Data Sheet / GR-301

SiRFstarIII

Easy to Use Ultra-High Performance

GPS Smart Antenna

RoHS
Compliant

Version 1.0

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Revision History

Ver.	Date	Description
1.0	Sep. 10th, 2007	Initial release

Contents

1 Introduction

1.1 Overview

As shown in the above pictures, NaviSys GR-301 is a low-power, ultra-high performance, easy to use GPS receiver based on SiRF's latest third generation single chip.

Its low power consumption and high performance enables the adoption of AVL and other location based applications. It supports different electrical interfaces such as USB, RS232, TTL etc. The connector interface and cable length could also be customized based on MOQ.

The standard NMEA0183 outputs data using datum of WGS-84.

1.2 Main Features

Our experienced design exhibits the full performance of SiRFstarIII chip.

- Full implementation of ultra-high performance **SiRFstarIII** single chip architecture
- High tracking sensitivity of **-159dBm**
- Low power consumption of **45mA** at full tracking (for USB interface)
- Small size of **36 (W) x 42 (L) x 15 (H)** (mm) with patch antenna of 25x25x4mm.
- **Built-in backup battery** for hot/warm starts and better performance
- **Firmware upgradeable** for future potential performance enhancements
- **Flexible connector interface and cable length**
- Industrial grade operating temperature (-40 ~ 85℃ except backup battery: -20~60℃)
- IPX6 waterproof
- Built-in magnet

1.3 Receiver Specifications

Features	Specifications
GPS receiver type	20 channels, L1 frequency, C/A code
Horizontal Position Accuracy	< 2.5m (Autonomous) < 2.0m (WAAS) (50% 24hr static, -130dBm)
Velocity Accuracy	<0.01 m/s (speed) <0.01° (heading) (50%@30m/s)
Time accuracy	1µs or less
TTFF (Time to First Fix) (50%, -130dBm, autonomous)	Hot Start: 1s Warm Start: 35s Cold Start: 42s
Sensitivity (Autonomous)	Tracking: –159dBm Acquisition: -142dBm (-142dBm 28dB-Hz with 4dB noise figure)
Measurement data output	Update time: 1 second NMEA output protocol: V.3.00 Baud rate: 4800 (default), 9600, 19200, 38400, 57600 bps (8-N-1) Datum: WGS-84 Default: GGA, GSA, RMC, VTG at 1Hz and GSV at 1/5Hz Other options: GLL, ZDA, or SiRF binary
Max. Altitude	<18,000m
Max. Velocity	<1,852 km/hr
SBAS Support	WAAS, EGNOS
Dynamics	<4g
Power consumption	45mA, continuous tracking mode (USB)
Power supply	3.3 ~ 5.5VDC
Dimension	single side 36(W) x 42(L) x 15(H) mm
Operating temperature	-40℃ ~ +85℃
Storage temperature	-40℃ ~ +125℃

1.4 Protocols

Both NMEA and SiRF binary protocols could be supported via serial UART I/O port – RXA/TXA. The default supported protocol is NMEA protocol.

1. Serial communication channel
   i. No parity, 8-data bit, 1-stop bit (N-8-1)
   ii. User selectable baud rate among 4800, 9600, 19200, 38400, and 57600

(default 4800) bps.

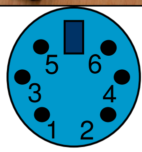
2. NMEA 0183 Version 3.00 ASCII output
    i. Default GGA (1 sec), GSA (1 sec), GSV (5 sec), RMC (1 sec), VTG (1 sec)
    ii. Optional GLL, ZDA

1.5 Antenna

GR-301 has a built-in patch antenna of dimension 25x25x4 (mm). Facing to sky appropriately allows it to receive GPS signals and output location data even in urban canyon environment.

2 Hardware Interface

2.1 I/O Connectors and Pin Assignment

	GR-301R	GR-301U
		
		
Pin	Mini-Din 6-pin PS/2 Male Plug	USB A type Male Plug
1	GND	VDD 5V
2	VCC	D-
3	TXD-TTL	D+
4	RX-RS232	GND
5	TX-RS232	
6	RXD-TTL	

2.2 Cable Length, Dimension and LED

The cable length for different models and the dimension are shown below.

