Data Sheet / GE-315

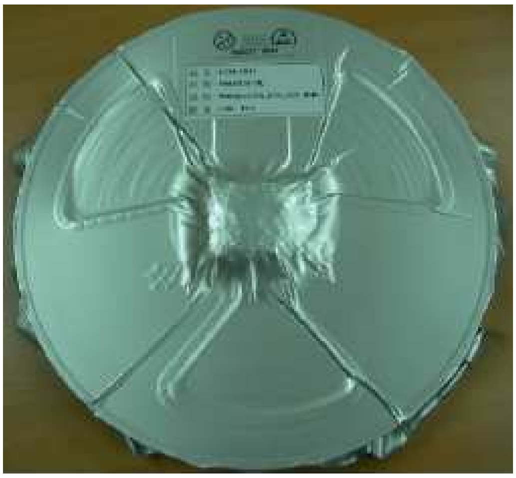
SiRFstarIII

Ultra-Small

Easy to Use Ultra-High Performance

GPS Engine Board

RoHS
Compliant



Version 1.2

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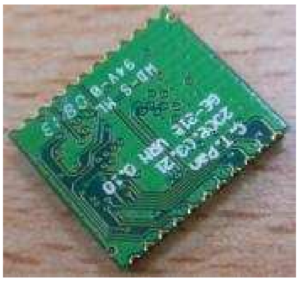
Revision History

Ver.	Date	Description
1.0	May. 2nd, 2008	Initial release
1.1	Jun. 16th, 2008	Add block diagram, tape & reel, input message
1.2	Apr. 27th, 2009	Add timing diagram, ON_OFF pin

Contents

1 Introduction

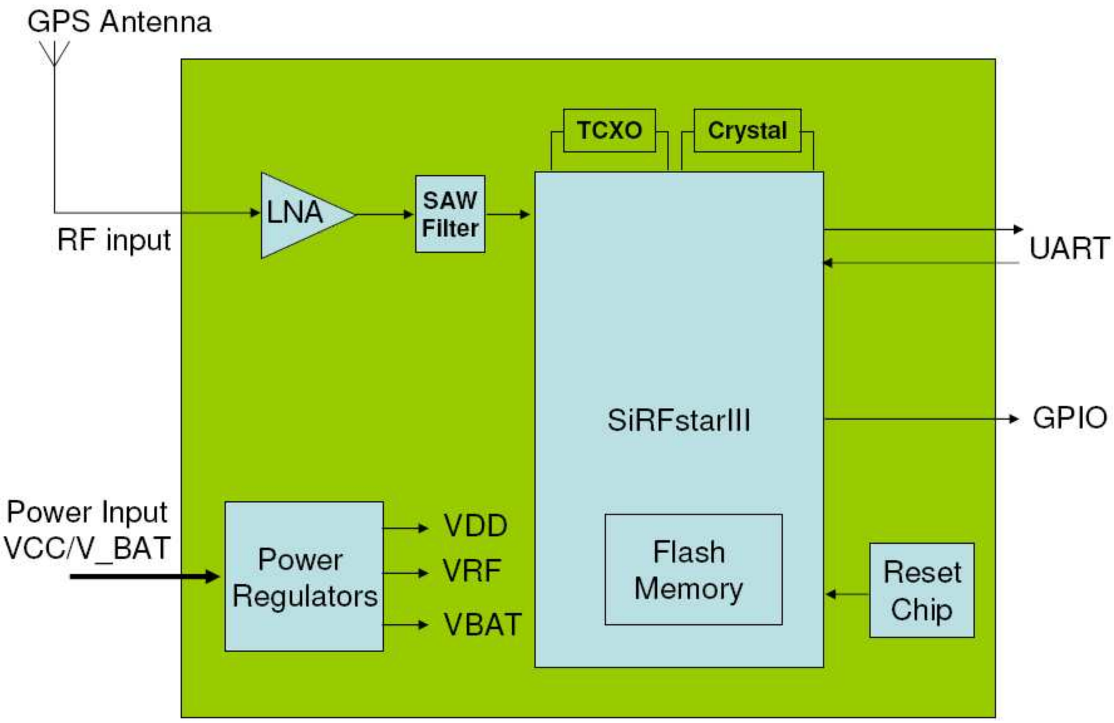
1.1 Overview



GE-315 is built-in with LNA, SAW filter, TCXO, regulators. It is an easy to use, ultra-high performance, low power GPS engine board. The built-in SiRFstarIII chip and our experienced design provide fast acquisitions and excellent tracking performance.

As shown in the above pictures, NaviSys GE-315 is a tiny and SMT mountable GPS receiver module. Its small size/low power consumption/high performance enables the adoption of small handheld applications such as personal navigation device, smart phone, feature phone, PDA, MID, GPS watch, personal locator etc. Its SMT design allows automatic pick and place assembly process.

1.2 Block Diagram



1.3 Main Features

Not only handheld but also any other GPS applications can share the following major features of GE-315.

- Full implementation of ultra-high performance **SiRFstarIII** single chip architecture
- High tracking sensitivity of **-159dBm**
- Low power consumption of **26mA** at full tracking
- Ultra-small size of **13 (W) x 15 (L) x 2.1 (H)** (mm)
- **Active and passive antenna support** via pin RF_IN
- **Backup power supply** pin for hot/warm starts and better performance
- **Optional SBAS (WAAS, EGNOS) support**
- Embedded **ARM7 CPU** is available for external applications
- **SMT** automatic pick and place assembly support to reduce production cost
- **Firmware upgradeable** for future potential performance enhancements
- Fully shielded for **EMC protection**
- **Industrial grade operating temperature:** -40 ~ 85℃

1.4 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, 9600, 19200, 38400 bps (8-N-1) Datum: WGS-84 Default: GGA, GSA, GSV, RMC, VTG Other options: GLL, ZDA, or SiRF binary
Max. Altitude	<18,000 m

Max. Velocity	<1,852 km/hr
SBAS Support	WAAS, EGNOS
Dynamics	<4g
Power consumption	26mA, continuous tracking mode
Power supply	3 ~ 6 VDC
Dimension	single side 13.0(W) x 15.0(L) x 2.1(H) mm
Operating temperature	-40℃ ~ +85℃
Storage temperature	-40℃ ~ +125℃

1.5 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 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

1.6 Programming Resources

The GPS receiver is embedded with an internal ARM7 SOC. Its programming resources are available through the use of SDK from SiRF. Following are its related programming resources:

- 50-MHz ARM7TDMI processor
- 1 Mb SRAM
- 4 Mb flash memory

Please note that the receiver itself will use part of above resources.

