YIC

GPS & GLONASS Antenna Module

YIC51616GMSGG-33

Datasheet

Revision History

Date	Reversion	Description
2022/12/20	1.0	First Draft, Based on YIC51616GMSGG-33
2024/03/28	2.0	Add PCB Design Guide Note

Directory

1. Product Information

1.1 Product Description

YIC51616GMSGG-33 GPS&GLONASS module with an embedded patch antenna and LNA brings high performance of MTK positioning engine to the industrial applications. It is able to achieve the industry's highest level of sensitivity, accuracy and TTFF with the lowest power consumption in a small-footprint leadless package. With 66 search channels and 22 simultaneous tracking channels, it acquires and tracks satellites in the shortest time even at indoor signal level. The embedded flash memory provides capacity for users to store some useful navigation data and allows for future updates.

YIC51616GMSGG-33 module combines many advanced features including EASY, AIC, LOCUS, AlwaysLocate™, FLP,Antenna Supervisor and so on. These features are beneficial to accelerate TTFF, improve sensitivity,save consumption and detect antenna status for GPS&GLONASS system. The module supports various positioning, navigation and industrial applications including autonomous GPS,GLONASS, SBAS (including WAAS, EGNOS, MSAS, and GAGAN), QZSS, and AGNSS

YIC51616GMSGG-33 simplifies the device's design and cost because of embedded Patch Antenna and LNA. Furthermore, YIC51616GMSGG-33 not only supports automatic antenna switching function which can achieve switching between external active antenna and internal patch antenna, but also supports external active antenna detection and short protection. The detection and notification of different external active antenna status will be shown in the NMEA message including external active antenna connection, open circuit for antenna and antenna shortage. So host can query the external active antenna status timely and conveniently.

EASY technology as the key feature of YIC51616GMSGG-33 is one kind of AGNSS. Capable collecting and processing all internal aiding information like GPS&GLONASS time, Ephemeris, Last Position,etc.,the GPS&GLONASS module delivers a very short TTFF in either Hot or Warm start.

YIC51616GMSGG-33 module is a SMD type module with the compact 16mm × 16mm ×7mm form factor. It can be embedded in your applications through the 12-pin pads with 2.54mm pitch. It provides necessary hardware interfaces for connection with the main PCB.

The module is fully RoHS compliant to EU regulation.

Applications

- LBS (Location Based Service)

- PND (Portable Navigation Device)

- Vehicle navigation system

- Mobile phone

1.2 Product Features

- Build on high performance, low-power MediaTek chip set
- Ultra high Track sensitivity: -165dBm
- Extremely fast TTFF at low signal level
- Built-in high gain LNA
- SMD type with stamp holes
- Low power consumption: Max 28mA@3.3V
- Operating voltage: 2.8V to 4.3V
- Operating temperature range:-40 to 85℃
- NMEA-0183 compliant protocol or custom protocol
- Patch Antenna Size: 15x15x4mm
- Small form factor: 16±0.5x16±0.5x7±0.3mm
- Communication type: UART/TTL
- RoHS Compliant (Lead-free)
- Supports external active antenna detection and short protection