Cable Length	1.5m for GR-301U 3m for GR-301R
Dimension	36 x 42 x 15 (mm)

An embedded LED is used to indicate the GPS position fixing status as following:

LED always ON: Position is not fixed, under fixing

LED Blinking: Position is fixed

3 Software Interface – NMEA Output

3.1 NMEA Output Messages

The NMEA-0183 Output Messages are shown as below:

NMEA Record	Descriptions
GPGGA	Global positioning system fixed data: time, position, fixed type
GPGLL	Geographic position: latitude, longitude, UTC time of position fix and status
GPGSA	GPS receiver operating mode, active satellites, and DOP values
GPGSV	GNSS satellites in view: ID number, elevation, azimuth, and SNR values
GPRMC	Recommended minimum specific GNSS data: time, date, position, course, speed
GPVTG	Course over ground and ground speed
GPZDA	PPS timing message (synchronized to PPS)

The GR-301 adopts interface protocol of National Marine Electronics Association's NMEA-0183 Version 3.00 interface specification. GR-301 supports 7 types of NMEA sentences (GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, and GPZDA).

The default output sentences are GPGGA, GPGSA, GPGSV, GPRMC, and GPVTG. The UART communication parameters are 4800 bps, 8 data bits, 1 stop bit, and no parity. Other output sentences, baud rate, and related configurations could be requested based on MOQ.

Single message example
$GPGGA,101229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*3E
$GPGLL,2446.8619,N,12100.2579,E,060725.000,A,A*7E
$GPGSA,A,3,05,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5*11
$GPGSV,3,1,12,07,62,081,37,16,61,333,37,01,60,166,37,25,56,053,36*74
$GPGSV,3,2,12,03,43,123,33,23,32,316,34,14,17,152,30,20,16,263,33*78
$GPGSV,3,3,12,19,17,210,29,06,08,040,,15,06,117,27,21,05,092,27*7E
$ GPRMC,151229.487,A,3723.2475,N,12148.3416,W,0.13,309.62,120598,,,A*5F
$GPVTG,,T,,M,0.00,N,0.0,K,A*13
$GPZDA,060526.000,20,06,2006,,*51

3.2 GPGGA - Global Positioning System Fix Data

- Example

$GPGGA,101229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*3E

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGGA		GGA protocol header
UTC Time	101229.487		hhmmss.sss hh: hour, mm: minute, ss: second
Latitude	3723.2475		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12158.3416		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	W		E: East Longitude, W: West Longitude
Position Fix Indicator	1		0: Fix not available or invalid, 1: GPS SPS Mode, fix valid, 2: Differential GPS, SPS Mode, fix valid, 3~5: Not supported, 6: Dead Reckoning Mode, fix valid
Satellites Used	07		Number of satellites used in positioning calculation (0 to 12)
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Unit	M		Meters
Geoidal separation		meters	
Units	M		Meters
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
checksum	*3E		
<CR><LF>			End of sentence

3.3 GPGLL - Geographic Position - Latitude / Longitude

- Example

$ GPGLL,2446.8619,N,12100.2579,E,060725.000,A,A*7E

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGLL		GLL protocol header
Latitude	2446.8619		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12100.2579		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	E		E: East Longitude, W: West Longitude
UTC Time	060725.000		hhmmss.sss hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Mode Indicator	A		A: Autonomous, D: DGPS, E: DR
checksum	*7E		
<CR><LF>			End of sentence

3.4 GPGSA - GNSS DOP and Active Satellites

- Example

  $GPGSA,A,3,05,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5*11

- Explanation

Contents	Example	Explanation
Message ID	$GPGSA	GSA protocol header
Mode 1	A	M: Manual—forced to operate in 2D or 3D mode A: 2D Automatic—allowed to automatically switch 2D/3D
Mode 2	3	1: Fix not available 2: 2D (< 4 Satellites used) 3: 3D (> 3 Satellite s used)
Satellite used in solution	05	Satellite on Channel 1
Satellite used in solution	02	Satellite on Channel 2
…		Display of quantity used (12 max)
PDOP	1.8	Position Dilution of Precision
HDOP	1.0	Horizontal Dilution of Precision
VDOP	1.5	Vertical Dilution of Precision
checksum	*11	
<CR><LF>		End of sentence

3.5 GPGSV - GNSS Satellites in View

- 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

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPGSV		GSV protocol header
Number of messages	2		Range 1 to 3
Message number	1		Range 1 to 3
Satellites in view	07		Number of satellites visible from receiver
Satellite ID number	07		Channel 1 (Range 1 to 32)
Elevation	79	degrees	Elevation angle of satellite as seen from receiver channel 1 (00 to 90)
Azimuth	048	degrees	Satellite azimuth as seen from receiver channel 1 (000 to 359)
SNR (C/No)	42	dBHz	Received signal level C/No from receiver channel 1 (00 to 99, null when not tracking)
…			
Satellite ID number	27		Channel 4 (Range 1 to 32)
Elevation	27	degrees	Elevation angle of satellite as seen from receiver channel 4 (00 to 90)
Azimuth	138	degrees	Satellite azimuth as seen from receiver channel 4 (000 to 359)
SNR (C/No)	42	dBHz	Received signal level C/No from receiver channel 4 (00 to 99, null when not tracking)
checksum	*71		
<CR><LF>			End of sentence

