axiom

NAVIGATION INC.

GPS Receiver Message Set Specification

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Contents

Preface

This document describes the command sets in any of Axiom Navigation's GPS Receivers, which is part of the Axiom Navigation GPS Evaluation Kit.

These commands can be exercised either using Axiom's Conductor GPS demonstration software, or by an application of your own. The information in this document is intended to provide the information you need to create an application to communicate with Axiom GPS receivers.

There are three command sets available:

- SiRF Binary Protocol — this provides the lowest level, and most complete control over the operation of the GPS receiver.
- NMEA Protocol — this outputs data in NMEA-0183 format, and accepts input messages in this format as well.
- Axiom Protocol — this is a proprietary command set for logging and reporting GPS data, such as for use in fleet management systems.

The command sets descriptions are primarily reference materials. However, example data and some longer descriptions of recommended usage are also provided.

Chapter 1 SiRF Binary Protocol

The SiRF Binary Protocol is the most complete message set for communicating with any of Axiom's SiRF-based GPS receivers.

The serial communication protocol is designed to provide:

- Reliable transport of messages
- Ease of implementation
- Efficient implementation
- Independence from payload

Message Structure

Each message sent to the GPS receiver is structured in a series of five sections, or protocol layers, forming the Transport Message. The message is structured as follows:

Table 1.1 SiRF Binary Transport Message Structure

Start Sequence	Payload Length	Payload	Payload Checksum	End Sequence
0xA0 [1], 0xA2	2 bytes (15 bits)	Up to 1022 bytes	2 bytes (15 bits)	0xB0, 0xB3
[1] 0xYY denotes a hexadecimal byte value. 0xA0 equals 160.				

Transport Layer

The transport layer of the protocol encapsulates a GPS message in two start characters and two stop characters. The values are chosen to be easily identifiable and such that they are unlikely to occur frequently in the data.

In addition, the transport layer prefixes the message with a two-byte (15-bit) payload length indicator, and follows it with a two-byte (15-bit) payload checksum.

The values of the start and stop characters and the 15-bit values for length and checksum were selected such that the payload length and payload checksum cannot be identical with either the start or stop codes.

Following the payload length prefix, and preceding the checksum suffix, is the message payload, the section of the message that contains the details of the instruction. These messages are described in detail later in this chapter.

Message Validation

The validation layer is part of the transport, but operates independently.

Payload Length

The payload length is the number of bytes in the payload. It is transmitted high order byte first, followed by the low byte.

High Byte	Low Byte
< 0x7F	Any value

Even though the protocol has a maximum length of (2^{15}-1) bytes, practical throughput considerations require a smaller number.

Payload Checksum

The payload checksum is a sum on the payload bytes. It is transmitted or received high order byte first followed by the low byte (big-endian order).

High Byte	Low Byte
< 0x7F	Any value

The checksum is a 15-bit checksum of the bytes in the payload data. The following pseudocode defines the algorithm used.

Let Payload be the array of bytes from the payload portion of the message to be sent by the transport.

```
ByteIndex = 0 (index to first byte of payload)
CheckSum  = 0

while ByteIndex <  number of bytes in the payload
   CheckSum  = CheckSum + Payload[ByteIndex]
   ByteIndex = ByteIndex + 1

CheckSum = CheckSum AND 7FFF(hex).
```

Payload Data

The payload data follows the message length. It contains the number of bytes specified by the message length. The payload data may contain any 8-bit value.

Where multi-byte values are in the payload data, neither the alignment nor the byte order are defined as part of the transport, although SiRF payloads use the big-endian order.

Switch To SiRF Protocol

To switch to SiRF binary protocol from NMEA, you must send the SiRF Switch to NMEA Protocol message. See NMEA input message ID 100.

Input Messages for SiRF Binary Protocol

All input messages are sent in *binary* format.

Table 1.2 SiRF Messages - Input Message List

Hex	Dec	Name	Description
0 x 80	128	Initialize Data Source	Set device initialization parameters and reboot
0 x 81	129	Switch To NMEA Protocol	Switch the unit to NMEA messaging mode
0 x 82	130	Set Almanac	Enable uploading an almanac
0 x 84	132	Software Version	Request unit software level
0 x 86	134	Set Main Serial Port	Set serial port A communication parameters
0 x 87	135	Set Message Protocol	Set the new message protocol to be used
0 x 88	136	Mode Control	Set unit mode parameters
0 x 89	137	DOP Mask Control	Dilution of precision angles
0 x 8A	138	DGPS Control	Set RTCM differential
0 x 8B	139	Elevation Mask	Set minimum satellite elevation
0 x 8C	140	Power Mask	Set minimum satellite power level
0 x 8D	141	Editing Residual	Not implemented
0 x 8E	142	Steady State Detection	Set steady state detection threshold
0 x 8F	143	Static Navigation	Not implemented
0 x 90	144	Clock Status	Request clock status
0 x 91	145	Set DGPS Serial Port	Set serial port B communication parameters
0 x 92	146	Poll Almanac	Poll for almanac data
0 x 93	147	Poll Ephemeris	Poll for ephemeris data
0 x 95	149	Set Ephemeris	Enable uploading ephemeris
0 x 97	151	Set TricklePower Parameters	Set low power modes

Initialize Data Source

Message ID 128

Payload Length 25

Description

This message sets the device initialization parameters and reboots the device. The device can be either cold or warm booted, as indicated by the Reset Configuration value.

The message payload arguments are listed in Table 1.3.

Table 1.3 Initialize Data Source Payload

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		80		ASCII 128
ECEF X[1]	4		FFD700F	meters	X-axis from earth center
ECEF Y[1]	4		FFBE5266	meters	Y-axis from earth center
ECEF Z[1]	4		003AC57A	meters	Z-axis from earth center
Clock Offset[2]	4		000124F8	Hz	Offset needed to correct for receiver clock drift. If 0, receiver will use default of 75,000 Otherwise: Min = 25,000 Max = 146,000
Time of Week[3]	4	*100	0083D600	seconds	Seconds into current GPS week.
Week Number[3]	2		039C		Current GPS week number
Channels[4]	1		0C		Range 1 -12
Reset Configuration	1		33		See Table 1.4

[1] ECEF is an acronym for Earth-Centered-Earth-Fixed. It has X, Y, and Z axes describing a three-dimensional position relative to the center of the earth:

- The X-axis is the intersection of the plane defined by the prime meridian and the equatorial plane.
- The Y-axis completes a right-handed orthogonal system by a plane 90 degrees east of the X-axis and its intersection with the equator.
- The Z-axis points towards the North Pole.

[2] Clock Offset can be determined from a previous run by using the Clock Drift field from the Clock Status Data message, ID 7.

[3] GPS time is defined by a week number and the number of seconds into the current week (TOW or time of week). Week zero began on January 6, 1980 (the transition from Saturday to Sunday at the prime meridian).

[4] When less than 12 channels are specified, output messages stay the same size and fill in unused channels with null values. Be aware that in limiting the number of channels, the navigation takes into account the highest initial elevation satellites first, and will not bring on new satellites until a satellite in the current solution drops below the mask angle.

Table 1.4 Reset Configuration Bitmap

Bit	Description
0	Data valid flag - set warm/hot start
1	Clear ephemeris - set warm start
2	Clear memory - set cold start
3	Reserved (must be 0)
4	Enable Raw Track Data and Clock Status (Yes = 1, No = 0)
5	Enable Development Data (for SiRF/Axiom use) (Yes = 1, No = 0)
6	Reserved (must be 0)
7	Reserved (must be 0)

If Raw Track Data is ENABLED then the resulting messages are:

- Message ID 0x05 (ASCII 5 – Raw Track Data)
- Message ID 0x07 (ASCII 7 – Clock Status)
- Message ID 0x08 (ASCII 8 – 50 BPS data)
- Message ID 0x11 (ASCII 17 – Raw DGPS data)

All messages except 50 BPS data are sent at 1 Hz. The 50 BPS data is sent every 6 seconds.

Example

The following message data sends instructions to reset the device as follows:

- Warm start the receiver with the following data
- ECEF XYZ (-2686727 m, -4304282 m, 3851642 m)
- Clock Offset (75,000 Hz)
- Time of Week (86,400 s)
- Week Number (924)
- Channels (12)
- Raw track data enabled
- Debug data enabled

Start Sequence and Payload Length	A0A20019
Payload data	80FFD700F9FFBE5266003AC57A000124F80083 D600039C0C33
Message Checksum and End Sequence	0A91B0B3

Switch To NMEA Protocol

Message ID **129**

Payload Length **24 bytes**

Description

This message switches the unit to NMEA messaging mode, and sets communication parameters. The message payload arguments are listed in Table 1.5.

Table 1.5 Switch To NMEA Protocol

Name	Bytes	Binary (Hex) Example	Units	Description
Message ID	1	81		ASCII 129
Mode	1	02		
GGA Message[1]	1	01	1/s	GGA message rate
Checksum[2]	1	01		
GLL Message	1	00	1/s	GLL message rate
Checksum	1	01		
GSA Message	1	05	1/s	GSA message rate
Checksum	1	01		
GSV Message	1	05	1/s	GSV message rate
Checksum	1	01		
RMC Message	1	00	1/s	RMC message rate
Checksum	1	01		
VTG Message	1	00	1/s	VTG message rate
Checksum	1	01		
Unused Field	1	00		Recommended value
Unused Field	1	01		Recommended value
Unused Field	1	00		Recommended value
Unused Field	1	01		Recommended value
Unused Field	1	00		Recommended value
Unused Field	1	01		Recommended value
Unused Field	1	00		Recommended value
Unused Field	1	01		Recommended value
Baud Rate	2	12C0		38400, 19200, 9600, 4800, 2400

Name	Bytes	Binary (Hex)	Units	Description
		Example		

[1] A value of 0x00 implies NOT to send message, otherwise data is sent at 1 message every X seconds requested (i.e., to request a message to be sent every 5 seconds, request the message using a value of 0x05). Maximum rate is 1/255s.

[2] A value of 0x00 implies the checksum is NOT calculated OR transmitted with the message (not recommended). A value of 0x01 will have a checksum calculated and transmitted as part of the message (recommended).

Example

In this example, the payload data contains the input to:

- Request the following NMEA data at 4800 baud:
- GGA – ON at 1 sec
- GLL – OFF
- GSA – ON at 5 sec,
- GSV – ON at 5 sec
- RMC – OFF
- VTG – OFF

Start Sequence and Payload Length	A0A20018
Payload	8102010100010501050100010001000110001000112C0
Message Checksum and End Sequence	0164B0B3

Set Almanac

Message ID **130**

Payload **897 bytes**

Description

This command enables the user to upload an almanac to the GPS receiver. The almanac contains orbital data on 32 satellites (Space Vehicles, or SVs). The data for each SV contains 14 16–bit words.

The almanac portion of the 50 bit–per–second data received from each SV is composed of 10 30–bit words (or subframes) containing parity and telemetry information, along with the almanac information. When stripped of the telemetry and parity bits, the resultant data, packed into 14 16–bit words per SV, makes up this message format.

Each subframe of 300 bits is stored into 10 32–bit words. Each word is right justified such that the two most significant bits are not used. Index these 10 words as d[0] through d[9], with d[0] containing the preamble. The packing into 14 16–bit words called Alm[0] through Alm[13] is as follows:

```
Alm[0]  = ((d[0] << 2) & 0xff00) | ((d[1] >> 22) & 0xff);
Alm[1]  = (d[1] >> 6) & 0xffff;
Alm[2]  = (d[2] >> 14) & 0xffff;
Alm[3]  = ((d[2] << 2) & 0xff00) | ((d[3] >> 22) & 0xff);
Alm[4]  = (d[3] >> 6) & 0xffff;
Alm[5]  = (d[4] >> 14) & 0xffff;
Alm[6]  = ((d[4] << 2) & 0xff00) | ((d[5] >> 22) & 0xff);
Alm[7]  = (d[5] >> 6) & 0xffff;
Alm[8]  = (d[6] >> 14) & 0xffff;
Alm[9]  = ((d[6] << 2) & 0xff00) | ((d[7] >> 22) & 0xff);
Alm[10] = (d[7] >> 6) & 0xffff;
Alm[11] = (d[8] >> 14) & 0xffff;
Alm[12] = ((d[8] << 2) & 0xff00) | ((d[9] >> 22) & 0xff);
Alm[13] = (d[9] >> 6) & 0xffff;
```

For details on the almanac data format in the satellite message see the Interface Control Document, GPS ICD–200 at:

http://www.navcen.uscg.mil/gps/geninfo/gpsdocuments/icd200/default.htm

The GPS ICD–200 is also on Axiom's Evaluation Kit CD in the **GPS** folder.

