GENERIC SENSOR FORMAT SPECIFICATION

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Generic Sensor Format Specification

REVISIONS			
Rev	**Date**	**Pages Affected**	**Remarks**
0	30 SEP 93	All	Initial Draft Version.
A	31 MAR 94	All	Final Draft Version.
B	30 JAN 95	All	Released as Draft MIL-STD-2415
C	29 JUL 96	All	Sequential encapsulation updated to reflect changes due to implementation of software version GSF-v1.02.
D	04 SEP 98	All	No longer designated as Draft. Changes as follows: • Updated specification to reflect changes due to implementations through GSF-v1.06. • Removed the direct access encapsulation (GSF/DA) from the specification, leaving only the sequential encapsulation. • Restricted all time fields in a data file to use precise time. All data currently conforms to this restriction. This change in effect codifies a restriction imposed by the use of the library as part of the standard. • Reformatted the document into Word 6.0(95) format. Updated all figures into Windows metafile format (WMF). • Limited editing resulting in spelling, grammatical and a few technical changes. • Changed the header numbering sequence from 1.1.1.a (1) to 1.1.1.1.1. • Split table 2 (GSF/S Record Definitions) into a separate table for each record. Added references for POSIX 1003.1 and GSF Library documentation.
E	12 NOV 98	All	Changes as follows: • Updated specification to reflect changes due to implementations through GSF-v1.07. • Modified the gsfPrintError function to call the gsfStringError function. • Defined a new GSF navigation error record that replaces the currently defined navigation error record. • Defined a new horizontal navigation error record that contains a text field describing the positioning system type. • Modified gsf_enc.c to encode the existing error array subrecords (depth_error, across_track_error and

			along_track_error) as two byte quantities. • Added two new array subrecords, horizontal error and vertical error, to the GSF swath bathymetry ping data structure,
F	07 OCT 99	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v1.08. • Updated the description of the beam angle forward array and the beam angle array subrecords. • Updated Appendix A.2 Swath Bathymetry Ping Subrecord Identifier Definition to reflect additions of EM3000_SPECIFIC, EM1002_SPECIFIC, EM300_SPECIFIC and CMP_SASS_SPECIFIC subrecord identifiers • Added Swath Bathymetry Ping Sensor-specific Subrecord Definitions for the SIMRAD EM3000 series sonar, Compressed SASS data, and TypeIII SASS data
G	12 OCT 99	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v1.09. • Modified Swath Bathymetry Ping Sensor-specific Subrecord Definition for the Compressed SASS data format.
H	20 OCT 00	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v1.10.
I	16 JAN 01	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v1.11.
J	03 APR 02	A-3	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v2.0. Reserved sensor specific subrecord IDs for Reson 81P series 8101, 8111, 8125, 8150, and 8160 sonar systems. Added sensor specific subrecord ID and subrecord definition for Simrad EM120
K	08 JUL 02	All	Changes as follows: Updated specifications to reflect changes due to implementations through GSF-v2.01.
L	20 JUN 03	All	Changes as follows:

			• Updated specifications to reflect changes due to implementations through GSF-v2.02, including updates for multibeam imagery per bathymetric receive beam
M	29 DEC 04	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v2.03.
N	30 JUN 06	All	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v2.04.
O	09 MAR 07	Various	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v2.05.
P	04 SEP 07	Various	Changes as follows: • Updated specifications to reflect changes due to implementations through GSF-v2.07.
Q	04 Dec 07	None	No changes to the text for GSFv2.08
R	30 Jan 08	Various	Changes as follows: • Added Swath Bathymetry Ping Subrecord Identifier for Klein 5410 Bathymetric Sidescan. • Added Swath Bathymetry Ping Subrecord for Klein 5410 Bathymetric Sidescan. • Added Bathymetric Receive Beam Imagery Sensor-specific Subrecord for Klein 5410 Bathymetric Sidescan.

1. INTRODUCTION

1.1 Purpose

This report documents a Generic Sensor Format (GSF) for use as an exchange format in the Department of Defense Bathymetric Library (DoDBL), one of three DoDBL processing formats. Similar formats are under development for the interchange of vector data, such as hydrographic soundings and features; and raster data, such as gridded bathymetry and processed acoustic imagery.

This standard focuses on the encoding of multibeam data, the highest priority for the DoDBL. It is also designed to be expandable to encode unprocessed acoustic imagery as those Defense Hydrographic Initiative (DHI) requirements become clearer. It is intended for coordination among the DoDBL nodes - the Defense Mapping Agency (DMA), the Naval Oceanographic Office (NAVOCEANO), the National Ocean Service (NOS), and the National Geophysical Data Center (NGDC), as well as academia and industry to collect data and design systems that use GSF.

1.2 Background

GSF is designed to efficiently store and exchange information produced by geophysical measurement systems before it has been processed into either vector or raster form. A sensor data set contains all the information needed to compute the depth or other values at a specific geographic position, but that calculation has not yet been made. This structure is particularly useful for data sets created by systems such as multibeam sounders that collect a large quantity of data from a single location and initially express geographic positions in relative terms. GSF not only saves storage space and reduces data transfer volumes, it also provides the receiver with critical information that may be lost when processing the oversampled data to either raster or vector form.

The current use of GSF is to define data from bathymetric surveying systems; however, this is only one of a class of sensors that GSF can support. Acoustic imagery, seismic reflection profiles, swept-frequency (chirp) sub-bottom imagery are other classes of data that may be incorporated into the DoDBL but cannot be efficiently stored in either vector or raster form.

This draft standard implementation was based on earlier work at the University of Rhode Island supported by DHI and other work at the Naval Research Laboratory (NRL). This paper does not present the rationale for this implementation. The rationale is based on two earlier papers, which describe the overall rationale and approach (Ferguson and Chayes, 1992 and 1995) and on extensive discussions with Mssrs. deMoustier and Charters at Scripps Institute of Oceanography.

1.3 DoDBL overview

The DoDBL is a distributed library of bathymetric and hydrographic data (note: the Hydrographic Source Assessment System (HYSAS) documentation uses these terms interchangeably). The data, which are acquired and archived by organizations in the Department of Defense (DoD) and the Department of Commerce National Oceanic and Atmospheric Administration (NOAA), may be stored in many different structures and formats. The intent of this specification is to ease data exchange among the nodes by standardizing the format for sensor data files, including unprocessed bathymetry and acoustic imagery. The two other general types of data in the DoDBL: vector (which includes single-beam soundings) and raster (which includes gridded bathymetry and rectified acoustic imagery) use similar specifications. GSF is also intended for data transfer between collection platforms and their respective DoDBL node.

There are many sources for DoDBL data sets. The GSF deals primarily with multibeam (swath) and acoustic imagery data sets that are collected by both DoD and non-DoD survey ships.

1.3.1 Usage of GSF outside of DoDBL

This specification describes the form of data being exchanged within the DoDBL. The format described in this specification is intended, however, to be of use outside the DoDBL. Using this format will increase the efficiency of data transfer between the agency's internal archive and the DoDBL and, perhaps, between agencies without direct access to the DoDBL. For use of this specification outside the DoDBL, Transmittal files and Metadata files are optional, although their use is encouraged. Many of the elements of the Metadata file may be most accurately described immediately after the data have been collected. From the moment the data are collected, adoption of the Metadata file as a method of maintaining important descriptive information can significantly enhance the data's long-term usability.

1.4 Goals

GSF is designed to be modular and adaptable to meet the unique requirements of a variety of sensors. The goals of the Generic Sensor Format are:

- Portability among all major computing platforms.
- Extensibility so that new types of data and measurements can be easily incorporated.
- Efficiency in terms of storage volume and data access.
- Endorsement by the major groups of users *outside* the DoDBL.
- Consistency with other DoDBL formats.

1.4.1 Portability

Portability among the various computing platforms that will collect, process, and store data in GSF is critical. Adequate data description and the exclusive use of industry, national and international standards for data encoding ensure portability in this standard. Where practical, GSF is consistent with industry standards for network exchange. This will reduce the time for some systems once the DoDBL nodes are fully networked.

1.4.2 Extensibility

Because of the rapid state of development in sensor systems, it is very important to provide a mechanism for planned growth and evolution. Increasing sophistication of the sensor systems and signal processing techniques have increased the information extracted from a single ping. It is essential that GSF allow for expansion to prevent early obsolescence of the format. GSF achieves extensibility through modular structure and self-description.

New data elements can be specified for new data records and these records can be introduced into a data stream without forcing all programs that may read them to be modified. These features taken together allow different network implementations to coexist on the same data path and are partly responsible for the popularity and success of the Ethernet transport protocol. By adopting a similar approach, GSF has been equipped with a mechanism for gradual change that should help ensure its long-term usefulness.

1.4.3 Efficiency

To enhance storage efficiency, GSF makes extensive use of binary encoding. Most data elements within GSF are numeric, and it is estimated that the use of standard binary 2- and 4-byte big endian (most significant byte first) integers reduces storage volume by 40-50%. The self-defining header schema and time-tagged records allow efficient data access.

1.4.4 Acceptance

The development of this specification incorporated inputs from many different segments of the swath mapping community. Representatives of commercial, academic and federal agencies all provided valuable feedback during the definition of this specification.

1.4.5 Consistency

This draft standard is consistent with the other standards to be used in the DoDBL. It has a common Transmittal Header File to allow rapid identification by the receiver, and common Metadata elements to provide the standard DHI ancillary information about the data set. It also uses big endian binary like the proposed Raster Data Exchange Standard (RDES) to obviate the need to develop unique utilities.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards, and handbooks

The following specifications, standards, and handbooks form a part of this document to the extent listed below. Unless otherwise specified, the issues of these documents are those listed in the current Department of Defense Index of Specifications and Standards (DODISS) and the supplement thereto.

MILITARY STANDARDS

MIL-STD-490A	Specification Practices
MIL-STD-600001	Mapping Charting & Geodesy Accuracy Standard, 26 February 1990
MIL-STD-600003	MC&G Product Generation Rules

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications

The following Government documents, drawings, and publications form a part of this document to the extent specified. Unless otherwise listed, the document versions are those cited in the solicitation.

DMA TM 8358.1	Datums, Ellipsoids, Grids, and Grid Reference Systems. First Edition. September 1990
DIAM 65-18	Defense Intelligence Agency Manual - Geopolitical Data Elements and Related Features. March 1984

(These publications are available from DMA by writing to: Director, Defense Mapping Agency, ATTN: PR, 8613 Lee Highway, Fairfax, VA 22031-2137.)

2.2 Non-Government publications

The following publications form a part of this document to the extent specified. Unless otherwise noted, the issues of the documents that are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. The issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

ANSI/IEEE 754-1985. IEEE Standard for Binary Floating Point Arithmetic. August 12, 1985. (Application for copies should be addressed to the publisher: IEEE, Inc., 345 East 47th St., NY, 10017)

ANSI/IEEE Std 1003.1b-1993. IEEE Standard for Information Technology – Portable Operating System Interface (POSIX) – Part 1: System Application Program Interface (API) – Amendment 1: Realtime Extension [C Language]. (Application for copies should be addressed to the publisher: IEEE, Inc., 345 East 47th St., NY, 10017)

ANSI x3.4-1977. Code for Information Interchange (ASCII) Adopted in FIPSPUB 1-1, 24 December 1980.

ISO 8601. International Organization for Standardization, Data Elements and Interchange Formats - Information Interchange - Representation of Dates and Times, 1988 (Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018).

Bureau of the Budget, United States National Map Accuracy Standards, Government Printing Office, 1947. (This standard is printed in its entirety in Thompson, Morris M., 1988, Maps for America, U.S. Geological Survey, 3rd ed., p. 104).

Chayes, D.A., Nishimura, C.E., Czarneki, M.F., Pitcher, D. 1991. A Paradigm for Processing Sidescan and Bathymetry: The Next Generation. Proceedings of the Maritime Technical Society.

Ferguson, J.S. and Chayes, D.A. 1992. A Generic Swath-Mapping Data Format. Marine Geodesy vol. 15, pp 129-140

Ferguson, J.S. and Chayes, D.A. 1995. Use of a Generic Sensor Format to Store Multibeam Data. Marine Geodesy vol. 18, pp 299-315

GSFlib, the Generic Sensor Format Library, 16 January 2001.

Non-government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other information services.

2.3 Order of precedence

If there is a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. CONVENTIONS

3.1 Accuracy

Data files exchanged using the GSF may be of any accuracy. However, the horizontal and vertical accuracy must be determined by standard method and cited in the Metadata File or supporting documentation.

3.2 Datums

The preferred horizontal datum is the World Geodetic System 1984 (WGS-84) ellipsoid. However, data files exchanged using the GSF may be referenced to any datum as long as the datum is cited in the Metadata File or supporting documentation

The preferred vertical (sounding) datum is the WGS-84 geoid. However, data files exchanged using the GSF may be referenced to any datum as long as the datum is cited in the Metadata File or supporting documentation. All depths shall be referenced as positive displacements below datum; e.g., a depth of 100 meters below datum would be represented as 100.

3.3 Swath-related nomenclature

Two methods of determining beam location relative to a vessel are allowed by GSF, as illustrated by Figure 3-1. Most multibeam sonars provide data in a mixture of both systems. The first is a polar coordinate system with the vessel at the center of a sphere. Individual soundings are located by measuring the range from the vessel to the bottom and the beam angle. The pitch angle is also required and is usually constant for a given ping.

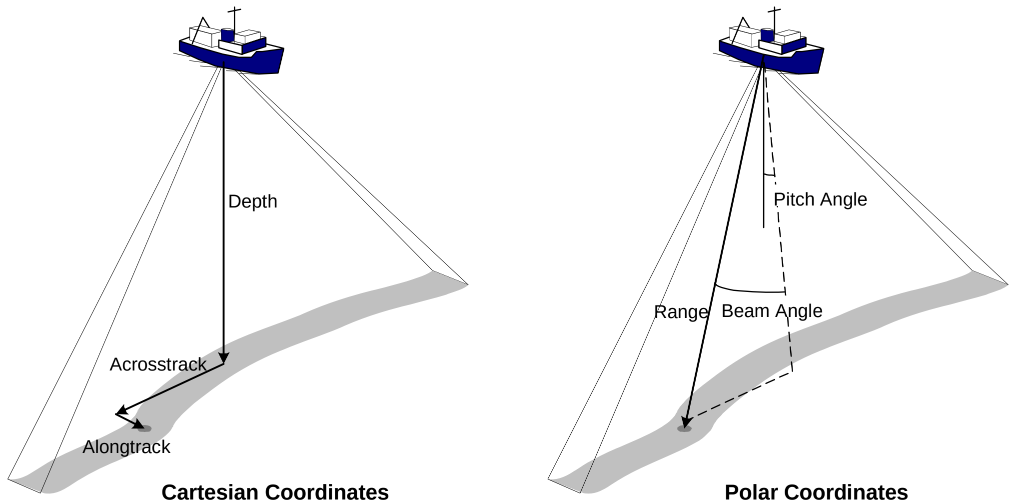

Figure 3-1 Coordinate systems for beam location

GSF also supports a Cartesian system in which individual soundings are located by describing their depth, acrosstrack and alongtrack offsets. Alongtrack offsets may be expressed for each ping or each beam, as appropriate to the specific system, and may be encoded as a distance or a pitch angle.

3.4 Ship-based coordinate system

Figure 3-2 shows the ship-based coordinate system used to refer to both onboard locations of sensors and their ship-based measurements. The vessel's direction of travel is along the x-axis. The z-axis is positive down to be consistent with the convention that depths are expressed as positive numbers. The y-axis is defined to point to starboard in order to form a right-handed coordinate system and is consistent with the usual convention that beam offsets increase in the positive direction. The origin of the coordinate system is arbitrarily located on the vessel, either at the center of the sonar's transducer array or at the vessel's center of motion, as appropriate.

