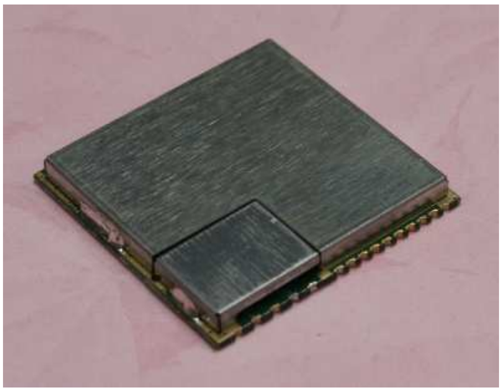
# GPS Engine Board Manual

## SR-90

**SiRF StarⅢ**

**V 1.1**



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2008/08/08

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**Specifications subject to change without prior notice!**

# Contents

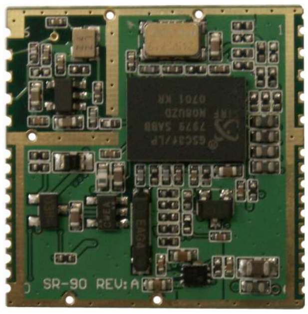
# 1. Introduction

## 1.1 Overview

SR-90 GPS module is a high performance receiver module for the Global Positioning System (GPS) solution. It combines SiRF StarⅢ GPS single chip, LNA circuit, SAW filter, oscillator, crystal and regulators into a land grid array module. The specified firmware is pre-loaded into the built-in 4-Mbit Flash memory of SR-90 for GPS application. It can be easily embedded into portable devices for GPS wireless communication.

## 1.2 Features

SiRF starⅢ high performance GPS Chip Set Very high sensitivity (Tracking Sensitivity: -159 dBm) Extremely fast TTFF (Time To First Fix) at low signal level Compact size (25.4mm * 25.4 mm * 3.3mm) suitable for space-sensitive application One size component, easy to mount on another PCB board Support NMEA 0183 and SiRF binary protocol



# 2. Technical Specifications

## 2.1. Electrical Characteristics

### 2.1.1 General

| | |
|---|---|
| Frequency | L1, 1575.42 MHz |
| C/A code | 1.023 MHz chip rate |
| Channels | 20 channels all in view tracking |

### 2.1.2 Sensitivity

| | |
|---|---|
| Tracking | -159 dBm typical |

### 2.1.3 Accuracy (Open Sky)

| | |
|---|---|
| Position | 10 meters, 2D RMS |
| | 5 meters 2D RMS, WAAS enabled |
| Time | 1 microsecond synchronized to GPS time |

### 2.1.4 Datum

| | |
|---|---|
| Default | WGS-84 |

### 2.1.5 Acquisition Rate (Open Sky)

| | |
|---|---|
| Hot start | 1 sec, average |
| Warm start | 38 sec, average |
| Cold start | 42 sec, average |
| Reacquisition | 0.1 sec, average |

### 2.1.6 Dynamic Conditions

| | |
|---|---|
| Altitude | 18,000 meters (60,000 feet) max |
| Velocity | 515 meters/sec (1000 knots) max |
| Acceleration | Less than 4 G |
| Jerk | 20 meters/sec max |

### 2.1.7 Power

| | |
|---|---|
| Main power input | 3.3 ± 5% VDC input |
| Supply Current | 68mA (Continuous mode) |

### 2.1.8 Serial Port

| | |
|---|---|
| Electrical interface | TTL level |
| Protocol support | NMEA-0183, SiRF Binary |
| Default NMEA | GGA, GSA, GSV, RMC, (GLL, VTG, and ZDA optional)<br>4800 baud rate (other rate optional)<br>8 bits data, 1 stop bit, no parity. |

### 2.1.9 Time

1 PPS Pulse, pulse duration 1μs.

Time reference at the pulse positive edge.

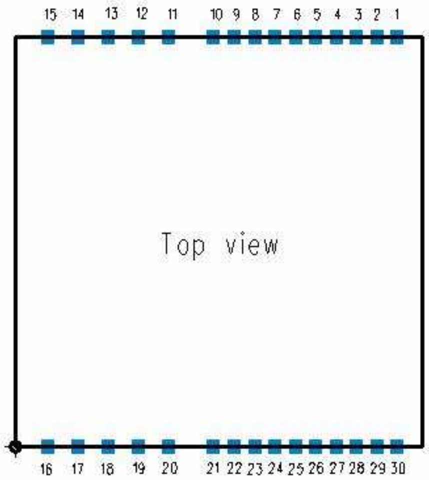
Synchronized to GPS time, ±1μs.

