GPS Protocol Reference Manual

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Leadtek®
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Table of Contents

Chapter 1 NMEA Input/Output Messages

The unit may also output data in NMEA -0183 format as defined by the National Marine Electronics Association (NMEA), Standard For Interfacing Marine Electronics Devices, Version 2.20, January 1, 1997.

1.1 NMEA Output Messages

The unit outputs the following messages as shown below (Table 1-1):

Table 1-1 NMEA -0183 Output Messages

NMEA Record	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

1.1.1 GGA – Global Positioning System Fixed Data

Table 1-2 contains the values for the following example:

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

Table 1-2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 1-3
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] SiRF does not support geoid correction. Values are WGS-84 ellipsoid heights.

Table 1-3 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

1.1.2 GLL – Geographic Position – Latitude/Longitude

Table 1-4 contains the values for the following example:

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

Table 1-4 GLL Data Format

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

1.1.3 GSA – GNSS DOP and Active Satellites

Table 1-5 contains the values for the following example:

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

Table 1-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 1-6
Mode 2	3		See Table 1-7
Satellite Used[1]	07		Sv on Channel 1
Satellite Unsed[1]	02		Sv on Channel 2
….			….
Satellite Unsed[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 1-6 Mode 1

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

Table 1-7 Mode 2

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

1.1.4 GSV- GNSS Satellites in View

Table 1-8 contains the values for the following example:

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

$GPGSV2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41

Table 1-8 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.

1.1.5 RMC- Recommended Minimum Specific GNSS Data

Table 1-9 contains the values for the following example:

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

Table 1-9 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.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		ddmmyy
Magnetic Variation[1]		degrees	E=east or W=west
Checksum	*10		
<CR> <LF>			End of message termination

[1] SiRF does not support magnetic declination. All “course over ground” data are geodetic WGS-84 directions.

1.1.6 VTG- Course Over Ground and Ground Speed

Table 1-10 contains the values for the following example:

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

Table 1-10 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG 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] SiRF does not support magnetic declination. All "course over ground" data are geodetic WGS-84 directions.

1.2 *SiRF Proprietary NMEA Input Messages*

NMEA input messages are provided to allow you to control the unit while in NMEA protocol mode. The unit may be put into NMEA mode by sending the SiRF Binary protocol message “Switch To NMEA Protocol – Message I.D. 129” using a user program or using **`Sirfdemo.exe`** and selecting Switch to NMEA Protocol from the Action menu. 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.

1.2.1 *Transport Message*

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR> <LF>[4]

[1] Message Identifier consisting of three numeric characters. Input messages begin at MID 100.

[2] Message specific data. Refer to a specific message section for <data>…<data> definition.

[3] CKSUM is a two-hex character checksum as defined in the NMEA specification. Use of checksums is required on all input messages.

[4] Each message is terminated using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D 0A. 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.

Note - All fields in all proprietary NMEA messages are required, none are optional. All NMEA messages are comma delimited.

1.2.2 SiRF NMEA Input Messages

Message	Message Identifier (MID)	Description
SetSerialPort	100	Set PORT A parameters and protocol
NavigationInitialization	101	Parameters required for start using X/Y/Z
SetDGPSPort	102	Set PORT B parameters for DGPS input
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLANavigationInitialization	104	Parameters required for start using Lat/Lon/Alt[1]
Development Data On/Off	105	Development Data messages On/Off

[1] Input coordininates must be WGS84

1.2.3 SetSerialPort

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 unit restarts using the saved parameters.

Table 1-11 contains the input values for the following example:

Switch to SiRF Binary protocol at 9600,8,N,1

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

Table 1-11 Set Serial Port Data Format

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF Binary, 1=NMEA
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		8
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*0C		
<CR> <LF>			End of message termination

1.2.4 NavigationInitialization

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 unit to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the unit to acquire signals quickly.

Table 1-12 contains the input values for the following example:

Start using known position and time.

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

Table 1-12 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 Evaluation Unit[1]
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table 1-13
Checksum	*22		
<CR> <LF>			End of message termination

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

Table 1-13 Reset Configuration

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

1.2.5 SetDGPSPort

This command is used to control Serial Port B which is an input-only serial port used to receive RTCM differential correction. 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 which 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 t hen the receiver restarts using the saved parameters.

Table 1-14 contains the input values for the following example:

Set DGPS Port to be 9600,8,N,1.

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

Table 1-14 Set DGPS Port Data Format

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

1.2.6 Query/Rate Control

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 1-15 contains the input values for the following examples:

1. Query the GGA message with checksum enabled

   $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

Table 1-15 Query/Rate Control Data Format (See example 1)

Name	Example	Units	Description
Message ID	$PSRF103		PSRF103 protocol header
Msg	00		See Table 1-16
Mode	01		0=SetRate, 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 1-16 Messages

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

1.2.7 LLANavigationInitialization

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 will enable the receiver to acquire signals quickly.

Table 1-17 contains the input values for the following example:

Start using known position and time.

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

Table 1-17 LLA 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 Evaluation Unit[1]
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	922		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table 1-18
Checksum	*3A		
<CR> <LF>			End of message termination

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

Table 1-18 Reset Configuration

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

1.2.8 Development Data On/Off

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 1-19 contains the input values for the following examples:

1. Debug on

   $PSRF105,1*3E

2. Debug Off

   $PSRF105,0*3F

Table 1-19 Development Data On/Off Data Format

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

1.3 Calculating Checksums for NMEA Input

The purpose of **`cksum.exe`** is to read a file containing NMEA sentences and calculate the correct NMEA checksum. You can use the checksum to verify operation of NMEA output sentences or to generate a checksum for an NMEA input message.

