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TITLE:

ZODIAC SOFTWARE DATA INTERFACE

I/O SPECIFICATION

(Proprietary - For Internal Use Only)

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1 ZODIAC DATA TYPES AND MESSAGE FORMATS

This document describes all of the various data types and messages that can be communicated across the host port serial data interface for any of the Zodiac family of Global Positioning System (GPS) receiver engines. Binary messages are described in Section 2. National Marine Electronics Association (NMEA) messages are described in Section 3. Radio Technical Commission For Maritime Services Special Committee 104 (RTCM SC-104) messages provide Differential GPS (DGPS) corrections to the Zodiac receiver and are described in Section 4.

Any subset of these messages used by a specific Zodiac receiver product will be described in the appropriate data sheet that corresponds to that product or in a separate Software Data Interface Specification.

1.1 Overview Of The Zodiac System

The Zodiac family of GPS receivers consists of two major software components: the Measurement Engine software and the Navigation Engine software. Both of these components work together with the Zodiac chip set to provide a complete solution for integrating GPS functionality into Original Equipment Manufacturer (OEM) products.

1.1.1 Measurement Engine Software. The Measurement Engine software is hosted on the Zodiac “Scorpio” 12-channel Digital Signal Processor (DSP) device. The “Scorpio” device contains an embedded Advanced Architecture Microprocessor 2-8 (AAMP 2-8) and embedded Multifunction Interface (MFI) logic.

The Measurement Engine software is responsible for all of the hardware dependent functions of the Zodiac system. This includes GPS satellite processing (acquisition, tracking, data demodulation), serial I/O, real-time clock support, and power management.

Its primary function is to produce GPS measurements and telemetry (navigation message) data for all visible satellites in an autonomous or commanded mode. Satellite pre-positioning is not required but is recommended for optimal performance.

Data is exchanged between the Measurement Engine and the rest of the navigation system. When the rest of the system resides in the AAMP 2-8 together with the Measurement Engine software, the data exchange occurs in the defined memory space directly between the Measurement Engine and the Navigation Engine software components.

When the rest of the system resides on a separate processor, data is accessed in one of two ways: 1) serial I/O messages may be used to communicate between the two processors to read and write data into I/O space, or 2) the navigation processor may implement a memory mapped interface using the external Measurement Engine’s Direct Memory Access (DMA) signals to read and write directly to the I/O space of the Measurement Engine.

In all three of the above cases, the intent is for the Measurement Engine’s core system to exchange data using the defined I/O memory space in the same way. Sections 2 and 3 of this document describe the serial data messages recognized by the Zodiac family of receivers. DMA I/O is described in Appendix A.

1.1.2 Navigation Engine Software. The Navigation Engine software is hardware independent and is portable to the OEM processor via a C-language library. The primary function of this software is to produce a navigation solution using the measurement and telemetry data from the Measurement Engine software.

The Navigation Engine software also manages the satellite database, computes the satellite state, performs differential corrections, and maintains the visible satellite list. After processing the Measurement Engine data, the Navigation Engine can provide feedback of satellite pre-positioning data and solution error data back to the Measurement Engine.

1.2 Binary Message Format And Word Structure

1.2.1 Binary Message Format. The input/output binary data stream format is transmitted as a series of 16-bit words. Each word is sent low byte first followed by the high byte ("little endian"). Each byte is output with its Least Significant Bit (LSB) first, followed by its higher order bits, ending with the Most Significant Bit (MSB) of the data byte (the usual serial format).

The binary message format is nearly identical to that used by the previous NavCore/MicroTracker series of receivers, except that all floating point values are now represented as fixed-point integer numbers with explicit or implied scale factors.

Each binary message consists of a header portion and a data portion, each with its own checksum. Each message will have a header, but some messages may not have data. Message acknowledgements are in the form of a header, and message requests are made using headers as well. Table I-1 shows the data types used to define the elements of the binary interface messages.

1.2.2 Word Structure. An integer is defined as 16 bits. While offsets are incorporated in the message description tables, the most convenient specification of memory layout in application implementation is likely to be a structure definition.

If the item is a fixed point quantity, the value of the LSB of the integer is given. To convert a fixed point item to a floating point variable, the integer representation is floated and multiplied by the resolution. When converting to float, consideration must be given to the range and resolution of the item to ensure that the type of float selected for the conversion has an adequate mantissa length to preserve the accuracy of the data item. Triple word items may require scaling portions of the variable separately and then adding them in floating point form.

1.2.3 Custom OEM Input Message. Message 1400 has been added to the message structure to support some OEM customers who need to receive custom messages, but who do not want to take over the entire message support on the associated queue.

Table 1-1. Binary Message Data Types

Type	Abbreviation	Words (Note 1)	Bits	Maximum Range
Bit (Note 2)	Bit	N/A	1 to 32 (Note 3)	0 or 1
Character (Note 4)	C	N/A	8	0 to 255
Integer	I	1	16	–32768 to +32767
Double Integer	DI	2	32	–2147483648 to +2147483647
Triple Integer	TI	3	48	–140737488355328 to +140737488355327
Unsigned Integer	UI	1	16	0 to 65535
Unsigned Double Integer	UDI	2	32	0 to 4294967295
Unsigned Triple Integer	UTI	3	48	0 to 281474976710656

Note 1: The term "word" is used throughout this document to specify a quantity which occupies 16 bits of storage.

Note 2: Data items using bit storage are specified with a format of w.b, where w is the word number and b is the bit number (0 to 15, 0 being the LSB) within the word. Multiple-bit items (bit fields) are indicated by a range of 'word.bit' values (e.g., 8.4 to 8.7).

Note 3: Bit number range depends on the data type of the specific location. It may be either 16 bits in a word, 32 bits in a double word, or 48 bits in a triple word.

Note 4: Although the AAMP2 processor and C compiler use 16-bit character representations, this data interface will use the more common 8-bit representation. The Navigation Engine will pack/unpack the character data internally as needed.

High Byte		Low Byte		
1000	0001	1111	1111	Word 1
MSB	LSB	MSB	LSB	
Message ID				Word 2
Data Word Count				Word 3
DCL0 QRAN 00XX XXXX				Word 4
Header Checksum				Word 5

Figure 1-1. Binary Message Header Format

Composite words may have independent definitions for each bit field in the word. Flag bits are either zero (false) or one (true). All bits that are designated as reserved within the bit descriptions of binary data have undefined values for outputs and must be set to zero for inputs.

1.3 Binary Message Header

The binary message header format has been modifed slightly from the NavCore V format to accommodate message logging requests. The format of the new message header is shown in Figure 1-1.

1.3.1 Message Header Word 1. Each input/output message starts with a synchronization word of the form 0x81FF with DEL (255 decimal) occupying the lower eight bits followed by the Start Of Header (SOH) (129 decimal) occupying the higher eight bits of the synchronization word.

1.3.2 Message Header Word 2. Word 2 contains the numeric message ID. For example, word 2 for Message ID 1000 would be:

High Byte		Low Byte	
0000	0011	1110	1000
MSB	LSB	MSB	LSB

Or 0x03E8 (1000 decimal).

1.3.3 Message Header Word 3. Word 3 contains the word count for the data portion of the message. The word count does not include the data checksum word. A zero data word count indicates a “header-only” message.

1.3.4 Message Header Word 4. The fourth word of the message header is a 16-bit field allocated to protocol and message related flags. These flag bits extend control over ACK/NAK requests and implement message logging requests. The zeroes represented in the word 4 field as shown in Figure 1-1 are reserved bits and should be set to zero within this word.

1.3.4.1 ACK/NAK Protocol. Implementation of a message acknowledge protocol is done at the discretion of the OEM. All output messages from the receiver do not require acknowledgement. Input message to the receiver may implement any or all of the protocol.

There are three bits used for the protocol: the Request bit (R) is set by the OEM to request use of the protocol; the Acknowledgement (A) and Negative Acknowledgement (N) bits are used by the OEM to specify the protocol and by the receiver to respond.

To have a message acknowledged, the R bit is set and either the A or the N bit is set, or both. Upon receipt of the message with the R bit set, the receiver validates the message. If it is received in good condition, and if the A bit was set, the receiver returns the header with a new checksum, with the R bit cleared, and with the A bit set and the N bit cleared. This is called an ACK message.

If the message received by the receiver fails a checksum, or if one or more of the data items are invalid (e.g., if an option is specified with an undefined value), and the incoming message had the N bit set, then the receiver responds by returning the header with the R and A bits cleared and the N bit set. This is called a NAK message.

The six LSBs of word 4 are for the OEM’s use. They are returned unaltered by the receiver in either an ACK or NAK message. These bits help the OEM distinguish between multiple messages of a specific type.

1.3.4.2 Connect and Log Protocol. Data output messages from the receiver may be logged, connected, disconnected, or queried by the OEM. Logging a message sets its output parameters (trigger, interval, offset). Connecting or disconnecting a message causes it to either be output according to the logging parameters, or to terminate and not be output. Logging can be combined with either connecting or disconnecting. Querying is a request for one-time output of the specified message at the next output interval.

Logged messages are composed of a header with the Log (L) bit set in the flag word (word 4), and with three data words and a data checksum attached (see Figure 1-2). The format of the log request is described in paragraph 1.3.6.

When the Connect (C) bit is set in the flag word, the specified message type is set for regular output according to the most recently established logging parameters. If the L bit is also set, the logging parameters contained in the message are used to establish the output interval. If the L bit is not set, the output interval will be set to the rate established by the last logging request. If no previous logging request has been sent since the receiver was last reset, the specified message is output at the default rate specified for each message (refer to the message descriptions in Section 2 of this document).

When the Disconnect (D) bit is set, the currently connected message is disconnected, or output is terminated. If the L bit is also set, the message logging parameters are updated. All messages currently connected can be disconnected with a single message. To do this, set the message ID to 0xFFFF, and set the D bit. Do not set logging parameters in a "Disconnect All" message.

1.3.5 Message Header Word 5. Word 5 of the message header is the header checksum, used to validate the header portion of the message. It is computed by summing (mod 2^{16}) all words (including the word containing DEL and SOH) contained in the header and then negating the sum.

To validate a message sum, all header words and the header checksum are added mod 2^{16}. The result should be zero.

The computation of the header checksum may be expressed mathematically as:

$$SUM = Mod\ 2^{16} \sum_{i=1}^{4} Word(i)$$

If sum = –32768, Header Checksum = SUM; else Header Checksum = –SUM

where:

- Unary negation is computed as the two's complement of a 16-bit data word.
- Mod 2^{16} indicates the least 16 bits of an arithmetic process. That is, carry bits from the most significant bit are ignored.
- The summation is the algebraic binary sum of the words indicated by the subscript i.
- The –32768 sum value must be treated as a special case since the value still equals –32768 if negated.

1.3.6 Log Request Messages. Figure 1-2 shows the format of the data portion of standard log request messages. The ranges for words 6, 7, and 8 of these messages are as follows:

Trigger 0 = on time, 1 = on update

Interval 0 to 65535 seconds. An interval of zero produces a query as if the Query bit (Q) in word 4 of the message header had been set. This field is ignored if the Trigger field is set to "on update."

Offset 0 to 60 seconds. Specifies the time after the start of the minute when the first output will occur. An offset of 0 means to output the message now. An offset of 60 means to output the message at the start of the next minute (i.e., 0 seconds into the next minute). This field is ignored if the Trigger field is set to "on update."

When the Trigger field is set to "on time" (integer value 0), the first output will occur at the next Offset seconds into the minute, and will repeat every Interval seconds thereafter. When the trigger field is set to "on update," the specified message will be output only when the data is updated (e.g., when satellite almanac is collected).

Trigger (on time, on update)	Word 6
Interval (sec)	Word 7
Offset (sec)	Word 8
Data Checksum	Word 9

Figure 1-2. Standard Log Request Message Format (Data Portion)

1.4 Binary Message Data

1.4.1 Data Checksum. The data portion of a message, if it exists, can be variable in length, as specified by the data word count found in the header. The Data Checksum follows the data and is not included in the data word count.

The Data Checksum is a 16-bit word used to validate the data portion of the message. It is transmitted as the last word of any message containing data (Figure 1-2).

When the Word Count field is zero, the Data Checksum does not exist. It is computed by summing (mod 2^{16}) all words in the data portion of the message and then negating that sum. The mathematical expression for the Data Checksum is:

$$SUM = Mod\ 2^{16} \sum_{i=6}^{5+N} Word(i)$$

If sum = –32768, Data Checksum = SUM; else Data Checksum = –SUM

where:

- Unary negation is computed as the two's complement of a 16-bit data word.
- Mod 2^{16} indicates the least 16 bits of an arithmetic process. That is, carry bits from bit position 16 are ignored.
- The summation is the algebraic binary sum of the words indicated by the subscript (i).
- N is the number of data words reported in word 3 of the message header.
- The –32768 sum value must be treated as a special case since the value still equals –32768 if negated.

Data elements identified as "Reserved" must be set to zero for input messages and are undefined for output messages. All data storage which is not explicitly defined should be handled as if it were marked "Reserved."

Unless otherwise stated, the resolution of each numeric data item is one integer unit, as specified by that item in the "Units" field.

1.4.2 Set Time. Most output messages give a "set time" in words 6 and 7. This time represents the number of T10 epochs (10 ms intervals) since the receiver was last reset. It has a range of 0 to 42949672.95 seconds, or just over 71 weeks. It does not directly relate to GPS time, but provides a mechanism to determine the relative age of data.

1.4.3 Sequence Number. Many binary messages contain a sequence number in the data area. Output messages put it in word 8, input messages use word 6. The number should be advanced every time a message is created with new data but not when a message contains previously transmitted data. This provides a mechanism for the recipient to detect when data has changed. Messages that have already been sent and are again requested are resent without changing the sequence number.

1.5 NMEA Messages, Format, And Sentence Structure

NMEA messages are output in response to standard Query (Q) or proprietary Log Control (ILOG) messages as described in Section 3. The timing of output messages is synchronized with the Time Mark output event.

1.5.1 NMEA Output Messages. The following supported NMEA output messages comply with the NMEA-0183 version 2.01 standard:

- ALT: Conexant Proprietary Altitude
- BIT: Conexant Proprietary Built-In Test Results
- ERR: Conexant Proprietary Error/Status
- GGA: GPS Fix Data
- GLL: Geographic Position - Latitude/Longitude
- GSA: GPS DOP and Active Satellites
- GSV: GPS Satellites in View
- RID: Conexant Proprietary Receiver ID
- RMC: Recommended Minimum Specific GPS Data
- VTG: Course Over Ground and Ground Speed
- ZCH: Conexant Proprietary Zodiac Channel Status
- ZDA: Time and Date

1.5.2 NMEA Input Messages. The following supported NMEA input messages comply with the NMEA-0183 version 2.01 standard:

- IBIT: Conexant Proprietary Built-in Test Command
- ILOG: Conexant Proprietary Log Control
- INIT: Conexant Proprietary Receiver Initalization
- IPRO: Conexant Proprietary Protocol
- Q: Standard Query

The Zodiac receiver supports four proprietary input messages used to command Built-In Test, to control the output of NMEA messages (ILOG), to command initialization (INIT), and to change the message protocol (IPRO). The first character of each sentence is "P" followed by a three-character mnemonic code for Conexant Systems (RWI) according to Appendix III of the NMEA-0183 standard. The Zodiac receiver also supports a custom proprietary input message used in some OEM builds to permit OEM customers to receive data in the OEM tasks without taking over the entire message handling duties.

1.5.3 NMEA Message Format. All NMEA-0183 data messages are in ASCII form. Each message begins with ASCII $ (0x24) and ends with ASCII <CR><LF> (0x0D and 0x0A). The valid character set consists of all printable ASCII characters, 0x20 to 0x7E, except that reserved characters may only be used as specified in Table 1-2.

Each NMEA message, or sentence, consists of a set of fields separated by a comma delimiter character. Each field can contain either a string of valid characters or no characters (null field). Valid characters must conform with the formats described in Table 1-3.

The maximum number of characters in a sentence is 82, consisting of a maximum of 79 characters between the starting delimiter "$" and the terminating <CR> and <LF>.

Since the number of data fields can vary from sentence to sentence, it is important that the "listener" (or application software) locate fields by counting delimiters rather than counting the total number of characters received from the start of the sentence.

1.5.4 NMEA-0183 Approved Sentences. An approved NMEA-0183 sentence contains the following elements, in the order shown:

$	Start of the sentence (0x24)
<address field>	Talker identifier and sentence formatter
[","<data field>]	Zero or more data fields
	•
	•
	•
[","<data field>]	
["*"<checksum field>]	Optional checksum field
<CR><LF>	End of sentence delimiter (0x0D 0A)

NOTE: Since the Zodiac receiver is a GPS device, the "talker" identifier is always "GP" or, for proprietary messages, "PRWI."

1.5.5 Checksum. The checksum is the 8-bit exclusive OR (no start or stop bits) of all characters in the sentence, including delimiters (except for the $ and the optional * delimiters). The hexadecimal value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first.

Table 1-2. NMEA Reserved Characters

Character	Hex Value	Decimal Value	Description
<CR>	0D	13	Carriage return (end of sentence delimiter)
<LF>	0A	10	Line feed (end of sentence delimiter)
$	24	36	Start of sentence delimiter
*	2A	42	Checksum field delimiter
,	2C	44	Field delimiter
!	21	33	Reserved
\	5C	923	Reserved
^	5E	94	Reserved
-	7E	126	Reserved

Table 1-3. NMEA Field Type Summary

Field Type:	Symbol:	Definition:
Special Format Fields		
Status	A	Single character field: A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set
Latitude	llll.ll	Fixed/variable length field: Degrees/minutes.decimal -- two fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/variable length field: Degrees/minutes.decimal -- three fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/variable length field: Hours/minutes/seconds.decimal -- two fixed digits of hours, two fixed digits of minutes, two fixed digits of seconds and a variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in the NMEA-0183 standard by the presence of one or more valid characters. The following characters and character strings used to indicate field types are excluded from the list of allowable characters: “A,” “a,” “c,” “hh,” “hhmmss.ss,” “llll.ll,” “x,” and “yyyyy.yy.”
Numeric Value Fields		
Variable numbers	x.x	Variable length integer or floating point numeric field: Optional leading and trailing zeros. The decimal point and associated decimal-franction are optional if full resolution is not required (e.g., 73.10 = 73.1 = 073.1 = 73).
Fixed HEX field	hh_ _	Fixed length hex numbers only, most significant bit on the left.
Information Fields		
Variable text	c- - c	Variable length valid character field.
Fixed alpha field	aa_ _	Fixed length field of uppercase or lowercase alpha characters.
Fixed number field	xx_ _	Fixed length field of numeric characters.
Fixed text field	cc_ _	Fixed length field of valid characters.

Notes:

1. Spaces may be used only in variable text fields.
2. A negative sign (“-” or 0x2D) is the first character in a field if the value is negative. The sign is omitted if the value is positive.
3. All data fields are delimited by a comma (“,”), or <CR><LF> (if the field is the last item in the message).
4. Null fields are indicated by no data between two delimiters (, ,).

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2 ZODIAC BINARY DATA MESSAGES

This section describes the binary data messages of the Zodiac GPS receiver. All of the output binary messages are listed in Table 2-1 and the input binary messages in Table 2-2 together with their corresponding message IDs. Not every version or build of the software will support every message. Refer to the data sheet for a specific software product to determine which messages may or may not be supported in that software.

Binary mode is selected according to the logic described in the hardware interface section of the *Zodiac GPS Receiver Family Designer's Guide*. Binary messages are transmitted and received across the host port serial I/O interface (RS-232) with the following default communications parameters:

- 9600 bps
- 8 data bits
- no parity
- 1 stop bit

All of the output binary messages are described in detail in section 2.1. All of the input binary messages are described in detail in section 2.2.

Table 2-1. Zodiac Binary Data Messages (1 of 4)

Message Name	Message ID	Used in Current S/W Configuration
Output Messages		
Geodetic Position Status Output	1000	yes (Note 1)
ECEF Position Status Output	1001	
Channel Summary	1002	yes (Note 1)
Visible Satellites	1003	yes (Note 1)
Differential GPS Output	1004	
Differential GPS Status	1005	yes
Channel Corrections	1006	yes
Channel Measurement	1007	yes
Best User Measurement	1008	yes
Reduced ECEF Position Status Output	1009	yes
Map Datum Output	1010	
Receiver ID	1011	yes
User-Settings Output	1012	yes
Raw Almanac Output	1040	yes
Raw Ephemeris Output	1041	yes
Raw Ionospheric and UTC Corrections Output	1042	yes
RAM Status	1050	
DR System Status	1051	yes (Note 4)
Timing Receiver Configuration Output	1055	yes
Timing Receiver Status Output	1056	yes
GPS/DR Calibration Output	1070	yes (Note 4)
DR Parameters Output	1071	yes (Note 4)
Gyro Temperature Data	1072	
DR Factory Calibration Response	1075	(Note 4)
Hardware Accelerator Command Status	1090	(Note 5)
Hardware Accelerator Measurement	1091	
Hardware Accelerator Control Output	1092	(Note 5)

Table 2-1. Zodiac Binary Data Messages (2 of 4)

Message Name	Message ID	Used in Current S/W Configuration
Output Messages (continued)		
Built-In Test Results (modified in software release v2.59)	1100	yes
Global Output Control Parameters	1101	yes
Measurement Time Mark	1102	yes
Explicit Acknowledgement Output	1106	(Note 6)
UTC Time Mark Pulse Output	1108	yes (Note 1)
Frequency Standard Parameters In Use	1110	yes
Temperature Sensor Filter Parameters In Use	1111	
Measurement Epoch Steering Parameters In Use	1112	
Measurement Time Offset In Use	1113	
Time Mark Signal Output In Use	1114	
Platform Dynamics Limits In Use	1115	
Measurement Rate In Use	1116	
Power Management Duty Cycle In Use	1117	yes
Cold Start Almanac Data In Use	1118	
Serial Port Communication Parameters In Use	1130	yes
Memory Speed Input Parameters In Use	1132	
EEPROM Update	1135	yes (Note 1)
EEPROM Status	1136	yes
vEEPROM/EEPROM Block Output	1137	yes (Note 6)
Idle Time Count	1138	
Raw RTCM SC-104	1150	yes (Note 3)
Decoded RTCM SC-104 Type 1	1151	
Decoded RTCM SC-104 Type 2	1152	
Decoded RTCM SC-104 Type 3	1153	
Decoded RTCM SC-104 Type 5	1155	
Decoded RTCM SC-104 Type 9	1159	
Frequency Standard Table Output Data	1160	yes
DR Heading Rate and Sensor Temperature Measurement 10 Hz Output	1170	yes (Note 4)
Time Tagged DR Speed Measurement 10 Hz Output	1171	yes (Note 4)
DR Heading Rate and Sensor Temperature Measurement Output	1172	(Note 4)
GPS Time Tagged DR Measurement Output	1173	yes (Note 4)
Flash Boot Status	1180	yes
Error/Status (added in software release v1.87)	1190	yes
Hardware Accelerator Measurement Output	1191	yes (Note 5)

Table 2-1. Zodiac Binary Data Messages (3 of 4)

Message Name	Message ID	Used in Current S/W Configuration
Input Messages		
Geodetic Position and Velocity Initialization	1200	yes
ECEF Position and Velocity Initalization	1201	
User-Defined Datum Definition	1210	yes
Map Datum Select	1211	yes
Satellite Elevation Mask Control	1212	yes
Satellite Candidate Select	1213	yes
Differential GPS Control	1214	yes
Power Management Control	1215	
Cold Start Control	1216	yes
Solution Validity Input	1217	yes
Antenna Type Select	1218	yes
User-Entered Altitude Input	1219	yes
Application Platform Control	1220	yes
Nav Configuration	1221	yes
Raw Almanac Input	1240	yes (Note 3)
Raw Ephemeris Input	1241	yes (Note 3)
Raw Ionospheric and UTC Corrections Input	1242	yes (Note 3)
Pseudorange Correction Input	1250	
Timing Receiver Configuration Input	1255	yes
DR Initialization Input	1270	(Note 4)
Hardware Accelerator Control Input	1292	(Note 5)
Perform Built-In Test Command	1300	yes
Global Input Control Parameters	1301	
Solution Error Feedback Parameters	1302	
Restart Command	1303	yes
Factory Test	1304	yes
DR Factory Test	1305	(Note 4)
Explicit Acknowledgement Input	1306	yes (Note 6)
Frequency Standard Input Parameters	1310	yes
Temperature Sensor Filter Input Parameters	1311	
Measurement Epoch Steering Parameters	1312	
Measurement Time Offset	1313	
Time Mark Signal Output Control	1314	
Platform Dynamics Limits	1315	
Measurement Rate Control	1316	
Power Management Control	1317	yes
Cold Start Almanac Data Update	1318	
Serial Port Communication Parameters	1330	yes
Message Protocol Control	1331	yes
Memory Speed Input Parameters	1332	

Table 2-1. Zodiac Binary Data Messages (4 of 4)

Message Name	Message ID	Used in Current S/W Configuration
Input Messages (continued)		
Backup vEEPROM or EEPROM Availability Status Input	1334	yes (Note 6)
vEEPROM/EEPROM Block Input	1337	yes (Note 6)
Enable/Disable Idle Timer	1338	
Factory Calibration Input	1350	yes
Raw DGPS RTCM SC-104 Data	1351	yes
Frequency Standard Table Input Data	1360	yes
Frequency Standard Drift Compensation Parameters	1361	
DR Speed Measurement Input	1370	(Note 4)
Flash Reprogram	1380	yes (Note 8)
Hardware Accelerator Command Input	1390	yes (Note 5)
OEM Custom Input	1400	

Note 1: Power-up default message for a GPS board-level product and a GPS chip set with Navigation Engine and Measurement Engine capability.

Note 2: Included only in software release v2.69 and above.

Note 3: Included only in software release v2.30 and above.

Note 4: Only used in software versions with the Dead Reckoning (DR) link.

Note 5: This message is only available in software that supports the Hardware Accelerator.

Note 6: This message available only with software that suppoorts virtual EEPROM (vEEPROM).

Note 7: This message is available only with the Jupiter LP GPS receiver (TU30-D160-001/011).

Note 8: This message is available with the Jupiter Flash GPS receiver (TU30-D230-011/021) or OEM Flash builds.

2.1 Output Message Descriptions

Most output messages include Set Time and Sequence Number as words 6-7 and 8, respectively. Set Time is an internal 10 ms timer that starts at zero at each receiver reset or power on, and counts upwards. It has a range of abut 71 weeks, after which it starts over at zero.

Sequence Number is an identifier assigned to a data set and advanced each time data is updated. It may be used to determine if a message's contents have changed since the last time it was received. See Appendix A for a further explanation of Sequence Number.

2.1.1 Geodetic Position Status Output (Message 1000). This message outputs the receiver's estimate of position, ground speed, course over ground, climb rate, and map datum. A solution status indicates whether or not the solution is valid (based on the solution validity criteria) and also the type of solution. The number of measurements used to compute the solution is also included.

The Polar Navigation flag is used to indicate that the solution estimate is too close to the North or South Pole to estimate longitude. When this flag is true, the longitude and true course outputs are invalid and are not updated. Users operating near the poles should use the ECEF Position Status Output message.

The contents of the Geodetic Position Status Output Message are described in Table 2.2.

Table 2-2. Message 1000: Geodetic Position Status Output Message (1 of 3)

Message ID:	1000				
Rate:	Variable, defaults to 1 Hz				
Message Length:	55 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
Navigation Solution Validity (10.0-10.15)					
10.0	Solution Invalid - Altitude Used (Note 2)	Bit		1 = true	
10.1	Solution Invalid - No Differential GPS (Note 2)	Bit		1 = true	
10.2	Solution Invalid - Not Enough Satellites in Track (Note 2)	Bit		1 = true	
10.3	Solution Invalid - Exceeded Maximum EHPE (Note 2)	Bit		1 = true	
10.4	Solution Invalid - Exceeded Maximum EVPE (Note 2)	Bit		1 = true	
10.5	Solution Invalid - No DR Measurements (Note 3)	Bit		1 = true	
10.6	Solution Invalid - No DR Calibration (Note 4)	Bit		1 = true	
10.7	Solution Invalid - No Concurrent DR Calibration by GPS (Note 5)	Bit		1 = true	
10.8-10.15	Reserved				
Navigation Solution Type (11.0-11.15)					
11.0	Solution Type - Propagated Solution (Note 6)	Bit		1 = propagated	
11.1	Solution Type - Altitude Used	Bit		1 = altitude used	
11.2	Solution Type -Differential	Bit		1 = differential	
11.3	Solution Type - Power Management (Note 7)	Bit		1 = RF off	
11.4	Solution Type - GPS (Note 8)	Bit		1 = true	
11.5	Solution Type - Concurrent GPS Calibrated DR (Note 9)	Bit		1 = true	
11.6	Solution Type - Stored Calibration DR (Note 10)	Bit		1 = true	

Table 2-2. Message 1000: Geodetic Position Status Output Message (2 of 3)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
11.7-11.15	Reserved				
12	Number of Measurements Used in Solution	UI		0 to 12	
13.0	Polar Navigation	Bit		1 = true (Note 11)	
13.1-13.15	Heading Uncertainty Standard Deviation (DR link only) (Note 12)	UI	degrees	0 to 300	10^{-2}
14	GPS Week Number (Note 13)	UI	weeks	0 to 65535	
15-16	GPS Integer Seconds From Epoch (Note 13)	UDI	seconds	0 to 604799	
17-18	GPS Fractional Seconds From Epoch (Note 13)	UDI	seconds	0 to 0.999999999	10^{-9}
19	UTC Day (Note 14)	UI	days	1 to 31	
20	UTC Month (Note 14)	UI	months	1 to 12	
21	UTC Year (Note 14)	UI	year	1980 to 2079	
22	UTC Hours (Note 14)	UI	hours	0 to 23	
23	UTC Minutes (Note 14)	UI	minutes	0 to 59	
24	UTC Seconds (Note 14)	UI	seconds	0 to 59	
25-26	UTC Nanoseconds From Epoch (Note 14)	UDI	seconds	0 to 0.999999999	10^{-9}
27-28	Latitude	DI	radians	± 0 to $\pi/2$	10^{-8}
29-30	Longitude	DI	radians	± 0 to π	10^{-8}
31-32	Ellipsoid Height (Note 15)	DI	meters	± 0 to 50000.00	10^{-2}
33	Geoidal Separation	I	meters	± 0 to 200.00	10^{-2}
34-35	Ground Speed	UDI	m/s	0 to 1000.00	10^{-2}
36	True Course	UI	radians	0 to 2π	10^{-3}
37	Magnetic Variation	I	radians	± 0 to $\pi/4$	10^{-4}
38	Climb Rate	I	m/s	–300 to + 300	10^{-2}
39	Map Datum (Note 16)	UI		0 to 188 and 300 to 304	
40-41	Expected Horizontal Position Error (Note 17)	UDI	meters	0 to 3200000.00	10^{-2}
42-43	Expected Vertical Position Error (Note 17)	UDI	meters	0 to 2500.00	10^{-2}
44-45	Expected Time Error (Note 17)	UDI	meters	0 to 3000000.00	10^{-2}
46	Expected Horizontal Velocity Error (Note 17)	UI	m/s	0 to 100.00	10^{-2}
47-48	Clock Bias (Note 17)	DI	meters	–90000.00 to +90000.00	10^{-2}
49-50	Clock Bias Standard Deviation (Note 17)	DI	meters	–90000.00 to +90000.00	10^{-2}

Table 2-2. Message 1000: Geodetic Position Status Output Message (3 of 3)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
51-52	Clock Drift (Note 17)	DI	m/s	–1000.00 to +1000.00	10^{-2}
53-54	Clock Drift Standard Deviation (Note 17)	DI	m/s	–1000.00 to +1000.00	10^{-2}
55	Data Checksum				

Note 1: The satellite measurement sequence number relates the position solution data in Message 1000 to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: These bits are set when limits established by the Solution Validity Input message (Message 1217) are not met.

Note 3: Either no DR messages are being received or data has been detected as inconsistent with GPS (DR software only).

Note 4: No calibration is available for DR measurements from concurrent GPS or from stored values (DR software only).

Note 5: DR solution only; no GPS measurements available to update DR calibration (DR software only).

Note 6: It should be noted that bit zero of word 11 does not refer to a solution propagated by the navigation software. This bit is used to indicate if the solution was propagated by the serial I/O manager to generate a 1 Hz output message when no new navigation state data was available. This happens during power management when the navigation software is inactive, or is an error condition potentially caused by a shortage of throughput in one cycle. It is unlikely to occur and is self correcting. Normal state propagation which occurs within the navigation software does not cause this bit to be set.

Note 7: This field is only valid for receivers that support power management.

Note 8: Navigation is based on GPS alone. Standard system or GPS/DR system with no DR measurements available.

Note 9: DR is running with concurrent calibration by GPS (DR link only).

Note 10: DR is running with calibration from stored values from prior operating session (DR link only).

Note 11: Above 89.99 degrees at the poles.

Note 12: Bits 1-15 are the heading standard deviation multiplied by 200. An uncertainty value of 0x7FFF indicates unknown heading. A message value 0x000D indicates Polar Navigation equals true and heading uncertainty SD equals 0.06 (0x000C = 12_{10}; 12/200 = 0.06 degrees).

Note 13: GPS week is the count of weeks in GPS time. GPS week 0 began on Sunday, January 6, 1980. GPS epoch is defined as midnight between Saturday and Sunday.

Note 14: UTC date and time differ from GPS time by an integer number of leap seconds that have been added to UTC since January 6, 1980, but not to GPS time. Therefore, GPS time is always ahead of UTC. UTC also differs from GPS time by some small fraction of a second representing the misalignment between the two times. GPS time is steered to remain no more than one microsecond ahead of or behind UTC.

Note 15: Ellipsoid height = (geoidal separation) + (altitude above mean sea level)

Note 16: The table in Appendix B contains map datum codes from 0 to 188. Codes 300 to 304 are user-defined (see Message 1210).

Note 17: The data displayed by this field is not valid until the receiver is in navigation mode.

2.1.2 ECEF Position Status Output (Message 1001). This message outputs the receiver's estimate of ECEF position and velocity, and map datum. A solution status indicates whether or not the solution is valid (based on the solution validity criteria) and also the type of solution. The number of measurements used to compute the solution is also included.

The contents of the ECEF Position Status Output Message are described in Table 2.3

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Table 2-3. Message 1001: ECEF Position Status Output Message (1 of 2)

Message ID:	1001	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	54 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
Navigation Solution Validity (10.0-10.15)					
10.0	Solution Invalid - Altitude Used (Note 2)	Bit		1 = true	
10.1	Solution Invalid - No Differential GPS (Note 2)	Bit		1 = true	
10.2	Solution Invalid - Not Enough Satellites in Track (Note 2)	Bit		1 = true	
10.3	Solution Invalid - Exceeded Maximum EHPE (Note 2)	Bit		1 = true	
10.4	Solution Invalid - Exceeded Maximum EVPE (Note 2)	Bit		1 = true	
10.5-10.15	Reserved				
Navigation Solution Type (11.0-11.15)					
11.0	Solution Type - Propagated Solution (Note 3)	Bit		1 = propagated	
11.1	Solution Type - Altitude Used	Bit		1 = alt used	
11.2	Solution Type -Differential	Bit		1 = differential	
11.3-11.15	Reserved				
12	Number of Measurements Used in Solution	UI		0 to 12	
13	GPS Week Number	UI	weeks	0 to 32767	
14-15	GPS Seconds Into Week	UDI	seconds	0 to 604799	
16-17	GPS Nanoseconds From Epoch	UDI	ns	0 to 99999999	
18	UTC Day	UI	days	1 to 31	
19	UTC Month	UI	months	1 to 12	
20	UTC Year	UI	year	1980 to 2079	
21	UTC Hours	UI	hours	0 to 23	
22	UTC Minutes	UI	minutes	0 to 59	
23	UTC Seconds	UI	seconds	0 to 59	
24-25	UTC Nanoseconds From Epoch	UDI	ns	0 to 99999999	
26-27	ECEF Position - X (Note 4)	DI	meters	–9000000 to +9000000	10^{-2}
28-29	ECEF Position - Y (Note 4)	DI	meters	–9000000 to +9000000	10^{-2}
30-31	ECEF Position - Z (Note 4)	DI	meters	–9000000 to +9000000	10^{-2}

Table 2-3. Message 1001: ECEF Position Status Output Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
32-33	ECEF Velocity - X (Note 4)	DI	m/s	–1000 to +1000	10^{-2}
34-35	ECEF Velocity - Y (Note 4)	DI	m/s	–1000 to +1000	10^{-2}
36-37	ECEF Velocity - Z (Note 4)	DI	m/s	–1000 to +1000	10^{-2}
38	Map Datum (Note 5)	UI		0 to 188 and 300 to 304	
39-40	Expected Horizontal Position Error (Note 4)	UDI	meters	0 to 1000	10^{-2}
41-42	Expected Vertical Position Error (Note 4)	UDI	meters	0 to 1000	10^{-2}
43-44	Expected Time Error (Note 4)	UDI	meters	0 to 1000	10^{-2}
45	Expected Horizontal Velocity Error (Note 4)	UI	m/s	0 to 300	10^{-2}
46-47	Clock Bias (Note 4)	DI	meters	–9000000 to +9000000	10^{-2}
48-49	Clock Bias Standard Deviation (Note 4)	DI	meters	–9000000 to +9000000	10^{-2}
50-51	Clock Drift (Note 4)	DI	m/s	±0 to 1000	10^{-2}
52-53	Clock Drift Standard Deviation (Note 4)	DI	m/s	±0 to 1000	10^{-2}
54	Data Checksum				

Note 1: The satellite measurement sequence number relates the position solution data to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: The value of this data item was initially set using the Solution Validity Criteria Message (Message 1217).

Note 3: It should be noted that bit zero of word 11 does not refer to a solution propagated by the navigation software. This bit is used to indicate if the solution was propagated by the serial I/O manager to generate a 1 Hz output message when no new navigation state data was available. This is an error condition potentially caused by a shortage of throughput in one cycle. It is unlikely to occur and is self correcting. Normal state propagation which occurs within the navigation software with or without measurements available for processing does not cause this bit to be set.

Note 4: The data displayed by this field is not valid until the receiver is in navigation mode.

Note 5: The table in Appendix B contains map datum codes from 0 to 188. Codes 300 to 304 are user-defined.

