KNCTEK GPS Module

SLF-1613 Specification

Version 3.1
2016/01/15

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Revision History

1. 2009-01-13 : Initiated Version 1.0.0
2. 2009-04-11 : Updated Version 2.0. for re-organized Electrical characteristics and performance characteristics chart on page 6&7.
3. 2009-06-04 : Updated Version 2.1 for Modified Hardware Interface on page 9.
4. 2013-11-18 : Updated Version 3.0 Due to Main Chip change from Venus 6 version to Venus 8 version.
5. 2016-01-15 : Updated Version 3.1 for Specification renewal.

SLF-1613 Operational Manual

INTRODUCTION

The **SLF-1613** is the newest generation of KNCTEK GPS Module. The GPS Module is powered by SkyTraq technology and KNCTEK proprietary navigation algorithm that providing you more stable navigation data. The miniature design is the best choice to be embedded in a portable device like various Trackers, various Vehicle & personal Locaters & Trackers and etc. The excellent sensitivity of **SLS-1613** gets the great performance when going though the urban canyon and foliage environmental condition.

PRODUCT FEATURES

- ✧ GPS L1 C/A Code
- ✧ Total 167 channels: 137 Channels for Acquisition, 30 Channels for Tracking
- ✧ Operable from 3.3V/Typ 33mA for Acquisition and 27mA for Tracking Mode
- ✧ A-GPS and QZSS, SBAS(WAAS, EGNOS, GAGAN) supported
- ✧ SAEE(Self-aided ephemeris estimation) supported
- ✧ Perform 16million time-frequency hypothesis testing per second
- ✧ Signal Detection better than -165dBm in Ultra High Tracking Sensitivity
- ✧ Enhanced Warm/Hot Acquisition Sensitivity at -157dBm
- ✧ Fast TTFF <25 seconds in Warm start and 29 seconds for Cold start
- ✧ Excellent Sensitive for Urban Canyon and Foliage Environmental condition
- ✧ NMEA-0183 compliant protocol
- ✧ Automotive-grade Quality GPS solution
- ✧ Small form factor (15.9X13.1X2.4mm)
- ✧ ODM/OEM development is fully supported Application Engineering
- ✧ Hardware and Software support from a dedicated GPS team

