Decimeters. See Validity Flag (bytes 30 – 31) and Coordinate Units (bytes 88 - 89). **NOTE:** Unless the **VALIDITY FLAG** Bit 13 “Position Interpolated” is set, the position stored in message 80 is the value recorded by Discover and is not the sonar’s position. It is the last navigation position received prior to pinging, and Layback is not applied.	INT32
88 – 89	Coordinate Units 1 = X, Y in millimeters 2 = Latitude, longitude in minutes of arc times 10000 3 = X, Y in decimeters	INT16

Table 2-3: Message Type 80 Navigation Data Block

BYTE OFFSETS	DESCRIPTION	SIZE
90 – 113	Annotation String (ASCII Data)	24 x UINT8
114 – 115	Samples **NOTE:** For protocol versions 0xA and above, the MSB1 field should include the MSBs (Most Significant Bits) needed to determine the number of samples. See bits 8-11 in bytes 16-17. Field MSB1 for MSBs for large sample sizes.	UINT16
116 – 119	Sampling Interval in Nanoseconds **NOTE:** For protocol versions 0xB and above, see the LSBs field should include the fractional component needed to determine the sample interval. See bits 0-7 in bytes 18-19. Field LSB1 for LSBs for increased precision.	UINT32
120 – 121	Gain Factor of ADC	UINT16
122 – 123	User Transmit Level Setting (0 – 100%).	INT16
124 – 125	Reserved – Do Not Use	INT16
126 – 127	Transmit Pulse Starting Frequency in daHz (decaHertz, units of 10Hz). **NOTE:** For protocol versions 0xA and above, the MSB1 field should include the MSBs (Most Significant Bits) needed to determine the starting frequency of transmit pulse. See Bits 0-3 in byte 16-17. Field MSB1 for MSBs for large transmit pulse.	UINT16
128 – 129	Transmit Pulse Ending Frequency in daHz (decaHertz, units of 10Hz). **NOTE:** For protocol versions 0xA and above, the MSB1 field should include the MSBs (Most Significant Bits) needed to determine the starting frequency of transmit pulse. See bits 4-7 in byte 16-17. Field MSB1 for MSBs for large transmit pulse.	UINT16
130 – 131	Sweep Length in Milliseconds. See bytes 18-19 for LSBs (Least Significant Bits). LSB2 bits 4 - 13 contain the microsecond portion (0 - 999). LSB2 part was added in protocol version 0xD and was previously 0.	UINT16
132 – 135	Pressure in Milli PSI (1 unit = 1/1000 PSI) See **VALIDITY FLAG** (bytes 30-31)	INT32
136 – 139	Depth in Millimeters (if not = 0) See **VALIDITY FLAG** (bytes 30-31).	INT32

BYTE OFFSETS	DESCRIPTION	SIZE
140 – 141	Sample Frequency of the Data in hertz **NOTE:** For all data types, EXCEPT RAW (Data Format = 2), this is the sampling frequency of the data. For RAW data, this is one-half the sample frequency of the data ($F_S/2$). All values are modulo 65536. Use this in conjunction with the Sample Interval (Bytes 114-115) to calculate the correct sample rate.	UINT16
142 – 143	Outgoing Pulse Identifier	UINT16
144 – 147	Altitude in Millimeters A zero implies not filled. See **VALIDITY FLAG** (Bytes 30-31)	INT32
148 – 151	Sound Speed in Meters per Second. See **VALIDITY FLAG** (Byte 30-31).	FLOAT
152 – 155	Mixer Frequency in Hertz For single pulses systems, this should be close to the center frequency. For multi-pulse systems, this should be the approximate center frequency of the span of all the pulses.	FLOAT

Table 2-4: Message Type 80 Pulse Information Block

BYTE OFFSETS	DESCRIPTION	SIZE
156 – 157	Year Data Recorded (CPU time), e.g., 2009. The Ping Time can also be determined from the Year, Day, Hour, Minute, and Seconds as per bytes 156 to 165. Provides 1 second-level accuracy and resolution. See Bytes 0-3. These 2-time stamps are equivalent and identical. For most purposes, this should not be used. For higher resolution (milliseconds), use the Year and Day values of bytes 156 to 159, use the milliSecondsToday value of bytes 200-203 to complete the timestamp. System time is set to UTC, regardless of the time zone. This time format is backward compatible with all older Protocol Revisions	INT16
158 – 159	Day (1 – 366) (should not be used)	INT16
160 – 161	Hour (see Bytes 200-203) (should not be used)	INT16
162 – 163	Minute (should not be used)	INT16
164 – 165	Second (should not be used)	INT16
166 – 167	Time Basis (always 3)	INT16

Table 2-5: Message Type 80 CPU Time Block

The trace data is transmitted as 16-bit integers in block floating-point format per message. This saves bandwidth and storage space while preserving dynamic range. The weighting factor MUST be applied to each of the 16-bit integer values to restore the original floating-point value.

BYTE OFFSETS	DESCRIPTION	SIZE
168 – 169	Weighting Factor for Block Floating Point Expansion -- defined as 2 to N Volts for LSB. All data MUST be scaled by 2^{-N}, where N is the Weighting Factor. (See **EQUATION 2-2-1**)	INT16
170 – 171	Number of Pulses in the Water	INT16

Table 2-6: Message Type 80 Weighting Factor Block

Each of the data samples then needs to be scaled by the weighting factor, *N*, according to the equation below:

$$ScaledDataSample = DataSample \times 2^{-N}$$

Equation 2-2-1

The following Compass Heading, Pitch, and Roll fields contain useful information about the sonar's attitude.

BYTE OFFSETS	DESCRIPTION	SIZE
172 – 173	Compass Heading (0 to 359.99) in units of 1/100 Degree. See **VALIDITY FLAG** (bytes 30-31). The Compass heading is the magnetic heading of the towfish. If a Gyro sensor is properly interfaced with the Discover Topside Acquisition Unit with a valid NMEA HDT message, this field will contain the Gyro heading relative to True North.	UINT16
174 – 175	Pitch [(degrees / 180.0) * 32768.0] maximum resolution. Positive values indicate bow up. See **VALIDITY FLAG** (bytes 30-31).	INT16
176 – 177	Roll [(degrees / 180.0) * 32768.0] maximum resolution. Positive values indicate port up. See **VALIDITY FLAG** (bytes 30-31).	INT16
178 – 179	Reserved	INT16

Table 2-7: Message Type 80 Orientation Sensor Data Block

Also, the trigger source is determined from this block.