1.3 Product Specifications

GPS Receiver		
Chip	MediaTek	
Receiver Type	Code 66 search channels, 22 synchronous tracking channels GPS&, QZSS, GALILEO: L1 1575.42MHz C/A GLONASS: L1OF 1602MHz SBAS: WAAS, EGNOS, MSAS, GAGAN	
Sensitivity	Tracking	-165dBm
	Re-acquisition	-156dBm
	Acquisition	-148dBm
TTFF(EASY enabled)	Cold start	14s typ @-130dBm
	Hot start	1s typ @-130dBm
TTFF (EASY disabled)	Cold start (Autonomous)	34s typ @-130dBm
	Hot start (Autonomous)	1s typ @-130dBm
Horizontal Position Accuracy (Autonomous)	<2.5m CEP @-130 dBm	
Update Rate	Up to 10Hz,1Hz by default	
Accuracy of 1PPS Signal	Typical accuracy: ±10ns	
	Time pulse width 100ms	
Acceleration Accuracy	Without aid	0.1m/s²
Dynamic Performance	Maximum altitude	18,000m
	Maximum velocity	515m/s
	Acceleration	4G
UART Port	UART Port: TXD and RXD 9600bps (default), Supports baud rate 4800bps to 115200bps.. UART port is used for NMEA output,MTK proprietary commands input and firmware upgrade	
Temperature Range	Operation temperature	-40°C ~ +85°C
	Storage temperature	-45°C ~ +125°C
Physical Characteristics	Size	16±0.5 × 16±0.5 × 7±0.3mm
	Weight	Approx. 6.0g

1.4 DC Electrical Characteristics

Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
Vcc	Supply voltage	Voltage must stay within the min/max values,including voltage drop,ripple,and spikes	2.8	3.3	4.3	V
IVCCP	Peak supply current	VCC=3.3V			100	mA
V_BCKP	Backup voltage supply		1.5	3.3	4.3	V
TOPR	Normal operating temperature		-40	25	80	$^\circ$C

Current Consumption:

Parameter	Conditions	Min.	Typ.	Max.	Units
I_{VCC}@Acquisition	VCC=V BCKP=3.3V		28		mA
I_{VCC}@Tracking	VCC=VBAT=3.3V		31		mA
I_{VCC}@Standby	VCC=VBAT=3.3V		2		mA
I_{BACK}@Backup	VBAT=3.3V		18		uA

The tracking current is tested in the following conditions:

- In Cold Start, 1 minutes after First Fix.
- In Hot Start, 5 seconds after First Fix.

Absolute Maximum Ratings:

Absolute maximum ratings for power supply and voltage on digital pins of the module are listed in the following table.

values within the specified boundaries by using appropriate protection diodes.

Parameter	Minimum	Maximum	Condition
Supply Voltage	-0.3	4.3	Volt
Backup Battery Voltage (V BCKP)	-0.3	4.3	Volt
Input Voltage at Digital Pins	-0.3	3.6	Volt
Input Power at EX_ANT		15	dBm
Storage Temperature	-45	125	degC

Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against over voltage or reversed voltage. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

YIC5 Series

2. Block Diagram

The following figure shows a block diagram of YIC51616GMSGG-33 module. It consists of a single chip GPS&GLONASS IC which includes the RF part and Baseband part, a SPDT, a patch antenna, a LNA, a SAW filter, a TCXO, a crystal oscillator, short protection and antenna detection circuit for active antenna.
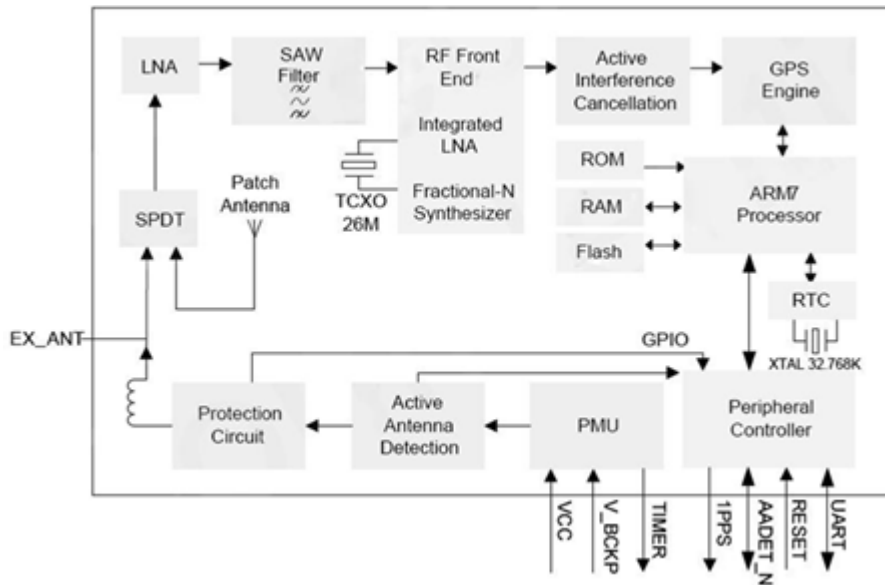