1.7 Antenna

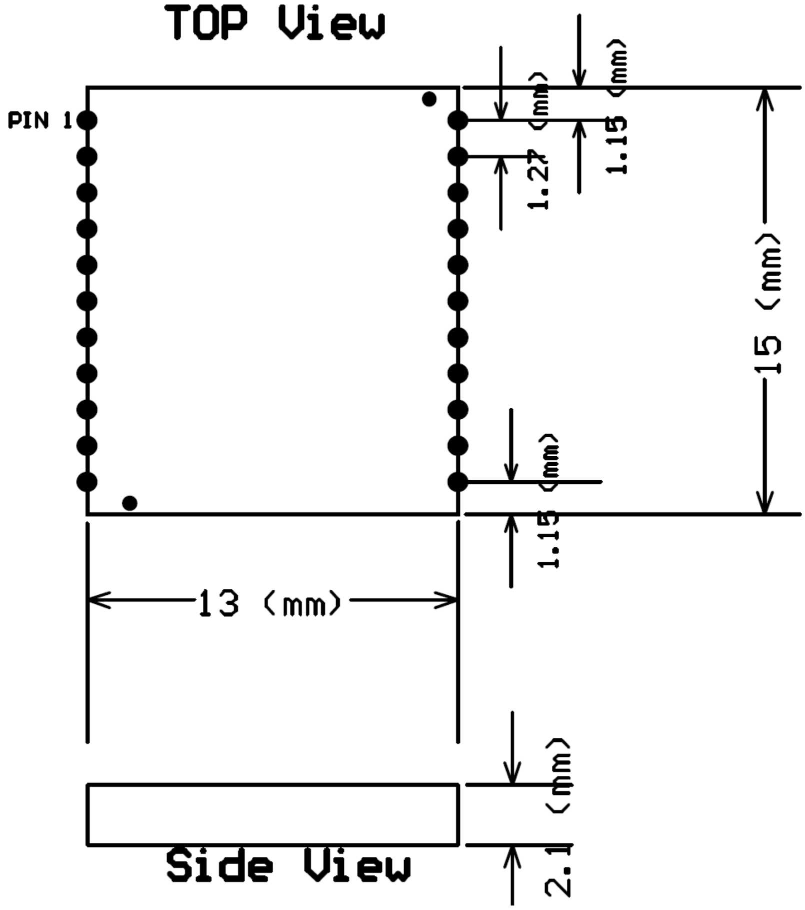
Antenna Signal	Passive or active antenna via pin RF_IN
Active Antenna Supply	If active antenna is selected, choose an appropriate power source for the active antenna. The power source should be clear. Power noise will degrade its performance.

	Pin VCC_RF (2.85V) could also be used to power an active antenna.

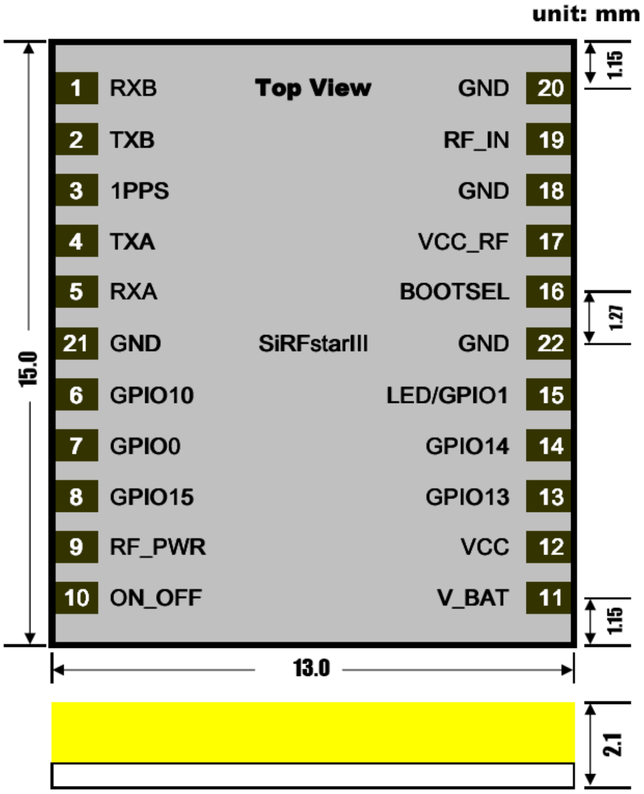
2 Hardware Interface

2.1 PCB Dimension

The dimension of GE-315 is 13 mm (W) x 15 mm (L) x 2.1 mm (H).



2.2 Pin Assignment



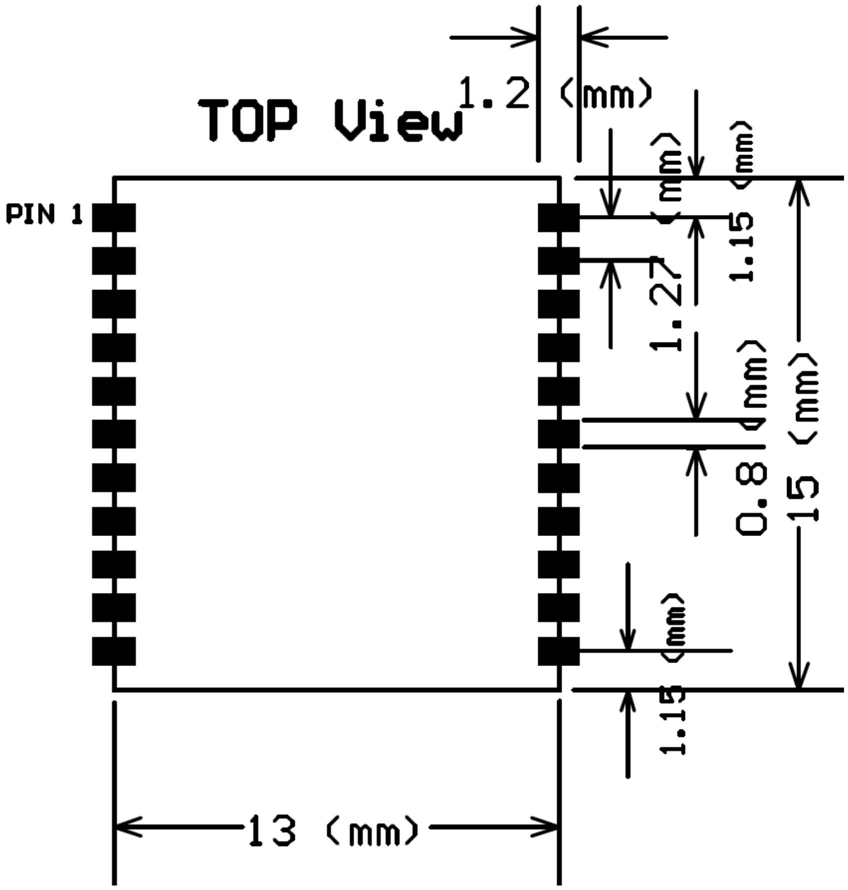
22-pin Interface

Pin	Name	Function	I/O
1	RXB	Port B serial data input (to GPS)	Input
2	TXB	Port B serial data output (from GPS)	Output
3	1PPS	1 Pulse Per Second signal	Output
4	TXA	Port A serial data output (from GPS)	Output
5	RXA	Port A serial data input (to GPS)	Input
6	GPIO10	General Purpose I/O control pin 10	I/O
7	GPIO0	General Purpose I/O control pin 0	I/O
8	GPIO15	General Purpose I/O control pin 15	I/O
9	RF_PWR	RF part power status indication for power saving control: "Low": off; "High": on. Normally, leave it open if it is not used.	Output
10	ON_OFF	Edge triggered pulse to shut down or wake up GPS. Open drain, recommend 10 kΩ pull-up. Limit the voltage on the pull-up to < 2.85 V.	Input
11	V_BAT	1.3 ~ 6V backup battery connection	Input
12	VCC	3 ~ 6V power supply	Input
13	GPIO13	General Purpose I/O control pin 13	I/O
14	GPIO14	General Purpose I/O control pin 14	I/O

15	LED/ GPIO1	LED display for position fixing or General Purpose I/O control pin 1	Output or I/O
16	BOOTSEL	"No Connect" for normal run; "High": for firmware upgrade	Input
17	VCC_RF	2.85V antenna power option. Leave it open if this pin is not used.	Output
18	GND	Ground	Input
19	RF_IN	GPS signal from antenna	Input
20	GND	Ground	Input
21	GND	Ground	Input
22	GND	Ground	Input

2.3 Layout Suggestion

Following is the pad layout recommendation data (top view):



Pad size (mm)

1.2 x 0.8

2.4 Power Saving

GE-315 supports various kinds of power saving mechanisms – Trickle Power, Adaptive Trickle Power, and Push To Fix. They are implemented by customized software. In other words, the standard firmware does not activate these features.