Example:

Create a text file containing an NMEA input sentence such as an input NMEA query message and determine the proper checksum.

    type query0.txt

    $PSRF103,00,01,00,01*xx

    cksum query0.txt

    INPUT FILE: query0.txt

    inline: $PSRF103,00,01,00,01*xx

    cksum: 25

The correct checksum for this message is 25. You can use Procomm or a similar terminal program to send the message.

Chapter 2 SiRF Binary Protocol Specification

The serial communication protocol is designed to include:

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

2.1 Protocol Layers

2.1.1 Transport Message

Start Sequence	Payload Length	Payload	Message Checksum	End Sequence
0xA0[1], 0xA2	Two-bytes (15-bits)	Up to $2^{10}-1$ (<1023)	Two-bytes (15-bits)	0xB0, 0xB3

[1] 0xYY denotes a hexadecimal byte value. 0xA0 equals 160.

2.1.2 Transport

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) message length and a two-byte (15-bit) check sum. The values of the start and stop characters and the choice of a 15-bit values for length and check sum are designed such that both message length and check sum can not alias with either the stop or start code.

2.1.3 Message Validation

The validation layer is of part of the transport, but operates independently. The byte count refers to the payload byte length. Likewise, the check sum is a sum on the payload.

2.1.4 Message Length

The message length 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 considerations require the SiRF GPS module implementation to limit this value to a smaller number. Likewise, the SiRF receiving programs (e.g., SiRFdemo) may limit the actual size to something less than this maximum.

2.1.5 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 will use the big-endian order.

2.1.6 Checksum

The check sum is transmitted high order byte first followed byte the low byte. This is the so-called big-endian order.

High Byte	Low Byte
< 0x7F	Any value

The check sum is 15-bit checksum of the bytes in the payload data. The following pseudo code defines the algorithm used.

```
Let message to be the array of bytes to be sent by the transport.
Let msgLen be the number of bytes in the message array to be transmitted.
  Index = first
  checkSum = 0
  while index < msgLen
    checkSum = checkSum + message[index]
  checkSum = checkSum AND (2^(15-1)).
```

2.2 Input Messages for SiRF Binary Protocol

Note - All input messages are sent in **BINARY** format.

Table 2-1 lists the message list for the SiRF input messages.

Table 2-1 SiRF Messages - Input Message List

Hex	ASCII	Name
0 x 80	128	Initialize Data Source
0 x 81	129	Switch to NMEA Protocol
0 x 82	130	Set Almanac (upload)
0 x 84	132	Software Version (poll)
0 x 85	133	DGPS Source Control
0 x 86	134	Set Main Serial Port
0 x 87	135	Not Used
0 x 88	136	Mode Control
0 x 89	137	DOP Mask Control
0 x 8A	138	DGPS Control
0 x 8B	139	Elevation Mask
0 x 8C	140	Power Mask
0 x 8D	141	Editing Residual
0 x 8E	142	Steady-State Detection
0 x 8F	143	Static Navigation
0 x 90	144	Clock Status (poll)
0 x 91	145	Set DGPS Serial Port
0 x 92	146	Almanac (poll)
0 x 93	147	Ephemeris (poll)
0 x 95	149	Set Ephemeris (upload)
0 x 96	150	Switch Operating Mode
0 x 97	151	Set Trickle Power Parameters
0 x 98	152	Navigation Parameters (Poll)
0 x A5	165	Change UART Configuration
0 x A6	166	Set Message Rate
0 x A7	167	Low Power Acquisition Parameters
0 x B6	182	Not Supported

2.2.1 Initialize Data Source - Message I.D. 128

Table 2-2 contains the input values for the following example:

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

Example:

A0A20019—Start Sequence and Payload Length

80FFD700F9FFBE5266003AC57A000124F80083D600039C0C33—Payload

0A91B0B3—Message Checksum and End Sequence

Table 2-2 Initialize Data Source

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		80		ASCII 128
ECEF X	4		FFD700F9	Meters	
ECEF Y	4		FFBE5226	Meters	
ECEF Z	4		003AC57A	Meters	
Clock Offset	4		000124F8	Hz	
Time of Week	4	*100	0083D600	Seconds	
Week Number	2		039C		
Channels	1		0C		Range 1-12
Reset Config.	1		33		See Table 2-3

Payload Length: 25 bytes

Table 2-3 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 (YES=1, NO=0)
5	Enable debug data (YES=1, NO=0)
6	Reserved (must be 0)
7	Reserved (must be 0)

Note - If Raw Track Data is ENABLED then the resulting messages are message I.D. 0x05 (ASCII 5 -Raw Track Data), message I.D. 0x08 (ASCII 8- 50 BPS data), and message I.D. 0x90 (ASCII 144 Clock Status). All messages are sent at 1 Hz.