Depths are positive and increase as one moves below the ocean's surface, acrosstrack offsets are positive to the vessel's starboard and negative to port, and alongtrack offsets are positive forward of the vessel's reference position and negative astern of it. Heave is positive if the vessel moves below the mean or reference surface.

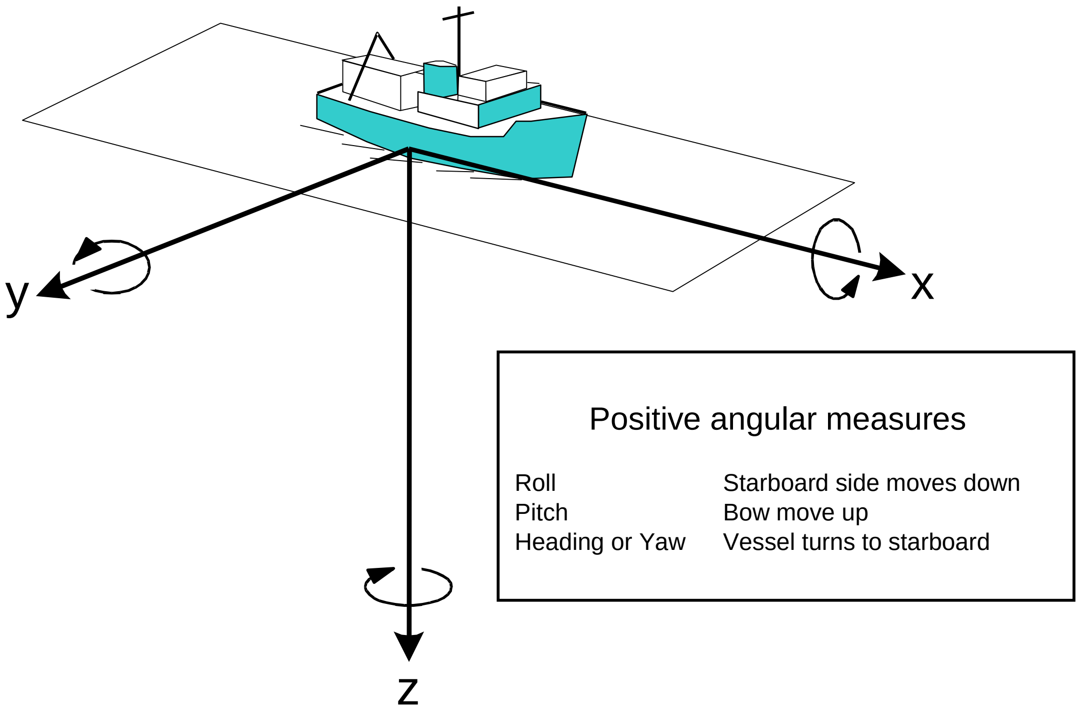

Figure 3-2 Ship-based coordinate system

3.5 Units of measure

Units of measurement in this specification are metric and are the preferred units of measurement for GSF files. However, data from systems that use English units may be recorded as such, so long as these units are properly documented.

3.6 Data element formats

3.6.1 Text

Text shall be standard ASCII characters as defined by ANSI x3.4-1977. Text fields shall normally be fixed-length, but Comments fields are variable-length. Text fields are left justified and are signified in this specification by a "T".

3.6.2 Binary integers

To reduce storage volume, GSF makes extensive use of binary integers. All integers shall be big endian (most significant byte first), and may be either 1-byte unsigned, 2-byte signed or unsigned, or 4-byte signed, as required and as specified in the file header. An "I" shall identify signed binary integers in this specification; a "U" shall identify unsigned integers.

GSF may make use of binary integer arrays. When specifying the length of the array, the format is <integer length>*<number of integers>. For example, a field type of "I" and a count of "2*3” indicate a 2-byte integer array with three elements. GSF often encodes several integers within one 32-bit word. The structure of these packed words is fully defined in this specification.

3.6.3 Geographic coordinates

Horizontal position coordinates may be encoded either as a special case of the text field or binary integer field.

3.6.3.1 Text form

Position in text form shall normally be used high-level GSF files such as the Metadata file and shall be specified in the format:

±DDDMMmmmm±DDMMmmmm,

where D=degrees, M=minutes and m=.0001 minutes, the first set of values specifies the longitude (+ is East), and the second set of values specifies the latitude (+ is North)

For example, -075300000+45160020 would be 45°16.002'N 75°30'W.

3.6.3.2 Binary form

To maintain consistency with the rest of the file and reduce storage volume, the GSF data files use position in binary form. Latitude and longitude are encoded using two 4-byte signed integer fields representing ten-millionths of degrees. Latitude is positive in the Northern Hemisphere and longitude is positive in the Eastern Hemisphere.

For example, latitude = 325000000 longitude = -0702550000,
would be 32.5°N (32°30'N) 70.255°W (70°15'18”W).

3.6.4 Depths

Normally, depth measurements shall be in meters or decimeters. Some multibeam systems consistently calculate depths according to the English measurement system, recording them in fathoms. These units are acceptable if properly documented. In all cases, it is imperative to explicitly state the assumptions used to derive these values. For example, depths reported in meters may assume a constant sound velocity of 1500 meters/second to derive the depths. This fact must be properly recorded in the SOUND_VELOCITY field of the metadata file.

3.6.5 Dates

Date fields shall conform to ISO 8601, paragraph 5.2.1.1 (Basic Format), and shall be of the form CCYYMMDD (e.g., 19920831 for August 31, 1992). A “D” shall identify date fields in this specification. Such fields are usually limited to transmittal and metadata files.

3.6.6 Times

The representation of time within the GSF is an important design element. Because time appears in many places within a GSF data set, it can have a significant impact on data volume. In transmittal and metadata files, ISO 8601 defines standards for representation of dates. In the data files, ISO 8601 is not appropriate because the standard only allows character representations. It would expand data volume by an unacceptable amount.

The POSIX System Application Program Interface standard controls representation of Time in GSF data files. This includes real-time extensions and uses a combination of three values: a reference time, the number of seconds that have elapsed since the reference point, and the number of nanoseconds that have elapsed since the beginning of the current second. The reference time may be any absolute time. Quite often, midnight of 01 January 1970 is used because many computers use this time in their time of day clocks. Alternatively, the beginning of the start date of the survey (as stated in the Metadata File or supporting documentation) may be used, especially if the data were collected prior to 1970. A 4–byte integer field specifies the number of elapsed seconds since the reference time. A second 4-byte integer field specifies the number of elapsed nanoseconds since the beginning of the current second.

3.6.7 Angular measures

Angular measures such as heading, course, yaw, roll and pitch are represented in hundredths of degrees and are stored as 2-byte signed or unsigned integers.

3.6.7.1 Heading and course

Heading refers to the direction of the vessel's bow and course refers to the direction of its motion through the water. Heading and course are measured from true North, and describe the vessel's rotation about the z-axis. They increase in value as the vessel turns to starboard in accordance with standard compass angular measures and have a range of 0.00 to 360.00 using a 2-byte unsigned integer.

3.6.7.2 Yaw

The vessel's short-term rotation about the z-axis is the Yaw. It is measured from the bow of the ship and increases toward the starboard side of the vessel. Yaw normally describes short-term oscillation or pointing errors due to gyrocompass or transducer array misalignment. Yaw has a valid range of –180.00 to +180.00 using a 2-byte signed integer.

3.6.7.3 Roll

Roll describes the vessel's rotation about the x-axis. Roll is measured from references established when the vertical reference sensor system is calibrated and should be near zero when the ship is evenly trimmed. Roll increases in value as the ship's starboard side moves downward and has a valid range of -180.00 to +180.00 using a 2–byte signed integer.

3.6.7.4 Pitch

Pitch describes a ship's rotation about the y-axis. Like roll, pitch is measured from references established when the vertical reference sensor system is calibrated and should be near zero when the ship is evenly trimmed. Pitch increases as the sensor platform moves upward and has a valid range of -180.00 to +180.00 using a 2-byte signed integer.

3.7 Record Description

Each record is composed of a set of fields that contain the data elements that are defined in subsequent tables. Fields may be big-endian binary (most significant byte first) or ASCII and may be fixed- or variable-length. This specification presents GSF records in tabular form. Figure 3-3 describes the conventions used in these tables.

Items in ***Bold Italics*** are the labels for the header

Field Name	***Field Description***	***Field Type***	***Count***
RECORD_POSITION	Position of record in file, in bytes	I	4
RECORD_LENGTH	Length of record, in bytes	I	4

Name for each field in the file, as specified in the file header

Description for each field in the file, as specified in the header. Items in **Bold** (not shown) are common to all DoDBL raster data sets and specify the actual field entry.

Field Type and Count for each field in the file, as specified in the header.

Figure 3-3 GSF definition conventions

4. DATA STRUCTURE

Data stored in Generic Sensor form are contained in several files, each with a specific use. A complete GSF data set contains all these files, related as shown in Figure 4-1. These files are:

- Transmittal files that describe what data are being transmitted in a given transaction and how they may be handled,
- Metadata Files that describe the contents and nature of a given collection of data, and
- Files containing the data themselves.

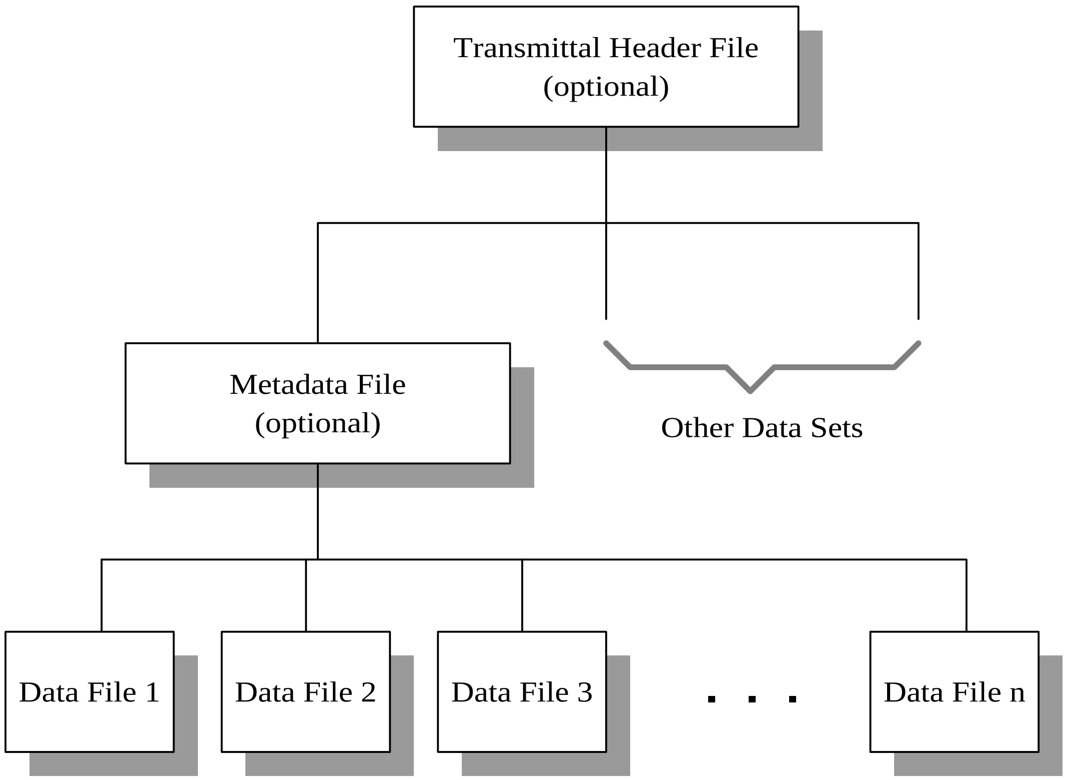

Figure 4-1 Data Set Organization

Transmittal files are developed to describe a particular transaction. Transmittal files are not a permanent record that describes the data, but record the transfer of data, document the prescribed handling, the format of the media and the specifications that describe the data's form.

Metadata files describe the data themselves, including their temporal and areal extent, and the overall condition of a GSF data set.

GSF data files are organized by time; data collected over a given time period shall be stored in a single file. All the data collected from a given sensor over a period of time is recorded in a single file. The amount of data recorded in a given sequential file may be fixed (e.g., data may be segregated by date of collection) or may be based on operational requirements such as survey layout. A GSF data set may be composed of one or more GSF data files. Data sets will generally be segregated based on operational or logistical factors such as survey area or cruise duration. A single metadata file describes the contents of the entire data set.

4.1 Transmittal Header File

This file, common to all DoDBL exchange sets, provides information on the type of data to be exchanged, the number of data sets in the exchange, the highest security classification, and the standards and specifications used for this transmittal. It can be printed and provided in hardcopy when the transmittal is by physical (not network) exchange. If the transmittal spans more than one volume, then each volume shall have a Transmittal Header File. The use of the Transmittal Header File is mandatory for exchanges within the DoDBL but is optional for data exchanged outside of the DoDBL. Table 4-1 specifies the contents of the Transmittal Header File.

Table 4-1 Transmittal Header File

Field Name	*Field Description*	*Field Type*	*Count*
VERSION	Version Number (reserved)	T	10
DATA_NAME	**DoDBL Sensor**	T	12
DATA_DESCRIPTION	General description of data	T	100
MEDIA_STD	Media standard used on this volume. E.g., ISO 9660	T	20
ORIGINATOR	Sender, e.g., DMAHTC	T	50
ADDRESSEE	Receiver with address	T	120
MEDIA_VOLUMES	Number of volumes in this transmittal	T	2
SEQ_NUMBER	Sequential order of this volume	T	2
NUM_DATA_SETS	Number of data sets in this transmittal	T	2
SECURITY_CLASS	Highest classification on this volume (See HRD)	T	1
DOWNGRADING	Originating Activity Determination Required (OADR)? **YES** or **NO**	T	3
DOWNGRADE_DATE	Date of downgrading, blank if OADR	D	1
RELEASABILITY	Releasability restrictions	T	20
OTHER_STD_NAME	**Generic Sensor Format**	T	50
OTHER_STD_DATE	Publication date of GSF	D	1
OTHER_STD_VER	Version of GSF	T	10

TRANSMITTAL_ID	Unique ID for this transmittal	T	12
EDITION_NUMBER	Edition number for this database	T	10
EDITION_DATE	Date of creation for this database	D	1

4.2 Metadata File

This file, also contained within all DoDBL exchange sets, provides information on the computed quality, the parameters used to compute quality, the areal extent, and the security classification of each individual data set. There is one Metadata File for each data set in the transmittal. It is permissible to forward a hardcopy listing of the information contained in the Metadata File as long as the information is complete and accurate. The use of the Metadata File is mandatory for exchanges within the DoDBL; it is optional for exchanges that do not occur within the DoDBL mechanism. Its use is strongly encouraged; however, to assure uniform maintenance of important descriptive data. The HYSAS Requirements Document (HRD) specifies the contents of the Metadata File.

4.3 GSF Data File

GSF data files are composed of a series of records arranged sequentially in time. A header record is the first record in the file; otherwise, there is no prescribed ordering. Note, however, that specific processing implementations may require the presence of other records in order to function, especially summary and processing parameter records.

4.3.1 GSF Record Structure

The first word of each record contains one 32-bit unsigned integer that defines the size of the data portion of the record. The second word is an identifier field consisting of a checksum flag, a reserved field and a record identification field. Figure 4-2 illustrates this structure.