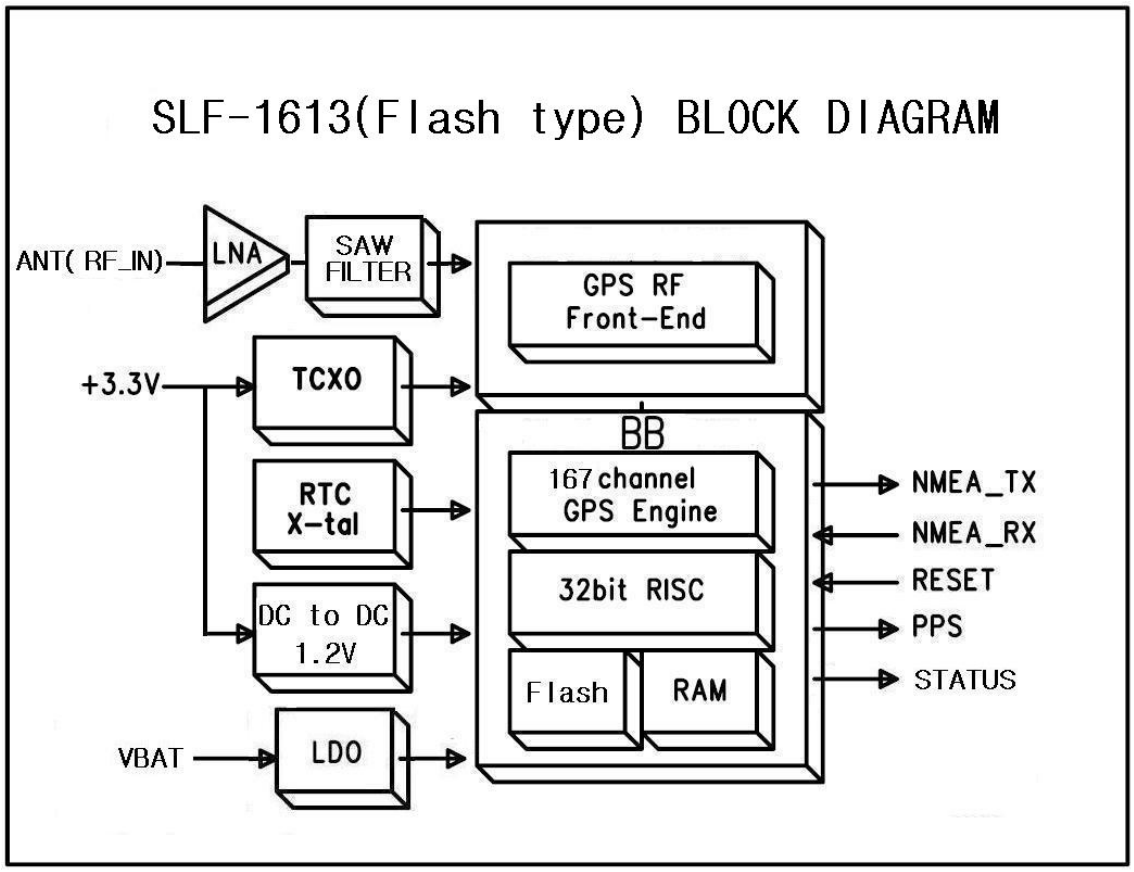
PRODUCT APPLICATION

- ✧ Automotive applications
- ✧ Speed camera detector and Data logger
- ✧ Personal and Car Navigation Devices
- ✧ Marine navigation
- ✧ Timing application and the others

PRODUCT PICTURE

SLF-1613 SYSTEM BLOCK DIAGRAM

The SLF-1613 consists of SkyTraq chipsets Technology, KNCTEK LNA and proprietary software. The system is described as follows.



TECHNICAL SPECIFICATION

1. Electrical Characteristics

1.1 Absolute Maximum Rating

Parameter	Symbol	Min	Max	Units
Power Supply				
Power Supply Volt.	VCC	-0.3	3.6	V
Input Pins				
Input Pin Voltage I/O	RX	-0.3	3.6	V
Backup Battery	Vbat	1.8	3.6	V
Environment				
Operating Temperature	Topr	-30	85	℃
Storage Temperature	Tstg	-40	85	℃
Peak Reflow Soldering Temperature < 10S	Tpeak		260	℃
Humidity			95	%

Note : Absolute maximum ratings are stress ratings only, and functional operation at the maximums is not guaranteed. Stress beyond the limits specified in this table may affect device reliability or cause permanent damage to the device.

For functional operating conditions, please refer to the operating conditions tables as follow.

1.2 Operating Condition

Parameter	Symbol	Condition	Min	Typ	Max	Units
Power supply voltage	Vcc		3.0	3.3	3.6	V
Power Supply voltage ripple	Vcc_PP	Vcc = 3.3V			30	mV
Acquisition current	IccA	Vcc = 3.3V		33		mA
Tracking current	IccT	Vcc = 3.3V		27		mA
Input high voltage	V_{IH}		2.0			V
Input low voltage	V_{IL}				0.8	V
Output high voltage	V_{OH}		2.9			V
Output low voltage	V_{OL}				0.4	V

2. General & Performance Specification

Parameter	Specification		
Receiver Type	L1 frequency band C/A code, 137 Channel Acquisition, 30 Channel Tracking		
Sensitivity	Tracking	-165dBm	
	Re-acquisition	-157dBm	
	Cold Start	-148dBm	
Accuracy	Position	2.5m CEP	
	Velocity	0.1m/s	
	Timing(PPS)	10ns RMS	
Acquisition Time	Cold Start	29 sec. typical (Open sky[1])	
	Warm Start	25 sec. typical (Open sky)	
	Hot Start	1 sec. typical (Open sky)	
	Reacquisition Time	1 sec	
	AGPS Support	4 sec. average	
	SAEE Support	Self-aided ephemeris estimation : 15 sec. avg	
Power Consumption	Tracking	27mA @ 3.3V	
	Acquisition	33mA	
	Back-up	9uA @ 3V	
Navigation Data Update Rate	1Hz_Default In case of using Binary input : Max 50Hz ** Please refer to the Binary Input Message		
Operational Limits	Velocity	Max 515 m/s	
	Altitude	Max 18,000m	
	Acceleration	Less than 4g	
Mechanical data	Dimension	15.9 X 13.1 X 2.4mm (+/- 0.3mm)	
	Weight	1.0grams ±5%	
Protocol	NMEA-0183 V3.01	GPGGA 1Hz	
		GPGLL 1Hz	
		GPGSA 1Hz	
		GPGSV 1/3Hz(one time per 3sec)	
		GPRMC 1Hz	
		GPVTG 1Hz	
		GPZDA 1Hz	