## 2.2. Environmental Characteristics

| | |
|---|---|
| Operating temperature range | -40 °C to +85 °C |
| Storage temperature range | -45 °C to +100 °C |

## 2.3. Physical Characteristics

Top view




Pin Assignment

| Pin | Signal Name | I/O | Description |
|---|---|---|---|
| 1 | VCC | I | DC Supply Voltage input |
| 2 | GND | G | Ground |
| 3 | Boot select | I | Boot mode |
| 4 5 6 7 | RXA TXA TXB RXB | I O O I | Serial port A Serial port A Serial port B Serial port B |
| 8 | GPIO14 | I/O | General –purpose I/O |
| 9 | RF_ON | | |
| 10 | GND | G | Digital Ground |
| 11 16 | GND_A | G | Analog Ground |
| 17 | RF_IN | I | GPS Signal input |
| 18 | GND_A | G | Analog Ground |
| 19 | V_ANT_IN | I | Active Antenna Bias voltage |
| 20 | VCC_RF | O | Supply Antenna Bias voltage |
| 21 22 | V_BAT Reset | I I | Backup voltage supply Reset (Active low) |
| 23 | GPIO10 | I/O | General purpose I/O |
| 24 25 26 | GPIO1 GPIO5 GPIO0 | I/O I/O I/O | General purpose I/O General purpose I/O General purpose I/O (support continuous power mode only) |
| 27 | GPIO13 | I/O | General purpose I/O |
| 28 29 30 | GPIO15 PPS GND | I/O O G | General purpose I/O One pulse per second Digital Ground |

## Definition of Pin assignment

**VCC**

This is the main DC supply for a 3.3V ± 5% DC input power module board.

**GND**

GND provides the ground for digital part.

**Boot select**

Set this pin to high for programming flash.

**RXA**

This is the main receiver channel and is used to receive software commands to the board from SIRFdemo software or from user written software.PS: Pull up if not used.

**RXB**

This is the auxiliary receiving channel and is used to input differential corrections to the board to enable DGPS navigation.PS: Pull up if not used.

**TXA**

This is the main transmitting channel and is used to output navigation and measurement data to SiRFdemo or user written software.

**TXB**

For user’s application (not currently used).

**RF_ON**

This pin indicates state of RF voltage.

**RF_IN**

This pin receiver signal of GPS analog .due to the RF characteristics of the signal the design has to certain criteria. The line on the PCB from theantenna (or antenna connector) has to be a controlled microstrip line at 50Ω

**V_ANT_IN**

This pin is reserved an external DC power supply for active antenna. If using 3.0V active antenna, pin 19 has to be connected to pin 20. If using 3.3V or 12V active antenna, this pin has to be connected to 3.3V or 5Vpower supply.

**VCC_RF**

This pin provides DC voltage 3.0 for active antenna. Reset This pin provides an active-low reset input to the board. It causes the board to reset and start searching for satellites. If not utilized, it may be left open.

**PPS**

This pin provides one pulse-per-second output from the board, which is synchronized to GPS time. This is not available in Trickle Power mode.