BYTE OFFSETS	DESCRIPTION	SIZE
180 – 181	Reserved	INT16
182 – 183	Trigger Source 0 = Internal 1 = External 2 = Coupled	INT16
184 – 185	Mark Number 0 = No Mark See bytes 16 –17 fields MSB1 for MSBs (Most Significant Bits) for large values (> 655350).	UINT16

Table 2-8: Message Type 80 Trigger Information Block

The following **Position Fix Hour**, **Position Fix Minutes**, and **Position Fix Seconds** fields (bytes 186-193) contain the time of the last position fix. If bit 13 is set (i.e., position interpolated) in the **VALIDITY FLAG** (byte 30-31), this will be the same as the CPU and ping time.

BYTE OFFSETS	DESCRIPTION	SIZE
186 – 187	Position Fix Hour (0 – 23) **NOTE:** the NAV time is the time of the latitude and longitude fix.	INT16
188 – 189	Position Fix Minutes (0 – 59) **NOTE:** the NAV time is the time of the latitude and longitude fix.	INT16
190 – 191	Position Fix Seconds (0 – 59) **NOTE:** the NAV time is the time of the latitude and longitude fix.	INT16
192 – 193	Course in Degrees (0 to 359.9) Starting with the protocol version, 0x0C two digits of fractional degrees are stored in LSB1. The fractional portion is in LSBs (Least Significant Bits). See bytes 18 – 19.	INT16
194 – 195	Speed – in Tenths of a Knot Starting with protocol version 0x0C, one additional digit of fractional knot (1/100) is stored in LSB2. For an additional fractional digit, see LSB2 (bytes 20 -21).	INT16
196 – 197	Position Fix Day (1 – 366)	INT16
198 – 199	Position Fix Year	INT16

Table 2-9: Message Type 80 NMEA Navigation Data Block

BYTE OFFSETS	DESCRIPTION	SIZE
200 – 203	Milliseconds Today (Since Midnight) Use with seconds since 1970 to get time to the milliseconds (time of Ping).	UINT32
204 – 205	Maximum Absolute Value of ADC Samples in this Packet	UINT16
206 – 207	Reserved	INT16
208 – 209	Reserved	INT16
210 – 215	Sonar Software Version Number - ASCII	6 x INT8
216 – 219	Initial Spherical Correction Factor in Samples times 100. A value of -1 indicates that the spherical spreading is disabled.	INT32
220 – 221	Packet Number Each ping starts with packet 1	UINT16
222 – 223	ADC Decimation * 100 times	INT16
224 – 225	Reserved	INT16
226 – 227	Water Temperature in Units of 1/10 Degree C. See **VALIDITY FLAG** (bytes 30-31).	INT16
228 – 231	Layback Distance to the sonar in meters.	FLOAT
232 – 235	Reserved	INT32
236 – 237	Cable Out in Decimeters See **VALIDITY FLAG (**bytes 30-31).	UINT16
238 – 239	Reserved	UINT16

Table 2-10: Message Type 80 Miscellaneous Data Block

Sonar trace data follows the 240-byte header and consists of 16-bit integer values. The number of integers to be read is found by multiplying the number of samples in the trace (bytes 114-115) by the number of integers per sample for the data type used (1 or 2). Furthermore, doubling this yields the byte size of the data section. This should exactly match the preceding Message Header byte count (bytes 12 –15) less the header size of 240.

2.3 Other Messages

There are other messages contained within the JSF file other than acoustic records. For example, there are system and timestamp information messages, and sometimes a padding message is also included. These structures are defined in the following subsections.

2.3.1 Message Type 181: Navigation Offsets

BYTE OFFSETS	DESCRIPTION	SIZE
0-3	X offset in meters	FLOAT
4-7	Y offset in meters	FLOAT
8-11	Latitude Offset in degrees	FLOAT
12-15	Longitude Offset in degrees	FLOAT
16-19	Aft Offset in meters: Forward is negative	FLOAT
20-23	Starboard Offset in meters: Port is negative	FLOAT
24-27	Depth Offset in meters: Up is negative	FLOAT
28-31	Altitude Offset in meters: Down is negative	FLOAT
32-35	Heading Offset in degrees	FLOAT
36-39	Pitch Offset in degrees: Nose up is positive	FLOAT
40-43	Roll Offset in degrees: Port side up is positive	FLOAT
44-47	Yaw Offset in degrees: Toward Port is negative	FLOAT
48-51	Tow point elevation offset (Up is positive)	FLOAT
52-63	Reserved [3]	FLOAT

Table 2-11: Message Type 181: Navigation Offsets

2.3.2 Message Type 182: System Information

The system information message contains details of the system used to acquire data. This message is normally present at the beginning of a JSF file and may be repeated if configuration parameters change.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	System Type	INT32
4 – 7	Low Rate I/O Enabled Option (0 = disabled)	INT32
8 – 11	Version Number of Sonar Software used to Generate Data	INT32
12 – 15	Number of Subsystems Present in this Message	INT32

BYTE OFFSETS	DESCRIPTION	SIZE
16 – 19	Number of Serial Port Devices Present in this Message	INT32
20 – 23	Serial Number of Tow Vehicle used to Collect Data	INT32
24 – End	Reserved	

Table 2-12: Message Type 182 System Information

The System Information Message size is subject to change, as more detailed information may be added in future versions of the software. The byte count in the message header should be used to determine the structure's total size and jump over to the next message in the file.

2.4 Auxiliary Messages

The JSF file may also contain auxiliary data messages from various sensors depending on the configuration. These auxiliary messages are not limited to NMEA strings, attitude records, pressure readings, Doppler Velocity Log (DVL) data, cable counter data, kilometer of pipe information, and container messages. These data blocks are described in the subsections below.