** [1]Open Sky means no obstructions in the sky

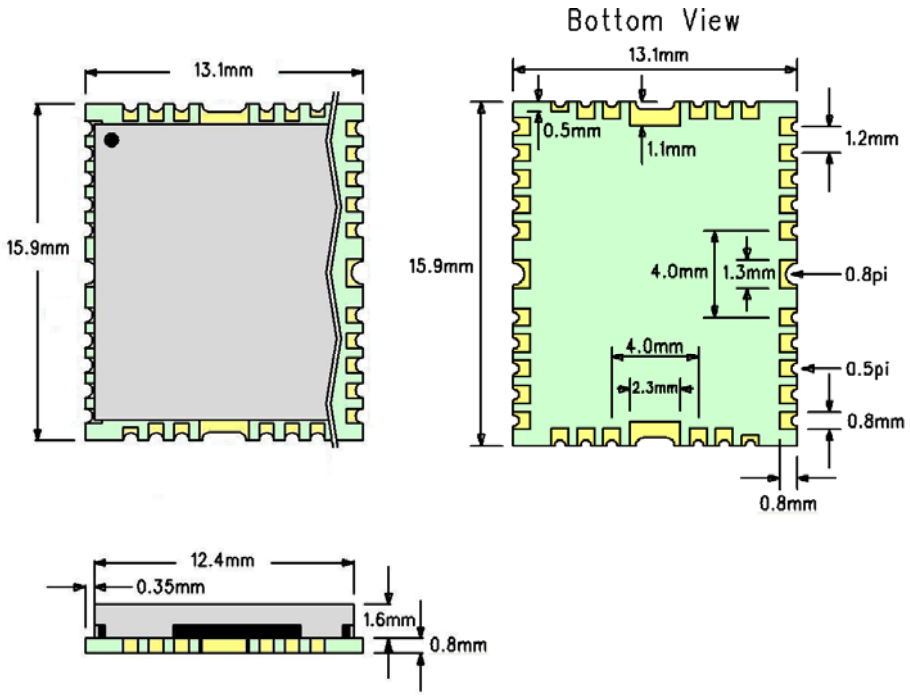
RECOMMENDED GPS ACTIVE EXTERNAL ANTENNA

It's recommended to use a GPS active external antenna with supply voltage of 3.3VDC and a current draw of 15mA maximum. The quality of the GPS active external antenna chosen is of paramount importance for the overall sensitivity of the GPS system. A GPS active external antenna should have a typical gain 20dB and a noise figure ≤ 1.5dB, which applies to more than 90% of the antennas available in the market.

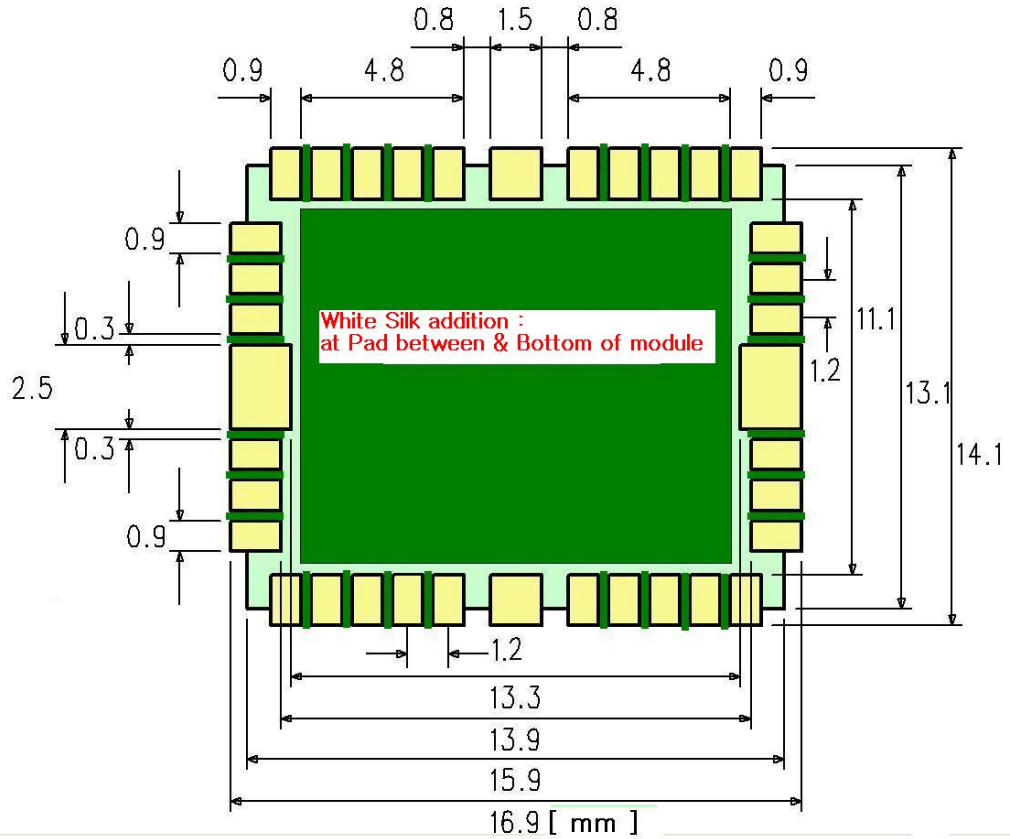
3.3V GPS Active External Antenna Specification