Figure 1: Block Diagram

2.1 Protocols Supported by the Module

Protocol	Type
NMEA	Output, ASCII, 0183, 3.01
PMTK	Input, MTK proprietary protocol

3. Module Pin Assignment

The module is equipped with a 12-pin 2.54mm pitch SMT pad that connects to your application platform. Sub-interfaces included in the pad are described in details in the following chapters.
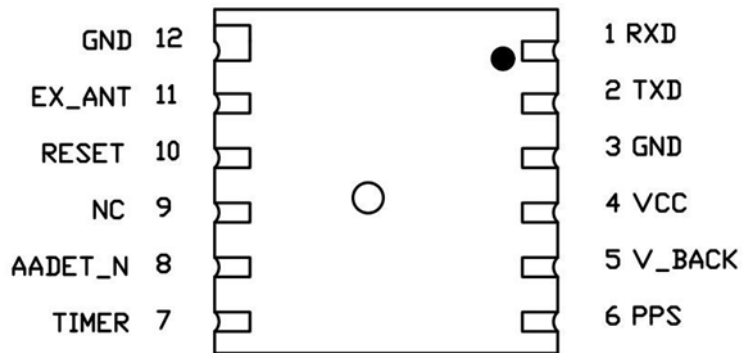

Figure 2: Pin Assignment

3.1 Pin Descriptions

Pin No.	Pin Name	I/O	DC Characteristics	Remark
1	RXD	I	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.6V	Receive data
2	TXD	O	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=3.1V	Transmit data
3	GND	G		Ground
4	Vcc	I		Module Power Supply
5	V_BCKP	I	Vmax=4.3V Vmin=1.5V Vnom=3.3V	Backup power supply. The V_BCKP pin can Backup power supply be directly supplied power by battery or connect it to VCC
6	1PPS	O	VOLmin=-0.3V VOLmax=0.4V VOHmin=2.4V VOHmax=3.1V	One pulse per second Synchronized at rising edge, the pulse width is 100ms. If unused, keep this pin open.
7	TIMER	O	VOLmin=-0.3V VOLmax=0.4V VOHmin=1.1V VOHmax=3.1V	An open drain output signal can be used to control GPS & GLONASS module main power on/off. It belongs to RTC domain. If unused, keep this pin open or connect to Ground externally.
8	AADET_N	I/O	VOLmax=0.7V VOHmin=1.3V	Active antenna detection. If unused, keep this pin open.
9	NC	N		Not connected
10	RESET	I	VILmin=-0.3V VILmax=0.8V VIHmin=2.0V VIHmax=3.6V	System reset. If unused, keep this pin open or connect it to VCC
11	EX_ANT	I		External active antenna RF input .If unused, keep this pin open. Refer to chapter 4.1 & 4.3
12	GND	G		Ground

3.2 Power Supply

VCC pin supplies power for BB, RF, I/O, LNA, short protection and antenna detection circuit. The load current of VCC varies according to the VCC level, processor load, the number of tracked satellites and the rate of satellite re-acquisition. Using external active antenna will consume additional 10mA from our module. So it is important to supply sufficient current and make the power clean and stable. VCC supply ripple voltage should meet the requirement: 54mV (RMS) max @f=0 … 3MHz and 15mV (RMS) max@f >3MHz. You should choose the LDO without built-in output high-speed discharge function to keep long output voltage drop-down period. The decouple combination of 10uF and 100nF capacitor is recommended nearby VCC pin.