2.2.2 Switch To NMEA Protocol - Message I.D. 129

Table 2-4 contains the input values for the following example:

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

Example:

A0A20018—Start Sequence and Payload Length

810201010001050105010001000100010001000100010001000112C0—Payload

0164B0B3—Message Checksum and End Sequence

Table 2-4 Switch To NMEA Protocol

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		81		ASCII 129
Mode	1		02		
GGA Message[1]	1		01	1/s	See Chapter 2 for format.
Checksum[2]	1		01		
GLL Message	1		00	1/s	See Chapter 2 for format.
Checksum	1		01		
GSA Message	1		05	1/s	See Chapter 2 for format.
Checksum	1		01		
GSV Message	1		05	1/s	See Chapter 2 for format.
Checksum	1		01		
RMC Message	1		00	1/s	See Chapter 2 for format.
Checksum	1		01		
VTG Message	1		00	1/s	See Chapter 2 for format.
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

Payload Length: 24 bytes

[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).

2.2.3 Set Almanac ? Message I.D. 130

This command enables the user to upload an almanac to the Unit.

Note - This feature is not documented in this manual. For information on implementation contact SiRF Technology Inc.

2.2.4 Software Version ? Message I.D. 132

Table 2-5 contains the input values for the following example:

Poll the software version

Example:

A0A20002? Start Sequence and Payload Length

8400? Payload

0084B0B3? Message Checksum and End Sequence

Table 2-5 Software Version

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

Payload Length: 2 bytes

2.2.5 Set Main Serial Port ? Message I.D. 134

Table 2-6 contains the input values for the following example:

Set Main Serial port to 9600,n,8,1

Example:

A0A20009? Start Sequence and Payload Length

860000258008010000? Payload

01340B3? Message Checksum and End Sequence

Table 2-6 Set DGPS Serial Port

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		86		ASCII 134
Baud	4		00002580		38400,19200,9600,4800,2400,1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0, Odd=1, Even=2
Pad	1		00		Reserved

Payload Length: 9 bytes

2.2.6 Mode Control - Message I.D. 136

Table 2-7 contains the input values for the following example:

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

Example:

A0A2000E? Start Sequence and Payload Length

880101010101000000014050101? Payload

00A9B0B3? Message Checksum and End Sequence

Table 2-7 Mode Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	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 2-7
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		00		Last Computed=0, Fixed to=1
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

Payload Length: 14 bytes

Table 2-8 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

2.2.7 DOP Mask Control - Message I.D. 137

Table 2-9 contains the input values for the following example:

Auto Pdop/Hdop, Gdop =8 (default), Pdop=8,Hdop=8

Example:

A0A20005? Start Sequence and Payload Length

8900080808? Payload

00A1B0B3? Message Checksum and End Sequence

Table 2-9 DOP Mask Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		89		ASCII 137
DOP Selection	1		00		See Table 2-10
GDOP Value	1		08		Range 1 to 50
PDOP Value	1		08		Range 1 to 50
HDOP Value	1		08		Range 1 to 50

Payload Length: 5 bytes

Table 2-10 DOP Selection

Byte Value	Description
0	Auto PDOP/HDOP
1	PDOP
2	HDOP
3	GDOP
4	Do Not Use

2.2.8 DGPS Control - Message I.D. 138

Table 2-11 contains the input values for the following example:

Set DGPS to exclusive with a time out of 30 seconds.

Example:

A0A20003? Start Sequence and Payload Length

8A011E? Payload

00A9B0B3? Message Checksum and End Sequence

Table 2-11 DGPS Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		8A		ASCII 138
DGPS Selection	1		01		See Table 2-12
DGPS Time Out	1		1E	seconds	Range 1 to 120

Payload Length: 3 bytes

Table 2-12 DGPS Selection

Byte Value	Description
0	Auto
1	Exclusive
2	Never
3	Mixed (not recommended)

2.2.9 Elevation Mask - Message I.D. 139

Table 2-13 contains the input values for the following example:

Set Navigation Mask to 15.5 degrees (Tracking Mask is defaulted to 5 degrees).

Example:

A0A20005? Start Sequence and Payload Length

8B0032009B? Payload

0158B0B3? Message Checksum and End Sequence

Table 2-13 Elevation Mask

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

Payload Length: 5 bytes

2.2.10 Power Mask – Message I.D. 140

Table 2-14 contains the input values for the following example:

Navigation Mask to 33 dBHz (tracking default value of 28).

Example:

A0A20003? Start Sequence and Payload Length

8C1C21? Payload

00C9B0B3? Message Checksum and End Sequence

Table 2-14 Power Mask

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		8C		ASCII 140
Tracking Mask	1		1C	dBHz	Not currently implemented
Navigation Mask	1		21	dBHz	Range 28 to 50

Payload Length: 3 bytes

2.2.11 Editing Residual - Message I.D. 141

Note - Not currently implemented.

2.2.12 Steady State Detection - Message I.D. 142

Table 2-15 contains the input values for the following example:

Set Steady State Threshold to 1.5 m/sec2.

Example:

A0A20002? Start Sequence and Payload Length

8E0F? Payload

009DB0B3? Message Checksum and End Sequence

Table 2-15 Steady State Detection

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

Payload Length: 2 bytes

2.2.13 Static Navigation – Message I.D. 143

Note - Not currently implemented.

2.2.14 Clock Status – Message I.D. 144

Table 2-16 contains the input values for the following example:

Poll the clock status.

Example:

A0A20002? Start Sequence and Payload Length

9000? Payload

0090B0B3? Message Checksum and End Sequence

Table 2-16 Clock Status

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

Payload Length: 2 bytes

2.2.15 Set DGPS Serial Port - Message I.D. 145

Table 2-17 contains the input values for the following example:

Set DGPS Serial port to 9600,n,8,1.

