PG-31
GPS Engine Board

User's Manual & Reference Guide

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Chapter 1 Introduction to PG-31 GPS Receiver

PG-31 GPS Receiver Module

Features

- SiRF Star II/LP (low power) chipset with embedded ARM7TDMI CPU available for customized applications through firmware
- 12 parallel satellite-tracking channels for fast acquisition and re-acquisition
- Compact size (only 30.6*26*9.8mm, includes RF shield and connector)
- High speed signal acquisition using 1920 time/frequency search channels
- Built-in WAAS/EGNOS demodulator
- Low power consumption with Advanced TricklePower and Push-To-Fix mode
- Optional Rechargeable battery for memory and RTC backup as well as fast Time to First Fix (TTFF)
- Support NMEA-0183 v2.2 data protocol and SiRF binary code
- Enhanced algorithms such as SnapLock and SnapStart provide superior navigation performance in urban, canyon, and foliage covered environments
- For Car Navigation, Marine Navigation, Fleet Management, AVL and Location-Based Services, Auto Pilot, Personal Navigation, Touring Devices, and general tracking devices/systems and Mapping applications

Specification overview

Snap Start < 3 sec (at < 25 minutes off period)
Hot Start 8 sec (typical)
Warm Start 38 sec (typical)
Cold Start 45 sec (typical)
Satellite Re-acquisition 100 ms
Time Accuracy 1 us
Channels 12 satellites
Position Accuracy 25m CEP without SA
Receiver L1, C/A code
Protocol NMEA-0183 V2.2, 4800, 8, N, 1, GGA, GSA, GSV,
MC (VTG , GLL, RMS option) or SiRF Binary
Maximum Altitude < 18,000 m (60,000 feet)
Maximum Velocity < 515 m/s (1000knots)
Max. Update Rate 1 Hz
RF Connector MMCX
Interface Interface connector 20-pin (2X10) low profile socket, 1mm
Dimension 30.6mm(L)x26mm(W)x9.8mm(H)
Weight 8g
Firmware Upgrade Flash memory for programming software available
Time Mark Output 1 pulse/sec, aligned with GPS time +/ -0.1 usec
Operating Temperature –40ºC to +85ºC
Storage Temperature –45ºC to +100ºC
Operating Humidity 5% to 95%, No Condensing
Electrical specifications: Less than 70mA (without antenna)
Output terminal and definition: Interface connector 20-pin (2X10) low profile socket, 1mm

Chapter 2 Specifications

PG-31

1. Electrical Characteristics

1.1 General	Frequency	L1,1575.42MHz
	C/A code	1.023 MHz chip rate
	Channels	12
1.2 Accuracy	Position	25 meters CEP without SA
	Velocity	0.1 meters/second, without SA
	Time	1 microsecond synchronized to GPS time
1.3 DGPS Accuracy	Position	1 to 5 meters, typical
	Velocity	0.05 meters/second, typical
1.4 Datum	WGS-84	
1.5 Acquisition Rate	Re-acquisition	0.1 sec., average
	Cold start	45 sec., average
	Warm start	38 sec., average
	Hot start	8 sec., average
1.6 Dynamic Condition	Altitude	18,000 meters (60,000 Feet) max.
	Velocity	515 meters/sec. (1000 Knots) max.
	Acceleration	4 g., max.
	Jerk	20 meters/sec.^{3} max.
1.7 Power	Main Power	3.3 Vdc ± 10%
	Supply Current, continuous	~ 70 mA
	Supply Current, TricklePower mode	~ 10 mA
	Backup Power	+2.5V to 3.1V
	Backup Current	10µA typical
1.8 External Reset	Active low input	
1.9 Serial Port	Electrical interface	Two full duplex serial communication (TTL level or EIA RS-232 level - optional)
	Protocol	Design-in binary and NMEA-0183, Version 2.20 with a baud rate selection
	NMEA output	GGA, GLL, GSA, GSV, RMC, and VTG (on customer request) Default six NMEA (Baud Rate :4800)
	DGPS protocol	RTCM SC-104, version 2.00, type 1,2 and 9 WAAS Supported
1.10 Time-1PPS Pulse	Level	TTL
	Pulse duration	100 ms
	Time reference	positive edge
	Measurements	Aligned to GPS second, ± 1µ sec.

2. Environmental Characteristics

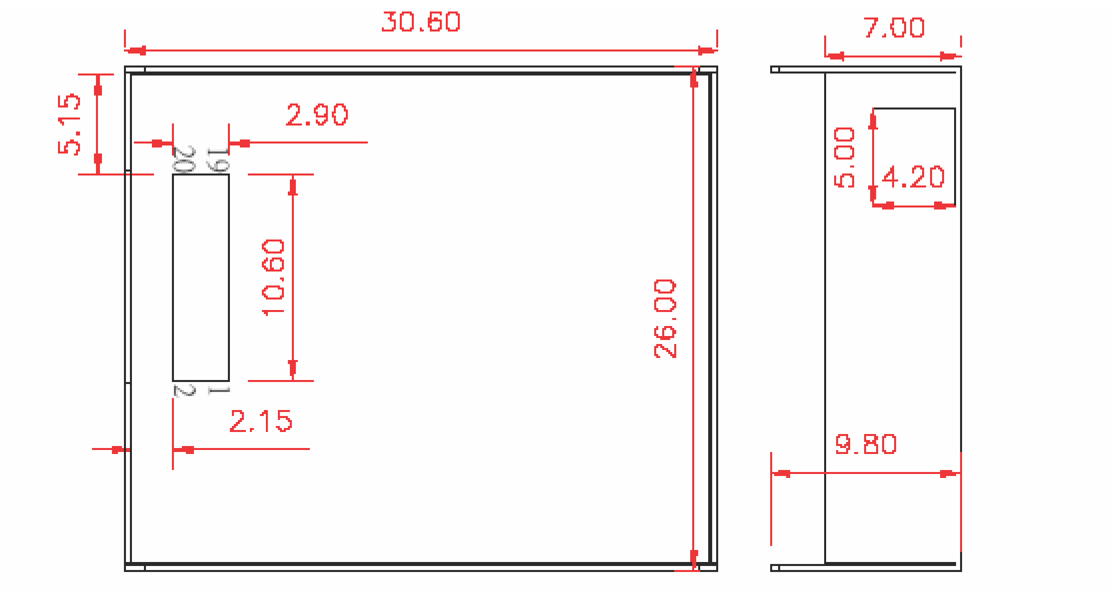
2.1 Temperature	Operating range	–40ºC to +85ºC
	Storage range	–45ºC to +100ºC
2.2 Physical characteristics	Dimension	30.6mm(L)x26mm(w)x9.8mm(H)

	Antenna connector	MMCX type
	Interface connector	20-pin (2X10) low profile socket, 1mm
3. Antenna	Passive or Active Antenna	
4. CPU Throughput	GPS Signal Processor & Software	Integrated 16-bit,50 MHz ARM7TDMI CPU core & 1M DRAM memory 90% CPU throughput available for user tasks
5. RF Interference	Assembled with fully shielded case design to withstand the most interference	

Chapter 3 Inter face and Options

This chapter describes the pin definitions of the interface connector and flexible options of the PG-31.