2.1.3 Channel Summary (Message 1002). This message provides a summary form of the satellite and signal tracking information on a per-channel basis. The contents of the Channel Summary Message are described in Table 2.4

Table 2-4. Message 1002: Channel Summary Message

Message ID:	1002				
Rate:	Variable; defaults to 1 Hz				
Message Length:	51 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
10	GPS Week Number	UI	weeks	0 to 32767	
11-12	GPS Seconds Into Week	UDI	seconds	0 to 604799	
13-14	GPS Nanoseconds From Epoch	UDI	ns	0 to 0.999999999	
Channel Summary Data (n = 0 to 11 for channels 1 to 12)					
15.0+(3*n)	Measurement Used	Bit		1 = used	
15.1+(3*n)	Ephemeris Available	Bit		1 = available	
15.2+(3*n)	Measurement Valid	Bit		1 = valid	
15.3+(3*n)	DGPS Corrections Available	Bit		1 = available	
16+(3*n)	Satellite PRN (Note 2)	UI		0 to 32	
17+(3*n)	C/No	UI	dB-Hz	0 to 60	
51	Data Checksum				

Note 1: The satellite measurement sequence number relates the position solution data in Message 1000 to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: 0 means not in use.

2.1.4 Visible Satellites (Message 1003). This message outputs the list of satellites visible to the receiver and their corresponding elevations and azimuths. The best possible DOPs, calculated from this visible list, are also provided. The contents of the Visible Satellites Message are described in Table 2-5.

Table 2-5. Message 1003: Visible Satellites Message

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID:	1003				
Rate:	Variable; default on update, ~30 seconds				
Message Length:	51 words				
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Best Possible GDOP	I		0 to 99	10^{-2}
10	Best Possible PDOP	I		0 to 99	10^{-2}
11	Best Possible HDOP	I		0 to 99	10^{-2}
12	Best Possible VDOP	I		0 to 99	10^{-2}
13	Best Possible TDOP	I		0 to 99	10^{-2}
14	Number of Visible Satellites	UI		1 to 12	
Visible Satellite Set (j = 0 to 11) (Note 1)					
15 + (3*j)	Satellite PRN	UI		0 to 32	
16 + (3*j)	Satellite Azimuth	I	radians	$\pm\pi$	10^{-4}
17 + (3*j)	Satellite Elevation	I	radians	$\pm\pi/2$	10^{-4}
51	Data Checksum				
Note 1: Only the satellite sets for the number of satellites reported in word 14 of this message are valid. This message always includes space for 12 visible satellites.					

2.1 5 Differential GPS Output (Message 1004). This message outputs the receiver's differential status and the RTCM data for each satellite that has available corrections. The contents of the Differential GPS Output Message are described in Table 2-6.

Table 2-6. Message 1004: Differential GPS Output Message

Message ID:	1004 **(THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION)**				
Rate:	Variable				
Message Length:	88 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0-9.15	Status - ***** TBD *****	Bit			
10	RTCM Message Type	UI		1, 2, or 9	
11	Z-Count	UI	0.6 seconds	0 to 35994	
12	Sequence Number	UI		0 to 7	
13	Station ID	UI		0 to 1023	
14	Station Health	UI		0 to 7	
15	Number of Observations	UI		0 to 12	
Per Satellite Correction Set (Note 1)					
16 + (6*j)	Satellite PRN (Note 2)	UI		1 to 32	
17 + (6*j)	IODE	UI		0 to 255	
18 + (6*j)	UDRE	UI		0 to 3	
[19 + (6*j)] and [20 + (6*j)]	Pseudorange Correction	DI	meters	0 to ±104876	10^{-2}
21 + (6*j)	Pseudorange Rate Correction	I	m/s	0 to ±4096	10^{-3}
88	Data Checksum				

Note 1: Only the correction sets for the number of observations reported in word 15 of this message are valid.

Note 2: j = the number of observations minus one when the number of observations is greater than zero.

2.1.6 Differential GPS Status (Message 1005). This message contains DGPS status information derived from the last set of differential corrections processed by the receiver. The contents of the Differential GPS Status Message are described in Table 2.7.

Table 2-7. Message 1005: Differential GPS Status Message (1 of 2)

Message ID:	1005				
Rate:	Variable				
Message Length:	25 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Status (9.0-9.15)					
9.0	Station Health (Note 1)	Bit		1 = station bad	
9.1	User Disabled (Note 2)	Bit		1 = user disabled	
9.2-9.15	Reserved				
10	Station ID (Note 1)	UI		0 to 1023	
11	Age of Last Correction	UI	seconds	0 to 999	
12	Number of Available Corrections	UI		0 to 12	
Correction Status Per Satellite (j = 13 to 24 for channels 1 to 12) (Note 3)					
j.0-j.5	Satellite PRN	UI		1 to 32	
j.6	Local Ephemeris	Bit		1 = ephemeris not avail in receiver	
j.7	RTCM Corrections	Bit		1 = corrections not avail.	
j.8	RTCM UDRE (Note 1)	Bit		1 = UDRE too high	
j.9	Satellite Health	Bit		1 = satellite data indicates bad health	

Table 2-7. Message 1005: Differential GPS Status Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
j.10	RTCM Satellite Health (Note 1)	Bit		1 = RTCM source declares satellite bad	
j.11	Corrections Stale (Note 4)	Bit		1 = received stale corrections	
j.12	IODE Mismatch (Note 5)	Bit		1 = IODE mismatch	
j.13-j.15	Reserved				
25	Data Checksum				

Note 1: Information in this field comes from the DGPS correction messages.

Note 2: This bit will be set if a satellite has been disabled using the Satellite Candidate Select message (Message 1213).

Note 3: Only the correction status words for the number of available corrections reported in word 12 of this message are valid.

Note 4: Corrections received have a time tag that is already older than the valid age of corrections (set by Message 1214, default = 45 seconds).

Note 5: A “1” means that the ephemeris used by the reference station does not agree with the current ephemeris in this receiver. This condition might occur with some reference stations that intentionally delay implementation of new ephemerides for one to two minutes, or if this receiver misses the latest ephemeris update from the satellite.

2.1.7 Channel Corrections (Message 1006). This message contains atmospheric, clock, and positional corrections for each of the receiver's 12 channels. The contents of the Channel Corrections Message are described in Table 2-8.

Table 2-8. Message 1006: Channel Corrections Message

Message ID: 1006					
Rate: Variable					
Message Length: 202 words					
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
Channel Corrections Summary Data (j = 0 to 11 for channels 1 to 12)**)**					
10 + 16*j	Tropospheric Correction (Note 2)	UI	meters	0 to 65535	10^{-3}
11 + 16*j	Ionospheric Correction (Note 3)	DI	meters	–200000 to +200000	10^{-3}
13 + 16*j	Satellite Clock Corrections (Note 2)	DI	meters	± 3.12	10^{-3}
15 + 16*j	Satellite ECEF Position X (Note 2)	TI	meters	$\pm 1.4 \times 10^{14}$	10^{-3}
18 + 16*j	Satellite ECEF Position Y (Note 2)	TI	meters	$\pm 1.4 \times 10^{14}$	10^{-3}
21 + 16*j	Satellite ECEF Position Z (Note 2)	TI	meters	$\pm 1.4 \times 10^{14}$	10^{-3}
24 + 16*j	Azimuth (Note 4)	I	radians	$\pm \pi \times 10^{4}$	10^{-4}
25 + 16*j	Elevation (Note 4)	I	radians	$\pm \pi/2 \times 10^{4}$	10^{-4}
202	Data Checksum				

Note 1: The satellite measurement sequence number relates the position solution data to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: This value is either reported by, or computed from information reported by, the satellite.

Note 3: The ionospheric correction includes group delay.

Note 4: Computed by the receiver from the last computed position and the satellite's reported position.

2.1.8 Channel Measurement (Message 1007). This message provides measurement and associated data for each of the receiver's 12 channels. Data in this message is a subset of data in Message 1102. The contents of the Channel Measurement Message are described in Table 2-9.

Table 2-9. Message 1007: Channel Measurement Message

Message ID:	1007				
Rate:	Variable				
Message Length:	154 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
Channel Measurement Data (Note 2)					
10 + 12*j	Pseudorange (Note 3)	TI	meters	$\pm 1.4 \times 10^{14}$	
13 + 12*j	Pseudorange Rate (Note 3)	DI	m/s	–21474.836 to +21474.835	10^{-3}
15 + 12*j	Carrier Phase	TI	meters	$\pm 1.4 \times 10^{14}$	
18 + 12*j	Carrier Phase Bias (Note 4)	TI	meters	$\pm 1.4 \times 10^{14}$	
21 + 12*j	Phase Bias Count (Note 5)	UI		0 to 65535	
154	Data Checksum				

Note 1: The satellite measurement sequence number relates the position solution data in Message 1000 to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: j = 0 to 11 for channels 1 to 12.

Note 3: Pseudorange and pseudorange rate are computed from the C/A code. The values are smoothed by the carrier phase. (**Do not publish the following sentence in any customer documents**) If conditional compile flag OUTPUT_RESIDUALS is defined at compile time, Pseudorange and Pseudorange Rate are replaced by Pseudorange Residual and Carrier Rate Residual, respectively.

Note 4: Carrier Phase Bias represents the difference between the pseudorange as measured from the C/A code ("code phase") and that measured by tracking carrier phase. Therefore, the carrier phase bias is a measure of the amount of carrier phase smoothing present in the pseudorange value.

Note 5: Phase bias count is the number of iterations performed by carrier smoothing. The higher this count, the more the pseudorange depends on carrier phase measurements rather than C/A code measurements.

2.1.9 Best User Measurement (Message 1008). This message provides the actual used Dilution of Precision (DOP), measurements, and system errors. The contents of the Best User Measurement Message are described in Table 2-10.

Table 2-10. Message 1008: Best User Measurement Message (1 of 2)

Message ID:	1008	**(BEFPRE v2.69, ONLY ENABLED IN SELECTED VERSIONS)**			
Rate:	Variable; defaults to 1 Hz				
Message Length:	148 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	GPS Week	UI	weeks	0 to 32767	
10-11	GPS Seconds From Epoch	UDI	seconds	0 to 604799	
12-13	GPS Nanoseconds From Epoch	UDI	ns	0 to 999999999	
14	Number of Satellites Used	UI		0 to 12	
15	Used GDOP	UI		0 to 99.99	10^{-2}
16	Used PDOP	UI		0 to 99.99	10^{-2}
17	Used HDOP	UI		0 to 99.99	10^{-2}
18	Used VDOP	UI		0 to 99.99	10^{-2}
19	Used TDOP	UI		0 to 99.99	10^{-2}
Channel Status (n = 1 to 12 channels)					
10 (n-1) + 20.0	Measurement Valid	Bit		1 = valid	
10 (n-1) + 20.1	Ephemeris Available	Bit		1 = ephemeris availalbe	
10 (n-1) + 20.2	Differential GPS Available	Bit		1 = corrections available	
10 (n-1) + 20.3	Measurement Used	Bit		1 = measurement used	
10 (n-1) + 20.4 to 20.9	C/No (dBHz)	Bit (6 bits)		0 to 63	
10 (n-1) + 20.10 to 20.15	PRN Number	Bit (6 bits)		0 to 32 (Note 1)	
10 (n-1) + 21 to 23	Pseudorange	UTI	seconds	0 to 0.16	$2^{-45}/50$
10 (n-1) + 24 to 26	Carrier Phase	UTI	seconds	0 to 0.16	$2^{-45}/50$

Table 2-10. Message 1008: Best User Measurement Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
10 (n-1) + 27 to 28	Carrier Rate	DI	sec/sec	$\pm 2^{-14}$	2^{-45}
10 (n-1) + 29	Phase Bias Count (Note 2)	UI		0 to 65535	
140	GPS Heading Error	UI	degrees	0 to 300	10^{-2}
141	GPS Velocity Error	UI	m/s	0 to 1000	10^{-2}
142 to 143	GPS Position Error	UDI	meters	0 to 320000000	10^{-2}
144	DR Heading Error (Note 3)	UI	degrees	0 to 300	10^{-2}
145	DR Velocity Error (Note 3)	UI	m/s	0 to 1000	10^{-2}
146 to 147	DR Position Error (Note 3)	UDI	meters	0 to 320000000	10^{-2}
148	Data Checksum				

Note 1: 0 = not tracking, 1 to 32 = satellite's PRN.

Note 2: Phase Bias Count is the number of iterations performed by carrier smoothing. The higher this count, the more the pseudorange depends on carrier phase measurements rather than C/A code measurements.

Note 3: DR links only.

2.1.10 Reduced ECEF Position Status Output (Message 1009). This message provides the navigation solution in terms of Earth Centered, Earth Fixed (ECEF) position and velocity (X, Y, Z). The contents of the Channel Measurement Message are described in Table 2-11.

Table 2-11. Message 1009: Reduced ECEF Position Status Output Message

Message ID:	1009				
Rate:	Variable				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Satellite Measurement Sequence Number (Note 1)	I		0 to 32767	
ECEF Navigation Solution					
10-11	ECEF Position - X (Note 2)	DI	meters	–9000000 to +9000000	10^{-2}
12-13	ECEF Position - Y (Note 2)	DI	meters	–9000000 to +9000000	10^{-2}
14-15	ECEF Position - Z (Note 2)	DI	meters	–9000000 to +9000000	10^{-2}
16-17	ECEF Velocity - X (Note 2)	DI	m/s	–100000 to +100000	10^{-2}
18-19	ECEF Velocity - Y (Note 2)	DI	m/s	–100000 to +100000	10^{-2}
20-21	ECEF Velocity - Z (Note 2)	DI	m/s	–100000 to +100000	10^{-2}
22	Data Checksum	UI			

Note 1: The satellite measurement sequence number relates the position solution data to a particular set of satellite measurements found in binary Messages 1002 and 1007 (Channel Summary Message and Channel Measurement Message, respectively).

Note 2: The data displayed by this field is not valid until the receiver is in navigation mode.

2.1.11 Map Datum Output (Message 1010). This message outputs the information associated with the datum currently being used by the receiver to transform its position solution. The contents of the Map Datum Output Message are described in Table 2-12.

Table 2-12. Message 1010: Map Datum Output Message

Message ID:	1010	**(THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION)**			
Rate:	Variable				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Current Datum ID (Note 1)	UI		0 to 188 and 300 to 304	
10-11	Semi-Major Axis - Integer Part	UDI	meters	6300000 to 6400000	
12	Semi-Major Axis - Fractional Part	UI	meters	0 to 999	
13	Inverse Flattening - Integer Part	UI		280 to 320	
14 to 15	Inverse Flattening - Fractional Part	UDI		0 to 99999999	
16-17	WGS-84 Datum Offset - dX	DI	meters	–9000000 to +9000000	10^{-2}
18-19	WGS-84 Datum Offset - dY	DI	meters	–9000000 to +9000000	10^{-2}
20-21	WGS-84 Datum Offset - dZ	DI	meters	–9000000 to +9000000	10^{-2}
22	Data Checksum				
Note 1: The table in Appendix B contains map datum codes from 0 to 188. Codes 300 to 304 are user-defined.					

2.1.12 Receiver ID (Message 1011). This message is output once automatically at startup after the receiver has completed its initialization. It can be used to determine when the receiver is ready to accept serial input. Manual requests for this message are also honored, and it can be set for automatic output as desired. The contents of the Receiver ID Message are described in Table 2-13.

Table 2-13. Message 1011: Receiver ID Message (1 of 3)

Message ID:	1011	**(MODIFIED IN v2.69 AND LATER, and IN v3.06 AND LATER)**			
Rate:	Variable (see above)				
Message Length:	59 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-18	Number of Channels (Note 1)	C			%02D
19-28	Software Version (Note 1)	C			%05.2F
29-38	Software Date (Note 1)	C	mm/dd/yy	%02d/%02d/%02d	
Configuration Words 39-58 had numerous new fields defined in versions 3.06 and higher. Prior versions only defined bits 39.0 and 39.1. Words 39-48 contain the ASCII representation of a single hexadecimal digit. See appropriate note for definition of the bits that comprise the digit.					
39	System Configuration Word 1 (Note 2)			Hex digit in ASCII	%1x
40	System Configuration Word 2 (Note 3)			Hex digit in ASCII	%1x
41	System Configuration Word 3 (Note 4)			Hex digit in ASCII	%1x
42	System Configuration Word 4 (Note 5)			Hex digit in ASCII	%1x
43	System Configuration Word 5 (Note 6)			Hex digit in ASCII	%1x
44-48	Reserved				
49	OEM Version (Note 7)	I		0 to 65535	
50	OEM Subversion (Note 7)	I		0 to 65535	
51	OEM Day (Note 7)	UI		0 to 65535	
52	OEM Month (Note 7)	UI		0 to 65535	
53	OEM Year (four digits) (Note 7)	UI		0 to 65535	
54	**Software Configuration Word 1 – Bit Details Follow – this word is designed to be used as an Unsigned Short integer**				
54.0	SysConfig: OEM Present	Bit		1=OEM Present	
54.1	Standard or OEM Build	Bit		0=Standard 1=OEM	
54.2	Factory Test Status	Bit		1=Activated	
54.3	NMEA Assured Mode	Bit		1=Activated	
54.4	ROM Default Mode	Bit		1=Activated	
54.5-54.7	Reserved				
54.8	ROM Almanac Installed	Bit		1=Enabled	
54.9	Almanac Upload Capability	Bit		1=Enabled	
54.10	Almanac Download Capability	Bit		1=Enabled	
54.11	Ephemeris Upload Capability	Bit		1=Enabled	
54.12	Ephemeris Download Capability	Bit		1=Enabled	
54.13	UTC/Iono Corrections Upload Capability	Bit		1=Enabled	
54.14	UTC/Iono Corrections Download Capability	Bit		1=Enabled	
54.15	Unused				

Table 2-13. Message 1011: Receiver ID Message (2 of 3)

55	**Software Configuration Word 2 – Bit Details Follow – this word is designed to be used as an Unsigned Short integer**				
55.0	Enable BIT Results Output	Bit		1=Enabled	
55.1	Enable BIT for RTC	Bit		1=Enabled	
55.2	Enable BIT for Signal Processors (Channels)	Bit		1=Enabled	
55.3	Enable BIT for ROM/Flash	Bit		1=Enabled	
55.4	Enable BIT for RAM	Bit		1=Enabled	
55.5	Enable BIT for Serial EEPROM	Bit		1=Enabled	
55.6	Enable BIT for Hardware Accelerator	Bit		1=Enabled	
55.7	Enable Special BIT testing (custom builds only)	Bit		1=Enabled	
55.8-55.10	Dead Reckoning Heading Source	Bit		0=None Enabled 1=Gyro into A/D 2-7 Reserved	
55.11-55.13	Dead Reckoning Speed Source	Bit		0=None Enabled 1=Wheel Ticks 2=Messages 3-7=Reserved	
55.14	Dead Reckoning Reduced Range Scale Factor	Bit		1=Enabled	
55.15	Dead Reckoning Gyro I/O Redirect	Bit		1=Enabled	
56	**Software Configuration Word 3 – Bit Details Follow – this word is designed to be used as an Unsigned Short integer**				
56.0	Enable OEM message control	Bit		1=Enabled	
56.1	Include extended OEM binary messages	Bit		1=Included	
56.2	Include extended OEM NMEA messages	Bit		1=Included	
56.3	Remove binary message set	Bit		1=Removed	
56.4	Remove NMEA message set	Bit		1=Removed	
56.5	Reserved (special applications binary and NMEA removed)	Bit		1=Removed	
56.6	Reserved (special applications: reduced message sets)	Bit		1=Reduced	
56.7-56.15	Reserved				
57	**Software Configuration Word 4 – Bit Details Follow – this word is designed to be used as an Unsigned Short integer**				
57.0	Enable Hardware Accelerator low C/N_0	Bit		1=Enabled	
57.1	Hardware Accelerator input clock speed	Bit		0=11 MHz clock 1=44 MHz clock	
57.2	Enable Hardware Accelerator external clock MUX	Bit		1=Enabled	
57.3	Control for Hardware Accelerator clock MUX	Bit		0=GPIO8 1=GPP0	
57.4	Hardware Accelerator processor clock speed	Bit		0=22 MHz 1=44 MHz	
57.5	Hardware Accelerator data load clock source	Bit		0=external clock 1=Internal PLL	
57.6-57.15	Reserved				
58	**Software Configuration Word 5 – Bit Details Follow – this word is designed to be used as an Unsigned Short integer**				
58.0	Enable time mark	Bit		1=Enabled	
58.1	Slew time mark to T20	Bit		1=Slew to T20	
58.2	Slew time mark to GPS time	Bit		1=Slew to GPS	
58.3	Reserved (special applications: disable TM in nav mode)	Bit		1=Disable	
58.4	Reserved				
58.5	Enable DARC for DGPS	Bit		1=Enabled	

Table 2-13. Message 1011: Receiver ID Message (3 of 3)

58.6	Reserved (special applications: DGPS removed)	Bit		1=Removed	
58.7	Enable FAR RAM segments	Bit		1=Enabled	
58.8	Enable Timing RAIM	Bit		1=Enabled	
58.9	Enable computing DOPs of actual satellites used	Bit		1=Enabled	
58.10	Reserved (special internal applications)	Bit		1=Enabled	
58.11-58.15	Reserved				
59	Data Checksum				

Note 1: This field contains a 20-character string initialized to 0x00 in all elements, then filled using the C format shown in the resolution column. Sample data for the first three strings is:

Number of Channels	12
Software Version	02.30
Software Date	07/08/99

Note 2: Software Configuration Word 1 (word 39) designates the following features

Bit	Meaning
0	0=ROM build; 1=Flash build
1	1=Hardware Accelerator supported
2	1=Special Timing Receiver software installed
3	not defined

Note 3: Software Configuration Word 2 (word 40) designates the following features

Bit	Meaning
0-2	DR Configuration: 0=No DR; 1=Wheel-tick version; 2=Speed-message version; 3-7=not defined
3	CPU Clock frequency: 0=29 MHz; 1=44 MHz

Note 4: Software Configuration Word 3 (word 41) designates the following features

Bit	Meaning
0-1	RFIC Supported: 0=Gemini/Pisces (R6732); 1=CX74051; 2-3=not defined
2-3	EEPROM Supported: 0=AT24C164; 1=AT24C32; 2=Special (reserved); 3=not defined

Note 5: Software Configuration Word 4 (word 42) designates the following features

Bit	Meaning
0-2	RTC Supported: 0=Dallas DS1302; 1=Epson EP4513; 2=Epson EP4543; 3=Philips PCF8563 4=Ricoh RS5C316; 5-7=not defined
3	Crystal Supported: 0=5333R09-005, with -40° C to +85° C temperature range; 1=5333R09-006, with -20° C to +60° C temperature range. The 5333R09-005 crystal has a cubic-curve temperature profile, while the 5333R09-006 has a flat temperature profile.

Note 6: Software Configuration Word 5 (word 43) designates the following features

Bit	Meaning
0	Temperature Sensor supported: 0=Internal; 1=External
1	ROM or Flash size: 0=Standard; 1=Reduced (usually to 1 Mbit)
2-3	not defined

Note 7: For versions 2.69 and later, these words are used to designate custom OEM versions. Word 49 is controlled by SiRF, and is set to 0 for standard builds, and other values designating specific customers as required. Words 50 to 53 are set to zero by SiRF, but can be set to any values by the OEM through the OEM API. Refer to files OKERNLIO.H and OEMKERNL.H for details of the appropriate data structure and arguments for the call to function PutKernelData ().

2.1.13 User Settings Output (Message 1012). This message provides a summary of the settings for many of the user-definable parameters which were set either to default values or to values supplied by the user in input messages. The contents of the User Settings Output Message are described in Table 2-14.

Table 2-14. Message 1012: User Settings Output Message (1 of 2)

Message ID:	1012				
Rate:	Variable				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 2147483647	
8	Sequence Number	I		0 to 32767	
Operational Status (9.0-9.15)					
9.0	Power Management Enabled (Note 1)	Bit		1 = enabled	
9.1	Cold Start Disabled (Note 2)	Bit		1 = disabled	
9.2	DGPS Disabled (Note 3)	Bit		1 = disabled	
9.3	Held Altitude Disabled (Note 4)	Bit		1 = disabled	
9.4	Ground Track Smoothing Disabled (Note 4)	Bit		1 = disabled	
9.5	Position Pinning Disabled (Note 4)	Bit		1 = disabled	
9.6	Low Quality Measurement Disabled (Note 5)	Bit		1 = disabled	
9.7	Jamming Detection Enabled (Note 6)	Bit		1 = enabled	
9.8	Active Antenna (Note 6)	Bit		1 = active 0 = passive	
9.9-9.15	C/No Threshold (Note 7)		dB-Hz	0 to 50	
10	Cold Start Time-Out (Note 8)	UI	seconds	0 to 32767	
11	DGPS Correction Time-Out (Note 9)	UI	seconds	0 to 32767	
12	Elevation Mask (Note 10)	I	radians	0 to $\pm\pi/2$	10^{-3}
Selected Candidates					
13.0-14.15	Selected Candidate (Note 11)	Bit		1 = included candidate	
Solution Validity Criteria (15-20)					
15.0	Attitude Not Used; default is “do not use” (Note 12)	Bit		1 = do not use	
15.1	Differential GPS; default is “not required” (Note 12)	Bit		1 = required	
15.2	DR Measurement; default is “not required” (Note 12, 13)	Bit		1 = required	
15.3	GPS Calibration; default is “not required” (Note 12 13)	Bit		1 = required	
15.4	GPS Only; default is “use DR” (Note 12, 13)	Bit		1 = ignore DR	
15.5-15.15	Reserved				
16	Number of Satellites in Track Required (Note 14)	UI		0 to 12	

Table 2-14. Message 1012: User Settings Output Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
17-18	Minimum Expected Horizontal Error (Note 15)	UDI	meters	0 to 100000	10^{-2}
19-20	Minimum Expected Vertical Error (Note 15)	UDI	meters	0 to 100000	10^{-2}
21	Application Platform (Note 16)	UI		0 = default 1 = static 2 = pedestrian 3 = marine (lakes) 4 = marine (sea level) 5 = land (auto) 6 = air	
22	Data Checksum				

Note 1: Only valid on LP builds. Set by Message 1317. Disabled by default.

Note 2: Set by Message 1216. Enabled by default.

Note 3: Set by Messsage 1214. Enabled by default.

Note 4: Set by Message 1221. Enabled by default.

Note 5 When this bit is set, the receiver will only use "perfect" measurements (i.e., measurements without any errors in tracking status or data). If the bit is not set, the system uses measurements that, while not perfect, are still good enough to use under SPS conditions.

Note 6: This feature is not implemented in current software versions.

Note 7: Set by Message 1221. Default is 32 dB-Hz.

Note 8: Set by Message 1216. Default is 300 seconds (5 minutes).

Note 9: Set by Message 1214. Default is 45 seconds.

Note 10: Set by Message 1212. Default is 5 degrees.

Note 11: The selected candidate list is a 32-bit flag, each bit representing candidate selection status for one satellite (i.e., bit 0 = SV1 status, bit 1 = SV2 status...bit 31 = SV32 status). Set by Message 1213. Default is "all satellites enabled."

Note 12: Set by Message 1217.

Note 13: DR builds only.

Note 14: Specifies the minimum number of satellites that must be in track before an update of the position is valid. Default is 0, which means to use whatever number allows all other criteria to be met (e.g., minimum expected errors). While four satellites may be required to generate an initial position, the system can update the position from data obtrained by observing fewer satellites.

Note 15: Set by Message 1217. Default is 100 m EHPE, 150 m EVPE.

Note 16: Set by Message 1220. Default is zero, equilvalent to value 5, land (auto).

2.1.14 Raw Almanac Output (Message 1040). This message outputs raw almanac data as received from satellite navigation messages. All data is represented as raw subframe page data (excluding parity bits), according to the GPS SPS Signal Specification. Almanac data is found in subframe 5, pages 1 to 25, and in subframe 4, pages 2 to 5, 7 to 10, and 25. This message is intended to download the almanac from the receiver and to store it in a file so it can be uploaded. When queried, the receiver will output Message 1040 containing the almanac for SV ID 1 to 32. When using Labmon to download the almanac (Message 1040) to a file, Labmon will create Message 1240 in the default file “Almanac.gps”. This file is ready to be uploaded to the receiver using Labmon by pressing <Shift><F12>. The contents of the Raw Almanac Output Message are described in Table 2-15.

Table 2-15. Message 1040: Raw Almanac Output Message

Message ID: 1040 (**v2.30 AND LATER ONLY)**

Rate: Query

Message Length: 424 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Almanacs (Note 1)					
9+(13*j)	Week Number (Note 2)	I	weeks	0 to 32767	
10+(13*j)	Raw Almanac Data (Note 3)	UI			
• • •					
21+(13*j)					
425	Data Checksum				

Note 1: For week number and raw almanac data:
j = 0 to 31 for SV IDs 1 to 32.

Note 2: Week number is the GPS week number. Week zero started on Sunday, January 6 1980. This value has been resolved from the 10-bit value reported by the satellites into a 16-bit value without ambiguity.

Note 3: Words 3 to 10 of subframe 4 (or 5), excluding parity bits. If a satellite does not exist, or if the receiver does not have an almanac for a satellite, all bits will be set to zero.

Example for SV ID = 1:
The Raw Almanac data words 10 to 15
Correspond to bits in subframe 4 or 5:
And the Raw Almanac data words 16 tc
Correspond to bits in subframe 4 or 5:

Data(10)	Data(11)	Data(12)	Data(13)	Data(14)	Data(15)
61 (Word 3) 84		91 (Word 4) 114	121 (Word 5) 144		151 (Word 6) 174
Data(16)	Data(17)	Data(18)	Data(19)	Data(20)	Data(21)
181 (Word 7) 204		211 (Word 8) 234	241 (Word 9) 264		271 (Word 10) 294

2.1.15 Raw Ephemeris Output (Message 1041). This message outputs ephemeris data for one satellite in the constellation. All data is represented as raw subframe page data (excluding parity bits), according to the Global Positioning System Standard Positioning Service Signal Specification. Ephemeris data is found in subframes 1 through 3, words 3 to 10. When this message is queried, the receiver will output one copy of Message 1041 for each ephemeris currently in memory. The contents of the Raw Ephemeris Output Message are described in Table 2-16.

Table 2-16. Message 1041: Raw Ephemeris Output Message

Message ID:	1041				**(v2.30 AND LATER ONLY)**
Rate:	Variable				
Message Length:	48 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Ephemeris Identification (9-47)					
9	Satellite PRN	I		1 to 32	
10	Momentum, Alert Flag (Note 1, 2)	I		0 to 1	
11	Synchronization, Anti-Spoof Flag (Note 1, 3)	I		0 to 1	
12-47	Ephemeris Data (Note 6)	UI			
48	Data Checksum				

Note 1: The meaning of this flag changes depending on the configuration code of the SV. The configuration code is reported in page 25 of subframe 4 of the navigation message. As of mid-1999, all satellites were "Block II" with configuration codes equal to 1. Refer to ICD-GPS-200 for further information.

Note 2: If SV configuration code = 0, word 10 is the Momentum Flag. Momentum Flag = 1 when a thruster type momentum dump has occurred since the last ephemeris upload. If SV configuration code = 1, word 10 is the Alert Flag. Alert Flag = 1 indicates that the SV URA may be worse than indicated for satellite PRN.

Note 3: If SV configuration code = 0, this is the Synchronization Flag. Synchronization Flag = 0 when the leading edge of the TLM word is coincident with the X1 epoch. If SV configuration code = 1, this is the Anti-Spoof Flag. Anti-Spoof Flag = 1 when the anti-spoof mode is ON in the satellite PRN.

Note 4:

The raw ephemeris data words 12 to 17	Data(12)	Data(13)	Data(14)	Data(15)	Data(16)	Data(17)
Corresponding to bits in subframe 1:	61 (Word 3) 84		91 (Word 4) 114	121 (Word 5) 144		151 (Word 6) 174
The raw ephemeris data words 18 to 23	Data(18)	Data(19)	Data(20)	Data(21)	Data(22)	Data(23)
Corresponding to bits in subframe 1:	181 (Word 7) 204		211 (Word 8) 234	241 (Word 9) 264		271 (Word 10) 294

Raw ephermeris data words 24 to 35 correspond to the bits 61 to 294 in subframe 2.

Raw ephermeris data words 36 to 47 correspond to the bits 61 to 294 in subframe 3.

2.1.16 Raw Ionospheric and UTC Corrections Output (Message 1042). This message outputs the parameters associated with correcting for the affects of the Earth’s ionosphere on GPS signal propagation and the parameters associated with UTC timekeeping. All data is represented as raw subframe page data (excluding parity bits), according to the Global Positioning System Standard Positioning Service Signal Specification. Ionospheric data is found in subframe 4, page 18, bits 9 through 24 of word 3 plus the 24 MSBs of words 4 and 5. UTC data is found in subframe 4, page 18, words 6 to 9 and the 8 MSBs of word 10.

This message is intended to download raw UTC from the receiver and store it in a file. When queried, the receiver will output Message 1042 containing the almanac for SV ID 1 to 32. When using Labmon to download UTC (Message 1042) to a file, Labmon will create Message 1242 in the default file “UTC.gps”. This file is ready to be uploaded to the receiver using Labmon by pressing <Shift><F12>. The contents of the Raw Ionospheric and UTC Corrections Output Message are described in Table 2-17.

Table 2-17. Message 1042: Raw Ionospheric and UTC Corrections Output Message

Message ID:	1042				**(VERSION 2.30 AND LATER ONLY)**
Rate:	Query				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Week Number (Note 1)	I	weeks	0 to 32767	
10-21	Raw Ionospheric and UTC Correction Ephemeris Data From Page 18 of Subframe 4 (Note 2)	UI			
22	Data Checksum				

Note 1: Week number is the GPS week number. Week zero started on Sunday, January 6 1980. The week number broadcast by the satellites is subject to a 1023-week ambiguity. That ambiguity is resolved by the receiver using its software build date and tracking history.

Note 2:

The raw iono and UTC data words 1(	Data(10)	Data(11)	Data(12)	Data(13)	Data(14)	Data(15)
Correspond to bits in page 18 of subf	61 (Word 3) 84		91 (Word 4) 114	121 (Word 5) 144	151 (Word 6) 174	
And the iono and UTC data words 16	Data(16)	Data(17)	Data(18)	Data(19)	Data(20)	Data(21)
Correspond to bits in page 18 of subf	181 (Word 7) 204		211 (Word 8) 234	241 (Word 9) 264	271 (Word 10) 294	

2.1.17 RAM Status (Message 1050). This message reports the status of data areas in RAM. If the receiver detects corruption of a specific data item in RAM (i.e., checksum failure), the corrupting bit is set. The contents of the RAM Status Message are described in Table 2-18.

Table 2-18. Message 1050: RAM Status Message

Message ID:	1050				
Rate:	Variable				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-10	Failure (Note 1)	Bit		1 = failed item	
11	Word 1 (RESERVED)	I			
12	Word 2 (RESERVED)	I			
13	Data Checksum				

Note 1: The failure words are a bit map with the following items (summary bit is set when any other bit is set). Failure is detected by a failed checksum calculation.

Bit	Failure	Bit	Failure
0	Summary	8	Gyro Bias Error (DR only)
1	Position	9	DR Speed Scale Factor (DR only)
2	Position Error	10	DR Speed Scale Factor Error (DR only)
3	Heading	11	RTC
4	Heading Error	12	Ephemeris Data (not implemented)
5	Gyro Scale Factor (DR only)	13	Almanac Data (not implemented)
6	Gyro Scale Factor Error (DR only)	14-31	Reserved
7	Gyro Bias (DR only)		

2.1.18 DR System Status (Message 1051). This message reports the status of the DR system. It is available in DR builds only. The contents of the DR System Status Message are described in Table 2-19.

Table 2-19. Message 1051: DR System Status Message

Message ID:	1051				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	Variable				
Message Length:	11 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Gyro Failure (Note 1)	Bit			
10	DR Speed Failure (Note 2)	Bit			
11	Data Checksum				

Note 1: The gyro failure word is a bit map with the following items (summary bit is set when any other bit is set):

Bit	Failure
0	Summary
1	Large Turn Rate Error
2	Long Period of High Turn Rate
3-15	Reserved

Note 2: The DR speed failure word is a bit map with the following items (summary bit is set when any other bit is set):

Bit	Failure
0	Summary
1	DR speed = 0 when GPS speed > 1
2	DR speed is > 0 when GPS speed = 0
3	Large Speed Error
4-15	Reserved

2.1.19 Timing Receiver Configuration Output (Message 1055). This message reports the current settings of the Timing Receiver configuration. It is only supplied in Timing Receiver builds. See Timing Receiver Configuration Input Message (Message 1255) for information on how to change the configuration. The contents of the Timing Receiver Configuration Output Message are described in Table 2-20.

Table 2-20. Message 1055: Timing Receiver Configruation Output Message (1 of 2)

Message ID:	1055		**(ONLY AVAILABLE IN TIMING RECEIVER BUILDS)**		
Rate:	Variable, usually only in response to a query				
Message Length:	26 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Timing Receiver Mode (Note 1)	UI		1 = Standard Navigation 2 = Self Survey for 24 hours 3 = Self Survey for time specified (see word 11) 4 = Self Survey for unlimited time 5 = Position Hold with current position 6 = Position Hold with specified position (see words 12-17)	
10	Timing Receiver Start-up Mode Configuration Word (Note 2)	UI		0 = Self Survey 1 = Position Hold 2 = Standard Navigation	
11-12	Time Mark Time-Delay Compensation	UDI	ns		
13	Self-Survey Mode Time Duration (Note 3)	UI	hours		
14-15	Timing Receiver Reference Position Latitude (Note 4)	DI	rads	0 to $\pm\pi/2$	10^{-8}
16-17	Timing Receiver Reference Position Longitude (Note 4)	DI	rads	0 to $\pm\pi$	10^{-8}
18-19	Timing Receiver Reference Position Altitude (Note 4)	DI	meters	-2000 to 50000	10^{-2}
Timing Pulse Output Configuratino Word (20.0-20.15)					
20.0	Reserved				
20.1	Time Mark Alignment	Bit		0 = Aligned to GPS time 1 = Aligned to UTC time	
20.2	Reserved				
20.3	Time Mark Suppressed When Invalid	Bit		1 = Suppressed	
20.4	Time Mark Suppressed on TRAIM Alarm	Bit		1 = Suppressed	
20.5-20.15	Reserved				

Table 2-20. Message 1055: Timing Receiver Configruation Output Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
TRAIM Alarm Configuration Word (21.0-21.15) (Note 5)					
21.0	TRAIM Alarm when Status is "Unavailable" (no navigation solution or only 1 satellite valid)	Bit		1 = Enabled	
21.1	TRAIM Alarm when Timing Error Estimate > Timing Error Threshold	Bit		1 = Enabled	
21.2	TRAIM Alarm when Status is "Detect Only" (two satellites valid)	Bit		1 = Enabled	
21.3-21.15	Reserved (Ignore)				
22	TRAIM Disabled	UI		0 = Enabled 1 = Disabled	
23	TRAIM Timing Eror Threshold	UI	ns	1 to 20000	50 ns
24-25	Reserved (Ignore)				
26	Data Checksum	I			

Note 1: Current operating mode of the receiver.