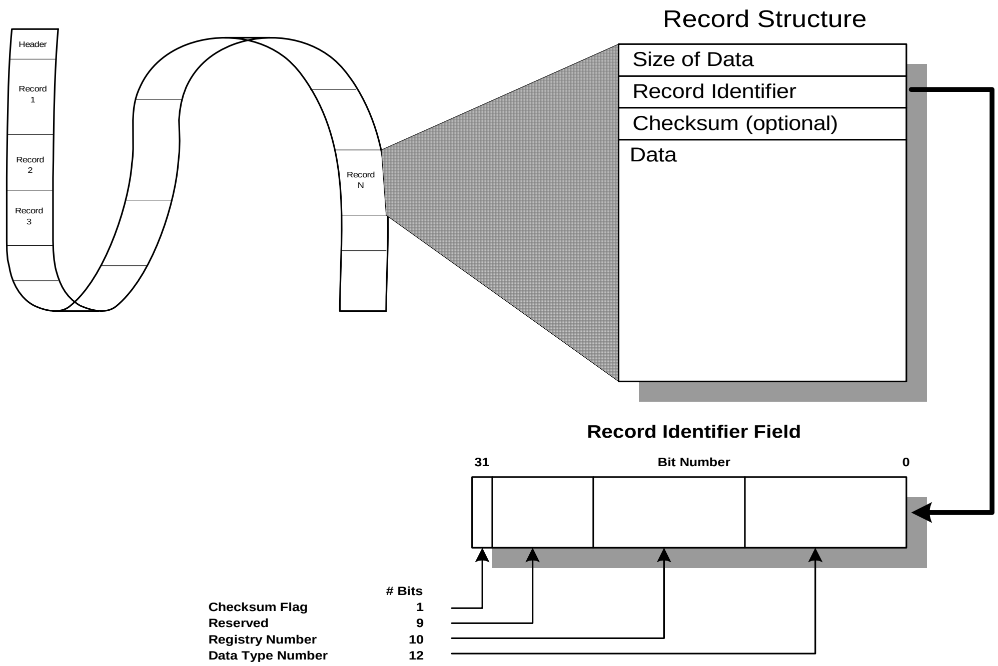

Figure 4-2 GSF Data File Structure

4.3.1.1 Checksum flag

The checksum flag is the first bit in the word; when set to one, a checksum immediately follows the record identifier.

4.3.1.2 Record identification field

The record identifier contains a number that can be related uniquely to the structure defining the data field. It is divided into registry and data type subfields to allow a distributed method of assigning these fields.

4.3.1.2.1 Registry

The registry portion of the record identifier is a ten-bit unsigned integer identifying the registrar responsible for assigning data type subfield numbers. It allows more than one group to be responsible for the assignment process by assigning registry numbers to each group. Those records, defined in Appendix A.1 of this document, have a registry number of zero. Other registry numbers are assigned to individual agencies, institutions or corporations, allowing them to define "private" data type identifiers that will not conflict with the standard ones. The group's registry number is a prefix for these private data records. Other groups need not know what types of data are contained within a private data record; they may simply ignore the record and skip to the next one. If some privately defined data types become commonly used, then reassigning them a new number with a registry number of zero and defining the data type within the standard incorporates them into the standard.

4.3.1.2.2 Data type

The data type portion of the record identifier field is a 12-bit unsigned integer that defines a specific data structure. The registrar identified in the registry portion is responsible for assigning data type numbers.

4.3.1.3 Checksum

If the checksum flag has been set, a record checksum is contained in the 32-bit word that follows the identifier field, otherwise this word is absent. If present, this word contains an integer number that is the sum of all the bytes between the checksum and the end of the record in modulo–32 form. Specifying the checksum allows GSF data to be reliably transmitted across a noisy communication path. Normally, checksums would not be used for data stored on disk.

4.3.1.4 Data record

A data structure that has been related to the data identifier by the appropriate registrar identifies the data record. The only restriction on a data record is that it must be an integral multiple of four bytes long; therefore, between zero and three empty bytes may be appended to the end of a data record.

4.3.2 GSF Record Types

As should be clear from the previous section, there are no restrictions on the type of data that can be encapsulated into Generic Sensor Format. At present, however, only bathymetry data are stored in this format. The format supports both single-beam and multibeam bathymetry data. The records currently defined include:

- a header record,
- a swath bathymetry ping record to contain multibeam bathymetry data,
- a single-beam sounding record to contain single-beam data,
- a summary record to record the temporal and spatial extremes of the data
- a sound velocity profile record,
- a navigation error record to allow the positional error estimate associated with a given data point to be described,
- an attitude record to record full time series attitude data
- a processing parameter record to define the state of the data recorded in the file,
- a sensor parameter record to record the state of the sensor when the data were produced,
- a comment record for annotating the data, and
- history records that provide an audit trail of processing that has been applied to the data.

Not all record types must be present to describe the data; for instance, a file may only consist of ping records if only those data are available or desirable. All records contain a time field consisting of precise time and will normally, but not necessarily, be in chronological order. The format of each GSF data record is defined in the following sections.

4.3.3 Header Record

The header record contains a single text field recording the version number of the GSF data file format as described in Table 4-2.

Table 4-2 Header Record Definition

Field Name	***Description***	***Field Type***	***Count***
VERSION	Version of GSF	T	12
		Header Record Size:	12

4.3.4 Swath Bathymetry Ping Record

A ping record consists of a mandatory ping header and one or more optional subrecords. Figure 4-3 shows the swath bathymetric ping record in schematic form. The normal configuration for a ping record consists of a ping header, a pair of array subrecords containing depth and acrosstrack values and other optional subrecords that may not appear in every ping. Table 4-3 defines the record's data elements including the ping header and all subrecords. Appendix A.2 defines swath bathymetric ping record identifiers.

In some cases, a subrecord may contain a set of values that applies to a series of pings. This subrecord is placed in the first record to which it applies. These values will then be considered to apply until a new instance of the subrecord appears. Subrecords which may be used in this manner include scale factor subrecords and the error array subrecords containing estimates of measurement errors, including the HORIZONTAL_ERROR_ARRAY, and VERTICAL_ERROR_ARRAY.

4.3.4.1 Ping header

A ping header consists of time, vessel's position, attitude, heading, course and speed, all of which are stored in standard form. The header also contains the number of beams in the ping's array records (defined as N for array subrecord definitions), the index, or column, number of the beam located nearest the vessel's keel, a ping flag, and both tide and depth offsets for the ping. Any tide and depth offsets present have already been added to the depth values in the ping's array records.

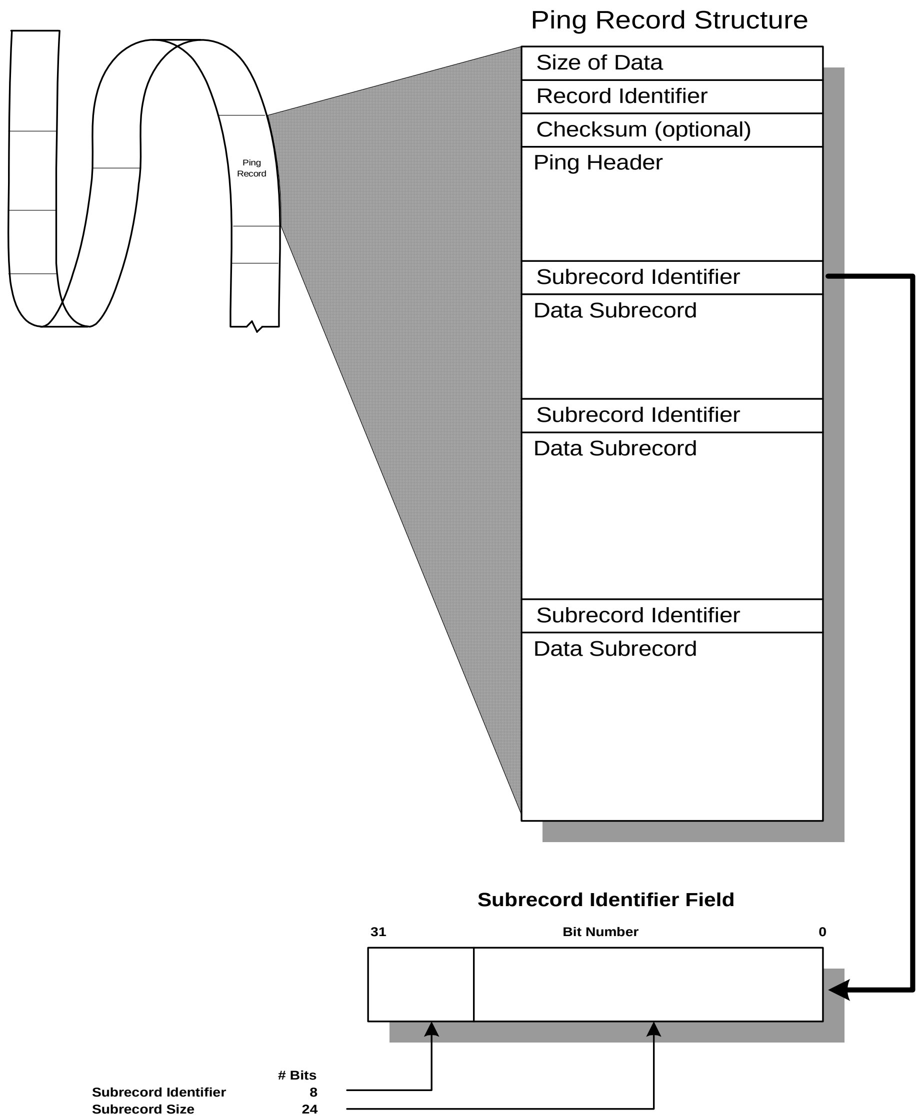

Figure 4-3 Ping record schematic

Two sets of flags are available in the ping record to provide for data to be flagged to indicate whether it is usable or not. Each ping header has a ping flag that is a 16-bit word that defines the usability of the ping's data. If the low-order bit (bit 0) of the ping flag is clear, the ping can be used for processing or display. If this bit is set, the ping data can not be used. The remaining fifteen bits are not defined within this specification; they allow users to define implementation-specific reasons for flagging the ping. Each ping may also contain a "BEAM_FLAGS_ARRAY" that indicates whether individual beams are usable. Section 4.3.4.15 further describes beam flags.

4.3.4.2 Scale-factor subrecord

Scale factors change the range and resolution of the values in array subrecords. This allows all ocean depths to be expressed in meters with sufficient resolution, and acoustical measurements to be expressed in decibels with sufficient resolution. After applying the scale factors, all of the beam array values are encoded in external form as signed or unsigned integers. Some beam array values allow the user to define the field size to support saving the data at a fixed precision. The depth, nominal depth, along track, across track, and travel time arrays can be saved as either two-byte or four-byte integer values as specified by the user. The field size value should be specified once and then enforced for all records within a file. The beam amplitude values and beam echo width values can be saved as either one-byte or two-byte quantities. The beam array scale factor values are saved in the scale factors sub-record of the ping record. This subrecord exists for the first ping of every file, and then again whenever the scale factors change. As a disk-space saving mechanism, this subrecord is not written for every ping record.

Table 4-3 Swath Bathymetry Ping Record Definition

Field Name	***Description***	***Field Type***	***Count***
	Ping Header Subrecord		*42*
TIME	Time of ping transmission	I	2*4
LONGITUDE	Longitude of ship in ten-millionths of degrees	I	4
LATITUDE	Latitude of ship in ten-millionths of degrees	I	4
NUM_BEAMS	Number of beams in ping (N)	I	2
CENTER_BEAM	Location of center beam. The first beam is the outermost port beam.	I	2
PING_FLAGS	Flags that indicate the usability of the ping data. See section 4.3.4.1		2
RESERVED			2
TIDE_CORRECTOR	Tidal offset in centimeters. This value has been added to all depth values in the ping whether they are flagged as usable or not.	I	2
DEPTH_CORRECTOR	Dynamic draft (or vessel depth for submersible vessels) in centimeters. This value has been added to all depth values in the ping.	I	4
HEADING	Ship's heading in hundredths of degrees including any offsets that have been applied to the data as documented in the processing parameter record	U	2

Field Name	***Description***	***Field Type***	***Count***
PITCH	Ship's pitch in hundredths of degrees including any offsets that have been applied to the data as documented in the processing parameter record	I	2
ROLL	Ship's roll in hundredths of degrees including any offsets that have been applied to the data as documented in the processing parameter record	I	2
HEAVE	Ship's heave in centimeters	I	2
COURSE	Ship's direction of motion through water in hundredths of degrees	U	2
SPEED	Ship's speed in hundredths of knots	U	2
Scale Factor Subrecord			*4+12M*
NUM_FACTORS	Number of scale factors (M)	I	4
SCALE_FACTOR_ARRAY	ID, compression flag, scale factor and offset values for each array subrecord in the ping, see section 4.3.4.2		12*M
Beam Array Subrecords. Some of the following arrays are used to record data from each beam.			
DEPTH_ARRAY	Depth (z) values for each beam in meters, corrected for measured sound velocity. Scale factors applied before storage.	U	2*N, or 4*N
NOMINAL_DEPTH_ARRAY	Depth (z) values for each beam in meters, using an average sound speed of 1500 m/s. Scale factors applied before storage.	U	2*N, or 4*N
ACROSS_TRACK_ARRAY	Acrosstrack (y) values in meters. Scale factors applied before storage.	I	2*N, or 4*N
ALONG_TRACK_ARRAY	Alongtrack (x) values in meters. Scale factors applied before storage.	I	2*N, or 4*N
TRAVEL_TIME_ARRAY	Travel time in seconds. Scale factors applied before storage.	U	2*N, or 4*N
BEAM_ANGLE_ARRAY	Incoming beam angle at transducer face in degrees. Scale	I	2*N

Field Name	*Description*	*Field Type*	*Count*
	factors applied before storage.		
MEAN_CAL_AMPLITUDE_ARRAY	Mean amplitude in decibels (referenced to 1 micropascal at 1 meter). Scale factors applied before storage.	I	1*N, or 2*N
MEAN_REL_AMPLITUDE_ARRAY	Mean amplitude in decibels relative to an arbitrary intensity. Scale factors applied before storage.	U	1*N, or 2*N
ECHO_WIDTH _ARRAY	Measured width of bottom echo in seconds. Scale factors applied before storage.	U	1*N, or 2*N
QUALITY_FACTOR_ARRAY	Measures of beam quality in arbitrary units. Meaning of each field is dependent on the sensor in use.	U	1*N
RECEIVE_HEAVE_ARRAY	Ship's heave at receive time in meters. Scale factors applied before storage.	I	1*N
DEPTH_ERROR_ARRAY	Estimated depth measurement error in meters. Scale factors applied before storage. ***(OBSOLETE: replaced with horizontal_error_array and vertical_error_array. New applications should use horizontal_error_array and vertical_error_array)***	U	2*N
ACROSS_TRACK_ERROR_ARRAY	Estimated across track measurement error in meters. Scale factors applied before storage. ***(OBSOLETE: replaced with horizontal_error_array and vertical_error_array. New applications should use horizontal_error_array and vertical_error_array)***	U	2*N
ALONG_TRACK_ERROR_ARRAY	Estimated along track measurement error in meters. Scale factors applied before storage. ***(OBSOLETE: replaced with horizontal_error_array and vertical_error_array. New applications should use horizontal_error_array and vertical_error_array)***	U	2*N
BEAM_FLAGS_ARRAY	Flags that indicate whether individual beam data are usable. See section 4.3.4.15	U	1*N