Example:

A0A20009? Start Sequence and Payload Length

910000258008010000? Payload

013FB0B3? Message Checksum and End Sequence

Table 2-17 Set DGPS Serial Port

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

Payload Length: 9bytes

2.2.16 Almanac – Message I.D. 146

Table 2-18 contains the input values for the following example:

Poll for the Almanac.

Example:

A0A20002? Start Sequence and Payload Length

9200? Payload

0092B0B3? Message Checksum and End Sequence

Table 2-18 Almanac

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

2.2.17 Ephemeris Message I.D. 147

Table 2-19 contains the input values for the following example:

Poll for Ephemeris Data for all satellites.

Example:

A0A20003? Start Sequence and Payload Length

930000? Payload

0092B0B3? Message Checksum and End Sequence

Table 2-19 Ephemeris Message ID

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		93		ASCII 147
Sv I.D. [1]	1		00		Range 0 to 32
TBD	1		00		Reserved

Payload Length: 3 bytes

[1] A value of 0 requests all available ephemeris records, otherwise the ephemeris of the Sv I.D. is requested.

2.2.18 Switch To SiRF Protocol

Note - To switch to SiRF protocol you must send a SiRF NMEA message to revert to SiRF binary mode. (See Chapter 1 "NMEA Input Messages" for more information.)

2.2.19 Switch Operating Modes – Message I.D. 150

Table 2-20 contains the input values for the following example:

Sets the receiver to track a single satellite on all channels.

Example:

A0A20007? Start Sequence and Payload Length

961E510006001E? Payload

0129B0B3? Message Checksum and End Sequence

Table 2-20 Switch Operating Modes

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		96		ASCII 150
Mode	2		1E51		1E51=test, 0=normal
SvID	2		0006		Satellite to Track
Period	2		001E	Seconds	Duration of Track

Payload Length: 7 bytes

2.2.20 Set Trickle Power Parameters – Message I.D. 151

Table 2-21 contains the input values for the following example:

Sets the receiver into low power Modes.

Example: Set receiver into Trickle Power at 1 hz update and 20 ms On Time.

A0A20009? Start Sequence and Payload Length

97000000C8000000C8? Payload

0227B0B3? Message Checksum and End Sequence

Table 2-21 Set Trickle Power Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		97		ASCII 151
Push To Fix Mode	2		0000		0N=1, 0FF=0
Duty Cycle	2	* 10	00C8	%	% Time ON
Milli Seconds On Time	4		000000C8	ms	Range 200 to 500 ms

Payload Length: 9 bytes

2.2.21 Computation of Duty Cycle and On Time

The Duty Cycle is the desired time to be spent tracking (range is 5% - 25% and 100%). The On Time is the duration of each tracking period (range is 200 – 500 ms). To calculate the Trickle Power update rate as a function of Duty cycle and On Time, use the following formula:

$$\text{Off Time} = \frac{\text{On Time} - (\text{Duty Cycle} * \text{On Time})}{\text{Duty Cycle}}$$

Update rate = Off Time + On Time

Note - On Time inputs of > 500 ms will default to 500 ms and Duty Cycle inputs >25% will default to 100%

Following are some examples of selections:

Table 2-22 Example of Selections for Trickle Power Mode of Operation

Mode	On Time (ms)	Duty Cycle (%)	Update Rate(1/Hz)
Continuous	1000	100	1
Trickle Power	200	20	1
Trickle Power	200	10	2
Trickle Power	300	10	3
Trickle Power	500	5	10

Note - To confirm the receiver is performing at the specified duty cycle and ms On Time, see “To Display the 12-Channel Signal Level View Screen”. The C/No data bins will be fully populated at 100% duty and only a single C/No data bin populated at 20% duty cycle. Your position should be updated at the computed update rate.

2.2.22 Push-to-Fix

In this mode, the user specifies the Duty Cycle 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 in proportion to how long it stayed on:

$$\text{Off period} = \frac{\text{On Period}*(1\text{-Duty Cycle})}{\text{Duty Cycle}}$$

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.

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

2.2.24 Poll Navigation Parameters – Message I.D. 152

Table 2-23 contains the input values for the following example:

Example: Poll receiver for current navigation parameters.

A0A20002—Start Sequence and Payload Length

9800—Payload

0098B0B3—Message Checksum and End Sequence

Table 2-23 Poll Receiver for Navigation Parameters

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		98		ASCII 152
Reserved	1		00		Reserved

Payload Length: 2 bytes

2.2.25 Set UART Configuration – Message I.D.165

Table 2-24 contains the input values for the following example:

Example: Set port 0 to NMEA with 9600 baud, 8 data bits, 1 stop bit, no parity. Set port 1 to SiRF binary with 57600 baud, 8 data bits, 1 stop bit, no parity. Do not configure ports 2 and 3.