Note 2: Specifies the receiver's mode of operation after a reset or power cycling. When Position-Hold mode is used at startup, the receiver examines the position in SRAM, and then the position in EEPROM. The first position found valid is used as the reference position. If neither is valid, the receiver enters Self-Survey mode and conducts a 24-hour survey, then switches to Position-Hold mode. Default is Self-Survey mode for 24 hours, then switch to Position-Hold mode.

Note 3: Only valid in Self-Survey mode with specified time (word 9 = 3). Specifies the number of hours to self survey before switching to Position-Hold mode.

Note 4: In Position-Hold mode, these words specify the position in use. In Self-Survey or Standard-Navigation mode, these words specify the most recently computed Self-Survey position.

Note 5: Bits indicate which conditions cause a TRAIM alarm to occur. An alarm occurs only if the appropriate bit is set, the alarm condition occurs, and if TRAIM is not disabled (see word 22).

2.1.20 Timing Receiver Status Output (Message 1056). This message reports the current Timing Receiver status. It is only supplied in Timing Receiver builds. The contents of the Timing Receiver Status Output Message are described in Table 2-21.

Table 2-21. Message 1056: Timing Receiver Status Output Message (1 of 2)

Message ID:	1056			**(ONLY AVAILABLE IN TIMING RECEIVER BUILDS)**	
Rate:	Variable, usually only in response to a query				
Message Length:	26 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Timing Receiver Mode Status (Note 1)	UI		0 = Self Survey 1 = Position Hold 2 = Standard Navigation	
Self-Survey Status Word (10.0-10.15) (Note 2)					
10.0	Finished Self Survey	Bit		1 = Finished	
10.1	Self Survey Disabled	Bit		1 = Disabled	
10.2	Navigation Solution not yet converged in Kalman filter	Bit		1 = Not Converged	
10.3	Not Enough Satellites	Bit		1 = Not Enough	
10.4	Expected Time Error Too Large	Bit		1 = Too Large	
10.5	Expected Horizontal Position Error Too Large	Bit		1 = Too Large	
10.6	Altitude Used – Insufficient Number of Valid Satellites	Bit		1 = Altitude Used	
10.7-10.15	Reserved				
11-12	Self-Survey Valid Measurements Count (Note 3)	UDI		0 to 4294967295	
13-14	Self-Survey Duration (Note 4)	UDI		0 to 4294967295	
Position-Hold Status Word (15.0-15.15)					
15.0	Positoin Hold Disabled	Bit		1 = Disabled	
15.1	No Valid Reference Position (Note 5)	Bit		1 = Not Avaliable	
15.2-15.15	Reserved				
Timing-Pulse Status Word (16.0-16.15)					
16.0	Time Mark Validiity	Bit		1 = Valid	
16.1	Time Mark Alignment	Bit		0 = GPS time 1 = UTC Time	
16.2	Time Mark UTC Precision (Note 6)	Bit		1 = High precision	
16.3	Time Mark Suppressed – Invalid	Bit		1 = Suppressed	
16.4	Time Mark Suppressed due to TRAIM Alarm	Bit		1 = Suppressed	
16.5-16.15	Reserved				
TRAIM Alarm Status Word (17.0-17.15) (Note 7)					
17.0	TRAIM Status: Unavailable (no navigation solution or only 1 valid satellite)	Bit		1 = Alarm detected	
17.1	TRAIM Timing Error Estimate > Timing Error Threshold	Bit		1 = Alarm detected	
17.2	TRAIM Status: Detect Only (only 2 satellites valid)	Bit		1 = Alarm detected	
17.3-17.15	Reserved				

Table 2-21. Message 1056: Timing Receiver Status Output Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
18	TRAIM Disabled	UI		0 = Enabled 1 = Disabled	
19	TRAIM Status (Note 8)	UI		0 = No Error 1 = Detect and Isolate 2 = Detect Only 3 = Unavailable	
20.0-21.15	TRAIM Bad Satellites (Note 9)	Bit		1 = Excluded Satellite	
22-23	TRAIM Timing Error Estimate	UDI	ns	0 to 429496729.5	10^{-1}
24-25	Reserved				
26	Data Checksum	I			

Note 1: Word 9 displays the receiver's current mode. Words 10 and 15 give the status of Self-Survey and Position-Hold modes, respectively. If a bit is set in either word 10 or 15, the receiver indicates a different mode from the one commanded, and the set bit(s) indicates the reason that mode is not currently active.

Note 2: Any time the receiver leaves Self-Survey mode, a bit is set in this word. If bit 10.0 is set, which indicates the self survey is complete, the receiver switched to Position-Hold mode. If the receiver is unable to add valid measurements to the current self survey, the receiver switches to Standard-Navigation mode, and bits 10.1 to 10.6 indicate the reason the self survey has been suspended.

Note 3: When in Self-Survey mode, this indicates the number of valid measurements that have been taken since the mode started. When in Position-Hold mode, this indicates the number of valid measurements completed in the self survey that generated the reference position (0 means that the reference position was entered manually; 1 means it was the result of standard navigation rather than self survey).

Note 4: This number is only valid when in Self-Survey mode, or when in Standard-Navigation mode because Self-Survey mode has been suspended. The number represents the number of valid measurements required to complete the current survey. If the receiver is in Self-Survey mode with no time limit, this value is 0. For each hour of self survey time requested by the command that starts the survey, this value is increased by 3600 (default: 86400 for a 24-hour survey). If the receiver is in Self-Survey mode, and another command to enter Self-Survey mode is received, the duration of the requested survey is added to the current number of valid measurements so that the survey continues for the number of hours indicated.

Note 5: If this bit is set, the receiver tried to enter Position-Hold mode but did not have a valid reference position either in SRAM, EEPROM, or in the command message. The receiver automatically enters Self-Survey mode and conducts a 24-hour survey, then enters Position-Hold mode.

Note 6: This bit is set when the receiver has a valid Ionospheric/UTC Corrections data block from the satellites' navigation message (subframe 4, page 18) that is less than 2 hours old.

Note 7: Word 17 indicates the current TRAIM alarm status. For a bit to be set in this word, TRAIM must be enabled, the specific alarm must be enabled, and the alarm condition must have been detected in the receiver.

Note 8: Word 19 indicates the current TRAIM status without regard to the alarm settings.

Note 9: Words 20 and 21 indicate which satellite(s) are excluded from the timing solution by TRAIM. The value is a bit map, with bit 0 of word 20 representing satellite 1, and bit 15 of word 21 representing satellite 32.

2.1.21 GPS/DR Calibration Output (Message 1070). This message contains the calibration values of the Dead Reckoning (DR) system. It is available in DR builds only. The contents of the GPS/DR Calibration Output Message are described in Table 2-22.

Table 2-22. Message 1070: GPS/DR Calibration Output Message

Message ID:	1070				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	Variable; defaults to off (intended for query or on-update mode)				
Message Length:	19 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	Data Invalid: Gyro Temperature (RESERVED)	Bit		0 = valid	
9.1	Data Invalid: Speed Scale Factor	Bit		0 = valid	
9.2	Data Invalid: Heading Rate Scale Factor	Bit		0 = valid	
9.3	Data Invalid: Heading Rate Bias	Bit		0 = valid	
10	Gyro Temperature (RESERVED)	I	degrees C	–40 to +85	10^{-2}
11	Speed Scale Factor (Note 1)	I		–1 to +16	2^{-11}
12	Speed Scale Factor Standard Deviation	UI		0 to +16	2^{-12}
13	Heading Rate Scale Factor (Note 2)	I		–1 to +16	2^{-11}
14	Heading Rate Scale Factor Standard Deviation	UI		0 to +16	2^{-12}
15	Heading Rate Bias (Note 2)	I	deg/s	–180 to +180	$180 * 2^{-15}$
16	Heading Rate Bias Standard Deviation	UI	deg/s	0 to 180	$180 * 2^{-16}$
17-18	Reserved				
19	Data Checksum				

Note 1:: Calibrated speed = measured speed/(1 + scale factor).

Note 2: For scale factor S, bias B, and uncalibrated DR measurements M*, the calibrated measurement M = (M* – B)/(1+S).

2.1.22 DR Parameters Output (Message 1071). This message contains the DR parameters used to specify the gyro and speed systems used for DR operation. These values are the current calculated parameters. Default values, stored in EEPROM, are loaded at each reset. Those defaults can be entered manually using Message 1270. After a reset, the EEPROM values are loaded into RAM and therafter updated by the system's continuous calibration. This message is available in DR builds only. The contents of the DR Parameters Output Message are described in Table 2-23.

Table 2-23. Message 1071: DR Parameters Output Message

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID:	1071 **(ONLY AVAILABLE IN DR BUILDS)**				
Rate:	Variable; default is "off"; Normal use = On-Update				
Message Length:	17 words				
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	DR Speed Standard Deviation (Note 1)	UI	m/s	0 to 100	10^{-2}
10	DR Speed Data Time Tag Resolution (Note 2)	UI	ms	0 to 65535	10^{-2}
11	DR Speed Latency (Note 3) (RESERVED)	UI	ms	0 to 65535	10^{-2}
12	Data Valid Flag Bit 0 = Gyro Scale and Gyro Bias Valid Bit 1 = Wheel Tick Rate Valid	Bit		1 = valid	
13	Gyro Scale	I	(deg/s)/(A/D count)	–0.32768 to +0.32767	10^{-5}
14	Gyro Bias	I	deg/s	–0.32768 to +0.32767	10^{-2}
15	Wheel Tick Rate (Note 4)	UI	ticks/km	0 to 65535	
16	Reserved				
17	Data Checksum				

Note 1: Expected accuracy of the input.

Note 2: The default is a value of 10, equivalent to 100 microseconds. This assumes use of the 10 kHz output of GPS for the time tag counter.

Note 3: (RESERVED) Estimated delay from the end of the speed measurement period to the time that the time tag in word 8 is latched.

Note 4: This is the starting DR calibration parameter. It may be set using Message 1270. Measured speed is computed by counting wheel ticks per unit time, then dividing by the wheel tick rate:

Measured speed (m/s) = [counted ticks/sec]/[wheel tick rate (km/s) × 1000]

2.1.23 Gyro Temperature Data (Message 1072). This message provides the table of bias and scale factors used by the receiver in the DR system. The contents of the Gyro Temperature Data Message are described in Table 2-24.

Table 2-24. Message 1072: Gyro Temperature Data Message

Message ID:	1072 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION BUT IS RESERVED**)				
Rate:	Variable				
Message Length:	206 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-10	Write Counter	UDI	count	0 to 4294967295	
11	Speed Scale Factor	I		–32768 to +32767	10^{-4}
12	Speed Scale Factor Date	UI	GPS week	0 to 65535	
13	Speed Scale Factor Jump	I	count	0 to 32786	1
14-77	Heading Rate Bias	UI	deg/s	0 to 16	0.125
78-141	Heading Rate Scale Factor	UI	percent	0 to 100	0.078125
142-205	Heading Rate Date	UI	week	0 to 255	1
206	Data Checksum				

2.1.24 DR Factory Calibration Response (Message 1075). This message provides the current status of the gyro factory calibration. The contents of the DR Factory Calibration Response Message are described in Table 2-25.

Table 2-25. Message 1075: DR Factory Calibration Response Message

Message ID:	1075				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	As required				
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	Factory Test Results (Note 1)	Bit		0 = passed 1 = failed	
9.1	Gyro Sensor	Bit		0 = passed 1 = failed	
9.2	Temperature Sensor (RESERVED)	Bit		0 = valid or absent 1 = invalid	
9.3	Test Identification (Note 2)	Bit		0 = gyro bias calibration, 1 = gyro SF calibration	
9.4-9.15	Reserved				
10	Data Checksum				

Note 1: This bit is a summary of the gyro and temperature bits.

Note 2: This bit identifies which calibration has been performed.

2.1.25 Hardware Accelerator Command Status (Message 1090). This message reports on the current Hardware Accelerator command settings. The contents of the Hardware Accelerator Command Status Message are described in Table 2-26.

Table 2-26. Message 1090: Hardware Accelerator Command Status Message

Message ID:	1090		**(ONLY AVAILABLE IN HARDWARE ACCELERATOR BUILDS)**		
Rate:	Variable				
Message Length:	77 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	Doppler Parameters Are Valid (Note 1)	Bit		1 = Valid	
9.1	Code Phase Parameters Are Valid (Note 2)	Bit		1 = Valid	
9.2	GPS XO Parameters Are Valid (Note 3)	Bit		1 = Valid	
9.3	GPS Reference Time is Valid (Note 4)	Bit		1 = Valid	
9.4	Force Acquisition of New Receiver Samples	Bit		1 = Force New Acquisition	
9.5	Enable Low C/N0 Operation	Bit		1 = Enable	
9.6	Continuous Tracking Mode is Valid	Bit		1 = Valid	
9.7-9.15	Reserved				
10-11	GPS Reference Time Integer (Note 4)	UDI	seconds	0 to 604799	
12-13	GPS Reference Time Fraction (Note 4)	UDI	seconds	0 to 0.999999999	10^{-9}
14	XO Error (Note 3)	I	ppm	–327.68 to 327.67	10^{-2}
15	XO Error Uncertainty (Note 3) (Note 5)	UI	ppm	0 to 655.35	10^{-2}
16	Number of Visible Satellites (Note 6)	I		0 to 32	
Satellite Data (n = 0 to 11 for channels 1 to 12)					
17 + n * 5	Satellite PRN (Note 7)	I		0 to 32	
18 + n * 5	Doppler (Note 1)	I	Hz	–32768 to 32767	2×10^{-1}
19 + n * 5	Doppler Uncertainty (Note 1) (Note 5)	UI	Hz	0 to 6553.5	10^{-1}
20 + n * 5	Code Phase (Note 2)	UI	C/A Chips	0 to 1022	
21 + n * 5	Code Phase Uncertainty (Note 2) (Note 5)	UI	C/A Chips	0 to 1023	
77	Data Checksum				

Note 1: When bit 9.0 is set, Doppler and Doppler Uncertainty contain valid data. Otherwise, ignore their contents.

Note 2: When bit 9.1 is set, Code Phase and Code Phase Uncertainty contain valid data. Otherwise, ignore their contents.

Note 3: When bit 9.2 is set, XOError and XOError Uncertainty contain valid data. Otherwise, ignore their contents.

Note 4: When bit 9.3 is set, GPS Reference Time Integer (integer part) and GPS Reference Time Fraction (fractional part) contain valid data. Otherwise, ignore their contents.

Note 5: Uncertainty values are entered as positive values. Value is applied as a ± value.

Note 6: Limited by command buffer size in the Measurement Engine/Navigation Engine interface. Specifies maximum number of satellites to search in one search effort. May exceed number of satellites actually visible. If Number of Visible Satellites is less than 12, then only the satellite data blocks following this word will contain valid data.

Note 7: A value of 0 indicates no satellite is being reported in this block, and all following words in this block, through Code Phase Uncertaintydo not contain valid data. Hardware Accelerator is capable of generating all Gold codes from the GPS set, including WAAS codes. Future implementations could expand the range of valid values accordingly

2.1.26 Hardware Accelerator Measurement (Message 1091). This message reports on the current Hardware Accelerator measurements. The contents of the Hardware Accelerator Measurement Message are described in Table 2-27.

Table 2-27. Message 1091: Hardware Accelerator Measurement Message (1 of 3)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID:	1091				**(Message not implemented – see message 1191)**
Rate:	Typically 1 Hz				
Message Length:	253 words				
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-12	GPS Measurement Time Integer Pportion (Note 1) Fractional Portion (Note 2)	 DI DI	 seconds seconds	 0 to 604799.98 ±0.02	 2×10^{-2} $2^{-29}/50$
GPS Time Status (13.0-13.15)					
13.0	Measurement Engine Initialization (default) (Note 3)	Bit		1 = initialized	
13.1	Navigation Initialization (time input) (Note 4)	Bit		1 = initialized	
13.2	Hand-Over-Word Decoded (Note 5)	Bit		1 = Hand-Over Word decoded	
13.3	Internal Feedback (Note 6)	Bit		1 = internal feedback applied	
13.4	Navigation Feedback (Note 7)	Bit		1 = external feedback applied	
13.5	Step Update	Bit		1 = updated	
13.6-13.15	Reserved				
14-15	Measurement Time Base Epoch	DI	seconds	0 to 604799.98	2×10^{-2}
16-17	Measurement Set Time (Note 8)	UDI			
18-20	GPS Time Phase (Note 9)	UTI	seconds	0 to 0.16	$2^{-45}/50$
21-22	GPS Time Velocity (Loop Aiding) (Note 10)	DI	sec/sec	$\pm 2^{-14}$	2^{-45}
23	Temperature Measurement (Note 11)	UI	counts	0 to ±65385	
24	Temperature Rate Measurement (Note 11)	I	counts/min	0 to ±32767	
PER CHANNEL OUTPUT					
n	Data Word Subframe Index (Note 12)	UI		0 to 49	

Table 2-27. Message 1091: Hardware Accelerator Measurement Message (2 of 3)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Channel Status Word One					
(n+1).0	Weak Signal (Note 13)	Bit		1 = weak	
(n+1).1	High Δθ (Note 14)	Bit		1 = high	
(n+1).2	Parity Error(s) (Note 15)	Bit		1 = errors	
(n+1).3	Pre-Position Data (Note 16)	Bit		1 = pre-positional	
(n+1).4	Propagated Track (Note 17)	Bit		1 = propagated	
(n+1).5	Bit Sync Flag	Bit		1 = bit sync unknown	
(n+1).6	Frame Sync Flag	Bit		1 = frame sync unknown	
(n+1).7	Z Count Flag	Bit		1 = z count unknown	
(n+1).8 to (n+1).15	Reserved				
Channel Status Word Two					
(n+2).0 to (n+2).4	Pre-Detection Interval (PDI) (Note 18)	UI		1 to 20	
(n+2).5 to (n+2).7	Reserved				
(n+2).8 to (n+2).15	Signal Problems (Note 19)	UI		0 to 255	
SATELLITE MEASUREMENTS					
n+3	Satellite Pseudorandom Noise Number (PRN) (Note 20)	I		0 to 32	
n+4	C/No (Note 21)	I	dB-Hz	–128 to +128	2^{-8}
n+5	Code Phase Measurement (Note 22)	UTI	seconds	0 to 8	$2^{-45}/50$
n+8	Carrier Phase Measurement (Note 23)	UTI	seconds	0 to 8	$2^{-45}/50$
n+11	Carrier Velocity Measurement (Note 24)	DI	sec/sec	2–31 to 2+31	2^{-45}
n+13	Code Phase Standard Deviation (Note 25)	UI	seconds	0 to 6553	$2^{-19}/50$
n+14	Carrier Phase Standard Deviation (Note 25)	UI	seconds	0 to 6553	$2^{-19}/50$
Channel Data Word One (Note 26)					
(n+15).0 to (n+15).29	SV Data Word One				
(n+15).30	Validity			0 = Invalid (unused) 1 = Valid (used)	
(n+15).31	Parity Error			0 = Correct 1 = Error	
Channel Data Word Two (Note 26)					
(n+17).0 to (n+17).29	SV Data Word Two				
(n+17).30	Validity			0 = Invalid (unused) 1 = Valid (used)	
(n+17).31	Parity Error			0 = Correct 1 = Error	
253	Data Checksum				

Table 2-27. Message 1091: Hardware Accelerator Measurement Message (3 of 3)

Note 1: Measurement time is always GPS time. The integer portion is the GPS bit count, in 20 ms bits, from start of week.

Note 2: The fractional portion of the solution measurement time is the offset from the bit count.

Note 3: The Measurement Engine has initialized time at zero.

Note 4: Reported time has been corrected based on feedback of navigation engine solution.

Note 5: The Measurement Engine has decoded and applied at least one Hand-Over Word. The GPS time is within about 15 ms of the correct GPS time of week.

Note 6: Internal feedback from existing tracks is being applied to refine the GPS time.

Note 7: External navigation feedback is being applied to refine the GPS time. (Bits 3 and 4 are mutually exclusive.)

Note 8: While words 6 and 7 provide the set time when the message was created, words 16 and 17 provide the set time when the measurement was made.

Note 9: Value of the GPS time integrator, modulo 20 ms, at the T20 following the measurement epoch. The resolution matches that of the code and carrier phase measurements.

Note 10: Velocity of time tracking error. Range is about ±61 ppm with a resolution of about 0.02 ps/s. By scaling this value, results can be converted to m/s or Hz. Scale factor for m/s is $C \times 2^{-45}$, which gives a range of ±18.3 km/s with a resolution of 8.5 µm/s. Scale factor for Hz is $L1 \times 2^{-45}$, which gives a range of ±96 kHz with a resolution of 45 µHz.

Note 11: Measurements are recorded at the same measurement time as time and channel data.

Note 12: Indication of the position in the GPS satellite downlink telemetry sequence of SV data word one (see Words n+15 to n+18). For example, a value of 10 indicates the first word of subframe 2. Data described in per channel output is repeated once for each channel.

n = 25 + (j*19), where j = 0 to 11 for channels 1 to 12

Note 13: 1 = the signal strength fell below a threshold.

Note 14: The relative phase between I and Q signals is changing at a rate above a threshold. High $\Delta\theta$ often indicates either a noisy signal or Doppler not properly compensated, perhaps due to a high phase noise in the crystal oscillator.

Note 15: 1 = carrier phase cycle slips may have affected this measurement or the previous measurement.

Note 16: 1 = the current search phase and carrier velocity values are provided as measurements during acquisition using pre-positioning.

Note 17: 1 = the track is propagated and provided as the measurement during reacquisition.

Note 18: Number of 1 ms cycles out of 20 used to determine the current measurement. A value of 20 generally means a good signal. Values below 20 indicate the tracking loop is trying to compensate for high $\Delta\theta$. Only specific values are valid, including 1, 2, 4, 10, and 20.

Note 19: Count of the number of data epochs in which problems were detected.

Note 20: PRN equal to 0 is used to indicate an unused channel.

Note 21: C/No observed for this measurement interval.

Note 22: Code phase (pseudorange) at the measurement epoch. The physical range value in meters is obtained by scaling by $c \bullet (2^{-45}/50)$, where c is the WGS-84 value of the speed of light. The factor of 50 results from the 50 Hz accumulation of code phase. The range is about twice the orbital height and the resolution is about 0.17 µm. The LSB of the second word is about 0.56 cm, so that the least significant word could be ignored.

Note 23: The reported code phase has been smoothed by the carrier phase. The continuously integrated carrier phase has the same characteristics as the code phase. The difference between the two signals is that code phase has the early-late signal superimposed on the carrier to code aiding.

Note 24: Velocity measurement is created from corrections required to keep the carrier phase tracked in a Phase-Locked Loop (PLL).

Note 25: Standard deviation of code phase measurements.

Note 26: Channel Data Words One and Two are the raw navigation message data recovered from the satellite. Data word frame index (Word n) specifies where the Channel Data Word One goes in the 50-word sequence. If SV Data Word One is invalid, so is Channel Data Word Two.

2.1.27 Hardware Accelerator Status Message (Message 1092). This message is available in Hardware Accelerator software only. It reports on the current Hardware Accelerator control settings and operational status. The contents of the Hardware Accelerator Status Message are described in Table 2-28.

Table 2-28. Message 1092: Hardware Accelerator Status Message

Message ID:	1092			**(ONLY AVAILABLE IN HARDWARE ACCELERATOR BUILDS)**	
Rate:	Variable				
Message Length:	29 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Hardware Accelerator Mode (Note 1)	I		0 = off 1 = fast acquire 2 = on	
10	EnableLowC/No (Note 2)	I	dB-Hz	0 = 34 (off) 1 = 32 (default) 2 = 30 3 = 28 4 = 26 5 = 24 6 = 22 7 = 20 8 = 18 9 = 16 10 = 14 11 = 12 12 = 10 13 = 8 14 = 6 15 = 4	
11-18	Reserved				
19	OK to Power Down (Note 3)	I		1 = yes	
20	Reserved	UI			
21-22	RTC Interval (Note 4)	UDI	μs	0 to 4294967296	
23-28	Reserved				
29	Data Checksum				

Note 1: The receiver's "off" mode runs as a GPS receiver without any Hardware Accelerator operation. "Fast acquire" mode uses the Hardware Accelerator to acquire signals in the acquisition phase, but uses normal tracking loops for all navigation and reacquisition. The receiver's "on" mode uses the Hardware Accelerator to acquire signals, transitions to tracking loops to obtain the navigation message, then uses the Hardware Accelerator to navigate, shutting down the RF section except when sampling. In the receiver's "on" mode, the receiver periodically returns to tracking loops when required to download new ephemerides or almanacs, or when required to reduce any errors that have built up in the navigation solution. While the receiver's "on" mode is the most power efficient tracking mode, the resulting measurements are typically noisier than tracking loop results due to the absence of carrier smoothing.

Note 2: User-specified tracking limit. The user can set the limit on how low the signal level should be tracked. Tracking low C/No signals requires additional processing and additional power consumption. When off, the value used is 34 dB-Hz.

Note 3: When this word is set to "yes," the receiver powers down when not required to be collecting data. It will use the RTC alarm feature to waken it when it is time to take the next satellite measurement. [This feature is not yet implemented.]

Note 4: Amount of time that has elapsed between receiver wake-up and receipt of the RTC time synchronization alarm. When the receiver's mode is "on," and word 19 is set ("yes"), the receiver is powered down after each observation (when using tracking loops during the receiver's "on" mode, the receiver is not powered down). When the receiver is awakened, it looks for an RTC alarm to synchronize it to the GPS time. If it is awakened too late to capture the alarm, it will have to wait almost a full second for the next alarm. If so, this value will be large (near 1,000,000), indicating that an observation has been missed and the receiver has been on longer than necessary. The wake-up time needs to be earlier so that this time period is very small and the receiver will be making most efficient use of its "on" time and power consumption. The wake-up time is not yet implemented.

2.1.28 Built-In Test (BIT) Results (Message 1100). This message provides detailed test results of the last BIT commanded since power-up. It is output automaticaly after the completion of a commanded BIT, but may also be queried manually as needed. Non-zero device failure status indicates failure. The contents of the Built-In Test (BIT) Results Message are described in Table 2-29.

Table 2-29. Message 1100: Built-In Test Results Message

Message ID:	1100				
Rate:	Variable				
Message Length:	20 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	ROM Failure (Note 1, 2)	UI		(Note 2)	
10	RAM Failure (Note 1, 3)	UI		1 = failure	
11	EEPROM Failure (Note 4)	UI		0 to 2	
12.0	Dual Port RAM Failure (Note 5)	Bit		1 = failure	
12.1	Hardware Accelerator Failure (Note 1, 6)	Bit		1 = failure or not present	
12.2-12.15	Not used (set to 0)				
13	Digital Signal Processor (DSP) Failure (Note 1, 7)	UI		(Note 6)	
14	Real-Time Clock (RTC) Failure (Note 1)	UI			
15	Serial Port 1 Receive Error Count	UI		0 to 65535	
16	Serial Port 2 Receive Error Count	UI		0 to 65535	
17	Serial Port 1 Receive Byte Count	UI		0 to 65535	
18	Serial Port 2 Receive Byte Count	UI		0 to 65535	
19	Software Version	UI		0.00 to 65535	10^{-2}
20	Data Checksum				

Note 1: A value of zero indicates a test has passed. A non-zero value indicates a device failure. Missing devices will be reported as failures. Therefore, the OEM's BIT pass/fail should ignore words for components that are not in the system under test.

Note 2: Each 32 kword ROM segment is tested by checksum. If a segment fails, a bit is set in this word. Bit 0 is set if the first segment fails, bit 1 is set if the second segment fails, etc.

Note 3: RAM is tested using a non-destructive write/read of the value 0xA5A5 5A5A. Any word that fails causes the failure word to be set to 1.

Note 4: EEPROM is tested by reading data blocks and verifying checksums. If EEPROM is not installed, or does not respond, the result is set to 1. If any checksum fails, the result is set to 2.

Note 5: Dual port RAM testing is not implemented. This result will always be reported as passing (0).

Note 6: Added Hardware Accelerator BIT in version 2.59.

Note 7: A total of six tests are performed on each channel. If any channel fails any test, a bit is set in this word. Bit 0 is set for channel 1, bit 1 is set for channel 2, bit 2 is set for channel 3, etc.

2.1.29 Global Output Control Parameters (Message 1101). This message provides the current status of the Measurement Engine mode. This message is designed for use with systems in which the navigation engine is hosted on a separate processor. The contents of the Global Output Control Parameters Message are described in Table 2-30.

Table 2-30. Message 1101: Global Output Control Parameters Message

Message ID:	1101				
Rate:	Variable				
Message Length:	12 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Current Measurement Engine Mode (Note 1)	UI		0 = Autonomous acquisition 1 = Sequential acquisition 2 = Commanded channel 3 = Parallel acquisition 4 = Reset	
10	Reserved				
11	Reserved				
12	Data Checksum				

Note 1: This mode cannot be commanded. The mode word is set to" initializing" by the Measurement Engine immediatly after power-up. When initialization is complete, the mode is changed to another value, typically autonomous cold start. The Initialized mode will never be seen by a Navigation Engine on the AAMP 2-8 because the mode will be changed before the Navigation Engine starts. It is intended for applications with the Navigation Engine on a remote processor.

2.1.30 Measurement Time Mark (Message 1102). This message provides raw measurement and associated data from the Measurement Engine. For a subset of this message's data, see Message 1007. The contents of the Measurement Time Mark Message are described in Table 2-31.

Table 2-31. Message 1102: Measurement Time Mark Message (1 of 4)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID: 1102					
Rate: Variable					
Message Length: 253 words					
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-12	GPS Measurement Time Integer Pportion (Note 1) Fractional Portion (Note 2)	 DI DI	 seconds seconds	 0 to 604799.98 ±0.02	 2×10^{-2} $2^{-29}/50$
GPS Time Status (13.0-13.15)					
13.0	Measurement Engine Initialization (default) (Note 3)	Bit		1 = initialized	
13.1	Navigation Initialization (time input) (Note 4)	Bit		1 = initialized	
13.2	Hand-Over-Word Decoded (Note 5)	Bit		1 = Hand-Over Word decoded	
13.3	Internal Feedback (Note 6)	Bit		1 = internal feedback applied	
13.4	Navigation Feedback (Note 7)	Bit		1 = external feedback applied	
13.5	Step Update	Bit		1 = updated	
13.6-13.15	Reserved				
14-15	Measurement Time Base Epoch	DI	seconds	0 to 604799.98	2×10^{-2}
16-17	Measurement Set Time (Note 8)	UDI			
18-20	GPS Time Phase (Note 9)	UTI	seconds	0 to 0.16	$2^{-45}/50$
21-22	GPS Time Velocity (Loop Aiding) (Note 10)	DI	sec/sec	$\pm 2^{-14}$	2^{-45}
23	Temperature Measurement (Note 11)	UI	counts	0 to ±65385	
24	Temperature Rate Measurement (Note 11)	I	counts/min	0 to ±32767	

Table 2-31. Message 1102: Measurement Time Mark Message (2 of 4)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
n = 25 + 19 * (channel number – 1)	**PER CHANNEL OUTPUT (repeats 12 times)**				
n	Data Word Subframe Index (Note 12)	UI		0 to 49	
Channel Status Word One					
(n+1).0	Data inverted	Bit		1 = Inverted	
(n+1).1	Weak Signal (Note 13)	Bit		1 = weak	
(n+1).2	High $\Delta\theta$ (Note 14)	Bit		1 = high	
(n+1).3	Parity Error(s) (Note 15)	Bit		1 = errors	
(n+1).4	Not Used				
(n+1).5	Propagated Track (Note 16)	Bit		1 = propagated	
(n+1).6	Not Used				
(n+1).7	Carrier Error	Bit		1 = Carrier Lock broken	
(n+1).8	Bit Sync Flag	Bit		1 = Data bit sync not achieved	
(n+1).9	Frame Sync Flag	Bit		1 = Frame sync not achieved	
(n+1).10	Z Count Flag	Bit		1 = Z Count not recovered	
(n+1).11	Hardware Accelerator Measurement	Bit		1 = Data from Magna measurement	
(n+1).12	Preamble Detection	Bit		1 = Preamble not detected	
(n+1).13	Fixed-up Measurement	Bit		1 = Measurement has been patched by hardware	
(n+1).14	Pre-Position Data (Note 17)	Bit		1 = Data prepositioned	
(n+1).15	SPS Invalid			1 = Track is invalid	
Channel Status Word Two					
(n+2).0 to (n+2).4	Pre-Detection Interval (PDI) (Note 18)	UI		1 to 20	
(n+2).5 to (n+2).7	Reserved				
(n+2).8 to (n+2).15	Signal Problems (Note 19)	UI		0 to 255	
SATELLITE MEASUREMENTS					
n+3	Satellite Pseudorandom Noise Number (PRN) (Note 20)	I		0 to 32	
n+4	C/N_0 (Note 21)	I	dB-Hz	–128 to +128	2^{-8}
n+5 to n+7	Code Phase Measurement (Note 22)	UTI	seconds	0 to 0.16	$2^{-45}/50$
n+8 to n+10	Carrier Phase Measurement (Note 23)	UTI	seconds	0 to 0.16	$2^{-45}/50$
n+11 to n+12	Carrier Velocity Measurement (Note 24)	DI	sec/sec	$\pm 2^{-14}$	2^{-45}
n+13	Code Phase Standard Deviation	UI	seconds	0 to 6553	$2^{-19}/50$
n+14	Carrier Phase Standard Deviation	UI	seconds	0 to 6553	$2^{-19}/50$

Table 2-31. Message 1102: Measurement Time Mark Message (3 of 4)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Channel Data Word One (Note 25) (Double word)					
(n+15).0-23	SV Data Word One				
(n+15).24-29	Not used				
(n+15).30	Validity			0 = Invalid or unused 1 = Valid or used	
(n+15).31	Parity Error			0 = Correct 1 = Error	
Channel Data Word Two (Note 25) (Double word)					
(n+17).0 to (n+17).29	SV Data Word Two				
(n+17).30	Validity			0 = Invalid or unused 1 = Valid or used	
(n+17).31	Parity Error			0 = Correct 1 = Error	
253	Data Checksum				

Table 2-31. Message 1102: Measurement Time Mark Message (4 of 4)

Note 1: Measurement time is always GPS time. The integer portion is the GPS bit count, in 20 ms bits, from start of week.

Note 2: The fractional portion of the solution measurement time is the offset from the bit count.

Note 3: The Measurement Engine has initialized time at zero.

Note 4: Reported time has been corrected based on feedback of navigation engine solution.

Note 5: The Measurement Engine has decoded and applied at least one Hand-Over Word. The GPS time is within about 15 ms of the correct GPS time of week.

Note 6: Internal feedback from existing tracks is being applied to refine the GPS time.

Note 7: External navigation feedback is being applied to refine the GPS time. (Bits 3 and 4 are mutually exclusive.)

Note 8: While words 6 and 7 provide the set time when the message was created, words 16 and 17 provide the set time when the measurement was made.

Note 9: Value of the GPS time integrator, modulo 20 ms, at the 20-ms interval following the measurement epoch. The resolution matches that of the code and carrier phase measurements.

Note 10: Velocity of time tracking error. Range is about ±61 ppm with a resolution of about 0.02 ps/s. By scaling this value, results can be converted to m/s or Hz. Scale factor for m/s is $c \times 2^{-45}$, which gives a range of ±18.3 km/s with a resolution of 8.5 μm/s. Scale factor for Hz is $L_1 \times 2^{-45}$, which gives a range of ±96 kHz with a resolution of 45 μHz. Note: c=299792458 m/s per GPS system definition, and L_1 = 1575.42 MHz.

Note 11: Measurements are recorded at the same measurement time as time and channel data.

Note 12: Indication of the position in the GPS satellite downlink telemetry sequence of SV data word one (see Words n+15 to n+18). For example, a value of 10 indicates the first word of subframe 2. Data described in per channel output is repeated once for each channel.

Note 13: 1 = the signal strength fell below a threshold.

Note 14: The relative phase between I and Q signals is changing at a rate above a threshold. High $\Delta\theta$ often indicates either a noisy signal or Doppler not properly compensated, perhaps due to a high phase noise in the crystal oscillator.

Note 15: 1 = carrier phase cycle slips may have affected this measurement or the previous measurement.

Note 16: 1 = the track is propagated and provided as the measurement during reacquisition.

Note 17: 1 = the current search phase and carrier velocity values are provided as measurements during acquisition using pre-positioning.

Note 18: Number of 1 ms cycles out of 20 used to determine the current measurement. A value of 20 (14 hex) generally means a good signal. Values below 20 indicate the tracking loop is trying to compensate for high $\Delta\theta$. Only specific values are valid, including 1, 2, 4, 10, and 20.

Note 19: Count of the number of data epochs in which problems were detected.

Note 20: PRN equal to 0 is used to indicate an unused channel.

Note 21: C/N_0 observed for this measurement interval.

Note 22: Code phase (pseudorange) at the measurement epoch. The physical range value in meters is obtained by scaling by $c(2^{-45}/50)$, where c is the WGS-84 value of the speed of light. The factor of 50 results from the 50 Hz accumulation of code phase. The range is about twice the orbital height and the resolution is about 0.17 μm. The LSB of the second word is about 0.56 cm, so that the least significant word could be ignored.

Note 23: The reported code phase has been smoothed by the carrier phase. The continuously integrated carrier phase has the same characteristics as the code phase. The difference between the two signals is that code phase has the early-late signal superimposed on the carrier-to-code aiding.

Note 24: Velocity measurement is created from corrections required to keep the carrier phase tracked in a Phase-Locked Loop (PLL).

Note 25: Channel Data Words One and Two are the raw navigation message data recovered from the satellite. Data word frame index (Word n) specifies where the Channel Data Word One goes in the 50-word sequence. If Data Word One is invalid, so is Data Word Two. For each word, the 24 data bits of the navigation message word are right justified into bits 0-23. Bits 24-29 are not used and should be ignored. Bit 31 will be set if the received data word contained a parity error; however, any 1-bit errors will have been corrected.

2.1.31 Explicit Acknowledgement Output (Message 1106).

This message provides a means to acknowledge receipt of other messages. It is used only to acknowledge receipt of a block of 1337 messages when restoring vEEPROM data. The contents of the Explicit Acknowledge Output Output Message are described in Table 2-32.

Table 2-32. Message 1106: Explicit Acknowledgement Output Message

Message ID:	1106				**(ONLY USED IN vEEPROM SOFTWARE)**
Rate:	Variable				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	ID of Message (Note 1)	UI		1000 to 1399	
10.0	Acknowledgement Status	Bit		1 = ACK	
10.1-10.15	Reserved				
11	Reserved				
12	Reserved				
13	Data Checksum				

Note 1: ID of the message whose acknowledgement status is being reported. This is currently limited to acknowledging the 1337 message.