Field Name	***Description***	***Field Type***	***Count***
QUALITY_FLAGS_ARRAY	Flags provided by Reson sonar systems describing bottom detection parameters and/or quality. This value is packed as a two-bit quantity per beam. ***(OBSOLETE: New applications should use the quality_factor array subrecord)***	U	N/4
SIGNAL_TO_NOISE_ARRAY	Signal to noise ratio of each beam.	I	1*N
BEAM_ANGLE_FORWARD_ARRAY	Beam angle in the fore-aft direction in degrees. Scale factors applied before storage.	I	2*N
VERTICAL_ERROR_ARRAY	Array of estimated vertical error (meters, at 95% confidence)	U	2*N
HORIZONTAL_ERROR_ARRAY	Array of estimated horizontal error (meters, at 95% confidence)	U	2*N
SECTOR_NUMBER_ARRAY	Array of values that specify the transit sector for this beam		1*N
DETECTION_INFO_ARRAY	Array of values that specify the method of bottom detection		1*N
INCIDENT_BEAM_ADJ_ARRAY	Array of values that specify incident beam angle adjustment from beam_angle		1*N
SYSTEM_CLEANING_ARRAY	Array of values that specify data cleaning information from the sensor		1*N
DOPPLER_CORR_ARRAY	Array of values used to correct the travel times for Doppler when transmission is FM		1*N
Sensor Specific Subrecord. See Appendix B.1 for definitions.			
BRB_INTENSITY, Structure containing bathymetric receive beam time series intensities, and associated per-ping information.			
BITS_PER_SAMPLE	Number of bits per intensity sample.	I	1
APPLIED_CORRECTIONS	Flags to describe corrections applied to intensity values.	I	4
SPARE	Reserved for future use.	I	16
SENSOR_IMAGERY	*Sensor specific imagery information. See Appendix B.3 for definitions.*		
TIME_SERIES_INTENSITY, Array of structures containing the per-beam time series intensity information.			***Size*N***

Field Name	*Description*	*Field Type*	*Count*
SAMPLE_COUNT	Number (Ns) of intensity samples for this beam.	I	2
DETECT_SAMPLE	Index of bottom detection sample for this beam.	I	2
SPARE	Reserved for future use.	I	8
SAMPLES_ARRAY	Array of Ns intensity samples, in dB.	I	4*Ns
Swath Bathymetry Ping Record Size:			variable

Figure 4-4 describes scale factor subrecords schematically. After the subrecord identifier is a count that defines the number of scale factors listed within the subrecord. Following the count are arrays of scale factors, one for each array subrecord used within the GSF data file. Each scale factor array element consists of the subrecord ID of the array subrecord being scaled, a compression flag describing the type of compression applied to the array subrecord and two scale factors, a multiplier and an offset. The one-byte compression flag is split into two sections. The high order four bits are used to control the field size for those array values that support more than one field size. The low order four bits are reserved for future use to specify an optional compression algorithm. In order to transform the values in the array subrecord into the engineering units defined Table 4-3, each element in the array must be divided by the multiplier and the offset subtracted from the result.

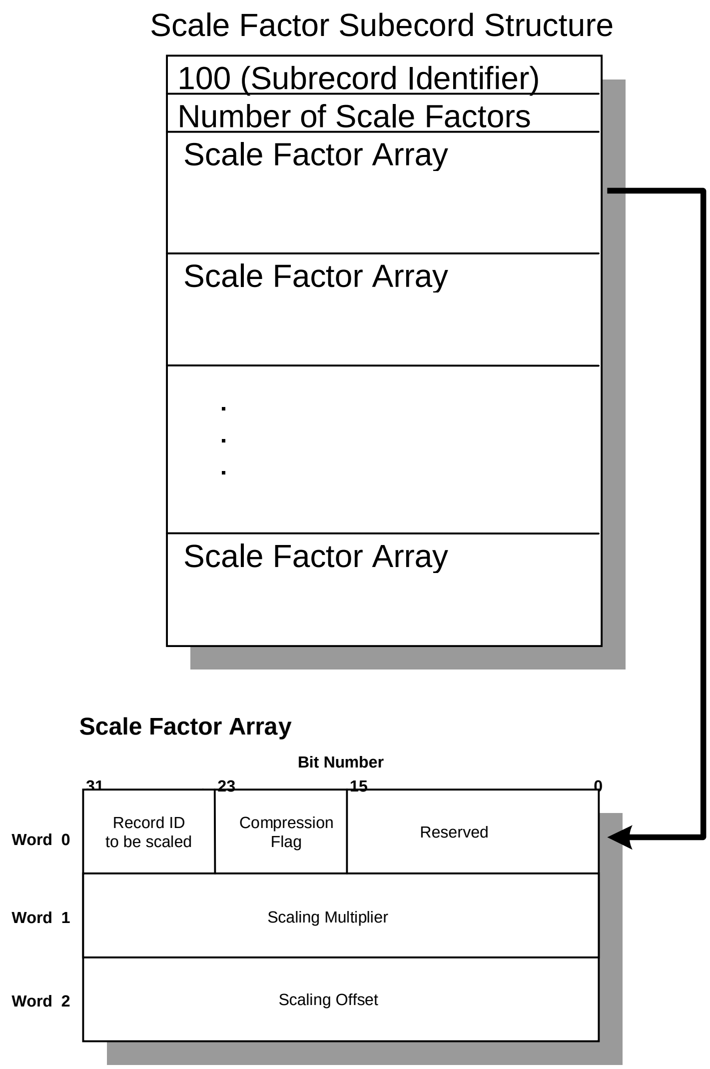

Figure 4-4 Ping Scale Factor Subrecord Schematic

4.3.4.3 Array subrecords

The major portion of a ping record consists of several array subrecords, each containing one kind of measurement derived for each beam. These arrays contain the data that are associated with each beam of the ping being described; examples of these data include the geometric location of the bathymetric point, parameters that describe the acoustic nature of the return or parameters that describe the statistical nature of the depth measurement. Table 4-3 defines valid array subrecords; subsequent sections describe these array subrecords in more detail. Some array subrecords are composed of either 8-bit or 16-bit integers that may represent either signed or unsigned quantities depending upon the kind of data they contain. For each array subrecord, the first beam is the outermost port beam.

4.3.4.4 Depth Array Subrecord

This field contains an array of depth values, one for each beam in the ping. Each depth value is encoded either as a 2-byte integer or as a 4-byte integer as specified by the field size component of the compression flag. The processing parameter record describes the calculation of the depths in the depth array. The units are meters before being scaled as defined in the scaling factor subrecord.

4.3.4.5 Nominal Depth Array Subrecord

This field contains an array of nominal depth values, one for each beam in the ping. The nominal depth values are relative to a fixed 1500 m/s sound speed profile. The corresponding across-track and along-track arrays are populated to properly locate the sounding point on the seafloor which requires ray tracing through the sound speed profile. For the case of a modern multibeam sonar, the nominal depth values are computed using the sonar's reported travel time array, the sonar's reported true depth array, and the sound speed profile. The nominal depth field is provided for sonar systems that are capable of producing two depth values, one (true depth) calculated using a measured sound velocity profile and another (nominal depth) calculated using a fixed sound speed of 1500 m/s. Note that if only one depth value is available it is written into the depth array no matter how the depths have been calculated. Each nominal depth value is encoded as a 2-byte integer, or as a 4-byte integer as specified by the field size component of the compression flag. The units are meters before being scaled as defined in the scaling factor subrecord.

4.3.4.6 Acrosstrack Array Subrecord

This field contains an array of acrosstrack distances, one for each beam in the ping. Each distance value is encoded as a 2-byte integer or as a 4-byte integer as specified by the field size component of the compression flag. The units are meters before being scaled as defined in the scaling factor subrecord.

4.3.4.7 Alongtrack Array Subrecord

This field contains an array of alongtrack distances for each beam in the ping. Each distance is encoded as a 2-byte integer or as a 4-byte integer as specified by the field size component of the compression flag. The units are meters before being scaled as defined in the scaling factor subrecord.

4.3.4.8 Travel-time Array Subrecord

This field contains an array of travel times for each beam in the ping. Each time is encoded as a 2-byte integer or as a 4-byte integer as specified by the field size component of the compression flag. The units are seconds before being scaled as defined in the scaling factor subrecord.

4.3.4.9 Beam-angle Array Subrecord

This field contains an array of beam angles for each beam in the ping. Each angle is encoded as a 2-byte integer. The units are degrees before being scaled as defined in the scaling factor subrecord. Each beam angle represents the rotation from vertical of the beam, so that beams pointed straight down have a “vertical” angle of zero. The range of vertical angle values is 0-180 degrees (downward looking sonars have a practical range of 0-90 degrees, with 90 degrees being horizontal).

4.3.4.10 Mean Calibrated Amplitude Array Subrecord

This field contains an array of average calibrated amplitude values for each beam. Each amplitude value is encoded as a 1-byte integer or as a 2-byte integer as specified by the field size component of the compression flag. The units are in decibels (re 1 micropascal at 1 meter) before being scaled as defined in the scaling factor subrecord.

4.3.4.11 Mean Relative Amplitude Array Subrecord

This field contains an array of average relative (uncalibrated) amplitude values for each beam in the ping. Each amplitude value is encoded as a 1-byte integer or as a 2-byte integer as specified by the field size component of the compression flag. The units are in decibels (re 1 micropascal at 1 meter) before being scaled as defined in the scaling factor subrecord.

4.3.4.12 Echo Width Array Subrecord

This field contains an array of width of the bottom echoes for each beam. Each time is encoded as a 1-byte integer or as a 2-byte integer as specified by the field size component of the compression flag. The units are seconds before being scaled as defined in the scaling factor subrecord.

4.3.4.13 Quality factor Array Subrecord

This field contains measures of beam quality in arbitrary sensor-dependent units, one for each beam in the ping.

In the case of Reson sonars, the quality factor for each beam will be a value from 0 to 15, which represents the 4-bit quality value from the Reson R-Theta message. (Note: Some implementations of GSF include Reson brightness and co-linearity flags in the packed 2-bit array subrecord referenced below. That subrecord should no longer be used, and this quality factor array should be used in its place.)

For Simrad EM series sonars, the quality factor for each beam will be a value from 0 to 254, which represents the 8-bit quality factor contained in the Simrad Depth datagram.

For the ELAC 1180 MKII, the quality factor will be a value from 1 to 8, where 1 is best quality and 8 is worst quality,

The quality factor for Seabeam 2112 sonars is will be a value from 0 to 3, where the lowest order bit will be set if the beam was flagged by the sonar as poor quality. The second lowest order bit is set if the data source is *Weighted Mean Time* (WMT). The data source is *Bearing Direction Indicator* (BDI) if the second bit is not set.

4.3.4.14 Receive Heave Array Subrecord

This field contains the platform's heave at receive time for each beam. Each heave is encoded as a 1-byte integer. The units are meters before being scaled as defined in the scaling factor subrecord.

4.3.4.15 Beam Flags Array Subrecord

This field contains flags that indicate the usability of the data in each beam in the ping. Each beam is represented by a 1-byte (8-bit) set of flags that indicate whether individual beams within a ping are usable or not. If the low-order bit (bit 0) of a given beam flag is clear the corresponding beam data are usable; if the bit is set that beam's data are not to be used for processing or display. The meaning of the remaining seven bits are not defined within this specification.

4.3.4.16 Quality Flags Array Subrecord

This field contains integers that consist of four 2-bit arrays. Each 2-bit array indicates information about the data in each beam in the ping. The meaning of the bit flags is dependent on the sensor in use. This beam array subrecord is considered obsolete, but is left in place for backwards compatibility. Future use of this type of information should make use of the Quality Factor array Subrecord.

4.3.4.17 Signal to Noise Array Subrecord

This field contains the signal to noise ratio (SNR) for each beam. SNR is encoded as a 1-byte integer. The values have no units and are scaled as defined in the scaling factor subrecord.

4.3.4.18 Beam Angle Forward Array Subrecord

This field contains an array of beam angles for each beam in the ping. Each angle is encoded as a 2-byte integer. The units are degrees before being scaled as defined in the scaling factor subrecord. The beam angle forward is the azimuth of the beam measured counterclockwise from directly to starboard. The range of the azimuthal angle is 0 - 360 degrees.

4.3.4.19 Vertical Error Array Subrecord

This field contains an array of vertical distances for each beam in a ping. Each distance is encoded as a 2-byte integer. The units are meters before being scaled as defined in the scaling factor subrecord. This subrecord is provided with the intent that when used in conjunction with the Horizontal Error Subrecord will functionally replace the currently defined error subrecords (DEPTH_ERROR_ARRAY, ACROSS_TRACK_ERROR_ARRAY, ALONG_TRACK_ERROR_ARRAY).

4.3.4.20 Horizontal Error Array Subrecord

This field contains an array of horizontal distances for each beam in a ping. Each distance is encoded as a 2-byte integer. The units are meters before being scaled as defined in the scaling factor subrecord. This subrecord is provided with the intent that when used in conjunction with the Vertical Error Subrecord will functionally replace the currently defined error subrecords (DEPTH_ERROR_ARRAY, ACROSS_TRACK_ERROR_ARRAY, ALONG_TRACK_ERROR_ARRAY).

4.3.4.21 Sector Number Array Subrecord

This field contains an array of transmit sector numbers for each beam in a ping. Each value is encoded as a 1-byte integer. The field value is dimensionless before being scaled as defined in the scaling factor subrecord. This value is used to record which transmit sector was used for each depth measurement in the ping.

4.3.4.22 Detection Info Array Subrecord

This field contains an array of bottom detection parameters for each beam in a ping. Each field is encoded as a 1-byte integer. The units are dimensionless before being scaled as defined in the scaling factor subrecord.

4.3.4.23 Incident Beam Adjustment Array Subrecord

This field contains an array of incident beam adjustment angles for each beam in a ping. This field contains the beam angle correction for ray-bending that is required to calculate the beam's true incidence angle on the seafloor. Each field is encoded as a 1-byte integer. The units are expressed in degrees before being scaled as defined in the scaling factor subrecord.

4.3.4.24 System Cleaning Array Subrecord

This field contains an array of sonar system data cleaning/filtering parameters for each beam in a ping. As of the GSFv2.07 release, this field is reserved for future use. Each field is encoded as a 1-byte integer. The units are dimensionless before being scaled as defined in the scaling factor subrecord.

4.3.4.25 Doppler Correction Array Subrecord

This field contains an array of Doppler correction values for each beam in a ping. The value in this field has already been applied to the reported travel time array values in order to compensate for Doppler correction. This field is only populated for sonar systems that employ transmit frequency modulation (FM). Each field is encoded as a 1-byte integer. The units are expressed in seconds before being scaled as defined in the scaling factor subrecord.

4.3.4.26 Sensor-specific Subrecords

These subrecords are designed to contain data that are not beam-oriented and that vary from ping to ping, but do not fit into the ping header. An example of this type of data might be the power amplifier gain settings for a particular ping. These data are, by nature, specific to a particular sonar system or manufacturer and are defined to ensure that all the data available in a particular ping record can be recorded. Because of the specificity of these data, these subrecords are usually located at the end of the ping record and may be ignored by the majority of processing and display software. Appendix B.1 defines the sensor-specific subrecords. It is important to note the presence of the sensor specific subrecord may identify the sensor that produced the data. Therefore, it may be desirable to define two different subrecords with identical data elements because the different sensor-specific subrecord identifiers identify the sensor.