Physical Diagram



Pin Definition of the Digital Interface Connector PG-31

Table 3-1 Pin List of the 20 pin Digital Interface Connector for the PG-31

Pin #	Name	Description
1	VCC	+3.3V +- 10% DC Power Input
2	TXA	Host Serial Data Output A
3	RXA	Host Serial Data Input A
4	TXB	Aux. Serial Data Output B
5	RXB	Aux. Serial Data Input B (DGPS)
6	TIMEMARK	1PPS Time Mark Output
7	BAT	Battery Backup Power Input
8	GPIOA	General Purpose Input/Output
9	RESET	Reset, Active Low
10	RESERVED	Reserved

11	GROUND	Ground
12	BOOTSEL	Internal/External Boot selective
13	GPIOB	General Purpose Input/Output
14	GPIOC	General Purpose Input/Output
15	GPIOD	General Purpose Input/Output
16	GPIOE	General Purpose Input/Output
17	GPIOF	General Purpose Input/Output
18	GPIOG	General Purpose Input/Output
19	GPIOH	General Purpose Input/Output
20	GROUND	Ground
**The Host Serial Data I/O is normally a CMOS logical high +3.3VDC. *The Host Serial Data Input A (Pin# 3) should be set to high (ex.100KΩserial to +Vcc) when not being used.*		

VCC
3.3 Vdc ±10% with a continuous Supply Current of ~ 70 mA.
Supply Current TricklePower mode ~ 10 mA (undetermined)

TXA
This is the main transmit channel and is used to output navigation and measurement data.
The Output is a TTL Level: Voh 2.4V, Vol 0.4V; Ioh=Iol=2mA.

RXA
This is the main receiver channel and is used by the PG-31 to receive software commands.
Receiver is TTL Level; Vih 0.7*VCC; Vil 0.3*VCC

TXB
For user's application (not currently used).

RXB
This is the auxiliary receive channel and is used to input differential corrections to the PG-31 board to enable DGPS navigation. Receiver is TTL Level; Vih 0.7*VCC; Vil 0.3*VCC.

TIMEMARK
This pin provides a one pulse-per-second output from the TMP board which is synchronized to GPS time. This is not available in TricklePower mode.

BAT

This is the battery backup input that powers the SRAM and RTC when the main power is removed. Typical current draw is 10uA. Without an external backup battery or supercap, PG-31 will execute a cold start after every power on. To achieve the faster start-up offered by a hot or warm start, either a battery backup must be connected or a supercap installed. To maximize battery life, the battery voltage should not exceed the supply voltage and should be between 2.5V and 3.1V.

GPIOA - GPIOH

These pins are connected to the digital interface connector for custom applications

RESET

This pin provides an active-low reset input to the PG-31 board. It causes the PG-31 board to reset and start searching for satellites. If not utilized, it may be left open.

GND

GND provides the ground for the PG-31 board.

BOOTSEL

Internal/External Boot select. For normal internal boot mode, this pin is "High".
For normal operation, the user must leave this pin disconnected.

Option Descriptions

TricklePower Option

The design of the PG-31 includes all the functionality necessary to implement the TricklePower mode. In this mode, the lowest average power dissipation is achieved by powering down the board (after a position is determined) in such a manner that when it is turned back on it can re-compute a position fix in the shortest amount of time. The standard TricklePower operates in three states:

(1) Tracking State

In this state, the board is fully powered, tracking satellites and gathering data.
The time in this state is selectable via the SiRF demo software from 200-900ms.
After this time the measurements to calculate a position are ready.

(2) CPU State

In this state, the GRF1/LX (RF IC) has been turned off (by the control signal) removing the clock to the GSP1/LX (Baseband ASIC). Without a clock, the GSP1/LX is effectively powered down (although the RTC keeps running). The CPU is kept running to process the GPS data until a position fix is determined and the result has been transmitted by the serial communication interface.

(3) Trickle State

In this state, the CPU is in a low power standby state and the receiver clocks are off with only the RTC clock active. After a set amount of time, the RTC generates an NMI signal to wakeup the Hitachi microprocessor and set the receiver back to the tracking state. The default time for each TricklePower state (and the approximate current consumed) is shown below in Table 3-3. For example, with the TricklePower duty cycle at 20% the average receiver power dissipation is approximately 165mW (50mA @ 3.3v) while maintaining a one-second update rate.

Table 3-2 TricklePower Consumption		
State	***Time***	***+3.3V Current***
Tracking	220mS	145mA
CPU	360mS	40mA
Trickle	420mS	0.5mA
Note: Table 3-2 does not include the external antenna power consumption.		

RS-232 I/O Option

PG-31 allows for the populating of an RS-232 driver. Customers can request the I/O to be TTL (5V) or RS-232 (12V).

Chapter 4 SiRF Binary Protocol Specification

The serial communication protocol is designed to include:

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

Protocol Layers

Transport Message

	Start Sequence	**Payload *Length Payload***	***Payload***	**Message Checksum**	**End Sequence**
	0xA0 [1],	Two-bytes	Up to $2^{10}-1$	Two-bytes	0xB0,
	0xA2	(15-bits)	(<1023)	(15-bits)	0xB3
1. 0xYY denotes a hexadecimal byte value. 0xA0 equals 160.					

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 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) checksum. The values of the start and stop characters and the choice of a 15-bit value for length and checksum are designed such that both message length and checksum can not alias with either the stop or start codes.

Message Validation

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

Payload Length

The payload length is transmitted high 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 also limit the actual size to something less than this maximum.

Payload Data

The payload data follows the payload length. It contains the number of bytes specified by the payload 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 convention.

Checksum

The checksum is transmitted high order byte first followed by the low byte. This is the so-called big-endian convention.

High Byte	Low Byte
< 0x7F	Any value

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

Let 'message' be the array of bytes to be sent.

