GPS Module DataSheet

Name: Ultra High Sensitivity and Low Power GPS Receiver Module

Model No.:   SKG13C

Revision: 003

Revision History:

Revision	Description	Approved	Date
001	Initial Release to 001	Neil	20100410
002	Added USB interface functions	Neil	20100701
003	Update Chipset	George	20120323

General Description

The SKG13C is a complete GPS engine module that features super sensitivity, ultra low power and small form factor. The GPS signal is applied to the antenna input of module, and a complete serial data message with position, velocity and time information is presented at the serial interface with NMEA protocol or custom protocol.

It is based on the high performance features of the MediaTek MT3339 single-chip architecture, Its −165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GPS was not possible before. The small form factor and low power consumption make the module easy to integrate into portable device like PNDs, mobile phones, cameras and vehicle navigation systems.

Applications

- LBS (Location Based Service)
- PND (Portable Navigation Device)
- Vehicle navigation system
- Mobile phone

Figure 1: SKG13C Top View

Features

- Ultra high sensitivity: -165dBm
- Extremely fast TTFF at low signal level
- Built-in 12 multi-tone active interference canceller
- Low power consumption: Typical 18mA@3.3V
- ±10ns high accuracy time pulse (1PPS)
- Advanced Features: AlwaysLocate; AIC; EPO;EASY
- QZSS,SBAS(WAAS,EGNOS,MSAS,GAGAN)
- Indoor and outdoor multi-path detection and compensation
- Small form factor: 15x13x2.2mm
- RoHS compliant (Lead-free)

Pin Assignment

Figure 2: SKG13C Pin Package
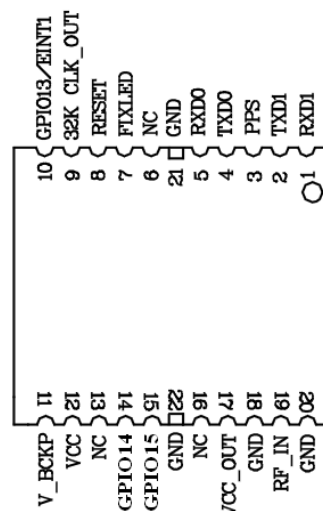
Pin Description

Pin No.	Pin name	I/O	Description	Remark
1	RXD1	O	UART Serial Data Input 1	Leave open if not used
2	TXD1	I	UART Serial Data Output 1	Leave open if not used
3	PPS	O	Time pulse Signal	Leave open if not used
4	TXD0	O	UART Serial Data Output 0	Leave open if not used
5	RXD0	I	UART Serial Data Input 0	Leave open if not used
6	NC			
7	FIXLED	O	Fixed LED Output	Leave open if not used
8	RESET	I	Module Reset (Active Low Status)	Leave open if not used
9	32K CLK_OUT	O	32.768KHz clock output from RTC	Leave open if not used
10	GPIO13/EINT1	I	Wakeup signal input from such a G sensor	Currently version do not support
11	V_BCKP	I	RTC and backup SRAM power (2.0-4.2V)	May be connect to Battery
12	VCC	I	Module Power Supply	Operating range: 3.0V to 4.2V
13	NC			
14	GPIO14	I/O	General Purpose I/O	Leave open if not used
15	GPIO15	I/O	General Purpose I/O	Leave open if not used
16	NC			
17	VCC_OUT	O	VCC power output	Leave open if not used
18	GND	G	Ground	
19	RF_IN	I	GPS Signal Input	50Ω@1.57542GHz
20	GND	G	Ground	
21	GND	G	Ground	
22	GND	G	Ground	

Interfaces Configuration

Power Supply

Regulated power for the SKG13C is required. The input voltage Vcc should be 3.0V to 4.2V range, current is no less than 100mA. Suitable decoupling must be provided by external decoupling circuitry (10uF and 1uF). It can reduce the Noise from power supply and increase power stability.

