



GPS Firmware GSC3-based Products

**A Description of the standard NMEA GPS firmware provided
on Vincotech's GPS modules based on SiRFstarIII – GSC3
A1080, A1084, A1088, A1035-D, A1035-H**

User's Manual

**Version 4.2
Firmware Revision 3.5.0**



Revision History

| Rev. | Date | Description |
|------|----------|---|
| 1.0 | 10-18-06 | Initial draft |
| 2.0 | 04-02-07 | New design |
| 3.0 | 07-03-07 | Reworked manual (NMEA only) |
| 4.0 | 08-19-08 | New layout; moved to Vincotech |
| 4.1 | 11-25-08 | Minor corrections |
| 4.2 | 03-11-09 | Renamed to "GSC3-based"; added command for shutdown |
| | mm-dd-yy | |

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Table of Contents

| | |
|--|-----------|
| 1 Introduction | 5 |
| 1.1 Serial Port Configuration | 5 |
| 2 Standard NMEA Sentences | 6 |
| 2.1 Introduction | 6 |
| 2.2 Supported NMEA Sentences | 6 |
| 2.2.1 GGA - Global Positioning System Fix Data | 7 |
| 2.2.2 VTG – Course Over Ground and Ground Speed | 8 |
| 2.2.3 RMC - Recommended Minimum Specific GPS Data | 9 |
| 2.2.4 GSA - GPS DOP and Active Satellites | 10 |
| 2.2.5 GSV – GPS Satellites in View | 11 |
| 2.2.6 GLL – Latitude, Longitude, UTC and status | 12 |
| 3 Start-up Message | 13 |
| 4 Proprietary NMEA Sentences | 14 |
| 4.1 Transport Message | 14 |
| 4.2 NMEA Input Messages | 15 |
| 4.3 Serial Port Set-up..... | 15 |
| 4.4 Reset Configuration (<i>SiRF's original: NavigationInitialization</i>) | 16 |
| 4.5 Query/Rate control | 17 |
| 4.6 Development Data On/Off..... | 19 |
| 4.7 Select Datum | 20 |
| 4.8 Shut-Down Module..... | 21 |
| 5 Related Information | 22 |
| 5.1 Contact..... | 22 |
| 5.2 Related Documents..... | 22 |
| 5.3 Related Tools | 22 |
| 6 List of Tables | 23 |

1 Introduction

This document contains a description of NMEA output sentences and NMEA commands which are implemented in the standard GPS firmware used in all GPS modules based on the SiRFstar GSC3 chip set: A1080's, A1084's, A1088, A1035-D, and A035-H. Only fully available commands are described. For more details of the original SiRF firmware please see chapter "5.2 Related Documents".

This revision of the manual refers to firmware **3.5.0!**

The purpose of this paper is the explanation of the behavior of the "NMEA" interface, i.e. a description of the outputs coming from this interface, and a summary of the commands that can be issued to this interface. This will allow easy and full adjustment and control of the module.

1.1 Serial Port Configuration

The firmware supports the bi-directional serial interface of Vincotech's GPS modules. It is implemented by use of the full duplex UART (Universal Asynchronous Receiver Transmitter) interface of the GPS processor.

- For the communication with UART the use of a kind of terminal program or another appropriate method is necessary.
- NMEA communication is always on port 0 (pin Tx0 and Rx0) of the module or on the serial USB port of one of the evaluation boards, respectively.
- The default configuration of this serial port is: 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control.

This interface is bi-directional, i.e. on the one side the output of the GPS modules (NMEA sentences, etc.) is sent to the UART interface, on the other side the UART interface can be used to send commands to Vincotech's GPS modules.

2 Standard NMEA Sentences

2.1 Introduction

The **N**ational **M**arine **E**lectronics **A**ssociation created a uniform interface standard for digital data exchange between different marine electronic products back in the early nineteen-eighties.

- NMEA information is transmitted from a 'vendor' in 'sentences' with a maximum length of 80 characters.
- The general format is:
"\$<vendor><message><parameters>*<checksum><CR><LF>".
- The combination of <vendor><message> is called address field.
- The vendor code for the Global Positioning System is "GP".
- In this document NMEA sentences refer to the NMEA 0183 Standard.

For details see:

<http://www.nmea.org/>

<http://www.nmea.org/pub/index.html>

2.2 Supported NMEA Sentences

The Vincotech's GPS firmware currently supports 6 NMEA sentences:

- \$GPGGA (default: ON)
- \$GPVTG (default: OFF)
- \$GPRMC (default: ON)
- \$GPGSA (default: ON)
- \$GPGSV (default: ON, 0.2Hz)
- \$GPGLL (default: OFF)

Note: Please consider max transfer rate (depending on baud rate setting) before activating additional NMEA sentences.

