# RGM-3000/REB-3000

# Operational Manual

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# RoyalTek GPS Module: RGM-3000/REB-3000101 Operational Manual

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# RGM-3000/REB-3000

# Operational Manual

## Introduction

RGM-3000/REB-3000 is the third generation of RoyalTek GPS Receiver. RGM-3000(E,M) consists of active antenna and GPS receiver. REB-3000(or RGM-3000L) consists of GPS receiver without active antenna. The GPS receiver is powered by SiRF Star II technology and RoyalTek proprietary navigation algorithm that providing you more stable navigation data. The miniature design is the best choice to be embedded in a portable device like PDA, mobile phone, person locator and vehicle locator. It supports TricklePower function which can be enabled by external command for power saving. The excellent sensitivity of RGM-3000 gets the great performance when going though the urban canyon and foliage.

## Product Features

### RGM-3000/REB-3000

- ✧ OEM product development is fully supported through applications engineering and WEB technique forum.
- ✧ Small form factor.
- ✧ 12 parallel channels
- ✧ 0.1 second re-acquisition time.
- ✧ Enhanced algorithm for navigation stability.
- ✧ NMEA-0183 compliant protocol/custom protocol.
- ✧ WAAS demodulator
- ✧ Excellent sensitive for urban canyon and foliage environments.
- ✧ Single satellite positioning.
- ✧ Dual multi path rejection.
- ✧ Data-log capability – At least 1 Mega-bits memory space will be implement in the product

## Product applications

### RGM-3000/REB-3000

- ✧ Portable IA device for personal navigation/ position commerce (P-Commerce)
- ✧ Automotive applications
- ✧ Personal positioning and navigation
- ✧ Marine navigation
- ✧ Timing application
- ✧ **Extendable I/O capability – provide programming I/O function and development tool kit for customer**

## Technique description

### RGM-3000M, RGM-3000E

**General information.** The RGM-3000 is a stamp size GPS receiver with an active antenna. It provides the antenna power through RF cable. The default DC input of active antenna is 2.8 ~3.3V. Since it needs 3 satellites or more to do the first position fix. The suitable view angle of the active antenna is necessary. It will determine the first time position update after getting good satellites geometry. If the satellites are blocked, it may take time to determine the position. ***Caution: Please do not put any metal stuff on the antenna.*** It results in GPS receiver getting nothing. In urban canyon, the fast 0.1 second re-acquisition capability can make it determine the position right away through the cross-intersection.

**REB-3000,RGM-3000L**

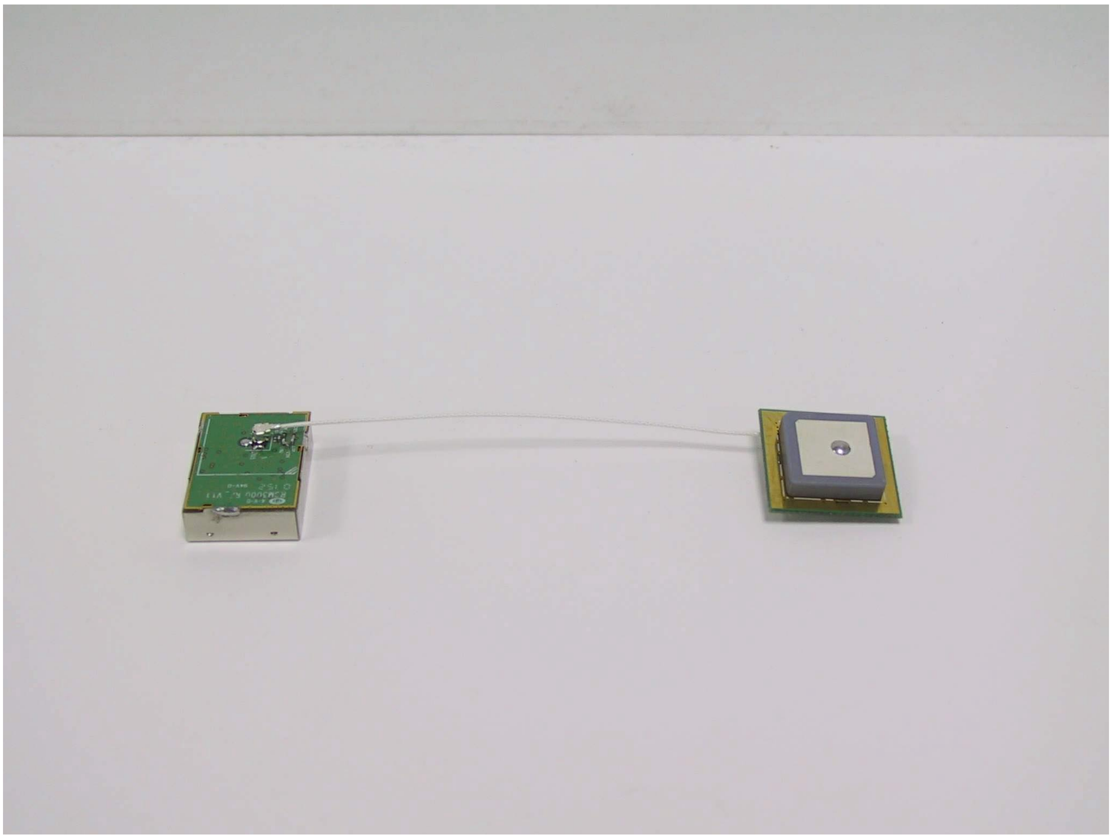
General Information. This is a stamp size GPS receiver without active antenna. It provides the external antenna power (2.8DCV ± 5%) through RF cable. There are 2 models for versatile antenna connectors:

1) RGM-3000L: with SMA RF cable.

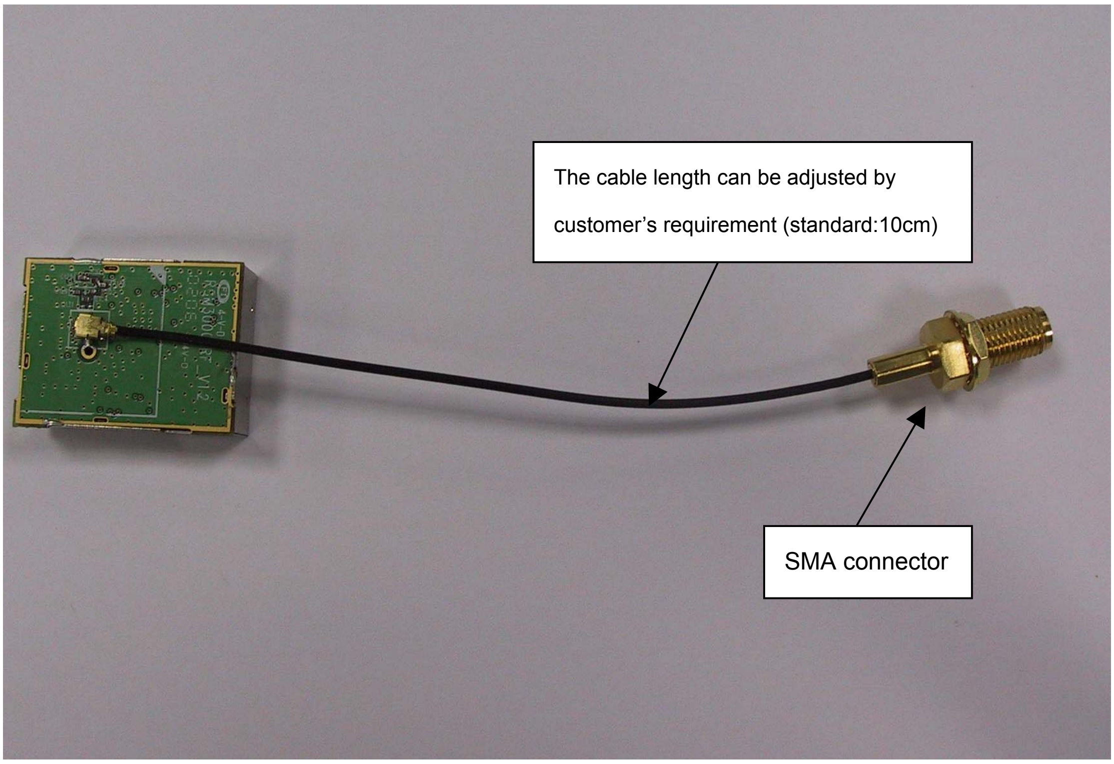
3) REB-3000: with HRS type of antenna connector (male) which you can connect to versatile types of antenna.