3.6 GPRMC - Recommended Minimum Specific GNSS Data

- Example

$GPRMC,151229.487,A,3723.2475,N,12148.3416,W,0.13,309.62,120598,,,A*5F

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPRMC		RMC protocol header
UTC Time	151229.487		hhmmss.sss hh: hour, mm: minute, ss: second
Status	A		A: Data valid, V: Data invalid
Latitude	3723.2475		ddmm.mmmm dd: degree, mm.mmmm: minute
North/South	N		N: North Latitude, S: South Latitude
Longitude	12148.3416		dddmm.mmmm dd: degree, mm.mmmm: minute
East/West	W		E: East Longitude, W: West Longitude
Speed over ground	0.13	knots	Receiver's speed
Course over ground	309.62	degrees	Receiver's direction of travel Moving clockwise starting at due north
Date	120598		ddmmyy dd: Day, mm: Month, yy: Year
Magnetic variation		degrees	This receiver does not support magnetic declination. All "course over ground" data are geodetic WGS84 directions.
Mode Indicator	A		A: Autonomous M: Manual D: DGPS S: Simulation E: Dead Reckoning N: Data Invalid
checksum	*5F		
<CR><LF>			End of sentence

3.7 GPVTG - Course Over Ground and Ground Speed

- Example

$GPVTG,309.62,T,,M,0.18,N,0.5,K,A*0F

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPVTG		VTG protocol header
Course over ground	309.62	degrees	Receiver's direction of travel Moving clockwise starting at due north (geodetic WGS84 directions)
Reference	T		True
Course over ground		degrees	Receiver's direction of travel
Reference	M		Magnetic
Speed over ground	0.18	knots	Measured horizontal speed
Unit	N		Knots
Speed over ground	0.5	km/hr	Measured horizontal speed
Unit	K		km/hr
Mode Indicator	A		A: Autonomous, D: DGPS, E: DR
checksum	*0F		
<CR><LF>			End of sentence

3.8 GPZDA - SiRF Timing Message

- Example

  $GPZDA,181813,14,10,2006,00,00*4A

- Explanation

Contents	Example	Unit	Explanation
Message ID	$GPZDA		ZDA protocol header
UTC time	181813		Either using valid IONO/UTC or estimated from default leap seconds
Day	14		Day according to UTC time (01 to 31)
Month	10		Month according to UTC time (01 to 12)
Year	2006		Year according to UTC time (1980 to 2079)
Local zone hour	00	hour	Offset from UTC (set to 00)
Local zone minutes	00	minute	Offset from UTC (set to 00)
checksum	*4F		
<CR><LF>			End of sentence

4 Software Interface – NMEA Input

4.1 NMEA Input Messages

In addition to the NMEA output messages, NMEA input messages allow users to control SiRFstarIII-based product while in NMEA protocol mode. If the receiver is in SiRF binary mode, all NMEA input messages are ignored and it can be switched to NMEA mode by using the SiRFDemo software and selecting Switch to NMEA Protocol from the Action menu. Once the receiver is put into NMEA mode, the following messages could be used to command the SiRFstarIII-based product.

4.2 Transport Message

There are four parts in a NMEA input message:

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

1. Message Identifier consisting of reserved word "$PSRF" and three numeric characters. Input messages begin from MID 100.
2. Message-specific data. Refer to a specific message section for <data>...<data> definition described in following sections.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification, NMEA-0183 Standard for Interfacing Marine Electronic Devices. Use of checksums is required on all input messages.
4. Each message is terminated using Carriage Return (CR) and Line Feed (LF) which is \r\n or hexadecimal 0D 0A. Because \r and \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.

Please note that all fields in all proprietary NMEA messages are required, none are optional. All NMEA, messages are comma delimited.

4.3 NMEA Input Messages Summary

Please note that following input messages are SiRF proprietary NMEA messages.

Message	MID	Description
SetSerialPort	100	Set PORT A parameters and protocol
NavigationInitialization	101	Parameters required for start using X/Y/Z. Input coordinates must be WGS84.
SetDGPSPort	102	Set PORT B parameters for DGPS input (Not applicable)
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLANavigationInitialization	104	Parameters required for start using Lat/Lon/Alt. Input coordinates must be WGS84.
Development Data On/Off	105	Development Data messages On/Off
Select Datum	106	Selection of datum to be used for coordinate transformations.
NaviSys Proprietary	109	Trickle power on/off etc

4.4 100—SetSerialPort

This command message is used to set the protocol (SiRF binary or NMEA) and/or the communication parameters (Baud, 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 for future use.