Main power supply Vcc current varies according to the processor load and satellite acquisition. Maximum Vcc peak current is about 30 mA during acquisition.

Backup Battery Power

In case of a power failure on pin Vcc, real-time clock and backup RAM are supplied through pin V_BCKP. This enables the SKG13C GPS Receiver to recover from power failure with either a hot start or a warm start (depending on the duration of Vcc outage). If no Backup Battery is connected, the receiver performs a cold start upon powered up.

Backup Battery Power V_BCKP draws typically 7 uA current in backup state.

RESET

The SKG13C modules include a RESET pin. Driving RESET low activates a hardware reset of the system. RESET is only an input and will not reset external circuitry. At power down the reset is forced when the Vcc drops below 2.7V.

NOTE

If not used, leave RESET not connected (floating).

Antenna

The SKG13C GPS receiver is designed for supporting the active antenna or passive antenna connected with pin RF_IN. The gain of active antenna should be no more than 25dB (18~20dB Typical). The maximum noise figure should be no more than 1.5dB and output impedance is at 50 Ohm.

NOTE

With passive antenna keep the cable loss at minimum (<1dB).

Vcc_out

Antenna power output pin. When user wants to use external active antenna. The pin supply power for active antenna.

UART Ports

The module supports one full duplex serial channels UART. The serial connections are at 2.85V LVTTL logic levels, if need different voltage levels, use appropriate level shifters. the data format is however fixed: X, N, 8, 1, i.e. X baud rate, no parity, eight data bits and one stop bit, no other data formats are supported, LSB is sent first. The modules default baud rate is set up 9600bps. The RXD0 & TXD0 recommended to pull up (10KΩ). It can increase the stability of serial data.

EINT1

The default EINT1 function is Standby mode control but the function is not supported; leave signal floating (not connected).

RF_IN

The transmission line must to be control impedance from RF_IN pin to the antenna or antenna connector of your choice. (Impedance 50Ω)

32K CLK_OUT

The 32K Out can output 32.768KHz clock which can be used to support some peripherals that need an real time clock source, don't need an external crystal and cost saving. The pin also could be programmed to be input pin which can receive the signal from an external accelerator sensor or vibration sensor to be the wake -up signal of SKG13C when the module is in low power mode.

PPS

A pulse per second (1 PPS) is an electrical signal that very precisely indicates the start of a second. Depending on the source, properly operating PPS signals have an accuracy ranging 10ns. The PPS signals are used for precise timekeeping and time measurement.

FIXLED

The default FIXLED function is valid fix indicator output. Without a valid fix the signal is at low state; during valid

fix condition the signal outputs 50ms pulses every seconds

Advanced Software Features

Standby Mode

User can issue software command to make GPS module go into standby mode that consumes less than 200uA current. GPS module will be awaked when receiving any byte. The following flow chart is an example to make GPS module go into standby mode and then wake up.

Periodic Mode

When GPS module is commanded to periodic mode, it will be in operation and standby periodically. Its status of power consumption is as below chart
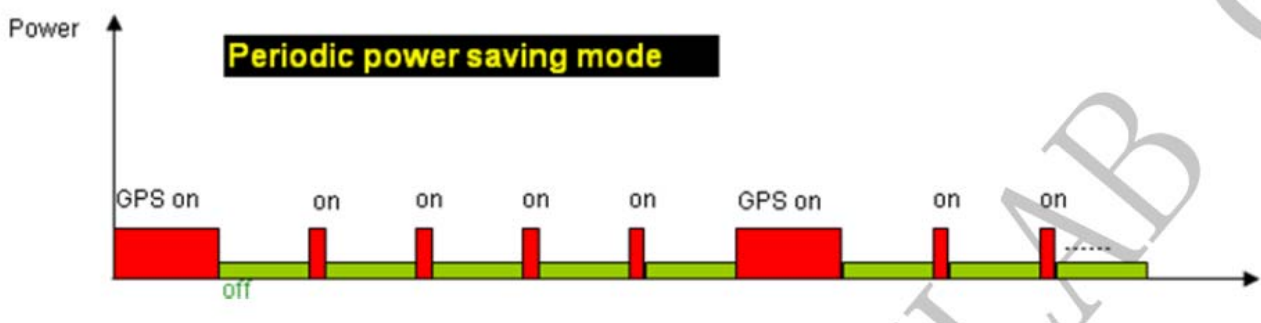
AlwaysLocate™