## Picture

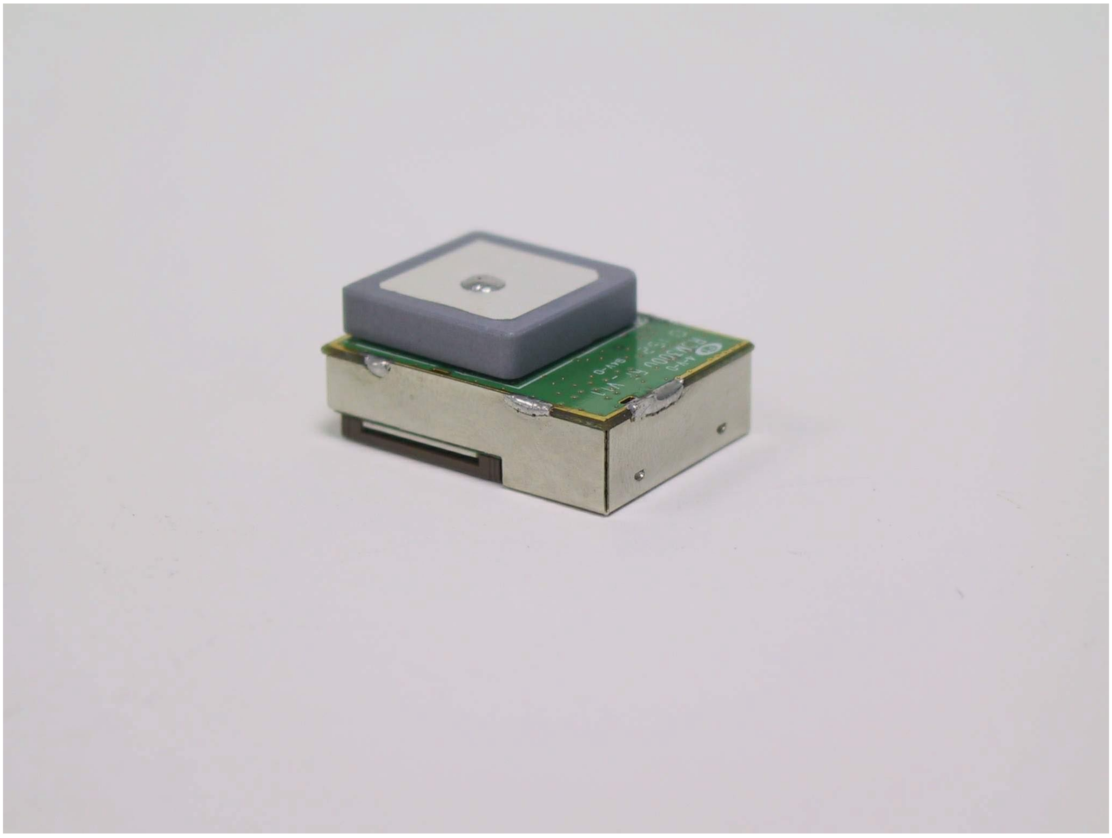
### RGM-3000E



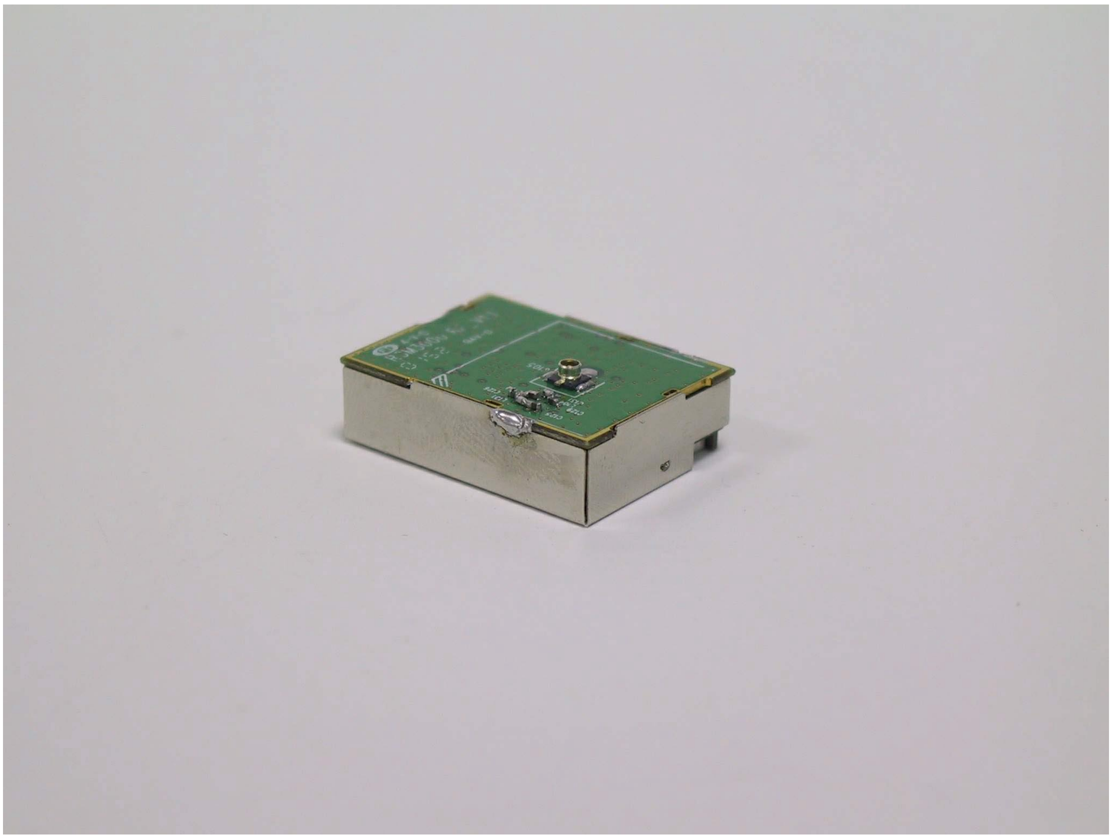
**RGM-3000L**




**RGM-3000M**



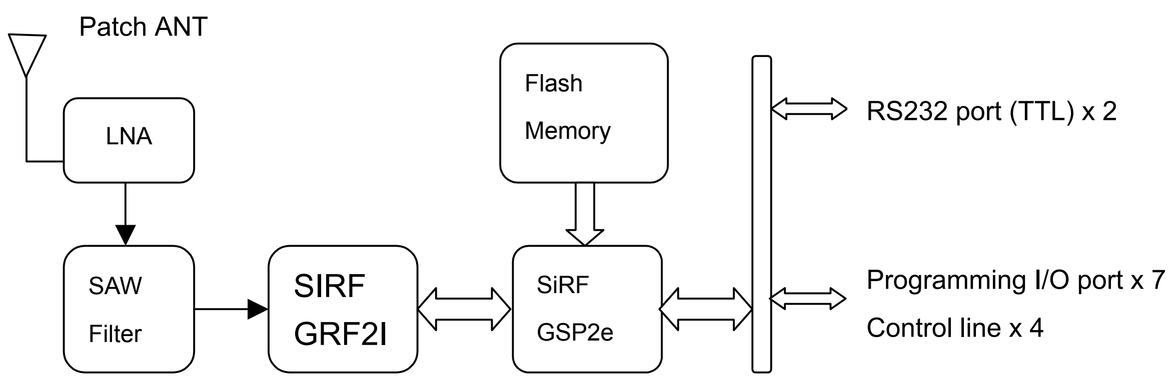
**REB-3000**



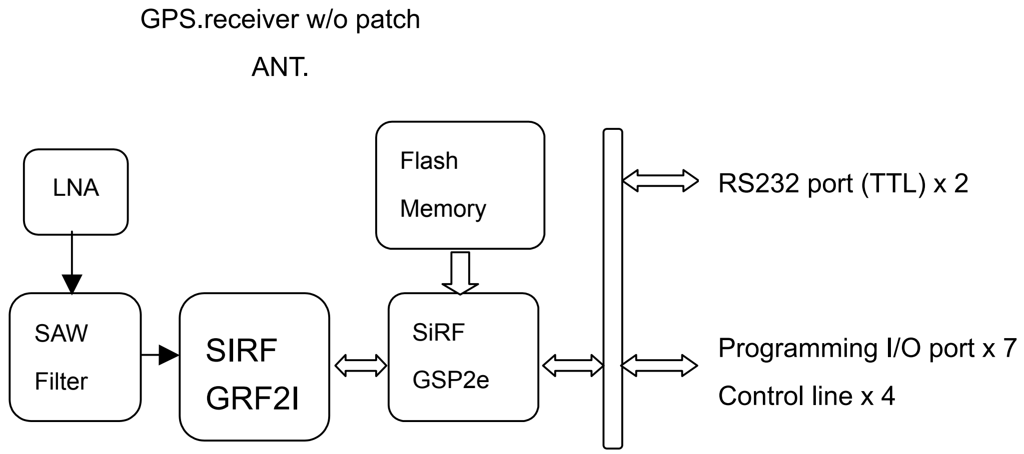
## RGM-3000/REB-3000 Series System Block Diagram

The RGM-3000/REB-3000 series consists of SiRF star II chipsets technology, RoyalTek LNA and proprietary software. The system is described as follows.

**RGM-3000M/RGM-3000E**



**RGM-3000L/REB-3000**



## Technique specifications

**RGM-3000/REB-3000 series.**

**Operational Characteristics.**

12 Channels

L1, 1575.42MHz.

C / A code, 1.023MHz chip rate.

Snap start: 3 seconds, typical

Hot start: 8 seconds, typical

Warm start: 40 seconds, typical

Cold start: 48 seconds, typical

Reacquisition:0.1 second, typical

Navigation update rate: Once per second.

Datum: WGS-84.

(The above specification is for standard version software . The specification for ES version of software may vary.)

**Accuracy.**

Position accuracy: 25m CEP without SA

Velocity accuracy:0.1 meters/second without SA

**DGPS Accuracy.**

Position:1 to 5 m, typical

Velocity: 0.05 meters/second, typical

**Dynamics.**

Altitude: 18000 meters (60000 feet) Max.

Velocity: 515 meters / second Max.

Acceleration: 4 g. , Max.

**Power Requirements.**

The input voltage is 3.3V±10%, ripple ≦ 200mV. The power of active antenna is supplied by RGM-3000/REB-3000 series. The full run (without trickle power) maximum current is less than 180mA.

**Weight. 30g(RGM-3000),15g(REB-3000)**

**Environment.**

**Temperature.**

Operating temperature -40 ~ +85 Degree (Celsius).

Storage temperature: -40 ~ +85 Degree (Celsius).