2.4.1 Message Type 2002: NMEA String

An NMEA string consists of a timestamp followed by an ASCII string as read from a GPS, Gyro, or another device. Each message is a single string, excluding the <CR>/<LF>.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8	Source 1 = Sonar 2 = Discover 3 = ETSI	UINT8
9 – 11	Reserved	3 x UINT8
12 – to Message Length	NMEA String Data	Remaining Length x INT8

Table 2-13: Message Type 2002 NMEA String

2.4.2 Message Type 2020: Pitch Roll Data

A pitch roll message consists of a single reading from a pitch roll sensor such as a Seatex MRU, TSS, or OCTANS device. Not all devices provide all data for the defined structure. Use the Validity Flags to determine which fields are populated.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved – Do Not Use	4 x UINT8
12 – 13	Acceleration in X Multiply by (20 * 1.5) / (32768) to get Gs	INT16
14 – 15	Acceleration in Y Multiply by (20 * 1.5) / (32768) to get Gs	INT16
16 – 17	Acceleration in Z Multiply by (20 * 1.5) / (32768) to get Gs	INT16
18 – 19	Rate Gyro in X Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
20 – 21	Rate Gyro in Y Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
22 – 23	Rate Gyro in Z Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
24 – 25	Pitch Multiply by (180.0 / 32768.0) to get Degrees Bow up is positive	INT16
26 – 27	Roll: Multiply by (180.0 / 32768.0) to get Degrees. Port up is positive	INT16
28 – 29	Temperature in Units of 1/10 of a Degree Celsius	INT16
30 – 31	Device-specific info. This is device-specific info provided for diagnostic purposes.	UINT16
32 – 33	Estimated Heave in Millimeters. Positive is down.	INT16
34 – 35	Heading in units of 0.01 Degrees (0…360)	UINT16

BYTE OFFSETS	DESCRIPTION	SIZE
36 – 39	Data Validity Flags Bit 0: Ax Bit 1: Ay Bit 2: Az Bit 3: Rx Bit 4: Ry Bit 5: Rz Bit 6: Pitch Bit 7: Roll Bit 8: Heave Bit 9: Heading Bit 10: Temperature Bit 11: Device Info Bit 12: Yaw	INT32
40 – 41	Yaw in units of 0.01 Degrees (0…360)	INT16
42 – 43	Reserved	INT16

Table 2-14: Message Type 2020 Pitch Roll

2.4.3 Message Type 2060: Pressure Sensor Reading

This message exists in the data stream if a pressure sensor is installed on the sonar system. While pressure sensors may be configured in different units, the default is PSI absolute. Use the Validity Flags to determine which fields are populated.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved – Do Not Use	4 x UINT8
12 – 15	Pressure in Units of 1/1000th of a PSI	INT32
16 – 19	Temperature in Units of 1/1000th of Degree Celsius.	INT32
20 – 23	Salinity in Parts Per Million	INT32

BYTE OFFSETS	DESCRIPTION	SIZE
24 – 27	Validity Data Flag: Bit 0: Pressure Bit 1: Temperature Bit 2: Salt PPM Bit 3: Conductivity Bit 4: Sound velocity Bit 5: Depth	INT32
28 – 31	Conductivity in Micro-Siemens per Centimeter	INT32
32 – 35	Velocity of Sound in Millimeters per Second	INT32
36 – 39	Depth in Meters	INT32
40 – 75	Reserved	9 x INT 32

Table 2-15: Message Type 2060 Pressure Sensor

2.4.4 Message Type 2071: Reflection Coefficient

The refection coefficient message contains details used in the reflection coefficient calculation. There is one 2071 message per ping at most. If the sonar is in dual alternating pulse mode (noted in the standard JSF field's CHANNEL FIELD), each ping for each channel of JSF data gets its own reflection coefficient identified via that channel field.

EdgeTech recommends smoothing the reflection coefficient values because they can be noisy. The values reported in 2071 are unaveraged, giving full control of the averaging scheme to whatever is processing the JSF downstream.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 - 11	Reserved-Do not use	4 x UINT8
12 - 15	pingNumber. The ping number the reflection coefficient that was computed for. Use with the subsystem, channel, and timestamp	UINT32
16 - 19	reflectionCoefficientDecibels. The reflection coefficient in decibels. Good values are between 0 and -40.	FLOAT
20 - 23	altitudeMilliseconds. Altitude in milliseconds where the reflection coefficient was computed.	FLOAT
24 - 27	calibrationGainDecibels. Pulse calibration gain in decibels applied to sonar samples before reflection coefficient calculation.	FLOAT
28 - 31	calibrationReferenceDecibels. The calibration “zero-point’ in	FLOAT
32-End	Reserved	UINT32

Table 2-16: Message Type 2071 Reflection Coefficient

2.4.5 Message Type 2080: Doppler Velocity Log Data (DVL)

This is data from a DVL (if fitted) and often includes velocity and altitude readings. Use the Validity Flag to determine which fields are populated.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved	4 x UINT8
12 – 15	Validity Data Flags: Bit 0: X, Y Velocity Present Bit 1: 0 = Earth Coordinates, 1= Ship coordinates Bit 2: Z (Vertical Velocity) Present Bit 3: X, Y Water Velocity Present Bit 4: Z (Vertical Water Velocity) Present Bit 5: Distance to Bottom Present Bit 6: Heading Present Bit 7: Pitch Present Bit 8: Roll Present Bit 9: Temperature Present Bit 10: Depth Present Bit 11: Salinity Present Bit 12: Sound Velocity Present Bit 31: Error Detected Rest: Reserved, Presently 0	UINT32
16 – 31	Four Integers: distance to bottom in centimeters for up to 4 beams. A value of 0 indicates an invalid or non-existing reading.	4 x INT32
32-33	X Velocity with Respect to the Bottom in millimeters per second. A positive value indicates Starboard or East.	INT16
34 – 35	Y Velocity with Respect to the Bottom in millimeters per second. A positive value indicates Forward or North.	INT16
36 – 37	Z Vertical Velocity with Respect to the Bottom in millimeters per second. A positive value indicates Upward.	INT16
38 – 39	X Velocity with respect to a water layer in millimeters per second. A positive value indicates Starboard or East.	INT16
40 – 41	Y Velocity with respect to a water layer in millimeters per second. A positive value indicates Forward or North.	INT16
42 – 43	Z Vertical Velocity with respect to a water layer in millimeters per second. A positive value indicates Upward.	INT16

BYTE OFFSETS	DESCRIPTION	SIZE
44 – 45	Depth from Depth Sensor in Decimeters	UINT16
46 – 47	Pitch in units of 0.01 of a Degree (-180 to +180). A positive value is Bow Up.	INT16
48 – 49	Roll in units of 0.01 of a Degree (-180 to +180). A positive value is Port Up.	INT16
50 – 51	Heading in units of 0.01 of a Degree (0 to 360)	UINT16
52 – 53	Salinity in 1 Part Per Thousand	UINT16
54 – 55	Temperature in units of 1/100 of a degree Celsius	INT16
56 – 57	Sound Velocity in Meters per Second	INT16
58 – 71	Reserved	7 x INT16

Table 2-17: Message Type 2080 DVL

2.4.6 Message Type 2091: Situation Comprehensive Message (Version 2)

This message contains a device header followed by a data block. The data block is a composite of several motion/position sensors. Use the Validity Flags to determine which fields are populated. The detailed data structure is shown below:

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved	4 x UINT8
12 – 15	Validity Flag: Bit 0: Timestamp Provided by the Source Valid Bit 1: Longitude Valid Bit 2: Latitude Valid Bit 3: Depth Valid Bit 4: Altitude Valid Bit 5: Heave Valid Bit 6: Velocity 1 & 2 Valid Bit 7: Velocity down Valid Bit 8: Pitch Valid Bit 9: Roll Valid Bit 10: Heading Valid Bit 11: Sound Speed Valid Bit 12: Water Temperature Valid Others: Reserved, Presently 0.	UINT32

BYTE OFFSETS	DESCRIPTION	SIZE
16	Velocity12 Directions (Velocity1 and Velocity2 Types): 0 = North and East, 1 = Forward and Starboard, 2 = +45 Degrees Rotated from Forward.	BYTE
17 – 19	Reserved	3 x BYTE
20 – 27	Timestamp (0.01 of a microsecond) Microsecond since 12:00:00 AM GST, January 1, 1970. To get seconds since 1970, divide by 1e7)	UINT64
28 – 35	Latitude in Degree (North is Positive)	DOUBLE
36 – 43	Longitude in Degree (East is Positive)	DOUBLE
44 – 47	Depth in Meter (Below Water Surface)	FLOAT
48 – 51	Altitude in Meter (Above Seafloor)	FLOAT
52 – 55	Heave in Meter (Positive is Down)	FLOAT
56 – 59	Velocity1 in Meters per Second (North Velocity or Forward)	FLOAT
60 – 63	Velocity2 in Meters per Second (East Velocity or Starboard)	FLOAT
64 – 67	Velocity Down in Meter per Second (Down Velocity)	FLOAT
68 – 71	Pitch in Degrees (Bow up is Positive)	FLOAT
72 – 75	Roll in Degrees (Port is Positive)	FLOAT
76 – 79	Heading in Degrees (0 to 359.9)	FLOAT
80 – 83	Sound Speed in Meters per Second	FLOAT
84 – 87	Water Temperature (in Degrees Celsius)	FLOAT
88 – 99	Reserved	3 x FLOAT

Table 2-18: Message Type 2091 Situation Comprehensive

2.4.7 Message Type 2100: Cable Counter Data Message

The cable counter data message is defined by the table below.

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved – Do Not Use	4 x UINT8
12 – 15	Cable Length in Meters	FLOAT
16 – 19	Cable Speed in Meters per Second	FLOAT
20 – 21	Cable Length Valid Flag (0 – Invalid)	INT16

BYTE OFFSETS	DESCRIPTION	SIZE
22 – 23	Cable Speed Valid Flag (0 – Invalid)	INT16
24 – 25	Cable Counter Error (0 – No Error)	INT16
26 – 27	Cable Tension Valid Flag (0 – Invalid)	INT16
28 – 31	Cable Tension in Kilograms	FLOAT

Table 2-19: Message Type 2100 Cable Counter

2.4.8 Message Type 2101: Kilometer of Pipe Data

The kilometer of pipe data message is as follows:

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8	Source 1 = Sonar 2 = DISCOVER 3 = ETSI	BYTE
9 – 11	Reserved	3 x BYTE
12 – 15	Kilometer of Pipe (KP)	FLOAT
16 – 17	Flag (Valid KP Value)	INT16
18 – 19	Flag (KP Report Error)	INT16

Table 2-20: Message Type 2101 Kilometer of Pipe

2.4.9 Message Type 2111: Container Timestamp Message

External entities may generate some messages contained within the JSF file that are passed to the recording system in a message called a Container Message. These messages are only checked to see if their length matches what is specified in the message header; no other type of validation is performed. Essentially, this message contains the receipt timestamp of the container message and should always precede the other desired message (e.g., 2111, then 2060).

BYTE OFFSETS	DESCRIPTION	SIZE
0 – 3	Time in Seconds since 1/1/1970	INT32
4 – 7	Milliseconds in the Current Second	INT32
8 – 11	Reserved	4 x UINT8

Table 2-21: Message Type 2111 Container

2.5 Bathymetric Messages

The JSF file has been extended to support data produced by EdgeTech's bathymetric systems and products. These new extensions, called Bathymetric Data Messages, consist of the 300X family of messages used for the time-stamped bathymetric data and supporting information such as position, motion, heading, etc. This document describes this set of messages and defines the essential calculations used by the bathymetry system.

Please note, in October of 2015, the 3005, or **StatusMessageType**, message was added to the JSF data stream to incorporate RTK Tide and GPS status information. Please see **2.5.6 MESSAGE TYPE 3005: STATUSMESSAGETYPE** for more information.

2.5.1 Message Type 3000: Bathymetric Data Message

Message ID: 3000

BathymetricDataMessageType is a source for bathymetry data.

This is the primary message sent from the bathymetry system. For each ping, there is one message for the port side and one for the starboard side. This message contains the *time delay*, *angle,* and *amplitude* of each assumed seafloor echo. Multiple messages of this type are interspersed throughout the data file or data stream. This message consists of a header, followed by the number of bathymetric samples (*numberOfSamples*), one corresponding to each sounding point.

2.5.1.1 Header Description

Use this data to derive the raw *X* and *Z* data samples before any motion correction. The header contains information static to each ping as follows:

BYTE OFFSET	DATA FIELD DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-11	Ping Number		UINT32
12-13	Number of BathymetricSampleType Entries		UINT16
14	Channel (0 – port, 1 – starboard)		Byte
15	Algorithm Type		Byte
16	Number of Pulses		Byte
17	Pulse Phase		Byte
18-19	Pulse Length	Milliseconds	UINT16
20-23	Transmit Pulse Amplitude (0 to 1)		FLOAT
24-27	Chirp Start Frequency	Hertz	FLOAT

BYTE OFFSET	DATA FIELD DESCRIPTION	UNITS	SIZE
28-31	Chirp End Frequency	Hertz	FLOAT
32-35	Mixer Frequency	Hertz	FLOAT
36-39	Sample Rate	Hertz	FLOAT
40-43	Offset to First Sample	Nanoseconds	UINT32
44-47	Time Delay Uncertainty	Seconds	FLOAT
48-51	Time Scale Factor	Seconds	FLOAT
52-55	Time Scale Accuracy	Percent	FLOAT
56-59	Angle Scale Factor	Degrees	UINT32
60-63	Reserved		UINT32
64-67	Time to First Bottom Return	Nanoseconds	UINT32
68	Format Revision Level (0 to 5)		Byte
69	Binning Flag (0 to 2)		Byte
70	TVG	dB/100m	Byte
71	Reserved		Byte
72-75	Span	Meters or Degrees	FLOAT
76-79	Bin Size	Meters or Degrees	FLOAT

Table 2-22: Header Description

NOTES:

- *As of May 2014, bytes 18-19, 44-47, 60-63, and 70 have been modified.*
- *If the unit field is empty, then that parameter is unitless.*
- *The TVG field (byte 70) is the value that has been applied to the bathymetry datagrams during data collection. This TVG does not apply to the side scan records.*
- *Bin Size field (byte 76-79). If output binning = 1, bin size (in meters). If output binning = 2, beam width (in degrees).*

2.5.1.2 Data Fields

Several data fields are contained within a 3000 message that needs to be interpreted to understand the bathymetric format. This section describes each.