AlwaysLocateTM is an intelligent controller of periodic mode. Depending on the environment and motion conditions, GPS module can adaptively adjust working/standby time to achieve balance of positioning accuracy and power consumption. In this mode, the host CPU does not need to control GPS module until the host CPU needs the GPS position data. The following flow chart is an example to make GPS module go into AlwaysLocateTm mode and then back to normal operation mode.

AGPS Support for Fast TTFF (EPO™)

The AGPS (EPO™) supply the predicated Extended Prediction Orbit data to speed TTFF ,users can download the EPO data to GPS engine from the FTP server by internet or wireless network ,the GPS engine will use the EPO data to assist position calculation when the navigation information of satellites are not enough or weak signal zone .

EASY™

The EASY™ is embedded assist system for quick positioning, the GPS engine will calculate and predict automatically the single emperies (Max. up to 3 days)when power on ,and save the predict information into the memory , GPS engine will use these information for positioning if no enough information from satellites , so the function will be helpful for positioning and TTFF improvement under indoor or urban condition ,the Backup power (VBACKUP) is necessary .

Embedded Logger function

The Embedded Logger function don't need host CPU (MCU) and external flash to handle the operation , GPS Engine will use internal flash (embedded in GPS chipset) to log the GPS data (Data format : UTC, Latitude , longitude, Valid ,Checksum), the max log days can up to 2 days under AlwaysLocate™ condition .

AIC_Multi-tone active interference canceller

Because different application (Wi-Fi , GSM/GPRS,3G/4G,Bluetooth)are integrated into navigation system , the harmonic of RF signal will influence the GPS reception , The multi- tone active-interference canceller can reject external RF interference which come from other active components on the main board , to improve the capacity of GPS reception without any needed HW change in the design .SKG13C can cancel up to 12 independent channel interference continuous wave.

Performance Specification

Parameter	Specification	
Receiver Type	L1 frequency band, C/A code, 22 Tracking / 66 Acquisition-Channel	
Sensitivity	Tracking	-165dBm Typical
	Acquisition	-148dBm Typical
Accuracy	Position	3.0m CEP50 without SA(Typical Open Sky)
	Velocity	0.1m/s without SA
	Timing (PPS)	10ns RMS
Acquisition Time	Cold Start	23s(Typical Open Sky)
	Warm Start	2-3s
	Hot Start	1s
	Re-Acquisition	<1s
Assisted GPS support	EPO	
Power Consumption	Tracking	18mA @3.3V Typical
	Acquisition	22mA @3.3V
Navigation Data Update Rate	Max 10Hz	Default 1Hz
Operational Limits	Altitude	Max 18,000m
	Velocity	Max 515m/s
	Acceleration	Less than 4g

Electrical Characteristics

Absolute Maximum Rating

Parameter	Symbol	Min	Max	Units
Power Supply				
Power Supply Volt.	VCC	-0.3	4.3	V
Input Pins				

Input voltage on any input connection	VIO	-0.3	3.6	V
Backup Battery	V_BCKP	-0.3	4.3	V
RF input power	RF_IN		10	dBm
Human Body Model ESD capability	RF_IN		2000	V
Machine Model ESD capability	RF_IN		100	V
Environment				
Storage Temperature	Tstg	-40	125	˚C
Peak Reflow Soldering Temperature <10s	Tpeak		260	˚C
Humidity			95	%

Note: Absolute maximum ratings are stress ratings only, and functional operation at the maxims 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, refer to the operating conditions tables as follow.