**Humidity** ≦95% noncondensing.

**GPS Antenna Specification(RGM-3000E, RGM-3000M)**

Center Frequency: 1575.42±1.023MHz

Bandwidth (-10dB return loss):9MHz min

Gain at Zenith: 3.0dBi Typ

Gain at 10° elevation :-1.0 dBi Typ

Polarization :R.H.C.P

Axial Ratio : 2.0dB max

**LNA Specification:(External ANT for RGM-3000E )**

Center Frequency: 1575.42±1.023MHz

Gain : 12dB Typ

Noise Figure : 1.8dB Typ

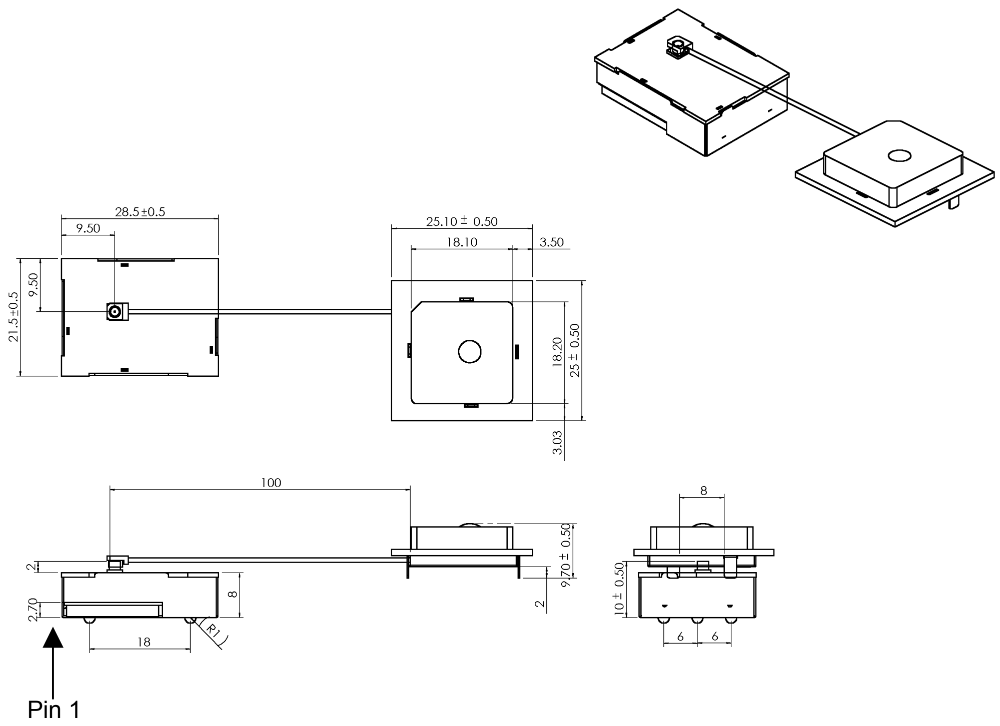
Out Band Attenuation : 7dB min for ±20MHz
20dB min for ±50MHz
30dB min for ±100MHz

| | |
|---|---|
| Output V.S.W.R | 2.0dB max |
| Voltage | DC 2.8.0±0.5V |
| Current | 12mA max |