2.1.32 UTC Time Mark Pulse Output (Message 1108). This message provides the UTC seconds into week associated with the 1 PPS Time Mark pulse. This message is output approximately 400 milliseconds before the Time Mark pulse strobe signal. When the receiver is in acquisition mode, the Time Mark is not synchronized. When the receiver transitions to navigation mode, the Time Mark is steered to align with GPS time and Time Mark validity is reported. Once the current relationship between UTC and GPS time becomes known, the Time Mark is steered to align with UTC time and GPS/UTC synchronization is reported. The contents of the UTC Time Mark Pulse Output Message are described in Table 2-33**.**

Table 2-33. Message 1108: UTC Time Mark Pulse Output Message (1 of 2)

Message ID:	1108			**(ENABLED IN SELECTED VERSIONS ONLY)**	
Rate:	1 Hz				
Message Length:	20 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
UTC TIME					
9-13	Reserved				
14-15	UTC Seconds Of Week (Note 1)	UDI	seconds	0 to 604799	
16	GPS to UTC Time Offset (integer part) (Note 2)	I	seconds	–32768 to +32767	
17-18	GPS to UTC Time Offset (fractional part) (Note 2)	UDI	ns	0 to 999999999	
UTC TIME VALIDITY (19.0-19.15)					
19.0	Time Mark Validity (Note 3)	Bit		1 = valid	
19.1	GPS/UTC Sync (Note 4)	Bit		0 = GPS 1 = UTC	
19.2	Time Mark UTC Precision (Note 5) (Note 6)	Bit		1 = UTC Second	
19.3	TRAIM Alarm (Note 5) (Note 7)	Bit		1 = Alarm	
19.4	Time Mark Suppressed (Note 5) (Note 8)	Bit		1 = Suppressed	
19.5-19.15	Reserved				
20	Data Checksum				

Table 2-33. Message 1108: UTC Time Mark Pulse Output Message (2 of 2)

Note 1:	When this message is output automatically (rather than in response to a query), the indicated time is the time at the next Time Mark Pulse.
Note 2:	GPS time and UTC time differ by an integer number of leap seconds (GPS time is ahead of UTC), and by a fractional part of a second representing the offset between second starts. While the fractional offset is steered to be 1 µs or less by the GPS Control Segment, that offset can be positive or negative. Conversely, integer leap seconds are positive. To compute leap seconds, add the reported integer and fractional parts to arrive at the total offset. Then, round the result. The UTC-GPS offset is then the difference between the computed leap seconds and the total offset. For example: Integer part: 12 Fractional part: 999999000 ($\times 10^{-9}$) Total offset: 12.999999 Leap seconds (rounded offset): 13 seconds GPS-UTC alignment: (13 seconds total offset – leap seconds) = 12.999999 – 13 = –0.000001 seconds
Note 3:	Set valid when receiver is in navigation mode and the Time Mark has been steered to GPS time.
Note 4:	Specifies if the time mark is synchronized to the GPS or UTC second. Set to UTC once a correction has been made for the GPS-to-UTC offset.
Note 5:	These bits are available only in Timing Software versions, beginning with version 3.02.
Note 6:	When this bit is set, the receiver has an Ionospheric/UTC Corrections data block from the satellites' navigation message (subframe 4, page 18) that is no more than 2 hours old. If the time mark should be aligned to UTC time, this bit and bit 19.0 are set when the time mark is aligned to UTC within the specified accuracy of the GPS navigation message.
Note 7:	This bit is set when any TRAIM alarm has been activated and the alarm condition has been detected.
Note 8:	When this bit is set, the time mark is suppressed either because it is invalid or because TRAIM has detected an alarm. Refer to Message 1056 for exact details of the current condition. Refer to Message 1255 to control the logic for time mark suppression.

2.1.33 Frequency Standard Parameters In Use (Message 1110). This message outputs the parameters used to support the receiver's uncompensated crystal oscillator. The contents of the Frequency Standard Parameters In Use Message are described in Table 2-34.

Message 1110 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1310 is similar -- the output message is used to capture data, while the input message is used to restore data. Note that Message 1110 has Set Time in Words 6 and 7 while Message 1310 does not!

NOTE: Do not use this message to collect data from one receiver and use that data to initialize another receiver. Message 1110 contents are only valid for the receiver that generates them.

Table 2-34. Message 1110: Frequency Standard Parameters In Use Message

Message ID:	1110				
Rate:	Variable				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Frequency Standard Issue Number (Note 1)	UI		0 to 65535	
TEMPERATURE CHARACTERISTIC					
10	C_0 (Aging and Calibration Offset) (Note 2)	I	sec/sec	$\pm 2^{-14}$	2^{-29}
11	C_1 (Linear Term) (Note 2)	I	sec/sec/deg C	$\pm 2^{-14}$	2^{-35}
12	C_2 (Second Order Term) (Note 2)	I	sec/sec/(deg C)^2	$\pm 2^{-14}$	2^{-41}
13	C_3 (Third Order Term) (Note 2)	I	sec/sec/(deg C)^3	$\pm 2^{-14}$	2^{-47}
14	T_{INF} (Inflection Point) (Note 2)	I	degrees C	–100 to +100	10^{-2}
TEMPERATURE DYNAMICS					
15	D_0 (Note 3)	I			
16	D_1 (Note 3)	I			
TEMPERATURE SENSOR CALIBRATION					
17	T_{REF} (Calibration ReferenceTemperature) (Note 4)	I	degrees C	–100 to +100	10^{-2}
18	T_0 (Temperature Sensor Reading at T_{REF}) (Note 4)	UI	counts	0 to 65535	
19	S_0 (Temperature Sensor Scale Factor) (Note 4)	I	deg C/count	$\pm 2^{-3}$	2^{-18}
UNCERTAINTY COEFFICIENTS					
20	U_0 (Note 5)	I	sec/sec	$\pm 2^{-14}$	2^{-29}
21	U_1 (Note 5)	I	sec/sec/deg C	$\pm 2^{-14}$	2^{-35}
22	Data Checksum				

Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data are only stored to EEPROM. The issue number is preserved from run to run if non-volatile storage is available.

Note 2: Defines a cubic in ($T - T_{INF}$). Over a range of $T_{INF} \pm 65$ degrees C, each term can produce from 0.002 to 60 ppm,approximately.

Note 3: D parameters are unused.

Note 4: These parameters define the temperature sensor scaling according to the equation:

$$T = T_{REF} + (T_{READING} - T_0)S_0$$

Where $T_{READING}$ is the current temperature sensor reading in counts, and T is the current temperature in degrees C.

Note 5: Defines a linear equation in ($T - T_{INF}$). Over a range of $T_{INF} \pm 65$°C, each term can produce from 0.002 to 60 ppm, approximately.

2.1.34 Temperature Sensor Filter Parameters In Use (Message 1111). This message ***** TBD definition *****. The contents of the Temperature Sensor Filter Parameters Message are described in Table 2-35.

NOTE: Message 1111 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1311 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-35. Message 1111: Temperature Sensor Filter Parameters In Use Message

Message ID:	1111	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Temperature Sensor Issue Number (Note 1)	UI		0 to 65535	
10	K_0 (Loop Gain) (Note 2)	I			
11	K_1 (Loop Gain) (Note 2)	I			
12	E_{TOL} (Loop Error Tolerance) (Note 2)	I			
13	Data Checksum				
Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data are only stored to EEPROM.					
Note 2: The parameters of the temperature filter can be optimized for alternative sensors, crystals, temperature environments, or other factors.					

2.1.35 Measurement Epoch Steering Parameters In Use (Message 1112). This message ***** TBD definition *****. The contents of the Measurement Epoch Steering Parameters In Use Message are described in Table 2-36.

NOTE: Message 1112 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1312 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-36. Message 1112: Measurement Epoch Steering Parameters In Use Message

Message ID:	1112 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	Variable				
Message Length:	15 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-12	Command Reference Time Integer Portion (Note 1) Fractional Portion (Note 2)	 DI DI	 seconds seconds	 0 to 60479998 0 to ±0.02	 2×10^{-2} $2^{-29}/50$
13	Time Offset Command	DI	seconds	0 to ±2	2^{-30}
14	Rate Offset Command	DI	sec/sec	0 to $\pm 2^{-27}$	2^{-50}
15	Data Checksum				
Note 1: Command Reference Time is the GPS time of validity for the Time Offset in the command.					
Note 2: The fractional portion of the Command Reference Time is the offset from the bit count.					

2.1.36 Measurement Time Offset In Use (Message 1113). This message ***** TBD definition *****. The contents of the Measurement Time Offset In Use Message are described in Table 2-37.

NOTE: Message 1113 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1313 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-37. Message 1113: Measurement Time Offset In Use Message

Message ID:	1113 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	Variable				
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Measurement Time Offset (Note 1)	I	seconds	0 to ±0.64	$2^{-10}/50$
10	Data Checksum				
Note 1: Delay from the selected GPS or UTC one second epoch for measurement data capture.					

2.1.37 Time Mark Signal Output In Use (Message 1114). This message ***** TBD definition *****. The contents of the Time Mark Signal Output In Use Message are described in Table 2-38.

NOTE: Message 1114 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1314 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-38. Message 1114: Time Mark Signal Output In Use Message

Message ID:	1114 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	Variable				
Message Length:	11 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Time Mark Control Flags (9.0 to 9.15)					
9.0	Command Time Mark On	UI		1 = time mark on	
9.1	Command K10 On	UI		1 = K10 on	
9.2-9.15	Reserved				
10	Time Mark Offset Command (Note 1)	DI	seconds	0 to ±0.64	$2^{-26}/50$
11	Data Checksum				
Note 1: Delay from selected GPS or UTC one second epoch for Time Mark signal epoch.					

2.1.38 Platform Dynamics Limits In Use (Message 1115). This message ***** TBD definition *****. The contents of the Platform Dynamics Limits In Use Message are described in Table 2-39.

NOTE: Message 1115 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1315 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-39. Message 1115: Platform Dynamics Limits In Use Message

Message ID:	1115	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	11 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Maximum Acceleration Command (Note 1)	I	g	0 to 10	0.1
10	Maximum Velocity Command (Note 1)	I	m/s	0 to 32767	1.0
11	Data Checksum				
Note 1:	Parameters are used to optimize parameter selection for acquisition, reacquisition, and tracking (limits may be different for each of these). **Additional information *** TBD *****				

2.1.39 Measurement Rate In Use (Message 1116). This message ***** TBD definition *****. The contents of the Measurement Rate In Use Message are described in Table 2-40.

NOTE: Message 1116 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1316 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-40. Message 1116: Measurement Rate In Use Message

Message ID:	1116	**(THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION)**			
Rate:	Variable				
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Measurement Interval Command (Note 1)	UI	seconds	0.1 to 65535	0.1
10	Data Checksum				
Note 1: The rate at which measurements are updated is not related to the duty cycling of the RF and digital circuitry when in power management mode. It simply specifies the rate at which measurements are taken.					

2.1.40 Power Management Duty Cycle In Use (Message 1117). This message displays the current power management setting in the receiver (as set by Message 1317). The contents of the Power Management Duty Cycle In Use Message are described in Table 2-41.

Table 2-41. Message 1117: Power Management Duty Cycle In Use Message

Message ID:	1117				**(ONLY AVAILABLE IN POWER MANAGEMENT BUILDS)**
Rate:	Variable				**(Modified in version 3.05)**
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Power Management On Duty Cycle (Note 1)	I	seconds	0 = off 1-4 = on	
10	Data Checksum				

Note 1: In power management mode, the RF power may be switched off to reduce power consumption. When this field is greater than zero, it represents the number of seconds the RF power is switched off in a cycle. The power will be switched on for one or two seconds out of each cycle (depending on software version). Prior to version 3.05, power was turned on two seconds: one second to stabilize and one second to take satellite measurements. In version 3.05 and following, power is turned on only 1 second total, with the need tostabilize the RF section compensated for in software. During the off second(s) and the one second of warm up (in earlier versions), the navigation engine computes solutions without aid from current satellite observations. See Message 1317 to set this value.

2.1.41 Cold Start Almanac Data In Use (Message 1118). This message ***** TBD definition *****. The contents of the Cold Start Almanac Data In Use Message are described in Table 2-42.

NOTE: Message 1118 is primarily used to output key parameters from GPS systems without non-volatile storage. This is why the format of input message 1318 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-42. Message 1118: Cold Start Almanac Data In Use Message (1 of 2)

Message ID:	1118	**(THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION)**			
Rate:	Variable				
Message Length:	26 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Almanac Data (Note 1)					
9.0-9.5	PRN (1st Almanac)	UI			
9.6	Health OK (1st Almanac)	UI		1 = OK	
9.7	Satellite Seen In Almanac (1st Almanac)	UI		1 = satellite seen	
9.8-9.13	PRN (2nd Almanac)	UI			
9.14	Health OK (2nd Almanac)	UI		1 = OK	
9.15	Satellite Seen In Almanac (2nd Almanac)	UI		1 = satellite seen	
10.0-10.5	PRN (3rd Almanac)	UI			
10.6	Health OK (3rd Almanac)	UI		1 = OK	
10.7	Satellite Seen In Almanac (3rd Almanac)	UI		1 = satellite seen	
10.8-10.13	PRN (4th Almanac)	UI			
10.14	Health OK (4th Almanac)	UI		1 = OK	
10.15	Satellite Seen In Almanac (4th Almanac)	UI		1 = satellite seen	
• • •					
25.0-25.5	PRN (31st Almanac)	UI			
25.6	Health OK (31st Almanac)	UI		1 = OK	
25.7	Satellite Seen In Almanac (31st Almanac)	UI		1 = satellite seen	
25.8-25.13	PRN (32nd Almanac)	UI			

Table 2-42. Message 1118: Cold Start Almanac Data In Use Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
25.14	Health OK (32nd Almanac)	UI		1 = OK	
25.15	Satellite Seen In Almanac (32nd Almanac)	UI		1 = satellite seen	
26	Data Checksum				

Note 1: Each integer (from 7 to 23) has data for two satellite almanacs, one in each byte. The offset runs from 1 to 10h, which provides entries for 32 satellites. The order of satellites takes two forms. If the Satellite Seen in Almanac bit is false (zero), the order of the PRN values in the list is arbitrary and is to be taken as a search order. If this bit is set, the PRNs are in orbit/station order. That is, the first 24 satellites must all have this bit set. The first four PRNs are for satellites in orbit 1, the second four are in orbit 2, and so on until the last four are in orbit 6. Within each orbit, the first PRN is in station 1, the second is in station 2, the third in station 3 and the fourth is in station 4.

Orbits and stations are defined at the GPS time equal to the reference time of the almanac. Orbit 1 is the orbit having its orbital plane intersecting the earth's equatorial plane closest to longitude = 0. Remaining orbits are defined by rotating the plane of orbit one to the west. Within each orbit, station 1 is that satellite which is rising from south to north and is closest to the equatorial plane. (This definition is arbitrary. A review of the current orbits is required to determine the best definition.)

2.1.42 Serial Port Communication Parameters In Use (Message 1130). This message contains the communication parameters for the receiver's two serial ports. By default, both ports are set for 8 data bits, 1 stop bit, and no parity bit. Port 1 defaults to 9600 baud unless NMEA is set as the default protocol. In that case, the port defaults to 4800 baud and port 2 defaults to 9600 baud. If either port is altered by command, the system stores the new settings in EEPROM (if available) and uses the same settings at the next reset. These parameters may be set using Message 1330. The contents of the Serial Port Communication Parameters In Use Message are described in Table 2-43.

Table 2-43. Message 1130: Serial Port Communication Parameters In Use Message (1 of 2)

Message ID:	1130				
Rate:	Variable				
Message Length:	21 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Port 1 Communication Parameters (9-14)					
9	Port 1 Character Width	UI		0 = 7 bits 1 = 8 bits	
10	Port 1 Stop BIts	UI		0 = 1 1 = 2	
11	Port 1 Parity	UI		0 = no parity 1 = odd parity 2 = even parity	
12	Port 1 bps Rate (Note 1)	UI		0 = custom 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600 10 = 76800 11 = 115200	
13	Port 1 Pre-Scale (Note 1)	UI		0 to 255	
14	Port 1 Post-Scale (Note 1)	UI		0 to 7	

Table 2-43. Message 1130: Serial Port Communication Parameters In Use Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Port 2 Communication Parameters (15-20)					
15	Port 2 Character Width	UI		0 = 7 bits 1 = 8 bits	
16	Port 2 Stop BIts	UI		0 = 1 1 = 2	
17	Port 2 Parity	UI		0 = no parity 1 = odd parity 2 = even parity	
18	Port 2 bps Rate (Note 1)	UI		0 = custom 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600 10 = 76800 11 = 115200	
19	Port 2 Pre-Scale (Note 1)	UI		0 to 255	
20	Port 2 Post-Scale (Note 1)	UI		0 to 7	
21	Data Checksum				
Note 1: When a custom bits-per-second (bps) rate is selected, the bps rate is equal to: CPU clock/(16 x pre-scale x $2^{post\text{-}scale}$)					

2.1.43 Memory Speed Input Parameters In Use (Message 1132). This message ***** TBD definition *****. The contents of the Memory Speed Input Parameters In Use Message are described in Table 2-44.

Table 2-44. Message 1132: Memory Speed Input Parameters In Use Message

Message ID:	1132	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	15 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Memory Speed Issue Number (Note 1)	UI		0 to 65535	
10	RAM Delay (Note 2)	UI	cycles	0 to 7	
11	ROM Delay (Note 2)	UI	cycles	0 to 7	
12	EEPROM Delay (Note 2)	UI	cycles	0 to 15	
13	Dual Port RAM Delay (Note 2)	UI	cycles	0 to 15	
14	Internal Delay (Note 3)	UI	cycles	0 to 1	
15	Data Checksum				

Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data is only stored to EEPROM.

Note 2: The delay is the number of bus cycles in addition to the minimum bus transaction time that is required to access the memory device. The number of delay cycles is increased for slower memory devices.

Note 3: Internal delay should be set to one cycle.

2.1.44 EEPROM Update (Message 1135). This message provides dynamic status notification for EEPROM writes. It contains the data block ID for the last set of data which was written to EEPROM. This message is most useful when configured for output on update (the default), as it will provide a notification of all stored configuration changes as they occur. The contents of the EEPROM Update Message are described in Table 2-45.

Table 2-45. Message 1135: EEPROM Update Message

Message ID: 1135

Rate: Variable; default on update

Message Length: 10 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0-9.7	Data ID (Note 1)	UI		0 to 27	
9.8-9.15	Satellite PRN (Note 2)	UI		0 to 32	
10	Data Checksum				

Note 1: Data item updated:

0 = Status
1 = Position
2 = UTC/Iono corrections
3 = Frequency standard cubic parameters
4 = Host port communication configuration
5 = Auxiliary port communication configuration
6 = Memory options
7 = Solution validity criteria
8 = Power management selections
9 = Selected datum
10 = Platform class
11 = Cold start control
12 = Elevation mask angle
13 = Satellite candidate list
14 = Antenna selection
15 = User entered altitude
16 = DGPS control
17 = Host port protocol selection
18 = Auxiliary port protocol selection
19 = Host port enabled messages
20 = Reserved (auxiliary port enabled messages)
21 = User datums
22 = Frequency/temperature table
23 = Almanac
24 = Frequency standard calibration data
25 = Nav configuration data
26 = DR navigation parameters (DR software only)
27 = Gyro temperature table (DR software only)

Note 2: This field is only valid when the Data ID = 23 (Almanac).

2.1.45 EEPROM Status (Message 1136). This message provides failure and storage status information for the EEPROM. Bits set in the failure words represent either write failures or reads that find invalid data. Bits set in the status words indicate that those data blocks have either been updated successfully or a read has found valid data in the EEPROM. In systems that use vEEPROM, where part of RAM is used as EEPROM, this message reports vEEPROM status rather than EEPROM status. The contents of the EEPROM Status Message are described in Table 2-46.

Table 2-46. Message 1136: EEPROM Status Message

Message ID: 1136
Rate: Variable
Message Length: 18 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	Device Not Present	Bit		1 = not present	
9.1-9.15	Reserved				
10-11	Almanac Failure (Note 1)	Bit			
12-13	Failure (Note 2)	Bit		(Note 2)	
14-15	Almanac Status (Note 1)	Bit		(Note 1)	
16-17	Status (Note 2)	Bit		(Note 2)	
18	Data Checksum				

Note 1: The Almanac Failure and Almanac Status words are 32-bit bit maps where the LSB = PRN 1 and the MSB = PRN 32.

Note 2: The Failure and Status words are bit maps with values as follows:

0 = Status
1 = Position
2 = UTC/Iono corrections
3 = Frequency standard cubic parameters
4 = Host port communication configuration
5 = Auxiliary port communication configuration
6 = Memory options
7 = Solution validity criteria
8 = Power management selections
9 = Selected datum
10 = Platform class
11 = Cold start control
12 = Elevation mask angle
13 = Satellite candidate list
14 = Antenna selection
15 = User entered altitude
16 = DGPS control
17 = Host port protocol selection
18 = Auxiliary port protocol selection
19 = Host port enabled messages
20 = Reserved (auxiliary port enabled messages)
21 = User datums
22 = Frequency/temperature table
23 = Reserved
24 = Frequency standard calibration data
25 = Nav configuration data
26 = DR navigation parameters (DR software only)
27 = Gyro temperature table (DR software only)
28 = Reserved
29 = Reserved
30 = Reserved
31 = Data is being updated

2.1.46 vEEPROM/EEPROM Dump (Message 1137). This message is provided for systems that typically use RAM as virtual EEPROM (vEEPROM). These systems require a means to output the entire vEEPROM contents so it can be restored at the next power-up. Data is restored using Message 1337.

Message 1334 is used to request the receiver to dump vEEPROM contents to the host computer. The contents of the vEEPROM/EEPROM Dump Message are described in Table 2-47.

Table 2-47. Message 1137: vEEPROM/EEPROM Dump Message

Message ID:	1137				**(ONLY AVAILABLE IN vEEPROM SOFTWARE)**
Rate:	As required				
Message Length:	139 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Block ID (Note 1)	UI		0 to 15	
10	Total Number of Blocks (Note 1)	I		N	
11-138	Data Words	UI			
139	Data Checksum				

Note 1: N is the total number of 128-word blocks in the vEEPROM or EEPROM. For 1024-word systems, N = 8; for 2048-word systems, N = 16. The block ID identifies which block of data is being reported in this message, where 0 represents the first, or lowest addressed, block and N–1 represents the highest addressed block.

2.1.47 Idle Time Count (Message 1138). This message ***
TBD definition *.** The contents of the Idle Time Count Message are described in Table 2-48.

Table 2-48. Message 1138: Idle Time Count Message

Message ID:	1138 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	Variable				
Message Length:	11 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-10	Idle Time Count	UDI			
11	Data Checksum				

2.1.48 Raw RTCM SC-104 (Message 1150). This message contains the raw (unformatted) data from the last valid received RTCM message. The parity bits have been removed from the incoming raw RTCM message. The contents of the Raw RTCM SC-104 Message are described in Table 2-49. Refer to the RTCM SC-104 Standard for more detailed information.

Table 2-49. Message 1150: Raw RTCM SC-104 Message

Message ID:	1150				
Rate:	Variable				
Message Length:	77 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9-10	RTCM Header (LSDW)	UDI			
11-12	RTCM Header (MSDW)	UDI			
13-14	RTCM Data #1 (LSDW)	UDI			
...					
75-76	RTCM Data #32 (MSDW)	UDI			
77	Data Checksum				

2.1.49 Decoded RTCM SC-104 Type 1 (Message 1151). This message contains the decoded correction data from the last received RTCM Type 1 message. The contents of the Decoded RTCM SC-104 Type 1 Message are described in Table 2-50.

Table 2-50. Message 1151: Decoded RTCM SC-104 Type 1 Message

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID:	1151	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	125 words				
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
RTCM HEADER					
9	Preamble	UI			
10	Type	UI		0 to 63	
11	Station ID	UI		0 to 1023	
12	Modified Z-Count	UI	seconds	0 to 3599.4	0.6
13	RTCM Sequence Number	UI		0 to 7	
14	Frame Length	UI	words	2 to 33	
15	Station Health (Note 1)	UI		0 to 7	
16	Number of Observations	UI		0 to 12	
CORRECTION DATA (Note 2)					
17+9*j	Bad Correction	Bit		1 = bad	
18+9*j	Scale Factor (Note 1)	Bit		0 to 1	
19+9*j	UDRE (Note 1)	UI		0 to 3	
20+9*j	Satellite ID (Note 1)	UI		0 to 31	
21+9*j	Pseudorange (Note 1)	UDI	meters		
23+9*j	Pseudorange Rate (Note 1)	UDI	m/s		
25+9*j	Issue Of Data Ephemeris (IODE) (Note 1)	UI		0 to 255	
125	Data Checksum				

Note 1: Refer to the RTCM SC-104 Standard for range details.

Note 2: j = The number of observations minus one when the number of observations is greater than zero.

2.1.50 Decoded RTCM SC-104 Type 2 (Message 1152). This message contains the decoded correction data from the last received RTCM Type 2 message. The contents of the Decoded RTCM SC-104 Type 2 Message are described in Table 2-51.

Table 2-51. Message 1152: Decoded RTCM SC-104 Type 2 Message

Message ID:	1152	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	125 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
RTCM HEADER					
9	Preamble	UI			
10	Type	UI		0 to 63	
11	Station ID	UI		0 to 1023	
12	Modified Z-Count	UI	seconds	0 to 3599.4	0.6
13	RTCM Sequence Number	UI		0 to 7	
14	Frame Length	UI	words	2 to 33	
15	Station Health (Note 1)	UI		0 to 7	
16	Number of Observations	UI		0 to 12	
DELTA CORRECTION DATA (Note 2)					
17+9*j	Bad Correction	Bit		1 = bad	
18+9*j	Scale Factor (Note 1)	Bit		0 to 1	
19+9*j	UDRE (Note 1)	UI		0 to 3	
20+9*j	Satellite ID (Note 1)	UI		0 to 31	
21+9*j	Delta Pseudorange (Note 1)	UDI	meters		
23+9*j	Delta Pseudorange Rate (Note 1)	UDI	m/s		
25+9*j	Issue Of Data Ephemeris (IODE) (Note 1)	UI		0 to 255	
125	Data Checksum				

Note 1: Refer to the RTCM SC-104 Standard for range details.

Note 2: j = The number of observations minus one when the number of observations is greater than zero.

2.1.51 Decoded RTCM SC-104 Type 3 (Message 1153). This message contains the decoded base station location data from the last received RTCM Type 3 message. The contents of the Decoded RTCM SC-104 Type 3 Message are described in Table 2-52.

Table 2-52. Message 1153: Decoded RTCM SC-104 Type 3 Message

Message ID:	1153 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	Variable				
Message Length:	22 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
RTCM HEADER					
9	Preamble	UI			
10	Type	UI		0 to 63	
11	Station ID	UI		0 to 1023	
12	Modified Z-Count	UI	seconds	0 to 33599.4	0.6
13	RTCM Sequence Number	UI		0 to 7	
14	Frame Length	UI	words	2 to 33	
15	Station Health (Note 1)	UI		0 to 7	
16-17	Station Postion (ECEF X)	UDI	meters	0 to 21474836	0.01
18-19	Station Postion (ECEF Y)	UDI	meters	0 to 21474836	0.01
20-21	Station Postion (ECEF Z)	UDI	meters	0 to 21474836	0.01
22	Data Checksum				
Note 1: Refer to the RTCM SC-104 Standard for range details.					

2.1.52 Decoded RTCM SC-104 Type 5 (Message 1155). This message contains the decoded base station location data from the last received RTCM Type 5 message. The contents of the Decoded RTCM SC-104 Type 5 Message are described in Table 2-53.

Table 2-53. Message 1155: Decoded RTCM SC-104 Type 5 Message

Message ID:	1155	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	65 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
RTCM HEADER					
9	Preamble	UI			
10	Type	UI		0 to 63	
11	Station ID	UI		0 to 1023	
12	Modified Z-Count	UI	seconds	0 to 3599.4	0.6
13	RTCM Sequence Number	UI		0 to 7	
14	Frame Length	UI	words	2 to 33	
15	Station Health (Note 1)	UI		0 to 7	
16	Number of Observations	UI		0 to 12	
HEALTH DATA (Note 2)					
17+4*j	Satellite ID	UI		0 to 31	
18.0+4*j	Reserved (by RTCM)	Bit			
18.1+4*j	IOD Link (Note 1)	Bit		0 to 1	
18.2+4*j to 18.4+4*j	Data Health (Note 1)	Bit		0 to 7	
18.5+4*j	Health Enable (Note 1)	Bit		0 to 1	
18.6+4*j	New Navigation Data (Note 1)	Bit		0 to 1	
18.7+4*j	Loss Warning (Note 1)	Bit		0 to 1	
18.8+4*j to 18.9+4*j	Spare (by RTCM) (Note 1)	Bit			
18.10+4*j to 18.15+4*j	Unused (Note 1)	Bit		0 to 1	
19+4*j	Time to Loss (Note 1)	UI	minutes	0 to 75	
20+4*j	C/No (Note 1)	UI	dB-Hz	25 to 55	
65	Data Checksum				

Note 1: Refer to the RTCM SC-104 Standard for range details.

Note 2: j = The number of observations minus one when the number of observations is greater than zero.

2.1.53 Decoded RTCM SC-104 Type 9 (Message 1159). This message contains the decoded correction data from the last received RTCM Type 9 message. The contents of the Decoded RTCM SC-104 Type 9 Message are described in Table 2-54.

Table 2-54. Message 1159: Decoded RTCM SC-104 Type 9 Message

Message ID:	1159	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	Variable				
Message Length:	125 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
RTCM HEADER					
9	Preamble	UI			
10	Type	UI		0 to 63	
11	Station ID	UI		0 to 1023	
12	Modified Z-Count	UI	seconds	0 to 3599.4	0.6
13	RTCM Sequence Number	UI		0 to 7	
14	Frame Length	UI	words	2 to 33	
15	Station Health (Note 1)	UI		0 to 7	
16	Number of Observations	UI		0 to 12	
CORRECTION DATA (Note 2)					
17+9*j	Bad Correction	Bit		1 = bad	
18+9*j	Scale Factor (Note 1)	Bit		0 to 1	
19+9*j	UDRE (Note 1)	UI		0 to 3	
20+9*j	Satellite ID	UI		0 to 31	
21+9*j to 22+9*j	Pseudorange (Note 1)	UDI	meters		
23+9*j to 24+9*j	Pseudorange Rate (Note 1)	UDI	m/s	0 to 1	
25+9*j	Issue of Data Ephemeris (IODE)	UI		0 to 255	
125	Data Checksum				

Note 1: Refer to the RTCM SC-104 Standard for range details.

Note 2: j = The number of observations minus one when the number of observations is greater than zero.

2.1.54 Frequency Standard Table Output Data (Message 1160). This message contains parameters and table data used in the receiver's frequency standard compensation model. It is intended that this message will be used in conjunction with message 1360 to retrieve and restore this information for external storage. The contents of the Frequency Standard Table Output Data Message are described in Table 2-55.

NOTE: This data is unique to the receiver reporting it. Do NOT collect data from one receiver and restore it into another.

Table 2-55. Message 1160: Frequency Standard Table Output Data Message

Message ID:	1160				
Rate:	Variable				
Message Length:	270 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Table Frequency Offset (Note 1)	I	ppm	±51	0.15
10.0	Table Frequency Offset Valid (Note 2)	Bit		1 = valid	
10.1-10.15	Reserved				
11	Offset Error Estimate (Note 3)	I	ppm	±51	2×10^{-3}
12	Aging Rate Estimate (Note 4)	I	ppm/yr	±5	2×10^{-4}
13	Last Rate Update Week (Note 5)	I	weeks	0 to 32767	
14-269	Frequency Standard Table (Note 6): LSB MSB	 UI (byte) I (byte)	 weeks ppm	 0 to 1020 ±19.05	 4 0.15
270	Data Checksum				

Note 1: Each value of frequency error in the table shares this common offset value.

Note 2: Flag to indicate that the offset has been established.

Note 3: Filtered estimate of accumulated error in the table offset value.

Note 4: Filtered estimate of the current aging rate.

Note 5: Whole GPS week number of the last update of the aging rate. Week zero started Sunday, January 6 1980.

Note 6: LSB = the approximate time of last table entry update. MSB = the frequency error at each table temperature, less the table offset.

2.1.55 DR Heading Rate and Sensor Temperature Measurement 10 Hz Output (Message 1170). This message provides 10 Hz measurements of gyro temperature and heading rate data. The contents of the DR Heading Rate and Sensor Temperature Measurement 10 Hz Output Message are described in Table 2-56.

Table 2-56. Message 1170: DR Heading Rate and Sensor Temperature Measurement 10 Hz Output Message

Message ID: 1170 **(ONLY AVAILABLE IN DR BUILDS)**

Rate: Fixed; 10 Hz

Message Length: 12 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	DR Heading Rate Valid	Bit		1 = valid	
9.1	DR Heading Rate Sensor Temperature Valid (Note 1) (**RESERVED**)	Bit		1 = valid	
9.2-9.15	Reserved			±90	
10	DR Heading Rate (Note 2)	I	deg/s	±90	10^{-2}
11	DR Heading Rate Sensor Temperature (Note 3) (**RESERVED**)	I	degrees C	–40 to +85	10^{-2}
12	Data Checksum				

Note 1: (**RESERVED**). Not implemented.

Note 2: Heading rate measurements taken over heading rate update period are averaged. This value has meaning only if bit 9.0 is set.

Note 3: (**RESERVED**). Temperature readings taken at the same frequency as the heading rate sensor input and averaged over the heading rate update period. This value has meaning only if bit 9.1 is set.

2.1.56 Time Tagged DR Speed Measurement 10 Hz Output (Message 1171). This message provides 10 Hz measurements of speed data that has been time-tagged to a specific GPS time.

The contents of the Time Tagged DR Speed Measurement 10 Hz Output Message are described in Table 2-57.

Table 2-57. Message 1171: Time Tagged DR Speed Measurement 10 Hz Output Message

Message ID:	1171				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	Fixed; 10 Hz				
Message Length:	12 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	DR Speed	UI	m/s	0 to 655.35	10^{-2}
10	DR Speed Time Tag (Note 1)	UI		0 to 65535	
11.0	Backup Status (Note 2)	Bit		1 = backing	
11.1-11.15	Reserved				
12	Data Checksum				

Note 1: This word contains the offset time since the last GPS Time Mark as recorded when the speed data was received from the measurement source. The units and resolution depend on the value of DR Speed Data Time Tag Resolution from the DR Initialization Input Message (Message 1270). The measurement source could be a car bus, wheel tick counter, or other arrangement.

Note 2: Indicated when the automobile is in reverse (backing up).

2.1.57 DR Heading Rate and Sensor Temperature Measurement Output (Message 1172). This message provides the current values of raw heading rate and gyro temperature.

The contents of the DR Heading Rate and Sensor Temperature Measurement Output Message are described in Table 2-58.

Table 2-58. Message 1172: DR Heading Rate and Sensor Temperature Measurement Output Message

Message ID:	1172				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	Variable; defaults to 1 Hz				
Message Length:	12 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	DR Heading Rate Valid	Bit		1 = valid	
9.1	DR Heading Rate Sensor Temperature Valid (Note 1) (RESERVED)	Bit		1 = valid	
9.2-9.15	Reserved				
10	DR Heading Rate (Note 2)	I	deg/s	±90	10^{-2}
11	DR Heading Rate Sensor Temperature (Note 3) (RESERVED)	I	degrees C	–40 to +85	10^{-2}
12	Data Checksum				

Note 1: (**RESERVED**). Not implemented.

Note 2: Heading rate measurements taken over heading rate update period are averaged. This value has meaning only if bit 9.0 is set.

Note 3: (**RESERVED**). Temperature readings taken at the same frequency as the heading rate sensor input and averaged over the heading rate update period. This value has meaning only if bit 9.1 is set.

2.1.58 GPS Time-Tagged DR Measurement Output (Message 1173). This message is currently not implemented in any software but is defined in the file IRBINO.C. The contents of the GPS Time-Tagged DR Measurement Output Message are described in Table 2-59.

Table 2-59. Message 1173: GPS Time-Tagged DR Measurement Output Message

Message ID:	1173	**(Not Currently Implemented -- ONLY AVAILABLE IN DR BUILDS)**			
Rate:	Typically1 Hz				
Message Length:	159 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
Measurement (n = 0 to 9 for 10 total measurements)					
9-10 + n * 15	Measurement Time	DI	GPS seconds	0 to 604799.99	10^{-2}
11-12 + n * 15	Heading Rate (Note 1)	DI	deg/sec	±359.99	10^{-2}
13-14 + n * 15	Heading Rate Count (Note 2)	DI	counts	0 to 2147483647	
15-16 + n * 15	Gyro Temperature (Note 3)	DI	°C	±99.99	10^{-2}
17-18 + n * 15	Speed (Note 1)	DI	m/s	±499.99	10^{-2}
19 + n * 15	Wheel Tick Count (Note 2)	UI		0 to 65535	
20.0 + n * 15	Heading Rate Valid (Note 4)	bit		1 = Valid	
20.0 + n * 15	Gyro Temperature Valid (Note 4)	bit		1 = Valid	
20.0 + n * 15	Backing Up Flag	bit		1 = Backing Up	
21-23 + n * 15	Reserved	UI			
159	Data Checksum				

Note 1: Heading rate and speed values are processed data, computed by biasing and scaling raw counts with the stored calibration and scale factors.

Note 2: Heading Rate Count and Wheel Tick Count are the actual raw data from the A/D converter and wheel tick sensors, respectively.

Note 3: Gyro Temperature is currently not implemented in the software.

Note 4: Heading Rate Valid and Gyro Temperature Valid flags indicate whether the heading rate and gyro temperature information in preceding words of this message are valid. A cleared bit indicates the associated values may be ignored.

2.1.59 Flash Boot Status (Message 1180). This message is output in the Jupiter Flash board receiver only at start-up to control the flash download process and to report the results of the flash ROM checksum validation test. The first output of this message is initiated by receipt of a 1380 message. Subsequent outputs are sent either as a result of ongoing reprogramming actions, or in response to data blocks sent from the host. Data blocks are not in the same format as other binary messages, but rather in a unique format optimized for data block transfer. The contents of the Flash Boot Status Message are described in Table 2-60.

Caution: This message does not follow the same format as most output messages.