The SKG13C module is Electrostatic Sensitive Device (ESD) and may be damaged with ESD or spike voltage. Although it has built-in ESD protection circuitry at digital I/O, please handle with care to avoid permanent malfunction or performance degradation. Note that RFIN has no ESD protection circuits.

Operating Conditions

Parameter	Symbol	Condition	Min	Typ	Max	Units
Power supply voltage	Vcc		3	3.3	4.2	V
Backup Battery	V_BCKP		2	3.3	4.2	V
Power supply voltage ripple	Vcc_PP	Vcc=3.3V			30	mV
Supply current, navigation	Icc	Vcc=3.3V		18	23	mA
Supply current, backup state	Ibckp	Vcc=3.3V		7		uA
VCC_OUT Antenna bias supply	VCC_OUT	I_{ANT} = 18 mA		3		V
Input high voltage	V_{IH}		2		3.6	V
Input low voltage	V_{IL}		-0.3		0.8	V
Output high voltage	V_{OH}		2.4		3.1	V
Output low voltage	V_{OL}		-0.3		0.4	V
Operating temperature	Topr		-40		85	˚C

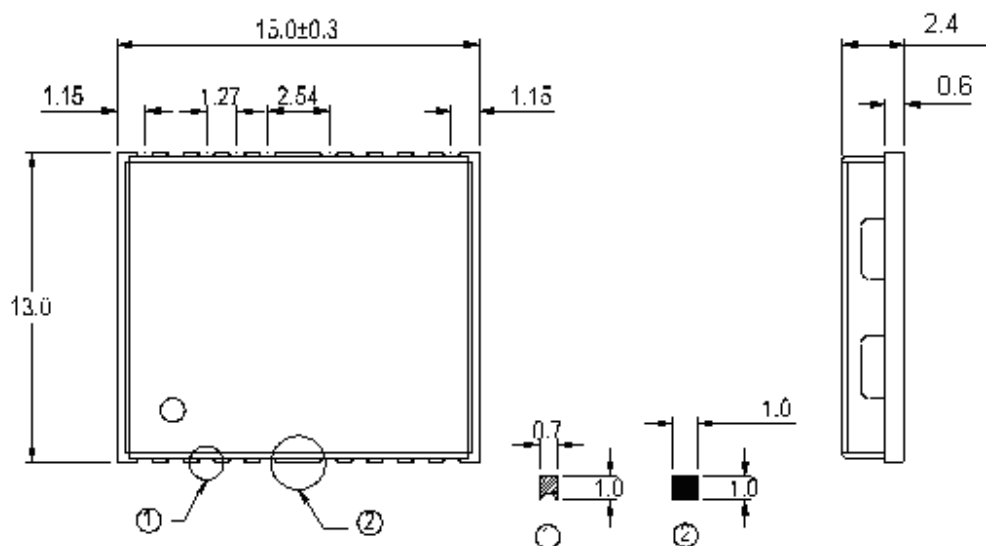## Mechanical Specification

Figure 3: SKG13C Dimensions
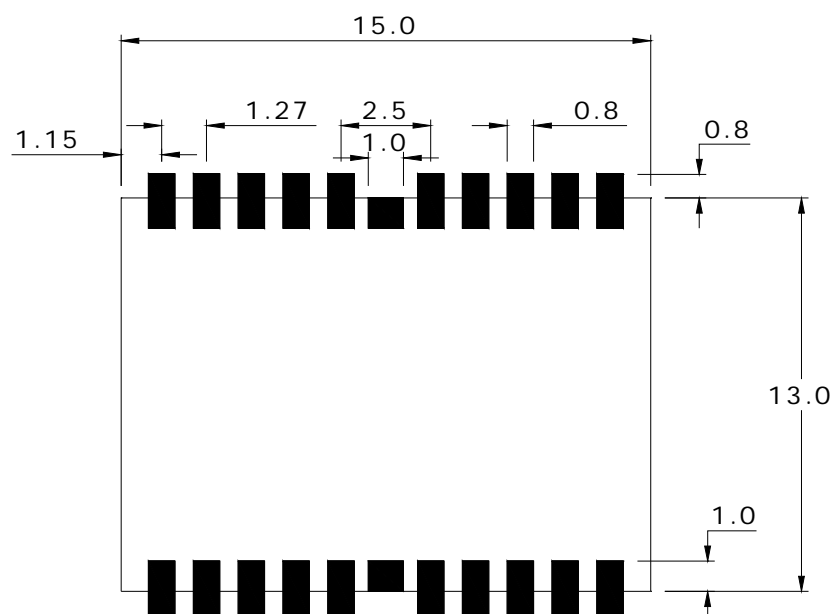
Recommend Layout

Figure 4: SKG13C Footprint
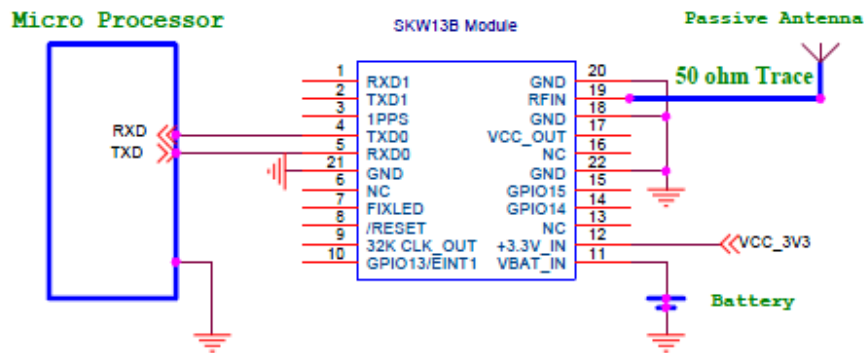
Reference design schematic

Figure 7: SKG13C application circuit that use passive antenna
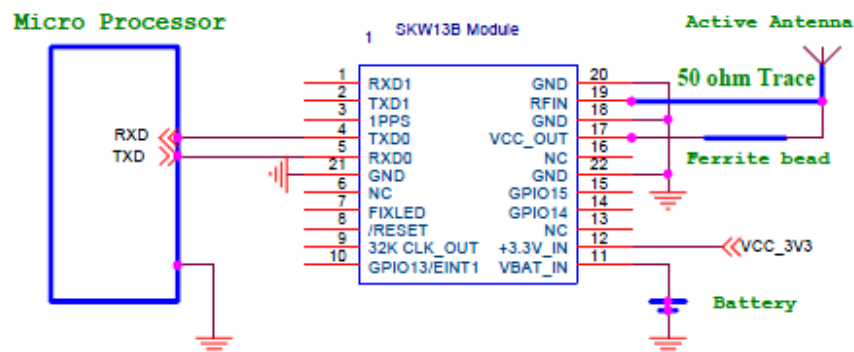

Figure 8: SKG13C application circuit that use active antenna

Packaging Specification

SKG13C modules are shipped in reel and with 1000 units per reel. Each tray is 'dry' package.