The V_BCKP pin supplies power for RTC domain. It should be valid when power on the module. The voltage of RTC domain ranges from 1.5V to 4.3V. In order to achieve a better TTFF, RTC domain should be valid all the time. It can supply power for SRAM memory in RTC domain which contains all the necessary GPS & GLONASS information for quick start-up and a small amount of user configuration variables.

● The module's internal power construction is shown as below.

VCC supplies power for PMU, and V_BCKP supplies power for RTC domain. TIMER signal highlighted in red in the following figure belongs to RTC domain and can be used to control the power switch on/off.
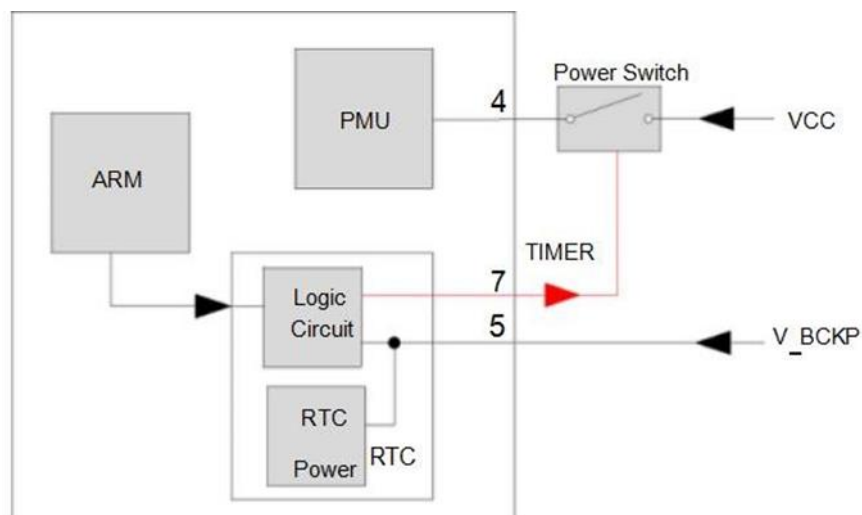
Figure 3 : Internal Power Construction

● Power supply solutions for YIC51616GMSGG-33 module are listed as the following.

The simplest power circuit for YIC51616GMSGG-33 module is 3.3V power source connected to VCC pin and V_BCKP pin of the module directly. In this case, once you powered on the module, the full cold start will be implemented.
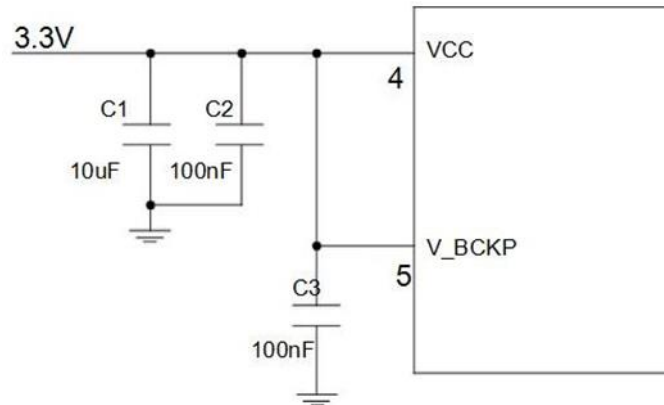

Figure 4: Reference Circuit for Power Supply

If your power supply circuit adopts the design mentioned above , YIC51616GMSGG-33 module does not support EASY technology and backup mode as well as other modes related to it,e.g. AlwaysLocate™ backup mode.

The other way is feeding V_BCKP through a backup battery directly. The module will enter into backup mode when power source (3.3V) is cut off. Furthermore, it is necessary to add an external charging circuit for rechargeable battery. The detailed schematic (mount R2 with 0R to replace Power switch) is shown as there is no charge source when power source (3.3V) is cut off. MS621FE FL11E from Seiko is recommended. The consumption of V_BCKP is as low as 7uA in backup mode.