**Backup battery (V_BAT)**

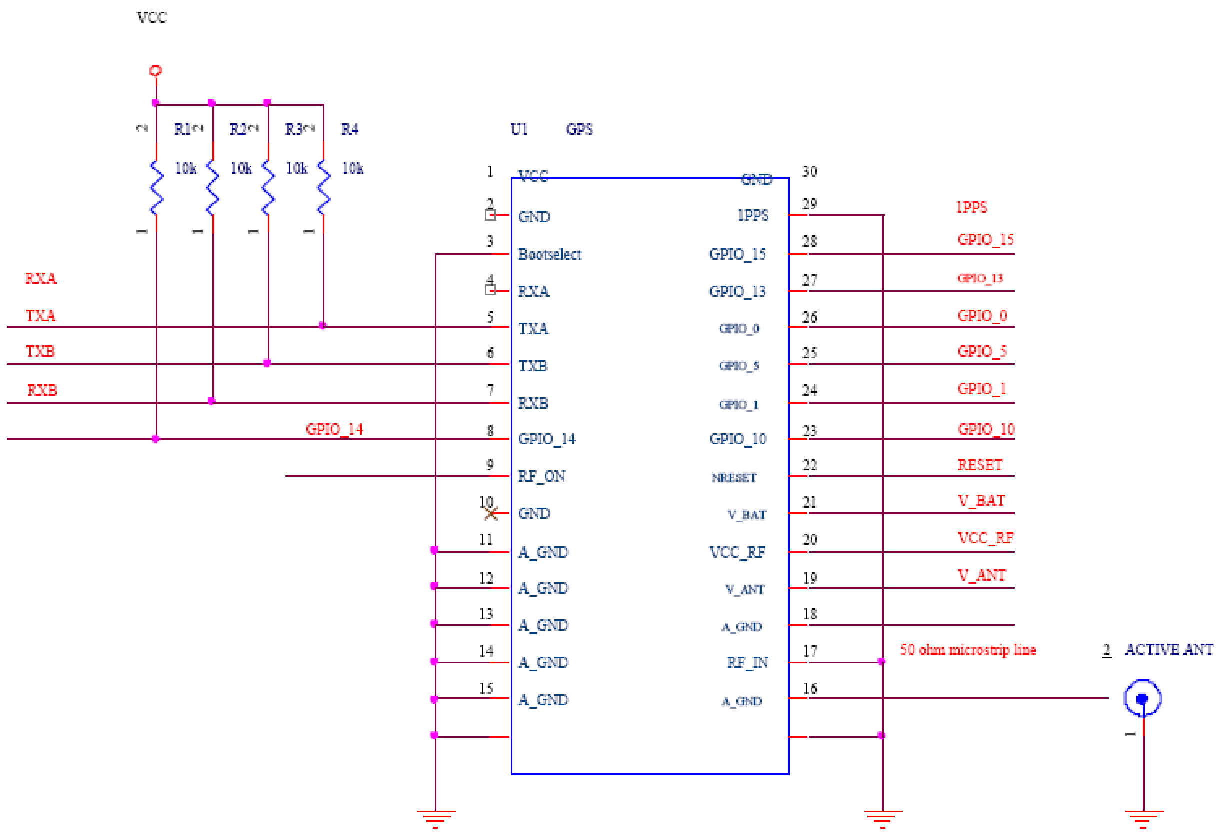
This is the battery backup input that powers the SRAM and RTC when main power is removed. Typical current draw is 15uA. Without an external backup battery, the module/engine board will execute a cold star after every turn on. To achieve the faster start-up offered by a hot or warm start, a battery backup must be connected. The battery voltage should be between 2.0v and 5.0v. Without an external backup battery or super cap, the TMP 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 super cap installed. To maximize battery lifetime, the battery voltage should not exceed the supply voltage and should be between 2.5V and 3.6V. With the super cap (B1) installed, and after at least ten minutes of continuous operation, the data retention is about seven hours. Note that even though all other components are rated at –30 to +85 deg C, a typical super cap is specified over a temperature range of –25 to +70 deg C and a typical rechargeable Lithium battery is over –20 to +70 deg C.

**GPIO Functions**

Several I/Os are connected to the digital interface connector or custom applications.

# Application Circuit



(1) Ground Planes: SR-90 GPS receiver needs two different ground planes. The GND_A pin(11、12、13、14、15、16、18) shall be connect to analog ground. The GND pin(2 、10、30) connect to digital ground.

(2) Serial Interface: The Serial interface pin(RXA 、TX1、TXB 、RXB) is recommended to pull up(10KΩ).

It can increase the stability of serial data.

(3) Backup Battery:

It's recommended to connect a backup battery to V_BAT. In order to enable the warm and hot start features of the GPS receiver. If you don't intend to use a backup battery, connect this pin to GND or open. If you use backup battery, shall need to add a bypassing capacitor (10uF) at V_bat trace. It can reduce noise and increase the stability.