Table 1.6 Set Almanac

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	82	ACSII 130
AlmanacData[14][2]	28		SV ID 1 Almanac
…			
AlmanacData[14][2]	28		SV ID 32 Almanac

Software Version

Message ID **132**

Payload **2 bytes**

Description

This message requests the GPS receiver to return its software level. The software level is returned by the Software Version String output message (Message ID 6).

Table 1.7 Software Version

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	84	ACSII 132
TBD	1	00	Reserved

Example

The following examples data polls for the software version:

Start Sequence and Payload Length	A0A20002
Payload	8400
Message Checksum and End Sequence	0084B0B3

Set Main Serial Port

Message ID **134**

Payload **9 bytes**

Description

This command sets the communications parameters for the GPS commands and output correction on serial port A, as shown in Table 1.8. SiRF and Axiom protocols are only valid for 8 data bits, 1 stop bit and no parity.

Table 1.8 Set Main Serial Port

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	86	ASCII 134
Baud	4	00004B00	38400, 19200, 9600, 4800, 2400, 1200
Data Bits	1	08	8, 7
Stop Bits	1	01	0, 1
Parity	1	00	0 = None, 1 = Odd, 2 = Even
Pad	1	00	Reserved

Example

This example message data sets Main Serial port to 19200,8,1,N.

Start Sequence and Payload Length	A0A20009
Payload	910000258008010000
Message Checksum and End Sequence	00DAB0B3

Set Message Protocol

Message ID **135**

Payload **2 bytes**

Description

This command sets the message protocol, as shown in Table 1.9. The receiver will reset immediately after this command in order to reinitialize with the new protocol.

Table 1.9 Set Message Protocol

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	87	ASCII 135
Protocol Number	1	04	0 = SiRF binary, 1 = NMEA, 4 = User1

Example

This example message data sets the protocol to Axiom User1.

Start Sequence and Payload Length	A0A20002
Payload	8704
Message Checksum and End Sequence	008BB0B3

Mode Control

Message ID **136**

Payload **14 bytes**

Description

This message is used to set a variety of modes, as described in Table 1.10.

Table 1.10 Mode Control

Name	Bytes	Binary (Hex)	Units	Description
		Example		
Message ID	1	88		ASCII 136
3D Mode	1	01		1 (always true=1)
Alt Constraint	1	01		Yes=1, No=0
Degraded Mode	1	01		See Table 1.11
TBD	1	01		Reserved
DR Mode	1	01		Yes=1, No=0
Altitude	2	0000	meters	Range -1,000 to 10,000
Alt Hold Mode	1	00		Auto=0, Always=1, Disable=2
Alt Source	1	02		Last Computed=0, Fixed to=1

Name	Bytes	Binary (Hex)	Units	Description
		Example		
Coast Time Out	1	14	seconds	0 to 120
Degraded Time Out	1	05	seconds	0 to 120
DR Time Out	1	01	seconds	0 to 120
Track Smoothing	1	01		Yes=1, No=0

Table 1.11 Degraded Mode Byte Value

Byte Value	Description
0	Use Direction then Clock Hold
1	Use Clock then Direction Hold
2	Direction (Curb) Hold Only
3	Clock (Time) Hold Only
4	Disable Degraded Modes

Example

This example sets:

- 3D Mode = Always
- Alt Constraining = Yes
- Degraded Mode = clock then direction
- TBD=1
- DR Mode = Yes
- Altitude = 0
- Alt Hold Mode = Auto
- Alt Source =Last Computed
- Coast Time Out = 20
- Degraded Time Out=5
- DR Time Out = 2
- Track Smoothing = Yes

Start Sequence and Payload Length	A0A2000E
Payload	880101010101000000002140501
Message Checksum and End Sequence	00A9B0B3

DOP Mask Control

Message ID **137**

Payload **5 bytes**

Description

DOP (Dilution of Precision) refers to the angles between the satellites and the receiver, which affects the precision of range calculations.

If the satellites are far apart, then the area of uncertainty is small. If the satellites are closer together, then the area of uncertainty is greater.

GDOP (Geometric DOP) can be broken down into TDOP (Time DOP), which is the range equivalent of clock bias, and PDOP (Position DOP), which is the dilution of precision based only on the geometry of the satellites, not counting the clock bias. PDOP can be further broken down into HDOP (Horizontal DOP) and VDOP (Vertical DOP).

The DOP Mask Control command specifies the maximum DOP allowed for navigation, and which, if any, DOP metric to use.

Table 1.12 DOP Mask Control

Name	Bytes	Binary (Hex) Example	Description
Message ID	1	89	ASCII 137
DOP Selection	1	00	See Table 1.13 (default 4)
GDOP Value	1	08	Range 1 to 50 (default 10)
PDOP Value	1	08	Range 1 to 50 (default 10)
HDOP Value	1	08	Range 1 to 50 (default 10)

Table 1.13 DOP Selection

Byte Value	Description
0	Auto (PDOP for 3-D navigation, HDOP for 2-D navigation)
1	PDOP
2	HDOP
3	GDOP
4	Do Not Use (default)

Example

The message data in this example sets the following:

- Auto PDOP/HDOP
- GDOP = 8
- PDOP = 8
- HDOP = 8

Start Sequence and Payload Length	A0A20005
Payload	8900080808
Message Checksum and End Sequence	00A1B0B3

DGPS Control

Message ID **138**

Payload **3 bytes**

Description

This command specifies how RTCM differential corrections (input on port B) are to be incorporated into the navigation solution, and how old the correction data can be.

Table 1.14 DGPS Control

Name	Bytes	Binary (Hex) Example	Units	Description
Message ID	1	8A		ASCII 138
DGPS Selection	1	01		See Table 1.15 (default 0)
DGPS Time Out	1	1E	seconds	Range 1 to 120 (default 30)

Table 1.15 DGPS Selection

Byte Value	Description
0	**Auto**: use DGPS corrections anytime they are available and not over the time limit. (default)
1	**Exclusive**: generate a navigation solution only if DGPS corrections are available and not over the time limit.
2	**Never**: generate a navigation solution without incorporating DGPS corrections whether they are available or not.
3	**Mixed**: use mixed DGPS (if available) and non-DGPS measurements (not recommended).

Example

The message data in this example sets DGPS to exclusive with a time out of 30 seconds.

Start Sequence and Payload Length	A0A20003
Payload	8A011E
Message Checksum and End Sequence	00A9B0B3

Elevation Mask

Message ID **139**

Payload **5 bytes**

Description

This command specifies the minimum satellite elevation above the horizon before it can be used. There are two components to this:

- The *Navigation mask* is the elevation angle needed before the satellite can be used in the navigation solution.
- The *Tracking mask* is the elevation angle needed before the receiver will attempt to track the satellite.

By using a tracking mask below the navigation mask, the receiver can collect ephemeris data ahead of time. Signal blockages and multi-path are more likely with a satellite close to the horizon, so a 7 to 20 degree navigation mask angle is often used.

Table 1.16 Elevation Mask

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		8B		ASCII 139
Tracking Mask	2	*10	0032	degrees	*Not currently implemented* (default 5)
Navigation Mask	2	*10	009B	degrees	Range -20.0 to +90.0 (default 7.5)

Example

This message data sets the Navigation Mask to 15.5 degrees.

Start Sequence and Payload Length	A0A20005
Payload	8B0032009B
Message Checksum and End Sequence	0158B0B3

Power Mask

Message ID **140**

Payload **3 bytes**

Description

This command defines minimum signal power level needed before a satellite can be used for tracking or navigation. This is the carrier-to-noise level, a common term for signal levels weaker than the natural ambient electromagnet noise.

As with the mask angle message (Message ID 139), both the tracking and the navigation components are specified.

Table 1.17 Power Mask

Name	Bytes	Binary (Hex)	Units	Description
		Example		
Message ID	1	8C		ASCII 140
Tracking Mask	1	1E	dB-Hz	Range 20 to 50 (decimal) *Not currently implemented*
Navigation Mask	1	21	dB-Hz	Range 28 to 50 (decimal)

Example

This example sets the Navigation mask to 33 dB-Hz (tracking default value of 30)

Start Sequence and Payload Length	`A0A20003`
Payload	`8C1E21`
Message Checksum and End Sequence	`00C9B0B3`

Editing Residual

Message ID **141**

Payload **3 bytes**

Description

This command specifies the editing residual threshold used by the Kalman filter for navigation.

Table 1.18 Editing Residual

Name	Bytes	Binary (Hex)	Units	Description
		Example		
Message ID	1	8D		ASCII 141
Editing Residual	2	2710	meters	Range 0 to 30000 (decimal) 0 disables

Steady State Detection

Message ID **142**

Payload **2 bytes**

Description

This message sets the steady state detection threshold. Steady state detection was implemented for S/A tuning as a filter for a satellite change in range as it moves towards or away from the receiver. It eliminates large jumps in range measurements due to S/A. Because S/A has been turned off, this message is now obsolete.

Table 1.19 Steady State Detection

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		8E		ASCII 142
Threshold	1	*10	0F	m/sec^2	Range 0 to 20

Example

This example data sets the Steady State Threshold to 1.5 m/sec^2 (15 ÷ 10 m/sec^2).

Start Sequence and Payload Length	A0A20002
Payload	8E0F
Message Checksum and End Sequence	009DB0B3

Static Navigation

Message ID **143**

Description

This message sets the static navigation threshold. A receiver with a velocity less than the threshold will revert to the static navigation mode, if enabled. Static navigation was implemented for S/A tuning to combat jumps due to S/A, and to smooth/clamp the jumps so the user has a moderate change in position due to S/A. Because S/A has been turned off, this message is now obsolete.

Table 1.20 Static Navigation Threshold

Name	Bytes	Binary (Hex)	Units	Description
		Example		
Message ID	1	8F		ASCII 143
Threshold	1	05	m/10 sec	Range: 0 to 20 Default: 5 0 = disabled

Example

This example data sets the Static Navigation Threshold to 5 m/10 sec.

Start Sequence and Payload Length	A0A20002
Payload	8F05
Message Checksum and End Sequence	0094B0B3

Clock Status

Message ID **144**

Payload **2 bytes**

Description

This message requests a clock status report. The status data is returned in a Clock Status Data output message (Message ID 7).

Table 1.21 Clock Status

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	90	ASCII 144
TBD	1	00	Reserved

Example

This example polls the clock status.

Start Sequence and Payload Length	A0A20002
Payload	9000
Message Checksum and End Sequence	0090B0B3

Set DGPS Serial Port

Message ID **145**

Payload **9 bytes**

Description

This command sets the communications parameters for the differential GPS correction on serial port B, as shown in Table 1.22.

Table 1.22 Set DGPS Serial Port

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	91	ASCII 145
Baud	4	00002580	38400, 19200, 9600, 4800, 2400, 1200
Data Bits	1	08	8, 7
Stop Bits	1	01	0, 1
Parity	1	00	0 = None, 1 = Odd, 2 = Even
Pad	1	00	Reserved

Example

This example message data sets DGPS Serial port to 9600,8,1,N.

Start Sequence and Payload Length	A0A20009
Payload	9100002580080100000
Message Checksum and End Sequence	013FB0B3

Poll Almanac

Message ID **146**

Payload **2 bytes**

Description

This message polls the GPS receiver for almanac data. The data is returned in an Almanac Data output message (Message ID 14). The message ID alone is sufficient to make the request.