The schematic with power supply circuit is shown as below. As power source (3.3V) is always valid and the battery is charged continuously, the capacity of the battery can be small. The detailed schematic for power switch circuit is shown in *Figure 5.*

For more details about backup mode, periodic backup mode and AlwaysLocate™ backup mode, please refer to the related chapters.
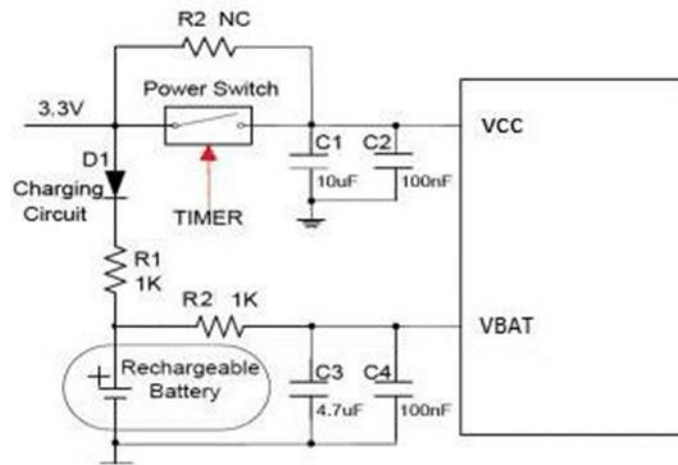
Figure 5: Reference Charging Circuit for Chargeable Battery

VCC does not supply power for RTC domain in YIC51616GMSGG-33 module, so the V_BCKP pin must be powered externally. Furthermore, it is strongly recommended to supply power to V_BCKP through a backup battery, which can ensure YIC51616GMSGG-33 module supports EASY technology and improves TTFF after next restart. For details about TTFF, please refer to *chapter1.3.*

3.3 Operating Modes

The table below briefly illustrates the relationship among different operating modes of
YIC51616GMSGG-33module.

Module Status switch

Current Mode	Next Mode					
	Backup	Standby	Full on	Periodic	Alwayslocate	FLP
Backup	N/A	N/A	Refer to Chapter3.3.3	N/A	N/A	N/A
Standby	N/A	N/A	Send any data via Uart	N/A	N/A	N/A
Full on	Refer to Chapter3.3.3	PMTK161	N/A	PMTK225	PMTK225	PMTK266
Periodic	N/A	N/A	Refer to Chapter3.3.4	N/A	N/A	N/A
Always Locate	N/A	N/A	Refer to Chapter3.3.5	N/A	N/A	N/A
FLP	N/A	N/A	Refer to Chapter3.3.6	N/A	N/A	N/A

3.3.1 Full on Mode

Full on mode includes tracking mode and acquisition mode. Acquisition mode is defined as the module starts to search satellites, determine visible satellites and coarse carrier frequency as well as code phase of satellite signals. When the acquisition is completed, it switches to tracking mode automatically. Tracking mode is defined as the module keeps tracking satellites and demodulates the navigation data from the specific satellites.

When the combination of VCC and V_BCKP is valid, the module will enter into full on mode automatically and follow the default configurations as below. You can refer to *chapter 3.2* about internal power construction to have a good comprehension. You can also use PMTK commands to change the configurations to satisfy your requirements.

Default Configurations

Item	Configuration	Comment
Baud Rate	9600bps	Can be configured as 4800bps~115200bps
Protocol	NMEA	RMC, VTG, GGA, GSA, GSV, GLL and GPTXT（MTK proprietary protocol）
Update Rate	1Hz	Can be configured as 1~10Hz
SBAS	Enable	
AIC	Enable	
LOCUS	Disable	
EASY	Disable	EASY will be disabled automatically when update rate exceeds 1Hz.

3.3.2 Standby Mode

Standby mode is a low-power consumption mode. In standby mode, the internal core and I/O power domain are still active, but RF and TCXO are powered off, and the module stops satellites search and navigation. UART is still accessible through PMTK commands or any other data, but there is no NMEA messages output.