Example:

A0A20031—Start Sequence and Payload Length

A50001010000258008010000000100000000E1000801000000FF050500000000 0000000000FF0505000000000000000000—Payload

0452B0B3—Message Checksum and End Sequence

Table 2-24 Set UART Configuration

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A5		Decimal 165
Port	1		00		For UART 0
In Protocol	1		01		For UART 0
Out Protocol	1		01		For UART 0
Baud Rate	4		00002580		For UART 0
Data Bits	1		08		For UART 0
Stop Bits	1		01		For UART 0
Parity	1		00		For UART 0
Reserved	1		00		For UART 0
Reserved	1		00		For UART 0
Port	1		00		For UART 1
In Protocol	1		01		For UART 1
Out Protocol	1		01		For UART 1
Baud Rate	4		0000E100		For UART 1
Data Bits	1		08		For UART 1
Stop Bits	1		01		For UART 1
Parity	1		00		For UART 1
Reserved	1		00		For UART 1
Reserved	1		00		For UART 1
Port	1		FF		For UART 2
In Protocol	1		05		For UART 2
Out Protocol	1		05		For UART 2
Baud Rate	4		00000000		For UART 2
Data Bits	1		00		For UART 2
Stop Bits	1		00		For UART 2
Parity	1		00		For UART 2

Reserved	1		00		For UART 2
Reserved	1		00		For UART 2
Port	1		FF		For UART 3
In Protocol	1		05		For UART 3
Out Protocol	1		05		For UART 3
Baud Rate	4		00000000		For UART 3
Data Bits	1		00		For UART 3
Stop Bits	1		00		For UART 3
Parity	1		00		For UART 3
Reserved	1		00		For UART 3
Reserved	1		00		For UART 3

Payload Length: 49 bytes

2.2.26 *Set Message Rate – Message I.D.166*

contains the input values for the following example:

Set message ID 2 to output every 5 seconds starting immediately.

Example:

A0A20008—Start Sequence and Payload Length

A601020500000000—Payload

00AEB0B3—Message Checksum and End Sequence

Table 2-25 Set UART Configuration

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A6		Decimal 166
Send Now	1		01		Poll message
MID to be set	1		02		
Update Rate	1		05	sec	Range = 1- 30
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved

Payload Length: 8 bytes

1. 0 = No, 1 = Yes, if no update rate the message will be polled.

2.2.27 Low Power Acquisition Parameters – Message I.D.167

contains the input values for the following example:

Set maximum off and search times for re-acquisition while receiver is in low power.

Example:

A0A20019—Start Sequence and Payload Length

A7000075300001D4C000000000000000000000000000000000—Payload

02E1B0B3—Message Checksum and End Sequence

Table 2-26 Set Low Power Acquisition Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A7		Decimal 167
Max Off Time	4		00007530	ms	Maximum time for sleep mode
Max Search Time	4		0001D4C0	ms	Max. satellite search time
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved

Payload Length: 25 bytes

2.3 Output Messages for SiRF Binary Protocol

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

Table 2-27 lists the message list for the SiRF output messages.

Table 2-27 SiRF Messages - Output Message List

Hex	**ASCII**	**Name**	**Description**
0x02	2	Measured Navigation Data	Position, velocity, and time
0x04	4	Measured Tracking Data	Signal to noise information
0x05	5	Raw Track Data	Measurement information
0x06	6	SW Version	Receiver software
0x07	7	Clock Status	
0x08	8	50 BPS Subframe Data	Standard ICD format
0x09	9	Throughput	CPU load
0x0B	11	Command Acknowledgement	Successful request
0x0C	12	Command NAcknowledgment	Unsuccessful request
0x0D	13	Visible List	Auto Output
0x0E	14	Almanac Data	Response to Poll
0x0F	15	Ephemeris Data	Response to Poll
0x13	19	Navigation Parameters	Response to Poll
0xFF	255	Development Data	Various data messages

2.3.1 Measure Navigation Data Out - Message I.D. 2

Output Rate: 1 Hz

Table 2-28 lists the binary and ASCII message data format for the measured navigation data

Example:

A0A20009? Start Sequence and Payload Length
02FFD6F78CFFBE536E003AC00400030104A00036B039780E3
0612190E160F04000000000000? Payload
09BBB0B3? Message Checksum and End Sequence

Table 2-28 Messaged 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	Vy?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	2		036B			875
GPS TOW	4	*100	039780E3	seconds	?100	602605.79
SVs in Fix	1		06			6
CH1	1		12			18
CH2	1		19			25
CH3	1		0E			14
CH4	1		16			22
CH5	1		0F			15
CH6	1		04			4
CH7	1		00			0
CH8	1		00			0
CH9	1		00			0
CH10	1		00			0
CH11	1		00			0
CH12	1		00			0

Payload Length: 41 bytes

[1] For further information, go to Table 2-29.

[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 2-30.

Note - Binary units scaled to integer values n eed to be divided by the scale value to receive true decimal value (i.e., decimal X vel = binary X vel ? 8).

Table 2-29 Mode 1

Mode 1		Description
Hex	**ASCII**	
0x00	0	No Navigation Solution
0x01	1	1 Satellite Solution
0x02	2	2 Satellite Solution
0x03	3	3 Satellite Solution (2D)
0x04	4	?4 Satellite Solution (3D)
0x05	5	2D Point Solution (Krause)
0x06	6	3D Point Solution (Krause)
0x07	7	Dead Reckoning (Time Out)
0x80	8	DGPS Position

Example: A value of 0 x 84 (132) is a DGPS ?4 satellite Solution (3D)

Table 2-30 Mode 2

Mode 2		Description
Hex	**ASCII**	
0x00	0	DR Sensor Data
0x01	1	Validated/Unvalidated
0x02	2	Dead Reckoning (Time Out)
0x03	3	Output Edited by U1
0x04	4	Reserved
0x05	5	Reserved
0x06	6	Reserved
0x07	7	Reserved

2.3.2 *Measured Tracker Data Out - Message I.D. 4*

Output Rate: 1 Hz

Table 2-31 lists the binary and ASCII message data format for the measured tracker data.