Characteristics	Specification
Center Frequency	1575.42±1.023MHz
Band Width(-10dB return loss)	10MHz
Gain at Zenith	5.0dBi Typical
VSWR	2.0 : 1 Max
Polarization	R.H.C.P
Axial Ratio	3.0dB max
Gain	Typical 25dB (minimum 20dB)
Noise Figure	Less than 1.5dB
Out Band Attenuation	20dB min for ±50MHz
Voltage	3.3 ± 10%VDC or 3.0 ~ 3.6 VDC
Current	< 15 mA

MECHANICAL PIN LAYOUT

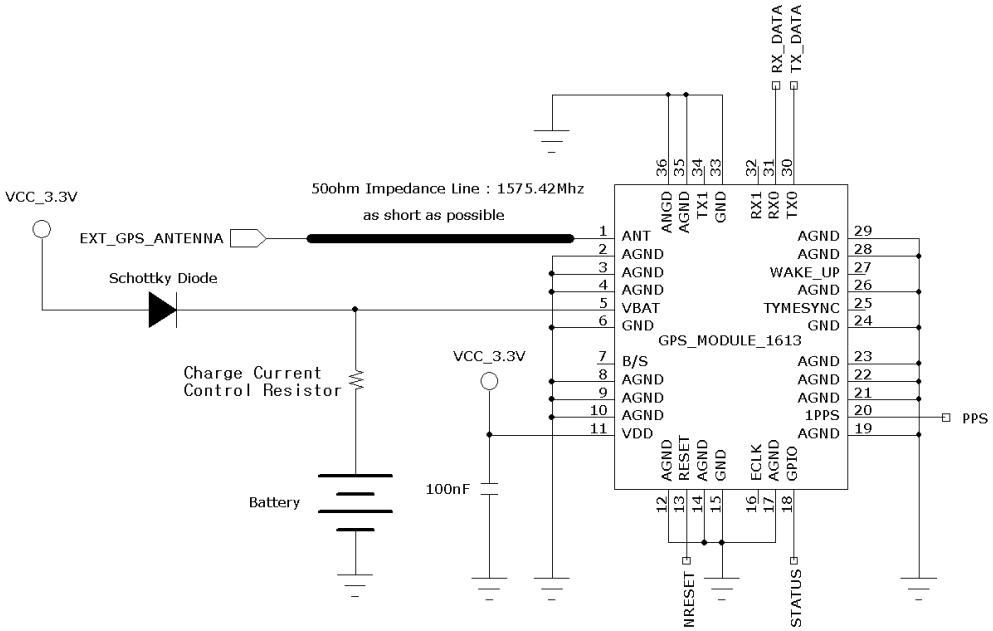


RECOMMENDED LAND PATTERN DIMENSION

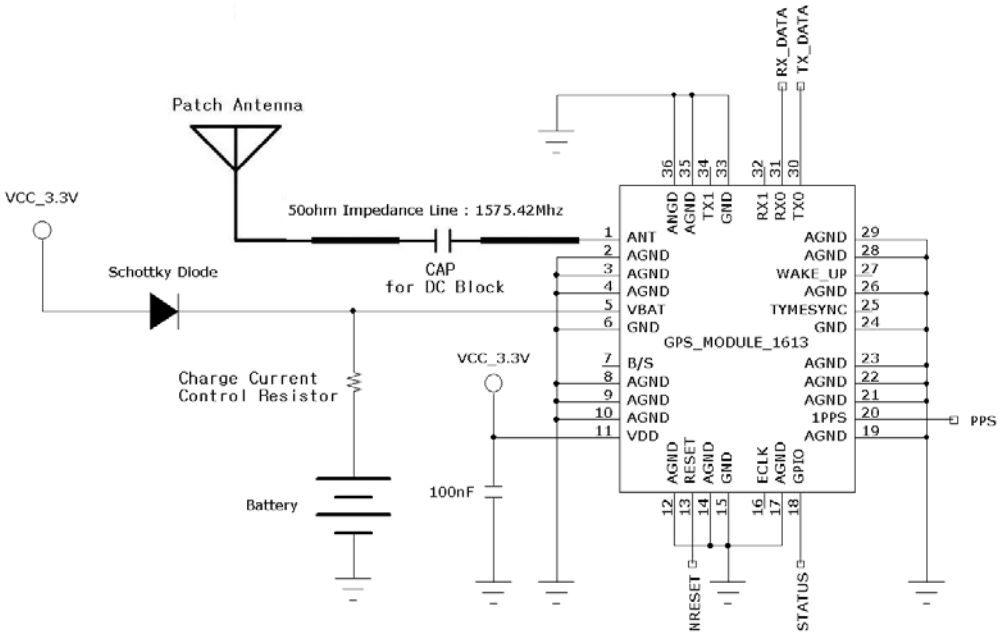


HARDWARE INTERFACE

1. Example 1 for GPS External active antenna



2. Example 2 for GPS Patch antenna



DEFINITION OF PIN ASSIGNDMENT

PIN	SIGNAL NAME	I/O	DESCRIPTION	CHARACTER
1	ANT	I	GPS SIGNAL INPUT	50Ω @ 1.57542GHz
2	GND	GND	Ground	
3	GND	GND	Ground	
4	GND	GND	Ground	
5	VBAT	I	Backup Battery supply, must not be unconnected	DC +1.8V ~ +3.3V
6	GND	GND	Ground	
7	NC	-	Not connecting	
8	GND	GND	Ground	
9	GND	GND	Ground	
10	GND	GND	Ground	
11	VDD	I	DC Power Supply Voltage input	DC +3.3V ±10%
12	GND	GND	Ground	
13	RESET	I	RESET(Active LOW)	Active LOW
14	GND	GND	Ground	
15	GND	GND	Ground	
16	NC	-	Not connecting	
17	GND	GND	Ground	
18	STATUS	O	GPS STATUS	If the position is fixed, the output is ok
19	GND	GND	Ground	
20	1PPS	O	1 Pulse per Second	If the position is fixed, the output is ok
21	GND	GND	Ground	
22	GND	GND	Ground	
23	GND	GND	Ground	
24	GND	GND	Ground	
25	NC	-	Not connecting	
26	GND	GND	Ground	
27	NC	-	Not connecting	
28	GND	GND	Ground	
29	GND	GND	Ground	
30	TX0	O	UART TX	NMEA_TX : UART output, 3.3V LVTTL

31	RX0	I	UART RXA	NMEA_RX : UART input,3.3V LVTTL
32	RX1(NC)	–	Not connecting	
33	GND	GND	Ground	
34	TX1(NC)	–	Not connecting	
35	GND	GND	Ground	
36	GND	GND	Ground	