Sending PMTK command "$PMTK161,0*28" will make YIC51616GMSGG-33 module enter into standby mode. Sending any data via UART can wake the module up. When the module exits from standby mode, it will use all internal aiding information like GPS&GLONASS time, Ephemeris, Last Position, etc., resulting to the fastest possible TTFF in either Hot or Warm start. The typical standby current consumption in this way is about 2mA @VCC=3.3V.

When the external active antenna is used, an additional 10mA will be consumed because the VCC still suppliespower for external active antenna in standby mode.

3.3.3 Backup Mode

Backup mode consumes lower power than standby mode. In this mode, only the backup supply V_BCKP is powered on while the main supply VCC is switched off by host or the TIMER signal of YIC51616GMSGG-33. In order to enter into backup mode autonomously via the TIMER pin, an external switch circuit is necessary. The following figure has shown a typical reference design about the switch circuit for TIMER.
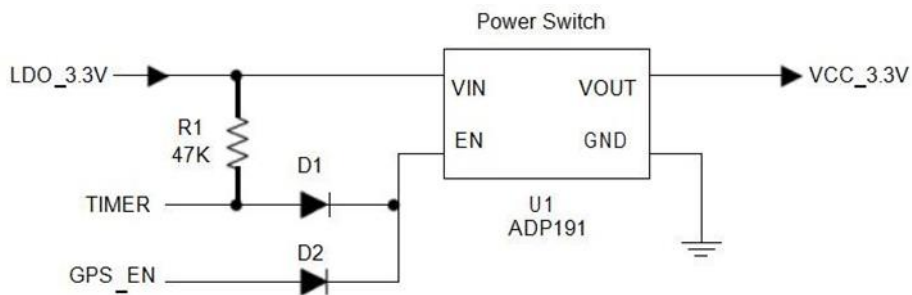

Figure 6: The External Switch Circuit for TIMER

- U1 is an integrated power switch component. The part number ADP191 is recommended. U1 also can bereplaced by discrete components.

- TIMER pin also can be used to control the EN pin of a LDO.

- TIMER and GPS_EN signals form an "OR" logic via the Schottky diodes D1 and D2. GPS_EN is a GPIO signal coming from the host.
- TIMER is an open drain output signal. When TIMER pin is used, please pull it high by using an external resistor.R1 is the pull-up resistor for TIMER signal.

Keeping GPS_EN signal low and sending PMTK command "$PMTK225,4*2F" will make YIC51616GMSGG-33 module enter into backup mode forever. When this command is executed successfully, TIMER signal will be pulled down to close the power switch, so YIC51616GMSGG-33 module can go into backup mode as the main power VCC is cut off. For this case, pulling the GPS_EN signal high by host is the only way to wake the module up.

In backup mode, YIC51616GMSGG-33 module stops to acquire and track satellites. UART is not accessible. But the backed-up memory in RTC domain which contains all the necessary GPS&GLONASS information for quick start up and a small amount of user configuration variables is alive. Due to the backed up memory, EASY technology is available. The typical consumption in backup mode can be as ow as 15uA.

As the main power supply for V_BCKP pin is battery. Coin-type rechargeable capacitor such as MS920SE from Seiko can be used and Schottky diode such as RB520S30T1G from ON Semiconductor is recommended to be used here for its low voltage drop.
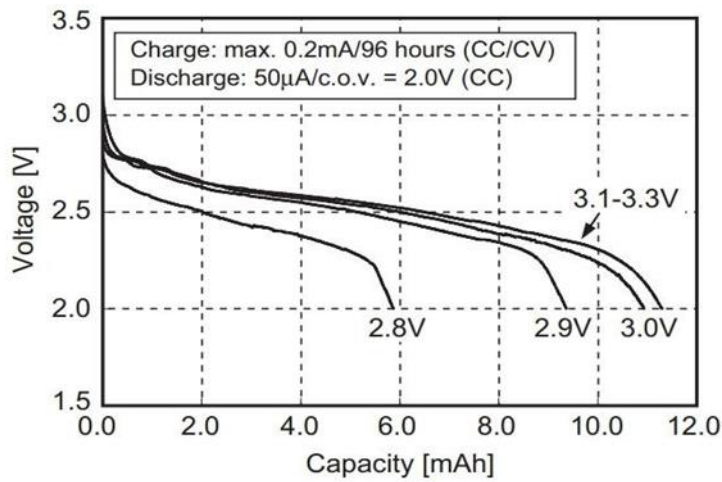