Example:

A0A200BC? Start Sequence and Payload Length

04036C0000937F0C0EAB46003F1A1E1D1D191D1A1A1D1F1D59423F1A1A ...? Payload

****B0B3? Message Checksum and End Sequence

Table 2-31 Measured Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	**Example**		**Scale**	**Example**
Message ID	1		04	None		4
GPS Week	2		036C			876
GPS TOW	4	s*100	0000937F	s	s?100	37759
Chans	1		0C			12
1st SVid	1		0E			14
Azimuth	1	Az*[2/3]	AB	deg	?[2/3]	256.5
Elev	1	El*2	46	deg	?2	35
State	2		003F	Bitmap[1]		63
C/No 1	1		1A			26
C/No 2	1		1E			30
C/No 3	1		1D			29
C/No 4	1		1D			29
C/No 5	1		19			25
C/No 6	1		1D			29
C/No 7	1		1A			26
C/No 8	1		1A			14
C/No 9	1		1D			29
C/No 10	1		1F			31
2nd SVid	1		1D			29
Azimuth	1	Az*[2/3]	59	deg	?[2/3]	89
Elev	1	El*2	42	deg	?2	66
State	2		3F	Bitmap[1]		63
C/No 1	1		1A			26
C/No 2	1		1A			63
….						

Payload Length: 188 bytes

[1] For further information, go to Table 2-32.

Note - Message length is fixed to 188 bytes with nontracking channels reporting zero values.

Table 2-32 TrktoNAVStruct.trk_status Field Definition

Field Definition	Hex Value	Description
ACQ_SUCCESS	0x0001	Set if acq/reacq is done successfully
DELTA_CARPHASE_VALID	0x0002	Integrated carrier phase is valid
BIT_SYNC_DONE	0x0004	Bit sync completed flag
SUBFRAME_SYNC_DONE	0x0008	Subframe sync has been done
CARRIER_PULLIN_DONE	0x0010	Carrier pullin done
CODE_LOCKED	0x0020	Code locked
ACQ_FAILED	0x0040	Failed to acquire S/V
GOT_EPHEMERIS	0x0080	Ephemeris data available

Note - When a channel is fully locked and all data is valid, the status shown is 0 x BF.

2.3.3 Raw Tracker Data Out - Message I.D. 5

GPS Pseudo-Range and Integrated Carrier Phase Computations Using SiRF Binary Protocol

This section describes the necessary steps to compute the GPS pseudo-range, pseudo-range rate, and integrated carrier phase data that can be used for post processing applications such as alternative navigation filters. This data enables the use of third party software to calculate and apply differential corrections based on the SiRF binary protocol. Additionally, description and example code is supplied to calculate the measurement data and decode the broadcast ephemeris required for post processing applications.

SiRF Binary Data Messages

The SiRF GPS chip set provides a series of output messages as described in this Guide. This is the raw data message required to compute the pseudo-range and carrier data.

The ephemeris data can be polled by the user or requested at specific intervals with customized software. Currently, there is no support for the automatic saving of the ephemeris when an update ephemeris is decoded. This will be included in future release version of the SiRFstarI/LX software. See the source file calceph.c for decoding instructions of the ephemeris data.

Output Rate: 1 Hz

Table 2-33 lists the binary and ASCII message data format for the raw tracker data.

Example:

A0A20033? Start Sequence and Payload Length

05000000070013003F00EA1BD4000D039200009783000DF45E

000105B5FF90F5C200002428272723272424272905000000070013003F? Payload

0B2DB0B3? Message Checksum and End Sequence

Note - The data that is sent from the unit is in binary format, SiRFdemo converts the data to ASCII for the log file. Data is NOT output in ASCII format.

Table 2-33 Raw Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		05			5
Channel	4		00000007			7
SVID	2		0013	bitmap[1]		19
State	2		003F	bit		63
Bits	4		00EA1BD4	ms		15342548
ms	2		000D	chip		13
Chips	2		0392	chip		914
Code Phase	4	2^{-16}	00009783	rad/2ms	?2^{-16}	38787
Carrier Doppler	4	2^{-10}	000DF45E	ms	?2^{-10}	914526
Time Tag	4		000105B5	cycle		66997
Delta Carrier	4	2^{-10}	FF90F5C2		?2^{-10}	-7277118
Search Count	2		0000	dBHz		0
C/No 1	1		24	dBHz		36
C/No 2	1		28	dBHz		40
C/No 3	1		27	dBHz		39
C/No 4	1		27	dBHz		39
C/No 5	1		23	dBHz		35
C/No 6	1		27	dBHz		39
C/No 7	1		24	dBHz		36
C/No 8	1		24	dBHz		36
C/No 9	1		27	dBHz		39
C/No 10	1		29	dBHz		41
Power Bad Count	1		05			5
Phase Bad Count	1		07			7
Accumulation Time	2		0013	ms		19
Track Loop Time	2		003F			63

[1] For further information, go to Table 2-34.

[2] Multiply by (1000?4?) ??^{16} to convert to Hz.