In addition, it also supports hardware power saving by sending a pulse to pin 21 (ON_OFF).

2.4.1 Power Saving of Adaptive Trickle Power

The Adaptive Trickle Power (ATP) saving is based on trickle power (TP) saving mechanism. TP is achieved by switching off and on CPU and RF at a fixed time interval. The biggest time interval to report a position is 10 seconds. The on and off ratio is configurable. TP provides a fixed power savings and provides a constant output rate, but may suffer lost fixes in a weak-signal environment. ATP operates similar to TP. However, when signal levels drop, ATP returns to full power so that message output rates remain constant even in difficult environments. This results in variable power savings but much more reliable performance for a fixed output rate. Applications using ATP should give performance very similar to full power, but with significant power savings in strong-signal conditions. This feature is done by firmware automatically if this feature is enabled. The standard firmware does not turn on this feature. It could be customized by request of MOQ.

2.4.2 Power Saving of Push To Fix

The Push To Fix (PTF) power saving mechanism generally keeps the receiver in a low-power mode, but wakes up either on demand or periodically (10 seconds to 2 hours, configurable) to refresh position, time, ephemeris data, RTC calibration and output position fixing data.

When the PTF mode is enabled, upon power on or a new PTF cycle, the receiver will stay on full power until the good navigation solution is computed. The low-power mode will follow for the remainder of the period. For example, for a PTF time interval of 30 minutes, if it took 36 seconds to fix position and refresh ephemeris, the receiver will sleep for the remaining 29 minutes and 24 seconds. When a position report is requested, application program can toggle the ON_OFF pin to wake up the receiver. When the receiver wakes up, a valid position can be computed in the normal hot-start time.

This mechanism is especially useful for applications that need position data only on demand. This feature is done by firmware automatically if this feature is enabled. The standard firmware does not turn on this feature. It could be customized based on request of MOQ.

2.4.3 Power Saving via Pin ON_OFF

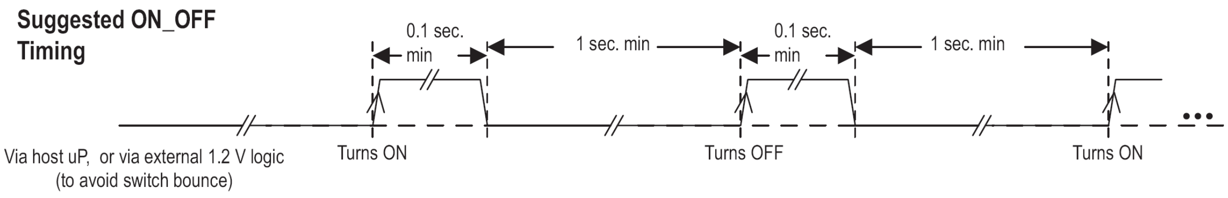
Sending pulses to this pin allows hibernating or wakeup GPS. In hibernating state, CPU and RF are all powered OFF. Only the RTC and core power is ON which consumes less than 20uA.

- If it is in ON state, it hibernates.
- If it is in hibernating state, it will enter normal full power running.

Please do not use this feature together with trickle power. Otherwise, the result is indeterminate.

Since it is a direct link to the Finite State Machine, this pin is limited to 1.5V. A 0 V to 1.5 V CMOS signal is preferred, rising edge triggered, and must stay high for 2 full clock cycles of the RTC clock, or > 70 us. This is not a fail safe pin.

Minimum ON pulse duration is two RTC ticks, about 63 μs. Minimum inter-pulse interval is one second. Minimum OFF duration is two RTC ticks, about 63 μs. Following figure gives a broad guideline for pulse waveforms that is achievable in most applications.



A critical item is to avoid contact bounce if mechanical switches are used.

2.4.4 Power Saving by Controlling VCC Power Supply

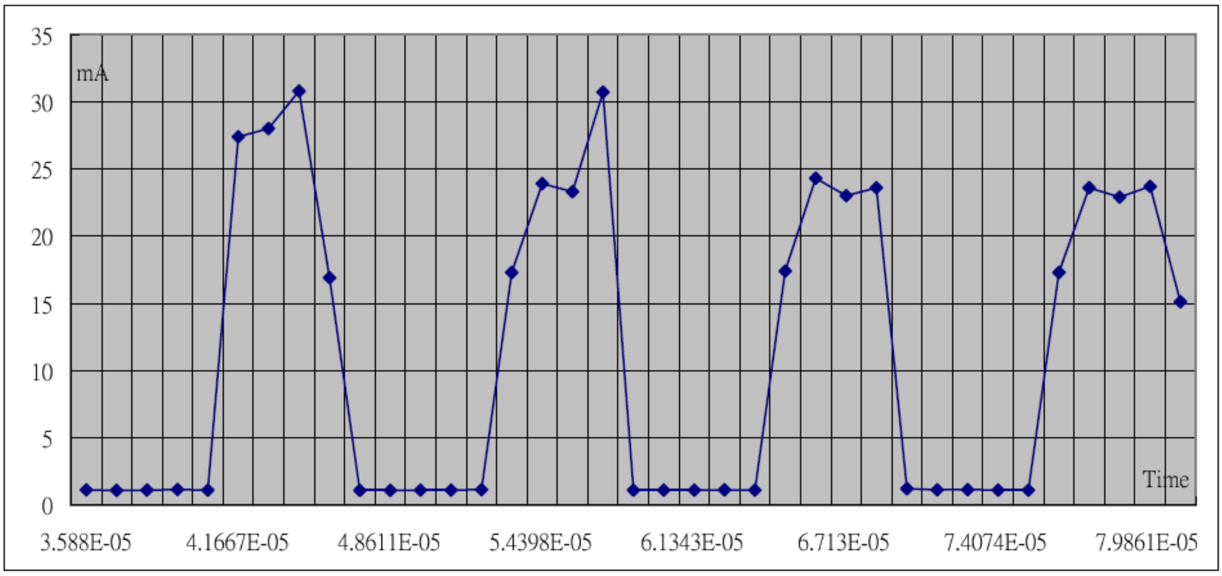
Another easy way to save the GPS power is to control the VCC power supply. Many handheld platforms allow controlling power supply by application program. When the power supply to GPS is cut, there is no power consumption.

Please note the power supply to V_BAT should always be connected. Otherwise, the position fixing data will get lost and thus it will suffer longer position fix time when the power supply is connected again.