2.5.1.2.1 Uncertainty Estimates

Each bathymetric measurement is composed of a vector from the sonar to a measurement point on the seafloor. The vector is defined by the time (and hence range) at which the measurement is made and the received angle relative to the nadir of the acoustic return at that instant. Each of these components (the range and angle) has some finite measurement uncertainty. The sonar captures these measurement values and provides an estimate for each.

The *Time Delay Uncertainty Estimate* (bytes 44-47) is the potential acoustic uncertainty of the true delay of each detected echo. This field is used to compute the range uncertainty, in meters, for each sample in the data packet and is expressed at the 2-sigma level. For more information, see SECTION 2.5.1.4.3.

The *Angle Uncertainty* is also computed and reported for each sounding. For more information, see SECTION 2.5.1.4.6.

2.5.1.2.2 Format Revision Level

The *Format Revision Level* (byte 68) may have a value between 0 and 5. The revision number affects the interpretation of the data fields listed in TABLE 2-21 and the N x 4 sample sets described in subsection 2.5.1.3 and includes the additional information for binned data. Revisions 0 through 2 only provide information for interferometric data, whereas Revisions 3 and 4 support the interferometric and pseudo multibeam data formats. Even though the latest *Format Revision Level* supports interferometric output, it is rarely used and should not be implemented unless necessary.

The latest *Format Revision Level* is 5 that is described in subsection 2.5.1.3.

2.5.1.2.3 Binning Flag

The *Binning Flag* (byte 69) specifies the type of binning output and may have a value between 0 and 2. A value of 0 indicates that no binning has been carried out. The data output is purely interferometric. A value of 1 indicates the data have been binned based on a user-defined equidistant across-track bin size to produce multibeam-like data. A value of 2 indicates that the data have been binned based on a user-defined equiangular beam size to create an alternate form of multibeam-like data.

When this binning process is carried out, the data is filtered (or cleaned of outliers) as much as possible before binning so that each local estimate is not corrupted by surface or wake artifacts. As opposed to an average, a median estimate is also used to reduce the effects of outliers on the local estimates.

As of July 2014, the Discover Bathymetric Acquisition Software no longer supports the interferometric output, and only binned data are provided. This change affects the *Flag Interpretation Fields* described in subsection 2.5.1.4.7.

2.5.1.2.4 Span

Span (bytes 72-75, TABLE 2-22) states the number of samples returned per side, per ping. This parameter can be specified in meters or degrees and depends on the binning type selected in byte 69.

The correlation between *Binning* and *Span* is defined below.

If *Binning* = 0, then *Span* =	Maximum processing range defined in the bathymetric processing parameters (in meters).
If *Binning* = 1, then *Span* =	Number of bins x bin size (in meters).
If *Binning* = 2, then *Span* =	Number of beams x beam size (in degrees).

Therefore, the final data set would be computed as *Span* x 2.

2.5.1.3 Format Revision Level 4 or higher

Following the **BathymetricDataMessageType** header (or 3000 message header) are N sample sets (N being derived from bytes 12 – 13, appropriately labeled *numberOfSamples*), with each having the 16-bit integer fields described below. Note the third set of 16 bits is broken down into the amplitude and angle uncertainty fields, whereas the last 16 bits compose the flag, SNR, and quality components.

BYTE OFFSET	DESCRIPTION	UNITS	BITS
	Time Delay	See Time Scale Factor (TABLE 2-22, Bytes 48-51)	UINT16
	Angle	See Angle Scale Factor (TABLE 2-22., Bytes 56-59)	INT16
	Amplitude	dB	Byte
	Angle Uncertainty	Degrees, 2-sigma level	Byte
	Flag	N/A	Byte
0-4	SNR	dB	5, unsigned
5-7	Quality	Percent	3, unsigned

Table 2-23: Format Revision Level 4 or Higher

> **CAUTION:** *Use the angle as a signed value! Please refer to sub-section **2.5.1.4.4** for further information.*

2.5.1.4 Essential Calculations / Definitions

The following calculations and definitions are essential to understanding and using the Bathymetric Message format:

2.5.1.4.1 Echo Time

The Echo Time is the total time it takes to receive an echo from the seafloor in seconds:

$$EchoTime = \left(\frac{timeToFirstSample}{1 \times 10^9} + (time\_delay \times timeScaleFactor) \right)$$

Equation 2-2: Echo Time Equation

2.5.1.4.2 Nominal Slant Range to Echo

The Slant Range to Echo is the slant range to each sample, in meters:

$$Slant\ Range = \left(\frac{soundVelocity}{2} \right) \times EchoTime$$

Equation 2-3: Nominal Slant Range to Eco Equation

Where *soundVelocity* must be in meters per second and should be acquired from the 3002 message, or **PressureMessageType**, described in **2.5.3 MESSAGE TYPE 3002: PRESSUREMESSAGETYPE**.

2.5.1.4.3 Range Uncertainty Estimate

The Range Uncertainty Estimate is the potential acoustic uncertainty of the range for each sample in the data packet. It is specified in meters at the 2-sigma level.

$$2\sigma_R = \left(\frac{soundVelocity}{2} \right) \times timeDelayUncertainty$$

Equation 2-4: Range Uncertainty Equation

2.5.1.4.4 The angle from Nadir for Each Sample

Angles, reported in degrees, are measured positive from Nadir of the Sonar Head and increase outwards from both port and starboard. If data for a specific channel, such as for the port side, falls behind Nadir, then these correspond to negative angles.