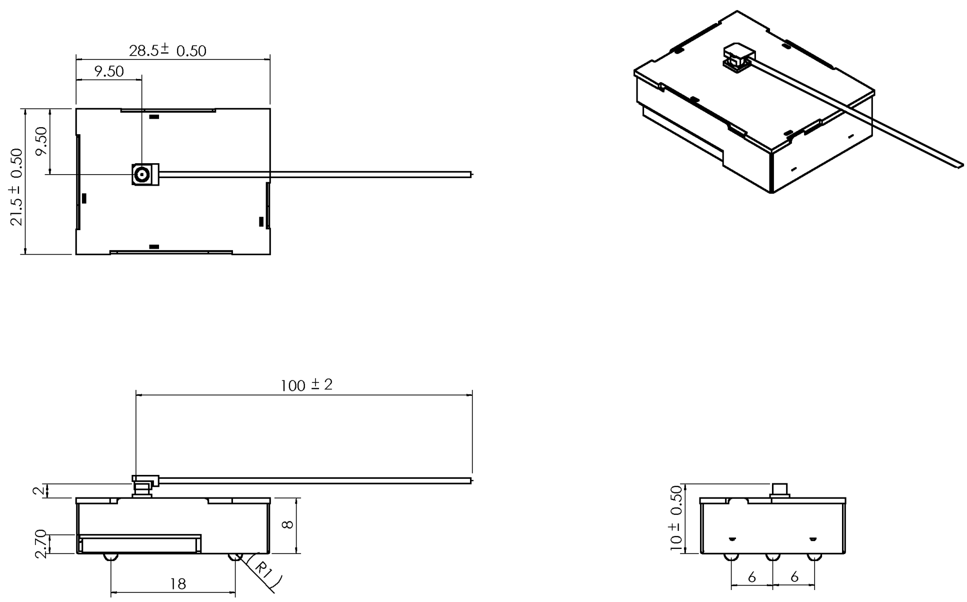
## Mechanical Layout

## RGM-3000/REB-3000 Mechanical Layout

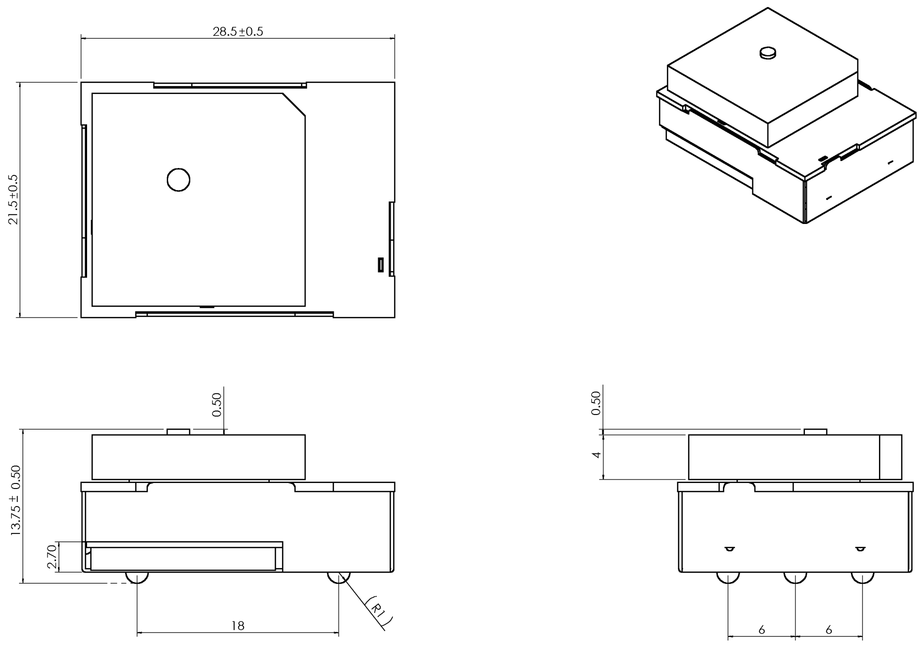
RGM-3000E



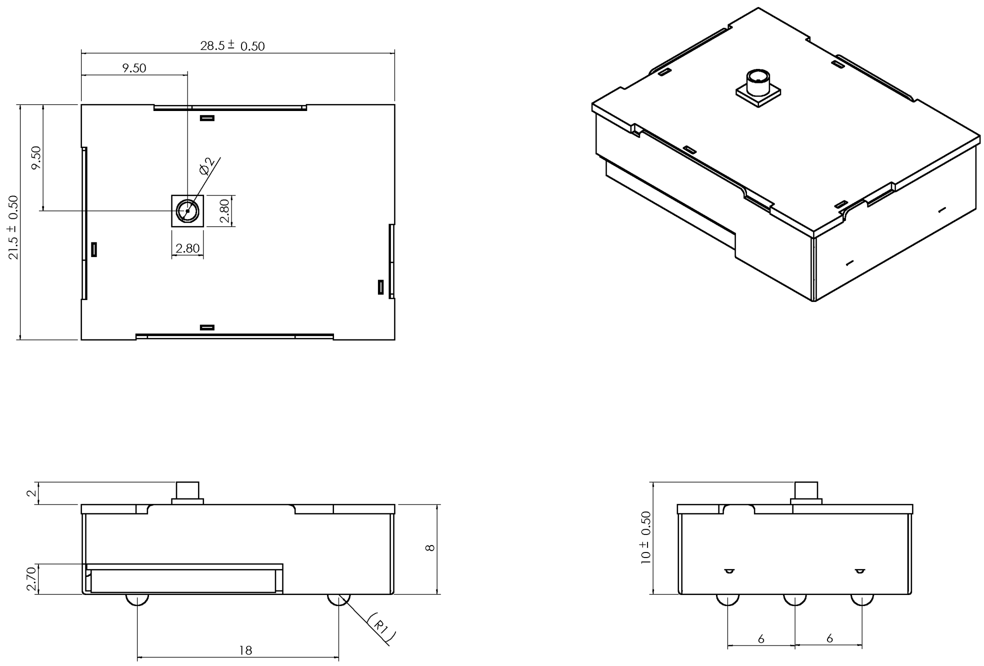

RGM-3000L



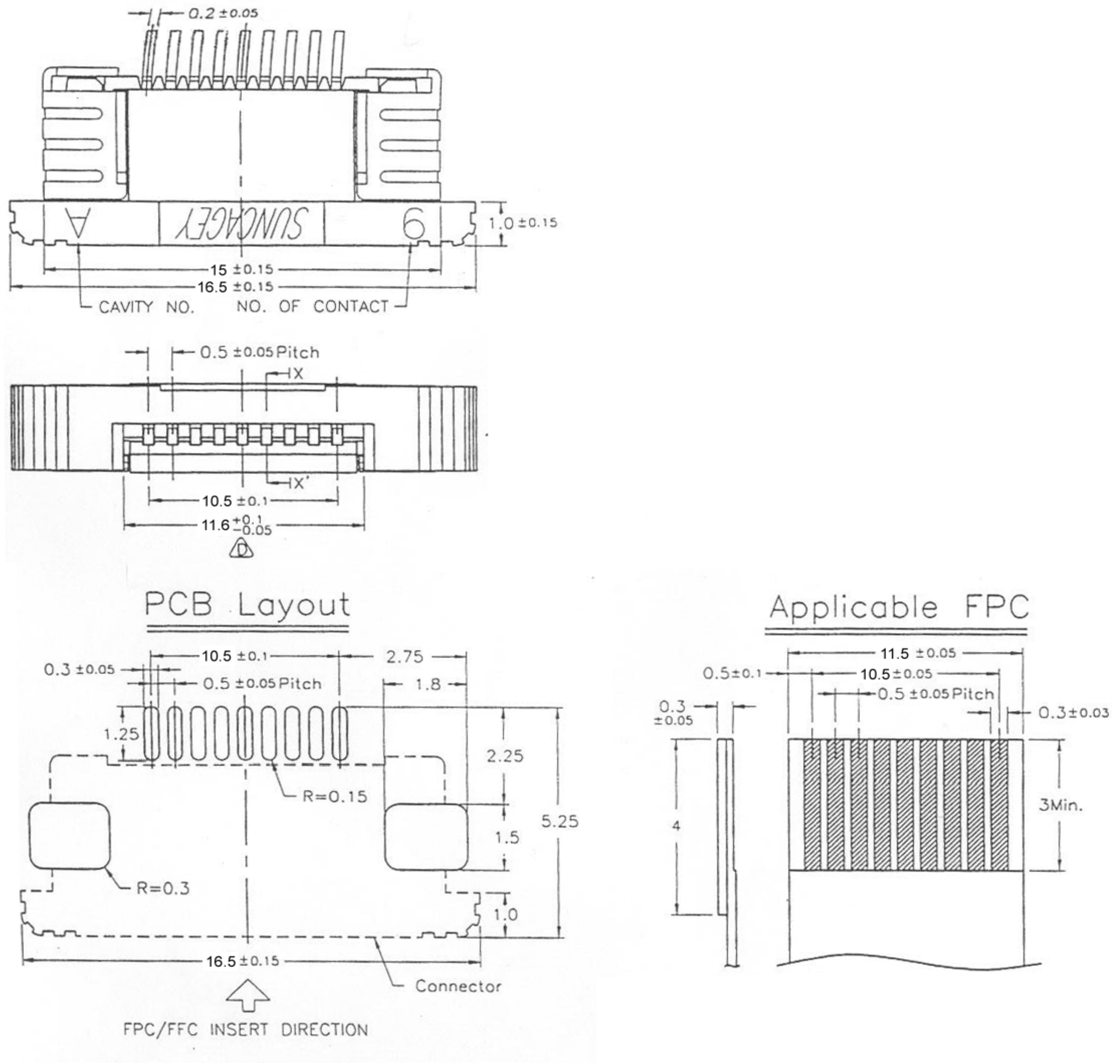
RGM-3000M




REB-3000



Flexible Flat Circuit & Connectot



## Hardware interface

**RGM-3000/REB-3000.**

| Pin NO | Name | I/O | Description | Characteristic |
|---|---|---|---|---|
| 1 | VCC | | System Power | DC 3.3V ± 10% |
| 2 | VCC | | System Power | DC 3.3V ± 10% |
| 3 | TXA | O | Navigation Data Output | TTL Level ; Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA |
| 4 | RXA | I | Serial Data Input | TTL Level ; Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 5 | TXB | O | Reserved | TTL Level ; Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA |
| 6 | RXB | I | RTCM 104 Differential GPS Input | TTL Level ; Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 7 | TIMEMARK | O | 1 Pulse per second time mark Output | Vil≦0.2V, Pulse Width≧10ms |
| 8 | RESET | I | System Reset , Active Low | Vil≦0.2V, Pulse Width≧1ms |
| 9 | BOOTSEL | I | Internal boot, Active High | TTL Level ; Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 10 | WAKEUP | I | Active low wakeup from the RTC | TTL Level ; Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA |
| 11 | VBAT | | External Backup Power Input | 2.1V≦ Vbat ≦3.6V |
| 12 | RESERVED | | | |
| 13 | GPIO3 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 14 | GPIO5 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 15 | GPIO6 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 16 | GPIO7 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 17 | GPIO10 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 18 | GPIO13 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 19 | GPIO15 | I/O | General Purpose I/O Pin | TTL Level ;<br>Output : Voh≧2.4V, Vol≦0.4V ; Ioh=Iol=2mA<br>Input : Vih≧0.7*VCC ; Vil≦0.3*VCC |
| 20 | GND | | System GND | |
| 21 | GND | | System GND | |
| 22 | GND | | System GND | |

**VCC DC Power Input**

This is the main power supply for the Engine board. The power range is from 3.3V±10%, ripple ≤ 200mV. The maximum current of RGM-3000 is ≤ 200mA.

**GND**

GND provides the ground for the Engine board. Connect all grounds.

**VBAT**

This is the battery backup supply that powers the SRAM and RTC when main power is removed. The input voltage level is from 2.1V~3.6V. Max current draw is 10 uA at 3.3volt. Without an external backup battery or on board battery, engine board will execute a cold start after every turn on. To achieve the faster start-up offered by a hot or warm start, either a backup battery must be connected or battery installed on board.

**TXA**

This is the main transmit channel and is used to output navigation and measurement data to user written software. The default setup is NMEA Output, 4800bps, 8 data bits, no parity, 1 stop bit. The default sentences are GPGGA, GPGSA, GPRMC once per second and GPGSV once per 5 seconds.

Please refer to "software interface" for the detail protocol.

**RXA**

This is the main receiving channel and is used to receive software commands to the Engine board from user written software. Please refer to "software interface" for the detail protocol.

**RXB**

This is used for DGPS differential input .

**BOOTSEL**

Pull Bootsel pin high & reset , then it will get to boot mode.

**GPIO**

This pin can be programmed to input or output. For more application, please refer to Configure GPIO direction – PSRF108.

## Absolute maximum ratings

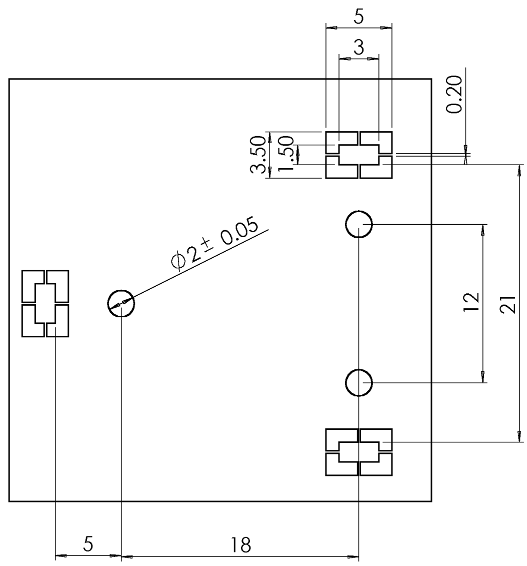
| Parameter | Symbol | Unit | Min. Value | Max. Value |
|---|---|---|---|---|
| Supply voltage | VCC | V | 2.97 | 3.63 |
| Output current | | mA | | 200 |

## Critical design guide and diagram

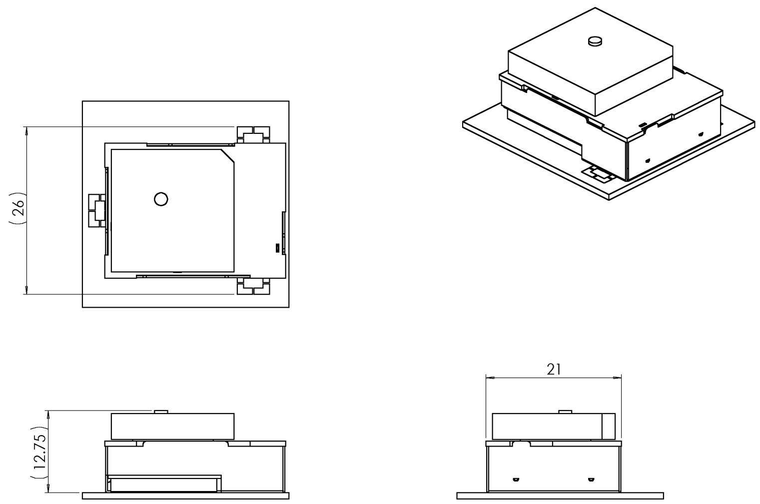
1. It is recommanded to attach GNDu plate (30*30MM) below RGM3000M module or the antenna module of RGM-3000E to increase the intensity of reception . Please refers to "Design Layout Diagram " .
2. During design of integrated layout, please isolate high frequency noise source (power Switch,data or address signal lines ) from GPS antenna.
3. Please don't place metal object above patch antenna.

## Design Layout Diagram

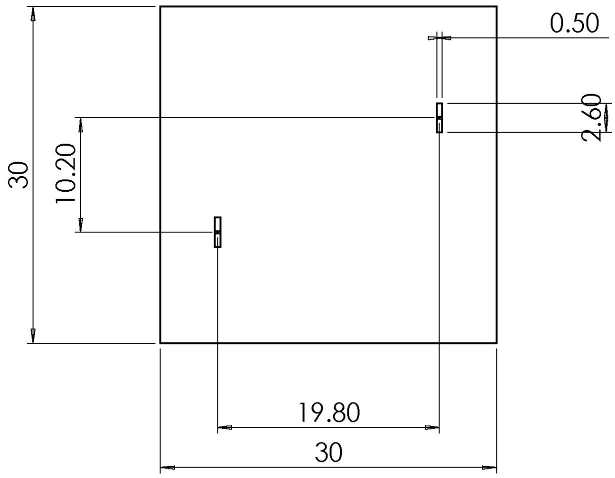
Recommanded Ground plate for RGM-3000M




RGM-3000M with ground plate



Recommanded RGM-3000-A Antenna Ground Plate




**Connector tool** (Option, not included in standard kit)

It is used to remove or install FPC on connector.