Table 2-60. Message 1180: Flash Boot Status Message

Message ID:	1180				**(ONLY AVAILABLE IN FLASH BUILDS)**
Rate:	As required				
Message Length:	7 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Boot Status (Note 1)	UI		0 to 9	
7	Data Checksum				

Note 1:

0 = Checksum passed
1 = Checksum failed
2 = Erasing flash memory
3 = Flash erase failed
4 = Send next block
5 = Flash reprogram failed
6 = Flash reprogram complete
7 = Flash erase complete
8 = Send initialization block
9 = Resend block

2.1.60 Error/Status Message (Message 1190). This message provides diagnostic information if the receiver encounters an error during execution of its firmware. The contents of the Error/Status Message are described in Table 2-61.

Table 2-61. Message 1190: Error/Status Message

Message ID: 1190					
Rate: Variable					
Message Length: 13 words					
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9	Class (Note 1)	UI		0 to 5	
10	Number (Note 1)	I			
11	Code Environment (CENV)	UI			
12	Program Counter (PC)	UI			
13	Data Checksum				

Note 1: Classes define exceptions reported by the AAMP2-8 processor. For each class of exception, several possible errors could be the cause. Each is assigned a unique number. The possible classes are listed below. Refer to Appendix C for tables of numbers associated with each of the following classes:

0 = User mode exception (see Table C-1)
1 = Exec mode exception (see Table C-1)
2 = Trap (see Table C-2)
3 = Executive error (see Table C-3)
4 = Executive Service Routine error (see Table C-3)
5 = User error (no numbers assigned to this class)

2.1.61 Hardware Accelerator Measurement Output Message (Message 1191). This message is available in Hardware Accelerator software only. It provides results of Hardware Accelerator measurements. The contents of the Hardware Accelerator Measurement Output Message are described in Table 2-62.

Table 2-62. Message 1191: Hardware Accelerator Measurement Output Message (1 of 2)

Message ID:	1191				**(ONLY AVAILABLE IN HARDWARE ACCELERATOR BUILDS)**
Rate:	Variable				
Message Length:	117 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6-7	Set Time	UDI	10 ms ticks	0 to 4294967295	
8	Sequence Number	I		0 to 32767	
9.0	Doppler Parameters Are Valid	Bit		1 = valid	
9.1	Code Phase and SNR Parameters Are Valid	Bit		1 = valid	
9.2	GPS XO Parameters Are Valid	Bit		1 = valid	
9.3	GPS Reference Time is Valid	Bit		1 = valid	
9.4	Command Execution is Complete	Bit		1 = complete	
9.5	Failed: Hardware Accelerator Not Responding	Bit		1 = failed	
9.6	Abort: Command Did Not Complete Normally	Bit		1 = aborted	
9.7	Continuous Tracking Mode is Valid	Bit		1 = valid	
9.8-9.15	Reserved				
10-11	GPS Reference Time Integer (Note 1)	UDI	seconds	604799	
12-13	GPS Reference Time Fraction (Note 1)	UDI	ns	0 to 999999999	
14-15	Measurement T20 (Note 2)	UDI	seconds	0 to 42949672.95	10^{-2}
16-17	Measurement Offset (Note 3)	UDI	seconds	0 to 1048575	32/(Fo * 137)
18	XO Error (Note 4)	I	ppm	–32768 to +327.67	10^{-2}
19	XO Error Uncertainty (Note 4, 5)	UI	ppm	0 to 655.35	10^{-2}
20	Number of Visable Satellites (Note 6)	I	VisSats	0 to 32	
Channel Data (Note 7)					
21 + n*8	Satellite PRN (Note 8)	I	PRN No.	0 to 12	
22 + n*8	Doppler Estimate (Note 9)	I	Hz	–6553.6 to +6553.5	2×10^{-1}
23 + n*8	Doppler Uncertainty Estimate (Note 5, 9)	UI	Hz	0 to 65535	10^{-1}
24, 25 + n*8	Code Phase (Note 10, 11)	UDI	C/A Chips	0 to 1022.999	10^{-3}
26 + n*8	Code Phase Uncertainty (Note 5, 10, 11)	UI	C/A Chips	0 to 10	10^{-3}
27 + n*8	SNR (Note 11)	UI	ratio	0 to 65535	
28 + n*8	C/No	I	dB-Hz	–3276.8 to +3276.7	10^{-1}
117	Data Checksum				

Table 2-62. Message 1191: Hardware Accelerator Measurement Output Message (2 of 2)

Note 1:	The GPS time (integer and fractional parts) at the beginning of the Hardware Accelerator data capture interval. This value is only valid if bit 9.3 is set.
Note 2:	The GPS time of the T20 (20 ms internal clock) following the start of the Hardware Accelerator data capture interval.
Note 3:	The offset from the start of the Hardware Accelerator data capture to the next T20 epoch measured with 137*Fo/32 = 44 MHz clock, where Fo is defined as the GPS 10.23 MHz reference frequency.
Note 4:	This value is valid only if bit 9.2 is set.
Note 5:	Uncertainties are single-sided. They should be applied as a ± value.
Note 6:	Limited by measurement buffer size in the Measurement Engine/Navigation Engine interface. This will equal the number of satellites actually detected and measured, up to the limit. Contents of any other buffers are not valid.
Note 7:	n = 0 to 11 for channels 1 to 12.
Note 8:	A value of zero indicates that no satellite is being reported in this block, and that all following words in this block (for this value of n), through C/No, do not contain valid data. The Hardware Accelerator can generate all gold codes from the GPS set including WAAS codes. Future implementations could expand the range of valid values accordingly.
Note 9:	A value of zero for Doppler uncertainty indicates that the uncertainty could not be estimated and should be treated as unknown. This value is valid only if bit 9.0 is set.
Note 10:	A value of zero for code phase uncertainty indicates that the uncertainty could not be estimated and should be treated as unknown. Units for Code Phase and Code Phase Uncertainty are in C/A chips. There are 1023 chips in the complete cycle, which limits the range of these values to 0 to 1022.999. One C/A chip represents 1 cycle of a 1.023 MHz signal, therefore corresponding to a wavelength of 293 m.
Note 11:	This value is valid only if bit 9.1 is set.

2.2 Input Message Descriptions

Most messages include Sequence Number as word 6. The Sequence Number should be assigned by the host computer so that new data sent in a previously used message has a new Sequence Number. For example, the first time Message 1200 is sent to the receiver, use Sequence Number 1. The next time a 1200 message is sent, use Sequence Number 2.

2.2.1 Geodetic Position and Velocity Initialization (Message 1200). This message allows the user to initialize the receiver with the specified geodetic position, ground speed, course over ground, and climb rate. The course may be either true or magnetic, as indicated by the Magnetic Course field.

The GPS/UTC time represents the time at which the solution was computed and, if present, will be used to propagate the solution to the current time. The contents of the Geodetic Position and Velocity Initialization Message are described in Table 2-63.

Caution: the receiver only processes this message periodically. If more than one 1200 message is transmitted to the receiver consecutively, it is possible to overwrite the contents of earlier 1200 messages before the system has time to use the contents of the earlier messages. To initialize multiple data elements (e.g., time and position), either combine the data into a single message or ensure sufficient time for the receiver to process old data before sending new data. The time required for this varies depending on other concurrent activities, but could be 2 to 3 seconds.

Table 2-63. Message 1200: Geodetic Position and Velocity Initialization Message (1 of 2)

Message ID:	1200				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	27 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Initialization Control (7.0-7.15)					
7.0	Force Time (Note 1)	Bit		0 = normal 1 = forced	
7.1	GPS Time Valid (Note 2)	Bit		1 = valid	
7.2	UTC Time Valid (Note 2)	Bit		1 = valid	
7.3	Lat/Lon Valid	Bit		1 = valid	
7.4	Altitude Valid	Bit		1 = valid	
7.5	Speed/Course Valid	Bit		1 = valid	
7.6	Magnetic Course	Bit		1 = magnetic	
7.7	Climb Rate Valid	Bit		1 = valid	
7.8-7.15	Reserved				
8	GPS Week Number (Note 3)	UI	weeks	0 to 32767	
9-10	GPS Seconds Into Week (Note 3)	UDI	seconds	0 to 604799	
11	UTC Day (Note 4)	UI	days	1 to 31	

Table 2-63. Message 1200: Geodetic Position and Velocity Initialization Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
12	UTC Month (Note 4)	UI	months	1 to 12	
13	UTC Year (Note 4)	UI	year	1980 to 2079	
14	UTC Hours (Note 4)	UI	hours	0 to 23	
15	UTC Minutes (Note 4)	UI	minutes	0 to 59	
16	UTC Seconds (Note 4)	UI	seconds	0 to 59	
17-18	Latitude (Note 5)	DI	radians	$\pm\pi/2$	10^{-9}
19-20	Longitude (Note 5)	DI	radians	$\pm\pi$	10^{-9}
21-22	Altitude (Note 6)	DI	meters	±50	10^{-2}
23-24	Ground Speed (Note 7)	UI	m/s	0 to 1000	10^{-2}
25	Course (Note 7, 8)	UI	radians	0 to 2π	10^{-3}
26	Climb Rate (Note 9)	I	m/s	–300 to +300	10^{-2}
27	Data Checksum				

Note 1: If this bit is set, force the receiver to use the time in this message even if the receiver has already determined a time. This permits resolving GPS week ambiguity.

Note 2: Bits 7.1 and 7.2 may not be used simultaneously.

Note 3: This value has meaning only if bit 7.1 is set. GPS week zero began on Sunday, January 6 1980.

Note 4: This value has meaning only if bit 7.2 is set.

Note 5: This value has meaning only if bit 7.3 is set.

Note 6: This value has meaning only if bit 7.4 is set.

Note 7: This value has meaning only if bit 7.5 is set.

Note 8: If bit 7.6 is set, course is magnetic. If bit 7.6 is cleared, course is true. Angles are clockwise from north. This value has meaning only if bit 7.5 is set.

Note 9: This value has meaning only if bit 7.7 is set.

2.2.2 ECEF

Position and Velocity Initialization (Message 1201). This message allows the user to initialize the receiver with the specified ECEF position and velocity. The GPS/UTC time represents the time at which the solution was computed and, if present, will be used to propagate the solution to the current time. The contents of the ECEF Position and Velocity Initialization Message are described in Table 2-64

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Table 2-64. Message 1201: ECEF Position and Velocity Initialization Message

Message ID:	1201 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	29 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Initialization Control (7.0-7.15)					
7.0	Force Time	Bit		0 = normal 1 = forced	
7.1	GPS Time Valid	Bit		1 = valid	
7.2	UTC Time Valid	Bit		1 = valid	
7.3	Position Valid	Bit		1 = valid	
7.4	Velocity Valid	Bit		1 = valid	
7.5-7.15	Reserved				
8	GPS Week Number	UI	weeks	0 to 32767	
9-10	GPS Seconds Into Week	UDI	seconds	0 to 604799	
11	UTC Day	UI	days	1 to 31	
12	UTC Month	UI	months	1 to 12	
13	UTC Year	UI	year	1980 to 2079	
14	UTC Hours	UI	hours	0 to 23	
15	UTC Minutes	UI	minutes	0 to 59	
16	UTC Seconds	UI	seconds	0 to 59	
17-18	ECEF Position - X	DI	meters	±0 to 900000	10^{-2}
19-20	ECEF Position - Y	DI	meters	±0 to 900000	10^{-2}
21-22	ECEF Position - Z	DI	meters	±0 to 900000	10^{-2}
23-24	ECEF Velocity - X	DI	m/s	±0 to 1000	10^{-2}
25-26	ECEF Velocity - Y	DI	m/s	±0 to 1000	10^{-2}
27-28	ECEF Velocity - Z	DI	m/s	±0 to 1000	10^{-2}
29	Data Checksum				

2.2.3 User-Defined Datum Definition (Message 1210). This message allows the user to define a datum to be used by the receiver to transform its position solution. Up to five user-defined datums may be stored. GPS coordinates are computed in the WGS-84 datum using a reference ellipsoid also referred to as WGS-84. User-defined datums may specify any reference ellipsoid, but must supply a semi-major axis and inverse flattening in this message. Values for several standard ellipsoids are given in Appendix B. Transformation of GPS coordinates to user datums involves a three-parameter transform (translations only) and conversion to the defined ellipsoid. Storage of these parameters requires EEPROM. The contents of the User-Defined Datum Definition Message are described in Table 2-65.

Note that datum definition does not imply datum use. Message 1211 is used to specify the "Datum In Use" for the navigation function. Also, any Message 1210 that contains an undefined datum code is ignored.

Table 2-65. Message 1210: User-Defined Datum Definition Message

Message ID:	1210				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	20 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	User Datum ID	UI		300-304	
8-9	Semi-Major Axis - Integer Part	UDI	meters	6300000 to 6400000	
10	Semi-Major Axis - Fractional Part	UI	meters	0 to 0.9999	10^{-4}
11	Inverse Flattening - Integer Part	UI		280 to 320	
12-13	Inverse Flattening - Fractional Part	UDI		0 to 0.999999999	10^{-9}
14-15	WGS-84 Datum Offset - dX	DI	meters	0 to ±90000.00	10^{-2}
16-17	WGS-84 Datum Offset - dY	DI	meters	0 to ±90000.00	10^{-2}
18-19	WGS-84 Datum Offset - dZ	DI	meters	0 to ±90000.00	10^{-2}
20	Data Checksum				

2.2.4 Map Datum Select (Message 1211). This message allows the user to select a datum to be used by the receiver to transform its position solution. The contents of the Map Datum Select Message are described in Table 2-66.

Table 2-66. Message 1211: Map Datum Select Message

Message ID:	1211				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Datum ID (Note 1)	UI		0 to 188 and 300 to 304	
8	Data Checksum				
Note 1: The table in Appendix B contains map datum codes from 0 to 188. Codes 300 to 304 are user-defined. If the code entered references a datum that has not been defined, this command will be ignored.					

2.2.5 Satellite Elevation Mask Control (Message 1212). This message allows the user to set the elevation mask angle used by the receiver to select visible satellites. Storage of the Elevation Mask Angle parameter requires EEPROM. The mask angle represents an angle above horizontal. If a satellite's elevation angle is less than the mask angle, the receiver may acquire and track it, but its data will not be used to compute the navigation solution. The contents of the Satellite Elevation Mask Control Message are described in Table 2-67.

Table 2-67. Message 1212: Satellite Elevation Mask Control Message

Message ID:	1212				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Elevation Mask Angle	UI	radians	0 to $\pi/2$	10^{-3}
8	Data Checksum				

2.2.6 Satellite Candidate Select (Message 1213). This message allows the user to construct the list of satellites which will be considered for selection by the receiver. The contents of the Satellite Candidate Select Message are described in Table 2-68.

Table 2-68. Message 1213: Satellite Candidate Select Message

Message ID: 1213

Rate: As required - maximum rate 1 Hz

Message Length: 10 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	Satellite PRN #1 (Note 1)	Bit		1 = included	
•					
•					
•					
7.15	Satellite PRN #16	Bit		1 = included	
8.0	Satellite PRN #17	Bit		1 = included	
•					
•					
•					
8.15	Satellite PRN #32	Bit		1 = included	
9.0	Non-Volatile Storage Select (Note 2)	Bit		1 = store in non-volatile memory	
9.1-9.15	Reserved				
10	Data Checksum				

Note 1: Unless this message is sent, all satellites are valid tracking candidates. If this message is sent, only those satellites with a corresponding bit set will be valid tracking candidates.

Note 2: If bit 9.0 is set, this candidate selection will become the default for all future tracking until another Message 1213 is received or EEPROM is cleared. If bit 9.0 is clear, this candidate selection will only be used until the system is reset and RAM is invalid.

2.2.7 Differential GPS Control (Message 1214). This message allows the user to control the behavior of the receiver's differential capability. Storage of this message's parameters requires EEPROM. The contents of the Differential GPS Control Message are described in Table 2-69.

Table 2-69. Message 1214: Differential GPS Control Message

Message ID:	1214				
Rate:	As required - maximum rate 1 Hz				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	DGPS Disable (Note 1)	Bit		1 = disable	
7.1	Correction Data Base Reset (Note 2)	Bit		1 = reset	
7.2-7.15	Reserved				
8	Correction Time-Out (Note 3)	UI	seconds	0 to 32767	
9	Data Checksum				

Note 1: By default, the receiver uses DGPS corrections if they are available. If this bit is set, DGPS will not be used. This bit and bit 7.1 of Message 1217 are mutually exclusive.

Note 2: If this bit is set, corrections currently in memory are removed and the receiver is also forced to collect new ephemerides.

Note 3: Each DGPS RTCM-104 message contains a time tag. The age of a correction is the difference between that time tag and the current time. This value specifies the maximum age at which a correction is used. The default value is 45 seconds.

2.2.8 Power Management Control (Message 1215). This message enables or disables the receiver's power management mode. Storage of the Power Management Enable parameter requires EEPROM. The contents of the Power Management Control Message are described in Table 2-70.

Note: This message has been replaced by message 1317.

Table 2-70. Message 1215: Power Management Control Message

Message ID:	1215 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Reserved (Sequence Number)	I		0 to 32767	
7.0	Power Management Enable	Bit		1 = enable	
7.1-7.15	Reserved				
8	Data Checksum				

2.2.9 Cold Start Control (Message 1216). This message allows the user to control the use of cold-start mode. When a receiver first starts to acquire satellites, it searches for a valid previous position (either in SRAM or EEPROM) and a valid time (either in SRAM or in the RTC). If either is missing, the system uses cold start regardless of this message. If it has both items, the receiver begins searching for satellites in another mode (hot or warm start) and starts the cold-start timer.

If the receiver is unable to acquire any satellites before the cold-start timer exceeds the cold-start timeout value, the receiver changes to cold-start mode. Acquisition of a satellite resets the cold-start timer.

In cold-start mode, the receiver uses the widest possible search windows, and searches for satellites sequentially rather than using a computed visibility list.

By default, cold-start timeout is set to 300 seconds (5 minutes) and transition to cold-start mode is enabled. This message permits the user to change the timeout period, as well as to preclude the mode transition. Users may want to disable the transition to permit faster startups when a vehicle is initially blocked (e.g., in a parking garage). The contents of the Cold Start Control Message are described in Table 2-71.

Table 2-71. Message 1216: Cold Start Control Message

Message ID:	1216				
Rate:	As required - maximum rate 1 Hz				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Reserved (Sequence Number)	I		0 to 32767	
7.0	Cold Start Disable (Note 1)	Bit		1 = disable	
7.1-7.15	Reserved				
8	Cold Start Time-Out	UI	seconds	0 to 32767	
9	Data Checksum				
Note 1: When this bit is set, the receiver does not transfer to cold start mode from either hot or warm start mode after a set period of time has been spent unsuccessfully searching for satellites.					

2.2.10 Solution Validity Input (Message 1217). The receiver will always output the best position solution it can attain, depending on the number and quality of available measurements. The Solution Validity Input Message allows the user to define the criteria for setting the position validity status specified in the position output messages. The status will be set to 'invalid' if any of the specified requirements are not met. Storage of this message's parameters requires EEPROM. This message provides a means to force the receiver to flag marginal solutions as invalid. The contents of the Solution Validity Input Message are described in Table 2-72.

Table 2-72. Message 1217: Solution Validity Input Message

Message ID:	1217				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	Altitude Not Used (Note 1)	Bit		1 = do not use altitude	
7.1	Differential GPS (Note 2)	Bit		1 = required	
7.2	DR Measurements Required (Note 3)	Bit		1 = required	
7.3	Concurrent GPS Calibration of DR Required (Note 4)	Bit		1 = required	
7.4	GPS Only Solution Required (Note 5)	Bit		1 = required	
7.5-7.15	Reserved				
8	Minimum Number of Satellites Used (Note 6)	UI		0 to 12	
9-10	Maximum Expected Horizontal Position Error (Note 7)	UDI	meters	0 to 1000	10^{-2}
11-12	Maximum Expected Vertical Position Error (Note 8)	UDI	meters	0 to 1000	10^{-2}
13	Data Checksum				

Note 1: When this bit is set, the receiver cannot use altitude to help create the initial solution. This will force the receiver to use data from at least four satellites before it can compute a navigation solution. Default is "altitude use is allowed."

Note 2: This bit and bit 7.0 of Message 1214 are mutually exclusive. At most, one of these two bits may be set. If both are set in successive messages, the one set last governs. Default is "DGPS not required."

Note 3: Must operate with DR. Standalone GPS not acceptable. Default is "DR not required."

Note 4: DR must be calibrated by concurrent GPS. Stored calibrations from past sessions are not acceptable. Default is "use stored data."

Note 5: DR must NOT be used, even if available. Default is "use DR when valid."

Note 6: Default is "0."

Note 7: Default is "100 m."

Note 8: Default is "150 m."

2.2.11 Antenna Type Select (Message 1218). This message allows the user to specify the type of antenna which is being used with the receiver. Selecting 'Active Antenna Present' will raise the floor on the receiver's expected signal level to reduce sideband correlations. Deselecting it indicates use of a passive antenna, allowing the receiver to be more sensitive to low signal levels and preventing it from searching "hot" signals. Storage for the Active Antenna Present parameter requires EEPROM. The contents of the Antenna Type Select Message are described in Table 2-73.

NOTE: Good system design requires that the antenna, antenna preamp (if present), and antenna cable be selected so that the strongest satellites exhibit a C/No (as reported in Message 1002 or 1102) between 45 and 49 dBHz. As long as C/No does not exceed 49 dBHz, system performance is maximized when a passive antenna type is selected regardless of the type of antenna used.

Table 2-73. Message 1218: Antenna Type Select Message

Message ID:	1218				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	Antenna Type (Note 1)	Bit		0 = passive 1 = active	
7.1-7.15	Reserved				
8	Data Checksum				
Note 1: Default antenna type is passive.					

2.2.12 User-Entered Altitude Input (Message 1219). This message allows the user to enter up to three altitudes to be used for altitude hold during 2-D navigation. If the Force Use field is not set, the receiver may ignore the altitude(s) input if it thinks it has a better estimate from navigation results. Bits 7.2 and 7.3 are used to control which of the three storage locations are used to hold the altitude entered. The contents of the User-Entered Altitude Input Message are described in Table 2-74. The effects of bits 7.2 and 7.3 are described in Table 2-75.

Table 2-74. Message 1219: User-Entered Altitude Input Message

Message ID:	1219				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	12 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Altitude Input Control (7.0-7.15)					
7.0	Force Use (Note 1)	Bit		1 = force	
7.1	MSL Select (Note 2)	Bit		1 = MSL	
7.2	Store (RAM) (Note 3)(Note 4)	Bit		1 = store	
7.3	Store (EEPROM) (Note 3)(Note 4)	Bit		1 = store	
7.4	Clear (RAM) (Note 4)	Bit		1 = clear	
7.5	Clear (EEPROM) (Note 4)	Bit		1 = clear	
7.6-7.15	Reserved				
8-9	Altitude (Note 4)	DI	meters	±50000	10^{-2}
10	Altitude Standard Deviation (Note 4)(Note 5)	UDI	meters	0 to 10000	10^{-2}
11	Data Checksum				

Note 1: If bit 7.0 is set, this altitude will be used for altitude aiding over any other altitude source, including navigation results. If more than one altitude is stored with bit 7.0 set, the system searches “Current Altitude,” “RAM Altitude,” then “EEPROM Altitude” and uses the first one it finds with the Force Use bit set.

Note 2: When set, the altitude is referenced to Mean Sea Level (MSL) or the geoid. If clear, altitude is referenced to the ellipsoid.

Note 3: Bits 7.2 and 7.3 control where to store this altitude (Current, RAM or EEPROM locations). If neither bit is set, the altitude will be stored in “Current Altitude,” which is cleared every time the receiver resets. If bit 7.2 is set, the altitude will be stored in “RAM Altitude,” which remains valid until either it is explicitly reset by a message 1219 with bit 7.4 set, or RAM becomes invalid due to loss of primary and backup power. If bit 7.3 is set, the altitude will be stored as “EEPROM Altitude,” and will remain valid until it is explicitly reset by another message 1219 with bit 7.5 set. Both bits 7.2 and 7.3 may be set in the same message, in which case the altitude will be stored in both RAM and EEPROM locations.

Note 4: If either bit 7.4 or 7.5 is set, bits 7.0 through 7.3, and words 8 through 10 will be ignored. The effects of bits 7.2 through 7.5 are summarized in Table 2.

Note 5: The altitude standard deviation permits weighting control to be applied to the value in the Kalman Filter. The value is single-ended, but is applied plus or minus (±). Entering a value of 0 causes the system to use the default standard deviation of 10.00 m.

Table 2-75. Message 1219 Bits 7.2 through 7.5 Truth Table

Bit 7.5	Bit 7.4	Bit 7.3	Bit 7.2	Action
1	0	X	X	Clear EEPROM Altitude. Ignore rest of message
0	1	X	X	Clear RAM Altitude. Ignore rest of message
1	1	X	X	Clear both RAM and EEPROM Altitudes. Ignore rest of message
0	0	0	0	Store altitude in Current Altitude (becomes invalid at receiver reset)
0	0	1	0	Store altitude in EEPROM Altitude (remains valid until cleared)
0	0	0	1	Store altitude in RAM Altitude (remains valid until cleared, or until RAM becomes invalid)
0	0	1	1	Store altitude in both RAM and EEPROM Altitudes
X = don’t care				

2.2.13 Application Platform Control (Message 1220). This message allows the user to adjust the receiver's dynamics based on the type of application in which the receiver is being used. Use of the Platform parameter (word 7) changes filtering constants in the Kalman filter, smoothing dynamics that are inappropriate for the selected type of platform. Storage for the Platform parameter requires EEPROM. The contents of the Application Platform Control Message are described in Table 2-76.

Table 2-76. Message 1220: Application Platform Control Message

Message ID: 1220					
Rate: As required - maximum rate is 1 Hz					
Message Length: 8 words					
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Platform (Note 1)	UI		0 = default 1 = static 2 = pedestrian 3 = marine (lakes) 4 = marine (sea level) 5 = land (auto) 6 = air	
8	Data Checksum				
Note 1: Default is zero, equilvalent to value 5, land (auto).					

2.2.14 Nav Configuration (Message 1221). This message allows the user to control various features in the navigation processing. The held altitude disable bit controls the use of stored GPS-based altitude to aid the receiver when the vertical geometry deteriorates (see Message 1219 to set altitude manually). The ground track smoothing bit controls the use of satellite range bias estimates to minimize the position shifts resulting from SA and constellation changes. The position pinning bit controls the use of a horizontal speed test to pin the position reported by the receiver and eliminate the wander associated with SA when static. Position pinning is set for land vehicles (automobiles, trucks, etc.) and should not be used for handheld or marine applications. Ground track smoothing and position pinning are not used when DGPS corrections are in use. Message 1012 is used to see what settings are currently in the receiver. The contents of the Nav Configuration Message are described in Table 2-77.

Table 2-77. Message 1221: Nav Configuration Message

Message ID:	1221				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	15 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Nav Configuration Word (7.0-7.15)					
7.0	Held Altitude Disable (default = enabled)	Bit		1 = disabled	
7.1	Ground Track Smoothing Disable (default = enabled)	Bit		1 = disabled	
7.2	Position Pinning Disable (default = enabled)	Bit		1 = disabled	
7.3	Disable Low Quality Measurements (Note 1)	Bit		1 = disabled	
7.4	Enable Jamming Detect	Bit		1 = disabled	
7.5-7.15	Reserved (must be set to zero)	Bit		0	
8	Proprietary Message Authorization (Note 2)	UI			
Proprietary Nav Configuration Word (9.0-9.15)					
9.0	Integrated Carrier Phase Processing Disable (default = enabled) (Note 3)	Bit		1 = disabled	
9.1	Iono Correction Disable (default = enabled) (Note 3)	Bit		1 = disabled	
9.2	Tropo Correction Disable (default = enabled) (Note 3)	Bit		1 = disabled	
9.3-9.15	Reserved (must be set to zero)	Bit		0	
10	C/N_O Threshold (Note 4)	UI	dB-Hz	0 to 50	
11-14	Reserved (must be set to zero)	UI		0	
15	Data Checksum				

Note 1: When this bit is set, the receiver will only use “perfect” measurements (i.e., measurements without any errors in tracking status or data). If the bit is not set, the system uses measurements that, while not perfect, are still good enough to use under SPS conditions.

Note 2: The proprietary message authorization word must be set to 21845 for words 9 through 15 to be accepted as valid. Any other value for the authorization word causes words 9 through 15 to be ignored.

Note 3: This is a proprietary bit or word. It is ignored unless the proprietary message authorization word is set to the authorization value.

Note 4: The receiver will not use any C/N_O value that is less than the threshold value.

NOTE: Any use of this description for message 1221 in a public document should replace the descriptive detail of words 8 through 14 with “Reserved (must be set to zero)” and have this NOTE removed.

2.2.15 Raw Almanac Input (Message 1240). This message allows the user to enter almanac data. All data is represented as raw subframe page data (excluding parity bits), according to the Global Positioning System Standard Positioning Service Signal Specification. Almanac data is found in subframe 5, pages 1 through 25 and in subframe 4, pages 2 through 5, 7 through 10, and 25. This message provides space to enter almanacs for all satellites at one time. Enter all zeros in the place of data for any satellite for which no almanac is to be entered. The data in this message is in the same format as Message 1040, which may be used as source data for this message. The contents of the Raw Almanac Input Message are described in Table 2-78. See ICD-GPS-200 for a detailed description of the contents of this data.

Table 2-78. Message 1240: Raw Almanac Input Message

Message ID:	1240				
Rate:	As required - maximum rate 1 Hz (Note 1)				
Message Length:	422 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Almanac (Note 2)					
7+(13*j)	Week Number (Note 3)	I	weeks	0 to 32767	
8+(13*j)	Raw Almanac Data (Note 3)	UI			
•					
•					
•					
19+(13*j)					
422	Data Checksum				

Note 1: This message is intended to upload raw almanac data to the receiver.

Note 2: j = 0 to 31 for satellites 1 to 32.

Note 3:

Example for SV ID = 1:
The Raw Almanac data words 8 to 13
Correspond to bits in subframe 4 to 5
And the Raw Almanac data words 14
Correspond to bits in subframe 4 to 5

Data(8)	Data(9)	Data(10)	Data(11)	Data(12)	Data(13)
61 (Word 3) 84	91 (Word 4) 114	121 (Word 5) 144	151 (Word 6) 174		
Data(14)	Data(15)	Data(16)	Data(17)	Data(18)	Data(19)
181 (Word 7) 204	211 (Word 8) 234	241 (Word 9) 264	271 (Word 10) 294		

2.2.16 Raw Ephemeris Input (Message 1241). This message allows the user to enter ephemeris data for one satellite in the constellation. All data is represented as raw subframe data (excluding parity bits), according to the Global Positioning System Standard Positioning Service Signal Specification. Ephemeris data is found in subframes 1 through 3, words 3 to 10. The data in this message is in the same format as Message 1041, which may be used as source data for this message. The contents of the Raw Ephemeris Input Message are described in Table 2-79. See ICD-GPS-200 for a detailed description of the contents of this data.

Table 2-79. Message 1241: Raw Ephemeris Input Message

Message ID:	1241				
Rate:	As required - maximum rate 1 Hz				
Message Length:	46 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Satellite PRN	I		1 to 32	
8	Momentum Alert Flag (Note 1)	I			
9	Synchronization Anti-Spoof Flag (Note 2)	I			
10-45	Ephemeris Data (Note 3)	UI			
46	Data Checksum				

Note 1: If SV configuration code = 0, this is the Momentum Flag. If SV configuration code = 1, this is the Alert Flag. Momentum Flag is = 1 when a thruster type momentum dump has occurred since the last ephemeris upload. Alert Flag = 1 indicates that the SV URA may be worse than indicated for satellite PRN.

Note 2: If SV configuration code = 0, this is the Synchronization Flag. If SV configuration code = 1, this is the Anti-Spoof Flag. Synchronization Flag is = 0 when the leading edge of the TLM word is coincident with the X1 epoch. Anti-Spoof Flag = 1 when the anti-spoof mode is ON in the satellite PRN.

Note 3:

The raw ephemeris data words 10 to	Data(10)	Data(11)	Data(12)	Data(13)	Data(14)	Data(15)
Corresponding to bits in subframe 1:	61 (Word 3) 84	91 (Word 4) 114	121 (Word 5) 144	151 (Word 6) 174		
The raw ephemeris data words 16 to	Data(16)	Data(17)	Data(18)	Data(19)	Data(20)	Data(21)
Corresponding to bits in subframe 1:	181 (Word 7) 204	211 (Word 8) 234	241 (Word 9) 264	271 (Word 10) 294		

Raw ephermeris data words 22 to 33 correspond to the bits 61 to 294 in subframe 2.

Raw ephermeris data words 34 to 45 correspond to the bits 61 to 294 in subframe 3.

2.2.17 Raw Ionospheric and UTC Corrections Input (Message 1242). This message allows the user to enter the parameters associated with the correction for the effects of the Earth's ionosphere on GPS signal propagation, and the parameters associated with UTC timekeeping. All data is represented as raw subframe page data (excluding parity bits), according to the Global Positioning System Standard Positioning Service Signal Specification. Ionospheric data is found in subframe 4, page 18, bits 9 through 24 of word 3 plus the 24 MSBs of words 4 and 5. UTC data is found in subframe 4, page 18, words 6 through 9 and the 8 MSBs of word 10. The data in this message is in the same format as Message 1042, which may be used as source data for this message. The contents of the Raw Ionospheric and UTC Corrections Input Message are described in Table 2-80. See ICD-GPS-200 for a detailed description of the data in this message.

Table 2-80. Message 1242: Raw Ionospheric and UTC Corrections Input Message

Message ID: 1242
Rate: As required - maximum rate 1 Hz (Note 1)
Message Length: 20 words

Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Week Number	I	weeks	0 to 32767	
8-19	Raw Ionospheric and UTC Correction Ephemeris Data in Page 18 of Subframe 4 (Note 2)	UI			
20	Data Checksum				

Note 1: This messsage is intended for uploading faw ionospheric and UTC corrections to the receiver.

Note 2:

The raw iono and UTC data words 8 to
Correspond to bits in subframe 4, page
And the raw iono and UTC data words 1
Correspond to bits in subframe 4, page

<table>
<tr><td colspan="2">Data(8)</td><td colspan="2">Data(9)</td><td colspan="2">Data(10)</td><td colspan="2">Data(11)</td><td colspan="2">Data(12)</td><td colspan="2">Data(13)</td></tr>
<tr><td colspan="3">61 (Word 3) 84</td><td colspan="3">91 (Word 4) 114</td><td colspan="3">121 (Word 5) 144</td><td colspan="3">151 (Word 6) 174</td></tr>
<tr><td colspan="2">Data(14)</td><td colspan="2">Data(15)</td><td colspan="2">Data(16)</td><td colspan="2">Data(17)</td><td colspan="2">Data(18)</td><td colspan="2">Data(19)</td></tr>
<tr><td colspan="3">181 (Word 7) 204</td><td colspan="3">211 (Word 8) 234</td><td colspan="3">241 (Word 9) 264</td><td colspan="3">271 (Word 10) 294</td></tr>
</table>

2.2.18 Pseudorange Correction Input (Message 1250). This message allows corrections produced by another base station receiver to be used for differential mode. This can be used as an alternative to the RTCM format correction input. The contents of the Pseudorange Correction Input Message are described in Table 2-81.

Table 2-81. Message 1250: Pseudorange Correction Input Message

Message ID:	1250 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	93 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Station ID	I		0 to 1023	
8	Number of Observations	I		0 to 12	
PER-SATELLITE CORRECTION SET (Note 1)					
9+(7*j)	Satellite PRN (Note 2)	I		1 to 32	
10+(7*j) and 11+(7*j)	GPS Seconds Into Hour	UDI	seconds	0 to 3599.99	10^{-2}
12+(7*j)	IODE	I		0 to 255	
13+(7*j) and 14+(7*j)	Pseudorange Correction	DI	meters	0 to ±1048.76	10^{-2}
15+(7*j)	Pseudorange Rate Correction	I	m/s	0 to ±4.096	10^{-3}
93	Data Checksum				

Note 1: Only the correction sets for the number of observations reported in word 8 of this message are valid.

Note 2: j = the number of observations minus one when the number of observations is greater than zero.

2.2.19 Timing Receiver Configuration Input (Message 1255). This message provides users of Timing Receiver software to configure the timing functions. The contents of the Timing Receiver Configuration Input Message are described in Table 2-82.

Table 2-82. Message 1255: Timing Receiver Configuration Input Message (1 of 2)

Message ID:	1255				
Rate:	As required - maximum rate is 1 Hz				
Message Length:	24 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Timing Receiver Mode	UI		0 =No mode change 1 =Standard Navigation 2 =Self-Survey for 24 Hours 3 = Self-Survey for time specified (see word 11) 4 =Self-Survey for unlimited time 5 =Position-Hold with current position 6 =Position-Hold with specified position (see words 12-17)	
8	Timing Receiver Start-up Mode Configuration Word (Note 1)	UI		0 =Self Survey 1 =Position Hold 2 =Standard Navigation	
9-10	Time Mark Time-Delay Compensation (Note 2)	UDI	ns	0 to $\pm$1000000	
11	Self-Survey Mode Time Duration (Note 3)	UI	hours	0 to 65535	
12-13	Position Hold Latitude (Note 4)	DI	rads	0 to $\pm\pi/2$	10^{-8}
14-15	Position Hold Longitude (Note 4)	DI	rads	0 to $\pm\pi$	10^{-8}
16-17	Position Hold Altitude (Note 4)	DI	meters	-2000 to 50000	10^{-2}
Timing Pulse Output Configuration Word (18.0 – 18.15)					
18.0	Reserved (must be set to 0)				
18.1	Time Mark Alignment (default: aligned to UTC time)	Bit		0 = GPS Time 1 = UTC Time	
18.2	Reserved (must be set to 0)				
18.3	Time Mark Suppressed When Invalid (default: suppress when invalid) (Note 5)	Bit		1 = Suppressed	
18.4	Time Mark Suppressed on TRAIM Alarm (default: do not suppress) (Note 6)	Bit		1 = Suppressed	
18.5-18.15	Reserved (must be set to zero)				

Table 2-82. Message 1255: Timing Receiver Configuration Input Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
TRAIM Alarm Configuration Word (19.0 – 19.15) (Note 7)					
19.0	TRAIM Alarm when Status is "Unavailable" (No navigation solution or only 1 satellite valid)(default: enabled)	Bit		1 = Enabled	
19.1	TRAIM Alarm when Timing Error Estimate > Timing Error Threshold (default: enabled)	Bit		1 = Enabled	
19.2	TRAIM Alarm when Status is "Detect Only" (2 satellites valid)(default: disabled)	Bit		1 = Enabled	
19.3-19.15	Reserved (must be set to 0)				
20	TRAIM Disable (default: enabled)	UI		1 = Disabled	
21	TRAIM Timing Error Threshold (default: 1 µs)	UI	ns	1 to 20000	50 ns
22-23	Reserved (must be set to 0)				
24	Data Checksum	I			

Note 1: Specifies the receiver's mode of operation after a reset or power cycling. When Position-Hold mode is used at startup, the receiver examines the position in SRAM and then the position in EEPROM. The first position found valid is used as the reference position. If neither is valid, the receiver enters Self-Survey mode and conducts a 24-hour survey, then switches to Position-Hold mode. Default is Self-Survey mode for 24 hours, then switch to Position-Hold mode.