4.3.4.27 Bathymetric Receive Beam Time Series Intensity Subrecord

This subrecord is designed to contain imagery data for each of the bathymetric receive beams. This record contains the number of bits per sample encoded as a 1-byte integer and a bitmasked set of flags describing the corrections that have been applied to the intensity values, encoded as a 4-byte integer. This record also contains 16 spare header bytes per ping and sensor specific data that is per-ping and relative to imagery. This record also contains an array of Intensity Time Series structures containing information for each beam in a ping. Each element in this array is a set of values that define the per-beam time series intensity information. These values are: the number of samples for the beam encoded as a 2-byte integer, the index of the sample that represents the bottom detection point for the beam encoded as a 2-byte integer, 8 spare bytes, and an array of samples for the beam encoded as a 1-byte integer. The samples in the array represent logarithmic intensity referenced to unity, in half dB steps, and are ordered increasing in range.

4.3.5 Single-beam Sounding Record

(This record should no longer be used, as of GSF v2.03. While this record is still supported, single-beam data should now be stored in the Swath Bathymetry Ping Record, with number of beams set to one.)

Table 4-4 defines the single beam sounding record. The basis for the single beam sounding record is the swath bathymetry ping record, but the single beam sounding record is much simpler.

Table 4-4 Single-beam Sounding Record Definition

Field Name	***Description***	***Field Type***	***Count***
TIME	Time of sounding	I	2*4
LONGITUDE	Longitude of ship in ten-millionths of degrees	I	4
LATITUDE	Latitude of ship in ten-millionths of degrees	I	4
TIDE_CORRECTOR	Tidal offset in centimeters.	I	2
DEPTH_CORRECTOR	Dynamic draft (or vessel depth for submersible vessels) in centimeters.	I	4
HEADING	Ship's heading in .01 degrees	U	2

Field Name	Description	Field Type	Count
	including any offsets that have been applied to the data as documented in the processing parameter record		
PITCH	Ship's pitch in .01 degrees including any offsets that have been applied to the data as documented in the processing parameter record	I	2
ROLL	Ship's roll in .01 degrees including any offsets that have been applied to the data as documented in the processing parameter record	I	2
HEAVE	Ship's heave in centimeters	I	2
DEPTH	Sounding depth in centimeters	I	4
SOUND_SPEED_ CORRECTION	Sound speed correction in meters	I	2
POSITIONING_ SYSTEM_TYPE	ID for type of positioning system.		2
Sensor Specific Subrecord. See Appendix B.2 for definitions			
		Single-beam Sounding Record Size	34 + sensor specific

4.3.6 Summary Record

The summary record contains a temporal and spatial synopsis of the data stored in the file. These records allow application programs to rapidly determine whether the data in the file are of interest. Table 4-5 defines the format of a summary record.

Table 4-5 Summary Record Definition

Field Name	Description	Field Type	Count
BEGIN_TIME	Time of earliest record in file	I	2*4
END_TIME	Time of latest record in file	I	2*4
MIN_LATITUDE	Southernmost extent of data records	I	4
MIN_LONGITUDE	Westernmost extent of data records	I	4
MAX_LATITUDE	Northernmost extent of data records	I	4
MAX_LONGITUDE	Easternmost extent of data records	I	4
MIN_DEPTH	Least depth in data records	I	4
MAX_DEPTH	Greatest depth in data records	I	4
		Summary Record Size	***40***

4.3.7 Sound Velocity Profile Record

The sound velocity profile record contains values of sound velocity used in estimating individual sounding locations. It consists of; the time the profile was observed, the time it was introduced into the sounding location procedure, the position of the observation, the number of points in the profile, and the individual points, expressed as depth and sound velocity pairs. Table 4-6 defines the format of a sound velocity profile record.

Table 4-6 Sound Velocity Profile Record Definition

Field Name	***Description***	***Field Type***	***Count***
OBS_TIME	Time SVP was observed.	I	2*4
APP_TIME	Time SVP was applied to sonar data.	I	2*4
LONGITUDE	Longitude of SVP observation in ten-millionths of degrees.	I	4
LATITUDE	Latitude of SVP observation in ten-millionths of degrees.	I	4
NUM_POINTS	Number of points in SVP observation (S).	I	4
SVP_ARRAY	Depth and sound velocity pair for each observation point, in centimeters and hundredths of meters/second, respectively.	I	4*2*S
		SVP Record Size	***28+8*S***

4.3.8 Processing Parameter record

Processing parameter records contain important scalar or vector values that describe overall survey conditions or operational values. Typical parameters include items such as the navigation sensor's antenna location or the reference ellipsoid for the geographic position. Table 4-7 defines the format of a processing parameter record. Each processing parameter record contains a time, a count of the parameters defined within the record, and a text string for each parameter definition. The string's length begins each parameter text string.

Table 4-7 Processing Parameter Record Definition

Field Name	***Description***	***Field Type***	***Count***
TIME	Time of processing parameter validity.	I	2*4
NUM_PARAMS	Number of processing parameters in record (P).	I	2
PARAM_SIZE(1)	Size of first processing parameter (P1).	I	2
PARAM_TEXT(1)	Text containing first processing parameter, see section 4.3.8.	T	P1
. . .	. . .		

Field Name	*Description*	*Field Type*	*Count*
. . .	. . .		
PARAM_SIZE(P)	Size of first processing parameter (PN).	I	2
PARAM_TEXT(P)	Text containing Pth processing parameter, see section 4.3.8.	T	PN
		Processing Parameter Record Size:	***Variable***

The parameter text string consists of a parameter keyword followed by an equals sign ("=") and then the value of the parameter, e.g., "KEYWORD=VALUE". Corrections or offsets that refer to the ship are in absolute ship-based coordinates as defined in section 3.4. These values are in meters relative to the origin of the coordinate system. Each such correction has both "APPLIED" and "TO_APPLY" values. This allows for the storage of corrections that are known when the data are recorded but have not been applied to the data. Table 4-8 defines the necessary processing parameter records. The first column defines acceptable keywords, the second defines a description of the values.

Table 4-8 Defined Processing Parameter Text Strings

Keyword	*Description*
"REFERENCE TIME"	String description of the beginning of the time epoch. Two choices for the beginning time are allowed. For recently collected data, the beginning of the epoch is often defined to be 1 January 1970 because many computers use this convention. An alternative beginning, especially for data collected prior to this date, is midnight of the beginning date of the survey. In any case, the format for the reference time consists of the full four-digit year, the ordinal day of year and the time expressed as hour, minute and second. Format: CCYY/DDD HH:MM:SS Example: "1970/001 00:00:00"
"ROLL_COMPENSATED"	Indicates whether the sounding data have been roll compensated. Format: "YES" or "NO"
"PITCH_COMPENSATED"	Indicates whether the sounding data have been pitch compensated. Format: "YES" or "NO"
"HEAVE_COMPENSATED"	Indicates whether the sounding data have been heave compensated. Format: "YES" or "NO"
"TIDE_COMPENSATED"	Indicates whether the sounding data have been tide compensated. Format: "YES", "NO",

Keyword	*Description*
	"PREDICTED" or "OBSERVED"
"DEPTH_CALCULATION"	Indicates whether the sounding data have been computed by integrating travel time through the water column; this is a "corrected" computation of depth. An alternative method for computing depth is to assume a constant sound speed, usually of 1500 meters/second. Note that this does not refer to the data contained in the NOMINAL_DEPTH_ARRAY subrecord of the ping record. Format: "CORRECTED" or "RELATIVE_TO_1500_MS"
"RAY_TRACING"	Indicates whether the angle/travel-time pairs have been corrected for ray tracing. Format: "YES" or "NO"
"DRAFT_TO_APPLY"	Value of a draft offset that is known, but has not yet been applied. More than one offset may be described to allow for sensors with more than one transducer. If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "+02.84,+02.73"" "
"PITCH_TO_APPLY"	Value of a pitch offset that is known, but has not yet been applied. More than one offset may be described to allow for sensors with more than one transducer. If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "+00.68,-01.03"
"ROLL_TO_APPLY"	Value of a roll offset that is known, but has not yet been applied. More than one offset may be described to allow for sensors with more than one

Keyword	*Description*
	transducer. If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "-00.13”
"GYRO_TO_APPLY"	Value of a heading offset that is known, but has not yet been applied. More than one offset may be described to allow for sensors with more than one transducer. If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "-00.50”
"POSITION_OFFSET_TO_APPLY"	Location of the ship's position reference (e.g., the navigation antenna) that is known but has not yet been applied. Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+05.30,-01.20,+03.62”
"TRANSDUCER_OFFSET_TO_APPLY"	Location of the ship's sensor transducer that is known but have not yet been applied. More than one location may be described to allow for sensors with more than one transducer. If six values are provided, the first three apply to the port transducer and the last three apply to the starboard transducer. Format: +XX.XX,+YY.YY,+ZZ.ZZ or +XX.XX,+YY.YY,+ZZ.ZZ,+XX.XX, +YY.YY,+ZZ.ZZ Example: "+05.30,-01.20,+03.62,+05.28,+01.76,+03.68”
“MRU_PITCH_TO_APPLY”	Value of a pitch offset for the motion sensor that is known, but has not yet been applied. Format: +XX.XX Example: “+00.13”

Keyword	***Description***
"MRU_ROLL_TO_APPLY"	Value of a roll offset for the motion sensor that is known, but has not yet been applied. Format: +XX.XX Example: "+00.13"
"MRU_HEADING_TO_APPLY"	Value of a heading offset for the motion sensor that is known, but has not yet been applied. Format: +XX.XX Example: "-01.48"
"MRU_OFFSET_TO_APPLY"	Location of the ship's motion sensor that is known but has not yet been applied. Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+02.15,-01.88,+02.91"
"CENTER_OF_ROTATION_OFFSET_TO_APPLY"	Location of the ship's center of rotation that is known but has not yet been applied. Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+02.15,-01.88,+02.91"
"APPLIED_DRAFT"	Value of the draft offset that has been applied to the sounding data. More than one offset may be described to allow for sensors with more than one transducer. If the correction is not known, then the applied draft correction is identified as "UNKNWN". If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "+02.84,+02.73" or "UNKNWN,UNKNWN"
"APPLIED_PITCH_BIAS"	Value of the pitch offset that has been applied to the sounding data. More than one offset may be described to allow for sensors with more than one transducer. If the correction is not known, then the applied pitch correction is identified as "UNKNWN". If more than one value is provided, the first value applies to

Keyword	Description
	the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "-01.34,+00.31" or "UNKNWN"
"APPLIED_ROLL_BIAS"	Value of the roll offset that has been applied to the sounding data. More than one offset may be described to allow for sensors with more than one transducer. If the correction is not known, then the applied roll correction is identified as "UNKNWN". If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "-01.06," or "UNKNWN,UNKNWN
"APPLIED_GYRO_BIAS"	Value of the heading offset that has been applied to the sounding data. More than one offset may be described to allow for sensors with more than one transducer. If the correction is not known, then the applied heading correction is identified as "UNKNWN". If more than one value is provided, the first value applies to the port transducer and the second applies to the starboard transducer. Format: +DD.DD or +DD.DD,+DD.DD Example: "+01.30,+01.00" or "UNKNWN,UNKNWN"
"APPLIED_POSITION_OFFSET"	Location of the ship's position reference (e.g., the navigation antenna) that has been applied to the sounding data. If the position offset is not known, then the applied offset is identified as "UNKNWN". Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+05.30,-01.20,+03.62" or

Keyword	***Description***
	"UNKNWN,UNKNWN,UNKNWN"
"APPLIED_TRANSDUCER_OFFSET"	Location of the ship's sensor transducer that has been applied to the data. More than one location may be described to allow for sensors with more than one transducer. If the transducer offset is not known, then the applied offset is identified as "UNKNWN". If six values are provided, the first three apply to the port transducer and the last three apply to the starboard transducer. Format: +XX.XX,+YY.YY,+ZZ.ZZ or +XX.XX,+YY.YY,+ZZ.ZZ,+XX.XX,+YY.YY,+ZZ.ZZ Example: "+05.30,-01.20,+03.62,+05.28,+01.76,+03.68" or "UNKNWN,UNKNWN,UNKNWN,UNKNWN,UNKNWN,UNKNWN"
"APPLIED_MRU_PITCH"	Value of a pitch offset for the motion sensor that has been applied to the data. Format: +XX.XX Example: "+00.13"
"APPLIED_MRU_ROLL"	Value of a roll offset for the motion sensor that has been applied to the data. Format: +XX.XX Example: "+00.13"
"APPLIED_MRU_HEADING"	Value of a heading offset for the motion sensor that has been applied to the data. Format: +XX.XX Example: "-01.48"
"APPLIED_MRU_OFFSET"	Location of the ship's motion sensor that has been applied to the data. Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+02.15,-01.88,+02.91"
"APPLIED_CENTER_OF_ROTATION_OFFSET"	Location of the ship's center of rotation that has been applied to the data.

Keyword	*Description*
	Format: +XX.XX,+YY.YY,+ZZ.ZZ Example: "+02.15,-01.88,+02.91”
"GEOID"	Definition of the horizontal datum in text form. Text is for informational purposes only, but should be descriptive enough to uniquely identify the datum. If the horizontal datum is not known, the value is identified as "UNKNOWN”. For example, "WGS-84”.
"TIDAL_DATUM"	Definition of the reference vertical datum in text form. If the tidal datum is not known, the value is identified as "UNKNOWN”. For example, "MLW” or "ALAT”.

4.3.9 Sensor Parameter record

Sensor parameter records contain parameters that are transmitted by the sonar at times such as startup, shutdown or when the sensor's mode of operation changes. Typical parameters include the sensor's mode, sensor offset locations, and draft compensation values. Table 4-9 defines the format of a processing parameter record. Each sensor parameter record contains a time, a count of the parameters defined within the record, and a text string for each parameter definition. Each text string is prefixed by string length. The text string consists of a parameter keyword followed by an equals sign (“=”) and then the value of the parameter. Sensor parameter records are by nature sensor-specific, therefore there are no standard keywords defined for these parameters. Important values such as draft correctors or sensor locations are reproduced in the processing parameter record.

Table 4-9 Sensor Parameter Record Definition

Field Name	*Description*	*Field Type*	*Count*
TIME	Time of sensor parameter validity.	I	2*4
NUM_PARAMS	Number of sensor parameters in record (Q).	I	2
PARAM_SIZE(1)	Size of first sensor parameter (Q1).	I	2
PARAM_TEXT(1)	Text containing first sensor parameter, see section 4.3.9.	T	Q1
. . .	. . .		
. . .	. . .		
PARAM_SIZE(Q)	Size of first sensor parameter (QN).	I	2
PARAM_TEXT(Q)	Text containing Qth sensor parameter, see section 4.3.9.	T	QN
		Sensor Parameter Record Size:	***Variable***

4.3.10 Comment record

The comment record maintains information that is not otherwise accommodated by the other records. It consists of a time, a text string and the length of the string. One use might be to include entry of watch personnel comments during a survey. Table 4-10 defines the format of a comment record.

Table 4-10 Comment Record Definition

Field Name	***Description***	***Field Type***	***Count***
TIME	Time of comment.	I	2*4
TEXT_LENGTH	Number of characters in text (R).	I	4
COMMENT_TEXT	Text containing comment.	T	R
	Comment Record Size:		***12+R***

4.3.11 History record

The history record is intended to support automatic documentation of processing which has been applied to the data. It includes: the time the processing step occurred; the name of the operator; the name of the computer doing the processing; the program being used, along with any command line arguments or pertinent parameters; and a comment field is available for a summary of the processing that occurred when the program was run. Table 4-11 defines the format of a history record.