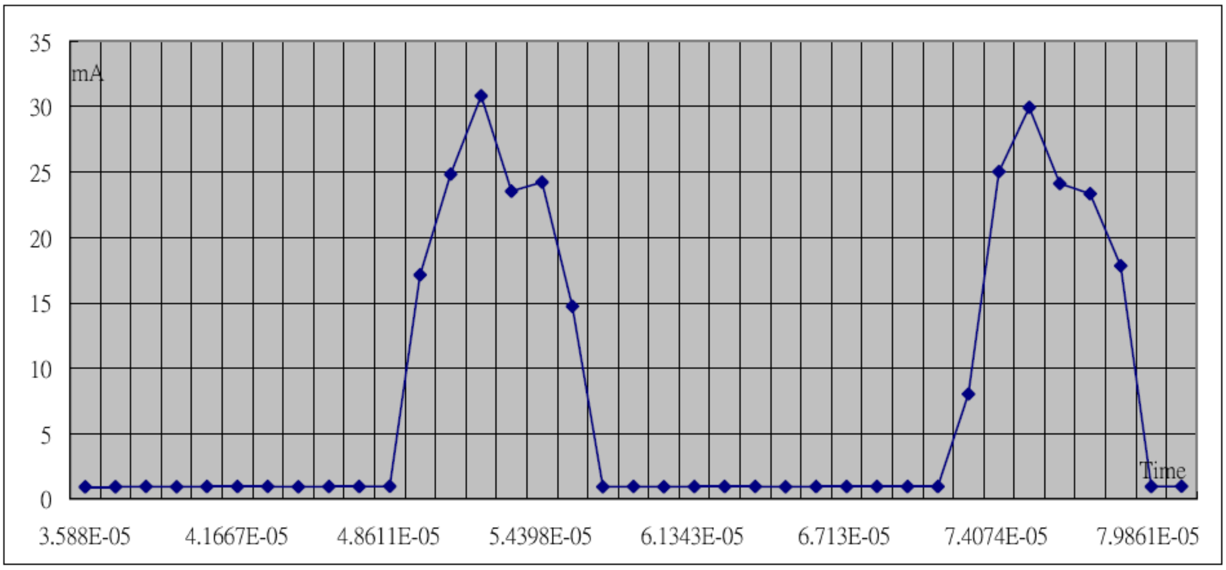
2.4.5 Power Saving Measurement

Navisys designs and verifies the power saving mechanism carefully to make sure that our customers could enjoy the most advanced technology appropriately. Following figures are the measurements for adaptive trickle power and push to fix.

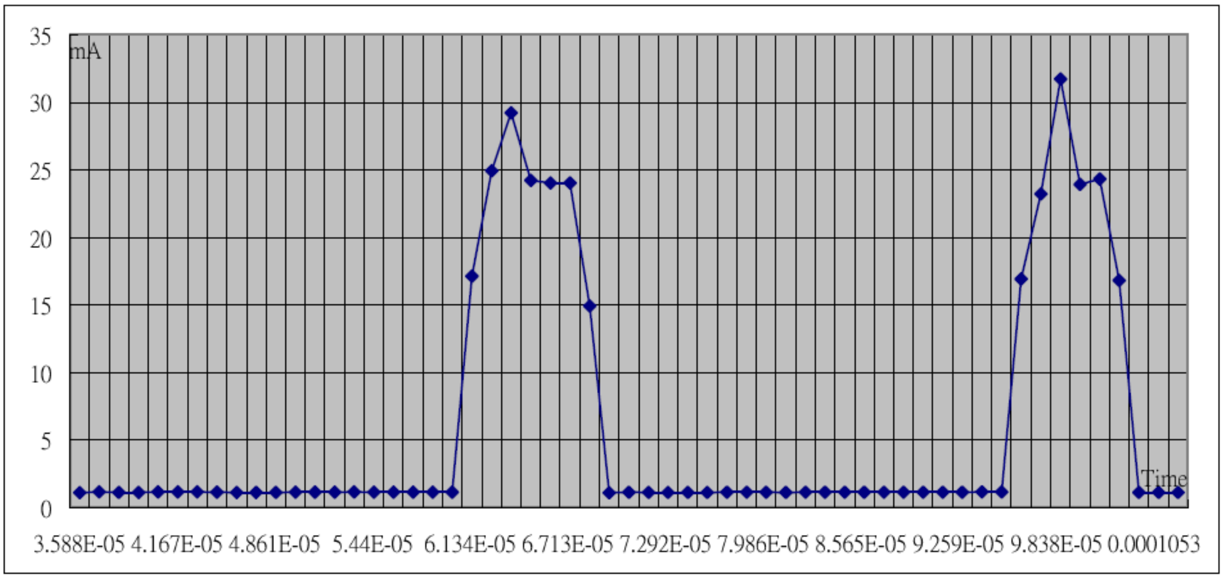
1. Adaptive trickle power: cycle time 1 second, on time 300ms



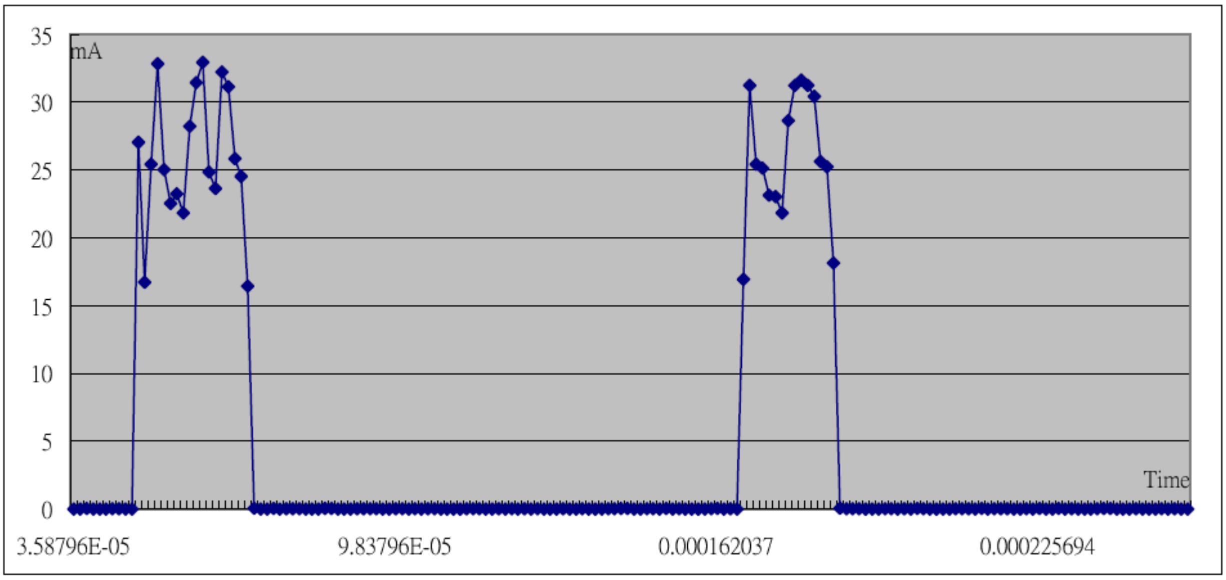
2. Adaptive trickle power: cycle time 2 seconds, on time 400ms



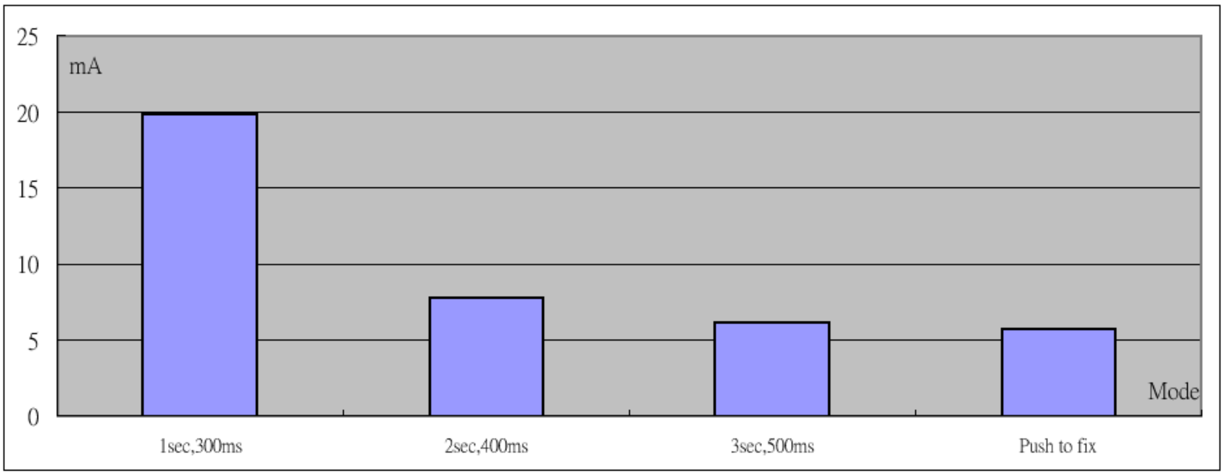
3. Adaptive trickle power: cycle time 3 seconds, on time 500ms