VDD(DC Power Input)

This is the main power supply for the Engine board. The power range is from 3.3V ±10%(the maximum and minimum voltage is 3.0V to 3.6V). Suitable decoupling must be provided by external decoupling circuitry.

GND

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

VBAT

This is the battery backup supply that powers the SRAM and RTC when main power is removed. The input voltage level is from 1.8V ~ 3.3V. Without an external backup battery or on board battery, engine board will execute a cold start after every turn on. To achieve the faster start-up offered by a hot or warm start, either a backup battery must be connected or battery installed on board. **This pin must be connected by power(normal Input power)for operating, must not be unconnected.**

TX0

NMEA_TX, UART output, 3.3V LVTTL logic level. This is the main transmit channel and is used to output navigation. The default setup is NMEA Output, 9600bps, 8 data bits, no parity, 1 stop bit. The default sentences are GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, GPZDA. GPGGA, GPGLL, GPGSA, GPRMC, GPVTG, GPZDA are once per second and GPGSV is once per 3 second.

RX0

NMEA_RX, UART input,3.3V LVTTL logic level. This is the main receiving channel and is used to receive software commands to the Engine board from user written software.

RESET

This is the function to restart the system, If the pin is lied to low. Leave unconnected if not used.

ANT

The Module supports passive & active antennas. The line on the PCB from the antenna(or antenna connector)has to be a controlled line (Micro strip at 50Ω @ 1575.42MHz).
The input provides also a bias supply(+3.3V typ.).