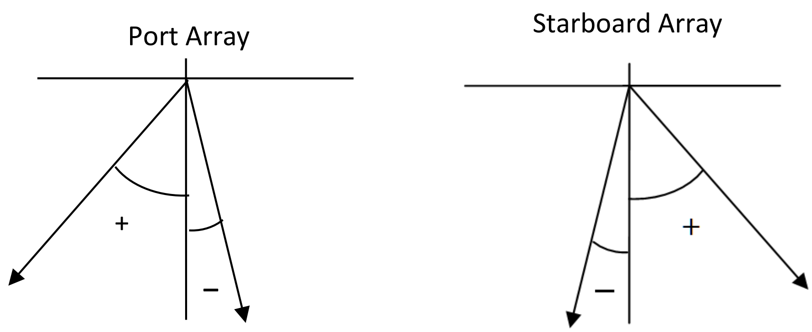

Figure 2-1: Angles per side, as reported from Nadir

When both port and starboard data sets are computed and rendered together in the same frame of reference, negative angles are plotted on the port side, and positive angles are plotted on the starboard side. This relationship is defined by the equation below, where *Channel* = 0 for port or 1 for starboard.

$$AngleFromNadir = (-1)^{(Channel+1)} \times angle \times angleScale\ Factor$$

Equation 2-5: Angle from Nadir Equation

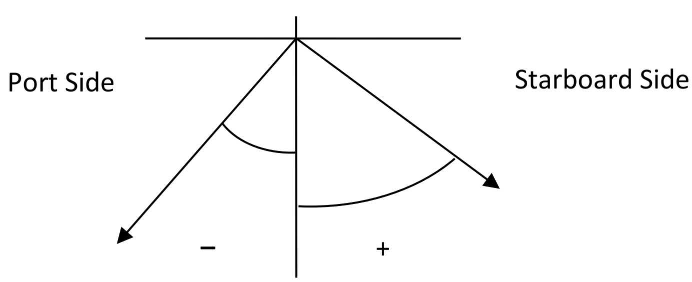

Figure 2-2: Angles displayed as a single reference frame

2.5.1.4.5 Amplitude

Amplitude is a fundamental attribute used to trim invalid data points from the final data set and primarily excludes weak echoes, such as the water column or very weak backscatter, based on some minimum threshold. Typically, good seafloor echoes are above 25 dB to 30 dB depending on bottom type; values less than 20 dB are typically not bottom echoes (i.e., noise).

The system's data points can have an amplitude value between 0 – 127.5dB and are reported in 0.5dB increments.

2.5.1.4.6 Angle Uncertainty Estimate

The Angle Uncertainty Estimate is reported at the 2-sigma level and can vary between 0 and 5.1 degrees, reported in 0.02-degree increments. Any angle uncertainty larger than 5.1 degrees is clamped to 5.1 degrees.

2.5.1.4.7 Flag Interpretation

These flags are used for data cleaning and, if set to 1, indicate data deemed invalid points by the processing algorithm. A description of these flags is listed below.

> **NOTE:** *As of July 2014, Discover Bathymetric Acquisition Software no longer supports the interferometric output. Therefore bits 0 through 4 can be safely disregarded unless parsing interferometric data is required.*
>
> *Bit 5, however, is essential to interpreting the binned data correctly (Binning Flag = 1 or 2). If it is not, then there will be a false sounding reported at the sonar head's location (0, 0).*

Bit 0: *Outlier Removal Flag* – if set, the processing algorithm deems these data points as having excessive deviations from the norm.

Bit 1: *Water Column Flag* – if set, the processing algorithm deems these data points as part of the water column and are not used in determining the seafloor estimates.

Bit 2: *Amplitude* – if set, the processing algorithm deems these data points as invalid based on the calculated threshold. This fundamental attribute is used primarily to exclude weak echo points, such as the water column returns and very weak backscatter amplitudes.

Bit 3: *Quality* – if set, the processing algorithm deems these data points as invalid based on angle uncertainty. This filter is used to eliminate points whose phase differences are greater than some specified tolerance.

Bit 4: *SNR* – if set, the processing algorithm deems these data points as invalid based on the SNR. This filter is very useful in trimming data points, where the angle estimation quality is low due to noise and multipath effects.

Bit 5: *Null Content Binned Data* – if set, the binned data contains null content and should be excluded from all processing (i.e., if the total across-track extent is too large for the depth, then some bins may be empty and will be deemed as null). This bit is only valid when the data are binned. (*See caution on the following page.)*

Bit 6 - 7: *Reserved*

CAUTION: *Null bins may or may not have null or 0 values for the* ***Time Delay****,* ***Angle****, or* ***Amplitude*** *fields in* **TABLE 2-22. ***Bit 5 must be used and is essential in removing invalid data points.*

2.5.1.4.8 Coherent SNR

Coherent SNR is a useful statistic used to trim invalid data points where the angle noise is high due to multipath effects. When estimating the primary (largest amplitude) angle of arrival, the process also returns an estimate of the power in this angle. This power is compared to the signal's total power at that instant, so a coherent Signal (primary echo) to Noise (noise plus all multipath echoes) can be estimated. In practice, the true noise component of this is very small over the useful range of the bathymetry data and is almost all due to multipath interference echoes.

SNR values greater than 20dB are excellent in terms of angle estimation quality, while less than 10dB are quite poor. Useful thresholds are between 10-20 dB, depending on the desire to have maximum swath (more noise) or lower noise and narrower swath widths.

This metric is described by a 5-bit value that ranges between 0 and 31dB in 1dB increments. Any value higher than 31dB is limited to 31dB.

2.5.1.4.9 EdgeTech Bathymetric Quality Factor

The EdgeTech Bathymetric Quality Factor is a metric used to identify how well the interstave phase measurements agree. The array used to determine the angles has 10 x ½ wavelength spaced elements. This allows the estimation of 9 interstave phase estimates. These would all agree in the ideal case (no errors, no noise, no interfering multipath). In practice, this is not the case, and interstave phases may either agree quite well (+/- 5 – 10 degrees) or not at all (up to +/- 90 deg). This metric is described by a 3-bit value and has been broken down into 8 discrete numbers associated with each:

0 – quality < 50%
1 – 50% <= quality < 60%
2 – 60% <= quality < 70%
3 – 70% <= quality < 75%
4 – 75% <= quality < 80%
5 – 80% <= quality < 85%
6 – 85% <= quality < 90%
7 – 90% <= quality

> **NOTE:** *Data with a Quality Factor of less than 50% should be discarded in most cases. High-quality data is anything above 70-80%. The quality factor can be set quite high (90%) in most cases, especially when the seafloor is very flat.*

2.5.1.4.10 Nadir Depth (or Depth below Sounder)

The system incorporates a single beam echo sounder mode with a 15-degree beamwidth. This depth is reported for each ping and is independent of any bathymetric calculations or principles (see **2.5.4 MESSAGE TYPE 3003: ALTITUDEMESSAGETYPE**). The value is specified in meters and is defined as:

$$DepthBelowSounder = \left(\frac{soundVelocity}{2}\right) \times timeToFirstBottomreturn$$

Equation 2-6: Depth Below Sounder (Nadir Depth) Equation

Where *soundVelocity* must be in meters per second and acquired from the 3002 message, or **PressureMessageType** described in **2.5.3 MESSAGE TYPE 3002: PRESSUREMESSAGETYPE**.