For details on the almanac data message format, both in the satellite message and as packed data in the receiver, see the Set Almanac message (Message ID 130).

Table 1.23 Poll Almanac

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	92	ASCII 146
TBD	1	00	Reserved

Example

Start Sequence and Payload Length	A0A20002
Payload	9200
Message Checksum and End Sequence	0092B0B3

Poll Ephemeris

Message ID **147**

Payload **3 bytes**

Description

This message polls the GPS receiver for Ephemeris Data for all satellites currently being tracked, or for just one satellite. The data is returned in the Ephemeris Data output message (Message ID 15).

For details on the ephemeris data message format, both in the satellite message and as packed data in the receiver, see the Ephemeris Data output message (Message ID 15).

Table 1.24 Poll Ephemeris

Name	Bytes	Binary (Hex)	Description
		Example	
Message ID	1	93	ASCII 147
SV ID [1]	1	00	Range 0 to 32
TBD	1	00	Reserved

[1] A value of 0 requests all available ephemeris records; otherwise the ephemeris of the SV ID is requested.

Example

Start Sequence and Payload Length	A0A20003
Payload	930000
Message Checksum and End Sequence	0092B0B3

Set Ephemeris

Message ID **149**

Payload **91 bytes**

Description

This command enables the user to upload ephemeris data to the GPS receiver. Ephemeris contains precise orbital data on 32 satellites (Space Vehicle, or SV). The data contains 3 subframes of 15 16–bit words. The ephemeris portion of the 50 BPS data received from each satellite is composed of 10 30–bit words containing parity and telemetry information, along with the almanac information. When stripped of the telemetry and parity bits, the resultant data packed into 45 (3 x 15) 16–bit words makes up this message format.

For details on the ephemeris data message format, both in the satellite message and as packed data in the receiver, see the Ephemeris Data output message (Message ID 15).

Table 1.25 Set Ephemeris Data

Name	Bytes	Binary (Hex) Example	Description
Message ID	1	95	ACSII 149
EphemerisData	90		Ephemeris for 1 SV (45 16-bit words)

Set TricklePower Parameters

Message ID **151**

Payload **9 bytes**

Description

Sets the receiver into low power modes, as shown in Table 1.26.

Table 1.26 Set TricklePower Parameters

Name	Bytes	Binary (Hex)		Description
		Scale	Example	
Message ID	1		97	ASCII 151
Push To Fix Mode	2		0000	ON = 1, OFF = 0
Duty Cycle	2	*10	0OC8	% Time ON
Milliseconds On Time	4		000000C8	range 200 - 500 ms

Computation of Duty Cycle and On Time

The Duty Cycle is the desired time to be spent tracking (range is 20% – 50% and 100%). The On Time is the duration of each tracking period (range is 200 - 500 ms). Calculate the TricklePower update rate as a function of Duty cycle and On Time, using the following formula:

```
Off Time = (On Time - ( Duty Cycle * On Time)) ÷
              Duty Cycle
Update rate = Off Time + On Time
```

Note: On Time inputs greater than 500 ms default to 500 ms and Duty Cycle inputs >50% default to 100%

Example Selections for Trickle Power Mode of Operation

Mode	On Time	Duty Cycle	Update Rate(l/Hz)
Continuous	1000 ms	100%	1
Trickle Power	200 ms	20%	1

Push-to-Fix

In this mode. the user specifies the DutyCycle parameter, ranging up to 10%. The receiver will turn on periodically to check whether ephemeris collection is required (i.e., if a new satellite has become visible). If it is required, the receiver will collect ephemeris at that time. In general this takes on the order of 18 to 30 seconds. If it is not required, the receiver will turn itself off again. In either case, the amount of time the receiver remains off will be proportionate to how long it stayed on:

```
Off period  =  (On Period * (1 - Duty Cycle)) ÷
                       Duty Cycle
```

Off Period is limited to not more than 30 minutes, which means that in practice the duty cycle will not be less than approximately On Period/1800, or about 1%. Because Push-to-Fix keeps the ephemeris for all visible satellites up to date, a position/velocity fix can generally be computed relatively quickly when requested by the user: on the order of 3 seconds versus 46 seconds if Push-to-Fix were not available and the receiver cold-started.

Note: The 3 second figure increases to 6 seconds if the off period exceeds 30 minutes. Frame synchronization is commanded in this case.

Example

Set receiver into Trickle Power at I Hz update and 200 ms On Time.

Start Sequence and Payload Length	AOA20009
Payload	97000000C8000000C8
Message Checksum and End Sequence	0227B0B3

Output Messages for SiRF Binary Protocol

All output messages are received in *binary* format. Conductor interprets the binary data and saves it to the log file in ASCII format.

Table 1.27 lists the message list for the SiRF output messages.

Table 1.27 SiRF Messages – Output Message List

Hex	Dec	Name	Description
0 x 02	2	Measured Navigation Data Out	Position, velocity and time
0 x 04	4	Measured Tracker Data Out	Signal to noise information
0 x 05	5	Raw Tracker Data Out	Measurement information
0 x 06	6	Software Version String	Receiver software
0 x 07	7	Clock Status Data	Returns clock status data
0 x 08	8	50 BPS Data	Standard ICD format
0 x 09	9	CPU Throughput	CPU load
0 x 0A	10	Error	Error
0 x 0B	11	Command Acknowledgment	Successful request
0 x 0C	12	Command NAcknowledgment	Unsuccessful request
0 x 0D	13	Get Visible List	Report on visible satellites
0 x 0E	14	Almanac Data	Report almanac data
0 x 0F	15	Ephemeris Data	Report ephemeris data
0 x 11	17	Raw DGPS	DGPS input data
0 x 12	18	OK To Send	TricklePower response period
0 x FF	255	Development Data	Various data messages

Measured Navigation Data Out

Message ID **2**

Payload **41 bytes**

Output Rate: **1 Hz**

Description

Table 1.28 lists the binary and ASCII message data format for the measured navigation data.

Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (e.g., decimal X_{vel} = binary X_{vel} ÷ 8).

Table 1.28 Measured Navigation Data Out - Binary & ASCII Message Data Format

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		02			2
X-position	4		FFD6F78C	m		-2689140
Y-position	4		FFBE536E	m		-4304018
Z-position	4		003AC004	m		3850244
X-velocity	2	*8	00	m/s	Vx÷8	0
Y-velocity	2	*8	03	m/s	Vx÷8	0.375
Z-velocity	2	*8	01	m/s	÷8	0.125
Mode 1	1		04	Bitmap [1]		4
DOP [2]	1	*5	A		÷5	2.0
Mode 2	1		00	Bitmap [3]		0
GPS Week [4]	2		036B			875
GPS TOW	4	*100	039780E3	seconds	÷100	602605.79
SVs in Fix	1		06			6
CH 1	1		12			18
CH 2	1		19			25
CH 3	1		0E			14
CH 4	1		16			22
CH 5	1		0F			15
CH 6	1		04			4
CH 7	1		00			0

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
CH 8	1		00			0
CH 9	1		00			0
CH 10	1		00			0
CH 11	1		00			0
CH 12	1		00			0

[1] For further information, go to Table 1.29.

[2] Dilution of precision (DOP) field contains value of PDOP when position is obtained using 3D solution and HDOP in all other cases.

[3] For further information, go to Table 1.30.

[4] The GPS week number rolled over on 22 August, 1999 from 1023 to 0, per ICD-GPS-200. To maintain rollover compliance, the week number is reported between 0 and 1023. Extended GPS week (ICD GPS week + 1024) information is available in the Clock Status Data message.

Table 1.29 Mode 1

Mode 1		Description
Bits	ASCII	
0 – 2	0	No Navigation Solution
0 – 2	1	1 Satellite Solution
0 – 2	2	2 Satellite Solution
0 – 2	3	3 Satellite Solution (2D)
0 – 2	4	≥4 Satellite Solution (3D)
0 – 2	5	2D Point Solution (Krause)
0 – 2	6	3D Point Solution (Krause)
0 – 2	7	Dead Reckoning (Time Out)
3	0	unused – reserved
4	0	unused – reserved
5	0	unused – reserved
6	64	DOP mask exceeded
7	128	DGPS used

Table 1.30 Mode 2

Mode 2		Description
Bit	ASCII	
0	1	DR Sensor Data
1	2	Validated/Invalidated
2	4	Dead Reckoning (Time Out)
3	8	Output Edited by UI
4	0	unused – reserved
5	0	unused – reserved
6	0	unused – reserved
7	0	unused – reserved

Example

Start Sequence and Payload Length	A0A20029
Payload	02FFD6F78CFFBE536E003AC0040 0030104A00036B039780E306121 90E160F04000000000000
Message Checksum and End Sequence	09BBB0B3

Measured Tracker Data Out

Message ID **4**

Payload **188 bytes**

Output Rate **1 Hz**

Description

Table 1.29 lists the binary and ASCII message data format for the measured tracker data. The Clock Status Data (Message ID 7) precedes and applies to this the measured data message that follows it.

Note: Message length is fixed to 188 bytes with non-tracking channels reporting zero values.

Table 1.31 Measured Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)
		Scale	Example		Example
Message ID	1		04	None	4
GPS Week [2]	2		036C		876
GPS TOW	4	s * 100	0000937F	s	37759
Chans	1		0C		12
SV ID	1		0E		14 (SV ID on chan. 1)
Azimuth	1	Az * [2/3]	AB	degree	256.5 (SV azimuth on chan. 1)
Elev	1	El * 2	46	degree	35 (SV elevation on chan. 1)
State	2		003F	bitmap [1]	63 (Channel 1 state)
C/No 1	1		1A	dB-Hz	26 (1 of 10 samples per sec)
C/No 2	1		1E	dB-Hz	30 (2 of 10 samples per sec)
C/No 3	1		1D	dB-Hz	29 (3 of 10 samples per sec)
C/No 4	1		1D	dB-Hz	29 (4 of 10 samples per sec)
C/No 5	1		19	dB-Hz	25 (5 of 10 samples per sec)
C/No 6	1		1D	dB-Hz	29 (6 of 10 samples per sec)
C/No 7	1		1A	dB-Hz	26 (7 of 10 samples per sec)
C/No 8	1		1A	dB-Hz	26 (8 of 10 samples per sec)
C/No 9	1		1D	dB-Hz	29 (9 of 10 samples per sec)
C/No 10	1		1F	dB-Hz	31 (10 of 10 samples per sec)
… The previous 14 fields (SV ID through C/No 10) are repeated for channels 2 through 12.					

[1] For further information, see Table 1.32.

[2] The GPS week number rolled over on 22 August, 1999 from 1023 to 0, per ICD-GPS-200. To maintain rollover compliance, the week number is reported between 0 and 1023. Extended GPS week (ICD GPS week + (1024 * number of rollovers) information is available in the Clock Status Data (Message ID 7).

Table 1.32 State Field Definition

Field Definition	Hex Value	Description
ACQ_SUCCESS	0x0001	Set if signal acquisition or reacquisition is successful
DELTA_CARPHASE_VALID	0x0002	Integrated carrier phase is valid
BIT_SYNC_DONE	0x0004	Bit sync completed
SUBFRAME_SYNC_DONE	0x0008	Subframe sync completed
CARRIER_PULLIN_DONE	0x0010	Carrier pull-in completed
CODE_LOCKED	0x0020	Code locked
ACQ_FAILED	0x0040	Failed to acquire SV
GOT_EPHEMERIS	0x0080	Ephemeris data available

When a channel is fully locked and all data is valid, the status shown is 0xBF.