# Software interface

## NMEA V2.2 Protocol

It is the RS-232 interface:9600 bps, 8 bit data, 1 stop bit and no parity. It supports the following NMEA-0183 messages:GGA, GLL, GSA, GSV, RMC and VTG.

NMEA Output Messages

The Engine board outputs the following messages as shown in Table 1:

*Table 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 2 contains the values of the following example: $GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,0000*18

*Table 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 2-1 |
| Satellites Used | 07 | | Range 0 to 12 |
| HDOP | 1.0 | | Horizontal Dilution of Precision |
| MSL Altitude | 9.0 | meters | |
| Units | M | meters | |
| Geoid Separation | | 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 |

*Table 2-1* 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 3 contains the values of the following example:$GPGLL, 3723.2475, N, 12158.3416, W, 161229.487, A*2C

*Table 3* 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.ss |
| 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 4 contains the values of the following example:$GPGSA, A, 3, 07, 02, 26, 27, 09, 04, 15, , , , , , 1.8,1.0,1.5*33

*Table 4* GSA Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSA | | GSA protocol header |
| Mode 1 | A | | See Table 4-2 |
| Mode 2 | 3 | | See Table 4-1 |
| Satellite Used | 07 | | Sv on Channel 1 |
| Satellite Used | 02 | | Sv on Channel 2 |
| …. | | | …. |
| Satellite Used | | | 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 |

Table 4-1 Mode 1

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

Table 4-2 Mode 2

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

## GSV-GNSS Satellites in View

Table 5 contains the values of 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* GSV Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSV | | GSV protocol header |
| Number of Messages[1] | 2 | | Range 1 to 3 |
| Messages 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.

## RMC-Recommended Minimum Specific GNSS Data

Table 6 contains the values of the following example: $GPRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13, 309.62, 120598, ,*10

*Table 6* *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 | | degrees | E=east or W=west |
| Checksum | *10 | | |
| ＜CR＞＜LF＞ | | | End of message termination |

## VTG-Course Over Ground and Ground Speed

Table 7 contains the values of the following example:$GPVTG, 309.62, T, , M, 0.13, N, 0.2, K*6E

*Table 7* 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 |
| 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 |

## SiRF Proprietary NMEA Input Messages

NMEA input messages allow you to control the Evaluation Unit 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 " on page 17 using a user program or using SiRFdemo.exe and selecting Switch to NMEA Protocol from the Action manual. If the receiver is in SiRF Binary mode, all the 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 consists 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 by 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 exceptional. All NMEA messages are comma delimited

## SIRF NMEA Input Messages

| Message | Message Identifier (MID) | 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/Alt1 |
| Development Data On/Off | 105 | Development Data messages On/Off |

Input coordinates must be WGS84.

## Set Serial Port

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 8 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 8* 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 |
| Data Bits | 8 | | 8,7[1] |
| Stop Bits | 1 | | 0,1 |
| Parity | 0 | | 0=None ,1=Odd,2=Even |
| Checksum | *0C | | |
| <CR><LF> | | | End of message termination |

[1]SiRF protocol is only valid for 8data bits, 1 stop bit, and no parity.

**LLA Navigation Initialization**

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

Table 9 contains the input values for the following example:Switch to SiRF Binary protocol at 9600,8,N,1

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

*Table 9* 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 |
| CLK Offset | 95000 | Hz | Clock Offset of the Evaluation Unit[1] |
| Time Of Week | 497260 | seconds | GPS Time OF Week |
| Week No | 921 | | GPS Week Number |
| Channel Count | 12 | | Range 1 to 12 |
| Reset Cfh | 3 | | See Table 10 |
| Checksum | *22 | | |
| <CR><LF> | | | End of message termination |

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

*Table 10* Reset Configuration

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

## Set DGPS Port

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, stop bit, and no parity. If a DGPS received , the parameters are stored in battery – backed SRAM and then the receiver restarts using the saved parameters.

Table 11 contains the input values for the following example:Set DGPS Port to be 9600,8,N,1. $PSRF102,9600,8,1,0*3C

*Table 11* Set DGPS Port Data Format

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

## Query/Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, 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 12 Query/Rate Control Data Format(See example 1.)

1.Quety 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 12* Query/Rate Control Data Format(See example 1.)

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $PSRF103 | | PSRF102 protocol header |
| Message | 00 | | See Table 13 |
| Mode | 01 | | 0=Set Rate, 1=Query |
| Rate | 00 | seconds | Output – off=0,max=255 |
| Cksum Enable | 01 | | 0=Disable Checksum, 1=Enable Checksum |
| Checksum | *25 | | |
| <CR><LF> | | | End of message termination |

*Table 13* Messages

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

## LLA Navigation Initialization

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 14 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 14* 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 |
| CLK Offset | 95000 | Hz | Clock Offset of the Evaluation Unit[1] |
| Time Of Week | 237759 | Seconds | GPS Time Of Week |
| Week No | 922 | | GPS Week Number |
| Channel Count | 12 | | Range 1 to 12 |
| Reset Cfg | 3 | | See Table 15 |
| Checksum | *3A | | |
| <CR><LF> | | | End of message termination |

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

*Table 15* 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 can not get the 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 of parameter out of specified range.

Table 16 contains the input values for the following examples:

1. Debug On $PSRF105,1*3E
2. Debug Off $PSRF 105,0*3F

*Table 16* 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 |

## Configure GPIO direction – Message I.D.108

PSRF108 is used to configure :

1. GPIO_direction (input or output)

2. GPIO_data.

Format: $PSRF108,<GPIO_Direction>,<GPIO_Data>,*CKSUM

Table17 Configure GPIO selection

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $PSRF108 | | PSRF108 protocol header |
| **GPIO direction** | 46 | | 1:Ouput, 0:Input |
| | | | Bit0:GPIO3 |
| | | | Bit1:GPIO5 |
| | | | Bit2:GPIO6 |
| | | | Bit3:GPIO7 |
| | | | Bit4:GPIO10 |
| | | | Bit5:GPIO13 |
| | | | Bit6:GPIO15 |
| | | | Bit7:Not Used |
| **GPIO data** | 10 | | 1.High ,0:Low |
| | | | Bit0:GPIO3 |
| | | | Bit1:GPIO5 |
| | | | Bit2:GPIO6 |
| | | | Bit3:GPIO7 |
| | | | Bit4:GPIO10 |
| | | | Bit5:GPIO13 |
| | | | Bit6:GPIO15 |
| | | | Bit7:Not Used |
| Checksum | 2D | | |
| <CR><LF> | | | |

**Note: GPIO data only valid for output port. It can't configure the input port.**

Example: $PSRF108,46,10*2D

Explanation: This parsing will assign GPIO3 as an input port.

GPIO5 as an output port and set output high

GPIO6 as an output port and set output low

GPIO7 as an output port and set output high

GPIO10 as an input port

GPIO13 as an output port and set output low.

GPIO15 as input port

After receiving PSRF108, RGM-3000/REB-3000 will output the following message: $ROYALIO, GPIODir, GPIOData*hh<CR><LF> .,then you can check the status of each port:

Following is the definition ROYALIO protocol. The cksum is same as NMEA protocol.

Table 18 ROYALIO Output Message

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $ROYALIO | | PSRF108 protocol header |
| **GPIO Dir** | 46 | | 1:Ouput, 0:Input |
| | | | Bit0:GPIO3 |
| | | | Bit1:GPIO5 |
| | | | Bit2:GPIO6 |
| | | | Bit3:GPIO7 |
| | | | Bit4:GPIO10 |
| | | | Bit5:GPIO13 |
| | | | Bit6:GPIO15 |
| | | | Not Used |
| **GPIOData** | 90 | | 1.High ,0:Low |
| | | | Bit0:GPIO3 |
| | | | Bit1:GPIO5 |
| | | | Bit2:GPIO6 |
| | | | Bit3:GPIO7 |
| | | | Bit4:GPIO10 |
| | | | Bit5:GPIO13 |
| | | | Bit6:GPIO15 |
| | | | Not used |
| Checksum | 44` | | |
| <CR><LF> | | | |

Example: $ROYALIO,46,90*44<CR><LF>

Explanation: From this example, we will know that:

GPIO3 is an input port, level: low

GPIO5 is an output port, level: high

GPIO6 is an output port, level: low

GPIO7 is an output port, level: high

GPIO10 is an input port, level: high

GPIO13 is an output port, level: low

GPIO15 is an input port, level: high

## Calculating Checksums for NMEA Input

The Checksum is the 8-bit exclusive OR of all the characters after $ and before *. (Not including $ and *)

## SiRF Binary Protocol

The serial communication protocol is designed to include:

- Reliable transport of messages
- Ease of implementation
- Efficient implementation

- Independence from payload

Protocol Layers Transport Message

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

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 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) 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 of start code.

**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.

**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., SiRF demo) may limit the actual size to something less than this maximum..