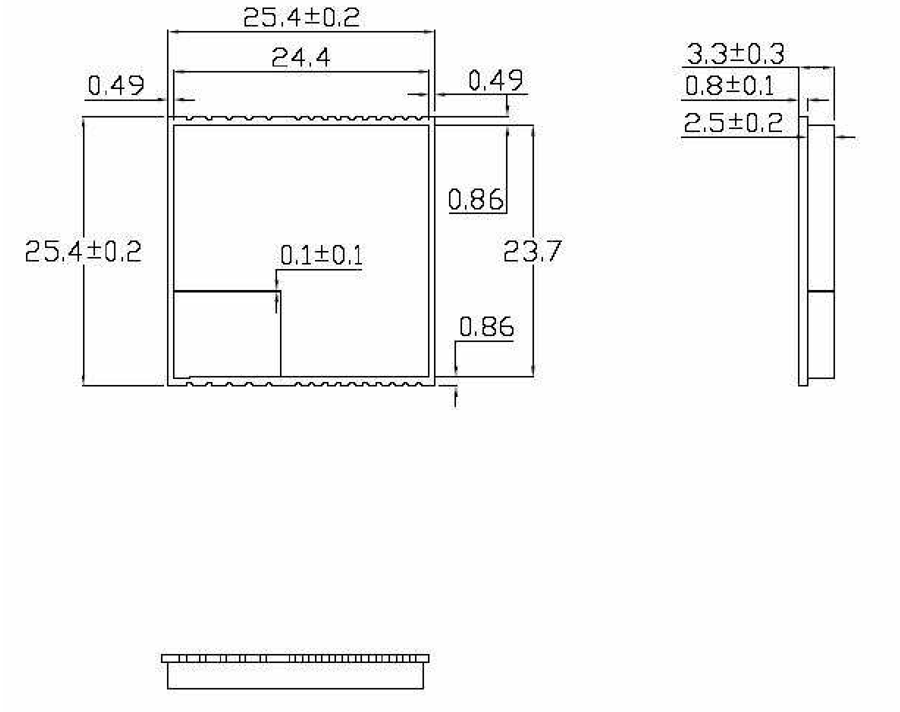
(4) Antenna:

Connecting to the antenna has to be routed on the PCB. The transmission line must to controlled impedance to connect RF_IN to the antenna or antenna connector of your choice.

(5) Active antenna bias voltage:

The Vcc_RF pin (pin 20) is providing voltage 3.3V. If you use active antenna, you can connect this pin to V_ANT_IN pin (pin 19) to provide bias voltage of active.

**Mechanical Layout**


25.4±0.2
24.4
0.49
0.49
0.86
25.4±0.2
0.1±0.1
23.7
0.86
3.3±0.3
0.8±0.1
2.5±0.2

# Appendix: Software Specifications

## NMEA Protocol

The interface protocol is based on the National Marine Electronics Association (NMEA) interface specification, namely, the NMEA 0183 standard. The unit is capable of supporting the following NMEA message formats specifically developed and defined by SiRF.

| **NMEA Message Prefix** | **Format** | **Direction** |
|---|---|---|
| **$GPGGA** | Time, position and fix type data. | **Out** |
| **$GPGLL** | Latitude, longitude, time of position fix and status. | **Out** |
| **$GPGSA** | **GNSS DOP and active satellites** | **Out** |
| **$GPGSV** | **Satellites in view.** | **Out** |
| **$GPMSS** | Radio beacon signal-to-noise ratio, signal strength, frequency, etc. | **Out** |
| **$GPRMC** | **Recommended minimum specific GNSS data.** | **Out** |
| **$GPVTG** | **Speed and course over ground.** | **Out** |
| **$GPZDA** | Date and time. | **Out** |

## General NMEA Format

**The general NMEA format consists of an ASCII string commencing with a '$' character and terminating with a <CR><LF> sequence. NMEA standard messages commence with 'GP' then a 3-letter message identifier. The message header is followed by a comma delimited list of fields optionally terminated with a checksum consisting of an asterix '*' and a 2 digit hex value representing the checksum. There is no comma preceding the checksum field. When present, the checksum is calculated as a bitwise exclusive of the characters between the '$' and '*'. As an ASCII representation, the number of digits in each number will vary depending on the number and precision, hence the record length will vary. Certain fields may be omitted if they are not used, in which case the field position is reserved using commas to ensure correct interpretation of subsequent fields.**

## *$GPGGA*

**This message transfers global positioning system fix data. Following is an example.**

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

**The $GPGGA message structure is shown below:**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **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 Indictor** | **1** | | **0: Fix not available or invalid.**<br>**1: GPS SPS mode, fix valid.**<br>2: Differ. GPS, SPS mode, fix valid<br>3-5: Not supported.<br>*6: Dead Reckoning Mode, fix valid.* (1) |
| **Satellites Used** | **07** | | **Number of satellites used to calculate fix. Range 0 to 12.** |
| **HDOP** | **1.0** | | **Horizontal Dilution of Precision.** |
| **MSL Altitude** (2) | **9.0** | **Meter** | **Altitude above mean seal level.** |
| **Units** | **M** | **Meter** | **M stands for "meters".** |
| **Geoid Separation** (2) | | **Meter** | **Separation from Geoids can be blank.** |
| **Units** | | **Meter** | **M stands for "meters".** |
| **Age of Diff. Corr.** | | **Second** | **Age in seconds. Blank (Null) fields when DGPS is not used.** |
| **Diff Ref. Station ID** | **0000** | | |
| **Checksum** | ***18** | | |
| **<CR> <LF>** | | | **Message terminator.** |