UNIT:mm

Figure 5: SKG13C Packaging

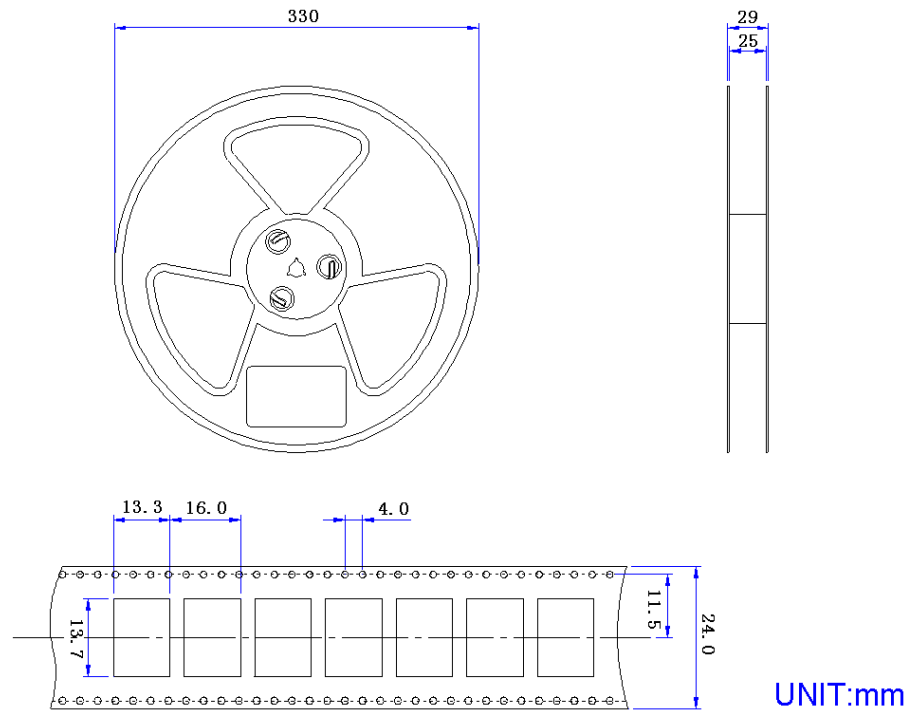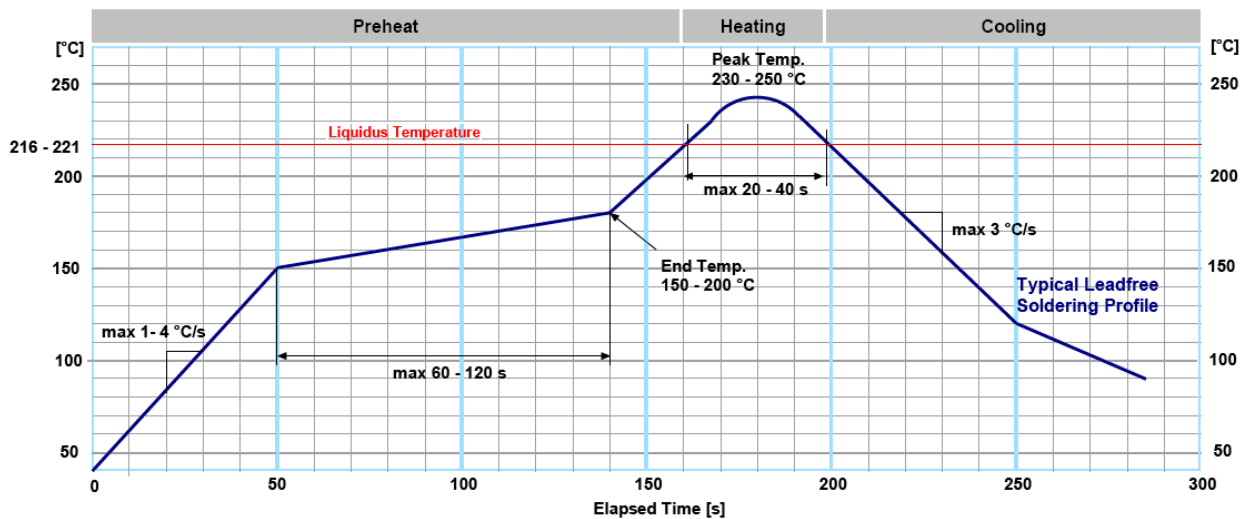## Manufacturing Process Recommendations

Figure 6: SKG13C Typical Leadfree Soldering Profile

Note：The final soldering temperature chosen at the factory depends on additional external factors like choice of soldering paste，size，thickness and properties of the baseboard，etc.　Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.