Example

Start Sequence and Payload Length	A0A200BC
Payload	04036C0000937F0C0EAB46003F1A1E1D 1D191D1A1A1D1F1D59423F1A1A...
Message Checksum and End Sequence	****B0B3

Raw Tracker Data Out

Message ID **5**

Payload **51 bytes per satellite tracked (up to 12)**

Output Rate **1 Hz**

Description

Table 1.33 lists the binary and ASCII message data format for the raw tracker data. Only active (tracking) channels are output. Satellites with bad health are still tracked and output, but not used in the navigation solution. The Clock Status Data (Message ID 7) precedes and applies to the multiple raw tracker data messages that follow it. To get Raw Tracker Data on a regular (one per second) basis you must command the raw data output via the Reset Configuration field from the Initialize Data Source command (Message ID 128).

Table 1.33 Raw Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)
		Scale	Example		Example
Message ID	1		05		5
Channel	4		00000007		7 (Range 1 to 12)
SV ID	2		0013		19
State	2		003F	bitmap [1]	63
Bits	4		00EA1BD4	bit	15342548 (20 ms intervals into the week; 1 bit at 50 bps = 20 ms; Range 0 to 30240000)
Ms	2		000D	ms	13 (# ms into the 20 ms bit time; Range 0 to 20)
Chips	2		0392	chip	914 (Code tracking chip number; Range 0 to 1023)
Code Phase	4	2^{-16}	00009783	chip	38787 (1/65536 of a chip)
Carrier Doppler	4	2^{-10}	000DF45E	rad/2ms	914526 (Doppler frequency in Hz / 0.0777)
Time Tag	4		000105B5	ms	66997 (Time tag of measurement)
Delta Carrier	4	2^{-10}	FF90F5C2	cycles	-7277118 (Current carrier phase; -delta pseudorange * Accumulated Time (ms) * 0.19 / 1.024)
Search Count	2		0000		0 (currently unused; # times to search for an SV)
C/No 1	1		24	dB-Hz	36 (1 of 10 samples per sec)
C/No 2	1		28	dB-Hz	40 (2 of 10 samples per sec)
C/No 3	1		27	dB-Hz	39 (3 of 10 samples per sec)
C/No 4	1		27	dB-Hz	39 (4 of 10 samples per sec)
C/No 5	1		23	dB-Hz	35 (5 of 10 samples per sec)
C/No 6	1		27	dB-Hz	39 (6 of 10 samples per sec)
C/No 7	1		24	dB-Hz	36 (7 of 10 samples per sec)
C/No 8	1		24	dB-Hz	36 (8 of 10 samples per sec)
C/No 9	1		27	dB-Hz	39 (9 of 10 samples per sec)
C/No 10	1		29	dB-Hz	41 (10 of 10 samples per sec)

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)
		Scale	Example		Example
Power Bad Cut	1		05		5 (# 20 ms checks that failed due to power below 31 dB-Hz)
Phase Bad Cut	1		00000007		7 (# 20 ms checks that failed due to carrier phase lock)
Delta Car Int	2		0013	ms	19 (# ms of carrier accumulation)
Correl Int	2		0005		5 (Correlation interval; 1 = 2 ms; 5 = 10 ms)

[1] For further information, see Table 1.32.

Example

Start Sequence and Payload Length	A0A20033
Payload	0500000070013003F00EA1BD4000D0 39200009783000DF45E000105B5FF90 F5C2000024282727232724242729050 00000070013003F
Message Checksum and End Sequence	0B2DB0B3

Software Version String

Message ID **6**

Payload **21 bytes**

Output Rate **Response to polling message**

Description

This message contains the GPS receiver software version number as a string. Both the SiRF baseline version and Axiom version is returned (separated by a dash). It is sent in response to the Software Version input message (Message ID 132).

Table 1.34 Software Version String

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	06	6
Character	20	[1]	[2]

1 312E332E32444B49543334342D303330314158	
2 1.3.2DKIT344-0301AX	

Convert ASCII values to characters to assemble the message (e.g., 0x4E is 'N'). These are low priority task and are not necessarily output at constant intervals.

Example

Start Sequence and Payload Length	A0A20015
Payload	06312E332E32444B4954333 4342D303330314158
Message Checksum and End Sequence	0443B0B3

Clock Status Data

Message ID **7**

Payload **20 bytes**

Output Rate **1 Hz or response to polling message**

Description

This message returns the clock status data, either on a regular basis or in response to a Clock Status input message (Message ID 144). To get Clock Status data on a regular (one per second) basis you must command the raw data output via the Reset Configuration field from the Initialize Data Source command (Message ID 128).

Table 1.35 Clock Status Data Message

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)
		Scale	Example		Example
Message ID	1		07		7
Extended GPS Week	2		03BD		True GPS week number, not rolled over: 957
GPS TOW	4	*100	02154924	seconds	349494.12
SVs	1		08		8
Clock Drift	4		2231	Hz	74289
Clock Bias	4		7923	nanoseconds	128743715

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)
		Scale	Example		Example
Estimated GPS Time	4		DAEF	milliseconds	349493999

Example

Start Sequence and Payload Length	A0A20014
Payload	0703BD0215492408223179 23DAEF
Message Checksum and End Sequence	0598B0B3

50 BPS Data

Message ID **8**

Payload **43 bytes per subframe (6 subframes per page, 25 pages Almanac)**

Output Rate **As available (12.5 minute download time)**

Descripiton

This message contains the 50 Bit–Per–Second navigation message transmitted from the satellite. To get this data on a regular basis you must command the Raw Data Output via the Reset Configuration field from the Initialize Data Source command (Message ID 128). Each tracking channel's data is output once every 6 seconds.

Data is logged in ICD format, available from http://www.navcen.uscg.mil/.

Table 1.36 50 BPS Data

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	08	8
Channel	1		
SV ID	1		
Word[10]	40		

Example

Start Sequence and Payload Length	A0A2002B
Payload	08********
Message Checksum and End Sequence	****B0B3

CPU Throughput

Message ID **9**

Payload **9 bytes**

Output Rate: **1 Hz**

Description

This message indicates interrupt service latency and leftover processor time within each 1 second period.

SegStatMax is the maximum number when the receiver finished processing.

SegStatLat is the maximum receiver interrupt latency over 1 second.

AveTrkTime is the average time spent in receiver SegStatTTL/TTLcnt.

LastMs is the millisecond on which the navigation code finished processing measurements on the previous navigation cycle. The range is 0-1000.

Table 1.37 CPU Throughput

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		09			9
SegStatMax	2	*186	003B	milliseconds	÷186	.3172
SegStatLat	2	*186	0011	milliseconds	÷186	.0914
AveTrkTime	2	*186	0016	milliseconds	÷186	.1183
Last MS	2		01E5	milliseconds		485

Example

Start Sequence and Payload Length	A0A20009

Payload	09003B0011001601E5
Message Checksum and End Sequence	0151B0B3

Error

Message ID **10**

Payload **variable**

Output Rate: **variable, as needed**

Description

This message reports run–time errors. It is of variable length, depending on the number of parameters passed. Generally, there is nothing for the application to do. Most error messages are simply informational. For example, Error ID 1 indicates that the 50 BPS data has a bad parity. This will normally happen when the antenna is obstructed, even momentarily, since data has been lost. The error messages are intended for SiRF and Axiom to monitor receiver performance. Since you may see this message ID appear on occasion, this description is only intended to explains why it exists, and not the details of every possible error message.

Table 1.38 Error

Name	Bytes	ASCII (Decimal)
		Example
Message ID	1	10
Error ID	2	Defines the error type
Count	2	Number of 32–bit words to follow (Range 0 to 18)
Word 1	4	
…		
Word n	4	

Command Acknowledgment

Message ID **11**

Payload **2 bytes**

Output Rate **Response to successful input message**

Description

This message is returned to indicate that an input message has been received and verified by its checksum. The message ID being acknowledged is included in this message.

Table 1.39 Command Acknowledgment

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	0B	11
Ack. ID	1	92	146 (Msg ID being acknowledged)

Example

This is a successful almanac (message ID 0x92) request example:

Start Sequence and Payload Length	A0A20002
Payload	0B92
Message Checksum and End Sequence	009DB0B3

Command NAcknowledgment

Message ID **12**

Payload **2 bytes**

Output Rate **Response to rejected input message**

Description

This message indicates that a message has been received but was invalid based on its checksum. The message ID not being acknowledged is included in this message.

Table 1.40 Command Nacknowledgment

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	0C	12
NAck. ID	1	92	146 (Msg ID being rejected)

Example

This is an unsuccessful almanac (message ID 0x92) request example:

Start Sequence and Payload Length	A0A20002
Payload	0C92
Message Checksum and End Sequence	009EB0B3

Get Visible List

Message ID **13**

Payload **62 bytes (maximum)**

Output Rate **Updated approximately every 2 minutes**

Description

This is a variable length message. The number of visible satellites is reported, along with their ID, azimuth and elevation (as defined by Visible SVs in Table 1.41). Maximum is 12 satellites.

Table 1.41 Visible List

Name	Bytes	Binary (Hex)	Units	ASCII (Decimal)
		Example		Example
Message ID	1	0D		13
Visible SVs	1	08		8
SV ID	1	07		7 (SV ID on first channel)
SV Azimuth	2	0029	degrees	41 (SV azimuth on first channel)
SV Elevation	2	0038	degrees	56 (SV elevation on first channel)
… The previous 3 fields (SV ID through SV Elevation) are repeated for up to 12 channels.				

Example

Start Sequence and Payload Length	A0A2002A
Payload	0D08070029003809013300 2C******************
Message Checksum and End Sequence	****B0B3

Almanac Data

Message ID **14**

Payload **30 bytes**

Output Rate **Response to poll**

Description

Returns data from the Poll Almanac input message (Message ID 146). The complete message is transmitted 32 times, representing data on 32 satellites (Space Vehicles — SVs). The data for each SV contains 14 16-bit words. The almanac portion of the 50 bit–per–second data received from each satellite is composed of 10 30–bit words containing parity and telemetry information, along with the almanac information. The telemetry and parity bits are stripped. The resultant data is packed into the 14 16–bit words.

For details on the almanac data message format, both in the satellite message and as packed data in the receiver, see the Set Almanac message (Message ID 130).

Table 1.42 Almanac Data

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	0E	14
SV ID	1	01	1 (range 1 to 32)
AlmanacData[14][2]	28		

Ephemeris Data

Message ID **15**

Payload **92 bytes**

Output Rate **Response to poll**

Description

Returns data from the Poll Ephemeris input message (Message ID 147). This enables the user to download satellite ephemeris from the GPS receiver. The ephemeris contains precise orbital data on a satellite (Space Vehicle, or SV). The data contains 3 subframes of 15 16–bit words. The ephemeris portion of the 50 BPS data received from each satellite is composed of 10 30–bit words containing parity and telemetry information, along with the almanac information. When stripped of the telemetry and parity bits, the resultant data packed into 45 (3 x 15) 16–bit words (90 bytes) makes up this message format.

For details on the ephemeris data format in the satellite message see the Interface Control Document, GPS ICD–200 at:

http://www.navcen.uscg.mil/gps/geninfo/gpsdocuments/icd200/default.htm

The GPS ICD–200 is also on Axiom's Evaluation Kit CD in the **GPS** folder.

For useful software and details on the packed ephemeris data format see the code modules **CALEPH.C** and **DATSTRUC.H** on Axiom's Evaluation Kit CD in the **\SiRF ToolKit\Other Tools\CalcPSR** folder.

Table 1.43 Ephemeris Data

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	0F	15
SV ID	1	13	19 (range 1 to 32)
EphemerisData	90		

Either 1 message is returned, when a specific satellite is requested, or all 32 satellites (32 messages) are returned. The EphemerisData field is all zeroes if no ephemeris exists for that satellite.

Raw DGPS

Message ID **17**

Payload **variable**

Output Rate: **1 Hz**

Description

This message reports the raw DGPS data coming in on port B. The message is of variable length. If no DGPS correction data is being input, then a zero length message will result. To get Raw DGPS Data on a regular (one per second) basis you must command the raw data output via the Reset Configuration field from the Initialize Data Source command (Message ID 128).