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)
```

Input Messages for SiRF Binary Protocol

Note – All input messages are sent in **BINARY** format. Table 4-1 lists the message list for the SiRF input messages.

Table 4- 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	Set DGPS Source Control
0 x 86	134	Set Main Serial Port
0 x 88	136	Mode Control
0 x 89	137	DOP Mask Control
0 x 8A	138	DGPS Mode
0 x 8B	139	Elevation Mask
0 x 8C	140	Power Mask
0 x 8D	141	Editing Residual (Not implemented)
0 x 8E	142	Steady-State Detection (Not implemented)
0 x 8F	143	Static Navigation
0 x 90	144	Poll Clock Status
0 x 91	145	Set DGPS Serial Port
0 x 92	146	Poll Almanac
0 x 93	147	Poll Ephemeris
0 x 94	148	Flash Update
0 x 95	149	Set Ephemeris (upload)
0 x 96	150	Switch Operating Mode
0 x 97	151	Set TricklePower Parameters

0 x 98	152	Poll Navigation Parameters
0 x A5	165	Set UART Configuration
0 x A6	166	Set Message Rate
0 x A7	167	Low Power Acquisition Parameters

Initialize Data Source - Message I.D. 128

Table 4-2 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 4- 2 Initialize Data Source

		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		80		ASCII 128
ECEF X	4		FFD700F	meters	
ECEF Y	4		FFBE5266	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 Table 4-3
Payload Length: 25 bytes					

Table 4- 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	Factory Reset
4	Enable raw track data (YES=1, NO=0)
5	Enable debug data for SiRF binary protocol (YES=1, NO=0)
6	Enable debug data for NMEA protocol (YES=1, NO=0)
7	Reserved (must be 0)
Note **–** If Nav Lib data is ENABLED then the resulting messages are enabled. Clock Status (MID 7), 50 BPS (MID 8), Raw DGPS (17), NL Measurement Data (MID 28), DGPS Data (MID 29), SV State Data (MID 30), and NL Initialize Data (MID 31). All messages are sent at 1 Hz and the baud rate will be automatically set to 57600.	

Switch to NMEA Protocol - Message I.D. 129

Table 4-4 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

810201010001050105010001000100010001000112C0— Payload
016AB0B3— Message Checksum and End Sequence

Table 4- 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 5 for format.
Checksum 2	1		01		
GLL Message	1		00	1/s	Se Chapter 5 for format.
Checksum	1		01		
GSA Message	1		05	1/s	See Chapter 5 for format.
Checksum	1		01		
GSV Message	1		05	1/s	See Chapter 5 for format.
Checksum	1		01		
RMC Message	1		00	1/s	See Chapter 5 for format.
Checksum:	1		01		
VTG Message	1		00	1/s	See Chapter 5 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 NOT transmitted with the message (not recommended). A value of 0x01 will have a checksum calculated and transmitted as part of the message (recommended).

Note – In TricklePower mode, the update rate is specified by the user. When you switch to NMEA protocol, the message update rate will be required again. The resulting update rate is the product of the TricklePower Update rate AND the NMEA update rate (i.e. TricklePower update rate = 2 seconds, NMEA update rate = 5 seconds, resulting update rate is every 10 seconds (2 X 5 = 10)).

Set Almanac – Message I.D. 130

This command enables the user to upload an almanac PG-31
example:

A0A20380 – Start Sequence and Payload Length
82xx… … … … … … … – Payload
xxxxB0B3 – Message Checksum and End Sequence

Table 4-5 Set Almanac message					
Name	**Bytes**	**Binary (Hex)**		**Units**	**Description**
		Scale	**Example**		
Message ID	1		82		ACSII 130
Almanac	896		00		Reserved
Payload Length: 897 bytes					

The almanac data is stored in the code as a 448 element array of INT16 values. These 448 elements are partitioned as 32 x 14 elements where the 32 represents the satellite number minus 1 and the 14 represents the number of INT16 values associated with this satellite. The data is actually packed and the exact format of this representation and packing method can be extracted from the ICD-GPS-2000 document. The ICD-GPS-2000 document describes the data format of each GPS navigation sub-frame and is available on the web at http://www.arinc.com/gps.

Software Version – Message I.D. 132
Table 4-6 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 4- 6 Set Almanac message					
Name	**Bytes**	**Binary**	**(Hex)**	**Units**	**Description**
		Scale	**Example**		
Message ID	1		84		ACSII 132
TBD	1		00		Not used
Payload Length: 2 bytes					

Set DGPS Source – Message I.D. 133
This command allows the user to select the source for DGPS corrections. Options available are: External RTCM Data (any serial port) WAAS (subject to WAAS satellite availability) Internal DGPS beacon receiver.

Example 1: Set the DGPS source to external RTCM Data

A0A200007— Start Sequence and Payload Length
8502000000000 — 0 Payload
0087B0 B3— Checksum and End Sequence

Table 4-7 Set DGPS Source					
Name	**Bytes**	**Binary (Hex)**		**Units**	**Description**
		Scale	**Example**		
Message ID	1		85		decimal 133
DGPS Source	1		02		See Table 4-9– DGPS
					Source Selections
Internal Beacon	4		00000000	Hz	Internal Beacon Search
Frequency					Settings
Internal Beacon	1		00	BPS	InternalBeacon Search
Bit Rate					Settings
Payload Length: 7 bytes					

Example2: Set the DGPS source to Internal DGPS Beacon Receiver (Currently PG-31 is not supported) Search Frequency 310000, Bit Rate 200

A0A200007— Start Sequence and Payload Length
85030004BAF0C802— Payload
02FEB0B3— Checksum and End Sequence

Table 4 - 8 DGPS Source Selection (Example 2)

Name	Bytes	Scale Hex	Units	Decimal	Description
Message I.D.	1	85		133	Message Identification.
DGPS Source	1	03		3	See Table 4-9 DGPS
					Source Selections.
Internal Beacon	4	0004BAF0	HZ	310000	See Table 4-9 Internal
Frequency					Beacon Search Settings .
Internal Beacon	1	C8	BPS	200	See Table 4-10 Internal
Bit Rate					Beacon Search Settings.

Table 4- 9 Set DGPS Source Selections

DGPS	Hex	Decimal	Description
None	0	0	DGPS corrections will not be Used (even if available).
WAAS	1	1	Uses WAAS Satellite (subject to availability).
External RTCM Data	2	2	External RTCM input source (i.e., Coast Guard Beacon).
Internal DGPS	3	3	Internal DGPS beacon receiver.
Beacon Receiver			
User software	4	4	Corrections provided using an interface module routine in a user application

Table 4- 10	Internal Beacon Search Settings		
Search Type	**Frequency¹**	**Bit Rate²**	**Description**
Auto Scan	0	0	Auto scanning of all frequencies and bit rates are performed
Full Frequency Scan	0	None Zero	Auto scanning of all frequencies and specified bit rate are performed
Full Bit Rate Scan	None Zero	0	Auto scanning of all bit rates and specified frequency are performed
Specific Search Scan	None Zero	None Zero	Only the specified frequency and bit rate search are performed

Set Main Serial Port - Message I.D. 134

Table 4-11 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

0134B0B3— Message Checksum and End Sequence

Table 4-11 Set Main Serial Port

Name	Bytes	Binary Scale	(Hex) Example	Units	Description
Baud	4		88		
Data Bits	1		01		8,7
Stop Bit	1		01		0,1
Parity	1		01		None=0, Odd=1, Even=2
Pad	1		01		Reserved
Payload Length: 9 bytes					

Mode Control - Message I.D. 136

Table 4-12 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

880101010101000000002140501— Payload

00A9B0B3— Message Checksum and End Sequence

Table 4-12 Mode Control

Name	Bytes	Binary Scale	(Hex) Example	Units	Description
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 4-13
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
Coast Time Out	1		14	Seconds	0 to 120
Degraded Time	1		05	Seconds	0 to 120
Out					
DR Time Out	1		01	Seconds	0 to 120
Track	1		01		YES=1, NO=0
Smoothing					
Payload Length: 14 bytes					

Table 4- 13	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

DOP Mask Control - Message I.D. 137

Table 4-14 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 4- 14 DOP Mask Control