Note 2: Time Mark Time-Delay Compensation permits adjustment for delays in the timing pulse caused by cables and connections. By default, compensation is zero. Positive adjustments advance the pulse to compensate for system delays. Negative adjustments may be used to adjust for unequal delays between separate timing systems. The available range permits adjustments up to ±1 ms.

Note 3: This word is ignored unless word 7 is set to 3. If this word is set to 0 the receiver switches to Self-Survey mode with unlimited time (same as if word 7 was set to 4).

Note 4: These words are ignored unless word 7 is set to 6.

Note 5: Time mark valid means that the receiver has set the time mark to the proper alignment (GPS or UTC time) as determined from the satellites present. When this bit designates that an invalid time mark should be suppressed, the receiver does not output a time mark until it is navigating from satellites and has aligned the time mark. The time mark remains as long as the receiver maintains tracking on at least one satellite.

Note 6: Time Pulse Suppressed mens that when a TRAM alarm occurs, the receiver stops sending the timing pulse, and does not restart the pulse until the alarm condition stops.

Note 7: These bits determine which conditions activate a TRAIM alarm. The alarm is only set if a particular condition exists, the associated alarm is enabled, and TRAIM is enabled (see word 20).

2.2.20 DR Initialization Input (Message 1270). This message is used to initialize the gyro and wheel tick DR parameters for the DR system. These values are stored in EEPROM. They will not be used until the next time the system is reset. Then, they are loaded into RAM and used as the starting values for the DR instruments. While the system is navigating in combined or GPS-only mode, the values in RAM are constantly updated. The actual values in use can be seen using Message 1071. Values from the 1071 message can be stored in EEPROM using Message 1270 to enhance future start-ups. The contents of the DR Initialization Input Message are described in Table 2-83.

Table 2-83. Message 1270: DR Initialization Input Message

Message ID:	1270				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	Once at initialization and as required for basic system performance changes				
Message Length:	15 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	DR Speed Standard Deviation (Note 1)	UI	m/s	0 to 10000	10^{-2}
8	DR Speed Data Time Tag Resolution (Note 2)	UI	ms	0 to 65535	10^{-2}
9	DR Speed Latency (RESERVED) (Note 3)	UI	ms	0 to 65535	10^{-2}
10	Data Valid Flags (Note 4) Bit 0 = Gyro Scale and Gyro Bias Valid Bit 1 = Wheel Tick Rate Valid	Bit		0 = invalid	
11	Gyro Scale (Note 4, 5)	I	(deg/s)/(A/D count)	–0.32767 to +0.32767	10^{-5}
12	Gyro Bias (Note 4, 5)	I	deg/s	–0.32767 to +0.32767	10^{-2}
13	Wheel Tick Rate (Note 4, 6)	UI	ticks/km	0 to 65535	
14	Reserved (Note 4)				
15	Data Checksum				

Note 1: These inputs anticipate the possibility of sensors of differing quality.

Note 2: The default is a value of 10 (meaning 100 µs). This assumes use of the 10 kHz output of GPS for the time tag counter.

Note 3: Estimated delay from end of speed measurement period to the time that the time tag in word 8 is latched.

Note 4: Words 10 to 14 are presently used for development only. Their final definition is pending.

Note 5: This value is meaningful only if bit 10.0 is set.

Note 6: This value is meaningful only if bit 10.1 is set.

2.2.21 Hardware Accelerator Control Input (Message 1292). This message controls the receiver's operational mode. The three possible modes are Off, Fast Acquisition, and On.

In the Off mode, the receiver functions as though the Hardware Accelerator was not present.

In the Fast Acquisition mode, the Hardware Accelerator is used only during satellite acquisition to find satellites very quickly, switches to the tracking loops for all tracking. This mode can reduce time to first fix by significant percentages under most circumstances.

In the On mode, the Hardware Accelerator is used for fast acquisition, then the tracking loops are used to download the navigation message and to compute the position. Then the receiver switches to power-saving mode using the Hardware Accelerator to navigate, but periodically switches back to tracking loops to recover new ephemerides and almanacs as required, and to reduce any position errors that may have accumulated. This mode can reduce total power consumption of the receiver by more than 50 %, but will yield positions with more noise (i.e., larger errors) than tracking loop solutions.

The contents of the Hardware Accelerator Control Input Message are described in Table 2-84.

Table 2-84. Message 1292: Hardware Accelerator Control Input Message

Message ID:	1292				**(ONLY AVAILABLE IN HARDWARE ACCELERATOR BUILDS)**
Rate:	Variable				
Message Length:	27 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Hardware Accelerator Mode (Note 1)	I		0 = off 1 = fast acquisition 2 = on	
8	Enable Low C/N_0 (Note 2)	I	dB-Hz	0 = 34 (off) 1 = 32 (default) 2 = 30 3 = 28 4 = 26 5 = 24 6 = 22 7 = 20 8 = 18 9 = 16 10 = 14 11 = 12 12 = 10 13 = 8 14 = 6 15 = 4	
9-26	Reserved				
27	Data Checksum				

Note 1: Hardware Accelerator Off Mode means the system does not use the Hardware Accelerator. Fast Acquisition Mode means to use the Hardware Accelerator to find satellites, then transition to tracking loops for all navigation. On Mode uses the Hardware Accelerator for fast acquisition, then uses tracking loops only as required to recover the ephemerides and almanacs from satellite navigation messages, and when needed to reduce position errors. Otherwise, On mode creates satellite measurements using the Hardware Accelerator with significant power savings as a result. The positions computed from the Hardware Accelerator measurements are not smoothed by carrier phase, and are therefore noisier than positions determined from tracking loop measurements.

Note 2: When Enable Low C/N_0 is off, the system will not track satellites with less than the specified C/N_0. When enabled, the lowest C/N_0 used will be as specified in the Range field. Tracking to lower C/N_0 values requires additional time and memory to create reliable satellite measurements. At lower values, this might reduce the measurement rate to less than one measurement per second. Note that the full range of values in this message may not be implemented. See the release note for the version in use to see the currently implemented range. Entering values outside the implemented range will cause the system to use the default value.

2.2.22 Perform Built-In Test Command (Message 1300). This message instructs the receiver to immediately execute its Built-In Test (BIT). Performance of the BIT will cause a system reset. Results of the BIT are available after the reset in the Built-In Test Results message (Message 1100). As a consequence of running the BIT, the receiver's Real-Time Clock (RTC) will lose approximately 2.5 seconds. This will not affect normal receiver start-up, and the clock will be corrected shortly after the receiver enters navigation mode. The contents of the Perform Built-In Test Command Message are described in Table 2-85.

Table 2-85. Message 1300: Perform Built-In Test Command Message

Message ID:	1300				
Rate:	As required - maximum rate approximately 0.1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Reserved (Set to 0)				
8	Data Checksum				

2.2.23 Global Input Control Parameters (Message 1301). This message controls the operational behavior of the Measurement Engine. The contents of the Global Input Control Parameters Message are described in Table 2-86.

Table 2-86. Message 1301: Global Input Control Parameters Message

Message ID:	1301 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Measurement Engine Mode	UI	enumeration	0 = autonomous acquisition (default) (Note 1) 1 = sequential acquisition (Note 2) 2 = commanded channel (Note 3) 3 = parallel acquisition (Note 4) 4 = reset (Note 5)	
8.0-8.15	Reserved				
9.0-9.15	Reserved				
10	Data Checksum				

Note 1: The Measurement Engine normally starts in autonomous acquisition mode. Transition to other modes is allowed.

Note 2: Sequential acquisition mode allows a satellite list and prepositioning data to be input using Message 1302. Satellites are acquired in the given order. No other satellites are tracked. Transition to cold start is allowed.

Note 3: The commanded channel mode provides the Measurement Engine user with the ability to specify to which physical channel a satellite is assigned. The channel assignment logic of the Measurement Engine is disabled in this mode.

Note 4: Parallel acquisition mode allows a satellite list and prepositioning data to be input using Message 1302. Each satellite is assigned to one channel. No other satellites are tracked.

Note 5: Reset the Measurement Engine to low power, re-initialized state with minimal interrupt loop activity. Wait for new input commands. This would be equivalent to power up at the point where the Measurement Engine first inspects the input data to determine its mode of operation except that the input data space is not reinitialized.

2.2.24 Solution Error Feedback Parameters (Message 1302). This message is the real-time mechanism for controlling the operation of the Measurement Engine's satellite tracking channels. The contents of the Solution Error Feedback Parameters Message are described in 2-87.

Table 2-87. Message 1302: Solution Error Feedback Parameters Message (1 of 2)

Message ID:	1302	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	As required - maximum rate 1 Hz				
Message Length:	variable (18 minimum, 126 maximum)				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7-10	Solution Feedback Time (Note 1) Integer Portion (Note 2) Fractional Portion (Note 3)	 DI DI	 seconds seconds	 0 to 604799.98 0 to ±0.02	 20 ms $2^{-29}/50$
11-12	Drift Error (Note 4)	DI	sec/sec	0 to $\pm 2^{-14}$	2^{-45}
13-14	Bias Error (Note 5)	DI	seconds	0 to ±0.08	$2^{-29}/50$
15	Drift Error Standard Deviation	UI	sec/sec	0 to 2^{-16}	2^{-32}
16	Bias Error Standard Deviation	UI	seconds	0 to 0.0025	$2^{-19}/50$
17.0-16.3	Reserved				
17.4-16.15	New Per Channel Input Data (Note 6): Bit k: 1 = New Data in Buffer 15-k 0 = No/Old Data in Bbuffer 15-k (k = 0 to x where x<12)	 Bits		 0 to 1	
18.0-17.3	Reserved				
18.4-17.15	Critical New Per Channel Input Data (Note 7): Bit k: 1 = New Data in Buffer 15-k 0 = No/Old Data in Buffer 15-k (k = 0 to x where x<12)	 Bits		 0 to 1	
18+(9*j)	Channel Commands (Reserved) (Note 8)	UI			
19+(9*j)	Satellite PRN (Note 9)	I		0 to 32	
20+(9*j)	C/No (Note 10)	I	dB-Hz	0 to 60	
21+(9*j)	Code Phase Preposition (Note 11)	UI	seconds	0 to 0.16	$2^{-29}/50$
22+(9*j)	Carrier Velocity Preposition (Note 12)	DI	sec/sec	0 to $\pm 2^{-14}$	2^{-45}
23+(9*j)	Code Phase Standard Deviation (Note 13)	UI	seconds	0 to 0.0025	$2^{-19}/50$
24+(9*j)	Carrier Velocity Standard Deviation (Note 14)	UI	sec/sec	0 to 2^{-16}	2^{-32}
126	Data Checksum				

Table 2-87. Message 1302: Solution Error Feedback Parameters Message (2 of 2)

Note 1:	When the Measurment Engine is not tracking satellites, the solution feedback time may be interpreted as a time initialization for the Measurement Engine. This really has no effect on the engine, but allows the engine's time function to provide the navigation software with GPS time inputs. The drift and bias inputs are set to zero for this case.
Note 2:	Solution feedback time is always GPS time. The integer portion is the GPS bit count from start of week.
Note 3:	The fractional portion of the solution feedback time is the offset from the bit count.
Note 4:	The drift error is the residual error in the estimated frequency standard offset.
Note 5:	Bias error feedback is an indication of the error in the measurement time epoch. Errors larger than 80 msec are resolved locally by the Measurement Engine without assistance using Hand-Over-Word data.
Note 6:	Per channel data can be ignored unless this item is non-zero. Nothing has changed since the prior issue of data (sequence number) in a channel unless its bit is set. Bit 0 is used to indicate if the clock bias and drift data have been updated since the last sequence number.
Note 7:	The critical new channel data flag indicates that a significant change has occurred for a channel. Examples of a critical change are a new PRN or, during acquisition, radical changes to C/No or pre-positioning parameters. Normal C/No or pre-positioning updates during navigation would not be tagged critical if the signal is currently in track. If bit 0 is set, the clock error (bias and drift) should be taken out by an immediate repartitioning or a step change. If bit 0 is not set, the clock error (bias and drift) should be removed by smoothly forcing the Measurement Engine GPS time loop to the new bias and drift values.
Note 8:	j = 0 to 11
Note 9:	PRN equal to 0 is used to indicate an unused assignment. This allows the Measurement Engine to turn off any unused channels.
Note 10:	Indicates the minimum C/No to be assumed in acquiring this satellite. It may be possible to acquire at a lower signal level but performance is not guaranteed.
Note 11:	Expected code position retard at the measurement epoch. Use the WGS-84 value for the speed of light when scaling to meters.
Note 12:	Expected LOS velocity at the measurement epoch. The physical range rate in m/s must be scaled by 2^{45}/c, where c is the WGS-84 value of the speed of light, to produce this parameter.
Note 13:	Scaling for the Code Phase Standard Deviation is similar to that for the Code Phase Preposition except that is only needs to have a range that covers a code period and a resolution of a p chip or better.
Note 14:	Scaling for the Carrier Velocity Standard Deviation is similar to that for the Carrier Velocity Preposition except that is only needs to have a range that covers the Doppler uncertainty with resolution a small enough part of a frequency search window.

2.2.25 Restart Command (Message 1303). This message commands a full restart (software reset) each time it is received. The contents of the Restart Command Message are described in Table 2-88.

Caution: Invalidation of the EEPROM, or frequency standards in the EEPROM, removes all clock characterization information. The next time the receiver enters navigation mode, it will assume the temperature is approximately 25 °C and will initialize the crystal temperature parameters and corrections tables based on that assumption. If the temperature is significantly different from 25 °C, a permanent bias will be stored in the EEPROM that could later cause unpredictable system operation at temperature extremes.

Table 2-88. Message 1303: Restart Command Message

Message ID:	1303				
Rate:	As required - maximum rate approximately 0.2 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Invalidation Control (7.0-7.15)					
7.0	Invalidate RAM (Note 1)	Bit		1 = invalidate	
7.1	Invalidate EEPROM (Note 2)	Bit		1 = invalidate	
7.2	Invalidate RTC (Note 3)	Bit		1 = invalidate	
7.3	Reserved				
7.4	Invalidate Ephemerides in RAM (Note 4)	Bit		1 = invalidate	
7.5	Invalidate Frequency Standards in EEPROM (Note 5)	Bit		1 = invalidate	
7.6-7.14	Reserved				
7.15	Force Cold Start (Note 6)	Bit		1 = force	
8	Data Checksum				

Note 1: 1 = invalidate the lower 32 kW of RAM address space before restart.

Note 2: 1 = invalidate the lower 2 kB of data in the EEPROM device (if present) before restart.

Note 3: 1 = invalidate all data in the RTC device (if present) before restart.

Note 4: Clear ephemerides in RAM, which forces the receiver to re-collect data from satellites. A restart with only this bit set would generally be considered a warm start, assuming time and position were still valid in the receiver.

Note 5: Only valid if bit 7.1 is also set. Limits EEPROM invalidation to the data areas containing frequency characteristics only (frequency standard cubic parameters, frequency/temperature table, and frequency standard calibration data). This is used during factory test where configuration data should not be altered but crystal characterization needs to be done.

Note 6: 1 = force a cold start reset by clearing the lower 32 kW in RAM and ignoring, but not clearing, the stored position in EEPROM. This provides cold start with the valid time (if present). If cold start without using the RTC time is desired, then the invalidate RTC bit (7.2) should also be set. Note: this bit is normally used only when testing a system to determine reset times.

2.2.26 Factory Test (Message 1304). This message is used to start the factory test. In factory test, the receiver searches for specific satellites with predefined ephemerides at a 1992 epoch. OEMs interested in using the factory test procedure need to contact SiRF for help. The contents of the Factory Test Message are described in Table 2-89.

Table 2-89. Message 1304: Factory Test Message

Message ID:	1304				
Rate:	As required				
Message Length:	7 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Data Checksum				

2.2.27 DR Factory Test (Message 1305). This message is used to start and control the DR factory test. Two versions of this message allow calibration of the two gyro calibration terms (see word 7). The contents of the DR Factory Test Message are described in Table 2-90.

Table 2-90. Message 1305: DR Factory Test Message

Message ID:	1305				**(ONLY AVAILABLE IN DR BUILDS)**
Rate:	As required - maximum rate approximately 0.2 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Bias/Scale Factor Calibration (Note 1)	UI		1 = bias test 3 = scale factor test	
8	Data Checksum				

Note 1: Selects the two gyro calibration tests, usually performed in the following order:

1 = bias test. The system is held at rest. The system "learns" the gyro rest, or bias, value.

3 = scale factor test. The system is rotated in a clockwise direction through 360 degrees. The system integrates the oujtput of the gyro and computes a scale factor that equates the result to 360 degrees.

2.2.28 Explicit Acknowledgement Input (Message 1306). This message is used by vEEPROM systems that use SRAM to simulate EEPROM space. The message is used by the receiver to acknowledge receipt of data and is usually set during program build to send an acknowledgement after receipt of 8 data blocks. An Acknowledgement Status of 1 means all 8 blocks have been received and validated. The contents of the Explicit Acknowledgement Input Message are described in Table 2-91.

Table 2-91. Message 1306: Explicit Acknowledgement Input Message

Message ID:	1306				**(ONLY AVAILABLE IN vEEPROM SOFTWARE)**
Rate:	Variable				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	ID of Message (Note 1)	UI		1000 to 1399	
8.0	Acknowledgement Status	Bit		1 = ACK	
8.1-8.15	Reserved				
9	Data Checksum				
Note 1:	ID of the message whose acknowledgement status is being reported. This is currently limited to acknowledging message 1137, and is sent after 8 blocks have been successfully received.				

2.2.29 Frequency Standard Input Parameters (Message 1310). This message defines the temperature polynomial, coefficients, and scale factors used by the receiver's frequency standard compensation model. The contents of the Frequency Standard Input Parameters Message are described in Table 2-92.

Message 1310 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1110 is similar – the output message is used to capture data while the input message is used to restore data. Note that message 1110 has set time in words 6 and 7, while this message does not.

NOTE: Do not use this message to input data collected by another receiver. Data is only valid in the receiver that reports it.

Table 2-92. Message 1310: Frequency Standard Input Parameters Message

Message ID:	1310				
Rate:	As required - maximum rate 1 Hz				
Message Length:	20 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Frequency Standard Issue Number (Note 1)	UI		0 to 65535	
TEMPERATURE CHARACTERISTIC					
8	C_0 (Aging and Calibration Offset) (Note 2)	I	sec/sec	-2^{15} to $+2^{15}$	2^{-29}
9	C_1 (Linear Term) (Note 2)	I	sec/sec/deg C		2^{-35}
10	C_2 (Second Order Term) (Note 2)	I	sec/sec/(deg C)^2		2^{-41}
11	C_3 (Third Order Term) (Note 2)	I	sec/sec/(deg C)^3		2^{-47}
12	T_{INF} (Inflection Point) (Note 2)	I	degrees C	–10000 to +10000	10^{-2}
TEMPERATURE DYNAMICS					
13	D_0 (Note 3)	I			
14	D_1 (Note 3)	I			
TEMPERATURE SENSOR CALIBRATION					
15	T_{REF} (Calibration ReferenceTemperature) (Note 4)	I	degrees C	–10000 to +10000	10^{-2}
16	T_0 (Temperature Sensor Reading at T_{REF}) (Note 4)	UI	counts	0 to 65535	
17	S_0 (Temperature Sensor Scale Factor) (Note 4)	I	deg C/count	-2^{15} to $+2^{15}$	2^{-18}
UNCERTAINTY COEFFICIENTS					
18	U_0 (Note 5)	I	sec/sec	-2^{15} to $+2^{15}$	2^{-29}
19	U_1 (Note 5)	I	sec/sec/deg C	-2^{15} to $+2^{15}$	2^{-35}
20	Data Checksum				

Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data are only stored to EEPROM. The issue number is preserved from run to run if non-volatile storage is available.

Note 2: Defines a cubic in ($T - T_{INF}$). Over a range of $T_{INF} \pm 65$ degrees C, each term can produce from 0.002 to 60 ppm,approximately.

Note 3: These parameters are currently not used.

Note 4: These parameters define the temperature sensor scaling according to the equation:

$$T = T_{REF} + (T_{READING} - T_0)S_0$$

where $T_{READING}$ is the current temperature sensor reading in counts and T is the current temperature in degrees Centigrade.

Note 5: Defines a linear equation in ($T - T_{INF}$). Over a range of $T_{INF} \pm 65°C$, each term can produce from 0.002 to 60 ppm, approximately.

2.2.30 Temperature Sensor Filter Input Parameters (Message 1311). This message definition is not complete. The contents of the Temperature Sensor Filter Input Parameters Message are described in Table 2-93.

NOTE: Message 1311 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1111 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-93. Message 1311: Temperature Sensor Filter Input Parameters Message

Message ID:	1311 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	11 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Temperature Sensor Issue Number (Note 1)	UI		0 to 65535	
8	K_0 (Loop Gain) (Note 2)	I			
9	K_1 (Loop Gain) (Note 2)	I			
10	E_{TOL} (Loop Error Tolerance) (Note 2)	I			
11	Data Checksum				
Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data are only stored to EEPROM.					
Note 2: The parameters of the temperature filter can be optimized for alternative sensors, crystals, temperature environments, or other factors.					

2.2.31 Measurement Epoch Steering Parameters (Message 1312). This message ***** TBD definition *****. The contents of the Measurement Epoch Steering Parameters Message are described in Table 2-94.

NOTE: Message 1312 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1112 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-94. Message 1312: Measurement Epoch Steering Parameters Message

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID: 1312 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)					
Rate: As required - maximum rate 1 Hz					
Message Length: 13 words					
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7-10	Command Reference Time: Integer Portion (Note 1) Fractional Portion (Note 2)	 DI DI	 seconds seconds	 0 to 604799.98 0 to ±0.02	 20 ms $2^{-29}/50$
11	Time Offset Command (Note 3)	DI	seconds	0 to ±2	2^{-30}
12	Rate Offset Command (Note 4)	DI	sec/sec	0 to $\pm 2^{-27}$	2^{-50}
13	Data Checksum				

Note 1: Command Reference Time is the GPS time of validity for the Time Offset in the message. The time offset varies due to the Rate Offset. The Command Reference Time defines when the Time Offset in the data block is valid. The integer portion is the GPS bit count from start of week.

Note 2: The fractional portion of the Command Reference Time is the offset from the bit count.

Note 3: Time Offset Command is the time offset from GPS time for measurement epochs at the Command Reference Time.

Note 4: Rate Offset Command is the rate offset from the GPS time rate for measurement epochs.

2.2.32 Measurement Time Offset (Message 1313). This message ***** TBD definition *****. The contents of the Measurement Time Offset Message are described in Table 2-95.

NOTE: Message 1313 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1113 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-95. Message 1313: Measurement Time Offset Message

Message ID:	1313	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Measurement Time Offset (Note 1)	I	seconds	0 to ±0.64	$2^{-10}/50$
8	Data Checksum				
Note 1: Delay from the selected GPS or UTC one second epoch for measurement data capture.					

2.2.33 Time Mark Signal Output Control (Message 1314). This message ***** TBD definition *****. The contents of the Time Mark Signal Output Control Message are described in Table 2-96.

NOTE: Message 1314 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1114 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-96. Message 1314: Time Mark Signal Output Control Message

Message ID:	1314 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Time Mark Control Flags (7.0- 7.15)					
7.0	Command Time Mark On	UI		0 to 1	
7.1	Command K10 On	UI		0 to 1	
7.2-7.15	Reserved				
8	Time Mark Offset Command (Note 1)	DI	seconds	0 to $\pm$0.64	$2^{-26}/50$
9	Data Checksum				
Note 1: Delay from selected GPS or UTC one second epoch for Time Mark signal epoch. Resolution is about 0.3 nsec.					

2.2.34 Platform Dynamics Limits (Message 1315). This message ***** TBD definition *****. The contents of the Platform Dynamics Limits Message are described in Table 2-97.

NOTE: Message 1315 is primarily used to input key parameters to GPS systems without non-volatile storage.

This is why the format of output message 1115 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-97. Message 1315: Platform Dynamics Limits Message

Message ID:	1315 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	9 words				
Word No.:	Name:	Type:	Units:	Range:	Resolution:
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Maximum Acceleration Command (Note 1)	I	g	0 to 10	10^{-1}
8	Maximum Velocity Command (Note 1)	I	m/s	0 to 32767	
9	Data Checksum				
Note 1: These parameters are used to optimize parameter selection for acquisition, reacquisition, and tracking (limits may be different for each of these).					
***** Additional Information TBD *****					

2.2.35 Measurement Rate Control (Message 1316). This message ***** TBD definition *****. The contents of the Measurement Rate Control Message are described in Table 2-98.

NOTE: Message 1316 is primarily used to input key parameters to GPS systems without non-volatile storage. This is why the format of output message 1116 is similar – the output message is used to capture data while the input message is used to restore data.

Table 2-98. Message 1316: Measurement Rate Control Message

Message ID:	1316 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Measurement Interval Command (Note 1)	UI	seconds	0.1 to 65535	10^{-1}
8	Data Checksum				
Note 1: The rate at which measurements are updated is not related to the duty cycling of the RF and digital circuitry when in power management mode. It simply specifies the rate at which measurements are taken.					

2.2.36 Power Management Control (Message 1317). This message controls the use of power management in the receiver. Message 1117 provides a means to examine the current setting.The contents of the Power Management Control Message are described in Table 2-99.

Table 2-99. Message 1317: Power Management Control Message

Message ID:	1317				**(ONLY AVAILABLE IN POWER MANAGEMENT BUILDS)**
Rate:	As required - maximum rate 1 Hz				**(Function of this message changed in version 3.05)**
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Power Management On Duty Cycle (Note 1)	I	seconds	0 = off 1-4 = on	
8	Data Checksum				

Note 1: In power management mode, the RF power may be switched off to reduce power consumption. When this field is greater than zero, it represents the number of seconds the RF power is switched off in a cycle. The power will be switched on for one or two seconds out of each cycle, depending on software version. Prior to version 3.05 software, power was switched on for one second to stabilize and one second to take satellite measurements. In version 3.05 and later, power is switched on only for 1 second. The software takes care of allowing the RF to stabilize. During the off second(s) and the one second of warm up (if applicable), the navigation engine computes solutions without the aid of current satellite observations. See message 1117 to output the current value.

2.2.37 Cold Start Almanac Data Update (Message 1318). This message ***** TBD definition *****. The contents of the Cold Start Almanac Data Update Message are described in Table 2-100.

NOTE: Message 1318 is primarily used to input key parameters to GPS systems without non-volatile storage. This message works with message 1118, which outputs the same data.

Table 2-100. Message 1318: Cold Start Almanac Data Update Message

Message ID:	1318 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	24 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
Almanac Data (Note 1)					
7.0-7.5	PRN (1st Almanac)	UI			
7.6	Health OK (1st Almanac)	Bit		1 = health OK	
7.7	Satellite Seen In Almanac (1st Almanac)	Bit		1 = satellite seen	
7.8-7.13	PRN (2nd Almanac)	UI			
7.14	Health OK (2nd Almanac)	Bit		1 = health OK	
7.15	Satellite Seen In Almanac (2nd Almanac)	Bit		1 = satellite seen	
8.0-8.5	PRN (3rd Almanac)	UI			
8.6	Health OK (3rd Almanac)	Bit		1 = health OK	
8.7	Satellite Seen In Almanac (3rd Almanac)	Bit		1 = satellite seen	
8.8-8.13	PRN (4th Almanac)	UI			
8.14	Health OK (4th Almanac)	Bit		1 = health OK	
8.15	Satellite Seen In Almanac (4th Almanac)	Bit		1 = satellite seen	
• • •					
23.0-23.5	PRN (31st Almanac)	UI			
23.6	Health OK (31st Almanac)	Bit		1 = health OK	
23.7	Satellite Seen In Almanac (31st Almanac)	Bit		1 = satellite seen	
23.8-23.13	PRN (32nd Almanac)	UI			
23.14	Health OK (32nd Almanac)	Bit		1 = health OK	
23.15	Satellite Seen In Almanac (32nd Almanac)	Bit		1 = satellite seen	
24	Data Checksum				

Note 1: Each integer (from 7 to 23) has data for two satellite almanacs, one in each byte. The offset runs from 1 to 10h, which provides entries for 32 satellites. The order of satellites takes two forms. If the Satellite Seen in Almanac bit is false (zero), the order of the PRN values in the list is arbitrary and is to be taken as a search order. If this bit is set, the PRNs are in orbit/station order. That is, the first 24 satellites must all have this bit set. The first four PRNs are for satellites in orbit 1, the second four are in orbit 2, and so on until the last four are in orbit 6. Within each orbit, the first PRN is in station 1, the second is in station 2, the third in station 3 and the fourth is in station 4.

Orbits and stations are defined at the GPS time equal to the reference time of the almanac. Orbit 1 is the orbit having its orbital plane intersecting the earth's equatorial plane closest to longitude = 0. Remaining orbits are defined by rotating the plane of orbit one to the west. Within each orbit, station 1 is that satellite which is rising from south to north and is closest to the equatorial plane. (This definition is arbitrary. A review of the current orbits is required to determine the best definition.)

2.2.38 Serial Port Communication Parameters (Message 1330). This message allows the user to set the communication parameters for the receiver's two serial ports. The contents of the Serial Port Communication Parameters Message are described in Table 2-101.

Table 2-101. Message 1330: Serial Port Communication Parameters Message (1 of 2)

Message ID:	1330				
Rate:	As required - maximum rate 1 Hz				
Message Length:	20 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
PORT CONTROL/VALIDITY DATA					
7.0	Port 1 Data Valid (Note 1)	Bit		1 = data valid	
7.1	Port 2 Data Valid (Note 1)	Bit		1 = data valid	
7.2-7.15	Reserved				
8	Port 1 Character Width	UI		0 = 7 bits 1 = 8 bits	
9	Port 1 Stop BIts	UI		0 = 1 1 = 2	
10	Port 1 Parity	UI		0 = no parity 1 = odd parity 2 = even parity	
11	Port 1 Bits Per Second (bps) Rate	UI		0 = custom 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600 10 = 76800 11 = 115200	
12	Port 1 Pre-Scale (Note 2)	UI		0 to 255	
13	Port 1 Post-Scale (Note 2)	UI		0 to 7	
14	Port 2 Character Width	Bit		0 = 7 bits 1 = 8 bits	
15	Port 2 Stop BIts	Bit		0 = 1 1 = 2	

Table 2-101. Message 1330: Serial Port Communication Parameters Message (2 of 2)

Word No.:	Name:	Type:	Units:	Range:	Resolution:
16	Port 2 Parity	Bit		0 = no parity 1 = odd parity 2 = even parity	
17	Port 2 bps Rate	Bit		0 = custom 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600 10 = 76800 11 = 115200	
18	Port 2 Pre-Scale (Note 2)	UI		0 to 255	
19	Port 2 Post-Scale (Note 2)	UI		0 to 7	
20	Data Checksum				

Note 1: Bits 7.0 and 7.1 specify whether subsequent data in the message is valid. If bit 7.0 is set, data in words 8-13 is valid; if bit 7.1 is set, data in words 14-18 is valid.

Note 2: Pre-scale and post-scale parameters are used to establish custom bps rates. These items are only valid when the Port bps rate is set to zero. The bps rate is equal to:

CPU clock/(16 x pre-scale x $2^{post\text{-}scale}$)

2.2.39 Message Protocol Control (Message 1331). This message allows the user to set the message format protocol which will be used to communicate information to and from the receiver through the host serial I/O port. Currently, the available protocols are binary (with fixed-point numbers) and NMEA-0183. Storage for the Protocol Type parameter requires EEPROM. The contents of the Message Protocol Control Message are described in Table 2-102.

Table 2-102. Message 1331: Message Protocol Control Message

Message ID:	1331				
Rate:	As required - maximum rate 1 Hz				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Data Stream Select (Note 1)	I		0 = host 1 = auxiliary	
8	Protocol Type (Note 2)	I		0 = binary 1 = NMEA 2 = RTCM SC-104 3 = OEM	
9	Data Checksum				

Note 1: Data stream select is only valid on special builds. Set this to 0 unless your SiRF technical contact directs you otherwise.

Note 2: RTCM SC-104 is not a valid protocol for the host data stream. OEM build only valid in special builds. Contact SiRF technical support.

2.2.40 Memory Speed Input Parameters (Message 1332). This message is used to set the number of wait states for the receiver. The contents of the Memory Speed Input Parameters Message are described in Table 2-103.

Table 2-103. Message 1332: Memory Speed Input Parameters Message

Message ID:	1332	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)			
Rate:	As required - maximum rate 1 Hz				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Memory Speed Issue Number (Note 1)	UI		0 to 65535	
8	RAM Delay (Note 2)	UI	cycles	0 to 7	
9	ROM Delay (Note 2)	UI	cycles	0 to 7	
10	EEPROM Delay (Note 2)	UI	cycles	0 to 15	
11	Dual Port RAM Delay (Note 2)	UI	cycles	0 to 15	
12	Internal Delay (Note 3)	UI	cycles	0 to 1	
13	Data Checksum				

Note 1: Unique identification of each update. This allows a different set of data to be in use while newer data is only stored to EEPROM.

Note 2: The delay is the number of bus cycles in addition to the minimum bus transaction time that is required to access the memory device. The number of delay cycles is increased for slower memory devices.

Note 3: Internal delay should be set to one cycle.

2.2.41 Backup vEEPROM or EEPROM Availability Status Input (Message 1334). This message is used by the host processor to control vEEPROM data transfers. Before the receiver power is removed, the host can send this message with the Output Request bit set, asking the receiver to dump vEEPROM contents (using the 1137 message). When receiver power is subsequently turned on, this message is sent with the Data Valid bit set, indicating that a vEEPROM restore operation is about to start. The host processor then follows with 1337 messages restoring the vEEPROM contents. The contents of the Backup vEEPROM or EEPROM Availability Status Input Message are described in Table 2-104.

Table 2-104. Message 1334: Backup vEEPROM or EEPROM Availability Status Input Message

Message ID:	1334				**(ONLY AVAILABLE IN vEEPROM SOFTWARE)**
Rate:	Variable				
Message Length:	9 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	EEPROM Data Valid (Note 1)	Bit		1 = valid	
7.1	EEPROM Output Request (Note 2)	Bit		1 = true	
7.2-7.15	Reserved				
8	Reserved				
9	Data Checksum				

Note 1: EEPROM or vEEPROM data is available and valid to upload for restoration. This bit is usually sent at power up to advise the receiver it has the data ready to restore vEEPROM data in SRAM. Following this message, data restoration begins with the host computer sending 1337 messages.

Note 2: This word requests that the receiver dump its vEEPROM data to the host computer for backup. This is typically done either just before power down or periodically to protect against unexpected power outages. With data backed up, the receiver's SRAM does not need to be kept alive during power off periods just to maintain vEEPROM data. After receipt of this message, the receiver sends 1137 messages with the vEEPROM data.

2.2.42 vEEPROM/EEPROM Block Input (Message 1337). This message is used to restore vEEPROM when the receiver is started after a loss of power. Data to be restored is saved by the host computer from data blocks received in 1137 messages. Message 1334 is sent to the receiver before these messages are sent. The contents of the vEEPROM/EEPROM Block Input Message are described in Table 2-105.

Table 2-105. Message 1337: vEEPROM/EEPROM Block Input Message

Message ID:	1337				**(ONLY AVAILABLE IN vEEPROM SOFTWARE)**
Rate:	Variable				
Message Length:	137 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Block ID (Note 1)	UI		0 to (N–1)	
8	Number of Blocks (Note 1)	UI		N	
9-136	Data Words	UI			
137	Data Checksum				
Note 1: N is the total number of 128-word blocks in the EEPROM or vEEPROM. For 1024-word systems, N = 8; for 2048-word systems, N = 16. The Block ID identifies which block is being output in this message, where 0 represents the first (lower addressed) block, and N–1 represents the highest addressed block.					

2.2.43 Enable/Disable Idle Timer (Message 1338). This message ***** TBD definition *****. The contents of the Enable/Disable Idle Timer Message are described in Table 2-106.

Table 2-106. Message 1338: Enable/Disable Idle Timer Message

Message ID:	1338 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	8 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Enable/Disable				
8	Data Checksum				

2.2.44 Factory Calibration Input (Message 1350). This message is used to inform the system about the quality of the frequency standard being used. The contents of the Factory Calibration Input Message are described in Table 2-107.

Table 2-107. Message 1350: Factory Calibration Input Message

Word No.:	Name:	Type:	Units:	Range:	Resolution:
Message ID: 1350					
Rate: As required - maximum rate 1 Hz					
Message Length: 10 words					
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Oscillator Temperature (Note 1)	I	deg C	–40 to +85	10^{-2}
8-9	Oscillator Frequency Error	I	ppm	–51 to +51	10^{-2}
10	Data Checksum				
Note 1: Externally supplied temperature measurement. An external temperature input causes the internal temperature sensor to be ignored as a source of temperature data.					

2.2.45 Raw DGPS RTCM SC-104 Data (Message 1351). This input message contains DGPS RTCM SC-104 data. The message is provided for backwards compatibility with the earlier MicroTracker GPS receiver and may be used in lieu of the auxiliary port data.

The contents of the Raw DGPS RTCM SC-104 Data Message are described in Table 2-108.

Table 2-108. Message 1351: Raw DGPS RTCM SC-104 Data Message

Message ID:	1351				
Rate:	As required. The maximum allowable rate is once every 100 ms				
Message Length:	Varies with message (Note 1)				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7 to n-1	*Any valid RTCM-104 raw data in multiples of 16 bits, not to exceed 32 16-bit words (Note 2)*				
n	Data Checksum (Note 1)				

Note 1: n must be less than or equal to 39. No more than 32 receiver 16-bit words of RTCM data should be delivered to the receiver with any one message.

Word Description	Number of Words
Header	4
Header Checksum	1
Reserved (Sequence Number)	1
RTCM Data	≤32
Data Checksum	1
Maximum number of words	≤39

Note 2: Raw demodulated data must conform to the “6 of 8” format described in the RTCM SC-104 standard. The data must also be packed into one or more 16-bit words and should be ordered chronologically from earliest to latest. Specifically, Word 7 should represent the earliest data and Word n-1 should represent the latest.