Table 1.44 Raw DGPS

Name	Bytes	ASCII (Decimal)
		Example
Message ID	1	17
Count	2	Number of bytes to follow
Byte 1	1	
…		
Byte n	1	

OK To Send

Message ID **18**

Payload **2 bytes**

Output Rate: **variable, as needed**

Description

This message indicates to an external application that the receiver is either going into sleep mode or is now out of sleep mode. This allows an external application to know when communication with the receiver is possible. This synchronization message is only meaningful when the receiver is operating in TricklePower mode, however it is output in all modes.

When the receiver is in sleep mode an external application will not be able to communicate with it. The application should wait for the OK To Send message, and then immediate send any commands needed.

It is not absolutely necessary to coordinate receiver communication with this message. However, without it, your communication may be "hit and miss." Sending your command on two or three retries typically will suffice, as well.

Table 1.45 OK To Send

Name	Bytes	ASCII (Decimal)
		Example
Message ID	1	18
Input Enabled	1	1 = Receiver is not in sleep mode 0 = Receiver is about to enter sleep mode

Development Data

Message ID **255**

Payload **Variable**

Output Rate **Variable**

Description

These messages are output to give the user information on receiver activity. The messages come from low priority tasks and are not necessarily output at constant intervals. These are primarily intended for SiRF and Axiom use only. Some users may find the data useful. To get Development Data you must command Enable Development Data via the Reset Configuration field from the Initialize Data Source command (Message ID 128).

Table 1.46 Development Data

Name	Bytes	Binary (Hex)	ASCII (Decimal)
		Example	Example
Message ID	1	FF	255
Byte 1	1		
…			
Byte n	1		

Example

Start Sequence and Payload Length	A0A2****
Payload	FF**************
Message Checksum and End Sequence	****B0B3

Chapter 2 NMEA Input/Output Messages

Axiom receivers can be set to output data in NMEA-0183 format, as defined by the National Marine Electronics Association (NMEA). Refer to the *Standard For Interfacing Marine Electronic Devices, Version 2.21*, for detailed information, available on the association's website at www.nmea.org/.

While in NMEA messaging mode, NMEA input messages can also be sent to Axiom receivers.

Setting NMEA Messaging Mode

Axiom receivers may be set to NMEA messaging mode by sending the SiRF Binary protocol **Switch To NMEA Protocol** message (Message ID 129).

In the Conductor demonstration software, you can change to NMEA messaging mode by selecting the **File ⇒ Message Set ⇒ NMEA Message Set** menu item, or by clicking the NMEA button.

NMEA Message Structure

NMEA input and output messages have four parts, as shown in the following table:

NMEA Transport Message Structure

Start Sequence	Message Identifier	Payload	Checksum	End Sequence
$PSRF	<MID>	<Data>	*<CKSUM>	<CR><LF>

The start sequence is always $PSRF.

The message identifier is three numeric characters. Input messages begin at MID 100.

The payload contains message specific data. Refer to each specific message section for the data definitions.

The CKSUM is a two digit hex character checksum, as defined in the NMEA specification. The checksum is always required, and is preceded with an asterisk (*). It is an 8–bit exclusive OR (XOR) of all characters between, but not including, the “$” and “*” delimiters.

Each message is terminated using carriage return (CR) and line feed (LF), or \r\n (hex 0D0A). Because \r\n are not printable ASCII characters, they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

All fields in all proprietary NMEA messages are required; none are optional. All NMEA message fields are comma delimited.

NMEA Input Messages

NMEA input messages are provided to allow you to control Axiom receivers while in NMEA protocol mode. If the receiver is in SiRF Binary mode, all NMEA input messages are ignored. Once the receiver is put into NMEA mode, the following messages may be used to command the module.

Table 2.1 SiRF NMEA Input Messages

Message	Message ID	Description
Set Serial Port	100	Set PORT A parameters and protocol
Navigation Initialization	101	Parameters required for start using X/Y/Z
Set DGPS Port	102	Set PORT B parameters for DGPS input
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLA Navigation Initialization	104	Parameters required for start using Lat/Lon/Alt
Development Data On/Off	105	Turn Development Data messages On/Off
Set Datum	106	Set user or predefined Datum
Set Low Power	107	Set low power modes

Set Serial Port

Message ID **100**

Description

This command message is used to set the protocol (SiRF Binary or NMEA) and/or the communication parameters (baud, data bits, stop bits, parity). Generally, this command is used to switch the module back to SiRF Binary protocol mode where a more extensive command message set is available. When a valid message is received, the parameters are stored in battery-backed SRAM and then the receiver restarts using the saved parameters.

Table 2.2 Set Serial Port Data Format

Name	Example	Description
Message ID	$PSRF100	PSRF100 protocol header
Protocol	0	0 = SiRF Binary, 1 = NMEA, 2 = Axiom
Baud	9600	4800, 9600, 19200, 38400
Data Bits	8	8, 7 [1]
Stop Bits	1	0, 1
Parity	0	0 = None, 1 = Odd, 2 = Even
Checksum	*0C	
<CR><LF>		End of message termination

[1] SiRF and Axiom protocols are only valid for 8 data bits, 1 stop bit and no parity.

Example

This example switches to SiRF Binary protocol at 9600, 8, N, 1:

```
$PSRF100,0,9600,8,1,0*0C
```

Navigation Initialization

Message ID 101

Description

This command is used to initialize the module for a warm start, by providing current position (in X, Y, Z coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

Table 2.3 Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	meters	X coordinate position
ECEF Y	-4304200	meters	Y coordinate position
ECEF Z	3851624	meters	Z coordinate position
ClkOffset	95000	Hz	Clock Offset of the receiver [1]
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table 2.4
Checksum	*22		
<CR><LF>			End of message termination

[1] Use 0 for last saved value if available. If unavailable, a default value of 96,000 will be used.

Table 2.4 Reset Configuration

Hex	Description
0x01	Data Valid – Warm/Hot Start = 1
0x02	Clear Ephemeris – Warm Start = 1
0x04	Clear Memory – Cold Start = 1

Examples

This example sets the unit to start using a known position and time:

```
$PSRF101,-2686700,-4304200,3851624,95000,
497260,921,12,3*22
```

Set DGPS Port

Message ID 102

Description

This command is used to control Port B – DGPS, which is an input-only serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. The default communication parameters for PORT B are 9600 baud, 8 data bits, stop bit, and no parity. If a DGPS receiver is used that has different communication parameters, use this command to allow the receiver to correctly decode the data. When a valid message is received, the parameters are stored in battery-backed SRAM and then the receiver restarts using the saved parameters.

Table 2.5 Set DGPS Port Data Format

Name	Example	Description
Message ID	$PSRF102	PSRF102 protocol header
Baud	9600	4800, 9600, 19200, 38400
Data Bits	8	8, 7
Stop Bits	1	0, 1
Parity	0	0 = None, 1 = Odd, 2 = Even
Checksum	*3C	
<CR><LF>		End of message termination

Example

This example sets the DGPS Port to be 9600,8,N,1:

```
$PSRF102,9600,8,1,0*3C
```

Query/Rate Control

Message ID **103**

Description

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, GSV, RMC, and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Table 2.6 Query/Rate Control Data Format (See Example 1.)

Name	Example	Units	Description
Message ID	$PSRF103		PSRF102 protocol header
Msg	00		See 0
Mode	01		0 = Set Rate, 1 = Query
Rate	00	seconds	Output – off = 0, max = 255
CksumEnable	01		0 = Disable Checksum, 1 = Enable Checksum
Checksum	*25		
<CR><LF>			End of message termination

Table 2.7 Messages

Value	Description
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG

Example

1. Query the GGA message with checksum enabled (see Table 2.6):

   `$PSRF103,00,01,00,01*25`

2. Enable VTG message for a 1 Hz constant output with checksum enabled:

   `$PSRF103,05,00,01,01*20`

3. Disable VTG message:

   `$PSRF103,05,00,00,01*21`

LLA Navigation Initialization

Message ID **104**

Description

This command is used to initialize the module for a warm start, by providing current position (in latitude, longitude, and altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

Table 2.8 Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	degrees	Latitude position (Range 90 to -90)
Lon	-121.97232	degrees	Longitude position (Range 180 to -180)
Alt	0	meters	Altitude position
ClkOffset	95000	Hz	Clock Offset of the receiver [1]
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	922		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See 0
Checksum	*3A		
<CR><LF>			End of message termination

[1] Use 0 for last saved value if available. If unavailable, a default value of 96,000 will be used.

Table 2.9 Reset Configuration

Hex	Description
0x01	Data Valid – Warm/Hot Start = 1
0x02	Clear Ephemeris – Warm Start = 1
0x04	Clear Memory – Cold Start = 1

Example

This example starts the unit using known position and time.

```
$PSRF104,37.3875111,-121.97232,0,95000,237759,922,
12,3*3A
```

Development Data On/Off

Message ID **105**

Description

Use this command to enable development data information if you are having trouble getting commands accepted. Invalid commands generate debug information that enables the user to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum or parameter out of specified range.

Table 2.10 Development Data On/Off Data Format

Name	Example	Description
Message ID	$PSRF105	PSRF105 protocol header
Debug	1	0 = Off, 1 = On
Checksum	*3E	
<CR><LF>		End of message termination

Table 2.10 contains the input values for the following examples:

1. Debug On

   `$PSRF105,1*3E`

2. Debug Off

   `$PSRF105,0*3F`

Set Datum

Message ID **106**

Description

This command message is used to specify either a preset datum, or a user defined datum. When a valid message is received, the parameters are stored in battery-backed SRAM and then the receiver restarts using the saved parameters. Table 2.13 lists 219 predefined datums. The default datum used is number 217, WGS 1984.

Table 2.12 lists 23 preset ellipsoids used with the preset datums. A datum is selected with its ID number in the datum table. Its corresponding ellipsoid is automatically used.

The reference ellipsoids and geodetic datum transformation parameters in the two tables are local to WGS-84 (from NIMA 8350.2 4 July 1977 and MadTran 1 October 1996)

Specifying a datum ID of 0 means user provided parameters of SemiMajorAxis, FlatteningCoeff, Dx, Dy, and Dz are used, rather than a predefined datum.

This command is only available with the NMEA message set in Axiom firmware builds based on SiRF baseline 1.3.2 and higher.

Table 2.11 Set Datum

Name	Example	Units	Description
Message ID	$PSRF106		PSRF106 protocol header
Datum	0		User defined, use next 5 parameters
SemiMajorAxis	6377397.155	Meters	Semi-Major Axis
FlatteningCoeff	299.1528128		Flattening Coefficient
Dx	-148	Meters	Delta X from WGS-84
Dy	507	Meters	Delta Y from WGS-84
Dz	685	Meters	Delta Z from WGS-84
Checksum	*7		
<CR><LF>			End of message termination

Example

The above example specifies a user defined datum.

```
$PSRF106,0, 6377397.155, 299.1528128,-
148,507,685*07
```

Example

This example specifies to use the Tokyo Mean datum (ID 208) from Table 2.13.

```
$PSRF106,208,0.0,0.0,0,0,0*2A
```

Table 2.12 Ellipsoids Used for Preset Datums

ID	Ellipsoid	Semi-major Axis	Flattening Coeff
0	User Defined		
1	Airy 1830	6377563.396	299.3249646
2	Modified Airy	6377340.189	299.3249646
3	Australian National	6378160	298.25
4	Bessel 1841 (Namibia)	6377483.865	299.1528128
5	Bessel 1841	6377397.155	299.1528128
6	Clarke 1866	6378206.4	294.9786982
7	Clarke 1880	6378249.145	293.465
8	Everest (India 1830)	6377276.345	300.8017
9	Everest (Sabah Sarawak)	6377298.556	300.8017
10	Everest (India 1956)	6377301.243	300.8017
11	Everest (Malaysia 1969)	6377295.664	300.8017
12	Everest (Malay. & Sing)	6377304.063	300.8017
13	Everest (Pakistan)	6377309.613	300.8017
14	Modified Fischer 1960	6378155	298.3
15	Helmert 1906	6378200	298.3
16	Hough 1960	6378270	297
17	Indonesian 1974	6378160	298.247
18	International 1924	6378388	297
19	Krassovsky 1940	6378245	298.3
20	GRS 80	6378137	298.2572221
21	South American 1969	6378160	298.25
22	WGS 72	6378135	298.26
23	**WGS 84**	**6378137**	**298.2572236**