- Example> Switch to SiRF binary protocol at 9600,8,N,1

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

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF binary, 1=NMEA
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		7, 8
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*0C		
<CR> <LF>			End of message termination

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

4.5 101-NavigationInitialization

This command is used to initialize the GPS device by providing current position (in X, Y, Z coordinates), clock offset, and time. This enables the GPS device to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable GPS device to acquire signals quickly.

- Example> Start using known position and time.

$PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*1C

Name	Example	Units	Description
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	meters	X coordinate position
ECEF Y	-4304200	meters	Y coordinate position
ECEF Z	3851624	meters	Z coordinate position
ClkOffset	96000	Hz	Clock offset of the evaluation receiver. Use 0 for last saved value if available. If this is unavailable, a default value of 96,000 is used.
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See following table
Checksum	*1C		
<CR> <LF>			End of message termination

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

Reset Configuration

Hex	Description
0x00	Perform a hot start using internal RAM data. No initialization data is used.
0x01	Use initialization data and begin in start mode. Uncertainties are 5 seconds time accuracy and 300km position accuracy. Ephemeris data in SRAM is used.
0x02	No initialization data is used, ephemeris data is cleared, and warm start performed using remaining data in RAM.
0x03	Initialization data is used, ephemeris data is cleared, and warm start performed using remaining data in RAM.
0x04	No initialization data is used. Position, time and ephemeris are cleared and a cold start is performed.
0x08	No initialization data is used. Internal RAM is cleared and a factory reset is performed.

4.6 102—SetDGPSPort

This command is used to control the serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. If a DGPS receiver is used that has different communication parameters, use this command to allow the receiver to correctly decode the data. When a valid message is received, the parameters are stored in battery-backed SRAM and the receiver restarts using the saved parameters.

- Example> Set DGPS Port to be 9600,8,N,1.

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

Name	Example	Units	Description
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		8,7

StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*12		
<CR> <LF>			End of message termination

4.7 103—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.

- Example>
  - 1. Query the GGA message with checksum enabled
    - $PSRF103,00,01,00,01*25
  - 2. Enable VTG message for a 1Hz 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		0: GGA, 1: GLL, 2: GSA, 3:GSV, 4:RMC, 5: VTG, 6:MSS, 7:reserved, 8: ZDA, 9: reserved.
Mode	01		0=SetRate, 1=Query
Rate	00	Seconds	Output-off = 0, max=255
CksumEnable	01		0=Disable checksum, 1=Enable checksum
Checksum	*25		
<CR> <LF>			End of message termination

4.8 104—LLANavigationInitialization

This command is used to initialize GPS DEVICE 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.

- Example> Start using known position and time.
- $PSRF104,37.3875111,-121.97232,0,96000,237759,1946,12,1*07

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	degrees	Latitude position (Range 90 to -90)
Lon	-121.97232	degrees	Longitude position (Range 180 to -180)
Alt	0	meters	Altitude position
ClkOffset	96000	Hz	Clock offset of the evaluation receiver. Use 0 for last saved value if available. If this is unavailable, a default value of

			96,000 is used.
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	1946		Extended GPS Week Number (1024 added)
ChannelCount	12		Range 1 to 12
ResetCfg	1		See following table
Checksum	*07		
<CR> <LF>			End of message termination

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

Reset Configuration

Hex	Description
0x01	Hot Start – All data valid.
0x02	Warm Start – Ephemeris cleared
0x03	Warm Start (with Init) – Ephemeris cleared, initialization data loaded
0x04	Cold Start – Clears all data in memory
0x08	Clear Memory – Clears all data in memory and resets receiver back to factory defaults.

4.9 105—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.

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

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

4.10 106—Select Datum

GPS receivers 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 WGS 84 (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.)

- Example> Datum select TOKYO_MEAN
  $PSRF106,178*32

Name	Example	Units	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		
<CR> <LF>			End of message termination

5 Electrical and Environmental Data

Electrical Data

Power Supply	3.3 ~ 5.5VDC (GR-301R) 5VDC (GR-301U)
Power Consumption (w/o antenna)	42mA/average tracking (GR-301R) 45mA/average tracking (GR-301U)

Environmental Data

Operating temperature	-40 ~ 85℃ Except battery -20 ~ 60℃
Waterproof	IPX6