This parameter is used in the calculation for the *Water Column Filter*. This filtering metric is useful at trimming the water column data but may also trim data from close-up targets such as dock walls, sharp banks, etc., so caution should be taken when surveying next to steep slopes. This filter can also be turned off when the water column filter is too aggressive or if it is desired to retain objects in the water column, such as a mast of a shipwreck.

2.5.1.4.11 Seafloor Samples

The seafloor samples are computed as raw *X* and *Z* values, reported in meters, and are calculated as:

$$x = SlantRange \times sin(AngleFromNadir)$$

Equation 2-7: Raw X Seafloor Sample Value Equation

$$z = SlantRange \times cos(AngleFromNadir)$$

Equation 2-8: Raw Z Seafloor Sample Value Equation

Once these data points are rendered, a median filter is run over the data to exclude data points whose *Z* values deviate significantly from the local median value. This filter, known as the *Outlier Removal Filter*, is effective when equidistant across-track binning is used. However, it is not used when equiangle binning is implemented, allowing large vertical structures to be retained.

2.5.1.4.12 Binning

Currently, there are two types of binning schemes the processor can utilize.

The first scheme uses equidistant sections and does a good job of plotting most seafloor topographies. The user must only specify the bin size, whereas the *Discover Bathymetric Software* automatically calculates the other two parameters. The maximum number of bins is 800. This relationship is defined below.

$$TotalSwath = NumberOfBins \times BinSize$$

Equation 2-9: Binning Total Swath Equation

This method, however, cannot plot vertical objects very well, as it inherently collapses the data within a single bin.

The second scheme uses equiangular bins and is very useful at plotting vertical objects. The user only should specify the bin (or beam) size. The total field of view is set to a constant 200 deg, and the maximum number of bins is 800. This relationship is described below.

$$200^{\circ} = NumberOfBeams \times BeamSize$$

Equation 2-10: Binning Total Swath Equation for Vertical Objects

This method, however, does not provide an evenly distributed seafloor profile like the equidistant method described above. Instead, it provides dense soundings near the nadir and fewer soundings as the angle increases from the nadir, which could result in poor object detection at the extremities.

2.5.2 Message Type 3001: AttitudeMessageType

Message ID: 3001

AttitudeMessageType is a source for roll, pitch, heave, and heading data. Yaw is not used. Some or all these fields may be valid (or set to 1) depending on which type of sensor or sensors are used.

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-11	Data Valid Flag Bit 0: Heading Bit 1: Heave Bit 2: Pitch Bit 3: Roll Bit 4: Yaw	0 – clear, 1 – set	UINT32
12-15	Heading (0 to 359.9)	Degrees	FLOAT
16-19	Heave	Meters	FLOAT
20-23	Pitch	Degrees	FLOAT
24-27	Roll	Degrees	FLOAT
28-31	Yaw	Degrees	FLOAT

Table 2-24: AttitudeMessageType

The EdgeTech convention is:

- **Roll** is positive port up
- **Pitch** is positive bow up
- **Heave** is positive down
- **Yaw** is positive to starboard

The validity of each field is indicated in the *Data Valid Flag* (bytes 8-11). This must be used to parse the fields correctly. The populated fields depend on the device used in conjunction with the sonar system supplying the data.

Since each message has a single unique timestamp, only one input string (or message) supplied from the incorporated device is in this message at any one time. Unused fields are flagged as such (or set to 0) in the *Data Valid Flag* (see examples below).

The timestamp accuracy of this message with respect to the sonar ping emission time is approximately one millisecond at 80% and two milliseconds at 100% of the samples.

2.5.2.1 Example 1

The data source is a TSS CMS attitude sensor and supplies roll, pitch, and heave over a single message (i.e., TSS1). The sensor does not supply yaw or heading. The *Data Valid Flag* would be:

Bit 0: heading = 0
Bit 1: heave = 1
Bit 2: pitch = 1
Bit 3: roll = 1
Bit 4: yaw = 0

2.5.2.2 Example 2

The data source is an OCTANS Inertial Navigation System (INS), and supplies roll, pitch, heave, and heading in a single message. The sensor does not supply yaw. The *Data Valid Flag* would be populated as follows:

Data Valid Flags:
Bit 0: heading = 1
Bit 1: heave = 1
Bit 2: pitch = 1
Bit 3: roll = 1
Bit 4: yaw = 0

2.5.3 Message Type 3002: PressureMessageType

Message ID: 3002

PressureMessageType is a source for sound velocity and possibly water temperature, salinity, conductivity, and depth.

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-11	Data Valid Flag Bit 0: Pressure Bit 1: Water Temperature Bit 2: Salinity Bit 3: Conductivity Bit 4: Sound Velocity Bit 5: Depth	0 – clear, 1 – set	UINT32
12-15	Absolute Pressure	PSI	FLOAT
16-19	Water Temperature	Degrees	FLOAT

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
20-23	Salinity (PPM)	Parts/Million	FLOAT
24-27	Conductivity	Degrees	FLOAT
28-31	Sound Velocity	Meters/Second	FLOAT
32-35	Depth	Meters	FLOAT

Table 2-25: PressureMessageType

Only subsea platforms (such as ROV, ROTV, and AUV applications) will have a valid *Depth* field (bytes 32-35) provided by the platform's depth or pressure sensor.

The *Sound Velocity* (bytes 28-31) is the sound velocity measured at the sonar head and must be used when calculating *Slant Range* in Message ID 3000 or **BATHYMETRICDATAMESSAGETYPE**.

The timestamp accuracy is 20 milliseconds or better.

The validity of each field is determined as in **2.5.2 MESSAGE TYPE 3001: ATTITUDEMESSAGETYPE**. Unused fields are flagged as such (or set to 0) in the *Data Valid Flag* (bytes 8-11).

2.5.4 Message Type 3003: AltitudeMessageType

Message ID: 3003

AltitudeMessageType is a source for altitude and possibly speed and heading.

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-11	Data Valid Flag Bit 0: Altitude Bit 1: Speed Bit 2: Heading	0 – clear, 1 – set	UINT32
12-15	Altitude	Meters	FLOAT
16-19	Speed	Knots	FLOAT
20-23	Heading (0 to 359.9)	Degrees	FLOAT

Table 2-26: AltitudeMessageType

This *Altitude* parameter (bytes 12-15) is reported for each ping and is the value computed from the *Depth Below Sounder* (2.5.1.4.10). This field will always be valid and should be added to the depth field (if available) from Message ID 3002, or **PRESSUREMESSAGETYPE**, to calculate the total water depth.