Within each word, the most significant bit (bit 15) should represent the latest received bit and the least significant bit (bit 0) should represent the earliest received bit. (Note that according to RTCM “6 of 8” format, bits 6 and 14 should be set marking (1) and bits 7 and 15 should be set spacing (0) for each word.) The intent of this bit ordering is to allow the user to pass on the raw RTCM data without modification. Faw, RTCM data received as a sequence of bytes should be stored in the data words filling the LSB first, then the MSB.

2.2.46 Frequency Standard Table Input Data (Message 1360). This message allows the user to input the parameters and table data used in the receiver's frequency standard compensation model. It is intended that this message will be used in conjunction with Message 1160 to retrieve and restore this information for external storage. The contents of the Frequency Standard Table Input Data Message are described in Table 2-109.

Table 2-109. Message 1360: Frequency Standard Table Input Data Message

Message ID:	1360				
Rate:	As required - maximum rate 1 Hz				
Message Length:	268 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Table Frequency Offset (Note 1)	I	ppm	±51	0.15
8.0	Table Frequency Offset Valid (Note 2)	Bit		1 = valid	
8.1-8.15	Reserved				
9	Offset Error Estimate (Note 3)	I	ppm	±51	2×10^{-2}
10	Aging Rate Estimate (Note 4)	I	ppm/yr	±5	2×10^{-4}
11	Last Rate Update Week (Note 5)	I	weeks	0 to 32767	
12-267	Frequency Standard Table (Note 6): LSB MSB	 UI (byte) I (byte)	 weeks ppm	 0 to 1020 ±19.05	 4 0.15
268	Data Checksum				

Note 1: Each value of frequency error in the table shares this common offset value.

Note 2: Flag to indicate that the offset has not been established.

Note 3: Filtered estimate of accumulated error in the table offset value.

Note 4: Filtered estimate of the current aging rate.

Note 5: Whole week number of the last update of the aging rate.

Note 6: LSB = the approximate time of last table entry update. MSB = the frequency error at each table temperature, less the table offset.

2.2.47 Frequency Standard Drift Compensation Parameters (Message 1361). This message ***** TBD definition *****. The contents of the Frequency Standard Drift Compensation Parameters Message are described in Table 2-110.

Table 2-110. Message 1361: Frequency Standard Drift Compensation Parameters Message

Message ID:	1361 (**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)				
Rate:	As required - maximum rate 1 Hz				
Message Length:	13 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	Temperature	I			
8	Drift Error	I	sec/sec	$\pm 2^{-14}$	2^{-29}
9	Drift Error Standard Deviation	UI	sec/sec	$\pm 2^{-16}$	2^{-32}
10	Drift Slope	I			
11	Slope Standard Deviation	UI			
12	Temperature Slope	I	counts/min		
13	Data Checksum				

2.2.48 DR Speed Measurement Input (Message 1370). This message is used to initialize the DR speed parameters for the DR system. The contents of the DR Speed Measurement Input Message are described in 2-111.

Table 2-111. Message 1370: DR Speed Measurement Input Message

Message ID:	1370				
Rate:	Variable; nominal 10 Hz				
Message Length:	10 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7	DR Speed	UI	m/s	0 to 65535	10^{-2}
8	DR Speed TIme Tag (Note 1)	UI		0 to 65535	
9.0	Backup Status (Note 2)	Bit		1 = backing up	
9.1-9.15	Reserved				
10	Data Checksum				

Note 1: This word contains the offset time since the last GPS Time Mark as recorded when the speed data was received from the measurement source. The units and resolution depend on the value of DR Speed Data Time Tag Resolution from the DR Initialization Message (message 1270). The measurement source could be a car, bus, a wheel tick counter, or other arrangements.

Note 2: Indicates when the automobile is in reverse (backing up). The backup status is latched as close as possible to the time the DR Speed Time Tag is latched.

2.2.49 Flash Reprogram (Message 1380). This message is used only in the Jupiter Flash board to force the receiver into the Reprogram Flash mode. When a Flash receiver is first powered on, or when it is reset, the boot loader software, stored in the first 0x2000 program words, sets the host port protocol to Conexant binary at 9600 baud, no parity, 8 data bits, and 1 stop bit. It then looks for a Message 1380 in the host port. If one is found, the boot loader enters the Flash reprogram protocol. If no 1380 message is found, the port is set to the correct protocol and communications setting, and the regular receiver software is started. The contents of the Flash Reprogram Message are described in Table 2-112.

Table 2-112. Message 1380: Flash Reprogram Message

Message ID:	1380				
Rate:	As required				
Message Length:	7 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Request Flag	Boolean		0 = false ±0 → true	
7	Data Checksum				
Note: This message does not provide the Sequence Number as Word 6.					

2.2.50 Hardware Accelerator Command Input (Message 1390). This message is used to set up the Hardware Accelerator's operational parameters. The contents of the Hardware Accelerator Command Input Message are described in Table 2-113.

Table 2-113. Message 1390: Hardware Accelerator Command Input Message

Message ID:	1390	**(ONLY AVAILABLE IN HARDWARE ACCELERATOR BUILDS)**			
Rate:	Variable				
Message Length:	75 words				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	I		0 to 32767	
7.0	Doppler Parameters Are Valid (Note 1)	Bit		1 = valid	
7.1	Code Phase Parameters Are Valid (Note 2)	Bit		1 = valid	
7.2	GPS XO Parameters Are Valid (Note 3)	Bit		1 = valid	
7.3	GPS Reference Time is Valid (Note 4)	Bit		1 = valid	
7.4	Force Acquisition of New Receiver Samples	Bit		1 = force new acquisition	
7.5	Enable Low C/NO Operation	Bit		1 = enable	
7.6	Continuous Tracking Mode is Valid	Bit		1 = valid	
8-9	GPS Reference Time Integer (Note 4)	UDI	seconds	0 to 604799	
10-11	GPS Reference Time Fraction (Note 4)	UDI	ns	0 to 999999999	10^{-9}
12	XO Error (Note 3)	I	ppm	–327.68 to +327.67	10^{-2}
13	XO Error Uncertainty (Note 3, 5)	UI	ppm	0 to 65535	10^{-2}
14	Number of Visible Satellites (Note 6)	I		0 to 32	
Satellite Data (n = 0 to 11)					
15 + n*5	Satellite PRN (Note 7)	I		0 to 32	
16 + n*5	Doppler (Note 1)	I	Hz	–327.68 to +327.67	2×10^{-1}
17 + n*5	Dopper Uncertainty (Note 1, 5)	UI	Hz	0 to 6553.5	10^{-1}
18 + n*5	Code Phase (Note 2)	UI	C/A chips	0 to 1022	
19 + n*5	Code Phase Uncertainty (Note 2, 5)	UI	C/A chips	0 to 1023	
75	Data Checksum				

Note 1: When bit 7.0 is set, the Doppler and Doppler uncertainty parameters contain valid data. Otherwise, their contents can be ignored.

Note 2: When bit 7.1 is set, the Code Phase and Code Phase uncertainty parameters contain valid data. Otherwise, their contents can be ignored.

Note 3: When bit 7.2 is set, the XO Error and XO Error uncertainty parameters contain valid data. Otherwise, their contents can be ignored.

Note 4: When bit 7.3 is set, the GPS Reference Time integer and GPS Reference Time fraction parameters contain valid data. Otherwise, their contents can be ignored.

Note 5: Uncertainty values are entered as positive numbers. Value is applied as a ± range.

Note 6: Limited by command buffer size in the Measurement Engine/Navigation Engine interface. Specifies the maximum number of satellites to search for in one search effort. May exceed the number of satellites actually visible. If the value of this word is less than 12, some of the data blocks that follow will not contain data.

Note 7: A value of zero indicates no satellite is being reported in this block and all of the following words in this block, through Code Phase uncertainty, do not contain valid data. The Hardware Accelerator can generate all Gold codes from the GPS set including WAAS codes. Future implementations could expand the range of valid values accordingly.

2.2.51 OEM Custom Input Message (Message 1400). This message is provided in special builds for OEM customers to permit them to receive input data without having to take over the entire binary message queue. When this message is enabled in the OEM build and the message is received by the receiver, it will be handed off to the OEM process for its actions. For compatibility with the rest of the message system, the Message Header, Header Checksum, Sequence Number and Data Checksum must conform to the same standards as other input messages. The contents of the OEM Custom Input Message are described in Table 2-114.

Table 2-114. Message 1400: OEM Custom Input Message

Message ID:	1400				
Rate:	Variable				
Message Length:	Varies with OEM specifications				
Word No.:	**Name:**	**Type:**	**Units:**	**Range:**	**Resolution:**
1-4	Message Header				
5	Header Checksum				
6	Sequence Number	UI		0 to 65535	
7	Sub Type	I		0 to 32767	
8	Data Size (Note 1)	I		0 to 32767	
9 to N - 1	Data Words (format and contents under OEM control)	UI		0 to 65535	
N	Data Checksum	UI			
Note 1:	Data size specifies the number of 16-bit words including the Sequency Number, Sub Type, Data Size and Data Words. In an N word message, Data size will be specified as N – 6.				

3 ZODIAC NMEA DATA MESSAGES

This section describes the National Marine Electronics Association (NMEA) data messages of the Zodiac GPS receiver. All of the output and input NMEA mesages are listed in Table III-1 together with their corresponding message IDs. Power-up default messages are also identified.

NMEA mode is selected according to the logic described in the hardware interface section of the *Zodiac GPS Receiver Family Designer's Guide*. NMEA messages are transmitted and received across the host port serial I/O interface (RS-232) with the following default communications parameters:

- 4800 bps
- 8 data bits
- no parity
- 1 stop bit

This interface conforms with the NMEA-0183, version 2.01, specification. All of the output NMEA messages are described in detail in section 3.1. All of the input NMEA messages are described in detail in section 3.2.

Table 3-1. Zodiac NMEA Data Messages

Output Message Name	Message ID	Used in Current S/W Configuration
Conexant Proprietary Altitude	ALT	
Conexant Proprietary Built-In Test Results	BIT	yes
Conexant Proprietary Error/Status	ERR	yes
GPS Fix Data (Note 1)	GGA	yes
Geographic Position - Latitude/Longitude	GLL	
GPS DOP and Active Satellites (Note 1)	GSA	yes
GPS Satellites in View (Note 1)	GSV	yes
Conexant Proprietary Receiver ID (Note 1)	RID	yes
Recommended Minimum Specific GPS Data (Note 1)	RMC	yes
Course Over Ground and Ground Speed	VTG	yes
Conexant Proprietary Zodiac Channel Status (Note 1)	ZCH	yes
Time and Date (Note 1)	ZDA	yes (3.01 and up)
Input Message Name	**Message ID**	
Proprietary OEM Input Message	CNXT	yes (3.01 and up)
Proprietary Built-In Test Command	IBIT	yes
Proprietary Log Control Message	ILOG	yes
Proprietary Receiver Initialization	INIT	yes
Proprietary Protocol	IPRO	yes
Standard Query Message	Q	yes
Note 1: Power-up default message for a GPS board-level product and a GPS chip set with Navigation Engine and Measurement Engine capability.		

3.1 Proprietary NMEA Messages

3.1.1 The NMEA message protocol provides a means for equipment manufacturers to create proprietary messages to support the unique requirements of their equipment. SiRF has implemented several such messages in the Zodiac. The Zodiac chipset was developed by Rockwell Semiconductor Systems, who then were spun off to become Conexant, which then was transferred to SiRF Technoloty, Inc. As a result, there multiple proprietary names used in the software. Here is the standard format description of the first field that applies to most proprietary messages in the Zodiac software.

$	First symbol in all NMEA messages
P	Proprietary message
RWI	3-character code assigned to Rockwell Semiconductor Systems. Some messages use CNXT rather than RWI
xxx	Message name (example: RID)

Example of the RID message:

$PRWIRID,[fields that follow contain the specific information defined for this message]

3.2 Output Message Descriptions

3.2.1 Conexant Proprietary Altitude (ALT). This message contains mean sea level (MSL) altitude and geoidal separation. Geoidal separation is the difference between the WGS-84 Earth ellipsoid and MSL (i.e., MSL altitude equals WGS-84 altitude plus geoidal separation).

The contents of the ALT Message are described in Table 3-2.

Table 3-2. ALT Message: Conexant Proprietary Altitude

Message ID:	ALT	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)		
Rate:	Variable			
Fields:	4			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _ _ _ALT	Start of sentence and address field		$PRWIALT
1	ALT_MSL	Antenna Altitude Above/Below Mean Sea Level (geoid)	x.x	28.9
2	M	Units of Antenna Altitude (meters)	M	M
3	GEOID_SEP	Geoidal Separation	x.x	-34.4
4	M	Units of Geoidal Separation (meters)	M	M
	CKSUM	Checksum	*hh	*68
	<CR><LF>	Sentence terminator		<CR><LF>

Sample Message:

```
$PRWIALT,28.9,M,-34.4,M*68
```

3.2.2 Conexant Proprietary Built-In Test (BIT) Results (BIT). This proprietary message provides detailed test results when a BIT is commanded. Non-zero device failure status indicates failure. See Conexant binary Message 1100 for a detailed interpretation of tests and failure reports.

The contents of the BIT Message are described in Table 3-3.

Table 3-3. BIT Message: Conexant Proprietary Built-In Test (BIT) Results Message

Message ID:	BIT			
Rate:	Variable			
Fields:	11			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PRWIBIT	Start of sentence and address field (Note 1)		$PRWIBIT
1	ROM_FAIL	ROM Failure (Note 2)	hhhh	0001
2	RAM_FAIL	RAM Failure (Note 2)	hhhh	0000
3	EEP_FAIL	EEPROM Failure (Note 2)	hhhh	0000
4	DPR_FAIL	Dual Port RAM and Magna Failure (Note 3)	hhhh	0000
5	DSP_FAIL	Digital Signal Processor (DSP) Failure (Note 2)	hhhh	0000
6	RTC_FAIL	Real-Time Clock (RTC) Failure (Note 2)	hhhh	0000
7	SP1-ERR	Serial Port 1 Receive Error Count	x.x	0
8	SP2_ERR	Serial Port 2 Receive Error Count	x.x	0
9	SP1_RCV	Serial Port 1 Receive Character Count	x.x	15
10	SP2_RCV	Serial Port 2 Receive Character Count	x.x	640
11	SW_VER	Software Version	x.x	01.02
	CKSUM	Checksum	*hh	*75
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: $ = NMEA message prefix
P = Proprietary message indicator
RWI = Conexant Systems, Inc. mnemonic
BIT = BIT Results message ID

Note 2: A value of zero indicates a test has passed. A non-zero value indicates a device failure. Missing devices will be reported as failures. Therefore, the OEM's BIT pass/fail should ignore words for components that are not in the system under test.

Note 3: Test results from dual-port RAM and the Magna Hardware Accelerator are both reported in this word. Results are interpreted as follows:

Results	Meaning
0	No failure
1	Dual-port RAM failed or absent (*****)
2	Magna Hardware Accelerator failed or absent
3	Both dual-port RAM and Magna failed or absent (*****)

(*) The dual-port RAM test is currently not implemented. These values will not be reported.

Sample Message:

```
$PRWIBIT,0001,0000,0000,0000,0000,0000,0,0,15,640,01.02*75
```

3.2.3 Conexant Proprietary Error/Status (ERR). This message provides diagnostic information if the receiver encounters an error during execution of its firmware.

The contents of the ERR Message are described in Table 3-4.

Table 3-4. ERR Message: Conexant Proprietary Error/Status Message

Message ID	ERR			
Rate:	Variable			
Fields:	3			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _ _ _ERR	Start of sentence and address field		$PRWIERR
1		Class: 0 = User mode exception 1 = Executive mode exception 2 = Trap 3 = Executive error 4 = ESR error 5 = User error	x.x	0
2		Exception, Trap, or Error Number	x.x	0
3		Word Address of Condition	hhhhhh	005BC9
	CKSUM	Checksum	*hh	*01
	<CR><LF>	Sentence terminator		<CR><LF>

Sample Message:
`$PRWIERR,0,0,005BC9*01`

3.2.4 GPS Fix Data (GGA). This message contains time, position, and fix related data for the Zodiac receiver. When a navigation solution passes all of the validity criteria (set using the binary Solution Validity Criteria message), a GGA message is generated automatically. Otherwise, if any of the validity criteria are invalid for the solution, a GGA message is not generated.

The contents of the GGA Message are described in Table 3-5.

Table 3-5. GGA Message: GPS Fix Data Message

Message ID:	GGA (while receiver is in Navigation Mode – Note 1)			
Rate:	Variable; defaults to 1 Hz			
Fields:	14			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _GGA	Start of sentence and address field		$GPGGA
1	POS_UTC	UTC of Position (hours, minutes, seconds, decimal seconds)	hhmmss.ss	222435
2	LAT	Latitude	llll.ll	3339.7334
3	LAT_REF	Latitude Direction (N = north, S = south)	a	N
4	LON	Longitude	yyyyy.yy	11751.7598
5	LON_REF	Longitude Direction (E = east, W = west)	a	W
6	GPS_QUAL	GPS Quality Indicator (Note 2)	x	2
7	NUM_SATS	Number of Satellites in Use, 00 to 12 (may be different from the number in view)	xx	06
8	HDOP	Horizontal Dilution of Precision (HDOP)	x.x	1.33
9	ALT_MSL	Antenna Altitude Above/Below Mean Sea Level (geoid) (Note 3)	x.x	27.0
10	M	Units of Antenna Altitude (meters)	M	M
11	GEOID_SEP	Geoidal Separation (Note 4)	x.x	-34.4
12	M	Units of Geoidal Separation (meters)	M	M
13	DGPS_AGE	Age of Differential GPS Data (Note 5)	x.x	7
14	STA_ID	Differential Reference Station ID (0000 to 1023) (Note 6)	xxxx	0000
	CKSUM	Checksum	*hh	*41
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: When the the navigation solution is invalid, fields 1 through 5 and 8 through 14 are null. Field 7 also has special meaning (see Note 3).

Note 2: GPS quality indicator:

0 = Fix not available or invalid
1 = GPS fix
2 = Differential GPS fix

Note 3: The geodetic altitude can be computed from the mean sea level altitude by adding the geoidal separation (word 11).

Note 4: Geoidal separation is the difference between the WGS-84 Earth ellipsoid and mean sea level (geoid).

Note 5: Time in seconds since the last SC104 Type 1 or Type 9 update; null field when DGPS is not used.

Note 6: This field is null when DGPS is not used.

Sample Message:

```
$GPGGA,222435,3339.7334,N,11751.7598,W,2,06,1.33,27.0,M,-34.4,M,7,0000*54
```

3.2.5 Geographic Position - Latitude/Longitude (GLL). This message contains the latitude and longitude of the present vessel position, the time of position, the fix, and the status.

The contents of the GLL Message are described in Table 3-6.

Table 3-6. GLL Message: Geographic Position - Latitude/Longitude Message

Message ID:	GLL	(**THIS MESSAGE IS NOT USED IN THE CURRENT SOFTWARE CONFIGURATION**)		
Rate:	Variable			
Fields:	6			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _GLL	Start of sentence and address field		$GPGLL
1	LAT	Latitude	llll.ll	3339.7332
2	LAT_REF	Latitude direction (N = north, S = south)	a	N
3	LON	Longitude	yyyyy.yy	11751.7598
4	LON_REF	Longitude Direction (E = east, W = west)	a	W
5	POS-UTC	UTC of Position (hours, minutes, seconds, decimal seconds)	hhmmss.ss	185203
6	DTA_STAT	Data Status (A = data valid, V = data invalid)	a	A
	CKSUM	Checksum	*hh	*3A
	<CR><LF>	Sentence terminator		<CR><LF>

Sample Message:

```
$GPGLL,3339.7332,N,11751.7598,W,185203,A*3A
```

3.2.6 GPS DOP and Active Satellites (GSA). This message contains the Zodiac receiver's operating mode, satellites used for navigation, and DOP values.

The contents of the GSA Message are described in Table 3-7.

Table 3-7. GSA Message: GPS DOP and Active Satellites Message

Message ID:	GSA			
Rate:	Variable			
Fields:	17			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _GSA	Start of sentence and address field		$GPGSA
1	OP_MODE	Mode (Note 1)	a	A
2	FIX_MODE	Mode (Note 2)	x	3
3-14	SATN	PRNs of Satellites Used in Solution (null for unused fields)	xx,xx,....	04, 16, 09, 24, ...
15	PDOP	Position Dilution of Precision (PDOP) (Note 3)	x.x	3.33
16	HDOP	Horizontal Dilution of Precision (HDOP) (Note 3)	x.x	1.96
17	VDOP	Vertical Dilution of Precision (VDOP) (Note 3)	x.x	2.70
	CKSUM	Checksum	*hh	*06
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: Mode (operating):

M = Manual, forced to operate in 3-D mode
A = Automatic, allowed to automatically switch between 2-D and 3-D

Note 2: Mode (fix):

1 = Fix not available
2 = 2-D
3 = 3-D

Note 3: DOPs are based on the set of satellites above the elevation mask angle, which may not be the same set as that used for navigation.

Sample Message:

```
$GPGSA,A,3,04,16,09,24,,,,,,,,,3.33,1.96,2.70*06
```

3.2.7 GPS Satellites in View (GSV). This message contains the number of satellites in view, PRN numbers, elevation, azimuth, and Signal-to-Noise Ratio (SNR) values. Each transmission identifies up to four satellites maximum; additional satellite data is sent in a second or third message. The total number of messages being transmitted and the number of the message being transmitted is indicated in the first two fields.

The contents of the GSV Message are described in Table 3-8.

Table 3-8. GSV Message: GPS Satellites in View Message

Message ID:	GSV			
Rate:	Variable; defaults to 0.5 Hz			
Fields:	19			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _GSV	Start of sentence and address field		$GPGSV
1	MAX_MSG	Total Number of Messages (1 to 3)	x	2
2	NUM_MSG	Message Number (1 to 3)	x	1
3	NUM_SATS	Total Number of Satellites in View	xx	07
4	SAT_PRN	Satellite PRN Number (Note 1)	xx	24
5	ELEV	Elevation in Degrees (90 degrees maximum) (Note 2)	xx	60
6	AZ	Azimuth in True Degrees (000 to 359) (Note 2)	xxx	216
7	SNR	SNR (C/NO) 00 to 99 dB, null when not tracking	xx	50
8-11	...	2nd Satellite PRN Number, Elevation, Azimuth, SNR (Note 1)	xx, xx, xxx, xx	...
12-15	...	3rd Satellite PRN Number, Elevation, Azimuth, SNR (Note 1)	xx, xx, xxx, xx	...
16-19	...	4th Satellite PRN Number, Elevation, Azimuth, SNR (Note 1)	xx, xx, xxx, xx	...
	CKSUM	Checksum	*hh	*75
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: The visible satellites may include one or more that are below the horizon. Since NMEA does not account for negative elevation angles, the elevation field will be null for these satellites.

Note 2: Azimuth and elevation are null when the satellite is in track, but a visible list is not available.

Sample Message:

```
$GPGSV,2,1,07,24,60,216,50,20,47,135,47,12,40,020,47,16,36,319,46*75
```

3.2.8 Conexant Proprietary Receiver ID (RID). This message is output automatically at startup after the receiver has completed its initialization. It can be used to determine when the receiver is ready to accept serial input. Manual requests for this message are also honored.

The contents of the RID Message are described in Table 3-9.

Table 3-9. RID Message: Conexant Proprietary Receiver ID Message

Field No.:	Symbol:	Field Description:	Field Type:	Example:
Message ID:	RID			**(MODIFIED IN v2.69 AND LATER)**
Rate:	Variable (see above)			
Fields:	5			
	$_ _ _ _RID	Start of sentence and address field		$PRWIRID
1	NUM_CHN	Number of Channels	xx	12
2	SW_VER	Software Version	x.x	00.90
3	SW_DATE	Software Date	cccccccc	12/25/95
4	OPT_LST	Options List (Note 1)	hhhh	0003
5	OEM_VER	OEM Version Information (Note 2)	hhhh hhhh mm/dd/yyyy	0000 0001 01/31/2000
	CKSUM	Checksum	*hh	*40
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: The options list is a bit-encoded configuration word represented as a four-digit hexadecimal number:

bit 0 minimize ROM usage
bit 1 minimize RAM usage
bits 2-15 reserved

Note 2: From version 2.69 and up, this field is used to report OEM version and subversion numbers, and OEM software date. Refer to Message 1011, words 49-53, for a complete description of these values, along with information on setting them through the OEM Application Programming Interface (API).

Sample Message:

```
$PRWIRID,12,00.90,12/25/95,0003,0000 0001 01/31/2000*40
```

3.2.9 Recommended Minimum Specific GPS Data (RMC). This message contains time, date, position, course, and speed data. The fields in this message will always contain data even when the receiver is not navigating. This allows user-initialized, stored, or default values to be displayed before a solution is obtained

The contents of the RMC Message are described in Table 3-10.

Table 3-10. RMC Message: Recommended Minimum Specific GPS Data Message

Message ID:	RMC			
Rate:	Variable; defaults to 1 Hz			
Fields:	11			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _RMC	Start of sentence and address field		$GPRMC
1	POS_UTC	UTC of Position (hours, minutes, seconds, decimal seconds)	hhmmss.ss	185203
2	POS_STAT	Position Status (A = data valid, V = data invalid) (Note 1)	a	A
3	LAT	Latitude	llll.ll	3339.7332
4	LAT_REF	Latitude Direction (N = north, S = south)	a	N
5	LON	Longitude	yyyyy.yy	11751.7598
6	LON_REF	Longitude Direction (E = east, W = west)	a	W
7	SPD	Speed Over Gground (knots)	x.x	0.000
8	HDG	Heading/Track Made Good (degrees True)	x.x	121.7
9	DATE	Date (dd/mm/yy)	xxxxxx	160496
10	MAG_VAR	Magnetic Variation (degrees)	x.x	13.8
11	MAG_REF	Magnetic Variation (E = east, W = west) (Note 2)	a	E
	CKSUM	Checksum	*hh	*55
	<CR><LF>	Sentence terminator		<CR><LF>
Note 1:	The position status flag will be set to “V” (data invalid) until the receiver is navigating. At that time, the flag is changed to “A” (data valid) and the information provided in the RMC message will reflect a navigation solution.			
Note 2:	Easterly variation (E) subtracts from True course. Westerly variation (W) adds to True course.			

Sample Message:

```
$GPRMC,185203,A,3339.7332,N,11751.7598,W,0.000,121.7,160496,13.8,E*55
```

3.2.10 Course Over Ground and Ground Speed (VTG). This message contains the course over ground (true and magnetic) and speed relative to the ground.

The contents of the VTG Message are described in Table 3-11.

Table 3-11. VTG Message: Course Over Ground and Ground Speed Message

Message ID:	VTG (while receiver is in Navigation Mode -- Note 1)			
Rate:	Variable			
Fields:	8			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _VTG	Start of Sentence and Address Feld		$GPVTG
1	TRU_CRS	Course Over Ground, Degrees True	x.x	291.3
2	T	True Course Indicator	T	T
3	MAG_CRS	Course Over Ground, Degrees Magnetic	x.x	277.3
4	M	Magnetic Course Indicator	M	M
5	SPD_N	Speed Over the Ground (knots)	x.x	0.784
6	N	Nautical Speed Indicator (N = knots)	N	N
7	SPD_K	Speed (kilometers)	x.x	1.452
8	K	Speed Indicator (K = km/hr)	K	K
	CKSUM	Checksum	*hh	*4F
	<CR><LF>	Sentence terminator		<CR><LF>
Note 1: Output of this message is temporarily suppressed while the receiver is in Acquisition Mode.				

Sample Message:

```
$GPVTG,291.3,T,277.3,M,0.784,N,1.452,K*4F
```

3.2.11 Conexant Proprietary Zodiac Channel Status (ZCH). This message complements the GSV message by providing satellite-to-channel mapping and a status indication for each channel.

The contents of the ZCH Message are described in Table 3-12.

Table 3-12. ZCH Message: Conexant Proprietary Zodiac Channel Status Message

Field No.:	Symbol:	Field Description:	Field Type:	Example:
Message ID:	ZCH			
Rate:	Variable; defaults to 1 Hz			
Fields:	24			
	$_ _ _ _ZCH	Start of sentence and address field		$PRWIZCH
1-2	SAT_PRN	Channel 1 Satellite PRN number (Note 1)	xx	05
2	STATUS	Channel 1 Status indication (Note 1)	hh_ _	F
3-4	...	Channel 2 Satellite PRN Nnumber and Status Indication	xx,hh_ _	...
5-6	...	Channel 3 Satellite PRN Number and Status Indication	xx,hh_ _	...
7-8	...	Channel 4 Satellite PRN Number and Status iIndication	xx,hh_ _	...
9-10	...	Channel 5 Satellite PRN Number and Status Indication	xx,hh_ _	...
11-12	...	Channel 6 Satellite PRN Number and Status Indication	xx,hh_ _	...
13-14	...	Channel 7 Satellite PRN Number and Status Indication	xx,hh_ _	...
15-16	...	Channel 8 Satellite PRN Number and Status Indication	xx,hh_ _	...
17-18	...	Channel 9 Satellite PRN Number and Status Indication	xx,hh_ _	...
19-20	...	Channel 10 Satellite PRN Number and Status iIndication	xx,hh_ _	...
21-22	...	Channel 11 Satellite PRN Number and Status Indication	xx,hh_ _	...
23-24	...	Channel 12 Satellite PRN Number and Status Indication	xx,hh_ _	...
	CKSUM	Checksum	*hh	*37
	<CR><LF>	Sentence terminator		

Note 1: Channel number (xx) is implied by position in message. Data for all 12 channels is always provided in this message. If a channel is unused, a value of 0 will appear for both channel fields. The status indication (hh_ _) is a one-digit, hexadecimal value which represents four bits as follows:

<y.0> Measurement of the satellite on this channel used in navigation solution.
<y.1> Ephemeris available for the satellite on this channel.
<y.2> Satellite on this channel is in track.
<y.3> DGPS corrections available for the satellite on this channel (NOTE: this bit will never be set whenever the configuration of a particular Zodiac GPS receiver does not support DGPS).

Sample Message:

```
$PRWIZCH,05,F,20,F,04,F,09,F,16,F,06,F,07,6,00,0,24,F,00,0,00,0,00,0*37
```

3.2.12 Time and Date (ZDA). This message contains the UTC time, day, month, year, and local time zone.

The contents of the ZDA Message are described in Table 3-13.

Table 3-13. ZDA Message: Time and Date Message

Message ID:	ZDA			
Rate:	Variable			
Fields:	6			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _ZDA	Start of sentence and address field		$GPZDA
1	TIME	UTC Time (hours, minutes, seconds, decimal seconds)	hhmmss.ss	234219.24
2	DAY	Day (01 to 31)	xx	18
3	MONTH	Month (01 to 12)	xx	05
4	YEAR	Year	xxxx	1994
5	ZONE_HR	Local Zone Description (Note 1) (Note 3)	xx	00
6	ZONE_MIN	Local Zone Minutes Description (Note 2) (Note 3)	xx	00
	CKSUM	Checksum	*hh	*66
	<CR><LF>	Sentence terminator		

Note 1: Zone description is the number of whole hours (00 to ±13 hours) added to local time to obtain Greenwich Mean Time (GMT). Zone description is negative for East longitudes.

Note 2: Local zone minutes have the same sign as local hours.

Note 3: Local time zones are not currently supported. This field is always zero.

Sample Message:

```
$GPZDA,234219.24,18,05,1994,00,00*66
```

3.3 Input Message Descriptions

3.3.1 Conexant Proprietary OEM Custom Input Message. This proprietary message is provided in certain OEM builds to allow OEM customers to implement custom imput messages without the need to take over the complete NMEA message processing functions. The contents of the OEM Custom Input Message are described in Table 3-14.

Table 3-14. Conexant Proprietary OEM Custom Input Message

Message ID:	CNXT			
Rate:	As required			
Fields:	As defined by OEM User			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	SIZE	Number of 16-bit data fields that follow.	xx	6
2 - N	DATA	OEM-Defined Data	hhhh	7C25
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>
Note 1:	$ = NMEA message prefix P = Proprietary message indicator CNXT = Conexant Proprietary Code			

Sample Message:

```
$PCNXT,3,43B7,5219,C3BA*2F
```

3.3.2 Conexant Proprietary Built-In Test (BIT) Command Message (IBIT). This proprietary message instructs the receiver to immediately execute its BIT. Results of the BIT are available in the Conexant Proprietary Built-In Test Results message. The data field is reserved and should be left null.

The contents of the IBIT Message are described in Table 3-15.

Table 3-15. IBIT Message: Conexant Proprietary Built-In Test (BIT) Command Message

Message ID:	IBIT			
Rate:	As required			
Fields:	1			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PRWIIBIT	Start of sentence and address field (Note 1)		$PRWIIBIT
1	RES	Reserved		
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>
Note 1: $ = NMEA message prefix P = Proprietary message indicator RWI = Conexant Systems, Inc. mnemonic IBIT = BIT command message ID				

Sample Message:

```
$PRWIIBIT,
```

3.3.3 Conexant Proprietary Log Control Message (ILOG). This proprietary message controls the output of the Zodiac receiver's NMEA messages.

The contents of the ILOG Message are described in Table 3-16.

Table 3-16. ILOG Message: Conexant Proprietary Log Control Message

Message ID:	ILOG			
Rate:	As required			
Fields:	5			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PRWIILOG	Start of sentence and address field (Note 1)		$PRWIILOG
1	MSG_ID	Approved sentence formatter of the data being requested (Note 2)	ccc	RMC
2	ENABLE	Output enable flag (A = enable, V = disable) (Note 3)	a	A
3	TRIG	Output trigger (T = on time, U = on update) (Note 4)	a	T
4	INTERVAL	Output interval (seconds, 0 = once) (Note 4)	x.x	5
5	OFFSET	Initial output offset (seconds from minute mark) (Note 4)	x.x	0
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: $ = NMEA message prefix
P = Proprietary message indicator
RWI = Conexant Systems, Inc. mnemonic
ILOG = Log control message ID

Note 2: A special form of this field disables all output messages. Use "???" as the message ID as in the following example:

```
$PRWIILOG,???,V,,,
```

Note 3: This field may be null to indicate that the previous setting should be left unchanged.

Note 4: The TRIG, INTERVAL, and OFFSET fields may be null to indicate that the previous setting should be left unchanged. Interval and Offset fields only affect outputs triggered on Time. When output is triggered by update, the message will be output when the receiver actually updates the information in the specified message. Output on Update is recommended for data which is prepared at potentially irregular intervals, such as satellite visibility (GSV message) and error status (ERR message). For regular information, such as position, course and speed, and channel status, we recommend output on Time.

Sample Message:

```
$PRWIILOG,RMC,A,T,5,0
```

3.3.4 Conexant Proprietary Receiver Initialization Message (INIT). This proprietary message commands the Zodiac receiver to perform a reset, modify its operating mode, or reinitialize itself using specified parameters.

The contents of the INIT Message are described in Table 3-17.

Table 3-17. INIT Message: Conexant Proprietary Receiver Initialization Message

Message ID:	INIT			
Rate:	As required			
Fields:	14			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PRWIINIT	Start of sentence and address field (Note 1)		$PRWIINIT
1	RESET	Software reset flag (A = reset, V = don't reset) (Note 2)	a	V
2	RES_1	Reserved		
3	RES_2	Reserved		
4	LAT	Latitude (Note 2)	llll.lll	3339.650
5	LAT_REF	Latitude direction (N = north, S = south) (Note 2)	a	N
6	LON	Longitude (Note 2)	yyyyy.yy	11751.680
7	LON_REF	Longitude direction (E = east, W = west) (Note 2)	a	W
8	ALT	Altitude (meters) (Note 2)	x.x	64.131
9	SPD	Ground speed (Note 2)	x.x	0.0
10	SPD_TYP	Ground speed units (M = m/sec, N = knots, K = km/hr) (Note 2)	a	M
11	HDG	Heading (0.0 to 360.0 degrees north) (Note 2)	x.x	0.0
12	HDG_TYP	Heading type (T = true, M = magnetic) (Note 2)	a	T
13	TIME	UTC time (hours, minutes, seconds) (Note 2)	hhmmss	162338
14	DATE	UTC date (Note 2)	ddmmyy	190594
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message indicator
RWI = Conexant Systems, Inc. mnemonic
INIT = Initialization message ID

Note 2: This function is enabled by default.

Each of the fields 1 through 14 may be null to indicate that the previous setting for the data item should be left unchanged. For example, reset may be commanded without specifying the other parameters by issuing the following command:

```
$PRWIINIT,A,,,,,,,,,,,,,<CR><LF>
```

When using null fields, the following restrictions apply:

If a supplied parameter has a corresponding unit specifier or reference indicator, it must also be supplied.

Both latitude and longitude must be provided to specify a valid horizontal position.

Both ground speed and heading must be provided to specify a valid horizontal velocity.

If a magnetic heading is specified, horizontal position (lat/lon), and UTC time and date must also be provided.

UTC time and date must be provided together.

Sample Message:

```
$PRWIINIT,V,,,3339.650,N,11751.680,W,64.131,0.0,M,0.0,T,162338,190594
```

3.3.5 Conexant Proprietary Protocol Message (IPRO). This proprietary message allows the user to set the message format protocol which will be used to communicate information to and from the receiver through the host serial I/O port. Currently, the available protocols are binary (with fixed-point numbers) and NMEA-0183. Storage for the Protocol Type parameter requires EEPROM.

The contents of the IPRO Message are described in Table 3-18.

Table 3-18. IPRO Message: Conexant Proprietary Protocol Message

Message ID:	IPRO			
Rate:	As required			
Fields:	2			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PRWIIPRO	Start of sentence and address field		$PRWIIPRO
1	RES	Reserved		
2	PRO_TYPE	Protocol Type (RBIN = Conexant binary)	cccc	RBIN
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>

Sample Message:
`$PRWIIPRO,,RBIN`

3.3.6 Query Sentences. Query sentences are used to request data in the form of approved sentences from the originator of data (the “talker”) across a NMEA interface. The approved query sentence contains the following elements, in the order shown:

- “$” Start of the sentence (0x24)
- <aa> Talker identifier of the requester
- <aa> Talker identifier for the device from which the data is being requested
- “Q” Query character identifies the query address
- “,” Data field delimiter
- <ccc> Approved sentence formatter of data being requested (see Table 3-1)
- [“*”<checksum field>] Optional checksum field
- <CR><LF> End of sentence delimiter (0x0D 0A)

3.3.6.1 Standard Query Message (Q). This message is used to request a one-time output of any of the approved NMEA messages from the Zodiac receiver. The typical response time between receipt of a query and the transmission of the requested message is approximately one second.