Table 2-34 Bit Description of the Tracking State

Bit Field Definition	**Description (LSB to MSB)**
Acq/Reacq	Set if acq/reacq is successful
Delta Carrier Phase	Set if integrated carrier phase is valid
Bit Sync	Set if bit sync is successful
Subframe Sync	Set if Frame sync is successful
Carrier Pullin	Set if carrier pullin completed
Code Lock	Set if Code lock is completed
Acquisition Failure	Set if Sv is not acquired
Ephemeris Status	Set if valid ephemeris has been collected

Note - The status is reflected by the value of all bits as the receiver goes through each stage of satellite acquisition. The status will have a 0xBF value when a channel is fully locked and all data is valid.

Message ID: Each SiRF binary message is defined based on the ID.

Channel: Receiver channel where data was measured (range 1-12).

SVID: PRN number of the satellite on current channel.

State: Current channel tracking state (see Table 2-34).

Bit Number: Number of GPS bits transmitted since Sat-Sun midnight (in Greenwich) at a 50 bps rate.

Millisecond Number: Number of milliseconds of elapsed time since the last received bit (20 ms between bits).

Chip Number: Current C/A code symbol being transmitted (range 0 to 1023 chips; 1023 chips = 1 ms).

Code Phase: Fractional chip of the C/A code symbol at the time of sampling (scaled by 2^{-16} , = 1/65536).

Carrier Doppler: The current value of the carrier frequency as maintained by the tracking loops.

Note - The Bit Number, Millisecond Number, Chip Number, Code Phase, and Carrier Doppler are all sampled at the same receiver time.

Receiver Time Tag:	This is the count of the millisecond interrupts from the start of the receiver (power on) until the measurement sample is taken. The ms interrupts are generated by the receiver clock.
Delta Carrier Phase:	The difference between the carrier phase (current) and the carrier phase (previous). Units are in carrier cycles with the LSB = 0.00185 carrier cycles. The delta time for the accumulation must be known.

Note - Carrier phase measurements are not necessarily in sync with code phase measurement for each measurement epoch.

Search Count:	This is the number of times the tracking software has completed full satellite signal searches.
C/No:	Ten measurements of carrier to noise ratio (C/No) values in dBHz at input to the receiver. Each value represents 100 ms of tracker data and its sampling time is not necessarily in sync with the code phase measurement.
Power Loss Count:	The number of times the power detectors fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).
Phase Loss Count:	The number of times the phase lock fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).
Integration Interval:	The time in ms for carrier phase accumulation. This is the time difference (as calculated by the user clock) between the Carrier Phase (current) and the Carrier Phase (previous).
Track Loop Iteration:	The tracking Loops are run at 2 ms and 10 ms intervals. Extrapolation values for each interval is 1 ms and 5 ms for range computations.

Calculation of Pseudo-Range Measurements

The pseudo-range measurement in meters can be determined from the raw track data by solving the following equation:

Pseudo-range (PR) = [Received Time (RT) – Transmit Time (TT)] * C

where C = speed of light

The following variables from the raw track data are required for each satellite:

Bit Number (BN) - 50 bits per second

Millisecond Number (MSN)

Chip Number (CN)

Code Phase (CP)

Receiver Time Tag (RTTag)

Delta Carrier Phase (DCP)

The following steps are taken to get the psr data and carrier data for each measurement epoch.

Note - See source code **`calcpsr`**.

1. Computation of initial Receiver Time (RT) in seconds.

Note - Where the initial arbitrary value chosen at start up to make the PR reasonable (i.e., set equal to TT + 70 ms) and then incriminated by one second for each measurement epoch.

2. Computation of Transmit Time (TT) in seconds.
3. Calculate Pseudo-range at a common receiver time of the first channel of the measurement data set.

Note - All channel measurements are NOT taken at the same time. Therefore, all ranges must be extrapolated to a common measurement epoch. For simplicity, the first channel of each measurement set is used as the reference to which all other measurements are extrapolated.

4. Extrapolate the pseudo-range based on the correlation interval to improve precision.
5. Compute the delta range.

If the accumulation time of the Delta Carrier Phase is 1000 ms then the measurement is valid and can be added to the previous Delta Carrier Phase to get Accumulated Carrier Phase data. If the accumulation time of the Delta Carrier Phase is not equal to 1000 ms then the measurement is not valid and the accumulation time must be restarted to get Accumulated Carrier Phase data.

Output Files

Several output files are generated by the **`calcpsr.exe`** program:

1. **`*.eph`** Ephemeris data decoded.
2. **`sv_data.###`** Individual raw track data per satellite (SiRF binary format).
3. **`p_range.###`** Satellite specific data in the format of receiver time, reference channel, reference Sv, Psr, Delta Psr, Delta-delta Psr (in meters).
4. **`*.msr`** Psr values and extrapolation values.

2.3.4 Software Version String (Response to Poll) - Message I.D. 6

Output Rate: Response to polling message

Example:

A0A20015? Start Sequence and Payload Length

0606312E322E30444B495431313920534D0000000000? Payload

0382B0B3? Message Checksum and End Sequence

Table 2-35 Software Version String

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

Payload Length: 21 bytes

1. 06312E322E30444B495431313920534D0000000000

2. 1.2.0DKit119 SM

Note - Convert to symbol to assemble message (i.e., 0 x 4E is ‘ N’). These are low priority task and are not necessarily output at constant intervals.