Name	Bytes	Binary Scale	(Hex) Example	Units	Description
Message ID	1		89		ASCII 137
DOP Selection	1		00		See Table 4-15
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 4- 15 DOP Selection

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

DGPS Control - Message I.D. 138

Table 4-16 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 4- 16 DGPS Control

		Binary (Hex)			
Name	Bytes	Scale	Example	Units	Description
Message ID	1		8A		ASCII 138
DGPS Selection	1		01		See Table 4-17
DGPS Time Out	1		1E	seconds	Range 0 to 255
Payload Length: 3 bytes					

*Table 4- 17*DGPS Selection

Byte Value	Description
0	Auto
1	Exclusive
2	Never Use

Note –Configuration of the DGPS mode using MID 138 only applies to RTCM corrections received from an external RTCM source or internal or external beacon. It does not apply to WAAS operation.

Elevation Mask – Message I.D. 139

Table 4-18 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 4- 18 Elevation Mask					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
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

Power Mask - Message I.D. 140

Table 4-19 contains the input values for the following example: Navigation mask to 33 dB Hz (tracking default value of 28) Example:

A0A2000 3— Start Sequence and Payload Length
8C1C21— Payload
00C9B0B3— Message Checksum and End Sequence

Table 4- 19 Power Mask					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		8C		ASCII 140
Tracking Mask	1		1C	DBHz	Not currently implemented
Navigation Mask	1		21	DBHz	Range 20 to 50

Payload Length: 3 bytes

Editing Residual– Message I.D. 141

Note – Not currently implemented.

Steady State Detection -Message I.D. 142

Note – Not currently implemented.

Static Navigation– Message I.D. 143

This command allows the user to enable or disable navigation on the PG-31. Example:

A0A20002 – Start Sequence and Payload Length
8F01 – Payload
xxxxB0B3 – Message Checksum and End Sequence

Table 4- 20 Static Navigation					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		8F		ASCII 143
Static Navigation Flag	1		01		ASCII 1
Payload Length: 2 bytes					

*Table 4- 21*Message ID 143 Description		
	Name	**Description**
Message ID		Message ID number
Static Navigation Flag		Valid values:
		1: enable static navigation
		0: disable static navigation

Poll Clock Status – Message I.D. 144

Table 4-22 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 4- 22 Clock Status					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		90		ACSII 144
TBD	1		00		Not used
Payload Length: 2 bytes					

Set DGPS Serial Port - Message I.D. 145

Table 4-23 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

Tab e 4- 23 Set DGPS Serial Port					
Name		**Binary (Hex)**		**Units**	**Description**
	Bytes	**Scale**	**Exampl e**		
Message ID	1		91		ASCII 145
Baud	4		00002580		38400,19200,9600,4800,2400,120
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		Non e= 0, Odd= 1, Even= 2
Pad	1		00		Reserved
Payload Length: 9 bytes					

Note – Setting the DGPS serial port using MID 145 will effect Com B only regardless of the port being used to communicate with the PG-31.

Table 4- 24 Almanac					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		92		ASCII 146
TBD	1		00		Reserved
Payload Length: 2 bytes					

Poll Ephemeris - Message I.D. 147

Table 4-25 contains the input values for the following example: Poll for Ephemeris Data from all satellites.

Example:

A0A20003— Start Sequence and Payload Length

930000— Payload

0092B0B3— Message Checksum and End Sequence

Table 4- 25 Ephemeris Message I.D.					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		93		ASCII 147
Sv I.D.[1]	1		00		Range 0 to 32
TBD	1		00		Not used
Payload Length: 3 bytes					
1. A value of 0 requests all available ephemeris records; otherwise the ephemeris of the Sv I.D. is requested.					

Flash Update - Message I.D. 148

This command allows the user to tell the Evaluation Receiver to go into internal boot mode without setting the boot switch. Internal boot mode allows the user to re-flash the embedded code in the receiver.

Note – It is highly recommended that all hardware designs should still provide access to the boot pin in the event of a failed flash upload.

Example:

A0A20001 – Start Sequence and Payload Length

94 – Payload

0094B0B3 – Message Checksum and End Sequence

Table 4- 26 Flash update					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		94		ASCII 148
Payload Length: 1 bytes					

Set Ephemeris – Message I.D. 149

This command enables the user to upload an ephemeris file to the Evaluation Receiver.

Example:

A0A2005B – Start Sequence and Payload Length
95… … … … … … – Payload
xxxxB0B3 – Message Checksum and End Sequence

Table 4-27 Ephemeris					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		95		ASCII 149
Ephemeris Data	90		00		Reserved

Payload Length: 91 bytes

The ephemeris data for each satellite is stored as a two dimensional array of [3] [15] UNIT16 elements. The 3 represents three separate sub-frames. The data is actually packed and the exact format of this representation and packing method can be extracted from the ICD-GPS-2000 document. The ICD-GPS-2000 document describes the data format of each GPS navigation sub-frame and is available on the web at http://www.arinc.com/gps.

Switch Operating Modes - Message I.D. 150

Table 4-28 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 4- 28 Switch Operating Mode I.D.150					
		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		96		ASCII 150
Mode	2		1E51		0=normal,
					1E51=Testmode1,
					1E52=Testmode2,
					1E53= not supported
SvID	2		0006		Satellite to Track
Period	2		001E	seconds	Duration of Track
Payload Length: 7 bytes					

Set TricklePower Parameters - Message I.D. 151

Table 4-29 contains the input values for the following example:
Sets the receiver into low power Mode.

Example: Set receiver into TricklePower at 1 hz update and 200 ms On Time.

A0A20009— Start Sequence and Payload Length
97000000C8000000C8— Payload
0227B0B3— Message Checksum and End Sequence

Table 4- 29 Set TricklePower Parameters I.D.151

Name	**Bytes**	**Binary (Hex)**		**Units**	**Description**			
		Scale	**Example**					
Message ID	1		97		ASCII 151			
Push To Fix Mode	2		0000		ON = 1, OFF = 0			
Duty Cycle	2	*10	00C8	%	% Time	ON.	A	duty
					cycle of	1000	(100%)	
					means	continuous		
					operation			
Milli Seconds On	4		000000C8	msec	range 200 - 500 ms			
Time								
Payload Length: 9 bytes								
Note- On time of 700, 800, 900 msec are invalid if update rate of 1 second is selected.								

Computation of Duty Cycle and On Time

The Duty Cycle is the desired time to be spent tracking. The On Time is the duration of each tracking period (range is 200 - 900 ms). To calculate the TricklePower 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 – It is impossible to enter an On Time of 900 ms.

The following are some examples:

Table 4- 30 Example of Selections for TricklePower Mode

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

Table 4- 31 TricklePower Mode Settings

On Time		**Update Rate (sec)**								
(ms)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
200	Y [1]	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
400	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
500	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
600	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
700	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
800	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
900	N	Y	Y	Y	Y	Y	Y	Y	Y	Y

1. Y = Yes (Mode supported)
2. N = No (Mode NOT supported)

Push-to-Fix