4. Push To Fix: duty 10 seconds



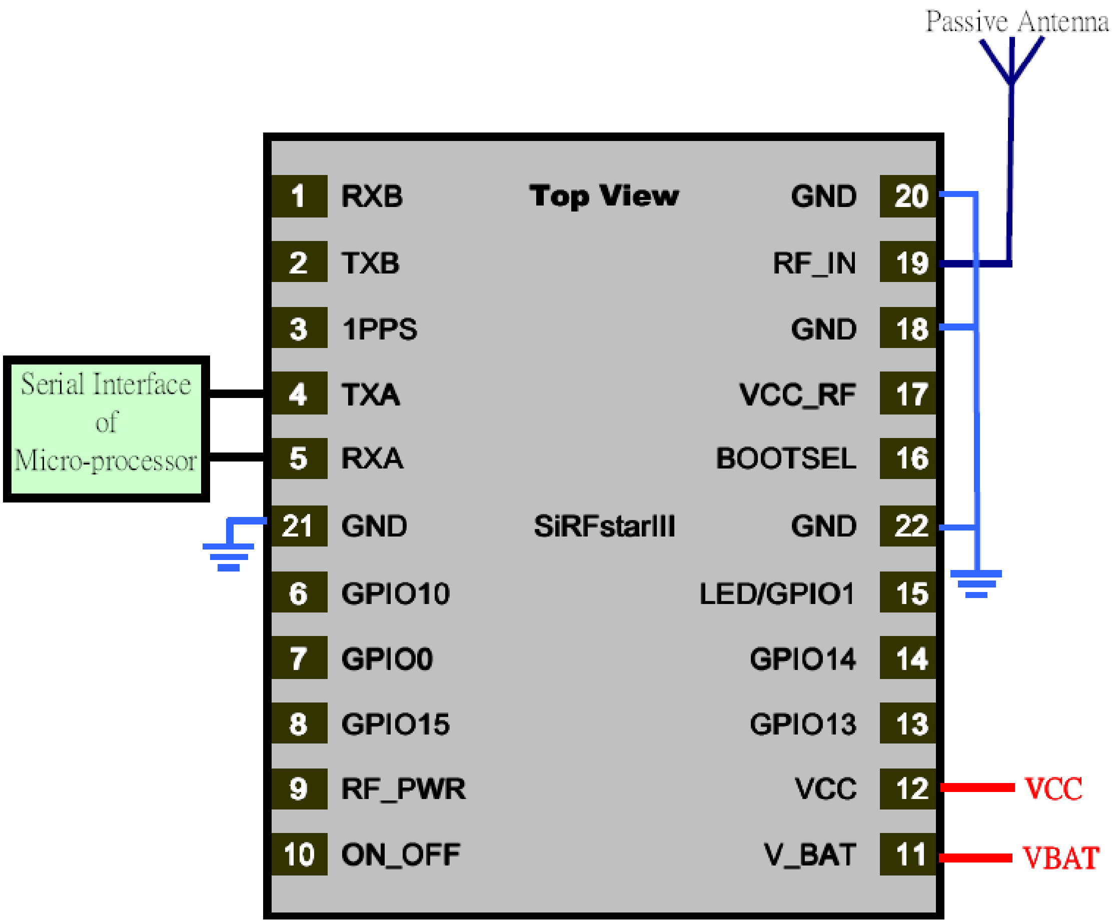
Summary:



2.5 Antenna Application

2.5.1 RF_IN Antenna Connection – Passive Antenna

Following figure is a simple illustration of connecting a passive antenna. The passive antenna is connected to Pin 19 (RF_IN).



2.5.2 RF_IN Antenna Connection – Active Antenna

For active antenna, a DC power supply is required. This power supply could be from pin 17 (VCC_RF) or other external power sources. The quality of antenna power affects the RF performance significantly. The peak to peak noise level should be less than 50mV. The power level from VCC_RF is 2.85VDC.

Please see section 7.1 for the reference circuit of active antenna connection.

2.6 LED/GPIO1 Output

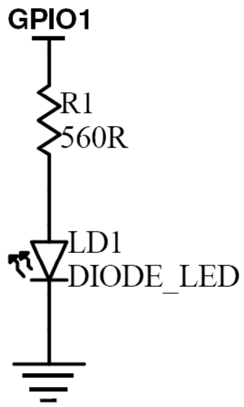
The LED/GPIO1 pin could be used to drive an LED for indicating position fixing status. The default output is “High” before position is fixed and “High”/”Low” alternating after position is fixed.

LED/GPIO1 output

- High: before position is fixed
- High/low alternating: after position is fixed

In the following connection example, LED would be

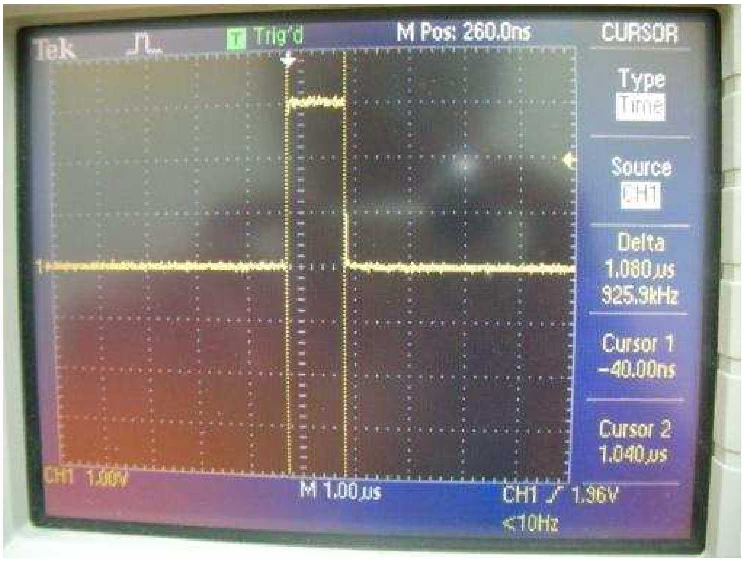
- ON: before position is fixed
- Blinking: after position is fixed



The output pattern could be changed by firmware based on MOQ.

2.7 1PPS Output

The 1 pulse per second signal output is a precise reference time signal. The rising edge of 1PPS pulse is synchronized to GPS second with precision of better than 1 micro-second, pulse width of 1 micro-second (us).



Please note that 1PPS signal will not output until the position has been fixed. Above is the typical 1PPS signal taken from the screen of oscilloscope. Please note that 1PPS signal will not output until the position has been fixed. Above is the 1PPS signal taken from the screen of oscilloscope.

1PPS output

- Low: before position is fixed
- High/low alternating: after position is fixed

Please note that duty cycle of 1us is not able to light up an LED due to too small duty cycle. To be able to light up an LED, firmware could be customized to output 1PPS pulse with longer duty cycle, say 100ms.

3 Software Interface – NMEA Output

3.1 NMEA Output Messages

Standard output follows NMEA-0183 standard. In addition to standard output, Navisys also provides customization service for outputting proprietary sentence based on MOQ.

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 GE-315 easy to use mountable GPS engine board adopts interface protocol of National Marine Electronics Association's NMEA-0183 Version 3.00 interface specification. GE-315 supports 7 types of NMEA sentences - (GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, and GPZDA).

The default output sentences are GPGGA, GPGSA, GPGSV, GPRMC, and/or 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,101229.487,A,3723.2475,N,12148.3416,W,0.13,309.62,120598,,,A*7A

$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.
East/West indicator			
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

A NMEA command is actually a NMEA input message. 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.