The following paragraphs give an overview of NMEA messages with example strings and short explanation.

2.2.1 GGA - Global Positioning System Fix Data

e.g. \$GPGGA,152145.000,4805.8193,N,01132.2317,E,1,04,2.5,607.5,M,47.6,M,,*67

| | | |
|------|------------|---|
| (1) | \$GPGGA | Vendor and message identifier |
| (2) | 152145.000 | Universal time coordinated (15h 21m 45.000s) |
| (3) | 4805.8193 | Latitude (48deg 05.8193min) |
| (4) | N | N North S South |
| (5) | 01132.2317 | Longitude (011deg 32.2317min) |
| (6) | E | E East W West |
| (7) | 1 | Fix quality: 0 fix not valid or invalid, 1 GPS SPS mode, fix valid, 2 Differential GPS, SPS mode, fix valid |
| (8) | 04 | Four satellites in use (min 00, max 12) |
| (9) | 2.5 | Horizontal dilution of precision |
| (10) | 607.5 | MSL altitude |
| (11) | M | Unit of antenna altitude: meters |
| (12) | 47.6 | Geoidal separation |
| (13) | M | Unit of geoidal separation: meters |
| (14) | <empty> | Age of differential GPS data, null field when DGPS is not used |
| (15) | <empty> | Differential reference station ID, null field when DGPS is not used |
| (16) | *67 | Checksum |

Table 1: GGA example and description

2.2.2 VTG – Course Over Ground and Ground Speed

| | | |
|--|---------|--|
| e.g. \$GPVTG,169.31,T,,M,0.31,N,0.5,K,A*6B | | |
| (1) | \$GPVTG | Vendor and message identifier |
| (2) | 169.31 | Track degrees |
| (3) | T | True |
| (4) | <empty> | Track degrees |
| (5) | M | Magnetic |
| (6) | 0.31 | Horizontal speed [knots] |
| (7) | N | Knots |
| (8) | 0.5 | Horizontal speed [kilometers per hour] |
| (9) | K | Kilometers per hour |
| (10) | A | A Autonomous mode D Differential mode E Estimated/dead reckoning |
| (11) | *6B | Checksum |

Table 2: VTG example and description

2.2.3 RMC - Recommended Minimum Specific GPS Data

e.g. \$GPRMC,092516.000,A,4805.8021,N,01132.2243,E,1.91,183.81,270302,0.0,W,A*7B

| | | |
|------|--------------------|--|
| (1) | \$GPRMC | Vendor and message identifier |
| (2) | 092516.000 | UTC - Universal Time Coordinated (09h 25m 16.000s) |
| (3) | A | A Fix valid V for invalid or no fix |
| (4) | 4805.8021 | Latitude (48deg 05.8021min) |
| (5) | N | N North S South |
| (6) | 01132.2243 | Longitude (011deg 32.2243min) |
| (7) | E | E East W West |
| (8) | 1.91 | Speed over ground in knots |
| (9) | 183.81 | Course over ground, degrees true |
| (10) | 270302 | Date (ddmmyy – 27 th March 2002) |
| (11) | 0.0 ⁽¹⁾ | Magnetic variation, degrees |
| (12) | W ⁽¹⁾ | W West E East |
| (13) | A | A Autonomous mode D Differential Mode E Estimated/dead reckoning |
| (14) | *7B | Checksum |

(1) SiRF Technology Inc. does not support magnetic declination. All course over ground data are geodetic WGS84 directions

Table 3: RMC example and description

2.2.4 GSA - GPS DOP and Active Satellites

e.g. \$GPGSA,A,3,03,20,14,31,,,,,,,,,3.7,2.5,2.8*3D

| | | |
|------|---------|---|
| (1) | \$GPGSA | Vendor and message identifier |
| (2) | A | A 2D automatic – allowed to automatically switch 2D/3D M Manual – forced to operate in 2D or 3D mode |
| (3) | 3 | 1 Fix not available 2 2D fix (<4 SVs used) 3 3D fix (>3 SVs used) |
| (4) | 03 | ID of satellite used in 1 st channel |
| (5) | 20 | ID of satellite used in 2 nd channel |
| ... | | ... |
| (23) | <empty> | ID of satellite used in 12 th channel |
| (24) | 3.7 | PDOP in meters |
| (25) | 2.5 | HDOP in meters |
| (26) | 2.8 | VDOP in meters |
| (27) | *3D | Checksum |