In this mode the receiver will turn on every 30 minutes to perform a system update consisting of an RTC calibration and satellite ephemeris data collection if required (i.e., a new satellite has become visible) as well as all software tasks to support SnapStart in the event of an NMI. Ephemeris collection time in general takes 18 to 30 seconds. If ephemeris data is not required then the system will re-calibrate and shut down. In either case, the amount of time the receiver remains off will be in proportion to how long it stays on:

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

The off period has a possible range between 10 and 7200 seconds. The default is 1800 seconds.

Poll Navigation Parameters - Message I.D. 152

Table 4-32 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 4-32 Poll Receiver for Navigation Parameters

		Binary (Hex)			
Name	**Bytes**	**Scale**	**Example**	**Units**	**Description**
Message ID	1		98		ASCII 152
Reserved	1		00		Reserved
Payload Length: 2 bytes					

Set UART Configuration - Message I.D. 165

Table 4-33 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

A50001010000258008010000000100000000E1000801000000FF0505000000000000000000FF0505000000000000000000— Payload

0452B0B3— Message Checksum and End Sequence

Table 4- 33 Set UART Configuration

Name	**Bytes**	**Binary (Hex)**		**Units**	**Description**
		Scale	**Example**		
Message ID	1		A5		ASCII 165
Port	1		00		For UART 0
In Protocol [1]	1		01		For UART 0
Out Protocol	1		01		For UART 0 (Set to in protocol)
Baud Rate [2]	4		00002580		For UART 0
Data Bits[3]	1		08		For UART 0
Stop Bits[4]	1		01		For UART 0
Parity [5]	1		00		For UART 0
Reserved	1		00		For UART 0

Reserved	1		00		For UART 0
Port	1		01		For UART 1
In Protocol	1		00		For UART 1
Out Protocol	1		00		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				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

1. 0 = SiRF Binary, 1 = NMEA, 2 = ASCII, 3 = RTCM, 4 = User1, 5 = No Protocol.

2. Valid values are 1200, 2400, 4800, 9600, 19200, 38400, and 57600.

3. Valid values are 7 and 8. 4.

Valid values are 1 and 2. 5. 0

= None, 1 = Odd, 2 = Even.

Set Message Rate - Message I.D. 166

Table 4-34 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 4-34 Set Message Rate					
Name	**Bytes**	**Binary (Hex)**		**Units**	**Description**
		Scale	**Example**		
Message ID	1		A6		ASCII 166
Send Now[1]	1		01		Poll message
MID to be set	1		02		
Update Rate	1		05	sec	Range = 1 - 30
Reserved	1		00		Not used
Reserved	1		00		Not used

Reserved	1		00		Not used
Reserved	1		00		Not used
Payload Length: 8 bytes					
1. 0 = No, 1 = Yes, if no update rate the message will be polled.					

Low Power Acquisition Parameter s - Message I.D. 167

Table 4-35 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

A7000075300001D4C00000000000000000000000000000000—Payload
02E1B0B3— Message Checksum and End Sequence

Table 4- 35 Set Low Power Acquisition Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A7		ASCII 167
Max Off Time	4		00007530	ms	Maximum time for sleep mode
Max Search	4		0001D4C	ms	Max. satellite search time
Time			0		
Push-To-Fix	4		0000003C	sec	Push-To-Fix cycle period
period					

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 4-36 lists the message list for the SiRF output messages.

Table 4- 36
SiRF Messages - Output Message List

Hex ASCII		Name	Description
0 x 02	2	Measured Navigation Data	Position, velocity, and time
0 x 03	3	True Tracker Data	Not Implemented
0 x 04	4	Measured Tracking Data	Satellite and C/No information
0 x 05	5	Raw Track Data	PG-31 not supported
0 x 06	6	SW Version	Receiver software
0 x 07	7	Clock Status	Current clock status
0 x 08	8	50 BPS Subframe Data	Standard ICD format
0 x 09	9	Throughput	Navigation complete data
0 x 0A	10	Error ID	Error coding for message failure
0 x 0B	11	Command Acknowledgment	Successful request
0 x 0C	12	Command acknowledgment	Unsuccessful request
0 x 0D	13	Visible List	Auto Output
0 x 0E	14	Almanac Data	Response to Poll
0 x 0F	15	Ephemeris Data	Response to Poll
0 x 10	16	Test Mode 1	For use with SiRFtest [1] (Test mode 1)
0 x 11	17	Differential Corrections	Received from DGPS broadcast
0 x 12	18	OkToSend	CPU ON / OFF (TricklePower)
0 x 13	19	Navigation Parameters	Response to Poll
0 x 14	20	Test Mode 2	Additional test data (Test mode 2)
0 x 1C	28	Nav. Lib. Measurement Data	Measurement Data
0 x 1D	29	Nav. Lib. DGPS Data	Differential GPS Data

0 x 1E	30	Nav. Lib. SV State Data	Satellite State Data
0 x 1F	31	Nav. Lib. Initialization Data	Initialization Data
0 x FF	255	Development Data	Various status messages

Measure Navigation Data Out - Message I.D. 2

Output Rate: 1 Hz

Table 4-37 lists the binary and ASCII message data format for the measured navigation data

Example:

A0A20029— Start Sequence and Payload Length

02FFD6F78CFFBE536E003AC00400030104A00036B0397
80E3 0612190E160F04000000000000— Payload

09BBB0B3— Message Checksum and End Sequence.

Table 4- 37 Measured Navigation Data Out - Binary & ASCII Message Data Format

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**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	Vz÷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
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
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

Payload Length: 41 bytes

1. For further information, go to Table 4-38.

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 4-39.

Note – The measurement of GPS Week item is expressed with ICD GPS week format (between 0 and 1023)

Note – Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (i.e., decimal X vel = binary X ^{vel} /$_{8}$).

Table 4- 38 Mode 1						
Bit	**7**	**6**	**5 4**	**3**	**2 1 0**	
Bit(s) Name	DGPS	DOP-Mask	ALTMODE	TPMODE	PMODE	
PMODE	Position mode		0	No navigation solution		
			1	1 satellite solution		
			2	2 satellite solution		
			3	3 satellite solution		
			4	>3 satellite solution		
			5	2D point solution (Least square)		
			6	3D point solution (Least square)		
			7	Dead reckoning		
TPMODE	TricklePower mode		0	Full power position		
			1	TricklePower position		
ALTMODE	Altitude mode		0	No altitude hold		
			1	Altitude used from filter		
			2	Altitude used from user		
			3	Forced altitude (from user)		
DOPMASK	DOP mask status		0	DOP mask not exceeded		
			1	DOP mask exceeded		
DGPS	DGPS status		0	No DGPS position		
			1	DGPS position		

Table 4-39	Mode 2	
Mode 2		
Hex	**ASCII**	**Description**
0 x 00	0	Solution not validated
0 x 01	1	DR sensor data
0 x 02	2	Validated (1), Unvalidated (0)
0 x 04	4	If set, Dead Reckoning (Time Out)
0 x 08	8	If set, Output Edited by UI (i.e., DOP Mask exceeded)
0 x 10	16	Reserved
0 x 20	32	Reserved
0 x 40	64	Reserved
0 x 80	128	Reserved

Measured Tracker Data Out - Message I.D. 4

Output Rate: 1 Hz

Table 4-38 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 4- 40 Measured Tracker Data Out						
		Binary (Hex)			**ASCII (Decimal)**	
Name	**Bytes**	**Scale**	**Example**	**Units**	**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		0 x BF
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			26
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 4-41						
Note – The measurement of GPS Week item is expressed with ICD GPS week format (between 0 and 1023)						
Note – Message length is fixed to 188 bytes with non-tracking channels reporting zero values.						

Table 4-41 TrktoNAVStruct.trk_status Field Definition		
Field Definition	**Hex**	**Description**
	Value	
ACQ_SUCCESS	0x0001	Set, if acq/reacq is done successfully
DELTA_CARPHASE_VALI	0x0002	Set, Integrated carrier phase is valid
D		
BIT_SYNC_DONE	0x0004	Set, Bit sync completed flag
SUBFRAME_SYNC_DONE	0x0008	Set, Subframe sync has been done
CARRIER_PULLIN_DONE	0x0010	Set, Carrier pullin done
CODE_LOCKED	0x0020	Set, Code locked
ACQ_FAILED	0x0040	Set, Failed to acquire S/V
GOT_EPHEMERIS	0x0080	Set, Ephemeris data available

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

Raw Tracker Data Out - Message I.D. 5

Not implemented for PG-31.

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 4- 42 Software Version String