Please note that for normal use, there is no need to input any message to the device.

4.1 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 “$PSRF” and three numeric characters. Input messages begin from MID 100.
2. Message-specific data. Refer to a specific message section for <data>...<data> definition described in following sections.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification, NMEA-0183 Standard for Interfacing Marine Electronic Devices. Checksum consists of a binary exclusive OR the lower 7 bits of each character after the “$” and before the “*” symbols. The resulting 7-bit binary number is displayed as the ASCII equivalent of two hexadecimal characters representing the contents of the checksum. 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.

4.2 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.

4.3 100 — 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, 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. Sometimes, it is used to set a new baud rate. When a valid message is received, the parameters are stored in battery-backed SRAM for future use.

- Example - Switch to SiRF binary protocol at 38400,8,N,1
  $PSRF100,0,38400,8,1,0*3C
- Explanation

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF binary, 1=NMEA
Baud	38400		4800, 9600, 19200, 38400
DataBits	8		7, 8
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*3C		
<CR> <LF>			End of message termination

4.4 101 — Navigation Initialization

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. This message is also used for TTFF (Time To First Fix) tests.

- Example - Start using known position and time.
  $PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*2F
- Explanation

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	*2F		
<CR> <LF>			End of message termination

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.

4.5 102 — Set DGPS Port

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
- Explanation

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

4.6 103 — 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 GSV message with checksum enabled.
  $PSRF103,03,01,00,01*26
- Example 2 - Enable VTG message for a 1Hz constant output with checksum enabled
  $PSRF103,05,00,01,01*20
- Example 3 - Disable VTG message
  $PSRF103,05,00,00,01*21
- Explanation

Name	Example	Units	Description
Message ID	$PSRF103		PSRF103 protocol header
Msg	03		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	*26		
<CR> <LF>			End of message termination

4.7 104 — Latitude / Longitude / Altitude Navigation Initialization

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
- Explanation

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

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.

4.8 105 — 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. Please note that this command is useful only when you develop your own application with SiRF SDK.

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

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

4.9 106 — 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 – Select datum TOKYO_KOREA
  $PSRF106,180*35
- Explanation

Name	Example	Units	Description
Message ID	$PSRF106		PSRF106 protocol header
Datum	180		21=WGS84 178=TOKYO_MEAN 179=TOKYO_JAPAN 180=TOKYO_KOREA 181=TOKYO_OKINAWA
Checksum	*35		
<CR> <LF>			End of message termination

5 Electrical and Environmental Data

Absolute Maximum Ratings

Power Supply (pin 12)	6.5 VDC
Backup Battery Supply (pin 11)	7 VDC

Warning – Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. Operation beyond the "DC Recommended Operating Condition" is not recommended and extended exposure beyond the "DC Recommended Operating Condition" may affect device reliability.

DC Recommended Operation Condition

Power Supply (pin 12)	3 ~ 6 VDC
Backup Battery Supply (pin 11)	1.3 ~ 6 VDC

Digital I/O Data

V_{IH}: 2 ~ 3.15V High level input voltage	V_{IL}: 0 ~ 0.85V Low level input voltage
V_{OH}: > 2.1V High level output voltage	V_{OL}: < 0.72V Low level output voltage

ON_OFF pin

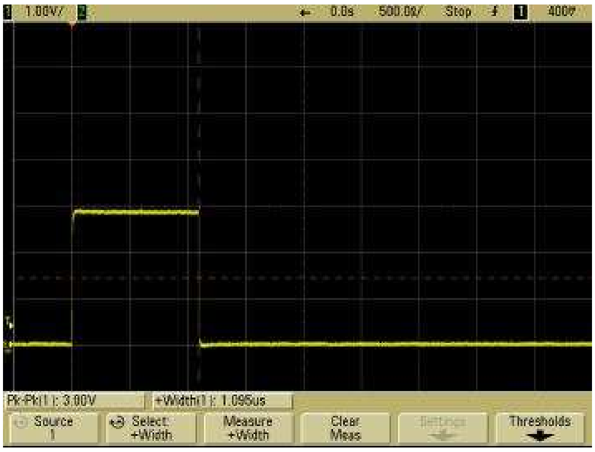
V_{IH}: 1.05 ~ 1.95V^{+} High level input voltage	V_{IL}: 0 ~ 0.45V Low level input voltage
V_{OH}: > 1.3V High level output voltage	V_{OL}: < 0. 2V Low level output voltage

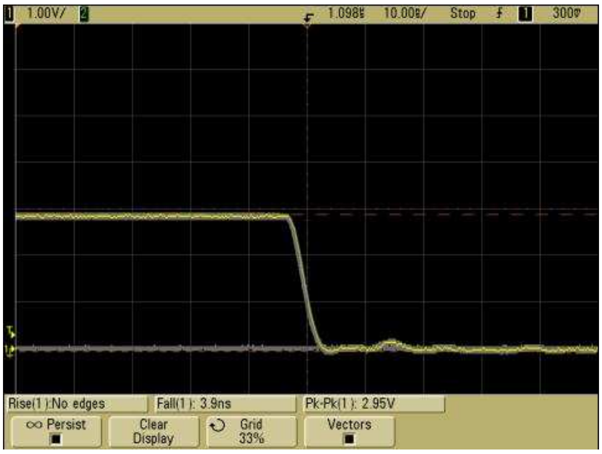
$^{+}$Note. This pin is 3.3V tolerant.

AC Characteristics / Signal Timing

Following pictures are captured with the Oscilloscope DSO6052A from Agilent Technology.

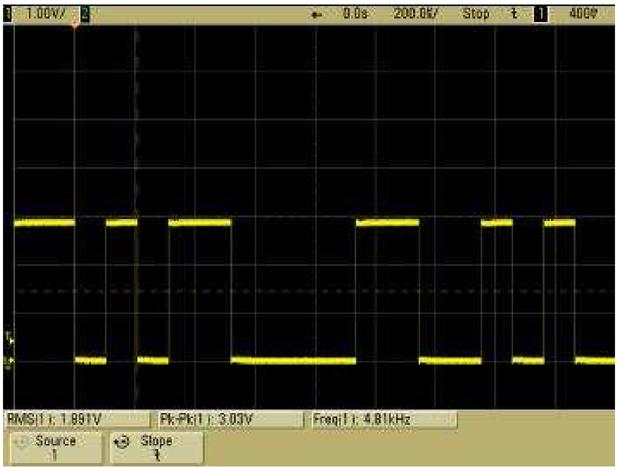
1PPS



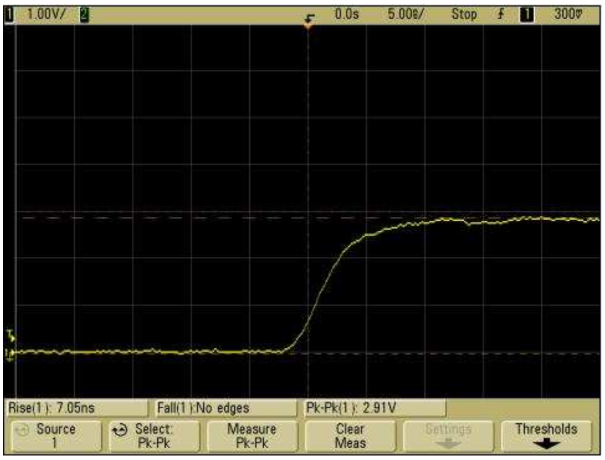


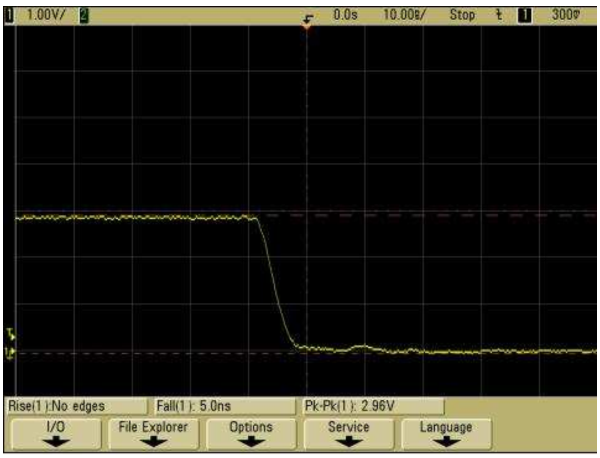
Note of jitter - Above right picture is a stored result by setting rising edge trigger for 1 hour.