Table 4: GSA example and description

2.2.5 GSV – GPS Satellites in View

| e.g. \$GPGSV,1,1,04,03,27,159,45,14,43,095,48,20,17,231,40,31,60,190,42*7F | | |
|--|---------|---|
| (1) | \$GPGSV | Vendor and message identifier |
| (2) | 1 | Total numbers of messages |
| (3) | 1 | Number of current message |
| (4) | 04 | Satellites in view |
| (5) | 03 | Satellite number of 1 st satellite |
| (6) | 27 | Elevation in degrees of 1 st satellite |
| (7) | 159 | Azimuth in degrees to true of 1 st satellite |
| (8) | 45 | SNR (signal to noise ratio) in dB of 1 st satellite (00 when not tracking) |
| (9) | 14 | Satellite number of 2 nd satellite |
| (10) | 43 | Elevation in degrees of 2 nd satellite |
| (11) | 095 | Azimuth in degrees to true of 2 nd satellite |
| (12) | 48 | SNR (signal to noise ratio) in dB of 2 nd satellite (00 when not tracking) |
| (13) | 20 | Satellite number of 3 rd satellite |
| (14) | 17 | Elevation in degrees of 3 rd satellite |
| (15) | 231 | Azimuth in degrees to true of 3 rd satellite |
| (16) | 40 | SNR (signal to noise ratio) in dB of 3rd satellite (00 when not tracking) |
| (17) | 31 | Satellite number of 4 th satellite |
| (18) | 60 | Elevation in degrees of 4 th satellite |
| (19) | 190 | Azimuth in degrees to true of 4 th satellite |
| (20) | 42 | SNR (signal to noise ratio) in dB of 4th satellite (00 when not tracking) |
| (21) | *7F | Checksum |

Table 5: GSV example and description

2.2.6 GLL – Latitude, Longitude, UTC and status

| | | |
|---|------------|--|
| e.g. \$GPGLL,3723.2475,N,12158.3416,W,161229.487,A,A*41 | | |
| (1) | \$GPGSV | Vendor and message identifier |
| (2) | 3723.2475 | Latitude (37deg 23.2475min) |
| (3) | N | N North S South |
| (4) | 12158.3416 | Longitude (121deg 58.3416min) |
| (5) | W | W West E East |
| (6) | 161229.487 | UTC - Universal Time Coordinated (16h 12m 29.487s) |
| (7) | A | A Data valid V Data not valid |
| (8) | A | A Autonomous mode D DGPS mode E DR mode |
| (9) | *41 | Checksum |

Table 6: GLL example and description

3 Start-up Message

After reset or power-off the GPS modules will transmit a start-up message first, this message will look like:

```
$PSRFTXT,Version: GSW3.5.0_3.5.00.00-C25P2.01 *03  
$PSRFTXT,TOW: 0*25  
$PSRFTXT,WK: 1517*67  
$PSRFTXT,POS: 6378137 0 0*2A  
$PSRFTXT,CLK: 96250*25  
$PSRFTXT,CHNL: 12*73  
$PSRFTXT,Baud rate: 4800*65
```

This message holds information on the firmware version, GPS time and position (if available) and others. The contents might change in future release so this information should not be used in an application (except for checking the firmware version).

4 Proprietary NMEA Sentences

NMEA input messages enable you to control the receiver while in NMEA protocol mode. By default, the receiver is configured for NMEA mode on port 0. Messages can be sent by using a terminal program, by using Vincotech's GPS Cockpit software, or the SiRFdemo software. If the receiver is in SiRF binary mode, all NMEA input messages are ignored. Once the receiver is put into NMEA mode, the following messages may be used to command the module.

All settings transmitted by NMEA or binary messages are stored in SRAM; as long as either Vcc or Vbak is supplied the settings are maintained.

The GPS module falls back to factory settings in case neither Vcc nor Vbak are supplied properly.

4.1 Transport Message

Device manufacturer define extensions of the standard NMEA protocol or sentences thereof.

- The general format is:
"\$<vendor><MID><parameters><*cksum><CR><LF>".
- | | |
|-------------|---|
| Vendor: | GSC3-based products use "PSRF" |
| MID: | Message identifier consisting of three numeric characters. Input Messages begin at MID 100. |
| Parameters: | Message specific parameters refer to a specific section for <data> ... <data> definition. |
| Cksum: | Two hex character checksum as defined in the NMEA specification. Use of checksum is required on all input messages! |
| <CR><LF> | A "Carriage Return" and "Line Feed" is mandatory to complete the NMEA message. |

Note1: All fields in all proprietary NMEA messages are required, none are optional. All NMEA messages are comma delimited.