Table 4-11 History Record Definition

Field Name	***Description***	***Field Type***	***Count***
TIME	Time of processing action.	I	2*4
NAME_SIZE	Number of characters in computer's name (U).	I	2
MACHINE_TEXT	Name of computer on which processing occurs.	T	U
OPERATOR_SIZE	Number of characters in operator's name (V).	I	2
OPERATOR_TEXT	Name of operator performing the processing.	T	V
COMMAND_SIZE	Number of characters in command line (W).	I	2
COMMAND_TEXT	Command line used to run processing action.	T	W
COMMENT_SIZE	Number of characters in comment (X).	I	2
COMMENT_TEXT	Summary of processing action.	T	X

Field Name	*Description*	*Field Type*	*Count*
		History Record Size:	***16+U+ V+W+ X***

4.3.12 Navigation error record * obsolete, as of GSF v1.07*

(*This record is obsolete, as of GSF v1.07. The HV Navigation error record supercedes this record and should be used in its place.)*

This record contains estimates of the horizontal position error inherent in the latitude and longitude values in a given data record, along with the first time that the error estimates are valid. The record ID containing the position whose error is being estimated is also included so that a file containing different types of records, each of which contain position, may attribute error estimates for each record. Table 4-12 defines the format of a navigation error record.

Table 4-12 Navigation Error Record Definition

Field Name	*Description*	*Field Type*	*Count*
TIME	Time of error estimate validity.	I	2*4
RECORD_ID	Record ID to which the estimates applies	I	4
LONGITUDE_ERROR	Estimated error in decimeters, 95% CE.	I	4
LATITUDE_ERROR	Estimated error in decimeters, 95% CE.	I	4
		Navigation Error Record Size:	***20***

4.3.13 HV Navigation error record

This record supercedes that specified by the Navigation Error Record. This record contains estimates of the horizontal and vertical position error inherent in a given data record, along with the time that the error estimates are valid. The record ID containing the position whose error is being estimated is also included so that a file containing different types of records, each of which contain position, may attribute error estimates for each record. A variable length field specifies the positioning system that provides the error estimates. Refer to the GSFlib documentation – Supporting Data Structures and Definitions -- for a list of the available four character positioning system codes. Additionally, a field of four characters has been reserved for future use. Table 4-13 defines the format of a HV Navigation error record.

Table 4-13 HV Navigation Error Record Definition

Field Name	*Description*	*Field Type*	*Count*
TIME	Time of error estimate validity.	I	2*4
RECORD_ID	Record ID to which the estimates applies	I	4
HORIZONTAL_ERROR	RMS Errors in meters	I	4
VERTICAL_ERROR	RMS Errors in meters	I	4
SPARE	Reserved space, for future used	T	4
POSITION_TYPE	Character String Code specifying type of positioning system	T	***v***
		Navigation Error Record Size:	***24 + v***

4.3.14 Attitude record

This record contains an array of measurements as reported by the vessel attitude sensor. This allows for the storage of every attitude measurement reported by the motion sensor. The attitude record consists of an integer value defining the number of measurements in the record, followed by arrays of time, pitch, roll, heave, and heading for each measurements. The number of measurements is variable and user-definable, but any single attitude record should contain no more than sixty seconds worth of measurements. Table 4-14 defines the format of an Attitude record.

Table 4-14 Attitude Record Definition

Field Name	*Description*	*Field Type*	*Count*
NUM_MEASUREMENTS	Number of attitude measurements in this record.	I	2
ATTITUDE_TIME	Array of attitude measurement times	I	N*2*4
PITCH	Array of pitch measurements	I	N*4
ROLL	Array of roll measurements	I	N*4
HEAVE	Array of heave measurements	T	N*4
HEADING	Array of heading measurements	T	N*4
		Attitude Record Size:	***Variable***

Appendix A.1 Record Identifier Definition

The record identifiers specified in this section define data records encoded in GSF. Record identifiers are recorded as decimal quantities.

Note that GSF data files may have records that have identifiers not described below; you may ignore records with undefined identifiers. This condition can occur because records with non-zero registry numbers are not defined within the formal specification. See section 4.3.1.2 for more information.

As of GSF v1.07 the NAVIGATION_ERROR record is obsolete. This record will remain as part of the GSF specification and the software library for the next few releases of GSF, allowing users of this record ample time to make the necessary software updates to migrate to the new record. New software releases should use the HV_NAVIGATION_ERROR record instead of the NAVIGATION_ERROR record.

Record Description		Record Identifier
HEADER		1
SWATH_BATHYMETRY_PING		2
SOUND_VELOCITY_PROFILE		3
PROCESSING_PARAMETERS		4
SENSOR_PARAMETERS		5
COMMENT		6
HISTORY		7
NAVIGATION_ERROR	*(obsolete)*	8
SWATH_BATHY_SUMMARY		9
SINGLE_BEAM_SOUNDING	*(use discouraged)*	10
HV_NAVIGATION_ERROR		11
ATTITUDE		12

Appendix A.2 Swath Bathymetry Ping Subrecord Identifier Definition

The subrecord identifiers specified in this section define data elements within the Swath Bathymetry Ping Records. Subrecord identifiers are recorded as decimal quantities.

Subrecord Description	Subrecord Identifier
DEPTH_ARRAY	1
ACROSS_TRACK_ARRAY	2
ALONG_TRACK_ARRAY	3
TRAVEL_TIME_ARRAY	4
BEAM_ANGLE_ARRAY	5
MEAN_CAL_AMPLITUDE_ARRAY	6
MEAN_REL_AMPLITUDE_ARRAY	7
ECHO_WIDTH_ARRAY	8
QUALITY_FACTOR_ARRAY	9
RECEIVE_HEAVE_ARRAY	10
DEPTH_ERROR_ARRAY (*obsolete*)	11
ACROSS_TRACK_ERROR_ARRAY (*obsolete*)	12
ALONG_TRACK_ERROR_ARRAY (*obsolete*)	13
NOMINAL_DEPTH_ARRAY	14
QUALITY_FLAGS_ARRAY	15
BEAM_FLAGS_ARRAY	16
SIGNAL_TO_NOISE_ARRAY	17
BEAM_ANGLE_FORWARD_ARRAY	18
VERTICAL_ERROR_ARRAY	19
HORIZONTAL_ERROR_ARRAY	20
INTENSITY_SERIES_ARRAY	21
SECTOR_NUMBER_ARRAY	22
DETECTION_INFO_ARRAY	23
INCIDENT_BEAM_ADJ_ARRAY	24
SYSTEM_CLEANING_ARRAY	25
DOPPLER_CORRECTION_ARRAY	26
SCALE_FACTORS	100
SEABEAM_SPECIFIC	102
EM12_SPECIFIC	103
EM100_SPECIFIC	104
EM950_SPECIFIC	105
EM121A_SPECIFIC	106
EM121_SPECIFIC	107
SASS_SPECIFIC (*To Be Replaced By CMP_SASS*)	108
SEAMAP_SPECIFIC	109
SEABAT_SPECIFIC	110
EM1000_SPECIFIC	111
TYPEIII_SEABEAM_SPECIFIC (*To Be Replaced By CMP_SASS*)	112
SB_AMP_SPECIFIC	113

Appendix A.3 Single-beam Sounding Subrecord Identifier Definition

The subrecord identifiers specified in this section define data elements within the Swath Bathymetry Ping Records. Subrecord identifiers are recorded as decimal quantities.

Subrecord Description	Subrecord Identifier
ECHOTRAC_SPECIFIC	201
BATHY2000_SPECIFIC	202
MGD77_SPECIFIC	203
BDB_SPECIFIC	204
NOSHDB_SPECIFIC	205

Appendix B.1Swath Bathymetry Ping Sensor-specific Subrecord Definitions

The sensor-specific subrecords are defined for use within the Swath Bathymetry Ping Records in Table B-1. Appendix A.2 defines subrecord identifiers for each subrecord. This specification does not provide detailed information about the data items within these subrecords. Use of these data requires a detailed knowledge of the sensor being used.

Table B-1 Swath Bathymetry Ping Sensor-specific Subrecord Definitions

Field Name	***Description***	***Field Type***	***Count***
SEABEAM ***Subrecord containing fields peculiar to SEABEAM sonar.***			*2*
ECLIPSE_TIME	Eclipse computer clock at time of ping.	U	2
SIMRAD EM100 ***Subrecord containing fields peculiar to Simrad EM100 sonar.***			*11*
SHIP_PITCH	Pitch of ship at ping time in 0.01 degree.	I	2
TRANSDUCER_PITCH	Angle of mechanical pitch stabilizer at ping time in 0.01 degree.	I	2
MODE	Description of sonar's mode.	I	1
POWER	Description of transmitter's power level.	I	1
ATTENUATION	Description of receiver's attenuation level.	I	1
TVG	Description of receiver's time-varying gain curve.	I	1
PULSE_LENGTH	Description of transmitted pulse length.	I	1
COUNTER	Ping counter from Simrad amplitude datagram	I	2
SIMRAD EM950 ***Subrecord containing fields peculiar to Simrad EM950 sonar.***			*10*
PING_NUMBER	Number assigned to ping by sonar.	I	2
MODE	Description of sonar's mode.	I	1
QUALITY	Description of ping quality.	I	1
SHIP_PITCH	Pitch of ship at ping time in hundredths of degrees.	I	2
TRANSDUCER_PITCH	Angle of mechanical pitch stabilizer at ping time in hundredths of degrees.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to	I	2

Field Name	*Description*	*Field Type*	*Count*
	calculate beam angle in tenths of meters/seconds.		
SIMRAD EM1000 ***Subrecord containing fields peculiar to Simrad EM1000 sonar.***			*10*
PING_NUMBER	Number assigned to ping by sonar.	I	2
MODE	Description of sonar's mode.	I	1
QUALITY	Description of ping quality.	I	1
SHIP_PITCH	Pitch of ship at ping time in hundredths of degrees.	I	2
TRANSDUCER_PITCH	Angle of mechanical pitch stabilizer at ping time in hundredths of degrees.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
SIMRAD EM121 ***Subrecord containing fields peculiar to Simrad EM121 sonar.***			*11*
PING_NUMBER	Number assigned to ping by sonar.	I	2
MODE	Description of sonar's mode.	I	1
VALID_BEAMS	Number of valid beams in ping.	I	1
PULSE_LENGTH	Description of transmitted pulse length.	I	1
BEAM_WIDTH	Description of receive beam width.	I	1
TRANSMIT_POWER	Description of transmitter's power level.	I	1
TRANSMIT_STATUS	Number of transmit channels not working.	I	1
RECEIVE_STATUS	Number of receive channels not working.	I	1
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
SIMRAD EM121A ***Subrecord containing fields peculiar to Simrad EM121A sonar.***			*11*
PING_NUMBER	Number assigned to ping by sonar.	I	2
MODE	Description of sonar's mode.	I	1
VALID_BEAMS	Number of valid beams in ping.	I	1
PULSE_LENGTH	Description of transmitted pulse	I	1

Field Name	***Description***	***Field Type***	***Count***
	length.		
BEAM_WIDTH	Description of receive beam width.	I	1
TRANSMIT_POWER	Description of transmitter's power level.	I	1
TRANSMIT_STATUS	Number of transmit channels not working.	I	1
RECEIVE_STATUS	Number of receive channels not working.	I	1
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
SIMRAD EM120, EM300, EM1002, EM3000, EM3002, and EM121A_SIS Subrecord containing fields peculiar to Simrad EM120, EM300, EM1002, EM3000, EM3002, and EM121A_SIS series sonars.			*21+47*L*
MODEL_NUMBER	Model number of Simrad sensor acquiring ping data.	I	2
PING_NUMBER	Number assigned to ping by sonar.	I	2
SERIAL_NUMBER	Serial number of multibeam sonar.	I	2
SURFACE_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
TRANSDUCER_DEPTH	Depth of transducer (transmit depth) in centimeters.	I	2
VALID_BEAMS	Number of valid beams in ping.	I	2
SAMPLE_RATE	Sampling rate (f) in Hz.	I	2
DEPTH_DIFFERENCE	Depth difference between sonar heads of the EM3000D in centimeters.	I	2
OFFSET_MULTIPLIER	Transducer depth offset multiplier	I	1
RUN_TIME_ID	Indicates existence and number of EM3000 series specific run-time parameter arrays (L) in subrecord. Bit 0 set (value of 1) indicates only one set of run-time parameters are included in the subrecord -- used for single headed sonar system. Bit 1 set (value of 2) indicates two sets of run-time parameters complete the	I	4

Field Name	***Description***	***Field Type***	***Count***
	subrecord -- used for the EM3000D series sonar (dual headed) systems. If bit 1 is set, the first element of the array represents the port transducer head while the second array element represents the starboard transducer head.		
RUN_TIME_MODEL_NUMBER(1)	Model number for sonar head	I	2
RUN_TIME_SECONDS(1)	Time at start of data record, in whole seconds since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_NANOSECONDS(1)	Time at start of data record, an additional fractional portion of whole seconds expressed in nanoseconds, since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_PING_NUMBER(1)	Number assigned to ping by sonar	I	2
RUN_TIME_SERIAL_NUMBER(1)	Serial number assigned to sonar head	I	2
RUN_TIME_SYSTEM_STATUS(1)	Identifier describing system status	I	2
RUN_TIME_MODE(1)	Identifier describing sonar mode	I	1
RUN_TIME_FILTER_ID(1)	Identifier describing sonar filter	I	1
RUN_TIME_MIN_DEPTH(1)	Minimum depth setting in meters	I	2
RUN_TIME_MAX_DEPTH(1)	Maximum depth setting in meters	I	2
RUN_TIME_ABSORPTION(1)	Absorption coefficient in hundredths of dB/km	I	2
RUN_TIME_PULSE_LENGTH(1)	Transmit pulse length in microseconds	I	2
RUN_TIME_TRANSMIT_BEAM_WIDTH(1)	Transmit beam width in tenths of degrees	I	2
RUN_TIME_POWER_REDUCTION(1)	Transmit power reduction in dB	I	1
RUN_TIME_RECEIVE_BEAM_WIDTH(1)	Receive beamwidth in tenths of degrees	I	1
RUN_TIME_RECEIVE_BANDWIDTH(1)	Receive bandwidth in fifty Hz resolution	I	1
RUN_TIME_RECEIVE_GAIN(1)	Receiver fixed gain setting in dB	I	1
RUN_TIME_CROSS_OVER_ANGLE(1)	TVG law crossover angle in degrees	I	1

Field Name	***Description***	***Field Type***	***Count***
RUN_TIME_SSV_SOURCE(1)	Source of sound speed at transducer	I	1
RUN_TIME_PORT_SWATH_WIDTH(1)	Maximum port swath width in meters	I	2
RUN_TIME_BEAM_SPACING(1)	Beam Spacing	I	1
RUN_TIME_PORT_COVERAGE_SECTOR(1)	Port coverage sector in degrees	I	1
RUN_TIME_STABILIZATION(1)	Yaw and pitch stabilization mode	I	1
RUN_TIME_STBD_COVERAGE_SECTOR(1)	Starboard coverage sector in degrees	I	1
RUN_TIME_STBD_SWATH_WIDTH(1)	Maximum starboard swath width in meters	I	2
RUN_TIME_HILO_FREQ_ABSORP_RATIO(1)	HiLo frequency absorption coefficient ratio	I	1
RUN_TIME_SPARE(1)	Reserved for future use.	I	4
RUN_TIME_MODEL_NUMBER(2)	Model number for sonar head	I	2
RUN_TIME_SECONDS(2)	Time at start of data record, in whole seconds since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_NANOSECONDS(2)	Time at start of data record, an additional fractional portion of whole seconds expressed in nanoseconds, since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_PING_NUMBER(2)	Number assigned to ping by sonar	I	2
RUN_TIME_SERIAL_NUMBER(2)	Serial number assigned to sonar head	I	2
RUN_TIME_SYSTEM_STATUS(2)	Identifier describing system status	I	2
RUN_TIME_MODE(2)	Identifier describing sonar mode	I	1
RUN_TIME_FILTER_ID(2)	Identifier describing sonar filter	I	1
RUN_TIME_MIN_DEPTH(2)	Minimum depth setting in meters	I	2
RUN_TIME_MAX_DEPTH(2)	Maximum depth setting in meters	I	2
RUN_TIME_ABSORPTION(2)	Absorption coefficient in hundredths of dB/km	I	2
RUN_TIME_PULSE_LENGTH(2)	Transmit pulse length in microseconds	I	2
RUN_TIME_TRANSMIT_BEAM_WIDTH(2)	Transmit beam width in tenths of degrees	I	2
RUN_TIME_POWER_REDUCTION(2)	Transmit power reduction in dB	I	1