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

Payload Length: 21 bytes

1. 06312E322E30444B495431313920534D0000000000

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

Response: Clock Status Data - 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 4- 43 Clock Status Data Message

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		07			7
GPS Week	2		03BD			957
GPS TOW	4	*100	002154924	s	100	349494.12
Svs	1		08			8
Clock Drift	4		2231	Hz		74289
Clock Bias	4		7923	nanosec		128743715
Estimated GPS Time	4		DAEF	millisec		349493999

Payload Length: 20 bytes

Note – The measurement of GPS week item is with Extended GPS week (=ICD GPS week + 1024)

50 BPS Data – Message I.D. *8*

Output Rate: As available (12.5 minute download time)

Example:

A0A2002B— Start Sequence and Payload Length
08xxxxxx— Payload
xxxxB0B3— Message Checksum and End Sequence

Table 4- 44 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 (5 subframes per page)						

Note – Data is logged in ICD format (available from www.navcen.uscg.gov). The ICD specification is 30-bit words. The output above has been stripped of parity to give a 240 bit frame instead of 300 bits.

CPU Throughput – Message I.D. 9

Output Rate: 1Hz

Example:

A0A20009— Start Sequence and Payload Length
09003B0011001601E5— Payload
0151B0B3— Message Checksum and End Sequence

Table 4- 45 CPU Throughput

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		09			9
SegStatMax	2	*186	003B	millisec	186	.3172
SegStatLat	2	*186	60011	millisec	186	.0914
AveTrkTime	2	*186	60016	millisec	186	.1183
Last MS	2		01E5	millisec		485
Payload Length: 9 bytes						

Command Acknowledgment – Message I.D. 11

Output Rate: Response to successful input message

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

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

Table 4- 46 Command Acknowledgment

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		0B			11
Ack. I.D.	1		92			146
Payload Length: 2 bytes						

Command Acknowledgment – Message I.D. 12

Output Rate: Response to rejected input message

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

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

Table 4- 47 Command Acknowledgment

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		0C			12
Nack. I.D.	1		92			146
Payload Length: 2 bytes						

Visible List – Message I.D. 13

Output Rate: Updated approximately every 2 minutes.

Note – This is a variable length message. Only the number of visible satellites is reported (as defined by Visible Svs in Table 4-48). Maximum is 12 satellites.

Example:

A0A2002A— Start Sequence and Payload Length
0D080700290038090133002C...xxxxxxxxxxxxxxxxx—Payload
xxxxB0B3— Message Checksum and End Sequence

Table 4- 48 Visible List

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		0D			13
Visible Svs	1		08			8
CH 1 – Sv	1		10			16
I.D.						
CH 1 – Sv	2		002A	degrees		42
Azimuth						
CH 1 – Sv	2		0038	degrees		56
Elevation						
CH 2 – Sv	1		09			9
I.D.						
CH 2 – Sv	2		0133	degrees		307
Azimuth						
CH 2 – Sv	2		002C	degrees		44
Elevation						
...						
Payload Length: Variable						

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 4- 49 Almanac Data				
Name	**Bytes**	**Binary (Hex)**		
		Scale	**Example**	
Message I.D.	1		0E	
Sv I.D.	1		01	Satellite PRN Number [1]
Almanac week and Status	2		1101	First 10 bits is the Almanac week. Next 5 bits have a zero value. Last bit is 1.
Almanac data	24		...	This information is taken from the 50BPS navigation message broadcast by the satellite. This information is the last 8 words in the 5th subframe but with the parity removed.[2]
Package checksum	2		4CA1	This is the checksum of The preceding data in the payload. It is calculated by Arranging the previous 26 bytes as 13 half-words and then summing them.[3]
Payload Length: 30 bytes				

1. Each satellite almanac entry is output as a single message.

2. There are 25 possible pages in subframe 5. Pages 1 through 24 contain satellite specific almanac information which is output as part of the almanac data. Page 25 contains health status flags and the almanac week number.

3. This checksum is not used for serial I/O data integrity. It is used internally for ensuring that the almanac information is valid.

Note – The data is actually packed and the exact format of this representation and packing method can be extracted from the ICD-GPS-2000 document. The ICD-GPS-2000 document describes the data format of each GPS navigation subframe and is available on the web at http://www.arinc.com/gps.

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-2000 format for ephemeris data.

OkToSend - Message I.D. 18

Output Rate: TricklePower CPU on/off indicator
Example:

A0A20002— Start Sequence and Payload Length
1200— Payload
0012B0B3— Message Checksum and End Sequence

Table 4- 50 Ephemeris Data

		Binary (Hex)			ASCII (Decimal)	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message I.D.	1		12			12
Send Indicator[1]	1		00			00
Payload Length: 2 bytes						
1.0 implies that CPU is about to go OFF, OkToSend==NO, 1 implies CPU has just come ON, OkToSend==YES						

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 4- 51 Navigation Parameters

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	**Example**		**Scale**	**Example**
Message ID	1		13			19
Reserved	4					
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	seconds		30
DR Timeout	1		3C	seconds		60
Track Smooth Mode	1		01			1
Static Navigation	1					
3SV Least Squares	1					
Reserved	4					
DOP Mask Mode [2]	1		04			4
Navigation Elevation	2					
Mask						
Navigation Power Mask	1					
Reserved	4					
DGPS Source	1					
DGPS Mode [3]	1		00			0
DGPS Timeout	1		1E	seconds		30
Reserved	4					
LP Push-to-Fix	1					
LP On-time	4					
LP Interval	4					
LP User Tasks Enabled	1					
LP User Task Interval	4					
LP Power Cycling	1					
Enabled						
LP Max. Acq. Search	4					
Time						
LP Max. Off Time	4					
Reserved	4					
Reserved	4					

Payload Length: 65 bytes 1. See Table 4-13. 2. See Table 4-14. 3. See Table 4-15

Navigation Library Measurement Data - Message I.D. 28
Output Rate: Every measurement cycle (full power / continuous: 1Hz)
Example:

A0A20038— Start Sequence and Payload Length
1C00000660D015F143F62C4113F42FF3FBE95E417B235C468C6964B8FBC5
82415CF1C375301734.....03E801F400000000— Payload
1533B0B3— Message Checksum and End Sequence

Table 4- 52 Measurement Data

Name	**Bytes**	**Binary (Hex)**		**Units**	**ASCII (Decimal)**	
		Scale	**Example**		**Scale**	**Example**
Message I.D.			1C			
Channel			00			
Time Tag			000660D0	ms		
Satellite ID			15			
GPS Software Time			F143F62C	ms		2.4921113
			4113F42F			696e+005
Pseudo-range			F3FBE95E	m		2.1016756
			417B235C			638e+007
Carrier Frequency			468C6964			1.6756767
						578e+004
Carrier Phase			B8FBC582			4.4345542
			415CF1C3			262e+004
Time in Track			7530	ms		10600
Sync Flags			17			23
C/No 1			34	dB-Hz		43
C/No 2				dB-Hz		43
C/No 3				dB-Hz		43
C/No 4				dB-Hz		43
C/No 5				dB-Hz		43
C/No 6				dB-Hz		43
C/No 7				dB-Hz		43
C/No 8				dB-Hz		43
C/No 9				dB-Hz		43
C/No 10				dB-Hz		43
Delta Range Interval			03E801F4	m		1000
Mean Delta Range Time			01F4	ms		500
Extrapolation Time			0000	ms		
Phase Error Count			00			0
Low Power Count			00			0
Payload Length: 56 bytes						

Table 4- 53 Sync Flag Fields

Bit Fields	*Description*
[0]	Coherent Integration Time
	0 = 2ms
	1 = 10ms
[2:1]	Synch State
	00 = Not aligned
	01 = Consistent code epoch alignment
	10 = Consistent data bit alignment
	11 = No millisecond errors
[0]	Coherent Integration Time
	0 = 2ms
	1 = 10ms
[2:1]	Synch State
	00 = Not aligned
	01 = Consistent code epoch alignment
	10 = Consistent data bit alignment
	11 = No millisecond errors

Table 4- 54 Detailed Description of the Measurement Data

Name	**Description**