1PPS

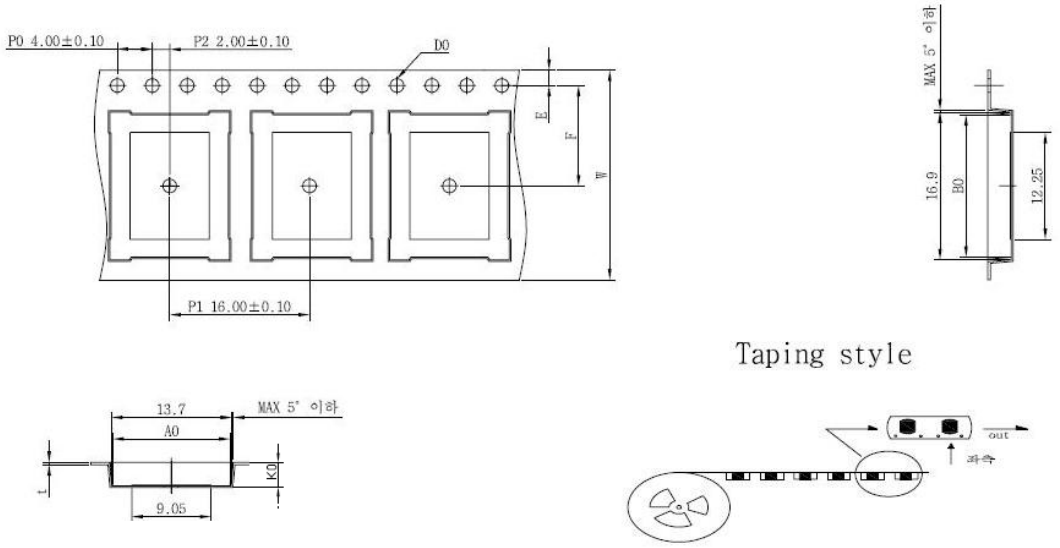
This pin is 1 pulse per second time-mark output and active after position fix. This goes high for about 4msec and 3.3V LVTTL.
1PPS pin must not be pulled-high during power on reset, or it'll enter into debug mode and freeze.

STATUS : GPS STATUS

This pin indicate GPS position status, 3.3V LVTTL. This is active low for no-fix, 1 pulse per 2 seconds after position fix.

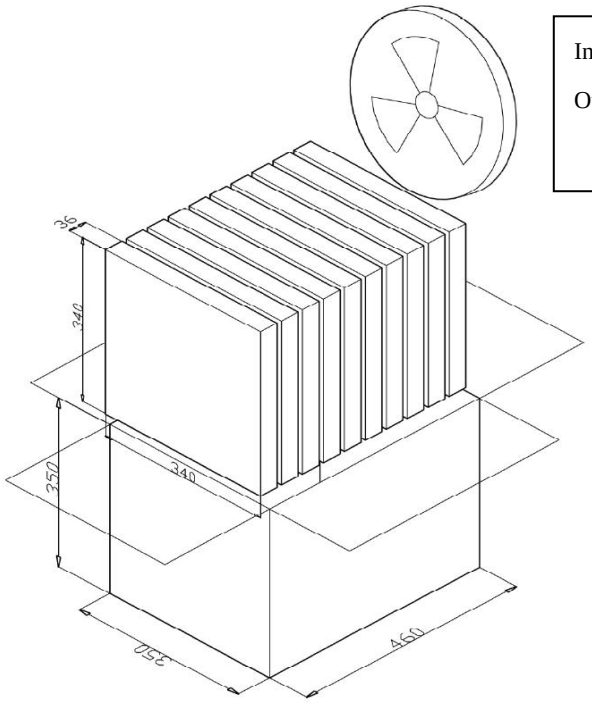
Packing Information

1. Carrier Tape Dimension



A0	13.40±0.10	E	1.75±0.10
B0	16.60±0.10	F	11.50±0.10
K0	2.70±0.10	t	0.30±0.05
D0	1.55±0.05	w	24.00±0.30

2. Inner & Out Box (Carton Box)



Inner Box : 1,500pcs by one Tape & Reel packing

Out Box : Contained 10sets of Inner Boxes.

(Total 15,000pcs)

GPS Receiver User's Tip

1. GPS signal will be affected by weather and environment conditions, thus suggest to use the GPS receiver under less shielding environments to ensure GPS receiver has better receiving performance.
2. When GPS receiver is moving, it will prolong the time to fix the position, so suggest to wait for the satellite signals to be locked at a fixed point when first power-on the GPS receiver to ensure to lock the GPS signal at the shortest time.
3. The following situation will affect the GPS receiving performance:
   a. Solar control filmed windows.
   b. Metal shielded, such as umbrella, or in vehicle.
   c. Among high buildings.
   d. Under bridges or tunnels.
   e. Under high voltage cables or near by radio wave sources, such as mobile phone base stations.
   f. Bad or heavy cloudy weather.
4. If the satellite signals can not be locked or encounter receiving problem (while in the urban area), the following steps are suggested:
   a. Please plug the external active antenna into GPS receiver and put the antenna on outdoor or the roof of the vehicle for better receiving performance.
   b. Move to another open space or reposition GPS receiver toward the direction with fewer blockages.
   c. Move the GPS receiver away from the interference resources.
   d. Wait until the weather condition is improved.