For *Speed* (bytes 16-19) and *Heading* (bytes 20-23), the *Data Valid Flag* (bytes 8-11) should be tested to determine if these fields are usable (or set to 1). The validity of these fields depends on what devices are connected to the sonar system. For example, if there is a device connected to the sonar which supplies heading only (such as a gyroscope), this heading field would be valid.

Again, the validity of each field is determined as in **2.5.2 MESSAGE TYPE 3001: ATTITUDEMESSAGETYPE**. Unused fields are flagged as such (or set to 0) in the *Data Valid Flag*.

2.5.5 Message Type 3004: PositionMessageType

Message ID: 3004

PositionMessageType is a source for position (latitude/longitude), heading, speed, and antenna altitude. UTM Zone, Easting, and Northing fields are not typically used.

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-9	Data Valid Flag Bit 0: UTM Zone Bit 1: Easting Bit 2: Northing Bit 3: Latitude Bit 4: Longitude Bit 5: Speed Bit 6: Heading Bit 7: Antenna Height	0 – clear, 1 – set	UINT16
10-11	UTM Zone		UINT16
12-19	Easting	Meters	DOUBLE
20-27	Northing	Meters	DOUBLE
28-35	Latitude	Degrees	DOUBLE
36-43	Longitude	Degrees	DOUBLE
44-47	Speed	Knots	FLOAT
48-51	Heading (0 to 359.9)	Degrees	FLOAT
52-55	Antenna Height	Meters	FLOAT

Table 2-27: PositionMessageType

The EdgeTech convention is:

- **Latitude** is positive North
- **Longitude** is positive East
- **Heading** is always positive
- **Antenna Height** is positive up

The *Data Valid Flag* (bytes 8-9) must be tested for the presence or absence of data in each field. If a GPS device is connected and it is a dual antenna system supplying heading, then the *Heading* field (bytes 48-51) is also valid (or set to 1).

Antenna Height, or ellipsoid height (bytes 52-55), may or may not be populated and depends on the GPS device connected. The validity of each field is determined as in section **2.5.2 MESSAGE TYPE 3001: ATTITUDEMESSAGETYPE**. Unused fields are flagged as such (or set to 0) in the *Data Valid Flag*.

2.5.6 Message Type 3005: StatusMessageType

Message ID: 3005

StatusMessageType is a source of GPS status and quality (i.e., fixed, float, DGPS, etc.). The status includes information such as the Number of Satellites and Horizontal Dilution of Precision. Its numerical code gives the quality indicator in the incoming GPS message. EdgeTech reads these status codes and indicates which message structure provided the information. Currently, there are only two sources that can provide the necessary status information: GGA or GGK.

> **NOTE:** *The Talker ID for the incoming GPS messages does not matter (e.g., $GPGGA, $PTNL,GGK, $INGGK, $GPGGK, etc.)*

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-3	Time Since 1/1/1970	Seconds	UINT32
4-7	Nanosecond Supplement to Time	Nanoseconds	UINT32
8-9	Data Valid Flag Bit 0: GGA Status Bit 1: GGK Status Bit 2: Number of Satellites Bit 3: Dilution of Precision	0 – clear, 1 – set	UINT16
10	Version		Byte
11	GGA Status		Byte
12	GGK Status		Byte

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
13	Number of Satellites		Byte
14-15	Reserved		Byte
16-19	Dilution of Precision	Meters	FLOAT
20-63	Reserved		11 X UINT32

Table 2-28: StatusMessageType

The *Data Valid Flag* must be tested for the presence or absence of data in each field. The validity of each field is determined as in **2.5.2 MESSAGE TYPE 3001: ATTITUDEMESSAGETYPE**. Unused fields are flagged as such (or set to 0) in the *Data Valid Flag*.

2.5.7 Message Type 3041: BathymetricParameterPublicMessageType

Message ID: 3041

BathymetricParameterPublicMessageType reports bathymetric processing parameters.

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
0-1	Bathymetric Processing 0: Off 1: Stave's Original Algorithm 2: Faster Algorithm		UINT16
2-3	Processing Flags Bit 0: Invert Heave Sign Bit 1: Reserved Bit 2: Reserved Bit 3: Ignore NMEA time (0: NMEA time,1: Ignore NMEA time) Bit 4: Altitude method (0: track bottom,1: manual) Bit 5: Auto amplitude (0: disable,1: enable)		UINT16
4-11	Installation Angle Byte 4 – 7: Port installation angle Byte 8 - 11: Starboard installation angle	Degrees	2 X FLOAT
12-15	Maximum Processing Range (0 – 350)	Meters	FLOAT
16-19	Minimum Processing Range (0 – 100)	Meters	FLOAT
20-23	Maximum Altitude (0 – 350)	Meters	FLOAT
24-27	Minimum Altitude (0 – 100)	Meters	FLOAT

BYTE OFFSET	DESCRIPTION	UNITS	SIZE
28-31	Manual Altitude	Meters	FLOAT
32-33	Array Elements Byte 32: Number of port array elements Byte 33: Number of starboard elements		2 X UINT8
34-35	Mounting Direction Byte 34: Mounting direction of the port array Byte 35: Mounting direction of starboard array		2 X UINT8
36-43	Installation Horizontal Offset Byte 36-39: Port array [0.0-10.0] Byte 40-43: Starboard array [0.0-10.0]	Meter	2 X FLOAT
44-47	Auto Amplitude Sensitivity Threshold [0.5-5.0]		FLOAT
48-51	Multi-Path Suppression Level Suppression Level: 1,3 & 5		UINT32
52-55	Covariance Max Region Size Max size [0.0-10.0]	Meter	FLOAT
56-59	Amplitude Threshold Rang: [0-1000]		UINT32
60-63	Minimum Quality Factor Range: [0.0 – 1.0]		FLOAT
64-67	Maximum Output Angle Range: [0.0 – 120.0]	Degree	FLOAT
68-71	Decimation Factor Range: [1 – 100]		UINT32
72	Altitude Data Source 0: Array selector port 1: Array selector starboard 3: Array selector sum 4: Array selector product 5: Array selector minimum		Unsigned Char
73	TVG		UINT8
74	Max TVG		UINT8
75	SNR Threshold Range: [0-40] dB		UINTT8

Table 2-29: BathymetricParameterPublicMessageType