Message I.D.	Message I.D. number.
Channel	Receiver channel number for a given satellite being searched or tracked.
Time Tag	This is the Time Tag in milliseconds of the measurement block in the receiver software time.
Satellite ID	Satellite or Space Vehicle (SV) I.D. number or Pseudo-random Noise (PRN) number.
GPS Software Time	This is GPS Time or Time of Week (TOW) estimated by the software in milliseconds.
Pseudo-range	This is the generated pseudo range measurement for a particular SV.
Carrier Frequency	This is can be interpreted in two ways: 1) The delta-pseudo range normalized by the reciprocal of the delta pseudo range measurement interval. 2) The frequency from the AFC loop. If, for example, the delta pseudo range interval computation for a particular channel is zero, then it can be the AFC measurement, otherwise it is a delta-pseudo range computation.
Carrier Phase	This is the integrated carrier phase given in meters.
Time in Track	The Time in Track counts how long a particular SV has been in track. For any count greater than zero (0), a generated pseudo range is present for a particular channel. The length of time in track is a measure of how large the pull-in error may be.

Sync Flags	This byte contains two 2-bit fields that report the integration interval and sync value achieved for a particular channel. **1)Bit 0:** Coherent Integration Interval (0 = 2 milliseconds, 1 = 10 milli- seconds) **2) Bits:** (1 2) = Synchronization **3) Bit:** (2 1) Value: {0 0} Not Aligned Value: {0 1} Consistent Code Epoch Alignment Value: {1 0} Consistent Data Bit Alignment Value: {1 1} No Millisecond Errors

Table 4- 55 Detailed Description of the Measurement Data *(Continued)*

Name	**Description**
C/No 1	This array of Carrier To Noise Ratios is the average signal
	power in dB-Hz for each of the 100-millisecond intervals in the
	previous second or last epoch for each particular SV being tracked
	in a channel. First 100 millisecond measurement
C/No 2	Second 100 millisecond measurement
C/No 3	Third 100 millisecond measurement
C/No 4	Fourth 100 millisecond measurement
C/No 5	Fifth 100 millisecond measurement
C/No 6	Sixth 100 millisecond measurement
C/No 7	Seventh 100 millisecond measurement
C/No 8	Eighth 100 millisecond measurement
C/No 9	Ninth 100 millisecond measurement
C/No 10	Tenth 100 millisecond measurement
Delta Range Interval	This is the delta-pseudo range measurement interval for the preceding second. A value of zero indicates that the receiver has an AFC measurement or no measurement in the Carrier Frequency field for a particular channel.
Mean Delta Range Time	This is the mean calculated time of the delta-pseudo range interval in milliseconds measured from the end of the interval backwards. Extrapolation Time This is the pseudo range extrapolation time in milliseconds, to reach the common Time tag value.
Phase Error Count	This is the count of the phase errors greater than 60 Degrees measured in the preceding second as defined for a particular channel.
Low Power Count	This is the low power measurements for signals less than 28 dB-Hz in the preceding second as defined for a particular channel.

Navigation Library DGPS Data - Message I.D. 29

Output Rate: Every measurement cycle (full power / continuous: 1Hz)
Example:

A0A2001A— Start Sequence and Payload Length

1D000F00B501BFC97C673CAAAAAB3FBFFE1240A0000040A00000- Payload
0956B0B3— Message Checksum and End Sequence

Table 4- 56 Measurement Data						
Name	**Bytes**	**Binary (Hex)**		**Units**	**ASCII (Decimal)**	
		Scale	**Example**		**Scale**	**Example**
Message I.D.	1		000F			
Satellite ID	2		00B5			
IOD	2		01			
Source [1]	1		BFC97C67	ms		
Pseudo-range Correction	4		3CAAAAAB	m/s		
Pseudo-range rate	4					
Correction						
Correction Age	4		3FBFFE12	s		
Reserved	4					
Reserved	4					

Payload Length: 26 bytes
1. 0 = Use no corrections, 1 = Use WAAS channel, 2 = Use external source, 3 = Use Internal Beacon, 4 = Set DGPS Corrections

Navigation Library SV State Data - Message I.D. 30

Output Rate: Every measurement cycle (full power / continuous: 1Hz)
Example:

A0A20053— Start Sequence and Payload Length
1E15....2C64E99D01....408906C8— Payload
2360B0B3— Message Checksum and End Sequence

Table 4- 57 SV State Data						
Name	**Bytes**	**Binary (Hex)**		**Units**	**ASCII (Decimal)**	
		Scale	**Example**		**Scale**	**Example**
Message I.D.	1		1E			
Satellite ID	1		15			
GPS Time	8			s		
Position X	8			m		
Position Y	8			m		
Position Z	8			m		
Velocity X	8			m/s		
Velocity Y	8			m/s		
Velocity Z	8			m/s		
Clock Bias	8			s		
Clock Drift	4		2C64E99D	/s		744810909
Ephemeris Flag[1]	1		01			1
Reserved	8					
Ionospheric Delay	4		408906C8	m		1082721992
Payload Length: 83 bytes						
1. 0 = no valid SV state, 1 = SV state calculated from ephemeris, 2 = Satellite state calculated from almanac						

Navigation Library Initialization Data - Message I.D. 31

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20054— Start Sequence and Payload Length

1F....00000000000001001E000F....00....000000000F....00....02....043402....

....02— Payload

0E27B0B3— Message Checksum and End Sequence

Table 4- 58 Measurement Data						
Name	**Bytes**	**Binary (Hex)**		**Units**	**ASCII (Decimal)**	
		Scale	**Example**		**Scale**	**Example**
Message I.D.	1		1E			
Reserved	1					
Altitude Mode[1]	1		00			0
Altitude Source	1		00			0
Altitude	4		00000000			0
Degraded Mode [2]	1		01			1
Degraded Timeout	2		001E			30
Dead-reckoning Timeout	2		000F			15
Reserved	2					
Track Smoothing Mode [3]	1		00			0
Reserved	1					
Reserved	2					
Reserved	2					
Reserved	2					
DGPS Selection [4]	1		00			0
DGPS Timeout	2					
Elevation Nav. Mask	2					
Reserved	2					
Reserved	1					
Reserved	2					
Reserved	1					
Reserved	2					
Static Nav.Mode [5]	1					
Reserved	2					
Position X	8					
Position Y	8					
Position Z	8					
Position Init. Source[6]	1		02			2
GPS Time	8					

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 4- 59 Development Data						
		Binary (Hex)			**ASCII (Decimal)**	
Name	**Bytes**	**Scale**	**Example**	**Units**	**Scale**	**Example**
Message ID	1		FF			255
Payload Length: Variable						
Note – MID 255 is output when SiRF binary is selected and development data is enabled. The data output using MID 255 is essential for SiRF assisted troubleshooting support.						

Additional Information

TricklePower Operation in DGPS Mode

When in TricklePower mode the serial port DGPS corrections are supported. The CPU goes into sleep mode but will wake up in response to any interrupt including UARTs. Any messages received during the TricklePower 'off' period are buffered and processed when the receiver awakens for the next TricklePower cycle.

GPS Week Reporting

Since Aug, 22, 1999, the GPS week roll from 1023 weeks to 0 weeks is in accordance with the ICD-GPS-2000 specification. To maintain roll over compliance, SiRF reports the ICD GPS week between 0 and 1023. If the user needs to have access to the Extended GPS week (ICD GPS week + 1024) this information is available through the Clock Status Message (007) under the Poll menu.

NMEA Protocol in TricklePower Mode

The NMEA standard is generally used in continuous update mode at some predefined rate. This mode is perfectly compatible with all SiRF TricklePower and Push-to-Fix modes of operation. There is *no* mechanism in NMEA that indicates to a host application when the receiver is on or in standby mode. If the receiver is in standby mode (chip set OFF, CPU in standby) then no serial communication is possible for output of NMEA data or receiving SiRF proprietary NMEA input commands. To establish reliable communication, the user must re-power the receiver and send commands while the unit is in full-power mode (during start-up) and prior to reverting to TricklePower operation. Alternatively, the host application could send commands (i.e., poll for position) repeatedly until the request has been completed. In TricklePower mode, the user is required to select an update rate (seconds between data output) and On Time (milliseconds the chipset is on). When the user changes to NMEA mode, the option to set the output rate for each of the selected NMEA messages is also required. These values are multiplied by the TricklePower update rate value as shown in Table 4-58.