Table 2.13 Preset Datums

ID	Datum	Ellip ID	dX	dY	dZ
0	User Defined	0			
1	Adindan – Burkina Faso	7	-118	-14	218
2	Adindan – Cameroon	7	-134	-2	210
3	Adindan – Ethiopia	7	-165	-11	206
4	Adindan – Mali	7	-123	-20	220
5	Adindan – Ethiopia; Sudan	7	-166	-15	204
6	Adindan – Senegal	7	-128	-18	224
7	Adindan – Sudan	7	-161	-14	205
8	Afgooye	19	-43	-163	45
9	Ain el Abd 1970 – Bahrain	18	-150	-250	-1
10	Ain el Abd 1970 – Saudi Arabia	18	-143	-236	7
11	American Samoa 1962	6	-115	118	426
12	Anna 1 Astro 1965	3	-491	-22	435
13	Antigua Island Astro 1943	7	-270	13	62
14	Arc 1950 – Botswana	7	-138	-105	-289
15	Arc 1950 – Burundi	7	-153	-5	-292
16	Arc 1950 – Lesotho	7	-125	-108	-295
17	Arc 1950 – Malawi	7	-161	-73	-317
18	Arc 1950 - Botswana; Lesotho; Zaire	7	-143	-90	-294
19	Arc 1950 – Swaziland	7	-134	-105	-295
20	Arc 1950 – Zaire	7	-169	-19	-278
21	Arc 1950 – Zambia	7	-147	-74	-283
22	Arc 1950 – Zimbabwe	7	-142	-96	-293
23	Arc 1960 - Kenya; Tanzania	7	-160	-6	-302
24	Arc 1960 - Kenya	7	-157	-2	-299
25	Arc 1960 – Tanzania	7	-175	-23	-303
26	Ascension Island 1958	18	-205	107	53
27	Astro Beacon E 1945	18	145	75	-272
28	Astro DOS 71/4	18	-320	550	-494
29	Astro Tern Island (FRIG) 1961	18	114	-116	-333
30	Astronomical Station 1952	18	124	-234	-25
31	Australian Geodetic 1966	3	-133	-48	148

32	Australian Geodetic 1984	3	-134	-48	149
33	Ayabelle Lighthouse	7	-79	-129	145
34	Bellevue (IGN)	18	-127	-769	472
35	Bermuda 1957	6	-73	213	296
36	Bissau	18	-173	253	27
37	Bogota Observatory	18	307	304	-318
38	Bukit Rimpah	5	-384	664	-48
39	Camp Area Astro	18	-104	-129	239
40	Campo Inchauspe	18	-148	136	90
41	Canton Astro 1966	18	298	-304	-375
42	Cape	7	-136	-108	-292
43	Cape Canaveral	6	-2	151	181
44	Carthage	7	-263	6	431
45	Chatham Island Astro 1971	18	175	-38	113
46	Chua Astro	18	-134	229	-29
47	Corrego Alegre	18	-206	172	-6
48	Dabola	7	-83	37	124
49	Deception Island	7	260	12	-147
50	Djakarta (Batavia)	5	-377	681	-50
51	DOS 1968	18	230	-199	-752
52	Easter Island 1967	18	211	147	111
53	Estonia; Coordinate System 1937	5	374	150	588
54	European 1950 – Cyprus	18	-104	-101	-140
55	European 1950 – Egypt	18	-130	-117	-151
56	European 1950 - England; Channel Islands; Scotland	18	-86	-96	-120
57	European 1950 - England; Ireland; Scotland	18	-86	-96	-120
58	European 1950 - Finland; Norway	18	-87	-95	-120
59	European 1950 – Greece	18	-84	-95	-130
60	European 1950 - Iran	18	-117	-132	-164
61	European 1950 - Italy (Sardinia)	18	-97	-103	-120
62	European 1950 - Italy (Sicily)	18	-97	-88	-135
63	European 1950 - Malta	18	-107	-88	-149
64	European 1950 - Austria; Belgium; Denmarc	18	-87	-98	-121
65	European 1950 - Austria; Belgium; France	18	-87	-96	-120

66	European 1950 - Iraq; Israel; Jordan	18	-103	-106	-141
67	European 1950 - Portugal; Spain	18	-84	-107	-120
68	European 1950 - Tunisia	18	-112	-77	-145
69	European 1979	18	-86	-98	-119
70	Fort Thomas 1955	7	-7	215	225
71	Gan 1970	18	-133	-321	50
72	Geodetic Datum 1949	18	84	-22	209
73	Graciosa Base SW 1948	18	-104	167	-38
74	Guam 1963	6	-100	-248	259
75	Gunung Segara	5	-403	684	41
76	GUX 1 Astro	18	252	-209	-751
77	Herat North	18	-333	-222	114
78	Hermannskogel Datum	4	653	-212	449
79	Hjorsey 1955	18	-73	46	-86
80	Hong Kong 1963	18	-156	-271	-189
81	Hu-Tzu-Shan	18	-637	-549	-203
82	Indian - Bangladesh	8	282	726	254
83	Indian - India; Nepal	10	295	736	257
84	Indian - Pakistan	13	283	682	231
85	Indian 1954	8	217	823	299
86	Indian 1960 - Vietnam (Con Son Island)	8	182	915	344
87	Indian 1960 - Vietnam (Near 16øN)	8	198	881	317
88	Indian 1975	8	210	814	289
89	Indonesian 1974	17	-24	-15	5
90	Ireland 1965	2	506	-122	611
91	ISTS 061 Astro 1968	18	-794	119	-298
92	ISTS 073 Astro 1969	18	208	-435	-229
93	Johnston Island 1961	18	189	-79	-202
94	Kandawala	8	-97	787	86
95	Kerguelen Island 1949	18	145	-187	103
96	Kertau 1948	12	-11	851	5
97	Kusaie Astro 1951	18	647	1777	-112
98	Korean Geodetic System	20	0	0	0
99	L. C. 5 Astro 1961	6	42	124	147
100	Leigon	7	-130	29	364

101	Liberia 1964	7	-90	40	88
102	Luzon - Philippines (excl. Mindanao)	6	-133	-77	-51
103	Luzon - Philippines (Mindanao)	6	-133	-79	-72
104	M'Poraloko	7	-74	-130	42
105	Mahe 1971	7	41	-220	-134
106	Massawa	5	639	405	60
107	Merchich	7	31	146	47
108	Midway Astro 1961	18	912	-58	1227
109	Minna – Cameroon	7	-81	-84	115
110	Minna - Nigeria	7	-92	-93	122
111	Montserrat Island Astro 1958	7	174	359	365
112	Nahrwan - Oman (Masirah Island)	7	-247	-148	369
113	Nahrwan – Saudi Arabia	7	-243	-192	477
114	Nahrwan - United Arab Emirates	7	-249	-156	381
115	Naparima BWI	18	-10	375	165
116	N. American 1927 - Alaska (Excluding Aleutian Ids)	6	-5	135	172
117	N. American 1927 - Alaska (Aleutian Ids East of 180øW)	6	-2	152	149
118	N. American 1927 - Alaska (Aleutian Ids West of 180øW)	6	2	204	105
119	N. American 1927 - Bahamas (Except San Salvador Id)	6	-4	154	178
120	N. American 1927 - Bahamas (San Salvador Island)	6	1	140	165
121	N. American 1927 - Canada (Alberta; British Columbia)	6	-7	162	188
122	N. American 1927 - Canada (Manitoba; Ontario)	6	-9	157	184
123	N. American 1927 - Canada (New Brunswick; Newfoundland)	6	-22	160	190
124	N. American 1927 - Canada (Northwest Territories)	6	4	159	188
125	N. American 1927 - Canada (Yukon)	6	-7	139	181
126	N. American 1927 - Canal Zone	6	0	125	201
127	N. American 1927 - Cuba	6	-9	152	178
128	N. American 1927 - Greenland (Hayes Peninsula)	6	11	114	195
129	N. American 1927 - Antigua; Barbados	6	-3	142	183

130	N. American 1927 - Belize; Costa Rica	6	0	125	194
131	N. American 1927 - Canada	6	-10	158	187
132	N. American 1927 - CONUS	6	-8	160	176
133	N. American 1927 - CONUS (East of Mississippi river)	6	-9	161	179
134	N. American 1927 - CONUS (West of Mississippi river)	6	-8	159	175
135	N. American 1927 – Mexico	6	-12	130	190
136	N. American 1983 - Alaska (Excluding Aleutian Ids)	20	0	0	0
137	N. American 1983 - Aleutian Islands	20	-2	0	4
138	N. American 1983 – Canada	20	0	0	0
139	N. American 1983 – CONUS	20	0	0	0
140	N. American 1983 – Hawaii	20	1	1	-1
141	N. American 1983 - Mexico; Central America	20	0	0	0
142	N. Sahara 1959	7	-186	-93	310
143	Observatorio Meteorologico 1939	18	-425	-169	81
144	Old Egyptian 1907	15	-130	110	-13
145	Old Hawaiian – Hawaii	6	89	-279	-183
146	Old Hawaiian – Kauai	6	45	-290	-172
147	Old Hawaiian - Maui	6	65	-290	-190
148	Old Hawaiian - Hawaii; Kauai; Maui	6	61	-285	-181
149	Old Hawaiian - Oahu	6	58	-283	-182
150	Oman	7	-346	-1	224
151	Ordnance Survey G. Britain 1936 - England	1	371	-112	434
152	Ordnance Survey G. Britain 1936 - England; Isle of Man; Wales	1	371	-111	434
153	Ordnance Survey G. Britain 1936 - England; Isle of Man	1	375	-111	431
154	Ordnance Survey G. Britain 1936 - Scotland; Shetland Islands	1	384	-111	425
155	Ordnance Survey G. Britain 1936 - Wales	1	370	-108	434
156	Pico de las Nieves	18	-307	-92	127
157	Pitcairn Astro 1967	18	185	165	42
158	Point 58	7	-106	-129	165
159	Pointe Noire 1948	7	-148	51	-291
160	Porto Santo 1936	18	-499	-249	314

161	Provisional S. American 1956 – Bolivia	18	-270	188	-388
162	Provisional S. American 1956 - Chile (Northern; Near 19øS)	18	-270	183	-390
163	Provisional S. American 1956 - Chile (Southern; Near 19øS)	18	-305	243	-442
164	Provisional S. American 1956 – Columbia	18	-282	169	-371
165	Provisional S. American 1956 - Ecuador	18	-278	171	-367
166	Provisional S. American 1956 – Guyana	18	-298	159	-369
167	Provisional S. American 1956 - Bolivia; Chile; Colombia	18	-288	175	-376
168	Provisional S. American 1956 – Peru	18	-279	175	-379
169	Provisional S. American 1956 - Venezuela	18	-295	173	-371
170	Provisional South Chilean 1963	18	16	196	93
171	Puerto Rico	6	11	72	-101
172	Pulkovo 1942	19	28	-130	-95
173	Qatar National	18	-128	-283	22
174	Qornoq	18	164	138	-189
175	Reunion	18	94	-948	-126
176	Rome 1940	18	-225	-65	9
177	S-42 (Pulkovo 1942) – Hungary	19	28	-121	-77
178	S-42 (Pulkovo 1942) – Poland	19	23	-124	-82
179	S-42 (Pulkovo 1942) - Czechoslavakia	19	26	-121	-78
180	S-42 (Pulkovo 1942) – Latvia	19	24	-124	-82
181	S-42 (Pulkovo 1942) – Kazakhstan	19	15	-130	-84
182	S-42 (Pulkovo 1942) - Albania	19	24	-130	-92
183	S-42 (Pulkovo 1942) - Romania	19	28	-121	-77
184	S-JTSK	5	589	76	480
185	Santo (DOS) 1965	18	170	42	84
186	Sao Braz	18	-203	141	53
187	Sapper Hill 1943	18	-355	21	72
188	Schwarzeck	5	616	97	-251
189	Selvagem Grande 1938	18	-289	-124	60
190	Sierra Leone 1960	7	-88	4	101
191	S. American 1969 – Argentina	21	-62	-1	-37
192	S. American 1969 – Bolivia	21	-61	2	-48
193	S. American 1969 - Brazil	21	-60	-2	-41