**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.

**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)
```

**Input Messages for SiRF Binary Protocol**

Note – All input messages are sent in BINARY

format

*Table 19* 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 |
| 0 x 84 | 132 | Software Version |
| 0x 85 | 133 | DGPS Source Control |
| 0x 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 |
| 0 x 8E | 142 | Steady-State Detection |
| 0 x 8F | 143 | Static Navigation |
| 0 x 90 | 144 | Clock Status |
| 0 x 91 | 145 | Set DGPS Serial Port |
| 0 x 92 | 146 | Almanac |
| 0 x 93 | 147 | Ephemeris |
| 0 x 95 | 149 | Set Ephemeris |
| 0 x 96 | 150 | Switch Operating Mode |
| 0 x 97 | 151 | Set Trickle Power Parameters |
| 0 x 98 | 152 | Navigation Parameters (Poll) |
| 0x A5 | 165 | Change UART Configuration |
| 0x A6 | 166 | Set Message Rate |
| 0x A7 | 167 | Low Power Acquisition Parameters |

## Initialize Data Source-Message I.D. 128

Table 18 contains the input values for the following example:Warm start the receiver with the following initialization data:ECEF WYZ (-2686727 m,-4304282 m,3851642 m),Clock Offset (75,000 Hz),Time of Week(86,400 s),Week Number(924),Week Number(924),and Channels(12). Raw track data Debug data enabled.

Example:

A0A20019-Start Sequence and Payload Length

80FFD700F9FFBE5266003AC57A000124 F80083S600039C0C33- Payload

0A91B0B3-Message Checksum and End Sequence

*Table 20* 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 | | 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 19 |

Payload Length: 25 bytes

*Table 21* Initialize Data Source

| 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 Nav Lib 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), GPS 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 20 contains the input values for the following example:

Request the following NMEA data at 9600 baud:

GGA – ON at 1 sec , GLL – 0sec , GSA – ON at 5 sec GSV – ON at 5 sec , RMC – 0 sec , VTG – 0 sec

Example:

A0A20018 – Start Sequence and Payload Length

810201010001050105010001000100010010001000112C0 – Payload

016AB0B3 – Message Checksum and End Sequence

*Table 22* 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 | |
| Checksum[2] | 1 | | 01 | | |
| GLL Message | 1 | | 00 | 1/s | |
| Checksum | 1 | | 01 | | |
| GSA Message | 1 | | 05 | 1/s | |
| Checksum | 1 | | 01 | | |
| GSV Message | 1 | | 05 | 1/s | |
| Checksum | 1 | | 01 | | |
| RMC Message | 1 | | 00 | 1/s | |
| Checksum | 1 | | 01 | | |
| VTG Message | 1 | | 00 | 1/s | |
| Checksum | 1 | | 01 | | |
| MSS Message | 1 | | 00 | | Recommended value |
| Checksum | 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 | 1 | | 12C0 | | 38400,19200,9600,4800,2400 |

Payload Length: 24bytes

(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).

## Set Almanac- Message I.D. 130

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

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

**Software Version – Message I.D. 132**

Table 21 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 23* Software Version

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

Payload Length: 2 bytes

## 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

A0A20007—Start Sequence and Payload Length

85020000000000—Payload

0087B0B3—Checksum and End Sequence

Table B-6 DGPS Source Selection (Example 1)

| Name | Bytes | Binary(Hex) Scale | Example | Units | Description |
|---|---|---|---|---|---|
| Message ID | 1 | | 85 | | Message identifier |
| DGPS Source | 1 | | 00 | | See Table B-8. DGPS Source Selections |
| Internal Beacon | 4 | | 00000000 | Hz | See Table B-9. Internal Beacon Search setting. |
| Internal Beacon Bit Rate | 1 | | 0 | BPS | See Table B-9. Internal Beacon Search setting. |

Payload: 7Bytes.

Example2: Set the DGPS source to Internal DGPS Beacon Receiver

Search Frequency 310000, Bit Rate 200

A0A20007—Start Sequence and Payload Length

85030004BAF0C802—Payload

02FEB0B3—Checksum and End Sequence

Table B-7 DGPS Source Selection (Example 2)

| Name | Bytes | Binary(Hex) Scale | Example | Units | Description |
|---|---|---|---|---|---|
| Message ID | 1 | | 85 | | Message identifier |
| DGPS Source | 1 | | 03 | | See Table B-8. DGPS Source Selections |
| Internal Beacon | 4 | | 0004BAF0 | Hz | See Table B-9. Internal Beacon Search setting. |
| Internal Beacon Bit Rate | 1 | | C8 | BPS | See Table B-9. Internal Beacon Search setting. |

Payload: 7Bytes.

*Table B- 8* DGPS Source Selections

| DGPS Source | Hex | Decimal | Description |
|---|---|---|---|
| None | 00 | 0 | DGPS corrections will not be used (even if available). |
| WAAS | 01 | 1 | Uses WAAS Satellite (subject to availability). |
| External RTCM Data | 02 | 2 | External RTCM input source (i.e., Coast Guard Beacon). |
| Internal DGPS Beacon Receiver | 03 | 3 | Internal DGPS beacon receiver. |

*Table B- 9* Internal Beacon Search Settings

| Search Type | Frequency | Bit Rate | Description |
|---|---|---|---|
| Auto Scan | 0 | 0 | Auto scanning of all frequencies and bit rates are performed. |
| Full Frequency Scan | 0 | Non zero | Auto scanning of all frequencies and specified bit rate are performed. |
| Full Bit Rate Scan | Non Zero | 0 | Auto scanning of all bit rates and specified frequency are performed. |
| Specific Search | Non Zero | Non Zero | Only the specified frequency and bit rate search are performed. |

## Set Main Serial Port-Message I.D. 134

Table B-10 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 B- 10* Set Main Serial Port

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |
| Message ID | 1 | | 86 | | Message identifier |
| 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

## Mode control – Message I.D .136

Table 24 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:

A0A2000W – Start Sequence and Payload Length

880101010101000000002140501 – Payload

00A9B0B3 – Message Checksum and End Sequence

*Table 24* 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 C-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 | | 02 | | 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 25* 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 26 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 26* DOP Mask Control

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |
| Message ID | 1 | | 88 | | ASCII 137 |
| DOP Selection | 1 | | 00 | | See Table 25 |
| 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 27* 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 28 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 28* DGPS Control

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |
| Message ID | 1 | | 8A | | ASCII 138 |
| DGPS Selection | 1 | | 01 | | See Table 27 |
| DGPS Time Out | 1 | | 1E | Seconds | Range 1 to 120 |

Payload Length:3 bytes

*Table 29* DGPS Selection

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

## Elevation Mask – Message I.D.139

Table 30 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

0269B0B3 – Message Checksum and End Sequence

*Table 30* 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

## Power Mask – Message I.D.140

Table 31 contains the input values for the following example: Navigation mask to 33dBHz (tracking default value of 28)

Example:

A0A20003 – Start Sequence and Payload Length

8C1C21 – Payload

00C9B0B3 – Message Checksum and End Sequence

*Table 31* 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

## Editing Residual – Message I.D.141

Note – Not implemented currently

## Steady State Detection – Message I.D.142

Table 32 contains the input values for the following example: Set Stead State Threshold to 1.5 m/$sec^2$

Example:

A0A20002 – Start Sequence and Payload Length

8E0F – Payload

009DB0B3 – Message Checksum and End Sequence

*Table 32* Steady Detection

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |
| Message ID | 1 | | 8E | | ASCII 142 |
| Threshold | 1 | | 0F | M /sec2 | Range 0 to 20 |

Payload: 2 bytes

## Static Navigation – Message I.D.144

*Table 33* Steady State Detection

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

Payload Length:2 bytes

### Set DGPS Serial Port – Message I.D 145

Table 34 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 34* 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: 9 bytes

## Almanac – Message I.D.146

Table 35 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 35* Almanac

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |

| | | | | | |
|---|---|---|---|---|---|
| Message ID | 1 | | 92 | | ASCII 146 |
| TBD | 1 | | 00 | | Reserved |

Payload Length: 2 bytes

## Ephemeris Message I.D.147

Table 36 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 36* Almanac

| 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

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

## Switch To SiRF Protocol

Note – To switch to SiRF protocol you must send a SiRF NMEA message to revert to SiRF binary mode. (See page 9, " NMEA Input Messages " for more information)

## Switch Operating Modes - Message I.D. 150

Table 37 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 37 Switch Operating Mode I.D. 150

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

Payload length: 7 bytes

## Set Trickle Power Parameters - Message I.D. 151

Table 38 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 200 ms On Time.

A0A20009—Start Sequence and Payload Length

97000000C8000000C8—Payload

0227B0B3—Message Checksum and End Sequence

Table 38 Set Trickle Power Parameters I.D. 151

| Name | Bytes | Binary(Hex) | | Units | Description |
|---|---|---|---|---|---|
| | | Scale | Example | | |
| Message ID | 1 | | 97 | | ASCII 151 |
| Push To FixMode | 2 | | 0000 | | ON=1, OFF=0 |
| Duty Cycle | 2 | *10 | 00C8 | % | % Time on |
| Milli Seconds On Time | 4 | | 000000C8 | ms | Range 200 ~ 500 ms |

Payload Length: 9bytes.

## 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:

Off Time = (On Time - (Duty Cycle * On Time)) / Duty Cycle

Update rate = Off Time + On Time