Note2: Both, GPS Cockpit and SiRFdemo software support the calculation of a checksum.

4.2 NMEA Input Messages

The following NMEA input messages are supported.

| Message | MID ⁽¹⁾ | Description |
|-------------------------|--------------------|---|
| Set serial port | 100 | Set Port 0 parameters and protocol |
| Reset Configuration | 101 | Initialize various start up behaviors |
| Query/rate control | 103 | Query standard NMEA message and/or set output rate |
| Development data On/Off | 105 | Development Data messages On/Off |
| Select Datum | 106 | Selection of datum to be used for coordinate transforming |

(1) Message Identification (MID)

Table 7: NMEA Input Messages

Note: NMEA input messages 100 to 106 are SiRF proprietary NMEA messages.

4.3 Serial Port Set-up

This command message is used to set the protocol (SiRF binary or NMEA) and/or the communication parameters (baud rate, data bits, stop bits, and 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 the GSC3-based products will restart using the saved parameters.

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

| Name | Example | Description |
|------------|-----------|---|
| Message ID | \$PSRF100 | PSRF100 protocol header |
| Protocol | 0 | 0 SiRF binary / 1 NMEA |
| Baud | 9600 | 4800, 9600, 19200, 38400, 57600, 115200 |
| DataBits | 8 | 8, 7 ⁽¹⁾ |
| StopBits | 1 | 0, 1 |
| Parity | 0 | 0 none / 1 odd / 2 even |
| Checksum | *0C | End of message termination |

(1) SiRF protocol is only valid for 8 data bits, 1 stop bit and no parity

Table 8: Serial Port Set-up

4.4 Reset Configuration (*SiRF's original: NavigationInitialization*)

This command is used to configure various reset situations (Hot Start, Warm Start and Cold Start).

- \$PSRF101,0,0,0,0,0,0,12,4*10

| Name | Example | Units | Description |
|--------------|-----------|---------|---|
| Message ID | \$PSRF101 | | PSRF101 protocol header |
| ECEF X | | meters | X coordinate position |
| ECEF Y | | meters | Y coordinate position |
| ECEF Z | | meters | Z coordinate position |
| ClkOffset | | Hz | Clock Offset of the GSC3-based product ⁽¹⁾ |
| TimeOfWeek | | seconds | GPS Time Of Week |
| WeekNo | | | GPS Week Number |
| ChannelCount | 12 | | Range 1 to 12 |
| ResetCfg | 4 | | Reset configurations: See Table 3-4 and Table 3-5 |
| Checksum | *10 | | End of message termination |

- (1) Use 0 for last saved value if available. If this is unavailable, a default value of 96,000 is used

Table 9: Navigation Initialization

| Hex | Description |
|------|---|
| 0x01 | Hot Start— All data valid |
| 0x02 | Warm Start—Ephemeris cleared |
| 0x04 | Cold Start—Clears all data in memory |
| 0x08 | Clear Memory—Clears all data in memory and resets the receiver back to factory defaults |

Table 10: Reset configurations

4.5 Query/Rate control

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

Table 3-6 contains the input values for the following examples:

1. Query the GGA message with checksum enabled
 - \$PSRF103,00,01,00,01*25
2. Enable VTG message for a 1 Hz constant output with checksum enabled
 - \$PSRF103,05,00,01,01*20
3. Disable VTG message
 - \$PSRF103,05,00,00,01*21

| Name | Example | Units | Description |
|-------------|-----------|---------|---|
| Message ID | \$PSRF103 | | PSRF103 protocol header |
| Msg | 00 | | See Table 3-7 |
| Mode | 01 | | 0=SetRate, 1=Query |
| Rate | 00 | seconds | Output rate 0 off Max 255 |
| CksumEnable | 01 | | 0 Disable Checksum 1 Enable Checksum |
| Checksum | *25 | | End of message termination |

Table 11: Query/Rate Control Data Format (See example 1)

| Value | Description |
|-------|---------------------------------------|
| 0 | GGA |
| 1 | GLL |
| 2 | GSA |
| 3 | GSV |
| 4 | RMC |
| 5 | VTG |
| 6 | MSS (If internal beacon is supported) |
| 7 | Not defined |
| 8 | ZDA (if 1PPS output is supported) |
| 9 | Not defined |

Table 12: NMEA Messages

Note: Please consider max transfer rate (depending on baud rate setting) before activating additional NMEA sentences.