Software Protocol

NMEA 0183 Protocol

The NMEA protocol is an ASCII-based protocol, Records start with a $ and with carriage return/line feed. GPS specific messages all start with $GPxxx where xxx is a three-letter identifier of the message data that follows. NMEA messages have a checksum, which allows detection of corrupted data transfers.

The Skylab SKG13C supports the following NMEA-0183 messages: GGA, GSA, GSV, RMC. The module default NMEA-0183 output is set up GGA、GSA、RMC、GSV , and default baud rate is set up 9600bps.

Table 1: NMEA-0183 Output Messages

NMEA Record	Description	Default
GGA	Global positioning system fixed data	Y
GLL	Geographic position—latitude/longitude	N
GSA	GNSS DOP and active satellites	Y
GSV	GNSS satellites in view	Y
RMC	Recommended minimum specific GNSS data	Y
VTG	Course over ground and ground speed	N
ZDA	Date and Time	N

GGA-Global Positioning System Fixed Data

This sentence contains the position, time and quality of the navigation fix.

See RMC for Fix Status, Fix Mode, Fix Date, Speed, and True Course.

See GSA for Fix Type, PDOP, and VDOP.

$GPGGA,021514.000,2232.1799,N,11401.1823,E,1,6,1.25,84.0,M,-2.2,M,,*74

Table 2: GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	021514.000		hhmmss.sss
Latitude	2232.1799		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	11401.1823		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 2-1
Satellites Used	6		Range 0 to 12
HDOP	1.25		Horizontal Dilution of Precision
MSL Altitude	84.0	meters	Altitude (referenced to the Ellipsoid)
AltUnit	M	meters	Altitude Unit
GeoSep	-2.2	meters	Geoidal Separation
GeoSepUnit	M	meters	Geoidal Separation Unit
Age of Diff.Corr.	<Null>	second	Null fields when it is not Used

Diff.Ref.Station ID	\<Null\>		Null fields when it is not Used
Checksum	*74		
EOL	\<CR\> \<LF\>		End of message termination

Table 2-1: Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

GLL-Geographic Position – Latitude/Longitude

This sentence contains the fix latitude and longitude.

$GPGLL,2232.1799,N,11401.1824,E,021513.000,A,A*50

Table 3: GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2232.1799		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	11401.1824		dddmm.mmmm
E/W Indicator	E		E=east or W=west
UTC Position	021513.000		hhmmss.sss
Fix Status	A		A=data valid or V=data not valid
Fix Mode	A		A=autonomous, N = No fix, D=DGPS, E=DR
Checksum	*50		
EOL	\<CR\> \<LF\>		End of message temination

GSA-GNSS DOP and Active Satellites

This sentence contains the mode of operation, type of fix, PRNs of the satellites used in the solution as well as PDOP, HDOP and VDOP.

$GPGSA,A,3,26,05,18,15,27,29,,,,,,,1.52,1.25,0.87*0F

Table 4: GSA Data Format

Name	Example	Units	Description
Message	$GPGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
ID of satellite used	26		Sv on Channel 1
ID of satellite used	05		Sv on Channel 2
…	…		…
ID of satellite used	\<Null\>		Sv on Channel 12 (Null fields when it is not Used)
PDOP	1.52		Position Dilution of Precision

HDOP	1.25		Horizontal Dilution of Precision
VDOP	0.87		Vertical Dilution of Precision
Checksum	*0F		
EOL	\<CR\> \<LF\>		End of message termination

Table 4-1: Mode 1

Value	Description
1	Fix not available
2	2D Fix
3	3D Fix

Table 4-2: Mode 2

Value	Description
M	Manual-forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

GSV-GNSS Satellites in View

This sentence contains the PRNs, azimuth, elevation, and signal strength of all satellites in view.