2.3.5 Clock Status Data (Response to Poll) - Message I.D. 7

Output Rate: 1 Hz or response to polling message

Example:

A0A20014? Start Sequence and Payload Length

0703BD021549240822317923DAEF? Payload

0598B0B3? Message Checksum and End Sequence

Table 2-36 Clock Status Data Message

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		07			7
GPS Week	2		03BD			957
GPS TOW	4	*100	02154924	s	?100	349494.12
Svs	1		08			8
Clock Drift	4		2231	Hz		74289
Clock Bias	4		7923	nano s		128743715
Estimated GPS Time	4		DAEF	milli s		349493999

Payload Length: 20 bytes

2.3.6 50 BPS Data - Message I.D. 8

Output Rate:As available (12.5 minute download time)

Example:

A0A2002B? Start Sequence and Payload Length

08********? Payload

****B0B3? Message Checksum and End Sequence

Table 2-37 50 BPS Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		08			8
Channel	1					
Sv I.D	1					
Word[10]	40					

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

Note - Data is logged in ICD format (available from `www.navcen.uscg.mil`). The ICD specification is 30-bit words. The above definition is 32-bit words; therefore, the user must strip the 2 MSB prior to decoding.

2.3.7 CPU Throughput - Message I.D. 9

Output Rate: 1 Hz

Example:

A0A20009? Start Sequence and Payload Length

09003B0011001601E5? Payload

0151B0B3? Message Checksum and End Sequence

Table 2-38 CPU Throughput

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

Payload Length: 9 bytes

2.3.8 Command Acknowledgment - Message I.D. 11

Output Rate: Response to successful input message

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

A0A20002? Start Sequence and Payload Length

0B92? Payload

009DB0B3? Message Checksum and End Sequence

Table 2-39 Command Acknowledgment

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0B			11
Ack. I.D.	1		92			146

Payload Length: 2 bytes

2.3.9 Command NAcknowledgment - Message I.D. 12

Output Rate: Response to rejected input message

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

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

Table 2-40 Command NAcknowledgment

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0C			12
NAck. I.D.	1		92			146

Payload Length: 2 bytes

2.3.10 Visible List - Message I.D. 13

Output Rate: Updated approximately every 2 minutes

Note - This is a variable length message. Only the numbers of visible satellites are reported (as defined by Visible Svs in Table 2-41). Maximum is 12 satellites.

Example:

A0A2002A? Start Sequence and Payload Length
0D080700290038090133002C*******************? Payload
****B0B3? Message Checksum and End Sequence

Table 2-41 Visible List

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0D			13
Visible Svs	1		08			8
CH 1 – Sv I.D.	1		07			7
CH 1 – Sv Azimuth	2		0029	degree		41
CH 1 – Sv Elevation	2		0038	degree		56
CH 1 – Sv I.D.	1		09			9
CH 1 – Sv Azimuth	2		0133	degree		307
CH 1 – Sv Elevation	2		002C	degree		44
…..						

Payload Length: 62 bytes (maximum)

2.3.11 Almanac Data - Message I.D. 14

Output Rate: Response to poll

Example:

A0A203A1? Start Sequence and Payload Length

0E01**************? Payload

****B0B3? Message Checksum and End Sequence

Table 2-42 Almanac Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	**Example**		**Scale**	**Example**
Message ID	1		0E			14
Sv I.D. (1)	1		01			1
AlmanacData[14][2]	28					
….						
Sv I.D. (32)	1		20			32
AlmanacData[14][2]	28					

Payload Length: 929 bytes

2.3.12 Ephemeris Data (Response to Poll) – Message I.D. 15

The ephemeris data that is polled from the receiver is in a special SiRF format based on the ICD- GPS -200 format for ephemeris data. Refer to the supplied utility program **`calcpsr.exe`** for decoding of this data.

Note - The source code provided is an example of the EPH decoding and GPS measurement calculations.

2.3.13 Navigation Parameters (Response to Poll) – Message I.D. 19

Output Rate: 1 Response to Poll

Example:

A0A20018—Start Sequence and Payload Length

130100000000011E3C0104001E004B1E00000500016400C8—Payload

022DB0B3—Message Checksum and End Sequence

Table 2-43 Navigation Parameters

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		13			19
Altitude Constraint	1		01			1
Altitude Hold Mode	1		00			0
Altitude Hold Source	1		00			0
Altitude Source Input	2		0000	meters		0
Degraded Mode[1]	1		01			1
Degraded Timeout	1		1E	second		30
DR Timeout	1		3C	second		60
Track Smooth Mode	1		01			1
DOP Mask Mode[2]	1		04			4
DGPS Mode[3]	1		00			0
DGPS Timeout	1		1E	seconds		30
Elevation Mask	2	*10	004B	degrees	?10	7.5
Power Mask	1		1E	dBHz		30
Editing Residual	2		0000			0
Steady-State Detection	1	*10	05	m/s^2	?10	0.5
Static Navigation	1	*10	00		?10	0
Low Power Mode[4]	1		01			1
Low Power Duty Cycle	1		64	percent		100
Low Power On-Time	2		00C8	ms		200

Payload Length: 24 bytes

[1] See Table 2-7.

[2] See Table 2-9.

[3] See Table 2-11.

[4] See **錯誤! 找不到參照來源。**.

2.3.14 Development Data – Message I.D. 255

Output Rate: Receiver generated

Example:

A0A2****—Start Sequence and Payload Length

FF**************—Payload

****B0B3—Message Checksum and End Sequence

Table 2-44 Development Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		FF			255

Payload Length: Variable

Note - Messages are output to give the user information of receiver activity. Convert to symbol to assemble message (i.e., 0 x 4E is ‘ N’). These are low priority task and are not necessarily output at constant intervals.