Note: In TricklePower mode, update rate is specified by the user. When switching to NMEA protocol, the message update rate is also required. The resulting update rate is the product of the TricklePower update rate and the NMEA update rate (i.e., TricklePower update rate = 2 seconds, NMEA update rate = 5 seconds, resulting update rate is every 10 seconds, $(2 \times 5 = 10)$).

4.6 Development Data On/Off

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

Table 3-10 contains the input values for the following examples:

1. Debug On

- \$PSRF105,1*3E

2. Debug Off

- \$PSRF105,0*3F

| Name | Example | Description |
|------------|-----------|----------------------------|
| Message ID | \$PSRF105 | PSRF105 protocol header |
| Debug | 1 | 0 Off 1 On |
| Checksum | *3E | End of message termination |

Table 13: Development Data On/Off Data Format

4.7 Select Datum

All GSC3-based GPS modules perform initial position and velocity calculations using an earth-centered earth-fixed (ECEF) coordinate system. Results may be converted to an earth model (geoid) defined by the selected datum. The default datum is WGS84 (World Geodetic System 1984) which provides a worldwide common grid system that may be translated into local coordinate systems or map datums. Local map datums are a best fit to the local shape of the earth and not valid worldwide.

The table below contains the input values for the following examples:

1. Datum select TOKYO_MEAN

- \$PSRF106,178*32

| Name | Example | Description |
|------------|-----------|---|
| Message ID | \$PSRF106 | PSRF106 protocol header |
| Datum | 178 | 21=WGS84 178=TOKYO_MEAN 179=TOKYO_JAPAN 180=TOKYO_KOREA 181=TOKYO_OKINAWA |
| Checksum | *32 | End of message termination |

Table 14: Select Datum Data Format

4.8 Shut-Down Module

All GSC3-based GPS modules will enter hibernate mode after this command has been issued. Data in SRAM are being maintained, the RTC will keep on running.

- \$PSRF117,16*0B

| Name | Example | Description |
|------------|-----------|----------------------------|
| Message ID | \$PSRF117 | PSRF117 protocol header |
| Shutdown | 16 | Shutdown command |
| Checksum | *0B | End of message termination |

Table 15: Shut-down command

To wake up the GPS module again one of the following methods can be used:

- Toggle ON-OFF
- Toggle nReset

5 Related Information

5.1 Contact

This manual was created with due diligence. We hope that it will be helpful to the user to get the most out of the GPS modules.

Inputs regarding errors or mistaken verbalizations and comments or proposals to Vincotech, Germany, for further improvements are highly appreciated.

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5.2 Related Documents

- SiRF_NMEA_Reference_Manual_2.2 (SiRF)
- SiRF_Binary_Reference_Manual_2.4 (SiRF)

- GPS Receiver A1080 (Vincotech)
- GPS Evaluation Kit EVA1080 (Vincotech)
- GPS Receiver A1084 (Vincotech)
- GPS Evaluation Kit EVA1084 (Vincotech)
- GPS Receiver A1088 (Vincotech)
- GPS Evaluation Kit EVA1088 (Vincotech)
- GPS Receiver A1035-D (Vincotech)
- GPS Evaluation Kit EVA1035-D (Vincotech)
- GPS Receiver A1035-H (Vincotech)
- GPS Evaluation Kit EVA1035-H (Vincotech)

5.3 Related Tools

- GPS Cockpit (Vincotech)
- SiRF Demo (SiRF)
- SiRF Flash (SiRF)

6 List of Tables

| | |
|--|----|
| Table 1: GGA example and description | 7 |
| Table 2: VTG example and description | 8 |
| Table 3: RMC example and description | 9 |
| Table 4: GSA example and description..... | 10 |
| Table 5: GSV example and description..... | 11 |
| Table 6: GLL example and description..... | 12 |
| Table 7: NMEA Input Messages | 15 |
| Table 8: Serial Port Set-up..... | 15 |
| Table 9: Navigation Initialization | 16 |
| Table 10: Reset configurations | 16 |
| Table 11: Query/Rate Control Data Format (See example 1) | 17 |
| Table 12: NMEA Messages | 17 |
| Table 13: Development Data On/Off Data Format..... | 19 |
| Table 14: Select Datum Data Format..... | 20 |
| Table 15: Shut-down command | 21 |