**Note –** On Time inputs of > 900 ms will default to 1000 ms

Following are some examples of selections:

Table 39 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 |

See Table 40 for supported/unsupported settings.

Table 40 Trickle Power Mode Settings

| On Time (ms) | Update Rate (second) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 200 | Y | Y | N | N | N | N | N | N |
| 300 | Y | Y | Y | Y | Y | Y | N | N |
| 400 | Y | Y | Y | Y | Y | Y | Y | Y |
| 500 | Y | Y | Y | Y | Y | Y | Y | Y |
| 600 | Y | Y | Y | Y | Y | Y | Y | Y |
| 700 | Y | Y | Y | Y | Y | Y | Y | Y |
| 800 | Y | Y | Y | Y | Y | Y | Y | Y |
| 900 | Y | Y | Y | Y | Y | Y | Y | Y |

Y = Yes (Mode supported)

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 a 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 this 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 stayed on:

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

Off Period is limited to 30 minutes. The duty cycle will not be less than approximately On Period/1800, or about 1%. Push-to-Fix keeps the ephemeris for all visible satellites up to date so position/velocity fixes can generally be computed within SnapStart times (when requested by the user) on the order of 3 seconds.

### Poll Navigation Parameters - Message I.D. 152

Table C-20 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 C-20 Poll Receiver for Navigation Parameters

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

Payload length: 2 bytes

### Set UART Configuration - Message I.D. 165

Table B-28 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

A50001010000258008010000000100000000E1000801000000FF0505000000000000000000000FF0505000000000000000000000—Payload

0452B0B3—Message Checksum and End Sequence

*Table B- 28* 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] | 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 | | 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 | | 00 | | For UART 1 |
| In Protocol | 1 | | 01 | | For UART 2 |
| Out Protocol | 1 | | 01 | | For UART 2 |
| Baud Rate | 4 | | 00000000 | | For UART 2 |
| Data bits | 1 | | 08 | | For UART 2 |
| Stop bits | 1 | | 01 | | For UART 2 |
| Parity | 1 | | 00 | | For UART 2 |
| Reserved | 1 | | 00 | | For UART 2 |
| Reserved | 1 | | 00 | | For UART 2 |
| Port | 1 | | 00 | | For UART 3 |
| In Protocol | 1 | | 01 | | For UART 3 |
| Out Protocol | 1 | | 01 | | For UART 3 |
| Baud Rate | 4 | | 00000000 | | For UART 3 |
| Data bits | 1 | | 08 | | For UART 3 |
| Stop bits | 1 | | 01 | | 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 B-29 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 B- 29* Set Message Rate

| Name | Bytes | Binary(Hex) Scale | Example | Units | Description |
|---|---|---|---|---|---|
| Message ID | 1 | | A6 | | Decimal 166 |
| Send Now[1] | 1 | | 01 | | Poll message |
| MID to 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.

## Low Power Acquisition Parameters - Message I.D. 167

Table B-30 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

A7000075300001D4C000000000000000000000000000000—Payload

02E1B0B3—Message Checksum and End Sequence

*Table B- 30* Set Low Power Acquisition Parameters

| Name | Bytes | Binary(Hex) Scale | Example | Units | Description |
|---|---|---|---|---|---|
| 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

## Output Messages for SiRF Binary Protocol

Note – All output messages are received in BINARY format. SiRF demo interprets the binary data and saves if to the log file in ASCII format.

*Table 42* lists the message list for the SiRF output messages

| 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 Date | Standard ICD format |
| 0x09 | 9 | Throughput | CPU load |
| 0x0B | 11 | Command Acknowledgment | Successful request |

| | | | |
|---|---|---|---|
| 0x0C | 12 | Command N Acknowledgment | Unsuccessful request |
| 0X0D | 13 | Visible List | Auto Output |
| 0x0E | 14 | Almanac Data | |
| 0x0F | 15 | Ephemeris Data | |
| 0x11 | 17 | Differential Corrections | Received from DGPS broadcast |
| 0x12 | 18 | OkToSend | CPU ON / OFF (Trickle Power) |
| 0x13 | 19 | Navigation Parameters | Response to Poll |
| 0x1C | 28 | Nav. Lib. Measurement Data | Measurement Data |
| 0x1D | 29 | Nav. Lib. DGPS Data | Differential GPS Data |
| 0x1E | 30 | Nav. Lib. SV State Data | Satellite State Data |
| 0x1F | 31 | Nav. Lib. Initialization Data | Initialization Data |
| 0x64 | 100 | RoyalTek Navigation Data | UTC , lat , lon, validate output |
| 0xFF | 255 | Development Data | Various data messages |

**Measure Navigation Data Out –**

**Message I.D.2**

Output Rate: 1 Hz

Table 43 lists the binary and ASCII message data format for the measured navigation data

Example:

A0A20029 – Start Sequence and Payload Length

02FFD6F78CFFBE869E003AC004000301

04A00036B039780E3

0612190E160F04000000000000 – Payload

09BBB0B3 – Message Checksum, and End Sequence

*Table 43* Measured Navigation Data Out – Binary & ASCII Message Data Format

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 02 | | | 2 |
| X – position | 4 | | FFD6F78C | M | | -2689140 |
| Y – position | 4 | | FFBE536E | M | | -4304018 |
| Z – position | 4 | | 003AC004 | M | | 3850244 |
| X – velocity | 2 | *8 | 00 | M/s | Vx/8 | 0 |
| Y – velocity | 2 | *8 | 03 | M/s | Vy/8 | 0.375 |
| Z – velocity | 2 | *8 | 01 | M/s | /8 | 0.125 |
| Mode[1] | 1 | | 04 | Bitmap1 | | 4 |
| DOP[2] | 1 | *5 | A | | /5 | 2.0 |
| Mode[3] | 1 | | 00 | Bitmap3 | | 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 42*

[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 43*

Note – Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (i.e., decimal Xvel = binary Xvel /8).

*Table 44* 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) |

*Table 45* 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 UI |
| 0x04 | 4 | Reserved |
| 0x05 | 5 | Reserved |
| 0x06 | 6 | Reserved |
| 0x07 | 7 | Reserved |

## Measured Tracker Data Out – Message I.D.4

Output Rate: 1 Hz

Table 46 lists the binary and ASCII message data format for the measured tracker data.

Example:A0A200BC – Start Sequence and Payload Length

04036C0000937F0C0EAB46003F1A1E1D1D191D1A1A1D1F1D59423

F1A1A…. – Payload ****B0B3 – Message Checksum and End Sequence

*Table 46* 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 |
| Channels | 1 | | 0C | | | 12 |
| 1st Sv ID | 1 | | 0E | | | 14 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Azimuth | 1 | Az*[2/3] | AB | Degree | /[2/3] | 256.5 |
| Elev. | 1 | El*2 | 46 | Degree | /2 | 35 |
| State | 2 | | 003F | Bitmap1 | | 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 | | | 26 |
| C/NO 9 | 1 | | 1D | | | 29 |
| C/NO 10 | 1 | | 1F | | | 31 |
| 2nd Sv ID | 1 | | 1D | | | 29 |
| Azimuth | 1 | Az*[2/3] | 59 | Degree | /[2/3] | 89 |
| Elev. | 1 | El*2 | 42 | Degree | /2 | 66 |
| State | 2 | | 3F | Bitmap1 | | 63 |
| C/NO 1 | 1 | | 1A | | | 26 |
| C/NO 2 | 1 | | 1A | | | 63 |
| ….. | | | | | | |

Payload Length: 188 bytes

For further information, go to *Table 45*.

Note – Message length is fixed to 188 bytes with non tracking channels reporting zero values

*Table 47* Trk. to NAV Struct. Trk._status Field Definition

| Field Definition | Hex Value | Description |
|---|---|---|
| ACQ_SUCCESS | 0x0001 | Set if acq/reacq if 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 pull in 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 0xBF

## Raw Tracker Data Out – Message I.D.5

Output Rate:1 Hz

Table 48 lists the binary and ASCII message data format for the raw tracker data .

Example:

A0A20033 – Start Sequence and Payload Length

05000000070013003F00EA1BD4000D03
9200009783000DF45E000105B5FF90F5
C200002428272723272424272905000000
0070013003F – Payload

0B2DB0B3 – Message Checksum and End Sequence

*Table 48* 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 | | | 19 |
| State | 2 | | 003F | Bitmap[1] | | 63 |
| Bits | 4 | | 00EA1BD4 | Bit | | 15342548 |
| Ms | 2 | | 000D | Ms | | 13 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Chips | 2 | | 0392 | Chip | | 914 |
| Code Phase | 4 | $2^{-16}$ | 00009783 | Chip | $/2^{-16}$ | 38787 |
| Carrier Doppler | 4 | $2^{-10}$ | 000DF45E | Rad/2ms | $/2^{-10}$ | 914526 |
| Time Tag | 4 | | 000105B5 | Ms | | 66997 |
| Delta Carrier[2] | 4 | $2^{-10}$ | FF90F5C2 | Cycles | $/2^{-10}$ | -7277118 |
| Search Count | 2 | | 0000 | | | 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 Loss Count | 1 | | 05 | | | 5 |
| Phase Loss Count | 1 | | 00000007 | | | 7 |
| Integration Interval | 2 | | 0013 | Ms | | 19 |
| Track Loop Iteration | 2 | | 003F | | | 63 |

Payload Length:51 bytes per satellite tracked (up to 12)

1.For further information,go to Table 45

2.Multiply by $(1000 \div 4\pi) \div 2^{16}$ to convert to Hz.

The meaning of I.D.5 is described as following table

| | |
|---|---|
| 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 45) |
| 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. |
| 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 searche.s |
| 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 time 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 Tine (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.

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+70ms) 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 Dalta 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.

## Response :Software Version String – Message I.D.6

Output Rate:Response to polling message

Example:

A0A20015 – Start Sequence and Payload Length

0606312E322E30444B495431313920534 D0000000000-Payload

0382B0B3 – Message Checksum and End Sequence

*Table 49* Software Tracker Data Out

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

Payload Length: 21 bytes

Note – Convert to symbol to assemble message (i.e., 0x4E is 'N'). These are low priority task and are not necessarily output at constant intervals.

## Response :Clock Status Data – Message I.D.7

Output Rate:1Hz or response to polling message

Example:

A0A20014 – Start Sequence and Payload Length

0703BD021549240822317923DAEF – Payload

0598B0B3 – Message Checksum and End Sequence

*Table 50* 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 | ns | | 128743715 |
| Estimated GPS Time | 4 | | DAEF | ms | | 349493999 |

Payload Length:20 bytes

## 50BPS 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 51* Clock Status Data Message

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

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

Note – Data is logged in ICD format

(available from www.navcen.uscg.mail)

## 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 52* CPU Throughput

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

Payload Length: 9 bytes

## 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 53* 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

## Command N Acknowledgment – Message I.D. 12

Output Rate: Response to rejected Input message

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

A0A20002 – Start Sequence and Payload Length

0C92 – Payload

009EB0B3 – Message Checksum and End Sequence

*Table 54* Command N Acknowledgment

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

Payload Length:2 bytes

## Visible List – Message I.D.13

Output Rate:Updated approximately every 2minutes. Note – This is a variable length message. Only the number of visible satellites are reported(as define by visible Svs in Table 55), Maximum is 12 satellites

Example:A0A2002A – Start Sequence and Payload Length

0D080700290038090133002C************

****** - Payload

****B0B3 – Message Checksum and End Sequence

*Table 55* 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 | Degrees | | 41 |
| CH 1 –Sv Elevation | 2 | | 0038 | Degrees | | 56 |
| CH 2 –Sv I.D | 1 | | 09 | | | 9 |
| CH 2 –Sv Azimuth | 2 | | 0133 | Degrees | | 307 |
| CH 2 –Sv Elevation | 2 | | 002C | Degrees | | 44 |
| …… | | | | | | |

Payload Length:62 bytes(maximum)

## 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 56* Visible List

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

Payload Length: 929 bytes(maximum)

## OkToSend - Message I.D. 18

Output Rate: Trickle Power CPU on/off indicator

Example:

A0A20002—Start Sequence and Payload Length

1200—Payload

0012B0B3—Message Checksum and End Sequence

*Table B- 52* Almanac Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 12 | | | 18 |
| 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 B- 53* Navigation Parameters

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 13 | | | 19 |
| Reserved | 4 | | 00000000 | | | |
| Altitude Hold Mode | 1 | | 00 | | | 0 |
| Altitude Hold Source | 1 | | 00 | | | 0 |
| Altitude Input Source | 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 Mask | 2 | | | | | |
| 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 Enabled | 1 | | | | | |
| LP Max. Acq. Search Time | 4 | | | | | |
| LP Max. Off Time | 4 | | | | | |
| Reserved | 4 | | | | | |
| Reserved | 4 | | | | | |

Payload Length: 65 bytes

1. See Table 22.

2. See Table 24.

3. See Table 26.

## Navigation Library Measurement Data - Message I.D. 28

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

Example:

A0A20038—Start Sequence and Payload Length

1C00000660D015F143F62C4113F42FF3FB E95E417B235C468C6964B8FBC5824 15CF1C375301734.....03E801F400000000 —Payload

1533B0B3—Message Checksum and End Sequence

*Table B- 54* Measurement Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 1C | | | 28 |
| Channel | 1 | | 00 | | | |
| Time Tag | 4 | | 000660D0 | ms | | |
| Satellite ID | 1 | | 15 | | | |
| GPS Software Time | 8 | | F143F62C 4113F42F | ms | | |
| Pseudo Range | 8 | | F3FBE95E 417B235C | m | | |
| Carrier Frequency | 4 | | 468C6964 | | | |
| Carrier Phase | 8 | | B8FBC582 415CF1C3 | | | |
| Time in Track | 2 | | 7530 | ms | | |
| Sync Flags | 1 | | 17 | | | |
| C/No1 | 1 | | 34 | | | |
| C/No2 | 1 | | | | | |
| C/No3 | 1 | | | | | |
| C/No4 | 1 | | | | | |
| C/No5 | 1 | | | | | |
| C/No6 | 1 | | | | | |
| C/No7 | 1 | | | | | |
| C/No8 | 1 | | | | | |
| C/No9 | 1 | | | | | |
| C/No10 | 1 | | | | | |
| Delta Range Interval | 2 | | 03E801F4 | m | | |
| Mean Delta Range Time | 2 | | 01F4 | ms | | |
| Extrapolation Time | 2 | | 0000 | ms | | |
| Phase Error Count | 1 | | 00 | | | |
| Low Power Count | 1 | | 00 | | | |

Payload Length: 56 bytes

## Navigation Library DGPS Data - Message I.D. 29

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

Example:

A0A2001A—Start Sequence and Payload Length

1D000F00B501BFC97C673CAAAAAB3FBF FE1240A0000040A00000—Payload

0956B0B3—Message Checksum and End Sequence

*Table B- 55* Measurement Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 1D | | | 29 |
| Satellite ID | 2 | | 000F | | | 15 |
| IOD | 2 | | 00B5 | | | 181 |
| Source[1] | 1 | | 01 | | | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Pseudo-range Correction | 4 | | BFC97C67 | m | | 3217652839 |
| Pseudo-range Rate Correction | 4 | | 3CAAAAAB | m/s | | 1017817771 |
| Correction Age | 4 | | 3FBFFE12 | s | | 1069547026 |
| 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 B- 56* SV State Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 1E | | | 30 |
| Satellite ID | 1 | | 15 | | | 21 |
| 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 B- 57* Measurement Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 1F | | | 31 |
| 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 | | 0000 | | | 0 |
| Elevation Nav. Mask | 2 | | 000F | | | 15 |
| Reserved | 2 | | | | | |
| Reserved | 1 | | | | | |
| Reserved | 2 | | | | | |
| Reserved | 1 | | | | | |
| Reserved | 2 | | | | | |
| Static Nav. Mode[5] | 1 | | 00 | | | 0 |
| Reserved | 2 | | | | | |
| Position X | 8 | | | | | |
| Position Y | 8 | | | | | |
| Position Z | 8 | | | | | |
| Position Init. Source[6] | 1 | | 02 | | | 2 |
| GPS Time | 8 | | | | | |
| GPS Week | 2 | | 0434 | | | 1076 |
| Time Init. Source [7] | 1 | | 02 | | | 2 |
| Drift | 8 | | | | | |
| Drift Init. Source [8] | 1 | | 02 | | | 2 |

Payload Length: 84 bytes

1. 0 = Use last know altitude 1 = Use user input altitude 2 = Use dynamic input from external source
2. 0 = Use direction hold and then time hold
   1 = Use time hold and then direction hold
   2 = Only use direction hold
   3 = Only use time hold
   4 = Degraded mode is disabled
3. 0 = True and 1 = False
4. 0 = Use DGPS if available
   1 = Only navigate if DGPS corrections are available
   2 = Never use DGPS corrections
5. 0 = True 1 = False
6. 0 = ROM position
   1 = User position
   2 = SRAM position
   3 = Network assisted position
7. 0 = ROM time
   1 = User time
   2 = SRAM time
   3 = RTC time
   4 = Network assisted time
8. 0 = ROM clock
   1 = User clock
   2 = SRAM clock
   3 = Calibration clock
   4 = Network assisted clock

## RoyalTek Navigation Data – Message I.D.100

Output Rate: 1Hz and Payload Length

Example :A0A2001A – Start Sequence 6407D1*********** - Payload

****B0B3 – Message checksum and End Sequence

*Table 57* Royaltek Navigation Data

| Name | Bytes | Binary(Hex) | | Units | ASCII(Decimal) | |
|---|---|---|---|---|---|---|
| | | Scale | Example | | Scale | Example |
| Message ID | 1 | | 64 | | | 100 |
| Year | 2 | | 07D1 | | | 2001 |
| Month | 2 | | 000C | | | 12 |
| Day | 2 | | 0005 | | | 5 |
| Hours | 2 | | 0011 | | | 17 |
| Minutes | 2 | | 001E | | | 30 |
| Seconds | 4 | *1000 | 5202 | Sec. | ÷1000 | 20.994 |
| Degree of Latitude | 2 | | 19 | degree | | 25 |
| Minutes of Latitude | 4 | *10000 | 0001818C | Min. | ÷10000 | 9.8700 |
| Degree of Longitude | 2 | | 79 | degree | | 121 |
| Minute of Longitude | 4 | *10000 | 0002BA64 | Min. | ÷10000 | 17.8788 |
| Altitude | 4 | | 000000FA | meter | | 250 |
| Validity | 1 | | 01 | | | 1 |
| Speed | 2 | *10 | 0064 | Km/h | ÷10 | 10.0 |
| Course over ground | 2 | | 0080 | Degree | | 128 |
| PDOP | 2 | *10 | 012C | | ÷10 | 30.0 |
| HDOP | 2 | *10 | 012C | | ÷10 | 30.0 |
| VDOP | 2 | *10 | 012C | | ÷10 | 30.0 |

Payload Length: 42 bytes. This protocol is provided from RoyalTek firmware Ver. 1.7. release

* *hh<CR><LF> Check Sum and sentence termination delimiter

## Set Ephemeris – Message I.D.254

This command enables the user to upload an ephemeris to the Evaluation unit.

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

## 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 58* 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., 0x4E is ‘N’) these are low priority task and are not necessarily output at constant intervals.

## GPS Receiver User's Tip

1. GPS signal will be affected by weather and environment conditions, thus suggest to use the GPS receiver under less shielding environments to ensure GPS receiver has better receiving performance.

2. When GPS receiver is moving, it will prolong the time to fix the position, so suggest to wait for the satellite signals to be locked at a fixed point when first power-on the GPS receiver to ensure to lock the GPS signal at the shortest time.

3. The following situation will affect the GPS receiving performance:
   a. Solar control filmed windows.
   b. Metal shielded, such as umbrella, or in vehicle.
   c. Among high buildings.
   d. Under bridges or tunnels.
   e. Under high voltage cables or near by radio wave sources, such as mobile phone base stations.
   f. Bad or heavy cloudy weather.
4. If the satellite signals can not be locked or encounter receiving problem (while in the urban area), the following steps are suggested:
   a. Please plug the external active antenna into GPS receiver and put the antenna on outdoor or the roof of the vehicle for better receiving performance.
   b. Move to another open space or reposition GPS receiver toward the direction with less blockage.
   c. Move the GPS receiver away from the interferences resources.
   d. Wait until the weather condition is improved.
5. While a GPS with a backup battery, the GPS receiver can fix a position immediately at next power-on if the build-in backup battery is full-recharged.

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