TXA



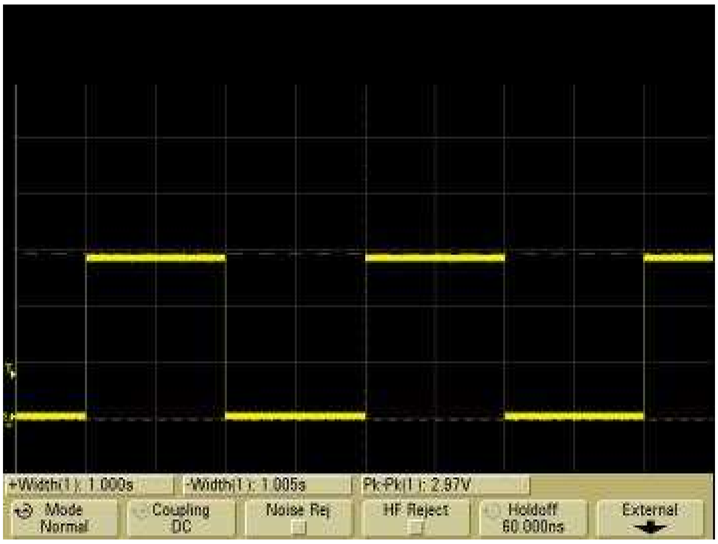
Above picture is a snapshot of UART port A's TX signal at baud 9600bps, N-8-1.





Above two pictures are for rising and falling edges of UART port A's TX signal respectively.

LED/GPIO1



Above picture is a snapshot of LED/GPIO1 signal when the position is fixed.

Environmental Data

Operating temperature	-40 ~ 85℃
Storage temperature	-40 ~ 125℃ without tape & reel 0 ~ 70℃ with tape & reel (long-term) -20 ~ 70℃ with tape & reel (within 2 days)

- GE-315 is backed at 125℃ for 4 hours before they are vacuum taped. It's unnecessary to bake GE-315 again if the assembly is from the tape directly.
- If GE-315 has been removed from the tape and stored in damp environment, suggest baking it again at 125 ℃ for 4 hours before assembly.

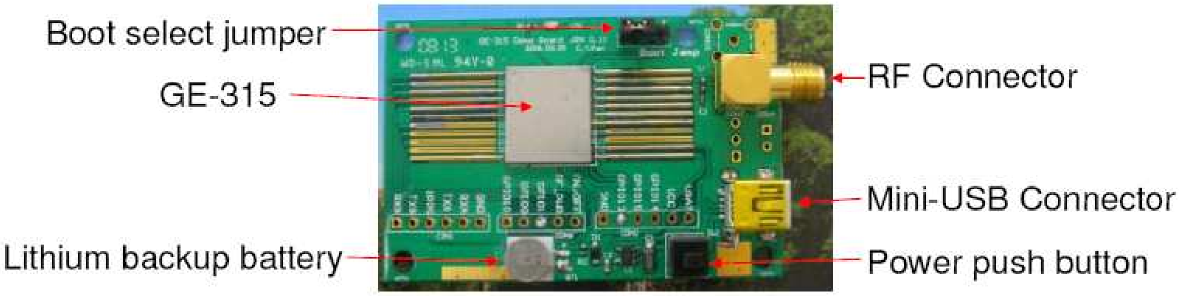
6 Evaluation Kit

The evaluation kit includes

- GE-315 engine board x 1
- GE-315 evaluation board x 1
- Mini-USB to USB type A data cable x 1
- SMA active antenna (optional) x 1

6.1 Evaluation Board Overview

The GE-315 evaluation board supports RF connector for external active antenna module connection. It is unnecessary to tune the RF trace in this application. Just plug-in and it's ready to use.



Please note that the RF connector could be SMA or I-PEX.

6.2 Power Button and Firmware Upgrade Jumper

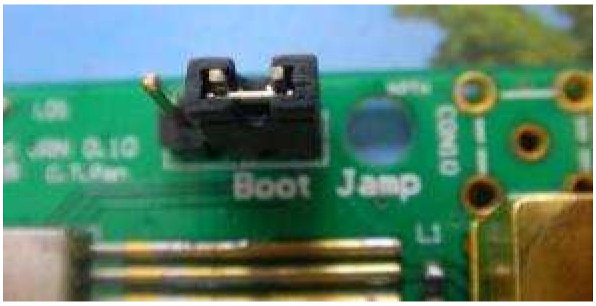
On the evaluation board, the power button is used to control the power into the GE-315 and the boot select jumper is used to control if a firmware upgrade is needed or not.

- Power control push-button x 1 –

  Power is **off** as it's at **high** position. Power is **on** as it's at **low** position.

- Boot jumper x 1 – normal run or firmware upgrade selection
  - Normal run (as shown below)

■ Firmware upgrade (as shown below)