Table 4- 60 NMEA Data Rates Under TricklePower Operation				
Power Mode	**Continuous**	**TricklePower**	**TricklePower**	**TricklePower**
Update Rate	1 every second	1 every second	1 every 5	1 every 8 seconds
			seconds	
On Time	1000	2000	4000	6000
NMEA Update	1 every second	1 every 5	1 every 2	1 every 5 seconds
Rate		seconds	seconds	
Message Output Rate	1 every second	1 every 5 seconds	1 every 10 seconds	1 every 40 seconds
Note – The On Time of the chip set has no effect on the output data rates.				

Chapter 5 NMEA Input/Output Messages

The PG-31 may also output data in NMEA-0183 format as defined by the National Marine Electronics Association (NMEA) standard for interfacing marine electronic devices, version 2.20, January 1, 1997. Refer to Chapter 4 for detailed instructions.

NMEA Output Messages

PG-31 outputs the following messages as shown in Table 5-1:

Table 5-1 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

GGA — Global Positioning System Fixed Data

Table 5-2 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 5- 2 GGA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGGA		GGA protocol header
UTC Time	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 5-3
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. Values are WGS84 ellipsoid heights.			

Table 5- 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

GLL— Geographic Position - Latitude/Longitude

Table 5-4 contains the values for the following example:

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

Table 5- 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 valid or V=data not valid
Checksum	*2C		
<CR> <LF>			End of message termination

GSA— GNSS DOP and Active Satellites
Table 5-5 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 5- 5 GSA Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 5-6
Mode 2	3		See Table 5-7
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 5- 6 Mode 1	
Value	**Description**
M	Manual—forced to operate in 2D or 3D mode
A	2Dautomatic—allowed to automatically switch 2D/3D

Table 5- 7 Mode 2	
Value	**Description**
1	Fix Not Available
2	2D
3	3D

GSV— GNSS Satellites in View

Table 5-8 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
$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41

Table 5- 8 GSV Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header
Number of	2		Range 1 t o 3
Messages [1]			
Message	1		Range 1 t o 3
Number [1]			
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.			

RMC— Recommended Minimum Specific GNSS Data

Table 5-9 contains the values for the following example:

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

Table 5- 9 RMC Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$GPRMC		RMC protocol header
UTC Time	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	0.13	knots	
Ground			
Course Over	309.62	degrees	True
Ground			
Date	120598		Ddmmyy
Magnetic		degrees	E=east or W=west
Variation [1]			
Checksum *10			
<CR> <LF>			End of message termination
1.All "course over ground" data are geodetic WGS84 directions.			

VTG— Course Over Ground and Ground Speed
Table 5-10 contains the values for the following example:

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

Table 5- 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		Kilometers per hour
Checksum	*6E		
<CR> <LF>			End of message termination
1. All "course over ground" data are geodetic WGS84 directions.			

SiRF Proprietary NMEA Input Messages
NMEA input messages are provided to allow you to control the Evaluation Unit while in NMEA protocol mode. The Evaluation 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.

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.

SiRF NMEA Input Messages		
Message	**MID** [1]	**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 [2]
Development Data On/Off	105	Development Data messages On/Off
1. Message Identification (MID).		
2. Input coordinates must be WGS84.		

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 Evaluation Unit restarts using the saved parameters.

Table 5-11 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 5- 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		8,7 [1]
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*0C		End of message termination
<CR> <LF>			
1. Only valid for 8 data bits, 1 stop bit, and no parity.			

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 PG-31 to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable PG-31 to acquire signals quickly.

Table 5-12 contains the input values for the following example:
Start using known position and time.

$PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*7F

Table 5- 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	96000	Hz	Clock Offset of PG-31[1]
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table 5-13
Checksum	*7F		
<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 5- 13	Reset Configuration
Hex	**Description**
0x01	Data Valid— Warm/Hot Starts=1
0x02	Clear Ephemeris— Warm Start=1
0x04	Clear Memory— Cold Start=1

SetDGPSPor t

This command is used to control Serial Port B 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, 1 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 then the receiver restarts using the saved parameters.

Table 5-14 contains the input values for the following example:
Set DGPS Port to be 9600,8,N,1.

$PSRF102,9600,8,1,0*12

Table 5- 14 Set DGPS Port Data Format			
Name	**Example**	**Units**	**Description**
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		8,7
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*12		
<CR> <LF>			End of message termination

Query/Rate Control

This command is used to control the output of the 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 5-15 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 5- 15 Query/Rate Control Data Format (See example 1.)

Name	**Example**	**Units**	**Description**
Message ID	$PSRF103		PSRF103 protocol header
Msg	00		See Table 5-16
Mode	01		0=SetRate, 1=Query
Rate	00	seconds	Output—off=0, max=255
CksumEnabe	01		0=Disable Checksum, 1=Enable Checksum
Checksum	*25		
<CR> <LF>			End of message termination

Table 5- 16 Messages

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

Note – In TricklePower mode, update rate is specified by the user. When you switch to NMEA protocol the message update rate is also required. The resulting update rate is the product of the TricklePower Update rate AND the NMEA update rate (i.e. TricklePower update rate = 2 seconds, NMEA update rate = 5 seconds, resulting update rate is every 10 seconds (2 X 5 = 10)).

LLANaviagtionInitialization

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 5-17 contains the input values for the following example:
Start using known position and time.

$PSRF104,37.3875111,-121.97232,0,96000,237759,922,12,3*37

Table 5- 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 5-18
Checksum	*37		
<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 5- 18	Reset Configuration
Hex	**Description**
0x01	Data Valid— Warm/Hot Starts=1
0x02	Clear Ephemeris— Warm Start=1
0x04	Clear Memory— Cold Start=1

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 checksums or parameters out of specified range.

Table 5-19 contains the input values for the following examples:

1. Debug On $PSRF105,1*3E
2. Debug Off $PSRF105,0*3F

Table 5- 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