Field Name	***Description***	***Field Type***	***Count***
RUN_TIME_RECEIVE_BEAM_WIDTH(2)	Receive beamwidth in tenths of degrees	I	1
RUN_TIME_RECEIVE_BANDWIDTH(2)	Receive bandwidth in fifty Hz resolution	I	1
RUN_TIME_RECEIVE_GAIN(2)	Receiver fixed gain setting in dB	I	1
RUN_TIME_CROSS_OVER_ANGLE(2)	TVG law crossover angle in degrees	I	1
RUN_TIME_SSV_SOURCE(2)	Source of sound speed at transducer	I	1
RUN_TIME_PORT_SWATH_WIDTH(2)	Maximum port swath width in meters	I	2
RUN_TIME_BEAM_SPACING(2)	Beam Spacing	I	1
RUN_TIME_PORT_COVERAGE_SECTOR(2)	Port coverage sector in degrees	I	1
RUN_TIME_STABILIZATION(2)	Yaw and pitch stabilization mode	I	1
RUN_TIME_STBD_COVERAGE_SECTOR(2)	Starboard coverage sector in degrees	I	1
RUN_TIME_STBD_SWATH_WIDTH(2)	Maximum starboard swath width in meters	I	2
RUN_TIME_HILO_FREQ_ABSORP_RATIO(2)	HiLo frequency absorption coefficient ratio	I	1
RUN_TIME_SPARE(2)	Reserved for future use.	I	4
SEAMAP ***Subrecord containing fields peculiar to Seamap sonar.***			*22*
PORT_TRANSMIT_1	Level of first port transmitter.	I	2
PORT_TRANSMIT_2	Level of second port transmitter.	I	2
STBD_TRANSMIT_1	Level of first starboard transmitter.	I	2
STBD_TRANSMIT_2	Level of second starboard transmitter.	I	2
PORT_GAIN	Gain of port receive channel, in tenths of decibels.	I	2
STBD_GAIN	Gain of starboard receive channel, in tenths of decibels.	I	2
PORT_PULSE_LENGTH	Length of port transmission, in tenths of seconds.	I	2
STBD_PULSE_LENGTH	Length of starboard transmission, in tenths of seconds.	I	2
PRESSURE_DEPTH	Depth measured by pressure sensor, in tenths of meters.	I	2
ALTITUDE	Distance of towbody from seafloor, in tenths of meters.	I	2
TEMPERATURE	Temperature at towbody location,	I	2

Field Name	*Description*	*Field Type*	*Count*
	in tenths of degrees Centigrade.		
SEABAT 9000 ***Subrecord containing fields peculiar to RESON SeaBat 9000 Series sonars. Obsolete; see SEABAT 9000 II Subrecord.***			*8*
PING_NUMBER	Number assigned to ping by sonar.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
MODE	Description of sonar mode setting.	I	1
RANGE	Description of sonar range setting.	I	1
TRANSMIT_POWER	Description of transmitter's power level.	I	1
RECEIVE_GAIN	Description of receiver's gain setting.	I	1
SEABEAM with Amplitude ***Subrecord containing fields peculiar to SEABEAM sonar with amplitude beam values.***			*2*
HOUR	Hour of Eclipse computer clock at time of ping.	I	1
MINUTE	Minute of Eclipse computer clock at time of ping	I	1
SECOND	Seconds of Eclipse computer clock at time of ping	I	1
HUNDREDTHS	Hundredths of seconds of Eclipse computer clock at time of ping	I	1
BLOCK_NUMBER	Block number	I	4
AVG_GATE_DEPTH	Average Depth of Bottom Gate	I	2
SEABAT 9000 II ***Subrecord containing fields peculiar to RESON SeaBat 9000 Series sonars. First SEABAT 9000 Subrecord is obsolete.***			*14*
PING_NUMBER	Number assigned to ping by sonar.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
MODE	Description of sonar mode setting.	I	1
RANGE	Description of sonar range setting.	I	1
TRANSMIT_POWER	Description of transmitter's	I	1

Field Name	***Description***	***Field Type***	***Count***
	power level.		
RECEIVE_GAIN	Description of receiver's gain setting.	I	1
TRANSMIT_BEAMWIDTH	Transmit beamwidth, in tenths of degrees.	I	1
RECEIVE_BEAMWIDTH	Receive array beamwidth, in tenths of degrees.	I	1
RESERVED	Reserved for future use	I	4
SEABAT 8101 ***Subrecord containing fields peculiar to RESON SeaBat 8101 Series sonars.*** ***Obsolete. See Reson 8100 subrecord.***			*31*
PING_NUMBER	Number assigned to ping by sonar.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
MODE	Description of sonar mode setting.	I	2
RANGE	Description of sonar range setting.	I	2
TRANSMIT_POWER	Description of transmitter's power level.	I	2
RECEIVE_GAIN	Description of receiver's gain setting.	I	2
PULSE_WIDTH	Transmit pulse width	I	2
TVG_SPREADING	TVG spreading coefficient	I	1
TVG_ABSORPTION	TVG absorption coefficient	I	1
TRANSMIT_BEAMWIDTH	Transmit beamwidth, in tenths of degrees.	I	1
RECEIVE_BEAMWIDTH	Receive array beamwidth, in tenths of degrees.	I	1
RANGE_FILTER_MINIMUM	Range filter minimum value in meters.	I	2
RANGE_FILTER_MAXIMUM	Range filter maximum value in meters.	I	2
DEPTH_FILTER_MINIMUM	Depth filter minimum value in meters.	I	2
DEPTH_FILTER_MAXIMUM	Depth filter maximum value in meters.	I	2
PROJECTOR_TYPE	Type of projector used for transmission	I	1
RESERVED	Reserved for future use	I	4

Field Name	***Description***	***Field Type***	***Count***
SEABEAM 2112 Subrecord containing fields peculiar to SEABEAM 2112 sonars.			*16*
MODE	Sonar mode of operation	I	1
SURFACE_SOUND_VELOCITY	Surface sound velocity in hundredths of meters/second	I	2
SSSV_SOURCE	Source of surface sound velocity	I	1
PING_GAIN	Ping gain	I	1
PULSE_WIDTH	Ping pulse width	I	1
TRANSMITTER_ATTENUATION	Transmitter attenuation	I	1
NUMBER_ALGORITHMS	Number of algorithms in use.	I	1
ALGORITHM_ORDER	Order of algorithm use.	I	4
RESERVED	Reserved	I	4
ELAC MKII Subrecord containing fields peculiar to ELAC BottomChart MkII sonar.			*11*
MODE	Sonar mode of operation	I	1
COUNTER	Ping counter	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity in meters/sec.	I	2
PULSE_LENGTH	Transmit pulse length in hundredth of seconds.	I	2
RECEIVER_GAIN_STBD	Starboard transceiver receive gain in decibels	I	1
RECEIVER_GAIN_PORT	Port transceiver receive gain in decibels	I	1
RESERVED	Reserved	I	2
TYPEIII SASS Subrecord containing fields peculiar to SASS TypeIII data. This subrecord will be replaced by the COMPRESSED SASS subrecord. Future releases should use the COMPRESSED SASS subrecord.			*10*
LEFTMOST_BEAM	Leftmost beam of sonar ping	I	2
RIGHTMOST_BEAM	Rightmost beam of sonar ping	I	2
TOTAL_NUMBER_OF_BEAMS	Number of beams in ping	I	2
NAVIGATION_MODE	Description of sonar's navigation mode	I	2
PING_NUMBER	Number assigned to ping by sonar	I	2
MISSION_NUMBER	Mission number assigned to ping	I	2
COMPRESSED SASS (BOSDATA) Subrecord containing fields peculiar to the SASS*YERG Compressed Data Format. This format may contain SASS, SASS IV, SASS V, NAVO Seabeam, BTOSS or Simrad Sonar Data.			*4*
LFREQ	Sea surface sound velocity in	I	2

Field Name	***Description***	***Field Type***	***Count***
	tenths of feet/second, from BOSDAT (lfreq)		
LNTENS	Since 1992, used to record heave value for ping in tenths of meters; prior to 1992, the content of this field is undocumented.	I	2
RESON 8100 ***Subrecord containing fields peculiar to RESON SeaBat 8100 Series sonars. This format may contain data from an 8101, 8111, 8125, 8150 or 8160 sonar.***			*31*
LATENCY	Time from ping to output (milliseconds).	I	2
PING_NUMBER	Number assigned to ping by sonar.	I	4
SONAR_ID	Least significant 4 bytes of Ethernet address.	I	4
SONAR_MODEL	Model number of sonar (8101, 8125, etc.).	I	2
FREQUENCY	Sonar frequency in KHz.	I	2
SURFACE_SOUND_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
SAMPLE_RATE	A/D samples per second.	I	2
PING_RATE	Pings per second.	I	2
MODE	Description of sonar mode setting.	I	2
RANGE	Description of sonar range setting.	I	2
TRANSMIT_POWER	Description of transmitter's power level.	I	2
RECEIVE_GAIN	Description of receiver's gain setting.	I	2
PULSE_WIDTH	Transmit pulse width	I	2
TVG_SPREADING	TVG spreading coefficient	I	1
TVG_ABSORPTION	TVG absorption coefficient	I	1
TRANSMIT_BEAMWIDTH	Transmit beamwidth, in tenths of degrees.	I	1
RECEIVE_BEAMWIDTH	Receive array beamwidth, in tenths of degrees.	I	1
PROJECTOR_TYPE	Description of sonar projector type.	I	1
PROJECTOR_ANGLE	Projector pitch steering angle.	I	2
RANGE_FILTER_MINIMUM	Range filter minimum value in meters.	I	2

Field Name	***Description***	***Field Type***	***Count***
RANGE_FILTER_MAXIMUM	Range filter maximum value in meters.	I	2
DEPTH_FILTER_MINIMUM	Depth filter minimum value in meters.	I	2
DEPTH_FILTER_MAXIMUM	Depth filter maximum value in meters.	I	2
FILTERS_ACTIVE	Describes if range filter and/or depth filters are active.	I	1
TEMPERATURE	Temperature at sonar head.	I	2
BEAM_SPACING	Across-track angular beam spacing in degrees.	I	2
RESERVED	Reserved for future use	I	2
SIMRAD EM710, EM302, EM122 ***Subrecord containing fields peculiar to Simrad EM710, EM302, EM122 series sonars.***			*21+47*L*
MODEL_NUMBER	Model number of Simrad sensor acquiring ping data.	I	2
PING_COUNTER	Number assigned to ping by sonar.	I	2
SERIAL_NUMBER	Serial number of multibeam sonar.	I	2
SURFACE_VELOCITY	Surface sound velocity used to calculate beam angle in tenths of meters/seconds.	I	2
TRANSDUCER_DEPTH	Depth of transducer (transmit depth) in 0.00005 meters.	I	4
VALID_DETECTIONS	Number of beams with a valid detection for this ping.	I	2
SAMPLING_FREQUENCY	Sampling rate (f) in 4.0e-9 Hz.	I	8
DOPPLER_CORRECTION_SCALE	Scale factor value to be applied to Doppler correction field prior to applying correction	I	4
VECHICLE_DEPTH	From 0x66 datagram, non-zero when sonar head is mounted on a sub-sea platform in 0.001 meters.	I	4
SPARE_1		I	16
TRANSMIT_SECTORS (Number Sectors)	The number of transmit sectors for this ping	I	2
Number Sector entries of:	Array of structures with transmit sector information, cycle repeats for each sector.		
Tilt Angle	The transmitter title angle in degrees.	I	2

Field Name	***Description***	***Field Type***	***Count***
Focus Range	The focusing range in meters. 0.0 for no focusing.	I	2
Signal Length	The transmit signal duration in seconds.	I	4
Transmit Delay	The sector transmit delay from the first transmission in seconds.	I	4
Center Frequency	The center frequency in Hz.	I	4
Mean Absorption	The mean absorption coefficient in 0.01 dB/kilometer	I	2
Waveform ID	The signal waveform ID (0=CW, 1=FM upsweep, 2=FM downsweep)	I	1
Sector Number	The transmit sector number	I	1
Signal Bandwidth	The signal Bandwidth in Hz.	I	4
Spare	Spare space reserved for future use.	I	16
SPARE_2	Spare space reserved for future use.	I	16
RUN_TIME_MODEL_NUMBER	Model number for sonar head	I	2
RUN_TIME_SECONDS	Time at start of data record, in whole seconds since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_NANOSECONDS	Time at start of data record, an additional fractional portion of whole seconds expressed in nanoseconds, since 00:00:00 Coordinated Universal Time, January 1, 1970.	I	4
RUN_TIME_PING_COUNTER	Number assigned to ping by sonar	I	2
RUN_TIME_SERIAL_NUMBER	Serial number assigned to sonar head	I	2
RUN_TIME_OPERATOR_STATION_STATUS	Bit mask of status information for operator station.	I	1
RUN_TIME_PROCESSING_UNIT_STATUS	Bit mask of status information for processing unit.	I	1
RUN_TIME_BSP_STATUS	Bit mask of status for BSP.	I	1
RUN_TIME_HEAD_TRANSCEIVER_STATUS	Bit mask of status for sonar transceiver.	I	1
RUN_TIME_MODE	Identifier describing sonar mode	I	1
RUN_TIME_FILTER_ID	Identifier describing sonar filter	I	1

Field Name	*Description*	*Field Type*	*Count*
RUN_TIME_MIN_DEPTH	Minimum depth setting in meters	I	2
RUN_TIME_MAX_DEPTH	Maximum depth setting in meters	I	2
RUN_TIME_ABSORPTION	Absorption coefficient in hundredths of dB/km	I	2
RUN_TIME_PULSE_LENGTH	Transmit pulse length in microseconds	I	2
RUN_TIME_TRANSMIT_BEAM_WIDTH	Transmit beam width in tenths of degrees	I	2
RUN_TIME_POWER_REDUCTION	Transmit power reduction in dB	I	1
RUN_TIME_RECEIVE_BEAM_WIDTH	Receive beamwidth in tenths of degrees	I	1
RUN_TIME_RECEIVE_BANDWIDTH	Receive bandwidth in fifty Hz resolution	I	1
RUN_TIME_RECEIVE_GAIN	Receiver fixed gain setting in dB	I	1
RUN_TIME_CROSS_OVER_ANGLE	TVG law crossover angle in degrees	I	1
RUN_TIME_SSV_SOURCE	Source of sound speed at transducer	I	1
RUN_TIME_PORT_SWATH_WIDTH	Maximum port swath width in meters	I	2
RUN_TIME_BEAM_SPACING	Beam Spacing	I	1
RUN_TIME_PORT_COVERAGE_SECTOR	Port coverage sector in degrees	I	1
RUN_TIME_STABILIZATION	Yaw and pitch stabilization mode	I	1
RUN_TIME_STBD_COVERAGE_SECTOR	Starboard coverage sector in degrees	I	1
RUN_TIME_STBD_SWATH_WIDTH	Maximum starboard swath width in meters	I	2
RUN_TIME_DUROTONG_SPEED	Outer beam angle coverage correction value for EM1002	I	2
RUN_TIME_HILO_FREQ_ABSORP_RATIO	HiLo frequency absorption coefficient ratio	I	1
RUN_TIME_SPARE	Reserved for future use.	I	16
PU_CPU_LOAD	Percent CPU load in the processor unit		2
SENSOR_STATUS	Bit mask containing status of sensor inputs		2
ACHIVED_PORT_COVERAGE	Achieved coverage to port in degrees		2
ACHIEVED_STDB_COVERAGE	Achieved coverage to starboard in degrees		2
YAW_STABILIZATION	Yaw stabilization in degress		2
SPARE			16