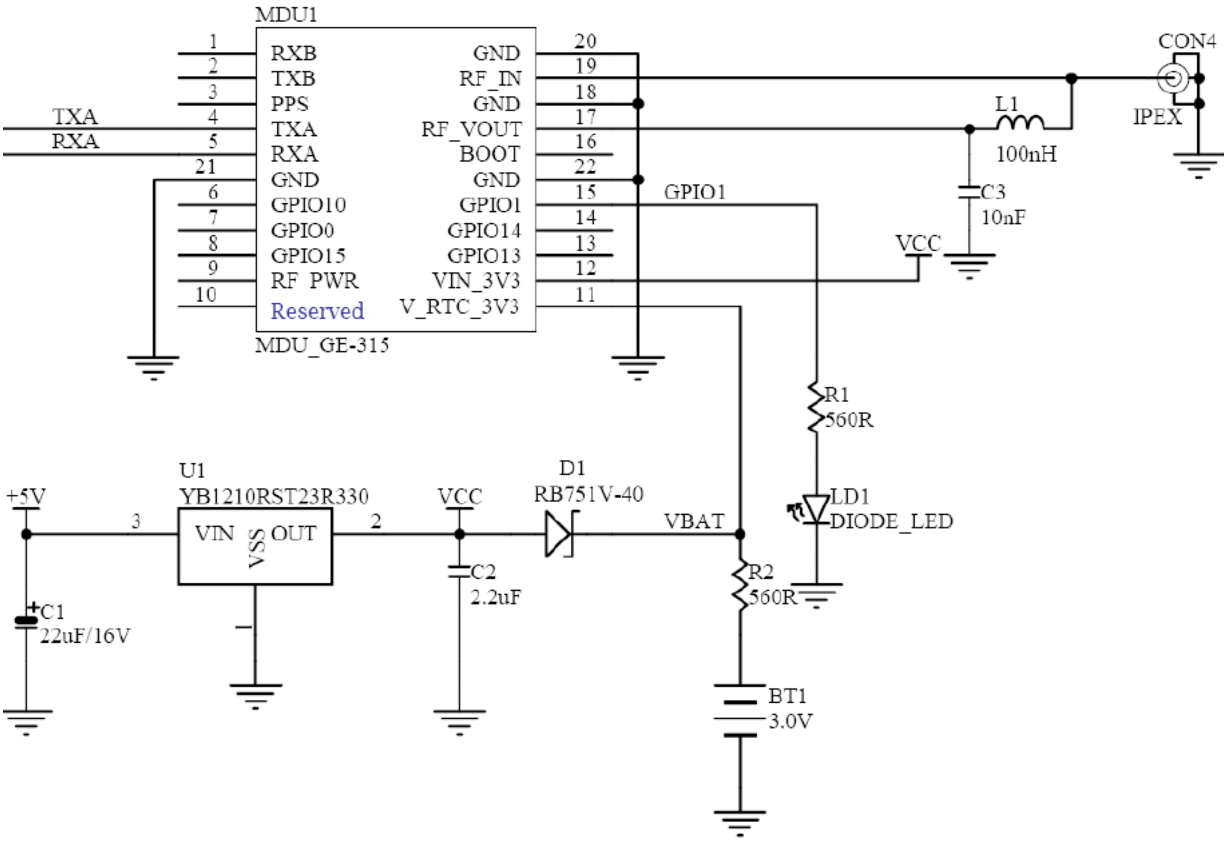


7 Reference Design

Following reference circuit is an application example used in the GE-315 evaluation board.

7.1 GE-315 Reference Circuit

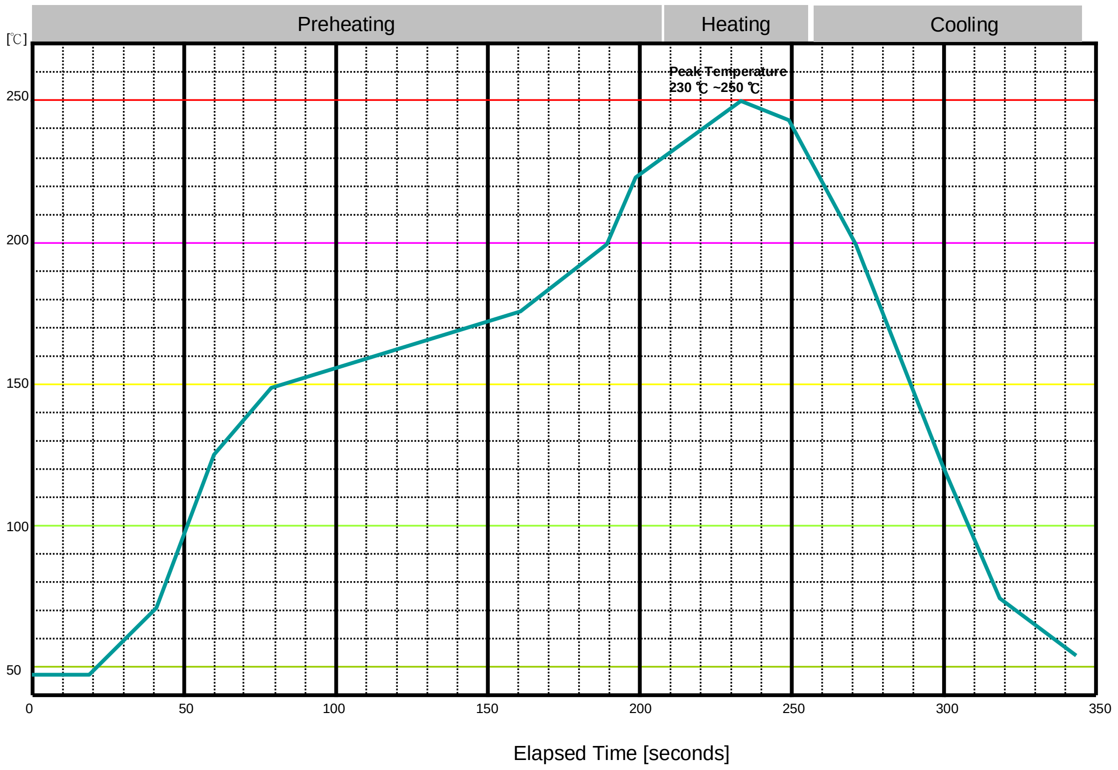
Following example shows how to connect an active antenna (CON4 is the RF connector to the active antenna module), how to connect a backup battery (BT1), how to show the position fixing status via LED (LD1) etc.



7.2 Reference Soldering Profile

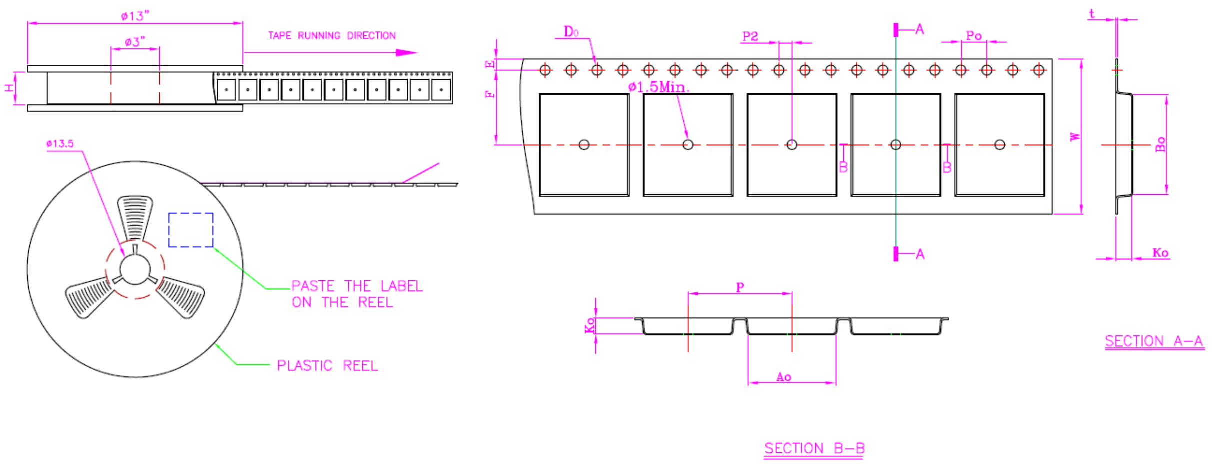
The following soldering profile is for the reference purpose only. The best profile depends on the reflow equipment.

Reference Lead-free Soldering Profile



7.3 Tape & Reel

Quantity: 1000 pcs per reel.



ITEM	W	A_0	B_0	K_0		P	F	E	D_0	P_0	P_2	t
DIM	$24.0^{+0.30}_{-0.30}$	$13.4^{+0.10}_{-0.10}$	$15.4^{+0.10}_{-0.10}$	$2.4^{+0.10}_{-0.10}$		$16.0^{+0.10}_{-0.10}$	$11.5^{+0.10}_{-0.10}$	$1.75^{+0.10}_{-0.10}$	$1.5^{+0.10}_{-0.00}$	$4.0^{+0.10}_{-0.10}$	$2.0^{+0.10}_{-0.10}$	$0.3^{+0.05}_{-0.05}$

NOTE:

1. 10 sprocket hole pitch cumulative tolerance ±0.2
2. Camber not to exceed 1mm in 100mm.
3. Material: Conductive Polystyrene.
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket.
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

7.4 Storage

All the modules are baked at 125℃ for 4 hours before vacuum tape & reeled.

- Please assembly the module within 48 hours after taking out from the tape or store the module inside moisture-proof box.
- If not, please bake the module at 125℃ for 4 hours before assembly.

8 Ordering Information

Each product has a default configuration. Customer is strongly suggested to check the product configuration before ordering.

GE-315X

A	GGA, GSA, RMC, VTG@1Hz, GSV@1/5Hz, 9600bps