While a GPS with a backup battery, the GPS receiver can fix a position immediately at next power-on if the build-in backup battery is full-recharged.

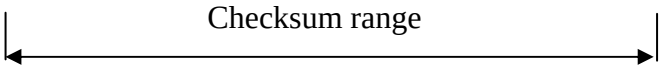
Introduction for NMEA

The SkyTraq NMEA 0183 protocol is designed based on NMEA(National Marine Electronics Association) 0183 Standard which is a standard protocol for interfacing navigational devices, e.g. GPS and DGPS receivers over serial interface. The SkyTraq NMEA 0183 protocol is fully compliant with “NMEA 0183 Standard for Interfacing Marine Electronic Devices, Version 3.0.1”. The standard may be obtained from NMEA at http://www.nmea.org.

NMEA Protocol Overview

Message Format

The structure of a NMEA message is shown below.



Start of Sequence	Address field	Data Field(s)	Checksum field	End of Sequence
$ or !	<Address>	[,<data field>].....[,<data field>]	*<checksum>	<CR><LF>

Start of Sequence

All sentences begin with the sentence start delimiter character “$” or “!”.

Address Field

The address Field is served to define the sentence. Characters with digits and upper case letters are permitted to be in the address field. It can not be a null field. This field is subdivided into 2 fields.

<XX>	<XXX>
Talker Identifier	Sentence Formatter

Talker Identifier is always **GP** for a GPS receiver. The sentence formatter defines the format and the type of data.

Data Field(s)

Data Fields are delimited by a “,” and contain valid characters specified in NMEA 0183 standard. It can be variable length fields.

Checksum

Checksum field is the 8-bit exclusive OR (no start or stop bits) of all characters in the sentence. Checksum consists of 2 characters and is represented as a hex number.

End of Sequence

All sentences always end with sentence termination delimiter <CR><LF>.

SUPPORTED MESSAGE LIST

The following NMEA messages are supported.

Sentence	Descriptions
GGA	Global Positioning System Fix Data
GLL	Geographic Position – Latitude/Longitude
GSA	GNSS DOP and Active Satellites
GSV	GNS Satellites in View
RMC	Recommended Minimum Specific GNSS Data
VTG	Course Over Ground and Ground Speed
ZDA	UTC, Day, Month, Year and Local Time Zone

NMEA MESSAGES

The full descriptions of supported NMEA messages are provided at the following paragraphs.

GGA - Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.

Structure:

$GPGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,,,,xxxx*hh<CR><LF>

1 2 3 4 5 6 7 8 9 10 11

Example:

$GPGGA,111636.932,2447.0949,N,12100.5223,E,1,11,0.8,118.2,M,,,,0000*02<CR><LF>

Field	Name	Example	Description
1	UTC Time	111636.932	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
2	Latitude	2447.0949	Latitude in ddmm.mmmm format Leading zeros transmitted
3	N/S Indicator	N	Latitude hemisphere indicator, ‘N’ = North, ‘S’ = South
4	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
5	E/W Indicator	E	Longitude hemisphere indicator, 'E' = East, 'W' = West
6	GPS quality indicator	1	GPS quality indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode 3: GPS PPS Mode, fix valid 4: Real Time Kinematic. System used in RTK mode with fixed integers 5: Float RTK. Satellite system used in RTK mode. Floating integers 6: Estimated (dead reckoning) Mode 7: Manual Input Mode

			8: Simulator Mode
7	Satellites Used	11	Number of satellites in use, (00 ~ 12)
8	HDOP	0.8	Horizontal dilution of precision, (00.0 ~ 99.9)
9	Altitude	108.2	mean sea level (geoid), (-9999.9 ~ 17999.9)
10	DGPS Station ID	0000	Differential reference station ID, 0000 ~ 1023 NULL when DGPS not used
11	Checksum	02	

GLL – Latitude/Longitude

Latitude and longitude of current position, time, and status.