Field Name	Description	Field Type	Count
Klein 5410 Bathymetric Sidescan ***Subrecord containing fields peculiar to Klein 5410 sidescan/bathymetry sonar systems.***			*86*
DATA_SOURCE	Descriptor for source data format: 0 indicates SDF.	U	2
SIDE	Descriptor for port/starboard side: 0 indicates port; 1 indicates starboard.	U	2
MODEL_NUMBER	Descriptor to indicate the specific Klein model number.	U	2
ACOUSTIC_FREQUENCY	The system frequency in Hz.	U	4
SAMPLING_FREQUENCY	The sampling frequency in Hz.	U	4
PING_NUMBER	Four byte ping counter.	U	4
NUM_SAMPLES	Total number of samples for this ping.	U	4
NUM_RAA_SAMPLES	The number of valid range, angle, amplitude triplets for this ping.	U	4
ERROR_FLAGS	The error flags for this ping.	U	4
RANGE	The sonar range setting.	U	4
FISH_DEPTH	Reading from towfish pressure sensor in Volts.	U	4
FISH_ALTITUDE	Towfish altitude in m.	U	4
SOUND_SPEED	Speed of sound at the transducer face in m/s.	U	4
TX_WAVEFORM	Descriptor for transmit pulse: 0 = 132 microseconds CW; 1 = 132 microseconds FM; 2 = 176 microseconds CW; 3= 176 microseconds FM.	U	2
ALTIMETER	Altimeter status: 0 = passive, 1 = active.	U	2
RAW_DATA_CONFIG	Raw data configuration.	U	4
SPARE[32]	Spare space reserved for potential use in the future.	I	32
GeoAcoustics Ltd GeoSwath Plus ***Subrecord containing fields peculiar to Geoacoustics GS+ interferrometric side-scan/bathymetry sonar systems. This format may contain data from an GS+ sonar.***			*31*
DATA_SOURCE	Descriptor for source data format. 0 indicates CBF, 1 indicates RDF	I	2
SIDE	Descriptor for port/starboard side. 0 indicates port, 1 indicates starboard.	I	2

Field Name	***Description***	***Field Type***	***Count***
MODEL_NUMBER	Descriptor to indicate the specific GS+ model number (100, 250, 500, …)	I	2
FREQUENCY	The system frequency in Hz.	F	2
ECHOSOUNDER_TYPE	Originates from RDF format.	I	2
PING_NUMBER	Four byte ping counter	I	4
NUM_NAV_SAMPLES	The number of navigation samples included for this ping.	I	2
NUM_ATTITUDE_SAMPLES	The number of attitude samples included for this ping.	I	2
NUM_HEADING_SAMPLES	The number of heading samples included for this ping.	I	2
NUM_MINISVS_SAMPLES	The number of surface sound speed measurments for this ping.	I	2
NUM_ECHOSOUNDER_SAMPLES	The number of vertical beam echosounder samples for this ping.	I	2
NUM_RAA_SAMPLES	The number of range, angle, amplitude triplets for this ping.	I	2
MEAN_SV	The mean sound speed in m/s	F	2
SURFACE_VELOCITY	The sound speed at the transducer	F	2
VALID_BEAMS	The number of valid measurements for this ping	I	2
SAMPLE_RATE	The sonar system sample rate in Hz.	F	2
PULSE_LENGTH	The acoustic pulse length in microseconds	F	2
TRANSMIT_POWER	The sonar system transmit power	I	2
SIDESCAN_GAIN_CHANNEL	The sonar system gain	I	2
STABILIZATION	0 indicates no stabilization, 1 indicates pitch stabilized	I	2
GPS_QUALITY	GPS quality indicator from RDF	I	2
RANGE_UNCERTAINTY	The range measurement uncertainty in meters	F	2
ANGLE_UNCERTAINTY	The angle measurement uncertainty in degrees	F	2
SPARE[32]	Spare space reserved for potential us in the future.	I	32
SB_ECHOTRAC ***Subrecord containing fields peculiar to ODOM Echotrac and PDD single-beam sonars, as well as ODEC Bathy 2000 single-beam sonars.***			*10*

Field Name	***Description***	***Field Type***	***Count***
NAV_ERROR	Navigation error.	I	2
MPP_SOURCE	Flag to determine source of navigation.	I	1
TIDE_SOURCE	Source of tide correctors, this information should also be stored in the ping flags.	I	1
DYNAMIC_DRAFT	Speed induced draft in meters	I	2
SPARE	Reserved for future use.	I	4
SB_MGD77 ***Subrecord containing fields peculiar to MGD77 single-beam archival data.***			*18*
TIME_ZONE_CORR	Time zone corrector	I	2
POSITION_TYPE_CODE	Position type code.	I	2
CORRECTION_CODE	Manner in which sound velocity correction was made.	I	2
BATHY_TYPE_CODE	Manner in which bathymetry was obtained	I	2
QUALITY_CODE	Navigation quality code.	I	2
TRAVEL_TIME	Two way travel time in 0.0001 seconds	I	4
SPARE	Reserved for future use.	I	4
SB_BDB ***Subrecord containing fields peculiar to BDB single-beam archival data..***			*14*
DOC_NO	Doc. No.	I	4
EVAL	Evaluation flag.	I	1
CLASSIFICATION	Classification flag.	I	1
TRACK_ADJ_FLAG	Track adjustment flag.	I	1
SOURCE_FLAG	Source flag.	I	1
PT_OR_TRACK_LN	Discrete point of track line flag.	I	1
DATUM_FLAG	Datum flag	I	1
SPARE	Reserved for future use.	I	4
SB_NOSHDB ***Subrecord containing fields peculiar to NOS HDB single-beam archival data..***			*8*
TYPE_CODE	Depth type code	I	2
CARTO_CODE	Cartographic code	I	2
SPARE	Reserved for future use.	I	4
SB_NAVISOUND ***Subrecord containing fields peculiar to Navisound single-beam data.***			*10*
PULSE_LENGTH	Pulse length in meters.	I	2
SPARE	Reserved for future use.	I	8

Appendix B.2Single-beam Sounding Sensor-specific Subrecord Definitions

The sensor-specific subrecords are defined for use within Single-beam Sounding Ping Records. Subrecord identifiers for each subrecord are defined in Appendix A.3. This specification does not provide detailed information about the data items within these subrecords. Usage of these data requires a detailed knowledge of the sensor being used.

Table B-2 Single-beam Sounding Sensor-specific Subrecord Definitions

Field Name	***Description***	***Field Type***	***Count***
ECHOTRAC ***Subrecord containing fields peculiar to ODOM Echotrac sonar.***			*4*
NAV_ERROR	Navigation error	I	2
NAV_SOURCE	Source of navigation	I	1
TIDE_SOURCE	Source of tide correctors.	I	1
BATHY2000 ***Subrecord containing fields peculiar to ODEC Bathy 2000 sonar.***			*4*
NAV_ERROR	Navigation error	I	2
NAV_SOURCE	Source of navigation	I	1
TIDE_SOURCE	Source of tide correctors.	I	1
MGD77 ***Subrecord containing fields peculiar to MGD77 archival data.***			*14*
TIME_ZONE_CORR	Time zone corrector	I	2
POSITION_TYPE_CODE	Position type code.	I	2
CORRECTION_CODE	Manner in which sound velocity correction was made.	I	2
BATHY_TYPE_CODE	Manner in which bathymetry was obtained	I	2
QUALITY_CODE	Navigation quality code.	I	2
TRAVEL_TIME	Two way travel time in 0.0001 seconds	I	4
BDB ***Subrecord containing fields peculiar to BDB archival data..***			*10*
DOC_NO	Doc. No.	I	4
EVAL	Evaluation flag.	I	1
CLASS	Classification flag.	I	1
TRACK_ADJ_FLAG	Track adjustment flag.	I	1
SOURCE_FLAG	Source flag.	I	1
PT_OR_TRACK_LN	Discrete point of track line flag.	I	1
DATUM_FLAG	Datum flag	I	1
NOSHDB ***Subrecord containing fields peculiar to NOS HDB archival data..***			*4*
TYPE_CODE	Depth type code	I	2
CARTO_CODE	Cartographic code	I	2

Appendix B.3 Bathymetric Receive Beam Imagery Sensor-specific Subrecord Definitions

The sensor-specific subrecords are defined for use within Bathymetric Receive Beam Intensity Ping subecords, and Wide Receive Beam Intensity subrecords. This specification does not provide detailed information about the data items within these subrecords. Usage of these data requires a detailed knowledge of the sensor being used.

Table B-3 Imagery Sensor-specific Subrecord Definitions

Field Name	***Description***	***Field Type***	***Count***
SIMRAD EM120, EM300, EM1002, EM3000, EM3002, and EM121A_SIS ***Subrecord containing fields peculiar to Simrad EM120, EM300, EM1002, EM3000, EM3002, and EM121A_SIS series sonars.***			*18*
RANGE_NORM	Range to normal incidence used to correct sample amplitudes (in samples)	I	2
START_TVG_RAMP	Start range sample of TVG ramp if not enough dynamic range (0 else)	I	2
STOP_TVG_RAMP	Stop range sample of TVG ramp if not enough dynamic range (0 else)	I	2
BSN	Normal incidence BS in dB	I	1
BSO	Oblique BS in dB	I	1
MEAN_ABSORPTION	Mean absorption coefficient in dB/km, resolution of 0.01 dB/km.	I	2
Offset	The DC offset used to scale imagery sample received from the sonar to range of positive values for storage in GSF.	I	2
Scale	The multiplier used to scale the values received from the sonar to range of positive values for storage in GSF.	I	2
SPARE	For future use.	I	4
RESON 8100 ***Subrecord containing fields peculiar to RESON SeaBat 8100 Series sonars. This format may contain data from an 8101, 8111, 8125, 8150 or 8160 sonar.***			*8*
SPARE	For future use.	I	8
SIMRAD EM122, EM302, EM710 ***Subrecord containing fields peculiar to Simrad EM122, EM302, and EM710 series sonars.***			
SAMPLING_FREQUENCY	The sonar system digitizing rate in 4e-9 Hz.	I	8
MEAN_ABSORPTION	The mean absorption coefficient in dB/kilometer.	I	2

Field Name	***Description***	***Field Type***	***Count***
TX_PULSE_LENGTH	The transmit pulse length in microseconds	I	2
RANGE_NORM	The range to normal incidence (in samples) used to correct sample amplitudes.	I	2
START_TVG_RAMP	The start range (in samples) of TVG ramp if not enough dynamic range, 0 means not used.	I	2
STOP_TVG_RAMP	The stop range (in samples) of TVG ramp if not enough dynamic range, 0 means not used.	I	2
BSN	The normal incidence BS in dB.	I	2
BSO	The oblique incidence in BS in dB.	I	2
TX_BEAM_WIDTH	The transmit beam width in 0.1 degrees.	I	2
TVG_CROSS_OVER	The TVG law crossover angle in 0.1 degrees.		
Offset	The DC offset used to scale imagery sample received from the sonar to range of positive values for storage in GSF.	I	2
Scale	The multiplier used to scale the values received from the sonar to range of positive values for storage in GSF.	I	2
SPARE		I	20
Klein 5410 Bathymetric Sidescan ***Subrecord containing fields peculiar to Klein 5410 sidescan/bathymetry sonar systems.***			*18*
RES_MODE	Descriptor for resolution mode: 0 = normal; 1 = high.	U	2
TVG_PAGE	TVG page number.	U	2
BEAM_ID[5]	An array of identifiers for five sidescan beam magnitude time series, starting with beam id 1 as the forward-most.	U	2*5
SPARE	For future use.	I	4

Appendix C.1 Standard Ping Flag Definitions

The following definitions represent commonly used definitions for the GSF ping bit flags. If GSF_IGNORE_PING is set and nothing else is set then the whole ping had no bottom detections made, otherwise bits 1 through 11 specify the reason(s) why the ping was flagged.

IGNORE_PING	GSF_IGNORE_PING
OFF_LINE_PING	GSF_PING_USER_FLAG_01
BAD_TIME	GSF_PING_USER_FLAG_02
BAD_POSITION	GSF_PING_USER_FLAG_03
BAD_HEADING	GSF_PING_USER_FLAG_04
BAD_ROLL	GSF_PING_USER_FLAG_05
BAD_PITCH	GSF_PING_USER_FLAG_06
BAD_HEAVE	GSF_PING_USER_FLAG_07
BAD_DEPTH_CORRECTOR	GSF_PING_USER_FLAG_08
BAD_TIDE_CORRECTOR	GSF_PING_USER_FLAG_09
BAD_SVP	GSF_PING_USER_FLAG_10
NO_POSITION	GSF_PING_USER_FLAG_11

The bit GSF_PING_USER_FLAG_12 is used to indicate that a delayed heave correction has been applied.

DELAYED_HEAVE_APPLIED	GSF_PING_USER_FLAG_12

The bits GSF_PING_USER_FLAG_14 and GSF_PING_USER_FLAG_15 are used to describe the source of the tide correctors applied to a ping, as described in Table C-1.

Table C-1 Ping Flag Tide Source Descriptions

Source of tide corrector.	***Bit 15***	***Bit 14***
Unkown	0	0
Predicted	0	1
Observed, preliminary	1	0
Observed, verified	1	1

Appendix C.2 Standard Beam Flag Definitions

The lower order two bits of the eight bit beam flag value are used to categorize the flag as either informational, a beam to ignore, or a selected beam. When the first two bits designate that a beam is flagged as ignore, the remaining bits specify the reason the beam is to be ignored. When the fist two bits designate that a beam is selected, the remaining six bits specify the reason why the beam is selected. The only informational bit defined is that a beam exceeds "class 1" criteria.

Category 00 (INFORMATIONAL)
xxx1xx00 => This beam exceeds class 1 criteria.

Category 01 (IGNORE)
00000001 => This beam is to be ignored, no detection was made by the sonar.
xxxxx101 => This beam is to be ignored, it has been manually edited.
xxxx1x01 => This beam is to be ignored, it has been filter edited.
xx1xxx01 => This beam is to be ignored, since it exceeds "class 2" criteria.
x1xxxx01 => This beam is to be ignored, since it exceeds the maximum footprint.
1xxxxx00 => This beam is to be ignored, since it exceeds the uncertainty criteria.

Category 10 (SELECTED)
00000010 => Selected sounding, no reason specified.
xxxxx110 => Selected sounding, it is a least depth.
xxxx1x10 => Selected sounding, it is a maximum depth.
xx1xxx10 => Selected sounding, it has been identified as a feature
x1xxxx10 => Selected sounding, spare.
1xxxxx10 => Selected sounding, spare.