The contents of the Q Message are described in Table 3-19.

Table 3-19. Q Message: Standard Query Message

Message ID: Q				
Rate: As required				
Fields: 1				
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$_ _ _ _ Q	Start of sentence and address field (Note 1)		$LCGPQ
1	MSG_ID	Approved sentence formatter of the data being requested (Note 2)	ccc	GSV
	CKSUM	Checksum (optional)	*hh	
	<CR><LF>	Sentence terminator		<CR><LF>
Note 1: The first two characters after the $ specify the device.requesting the information. The next two characters specify the device receiving the request and must be set to “GP” for the Zodiac GPS receiver.				
Note 2: MSG_ID may be any of the message IDs of NMEA output messages as specified in Table 3-1.				

Sample Message:
`$LCGPQ,GSV`

3.4 Automatic Vehicle Location (AVL) Messages

3.4.1 The AVL Message Package. Several messages are defined to implement an Automatic Vehicle Location (AVL) function in the Zodiac software. These messages are all prorpietary messages, and are only available in a special AVL build.

3.4.2 AVL Alarm Settings Output Message (Proprietary Output Message 001). This message reports on the current settings of the AVL alarms. It is sent in response to a AVL Query Alarm Settings Input Message. The contents of the AVL Alarm Settings Output Message are described in Table 3-20.

Table 3-20. CNXT,001 Message: Alarm Settings Output

Message ID:	CNXT,001			**AVL Software Only**
Rate:	In response to CNXT,501 Query			
Fields:	9			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	001	Code for Alarm Set Input Message	xxx	001
2	ALARMS	Type of Alarms Currently Enabled (Note 2)	h	F
3	FenceCenter	Source of Virtual Fence Center (Note 3)	C	C
4	Lat	Latitude of Virtual Fence Center, + means North (Note 4)	llll.ll	3339.7334
5	Lon	Longitude of Virtual Fence Center, + means East (Note 4)	yyyyy.yy	–11751.7598
6	Alt	Altitude of Virtual Fence Center (Note 4)	xx.xx	25
7	Radius	Radius of the Virtual Fence (m) (Note 4)	xx	100
8	Velocity	Velocity at which velocity alarm will be sent (m/s)	xx	10
9	DistanceTravelled	Total distance traveled to cause an alarm (km)	xx	10
	CKSUM	Checksum	*hh	*9B
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: Single hex digit specifying which alarms are set, where:

Bit 0 Set indicates an alarm is sounded because the vehicle entered the virtual fence circle
Bit 1 Set indicates an alarm is sounded because the vehicle left the virtual fence circle
Bit 2 Set indicates an alarm is sounded because the velocity exceeds the set value (see field 8, default = 10 m/s)
Bit 3 Set indicates an alarm is sounded because the distance traveled exceeds the set value (see field 9, default = 10 km)

Note 3: Field 3 specifies the source of the virtual fence center. “C” means the receiver used its own position. “R” means a remote position was provided to the receiver. If no virtual fence alarm has been set, this field is null.

Note 4: If a virtual fence has been activated, these fields indicate the center. If no virtual fence has been defined, these fields are reported as nulls.

Example:

```
$PCNXT,001,F,C,3339.7334,-11751.7598,25,100,10,10*9B
```

3.4.3 AVL Alarm Status Output Message (Proprietary Output Message 002). This message reports the current alarm status. It is output once upon detection of an alarm condition, or in response to the AVL Query Alarm Status Input Message. The contents of the AVL Alarm Status Output Message are described in Table 3-21.

Table 3-21. CNXT,002 Message: Alarm Status Output

Message ID:	CNXT,002			**AVL Software Only**
Rate:	Output once upon detection of alarm, or in response to CNXT,502 Query message			
Fields:	8			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	002	Code for Alarm Status Output Message	xxx	002
2	ALARM	Current Alarm Activated (Note 2)	h	2
3	Lat	Current Latitude, + means North (Note 3)	lllll.llll	3339.7351
4	Lon	Current Longitude, + means East (Note 3)	yyyyy.yyyy	–11751.7536
5	Alt	Current Altitude (m) (Note 3)	xx.xx	56.71
6	Radius	Current Distance from Center of Virtual Fence (m) (Note 3)	xxx.xx	107.35
7	Velocity	Current Velocity (m/s) (Note 3)	xx.xx	12
8	DistanceTravelled	Current Distance Traveled (km) (Note 3)	xx.xxx	10.23
	CKSUM	Checksum	*hh	*53
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: Current alarm(s) active. Bit-mapped hex value where:

Bit 0 Set indicates an alarm occurred because the vehicle entered the virtual fence circle
Bit 1 Set indicates an alarm occurred because the vehicle left the virtual fence circle
Bit 2 Set indicates an alarm occurred because the velocity exceeded the set value
Bit 3 Set indicates an alarm occurred because the distance traveled exceeded the set value

More than one alarm may be activated at one time. However, only alarms enabled by the Alarm Set Input message (CNXT,001) are reported.

Note 3: These values are reported only as they relate to the current alarm(s) being reported. Any values not associated with the current alarm condition are reported as null.

Example:

```
$PCNXT,002,2,3339.7351,-11751.7536,56.71,107.35,,*53
```

3.4.4 AVL Report ID Output Message (Proprietary Output Message 020). This message reports the current Receiver ID value stored in non-volatile memory. The message is sent in response to an AVL Query Receiver ID Input Message. The receiver ID is set using the AVL Set Receiver ID Input Message. The contents of the AVL Report ID Output Message are described in Table 3-22.

Table 3-22. CNXT,020 Message: Report ID Output

Message ID:	CNXT,020			**AVL Software Only**
Rate:	In response to CNXT,520 Query message			
Fields:	3			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	020	Code for Receiver ID Output Message	xxx	020
2	ID	Receiver ID (Note 2)	xxxx	0027
	CKSUM	Checksum	*hh	*7B
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: ID code set by Message CNXT,020 (Set ID Input) and stored in EEPROM. If no value has been set, this is reported as 0000. Value in this field is always padded with leading zeros as necessary to be four digits long whenever the ID value is less than 1000.

Example:

```
$PCNXT,020,0027,211635*7B
```

3.4.5 AVL Position Output Message (Proprietary Output Message 030). The AVL Position Output messae is output in response to a AVL Position Query Message (Proprietary Message 530). It reports the position of the vehicle, and if the vehicle is currently not tracking satellites, the length of time it has been since that position was computed. The contents of the AVL Position Output Message are described in Table 3-23.

Table 3-23. CNXT,030 Message: AVL Position Output

Message ID:	CNXT,030			**AVL Software Only**
Rate:	In response to CNXT,530 Query message			
Fields:	5			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	031	Code for AVL Position Message		
2	LAT	Latitude, + is North	llll.lll	3339.733
3	LON	Longitude, + is East	yyyyy.yyy	–11751.760
4	TIME	UTC Time of Position (Note 2)	hhmmss.ss	222435
5	AGE	Age of Position, seconds (Note 3)	xx	6
	CKSUM	Checksum	*hh	*29
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: UTC time when the report is made.

Note 3: If the receiver is not tracking, this is the age in seconds of the position reported. When the receiver is tracking, this field is reported as a null.

Example:

```
$PCNXT,030,3339.733,-11751.760,222435,*29
```

3.4.6 AVL Alarm Set Input Message (Proprietary Input Message 001). This proprietary message sets various AVL alarm thresholds.

The contents of the AVL Alarm Set Message are described in Table 3-24.

Table 3-24. CNXT,001 Message: AVL Alarm Set Input

Message ID:	CNXT, 001			
Rate:	As required			
Fields:	9			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	001	Code for Alarm Set input Message	xxx	001
2	ACTION	Type of Alarms to Enable (Note 2)	h	F
3	FenceCenter	Source of Virtual Fence Center (Note 3)	C	C
4	Lat	Latitude of Virtual Fence Center, + means North (Note 3)	llll.ll	3339.7334
5	Lon	Longitude of Virtual Fence Center, + means East (Note 3)	yyyyy.yy	-11751.7334
6	Alt	Altitude of Virtual Fence Center (Note 3)	xx.xx	25
7	Radius	Radius of Virtual Fence (m) (Note 4)	xx	100
8	Velocity	Velocity at which velocity alarm will be sent (m/s) (Note 4)	xx	10
9	Distance Traveled	Total distance traveled to cause an alarm (m) (Note 4)	xx	10000
	CKSUM	Checksum	*hh	*3F
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1: $ = NMEA message prefix
P = Proprietary message indicator
CNXT = Conexant special message

Note 2: Single hex digit, where:

Bit 0 Set activates the alarm when the vehicle enters the virtual fence circle
Bit 1 Set activates the alarm when the vehicle leaves the virtual fence circle
Bit 2 Set activates the alarm when the velocity exceeds the set value (see field 8, default = 10 m/s)
Bit 3 Set activates the alarm when the distance traveled exceeds the set value (see field 9, default = 10000 m)

Any combination of bits may be set. Setting bit 3 clears the current accumulated distance, if any.

Note 3: Field 3 specifies the source of the virtual fence center. "C" means use the current position in the receiver (fields 4 to 6 are ignored). "R" means use a remote center, which must be contained in fields 4 to 6. Entering an altitude in field 6 is optional, and any value is ignored.

If either fields 4 or 5 are null when field 3 specifies a remote center, the receiver uses prior settings. If no prior settings exist, the receiver ignores the request to set a virtual fence alarm.

Note 4: Values in these fields are optional. When values are omitted, the system uses the last value entered, or the default value if none has been entered previously. Values entered are stored in SRAM, and become lost when primary and backup power are removed. Default values: radius = 100 m; velocity = 10 m/s; distance traveled = 10000 m.

Sample Message:
```
$PCNXT,001,2,C,,,,200,,*3F
```

3.4.7 AVLSet ID Input Message (Proprietary Input Message 020): This message provides a method for the operator to set the receiver ID for an AVL receiver. The ID value is stored in non-volatile storage in the receiver, and can be queried by requesting the Report ID Output Message (Proprietary Output Message 020). The contents of the Set ID Input Message are described in Table 3-25.

Table 3-25. CNXT,020 Message: Set ID Input

Message ID:	CNXT,020			**AVL Software Only**
Rate:	As required			
Fields:	2			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	020	Code for ID Input Message	xxx	020
2	ID	Receiver ID, range 0 to 4294967296 (Note 2)	xxxx	612
	CKSUM	Checksum	*hh	*7C
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: Value entered is stored in EEPROM and reported in Message CNXT,020 (Report ID Output). If the entered value is four digits or less, it is reported in a four-digit field with leading zeros as required.

Example:

```
$PCNXT,020,612*7C
```

3.4.8 AVL Query Alarm Setting Input Message (Proprietary Input Message 501). This message is sent to the receiver to request the current alarm settings. In response, the receiver will send an AVL Alarm Settings Output Message. The contents of the Query Alarm Setting Input Message are described in Table 3-26.

Table 3-26. CNXT,501 Message: Query Alarm Setting Input

Message ID:	CNXT,501			**AVL Software Only**
Rate:	As required			
Fields:	1			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	501	Code for Query Alarm Setting Input Message (Note 2)	xxx	501
	CKSUM	Checksum	*hh	*34
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: In response to this message, the receiver sends Message CNXT,001 (Alarm Settings Output).

Sample Message:

```
$PCNXT,501*34
```

3.4.9 AVL Query Alarm Status Input Message (Proprietary Input Message 502). This message allows the AVL host system to request the current status of the alarm system. In response to this message, the receiver will respond with an AVL Alarm Status Output Message. The contents of the AVL Query Alarm Status Input Messsage are described in Table 3-27.

Table 3-27. CNXT,502 Message: Query Alarm Status Input

Message ID:	CNXT,502			**AVL Software Only**
Rate:	As required			
Fields:	1			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	502	Code for Query Alarm Status Input Message (Note 2)	xxx	502
	CKSUM	Checksum	*hh	*33
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: In response to this message, the receiver sends Message CNXT,002 (Alarm Status Output).

Sample Message:

```
$PCNXT,502*33
```

3.4.10 AVL Query ID Input Message (Proprietary Input Message 520). This message allows the user to determine the ID code stored in the receiver. The ID code is set by AVL Set Receiver ID Message. In response to this message, the receiver will send a Report ID Output Message. The contents of the AVL Query ID Input Message are described in Table 3-28.

Table 3-28. CNXT,520 Message: Query ID Input

Message ID:	CNXT,520			**AVL Software Only**
Rate:	As required			
Fields:	1			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	520	Code for Query ID Input Message (Note 2)	xxx	502
	CKSUM	Checksum	*hh	*65
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: In response to this message, the receiver sends Message CNXT,020 (Report ID Output).

Example:

```
$PCNXT,520*65
```

3.4.11 Query AVL Position Input Message (Proprietary Input Message 530). This message allows the user to ask the receiver for its current position. In response to this message the receiver will send the AVL Position Output Message. The contents of the Query AVL Position Input Message are described in Table 3-29.

Table 3-29. CNXT,530 Message: Query AVL Position Input

Message ID:	CNXT,530			**AVL Software Only**
Rate:	As required			
Fields:	1			
Field No.:	**Symbol:**	**Field Description:**	**Field Type:**	**Example:**
	$PCNXT	Start of sentence and address field (Note 1)		$PCNXT
1	530	Code for Query AVL Position Input Message (Note 2)	xxx	530
	CKSUM	Checksum	*hh	*81
	<CR><LF>	Sentence terminator		<CR><LF>

Note 1:
$ = NMEA message prefix
P = Proprietary message
CNXT = Conexant special message

Note 2: In response to this message, the receiver sends Message CNXT,030 (AVL Position Output).

Example:

```
$PCNXT,530*81
```

4 RTCM DATA PORT

This section presents a brief description of the Zodiac family of GPS receivers' auxiliary serial data port. This port is dedicated to RTCM SC-104 data input. The RTCM SC-104 standard provides the established convention for differential GPS (DGPS) corrections.

4.1 Zodiac Receiver Auxiliary Data Port Description

4.1.1 Data Format. Each of the receivers in the Zodiac family contain a separate serial port, referred to as the auxiliary port, dedicated to direct processing of RTCM SC-104 DGPS messages. No preprocessing of the DGPS corrections is required since this port operates directly on the RTCM SC-104 6-of-8 format specified in version 2.1 of the RTCM SC-104 specification. The auxiliary port is electrically equivalent to the host port.

4.1.2 DGPS Control Messages. The port may be configured to any of the data transmission rates specified in RTCM SC-104 using the port configuration message (binary Message 1330). Default values for this port are 9600 bps, 8 data bits, no parity, and 1 stop bit. DGPS operation and RTCM Type 5 message processing can be enabled or disabled using the DGPS control message (binary Message 1214). These messages are passed through the host serial port.

4.1.3 Operation. During DGPS operation, the auxiliary serial port is configured in a listen-only mode. Through a combination of host port input control messages and raw RTCM data output by the auxiliary port, DGPS operations are supported as described in Section 2 of the *Zodiac GPS Receiver Family Design Guide*.

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APPENDIX A: Direct Memory Access (DMA)

Location of Measurement Engine I/O Data Space. Measurement Engine I/O data space locations are specified in Table A-I. These are provided so that an OEM processor that accesses the Measurement Engine using memory mapped access can determine the location of the data even though the location of the base address of this data is variable from one software version to the next.

This is accomplished by specifying the base address in a fixed code space (ROM/EPROM/Flash) location that does not change. This ROM-based pointer provides the location of a table of 64 additional pointers plus two offset increments that are located in RAM. Separate pointers are provided for each defined data block.

Input block addresses are located in the lower half of the table while output block addresses are located in the upper half. The table accommodates the independent modification of existing data blocks, the addition of new data blocks, and the relocation by the linker of data blocks in RAM from link to link.

The two given offset increments are channel increments for per-channel data found in Solution Error Feedback (input) and Measurement Time Mark (output) data. The channel increments allow per channel data size to be determined at run time.

Placing these pointers and increments in RAM allows for a future system with a fixed value for the ROM value. In this case, the OEM will only have to decode RAM locations.

Integer Sequence Number. Many of the binary message data sets defined in this document include an integer sequence number. These all operate in a uniform manner. The sign bit, bit 15, is a busy bit. It is used to indicate that the data is changing. In general, the data update procedure is:

1. Set the sign bit.
2. Write the new data.
3. Advance the sequence number.
4 Clear the sign bit.

The sequence numbers should advance from 0 to 32767 and then roll over to 0.

Table A-I. Location Of Binary I/O Data Space Base Address Values For Measurement Engine

Word Address (hex):	Location:	Contents:
(varies; reported with the software)	ROM	Base (I/O Data Base Address)
Base	RAM	Global Input Control Parameters
Base + 2	RAM	Frequency Standard Input Parameters
Base + 4	RAM	Temperature Sensor Filter Input Parameters
Base + 6	RAM	Measurement Epoch Steering Parameters
Base + 8	RAM	Measurement Time Offset Control
Base + A	RAM	Time Mark Signal Output Control
Base + C	RAM	Platform Dynamics Limits
Base + E	RAM	Measurement Rate Control
Base + 10	RAM	Power Management Control
Base + 12	RAM	Cold Start Almanac Data Update
Base + 14	RAM	Serial Port 1 Communication Parameters
Base + 16	RAM	Serial Port 2 Communication Parameters
Base + 18	RAM	Memory Speed Input Parameters
Base + 1A	RAM	Solution Error Feedback
Base + 1C	RAM	Built-In Test Command
Base + 1E	RAM	Restart Command
Base + 20	RAM	Oscillator Temperature External Input
Base + 22 through 3F	RAM	Reserved
Base + 40	RAM	Global Output Control Parameters
Base + 42	RAM	Frequency Standard Parameters In Use
Base + 44	RAM	Temperature Sensor Filter Parameters In Use
Base + 46	RAM	Measurement Epoch Steering Parameters In Use
Base + 48	RAM	Measurement Time Offset In Use
Base + 4A	RAM	Time Mark Signal Output In Use
Base + 4C	RAM	Platform Dynamics Limits In Use
Base + 4E	RAM	Measurement Rate In Use
Base + 50	RAM	Power Management Duty Cycle In Use
Base + 52	RAM	Cold Start Almanac Data In Use
Base + 54	RAM	Serial Port 1 Communication Parameters In Use
Base + 56	RAM	Serial Port 2 Communication Parameters In Use
Base + 58	RAM	Memory Speed Parameters In Use
Base + 5A	RAM	Measurement Time Mark
Base + 5C	RAM	Built-In Test Results
Base + 5E through 7F	RAM	Reserved
Base + 80	RAM	Input Channel Increment (Words)
Base + 81	RAM	Output Channel Increment (Words)

APPENDIX B: Reference Ellipsoids And Datum Table

Source: DoD World Geodetic System 1984, DMA TR 8350.2-B, 1 Dec 1987, Second Printing. Includes 1 Sept 1991 updates.

Table B-1: Reference Ellipsoids

REFERENCE ELLIPSOIDS			
No.:	**Name:**	**Semi-Major Axis:**	**Inverse Flattening:**
1	Airy	6377563.396000	299.324965
2	Modified Airy	6377340.189000	299.324965
3	Australian National	6378160.000000	298.250000
4	Bessel 1841	6377397.155000	299.152813
5	Clarke 1866	6378206.400000	294.978698
6	Clarke 1880	6378249.145000	293.465000
7	Everest 1830	6377276.345000	300.801700
8	Everest 1948	6377304.063000	300.801700
9	Fischer 1960	6378166.000000	298.300000
10	Modified Fischer 1960	6378155.000000	298.300000
11	Fischer 1968	6378150.000000	298.300000
12	GRS 1980	6378137.000000	298.257222
13	Helmert 1906	6378200.000000	298.300000
14	Hough	6378270.000000	297.000000
15	International	6378388.000000	297.000000
16	Krassovsky	6378245.000000	298.300000
17	South American 1969	6378160.000000	298.250000
18	WGS 60	6378165.000000	298.300000
19	WGS 66	6378145.000000	298.250000
20	WGS 72	6378135.000000	298.260000
21	WGS 84 (default)	6378137.000000	298.257224
22	Bessel 1841 (Namibia)	6377483.865000	299.152813
23	Everest 1956	6377301.243000	300.801700
24	Everest 1969	6377295.664000	300.801700
25	Everest (Sabah & Sarawak)	6377298.556000	300.801700
26	SGS 85	6378136.000000	298.257000

Table B-2: ROM Datums (1 of 6)

ROM Datums					
Code:	**Name:**	**Ell:**	**dx:**	**dy:**	**dz:**
0	WGS 84 (default)	21	0	0	0
1	Adindan - MEAN FOR Ethiopia, Sudan	6	–166	–15	204
2	Adindan - Burkina Faso	6	–118	–14	218
3	Adindan - Cameroon	6	–134	–2	210
4	Adindan - Ethiopia	6	–165	–11	206
5	Adindan - Mali	6	–123	–20	220
6	Adindan - Senegal	6	–128	–18	224
7	Adindan - Sudan	6	–161	–14	205
8	Afgooye - Somalia	16	–43	–163	45
9	Ain el Abd 1970 - Bahrain	15	–150	–251	–2
10	Ain el Abd 1970 - Saudi Arabia	15	–143	–236	7
11	Anna 1 Astro 1965 - Cocos Islands	3	–491	–22	435
12	Antigua Island Astro 1943 Antigua (Leeward Islands)	6	–270	13	62
13	Arc 1950 MEAN FOR Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe	6	–143	–90	–294
14	Arc 1950 - Botswana	6	–138	–105	–289
15	Arc 1950 - Burundi	6	–153	–5	–292
16	Arc 1950 - Lesotho	6	–125	–108	–295
17	Arc 1950 - Malawi	6	–161	–73	–317
18	Arc 1950 - Swaziland	6	–134	–105	–295
19	Arc 1950 - Zaire	6	–169	–19	–278
20	Arc 1950 - Zambia	6	–147	–74	–283
21	Arc 1950 - Zimbabwe	6	–142	–96	–293
22	Arc 1960 - MEAN FOR Kenya, Tanzania	6	–160	–6	–302
23	Ascension Island 1958 Ascension Island	15	–191	103	51
24	Astro Beacon E 1945 - Iwo Jima	15	145	75	–272
25	Astro DOS 71/4 - St Helena Island	15	–320	550	–494
26	Astro Tern Island (FRIG) 1961 Tern Island	15	114	–116	–333
27	Astronomical Station 1952 Marcus Island	15	124	–234	–25
28	Australian Geodetic 1966 Australia & Tasmania	3	–133	–48	148
29	Australian Geodetic 1984 Australia & Tasmania	3	–134	–48	149
30	Ayabelle Lighthouse - Djibouti	6	–79	–129	145

Table B-2: ROM Datums (2 of 6)

Code:	Name:	Ell:	dx:	dy:	dz:
31	Bellevue (IGN) Efate & Erromango Islands	15	–127	–769	472
32	Bermuda 1957 - Bermuda	5	–73	213	296
33	Bissau - Guinea-Bissau	15	–173	253	27
34	Bogota Observatory - Colombia	15	307	304	–318
35	Bukit Rimpah Indonesia (Bangka & Belitung Islands)	4	–384	664	–48
36	Camp Area Astro Antarctica (McMurdo Camp Area)	15	–104	–129	239
37	Campo Inchauspe - Argentina	15	–148	136	90
38	Canton Astro 1966 - Phoenix Islands	15	298	304	–375
39	Cape - South Africa	6	–136	108	–292
40	Cape Canaveral - Bahamas, Florida	5	–2	151	181
41	Carthage - Tunisia	6	–263	6	431
42	Chatham Island Astro 1971 New Zealand (Chatham Island)	15	175	–38	113
43	Chua Astro - Paraguay	15	–134	229	–29
44	Corrego Alegre - Brazil	15	–206	172	-6
45	Dabola - Guinea	6	–83	37	124
46	Djakarta (Batavia) Indonesia (Sumatra)	4	–377	681	–50
47	DOS 1968 New Georgia Islands (Gizo Island)	15	230	–199	–752
48	Easter Island 1967 - Easter Island	15	211	147	111
49	European 1950 MEAN FOR Austria, Belgium, Denmark, Finland, France, West Germany, Gibralter, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland	15	–87	–98	–121
50	European 1950 MEAN FOR Austria, Denmark, France, West Germany, Netherlands, Switzerland	15	–87	–96	–120
51	European 1950 MEAN FOR Iraq, Israel, Jordan, Lebanon, Kuwait, Saudi Arabia, Syria	15	–103	–106	–141
52	European 1950 - Cyprus	15	–104	–101	–140
53	European 1950 - Egypt	15	–130	–117	–151
54	European 1950 England, Channel Islands, Ireland, Scotland, Shetland Islands	15	–86	–96	–120
55	European 1950 - Finland, Norway	15	–87	–95	–120
56	European 1950 - Greece	15	–84	–95	–130
57	European 1950 - Iran	15	–117	–132	–164
58	European 1950 - Italy (Sardinia)	15	–97	–103	–120
59	European 1950 - Italy (Sicily)	15	–97	–88	–135
60	European 1950 - Malta	15	–107	–88	–149
61	European 1950 - Portugal, Spain	15	–84	–107	–120
62	European 1979 MEAN FOR Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland	15	–86	–98	–119
63	Fort Thomas 1955 Nevis, St. Kitts (Leeward Islands)	6	–7	215	225
64	Gan 1970 - Republic of Maldives	15	–133	–321	50
65	Geodetic Datum 1949 - New Zealand	15	84	–22	209

Table B-2: ROM Datums (3 of 6)

Code:	Name:	Ell:	dx:	dy:	dz:
66	Graciosa Base SW 1948 Azores (Faial, Graciosa, Pico, Sao Jorge, Terceira)	15	–104	167	–38
67	Guam 1963 - Guam	5	–100	–248	259
68	Gunung Segara - Indonesia (Kalimantan)	4	–403	684	41
69	GUX 1 Astro - Guadalcanal Island	15	252	–209	–751
70	Herat North - Afghanistan	15	–333	–222	114
71	Hjorsey 1955 - Iceland	15	–73	46	–86
72	Hong Kong 1963 - Hong Kong	15	–156	–271	–189
73	Hu-Tzu-Shan - Taiwan	15	–637	–549	–203
74	Indian - Bangladesh	7	282	726	254
75	Indian - India, Nepal	23	295	736	257
76	Indian 1954 - Thailand, Vietnam	7	218	816	297
77	Indian 1975 - Thailand	7	209	818	290
78	Ireland 1965 - Ireland	2	506	–122	611
79	ISTS 061 Astro 1968 South Georgia Islands	15	–794	119	–298
80	ISTS 073 Astro 1969 - Diego Garcia	15	208	–435	–229
81	Johnston Island 1961 - Johnston Island	15	189	–79	–202
82	Kandawala - Sri Lanka	7	–97	787	86
83	Kerguelen Island 1949 Kerguelen Island	15	145	–187	103
84	Kertau 1948 - West Malaysia & Singapore	8	–11	851	5
85	Kusaie Astro 1951 - Caroline Islands	15	647	1777	–1124
86	L. C. 5 Astro 1961 - Cayman Brac Island	5	42	124	147
87	Leigon - Ghana	6	–130	29	364
88	Liberia 1964 - Liberia	6	–90	40	88
89	Luzon Philippines (Excluding Mindanao)	5	–133	–77	–51
90	Luzon - Philippines (Mindanao)	5	–133	–79	–72
91	Mahe 1971 - Mahe Island	6	41	–220	–134
92	Massawa - Ethiopia (Eritrea)	4	639	405	60
93	Merchich - Morocco	6	31	146	47
94	Midway Astro 1961 - Midway Islands	15	912	–58	1227
95	Minna - Cameroon	6	–81	–84	115
96	Minna - Nigeria	6	–92	–93	122
97	Montserrat Island Astro 1958 Montserrat (Leeward Islands)	6	174	359	365
98	M'Poraloko - Gabon	6	–74	–130	42
99	Nahrwan - Oman (Masirah Island)	6	–247	–148	369
100	Nahrwan - Saudi Arabia	6	–243	–192	477

Table B-2: ROM Datums (4 of 6)

Code:	Name:	Ell:	dx:	dy:	dz:
101	Nahrwan - United Arab Emirates	6	–249	–156	381
102	Naparima BWI - Trinidad & Tobago	15	–10	375	165
103	North American 1927 MEAN FOR Antigua, Barbados, Barbuda, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Turks Islands	5	–3	142	183
104	North American 1927 MEAN FOR Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua	5	0	125	194
105	North American 1927 - MEAN FOR Canada	5	–10	158	187
106	North American 1927 - MEAN FOR CONUS	5	–8	160	176
107	North American 1927 MEAN FOR CONUS (East of Mississippi River) including Louisiana, Missouri, Minnesota	5	–9	161	179
108	North American 1927 MEAN FOR CONUS (West of Mississippi River)	5	–8	159	175
109	North American 1927 - Alaska	5	–5	135	172
110	North American 1927 Bahamas (Except San Salvador Island)	5	–4	154	178
111	North American 1927 Bahamas (San Salvador Island)	5	1	140	165
112	North American 1927 Canada (Alberta, British Columbia)	5	–7	162	188
113	North American 1927 Canada (Manitoba, Ontario)	5	–9	157	184
114	North American 1927 Canada (New Brunswick, Newfoundland, Nova Scotia, Quebec)	5	–22	160	190
115	North American 1927 Canada (Northwest Territories, Saskatchewan)	5	4	159	188
116	North American 1927 - Canada (Yukon)	5	–7	139	181
117	North American 1927 - Canal Zone	5	0	125	201
118	North American 1927 - Cuba	5	–9	152	178
119	North American 1927 Greenland (Hayes Peninsula)	5	11	114	195
120	North American 1927 - Mexico	5	–12	130	190
121	North American 1983 Alaska, Canada, CONUS	12	0	0	0
122	North American 1983 Central America, Mexico	12	0	0	0
123	Observatorio Metereo 1939 Azores (Corvo & Flores Islands)	15	–425	–169	81
124	Old Egyptian 1907 - Egypt	13	–130	110	–13
125	Old Hawaiian MEAN FOR Hawaii, Kauai, Maui, Oahu	5	61	–285	–181
126	Old Hawaiian - Hawaii	5	89	–279	–183
127	Old Hawaiian - Kauai	5	45	–290	–172
128	Old Hawaiian - Maui	5	65	–290	–190
129	Old Hawaiian - Oahu	5	58	–283	–182
130	Oman - Oman	6	–346	–1	224

Table B-2: ROM Datums (5 of 6)

Code:	Name:	Ell:	dx:	dy:	dz:
131	Ord. Survey G. Britain 1936 MEAN FOR England, Isle of Man, Scotland, Shetland Islands, Wales	1	375	–111	431
132	Ord. Survey G. Britain 1936 - England	1	371	–112	434
133	Ord. Survey G. Britain 1936 England, Isle of Man, Wales	1	371	–111	434
134	Ord. Survey G. Britain 1936 Scotland, Shetland Islands	1	384	–111	425
135	Ord. Survey G. Britain 1936 - Wales	1	370	–108	434
136	Pico de las Nieves - Canary Islands	15	–307	–92	127
137	Pitcairn Astro 1967 - Pitcairn Island	15	185	165	42
138	Point 58 MEAN FOR Burkina Faso & Niger	6	–106	–129	165
139	Pointe Noire 1948 - Congo	6	–148	51	–291
140	Porto Santo 1936 Porto Santo, Madeira Islands	15	–499	–249	314
141	Provisional S. American 1956 MEAN FOR Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela	15	–288	175	–376
142	Provisional S. American 1956 - Bolivia	15	–270	188	–388
143	Provisional S. American 1956 Chile (Northern, Near 19°S)	15	–270	183	–390
144	Provisional S. American 1956 Chile (Southern, Near 43°S)	15	–305	243	–442
145	Provisional S. American 1956 - Colombia	15	–282	169	–371
146	Provisional S. American 1956 - Ecuador	15	–278	171	–367
147	Provisional S. American 1956 - Guyana	15	–298	159	–369
148	Provisional S. American 1956 - Peru	15	–279	175	–379
149	Provisional S. American 1956 Venezuela	15	–295	173	–371
150	Provisional S. Chilean 1963 Chile (South, Near 53°S) (Hito XVIII)	15	16	196	93
151	Puerto Rico Puerto Rico, Virgin Islands	5	11	72	–101
152	Qatar National - Qatar	15	–128	–283	22
153	Qornoq - Greenland (South)	15	164	138	–189
154	Reunion - Mascarene Islands	15	94	–948	–1262
155	Rome 1940 - Italy (Sardinia)	15	–225	–65	9
156	Santo (DOS) 1965 Espirito Santo Island	15	170	42	84
157	Sao Braz Azores (Sao Miguel, Santa Maria Islands)	15	–203	141	53
158	Sapper Hill 1943 - East Falkland Island	15	–355	21	72
159	Schwarzeck - Namibia	22	616	97	–251
160	Selvagem Grande - Salvage Islands	15	–289	–124	60

Table B-2: ROM Datums (6 of 6)

Code:	Name:	Ell:	dx:	dy:	dz:
161	SGS 85 - Soviet Geodetic System 1985	26	3	9	–9
162	South American 1969 MEAN FOR Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Trinidad & Tobago, Venezuela	17	–57	1	–41
163	South American 1969 - Argentina	17	–62	–1	–37
164	South American 1969 - Bolivia	17	–61	2	–48
165	South American 1969 - Brazil	17	–60	–2	–41
166	South American 1969 - Chile	17	–75	–1	–44
167	South American 1969 - Colombia	17	–44	6	–36
168	South American 1969 - Ecuador	17	–48	3	–44
169	South American 1969 Ecuador (Baltra, Galapagos)	17	–47	27	–42
170	South American 1969 - Guyana	17	–53	3	–47
171	South American 1969 - Paraguay	17	–61	2	–33
172	South American 1969 - Peru	17	–58	0	–44
173	South American 1969 - Trinidad & Tobago	17	–45	12	–33
174	South American 1969 - Venezuela	17	–45	8	–33
175	South Asia - Singapore	10	7	–10	–26
176	Tananarive Observatory 1925 Madagascar	15	–189	–242	–91
177	Timbalai 1948 Brunei, East Malaysia (Sabah, Sarawak)	25	–679	669	-48
178	Tokyo - MEAN FOR Japan, Korea, Okinawa	4	–148	507	685
179	Tokyo - Japan	4	–148	507	685
180	Tokyo - Korea	4	–146	507	687
181	Tokyo - Okinawa	4	–158	507	676
182	Tristan Astro 1968 - Tristan da Cunha	15	–632	438	–609
183	Viti Levu 1916 Fiji (Viti Levu Island)	6	51	391	–36
184	Wake-Eniwetok 1960 - Marshall Islands	14	102	52	–38
185	Wake Island Astro 1952 - Wake Atoll	15	276	–57	149
186	WGS 1972 - Global Definition	20	0	0	0
187	Yacare - Uruguay	15	–155	171	37
188	Zanderij - Suriname	15	–265	120	–358

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APPENDIX C: Message 1190 Error Codes

Message 1190 provides diagnostic information for receiver errors generated during firmware execution. The “class” number generated by this message defines the type of error. For each class, several possible errors could occur. Each error is assigned a unique number. This Appendix provides tables for all of these exception codes.

Table C-I. Processor-Generated Interrupts – Exceptions (Applies to Class 0 and Class 1 Errors)

Code	Definition (Instruction)	Result
0	EXCEPT0 instruction	User defined
1	EXCEPT2 instruction	User defined
2	EXCEPT2 instruction	User defined
3	Convert double word to single word overflow (CVTDS)	Saturate
4	Convert floating point to doublel word overflow (CVTFD, DVTFED)	Saturate
5	Absolute value or negate single word overflow (ABS, NEG)	Saturate
6	Absolute value or negate double word overflow (ABSD, NEGD)	Saturate
7	Addition or subtraction single word overflow (ADD, SUB, INCS, INCSI, INCSLE, DECS, DECSI, DECSLE)	Modulo 2^{16}
8	Addition or subtraction double word overflow (ADDD, SUBD, INCD, DECD)	Modulo 2^{32}
9	Multiply integer single word negative overflow (MPYI)	Modulo 2^{16}
10	Multiply integer single word positive overflow (MPYI)	Modulo 2^{16}
11	Multiply integer double word negative overflow (MPYID)	Modulo 2^{32}
12	Multiply integer double word positive overflow (MPYID)	Modulo 2^{32}
13	Divide integer single word overflow (DIVI)	Saturate
14	Divide integer single word by zero (DIVI, MODI, REMI)	Saturate or Dividend
15	Divide integer double word overflow (DIVID)	Saturate
16	Divide integer double word by zero (DIVID, MODID, REMID)	Saturate or Dividend
17	Multiply fractional single word overflow (MPY)	Saturate
18	Multiply fractional double word overflow (MPYD)	Saturate
19	Divide fractional single word overflow (DIV)	Saturate
20	Divide fractional single word by zero (DIV)	Saturate
21	Divide fractional double word overflow (DIVD)	Saturate
22	Divide fractional double word by zero (DIVD)	Saturate
23	Floating point exponent overflow (ADDF, SUBF, MPYF, DIVF)	Exponent Modulo 2^8
24	Floating point divide by zero (DIVF)	Saturate
25	Extended floating point exponent overflow (ADDFE, SUBFE, MPYFE, DIVFE)	Exponent Modulo 2^8
26	Extended floating point divide by zero (DIVFE)	Saturate
27	Floating point negative square root (SQRTF)	Square root of positive
28	Extended floating point negative square root (SQRTFE)	Square root of positive

Table C-2. Processor-Generated Interrupts – User Traps (Applies to Class 2 Errors)

Code	Definition
0	User task completion (outer procedure return)
1	Illegal instruction in user task
2	Nonlocal search error on user process stack
3	The user stack has overflowed (TOS < SKLM)
4	The user stack has underflowed (TOS > LENV – 4)
5	A paging instruction was found in a user procedure with no page header
6	Initiation of a user task with undefined entry point was attempted
7	Unused
8	User (or executive) software generated trap 0
9	User (or executive) software generated trap 1
• •	• •
65535	User (or executive) software generated trap 65527

Table C-3. Processor-Generated Interrupts – Executive Errors (Applies to Class 3 and Class 4 Errors)

Code	Definition
0	A HALT instruction has been executed in the executive
1	An illegal instruction has been detected in the executive code
2	A nonlocal search in the executive process stack failed
3	The executive stack has overflowed (TOS < SKLM)
4	The executive stack has underflowed (TOS > LENV – 4)
5	A paging instruction was found in an executive procedure with no page header
6	Unused
7	Built-in self test failed
8	A transfer error has occurred in executive mode
9	The initial executive PROCID is zero
10	The transfer error handler PROCID is zero
11	The nonmaskable interrupt handler PROCID is zero
12	The maskable interrupt handler PROCID is zero
13	The trap handler PROCID is zero

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