Structure:

$GPGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh<CR><LF>

1 2 3 4 5 6 7 8

Example:

$GPGLL,2447.0944,N,12100.5213,E,112609.932,A,A*57<CR><LF>

Field	Name	Example	Description
1	Latitude	2447.0944	Latitude in ddmm.mmmm format Leading zeros transmitted
2	N/S Indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
3	Longitude	12100.5213	Longitude in dddmm.mmmm format Leading zeros transmitted
4	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
5	UTC Time	112609.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
6	Status	A	Status, 'A' = Data valid, 'V' = Data not valid
7	Mode Indicator	A	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
8	Checksum	57	

GSA – GNSS DOP and Active Satellites

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Structure:

$GPGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>

1 2 3 3 3 3 3 3 3 3 3 3 3 4 5 6 7

Example:

$GPGSA,A,3,05,12,21,22,30,09,18,06,14,01,31,,1.2,0.8,0.9*36<CR><LF>

Field	Name	Example	Description
1	Mode	A	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
2	Mode	3	Fix type 1 = Fix not available 2 = 2D 3 = 3D
3	Satellite used 1~16	05,12,21,22,30,09,18,06,14,01,31,,	Satellite ID number, 01 to 32, 193 to 197, of satellite used in solution, up to 16 transmitted
4	PDOP	1.2	Position dilution of precision (00.0 to 99.9)
5	HDOP	0.8	Horizontal dilution of precision (00.0 to 99.9)
6	VDOP	0.9	Vertical dilution of precision (00.0 to 99.9)
7	Checksum	36	

GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Structure:

$GPGSV,x,x,xx,xx,xx,xxx,xx,…,xx,xx,xxx,xx *hh<CR><LF>

1 2 3 4 5 6 7 4 5 6 7 8

Example:

$GPGSV,4,1,16,05,54,069,45,12,44,061,44,21,07,184,46,22,78,289,47*72<CR><LF>

$GPGSV,4,2,16,30,65,118,45,09,12,047,37,18,62,157,47,06,08,144,45*7C<CR><LF>

$GPGSV,4,3,16,14,39,330,42,01,06,299,38,31,30,256,44,32,36,320,47*7B<CR><LF>

$GPGSV,4,4,16,42,64,169,45,50,74,261,44,21,07,184,46,193,68,189,47*72<CR><LF>

Field	Name	Example	Description
1	Number of message	4	Total number of GSV messages to be transmitted (1-4)
2	Sequence number	1	Sequence number of current GSV message
3	Satellites in view	16	Total number of satellites in view (00 ~ 16)
4	Satellite ID	05	Satellite ID number, GPS: 01 ~ 32, SBAS: 33 ~ 64 (33 = PRN120), QZSS : 193 ~ 197
5	Elevation	54	Satellite elevation in degrees, (00 ~ 90)
6	Azimuth	069	Satellite azimuth angle in degrees, (000 ~ 359)
7	SNR	45	C/No in dB (00 ~ 99) Null when not tracking
8	Checksum	72	

RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.

Structure:

$GPRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,,,a*hh<CR><LF>

1 2 3 4 5 6 7 8 9 10 11

Example:

$GPRMC,111636.932,A,2447.0949,N,12100.5223,E,000.0,000.0,030407,,,A*61<CR><LF>

Field	Name	Example	Description
1	UTC time	0111636.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
2	Status	A	Status 'V' = Navigation receiver warning 'A' = Data Valid
3	Latitude	2447.0949	Latitude in dddmm.mmmm format Leading zeros transmitted
4	N/S indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
5	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
6	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
7	Speed over ground	000.0	Speed over ground in knots (000.0 ~ 999.9)
8	Course over ground	000.0	Course over ground in degrees (000.0 ~ 359.9)
9	UTC Date	030407	UTC date of position fix, ddmmyy format
10	Mode indicator	A	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
11	checksum	61	

VTG – Course Over Ground and Ground Speed

The Actual course and speed relative to the ground.

Structure:

GPVTG,x.x,T,,M,x.x,N,x.x,K,a*hh<CR><LF>

1 2 3 4 5

Example:

$GPVTG, 000.0,T,,M,000.0,N,0000.0,K,A*3D<CR><LF>

Field	Name	Example	Description
1	Course	000.0	True course over ground in degrees (000.0 ~ 359.9)
2	Speed	000.0	Speed over ground in knots (000.0 ~ 999.9)
3	Speed	0000.0	Speed over ground in kilometers per hour (0000.0 ~ 1800.0)
4	Mode	A	Mode indicator 'N' = not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
5	Checksum	3D	

ZDA – Time & Date

UTC, day, month, year and local time zone.

Structure:

$GPZDA,hhmmss.sss,xx,xx,xxxx,xx,xx*hh<CR><LF>

1 2 3 4 5 6 7

Example:

$GPZDA,052633.376,13,07,2012,00,00*51<CR><LF>

Field	Name	Example	Description
1	UTC time	0111636.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
2	Day	13	Day, 01 to 31
3	Month	07	Month, 01 to 12
4	Year	2012	Year in yyyy format
5	Local zone hours	00	Local zone hours, 00 to +/- 13 hrs
6	Local zone minutes	00	Local zone minutes, 00 to +59
7	checksum	51	

Contact Information Section

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