194	S. American 1969 – Chile	21	-75	-1	-44
195	S. American 1969 - Colombia	21	-44	6	-36
196	S. American 1969 - Ecuador	21	-48	3	-44
197	S. American 1969 - Ecuador (Baltra; Galapagos)	21	-47	26	-42
198	S. American 1969 - Guyana	21	-53	3	-47
199	S. American 1969 - Argentina; Bolivia; Brazil	21	-57	1	-41
200	S. American 1969 - Paraguay	21	-61	2	-33
201	S. American 1969 – Peru	21	-58	0	-44
202	S. American 1969 – Trinidad; Tobago	21	-45	12	-33
203	S. American 1969 - Venezuela	21	-45	8	-33
204	South Asia	14	7	-10	-26
205	Tananarive Observatory 1925	18	-189	-242	-91
206	Timbalai 1948	9	-679	669	-48
207	Tokyo – Japan	5	-148	507	685
208	Tokyo - MEAN FOR Japan; South Korea; Okinawa	5	-148	507	685
209	Tokyo - Okinawa	5	-158	507	676
210	Tokyo - South Korea	5	-147	506	687
211	Tristan Astro 1968	18	-632	438	-609
212	Viti Levu 1916	7	51	391	-36
213	Voirol 1960	7	-123	-206	219
214	Wake Island Astro 1952	18	276	-57	149
215	Wake-Eniwetok 1960	16	102	52	-38
216	WGS 1972	22	0	0	0
217	**WGS 1984**	**23**	**0**	**0**	**0**
218	Yacare	18	-155	171	37
219	Zanderij	18	-265	120	-358

Set Low Power Mode

Message ID **107**

Description

This command message is used to set the receiver to one of the low power modes available on Axiom receivers. When a valid message is received, the parameters are stored in battery-backed SRAM and then the receiver configures itself from the saved parameters.

This command is only available with the NMEA message set in Axiom firmware builds based on SiRF baseline 1.3.2 and higher.

Table 2.14 Set Low Power Modes

Name	Example	Units	Description
Message ID	$PSRF107		PSRF107 protocol header
Push to Fix	0		0 = TricklePower or Continuous, 1 = Push-to-Fix enabled
Duty Cycle	200	percent (* 10)	10 times desired duty cycle Values are rounded up to10%, 20%, 30%, 40%, 50%, or 100%. 100% means continuous power
Milliseconds	200	ms	Milliseconds tracking time per TricklePower cycle. Minimum = 200
Checksum	*3D		
<CR><LF>			End of message termination

Example

This example commands the receiver run in TricklePower mode at a 20% duty cycle, with 200ms tracking time per cycle:

```
$PSRF107,0,200,200*3D
```

Push-to-Fix mode is enabled when PushToFix is 1, This runs with a tracking period of 200 ms and off-time set to

```
OffTime = 200000 / DutyCycle – 200 ms
```

So a 20% duty cycle would result in an OffTime of 800 ms.

The Milliseconds parameter is ignored if PushToFix is 1.

If PushToFix is 0, then either TricklePower or Continuous Track (i.e., non-low power mode) is set. If DutyCycle is greater than 500 (i.e. desired duty cycle > 50%), Continuous Track is enabled. Otherwise, TricklePower is enabled.

NMEA Output Messages

Axiom receivers output the messages listed in Table 2.15:

Table 2.15 NMEA-0183 Output Messages

NMEA Message	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

GGA —Global Positioning System Fixed Data

Description

This message reports the global positioning system fixed data, as shown in Table 2.16.

Table 2.16 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hh mm ss.sss
Latitude	3723.2475		dd mm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12158.3416		ddd mm.mmmm
E/W Indicator	W		E = east or W = west
Position Fix Indicator	1		See 0
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude [1]	9.0	meters	
Units	M	meters	
Geoid Separation [1]		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
<CR><LF>			End of message termination

[1] Axiom receivers do not support geoid corrections. Values are WGS-84 ellipsoid heights.

Table 2.17 Position Fix Indicator

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

Example

This values reported in this example reports are interpreted as shown in Table 2.16:

```
$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,
1.0,9.0,M, , , ,0000*18
```

GLL—Geographic Position - Latitude/Longitude

Description

This message reports latitude and longitude geographic positioning data, as described in Table 2.18.

Table 2.18 GLL Data Format

Name	Example	Description
Message ID	$GPGLL	GLL protocol header
Latitude	3723.2475	dd mm.mmmm
N/S Indicator	N	N = north or S = south
Longitude	12158.3416	ddd mm.mmmm
E/W Indicator	W	E = east or W = west
UTC Position	161229.487	hh mm ss.sss
Status	A	A = data valid or V = data not valid
Checksum	*2C	
<CR><LF>		End of message termination

Example

The values reported in this example are interpreted as shown in Table 2.18:

```
$GPGLL,3723.2475,N,12158.3416,W,161229.487,A*2C
```

GSA—GNSS DOP and Active Satellites

Description

This message reports the satellites used in the navigation solution reported by the GGA message. GSA is described in Table 2.19.

Table 2.19 GSA Data Format

Name	Example	Description
Message ID	$GPGSA	GSA protocol header
Mode 1	A	See Table 2.20
Mode 2	3	See Table 2.21
Satellite Used [1]	07	SV on Channel 1
Satellite Used [1]	02	SV on Channel 2
….		….
Satellite Used [1]		SV on Channel 12
PDOP	1.8	Position Dilution of Precision
HDOP	1.0	Horizontal Dilution of Precision
VDOP	1.5	Vertical Dilution of Precision
Checksum	*33	
<CR><LF>		End of message termination

[1] Satellite used in solution.

Table 2.20 Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 2.21 Mode 2

Value	Description
M	Manual - forced to operate in 2D or 3D mode
A	Automatic - allowed to automatically switch 2D/3D

Example

The values reported in this example reports are interpreted as shown in Table 2.19:

```
$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,
1.8,1.0,1.5*33
```

GSV—GNSS Satellites in View

Description

This message reports the satellites in view, their ID numbers, elevation, azimuth, and SNR values (up to four satellites per message). GSV is described in Table 2.22.

Table 2.22 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages [1]	2		Range 1 to 3
Message Number [1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1 (Range 1 to 32)
Elevation	79	degrees	Channel 1 (Maximum 90)
Azimuth	048	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
….			….
Satellite ID	27		Channel 4 (Range 1 to 32)
Elevation	27	degrees	Channel 4 (Maximum 90)
Azimuth	138	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR><LF>			End of message termination

[1] Depending on the number of satellites tracked multiple messages of GSV data may be required.

Example

The values reported in this example reports are interpreted as shown in Table 2.22. Two messages are require to complete the data transmission.

```
$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,
42,27,27,138,42*71
```

```
$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,
42*41
```

RMC—Recommended Minimum Specific GNSS Data

Description

This message reports the time, date, position, course, and speed from the receiver's navigation solution. RMC is described in Table 2.23.

Table 2.23 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hh mm ss.sss
Status	A		A = data valid or V = data not valid
Latitude	3723.2475		dd mm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12158.3416		ddd mm.mmmm
E/W Indicator	W		E = east or W = west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		dd mm yy
Magnetic Variation [1]		degrees	E = east or W = west
Checksum	*10		
<CR><LF>			End of message termination

[1] Axiom receivers do not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.

Example

The values reported in this example reports are interpreted as shown in Table 2.23:

```
$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,
309.62,120598, ,*10
```

VTG—Course Over Ground and Ground Speed

Description

This message reports current ground course and speed data. Course is reported relative to true north only.

Table 2.24 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		RMC protocol header
Course	309.62	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic [1]
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Checksum	*6E		
<CR><LF>			End of message termination

[1] Axiom receivers do not support magnetic declination. All "course over ground" data are geodetic WGS84.

Example

The values reported in this example reports are interpreted as shown in Table 2.24:

```
$GPVTG,309.62,T, ,M,0.13,N,0.2,K*6E
```

Chapter 3 Axiom Protocol

The Axiom protocol was developed for data logging in Axiom Fleet Management (FMS) products. The protocol has been optimized for the retrieval of specific data from Axiom Mobile Units. The data retrieved varies from application to application with the relevant data. This documents just a portion of the Axiom protocol — enough to make use of the data logging feature of Axiom GPS boards.

Messages

All data transferred during a conversation comes and goes in the form of binary messages. The binary data must be transferred in little endian order (least significant byte first). The messages are each comprised of a header and an optional payload. The header and the payload each have a two-byte checksum for validation.

Message Structure

Header

Every message has a header. The header defines the message, the speaker, and payload (if any) that is to follow. (12 bytes total)

Prefix

4040h or "@@"

This is merely a known pattern of bytes at the front of each message that message-processing programs can lock-on to as the likely beginning of a message. (2 bytes)

Type

The Message Type field defines what kind of message this is, which usually either has flow-control significance or indicates what kind of data is in the payload. Message Types are normally 2-character combinations for readability. It is not necessary that these always be ASCII characters in the future, but at the time of this writing they all are. For example, "FO" indicates a hello-type message.

Sequence Number

The Sequence Number field carries an incrementing sequential number for record downloaded, per request. This number is used in fleet management systems to detect dropped records due to wireless errors.

The Sequence Number is interpreted as an unsigned short integer. (2 bytes)

Mobile ID

The Mobile ID field carries an ID number for the mobile unit involved in the conversation. This number must be set for each unit at the time the unit is programmed (initialized). These numbers only need be unique within any given application (for any one base station, for example), although some applications use the serial number of the mobile GPS receiver for this.

The Mobile ID is typically used by base station software to determine what unit the incoming data belongs to (in asynchronous applications) and to double-check that the correct phone number has been dialed (connection-based applications). The Mobile ID is interpreted as an unsigned short integer. (2 bytes) It will be 65535 (0FFFF hex), if not set to any other value.

Payload Length

This field describes the number of bytes used in the payload of this message. If there is no payload, then the length is zero. Payload Length is interpreted as an unsigned short integer. (2 bytes)

Header Checksum

This field contains the 2's compliment checksum of the header. This value should be used to verify that the header data is intact. If the checksum fails, the entire message should be discarded. For information about calculating and verifying the checksum, see Checksum Details later in this chapter.

Payload

The payload of a message is optional. If no payload is used, the Payload Length field of the message header should be set to zero, and there is no payload checksum. (Variable byte count)

Payload Data

The structure of the data will vary depending on the type of message and what is expected from the mobile unit. (Almost all data comes from the mobile units rather than the base.) Detailed descriptions of specific messages will outline the payload structure as required. The only protocol restriction is that the data must be an even number of bytes. This is because of the nature of the checksum used. Odd-sized data is padded with a null before the final checksum. (Variable byte count)

Payload Checksum

The payload data requires a checksum just like the header. Use it to verify that the data is intact. If the payload checksum fails but the header checksum passes, then it is possible (with two-way communications) to respond with an error message specifying the message type that failed. There is no checksum if there is no payload data. (2 bytes)

Checksum Details

The checksum type used in this protocol is referred to as 2's Compliment. It provides reasonable assurance of message validity while remaining fairly simple to process.

Calculating the Checksum

To calculate a 2's Compliment checksum, treat every 2 bytes of the header or payload as an unsigned short integer and add them all up (discard overflow bits). The checksum is the negative of that sum. When calculating the header checksum, remember to include the prefix, "@@", in the calculation.