**(1)** Only apply to NMEA version 2.3 (and later) in this NMEA message description.
**(2) SiRF does not support geoid corrections. Values are WGS84 ellipsoid heights.**

## *$GPGLL*

**This message transfers geographic position, latitude, longitude, and time. Following is an example.**

**$GPGLL,3723.2475,N,12158.3416,W,161229.487,A,A*41**

**The $GPGLL message structure is shown below:**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **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 Time** | **161229.487** | | **hhmmss.sss** |
| **Status** | **A** | | **A: Data valid or V: Data invalid.** |
| ***Mode*** | ***A*** | | *A=Autonomous, D=DGPS, E=DR (Only present in NMEA version 3.00).* |
| **Checksum** | ***41** | | |
| **<CR><LF>** | | | **Message terminator.** |

## *$GPGSA*

**This message transfers DOP and active satellites information. Following is an example.**

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

**The $GPGSA message structure is shown below:**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPGSA** | | **GSA protocol header.** |
| **Mode** | **A** | | **M: Manual, forced to operate in selected 2D or 3D mode.**<br>**A: Automatic switching between modes.** |
| **Mode** | **3** | | **1 Fix not available.**<br>**2 2D position fix.**<br>**3 3D position fix.** |
| **Satellites Used (1)** | **07** | | **SV on channel 1.** |
| **Satellites Used (1)** | **02** | | **SV on channel 2.** |
| **…** | | | **..** |
| **Satellites Used (1)** | | | **SV on channel 12.** |
| **PDOP** | **1.8** | | |
| **HDOP** | **1.0** | | |
| **VDOP** | **1.5** | | |
| **Checksum** | ***33** | | |
| **<CR> <LF>** | | | **Message terminator.** |

**(1) Satellites used in solution.**

## *$GPGSV*

**This message transfers information about satellites in view. The $GPGSV message structure is shown below. Each record contains the information for up to 4 channels, allowing up to 12 satellites in view. In the final record of the sequence the unused channel fields are left blank with commas to indicate that a field has been omitted. Following is an 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**

**The $GPGSV message structure is shown below:**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPGSV** | | **GSA protocol header.** |
| **Number of messages** (1) | **2** | | **Number of messages, maximum 3.** |
| **Message number** | **1** | | **Sequence number, range 1 to 3.** |
| **Satellites in view** | **07** | | **Number of satellites currently in view.** |
| **Satellite ID** | **07** | | **Channel 1, ID range 1 to 32.** |
| **Elevation** | **79** | **degree** | **Elevation of satellite, maximum 90.** |
| **Azimuth** | **048** | **degree** | **Azimuth of satellite, range 0 to 359.** |
| **SNR ($C/N_0$)** | **42** | **dBHz** | Range 0 to 99, null when not tracking. |
| **Satellite ID** | **02** | | **Channel 2, ID range 1 to 32.** |
| **Elevation** | **51** | **degree** | **Elevation of satellite, maximum 90.** |
| **Azimuth** | **062** | **degree** | **Azimuth of satellite, range 0 to 359.** |
| **SNR ($C/N_0$)** | **43** | **dBHz** | Range 0 to 99, null when not tracking. |
| **Satellite ID** | **26** | | **Channel 3, ID range 1 to 32.** |
| **Elevation** | **36** | **degree** | **Elevation of satellite, maximum 90.** |
| **Azimuth** | **256** | **degree** | **Azimuth of satellite, range 0 to 359.** |
| **SNR ($C/N_0$)** | **42** | **dBHz** | Range 0 to 99, null when not tracking. |
| **Satellite ID** | **27** | | **Channel 4, ID range 1 to 32.** |
| **Elevation** | **27** | **degree** | **Elevation of satellite, maximum 90.** |
| **Azimuth** | **138** | **degree** | **Azimuth of satellite, range 0 to 359.** |
| **SNR ($C/N_0$)** | **42** | **dBHz** | Range 0 to 99, null when not tracking. |
| **Checksum** | ***71** | | |
| **<CR> <LF>** | | | **Message terminator.** |