$GPGSV,3,1,12,15,79,333,42,42,50,127,,29,45,263,44,02,36,124,30*7E

$GPGSV,3,2,12,26,36,226,34,05,35,046,22,27,33,161,29,21,16,319,*7D

$GPGSV,3,3,12,10,15,066,31,18,14,285,45,24,12,319,15,08,09,047,18*7E

Table 5: GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Message	3		Total number of GSV sentences (Range 1 to 3)
Message Number	1		Sentence number of the total (Range 1 to 3)
Satellites in View	12		Number of satellites in view
Satellite ID	15		Channel 1(Range 01 to 32)
Elevation	79	degrees	Channel 1(Range 00 to 90)
Azinmuth	333	degrees	Channel 1(Range 000 to 359)
SNR(C/NO)	42	dB-Hz	Channel 1(Range 00 to 99, null when not tracking)
…			…
Satellite ID	02		Channel 4(Range 01 to 32)
Elevation	36	degrees	Channel 4(Range 00 to 90)
Azimuth	124	degrees	Channel 4(Range 000 to 359)
SNR(C/NO)	30	dB-Hz	Channel 4(Range 00 to 99, null when not tracking)
Checksum	*7E		
EOL	\<CR\> \<LF\>		End of message termination

Depending on the number of satellites tracked multiple messages of GSV data may be required.

RMC-Recommended Minimum Specific GNSS Data

This sentence contains the recommended minimum fix information.

See GGA for Fix Quality, Sats Used, HDOP, Altitude, Geoidal Separation, and DGPS data.

See GSA for Fix Type, PDOP and VDOP.

$GPRMC,023345.000,A,2232.1767,N,11401.1953,E,0.18,151.55,100410,,,A*6B

Table 6: RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTS Position	023345.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2232.1767		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	11401.1953		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed Over Ground	0.18	Knots	
Course Over Ground	151.55	Degrees	True Course
Date(UTC)	100410		ddmmyy
Magnetic variation	<Null>	Degrees	Null fields when it is not Used
Magnetic Variation Direction	<Null>		E=east or W=west (Null fields when it is not Used)
Fix Mode	A		A=autonomous, N = No fix, D=DGPS, E=DR
Checksum	*6B		
EOL	<CR> <LF>		End of message termination

VTG-Course Over Ground and Ground Speed

This sentence contains the course and speed of the navigation solution.

$GPVTG,148.81,T,,M,0.13,N,0.24,K,A*3D

Table 7: VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Tcourse	148.81	Degrees	True Course
Reference	T		T = True
Mcourse	<Null>	Degrees	Magnetic Course (Null fields when it is not Used)
Reference	M		M = Magnetic (Null fields when it is not Used)
Speed over ground	0.13	Knots	Nautical Miles per Hour
Units	N		Knots
Speed over ground	0.24	Km/hr	in Kilometers per Hour
Units	K		Kilometer per hour
Mode	A		A=Autonomous, N=No fix, D=DGPS, E=DR
Checksum	*3D		
EOL	<CR> <LF>		End of message termination

ZDA-Date and Time

This sentence contains UTC date & time, and local time zone offset information.

$GPZDA,023345.000,10,04,2010,,*50

Table 8: ZDA Data Format

Name	Example	Units	Description
Message ID	$GPZDA		ZDA protocol header
UTC Time	023345.000		hhmmss.sss
Day	10		UTC time: day (01 ... 31) dd
Month	04		UTC time: month (01 ... 12) mm
Year	2010		UTC time: year (4 digit year) yyyy
local zone hours	<null>		Local Time Zone Offset Hours (Null fields when it is not Used)
local zone minutes	<null>		Local Time Zone Offset Minutes (Null fields when it is not Used)
Checksum	*50		
EOL	<CR> <LF>		End of message termination

Skylab M&C Technology Co., Ltd.