For example, take our sample header (values are hexadecimal):

40 40 53 46 03 00 00 00 28 00

First calculate the sum of byte pairs (bytes are reversed for readability):

4040h + 4653h + 3h + 0h + 28h = 86BEh

The checksum is the negative of the sum:

-86BEh = 7942h

So the checksum, as data sent little endian, is:

42 79

The complete data stream, with checksum, is then:

40 40 53 46 03 00 00 00 28 00 42 79

Verifying the Checksum

Verifying a 2's Compliment checksum is even easier than calculating it. Again, treat every 2 bytes of the header or payload as a short integer. This time, add up *all* of them including the checksum, and discard any bit overflow past 2 bytes. Because the checksum is the negative of the sum of the rest, the total sum this time should always be zero. If the sum is zero, then the data is valid.

For example, again take our sample header data with checksum (values are hexadecimal):

40 40 53 46 03 00 00 00 28 00 42 79

The calculation is to simply add the byte pairs (bytes reversed for readability):

4040h + 4653h + 3h + 0h + 28h + 7942h = 10000h = 0h

The last equality is the result of discarding the overflow bits.

Conversation Details

The specific conversation method used in the Axiom protocol reflects methods used in Axiom's line of FMS products.

This section will refer to messages on a somewhat general level. For the details on how to assemble and interpret these messages, refer to Message Type Details later in this chapter.

Sample Conversation

This sample conversation illustrates how to go about communicating to a mobile unit from the base.

Getting the History of a Mobile Unit

Base	Mobile (Reply)
Req. Logging Stats. (RL)	OK (FO)
	Send Logging Stats. (LS)
OK (FO)	
Req. History (RQ)	OK (FO)
	Send History Part 1 (SF)
	Send History Part 2 (SF)
…	…
	Send History Part N (SF)
	Send Complete (SC)
Clear History (CH)	OK (FO)

This is an updated method of history transfers, in which history records are grouped together as messages with sequence numbers. No OK messages are required for "sequenced" history messages, to speed up the transfer.

Message Type Details

The following descriptions provide information needed to either assemble or interpret messages between the base station and a mobile unit.

All byte counts for the payloads described here do not include the 2-byte checksum. (Add 2 to the totals to get the true length.) Payload data is not separated by any delimiters, so it is important to know the exact byte location of the data to be extracted.

Messages from Base to Mobile

The messages sent from the base unit to the mobile unit are summarized in table 1.1.

Table 3.1 Base to Mobile Messages

Name	Message ID	Description
Request Logging Statistics	RL	Request mobile send log statistics
Request History	RP	Request mobile to begin sending history
Clear History	CH	Request mobile to clear its history log
Set History Interval	HI	Set the mobile history interval
Set Mobile ID	MI	Set the mobile's ID number

Request Logging Statistics

Message ID **RL**

Payload **None**

Use

Request that the mobile unit send back certain information describing data stored in its history log.

Response **LS**

Request History

Message ID **RP**

Payload

The Request History message starts a download of the history.

Use

Request that the mobile unit send its entire log history.

Response **SF (one for each record in the history)**

Clear History

Message ID **CH**

Payload **None**

Use

Command the mobile unit to clear its history log from flash. It is important to clear the history after it has been received so that old data is not downloaded the next time. This speeds up the next download.

Response **FO**

Set History Interval

Message ID **HI**

Payload

The Set History Interval payload consists of a total of 12 bytes, as described in Table 3.2

Table 3.2 Set History Interval Payload

Message Item	Size (bytes)
Header	2
Unsigned Short Integer Time Interval	2
Unsigned Short Integer Distance Interval	2
Unsigned Short Integer Log Stops (Unused)	2
Unsigned Short Integer Max Speed	2
Padding	2

Use

Normally used by the base to set the history logging interval for the mobile unit. There are 4 ways to log: by time, by distance, by stops, and by speed. They are not exclusive, so any combination is allowed.

Response **FO**

Notes

Time Interval is the number of seconds after which the mobile unit must log. The maximum is approximately 18 hours. Set to zero to disable.

Distance Interval is the number of meters after which the mobile unit must log. The maximum is approximately 40 miles. The minimum is 10 meters. Set to zero to disable.

Stop Log is the number of seconds stopped after which the mobile unit must log. UNUSED, will be 0.

The mobile unit will log whenever its speed exceeds Max Speed (in meters per second) and whenever its speed drops below Max Speed. The minimum is 10 m/s. There is no defined maximum, but an value well beyond what a normal vehicle can attain may have unpredictable results.

Set Mobile ID

Message ID **MI**

Payload

The Set Mobile message payload consists of a total of 6 bytes, as described in Table 3.3

Table 3.3 Set Mobile ID Payload

Message Item	Size (bytes)
Header	2
Unsigned Long Integer New ID	4

Use

Used by the base to set the mobile ID number used by the mobile unit. This is the number that is included in the header of every message sent by the mobile unit. It is critical when the mobile unit originates a call and the base must identify which unit it is connected to.

Response: **FO**

Messages from Mobile to Base

Table 3.4 Mobile to Base Messages

Name	Message ID	Description
Send Fixed	SF	One fixed-length history record
Send Complete	SC	Signal end of history download

Send Logging Statistics

Message ID **LS**

Payload

The Send Logging Statistics message payload consists of a total of 12 bytes, as shown in Table 3.5.

Table 3.5 Send Logging Statistics Payload

Message Item	Size (bytes)
Header	2
Unsigned Long Integer Packed Log Start Time	4
Unsigned Long Integer Packed Log End Time	4
Unsigned Short Integer Record Count	2

Use

Reports the status of the mobile unit's history log, including how much time it covers, and how many records are stored.

Response **None**

Send Fixed

Message ID **SF**

Payload

The Send Fixed message results in downloading the entire history log, one record at a time. The payload (one record) consists of 18 bytes, as shown in Table 3.6.

Table 3.6 Send Fixed History Payload

Item	Description	Size (bytes)
Record 1 - n	Unsigned Long Integer Packed Time	4
	Long Integer Packed Latitude	4
	Long Integer Packed Longitude	4
	Unsigned Long Integer SVs Used	4
	Unsigned Byte Integer Packed Speed	1
	Unsigned Byte Integer Status Flags	1

Notes

Each SF message holds one history record, which is a point in time when the mobile unit's position and state was recorded. See Unpacking Time Data later in this chapter for details about how to unpack the 4 time bytes.

- Divide Latitude by 2^{24} (16777216)
- Divide Longitude by 2^{23} (8388608)
- Divide Speed by 2

See Unpacking Status Bit Flags later in this chapter for details about how to unpack the 1 byte Status Flags.

Use

Respond to an RP message, transmit the history of the mobile unit's location and other data. Multiple SF messages are transmitted one after the other until the entire history has been sent. A SC message follows the last SF message.

Response

FO

Send Complete

Message ID

SC

Payload

The Send Complete message payload consists of 4 bytes, as shown in Table 3.7.

Table 3.7 Send Complete Payload

Message Item	Size (bytes)
Header	2
Sequence Number	2

Use

Indicates that the entire history has been sent. It follows the last SF message.

Response

FO

Messages from Either Base or Mobile

Table 3.8 Messages from Base or Mobile

Name	Message ID	Description
OK	FO	Ready to talk. Message received okay.

OK

Message ID **FO**

Payload **None**

Use

Indicate that sender is "ready to talk," or a message received correctly.

Response **None**

Unpacking Time Data

The time data sent to a mobile unit (RQ message) or from mobile units (SS, LS, and SN messages) is well packed into a 4 byte long integer. That integer must be separated into 2 values: GPS Week Number and GPS Time of Week. Once those are separated, they are still not usable by a normal PC, and must be converted into a readable date and time, for example a Windows Date (double-precision floating point for days and fractions of days since 12/30/1899).

The first 22 bits of the Packed Time represent GPS Time of Week in quarter-seconds. Divide the integer value of those 22 bits by 4 to get GPS Time of Week. The last 10 bits of the Packed Time represent GPS Week Number.

GPS Week Number is the number of full weeks elapsed since the 6th of January, 1980. GPS Time of Week is the number of seconds elapsed since midnight Sunday morning of the current week.

The following C++ code unpacks GPS Time:

```
short UnpackGPSTime
(
   long    GPSTime,
   short*  WeekNum,
   double* GPSSeconds
)
{
   typedef struct
   {
      int Seconds:22;
      int Week   :10;
   } GPSTimeT;

   GPSTimeT  Temp;

   Temp = *((GPSTimeT *) &GPSTime);

   *WeekNum    = (int)Temp.Week & 0x03ff;
   *GPSSeconds = (double)Temp.Seconds /4;
   return 1;
}
```

The following VisualBasic code can be used to translate GPS Time to a Windows Date and back. It has been updated to account for the August 1999 GPS Week Rollover event.

```
Const Jan_6_1980 As Double = 29226
Const Sep_1_1999 As Double = 36404

Function ConvGPSDateToGregorian(GPSWeek As Integer, _
         GPSSec As Double) As Date
   Dim RealGPSWeek As Long
   RealGPSWeek = ExtendGPSWeek(GPSWeek)
   ConvGPSDateToGregorian = _
      RealGPSWeek * 7 + Jan_6_1980
   ConvGPSDateToGregorian = _
      ConvGPSDateToGregorian + GPSSec / SecsPerDay
End Function

Sub ConvGregorianDateToGPS(Greg As Date, _
    ByRef GPSWeek As Integer, _
    ByRef GPSSec As Double, _
    Optional Extended As Boolean = True)
   Dim GPSDays As Double
   GPSDays = Greg - Jan_6_1980
   'If extended week was not asked for,
   ' truncate week to 10 bits.
   GPSWeek = IIf(Extended, Int(GPSDays / 7), _
                 Int(GPSDays / 7) And &H3FF)
   GPSSec = (GPSDays - (GPSWeek * 7)) * SecsPerDay
End Sub

Function ExtendGPSWeek(Week As Integer) As Long
   'Add more bits to the 10bit GPSWeek _
   ' by tacking on upper bits from _
   ' the current extended GPSWeek.
   Dim NowWeek As Integer, NowSec As Double
   ConvGregorianDateToGPS Cdate(Sep_1_1999), _
                          NowWeek, NowSec, True
   ExtendGPSWeek = (NowWeek And &HFC00) Or _
                   (Week And &H3FF)
   'Check for and invalid week number
   ' (date is too far in the future)
   If ExtendGPSWeek > NowWeek + &H1FF Then _
      ExtendGPSWeek = Week
End Function
```

Unpacking Status Bit Flags

The status byte is included in every record of a SF message.

Bit 0 - Position Valid

The first bit is set to 1 if the position information of the accompanying record is valid, meaning that the GPS receiver was actually tracking satellites and navigating at the time the record was made. For example, say the mobile unit can't see the sky (perhaps it's in a garage) at the time the base contacts it for a state report. If it is *unable* to navigate at the time of the call, it will send a state response (SS) with the last known position and the Position Valid bit of the status byte set to 0. Otherwise, the true position will be sent with the Position Valid bit set to 1.

Bit 1 - DGPS State

The second bit is set if the GPS receiver is configured for base-side post-processing DGPS. This essentially means that all navigation filtering is shut off. If the bit is 0 then normal navigation filtering is enabled, and it is NOT recommended that DGPS corrections be applied by the base.

Bit 2 – Discrete Input 1

The third bit is set to 1 if the Mobile Unit discrete input number 1 is pulled low (grounded).

Bit 3 – Discrete Input 2

The third bit is set to 1 if the Mobile Unit discrete input number 2 is pulled low (grounded).

Bit 4 – Discrete Input 3

The third bit is set to 1 if the Mobile Unit discrete input number 3 is pulled low (grounded).

Bit 5 – Discrete Input 4

The third bit is set to 1 if the Mobile Unit discrete input number 4 is pulled low (grounded).

Bit 6 - *unused*

That bit is not currently used.

Bit 7 - STOPPED State

The last bit is used for the Stop Logging feature. When the mobile unit has been at a velocity less than that induced by S/A (about 1.788 m/s or 4.0 MPH) for a specified amount of time, bit 7 is set to 1. See the **HI** command for details on setting the stop threshold time.