**(1) Depending on the number of satellites tracked multiple messages of GSV data may be required.**

## *$GPMSS*

**This message transfers information about radio beacon signal-to-noise ratio, signal strength, frequency, etc. Following is an example.**

**$GPMSS,55,27,318.0,100,1,*57**

**The $GPMSS message format is shown below.**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPMSS** | | **MSS protocol header.** |
| Signal Strength | **55** | **dB** | SS of tracked frequency. |
| Signal-to-Noise Ratio | **27** | **dB** | SNR of tracked frequency. |
| Beacon Frequency | **318.0** | **kHz** | Currently tracked frequency. |
| Beacon Bit Rate | **100** | | Bits per second. |
| *Channel Number* (1) | ***1*** | | *The channel of the beacon being used if a multi-channel beacon receiver is used.* |
| **Checksum** | ***57** | | |
| **<CR> <LF>** | | | **Message terminator.** |

***(1)*** *Fields marked in italic red apply only to NMEA version 2.3 (and later) in this NMEA message description.*

## *$GPRMC*

**This message transfers recommended minimum specific GNSS data. Following is an example.**

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

**The $GPRMC message format is shown below.**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPRMC** | | **RMC protocol header.** |
| **UTC Time** | **161229.487** | | **hhmmss.sss** |
| **Status** | **A** | | **A: Data valid or V: Data invalid.** |
| **Latitude** | **3723.2475** | | **ddmm.mmmm** |
| **N/S Indicator** | **N** | | **N=north or S=south.** |
| **Longitude** | **12158.3416** | | **ddmm.mmmm** |
| **E/W indicator** | **W** | | **E=east or W=west.** |
| **Speed over ground** | **0.13** | **knot** | **Speed over ground** |
| **Course over ground** | **309.62** | **degree** | **Course over ground** |
| **Date** | **120598** | | **ddmmyy, current date.** |
| **Magnetic variation (1)** | | **degree** | **Not used.** |
| ***Mode (2)*** | ***A*** | | *A=Autonomous, D=DGPS, E=DR.* |
| **Checksum** | ***10** | | |
| **<CR> <LF>** | | | **Message terminator.** |

**(1) SiRF does not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.**
*(2) Fields marked in italic red apply only to NMEA version 2.3 (and later) in this NMEA message description.*

## *$GPVTG*

**This message transfers velocity, course over ground, and ground speed. Following is an example.**

**$GPVTG,309.62,T, ,M,0.13,N,0.2,K,A*23**

**The $GPVTG message format is shown below.**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPVTG** | | **VTG protocol header.** |
| **Course (true)** | **309.62** | **degree** | **Measured heading** |
| **Reference** | **T** | | **T = true heading** |
| **Course (magnetic)** | | **degree** | **Measured heading** |
| **Reference (1)** | **M** | | **M = magnetic heading (1)** |
| **Speed** | **0.13** | **knot** | **Speed in knots** |
| **Units** | **N** | | **N = knots** |
| **Speed** | **0.2** | **km/hr** | **Speed** |
| **Units** | **K** | | **K = km/hour.** |
| ***Mode (2)*** | ***A*** | | *A=Autonomous, D=DGPS, E=DR.* |
| **Checksum** | ***23** | | |
| **<CR> <LF>** | | | **Message terminator.** |

**(1) SiRF does not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.**
*(2) Fields marked in italic red apply only to NMEA version 2.3 (and later) in this NMEA message description.*

## *$GPZDA*

**This message transfers UTC Time and Date. Following is an example.**

**$GPZDA,181813,14,10,2003,00,00*4F**

**The $GPZDA message format is shown below.**

| Field | Example | Unit | Notes |
|---|---|---|---|
| **Message ID** | **$GPZDA** | | **ZDA protocol header.** |
| **UTC Time** | **181813** | | Either using valid IONO/UTC or estimated from default leap seconds. |
| **UTC Day** | **14** | | **01 to 31, day of month.** |
| **UTC Month** | **10** | | **01 to 12.** |
| **UTC Year** | **2003** | | **1980 to 2079.** |
| **Local zone hours** | **00** | | **Offset from UTC (set to 00).** |
| **Local zone minutes** | **00** | | **Offset from UTC (set to 00).** |
| **Checksum** | ***4F** | | |
| **<CR> <LF>** | | | **Message terminator.** |