Figure 7: Seiko MS920SE Charge and Discharge Characteristics

3.3.4 Periodic Mode

Periodic mode is a power saving mode of YIC51616GMSGG-33 that can control the full on mode and standby/backup mode periodically to reduce power consumption. It contains periodic standby mode and periodic backup mode.

● The format of the command which enables the module to enter into periodic mode is as follows:

PMTK Command Format

Format:

$PMTK225,<Type>,<Run_time>,<Sleep_time>,<2nd_run_time>,<2nd_sleep_time>*<checksum>
< CR><LF>

Parameter	Format	Description
Type	Decimal	Type=1 for Periodic Backup Mode
		Type=2 for Periodic Standby Mode
Run_time	Decimal	Full on mode period (ms)
Sleep_time	Decimal	Standby/Backup mode period (ms)
2nd_run_time	Decimal	Full on mode period (ms) for extended acquisition in case GPS&GLONASS module's acquisition fails during the Run_time
2nd_sleep_time	Decimal	Standby/Backup mode period (ms) for extended sleep in case GPS&GLONASS module's acquisition fails during the Run_time
Checksum	Hexadecimal	Hexadecimal checksum

Example

$PMTK225,1,3000,12000,18000,72000*16<CR><LF>

$PMTK225,2,3000,12000,18000,72000*15<CR><LF>

Sending "$PMTK225,0*2B" in any time will make the module enter into full on mode from periodic standby mode.

Sending "$PMTK225,0*2B" just in **Run_time** or **2nd_run_time** can make the module enter into full on mode from periodic backup mode.

- The precondition is that the external switch circuit supports periodic backup mode. For details, please refer to *chapter 3.3.3.*
- Before entering into periodic backup mode, please ensure the GPS_EN signal is low and power supply for VBCKP is alive.

The following figure has shown the operation of periodic mode. When you send PMTK command, the module will be in the full on mode firstly. After several minutes, the module will enter into the periodic mode and follow the parameters set by you. When the module fails to fix the position in **run_time**, the module will switch to **2nd_run_time** and **2nd_sleep_time** automatically. As long as the module fixes the position again, the module will return to **Run_time** and **Sleep_time**.

Please ensure the module is in the tracking state before entering into periodic mode. Otherwise, the module will have a risk of failure to track the satellites. If GPS&GLONASS module is located in weak signal environment, it is better to set a longer **2nd_run_time** to ensure the success of re-acquisition.

The average current value can be calculated by the following formula:

I periodic= (I tracking× T1+Istandby/backup× T2)/ (T1+T2) T1: **Run_time**, T2: **Sleep_time**

Example

PMTK225,2,3000,12000,18000,72000*15 for periodic mode with 3s in tracking mode and 12s in standby mode.

The average current consumption is calculated below:

I periodic= (I tracking× T1+I standby× T2)/(T1+T2)=(20mA× 3s + 1mA× 12s)/(3s+12s)≈4.8 (mA)

PMTK225,1,3000,12000,18000,72000*16 for periodic mode with 3s in tracking mode and 12s in backupmode. The average current consumption is calculated below:

I periodic= (I tracking× T1+I backup× T2)/ (T1+T2)=(20mA× 3s + 0.007mA× 12s)/(3s+12s)≈4.0 (mA)
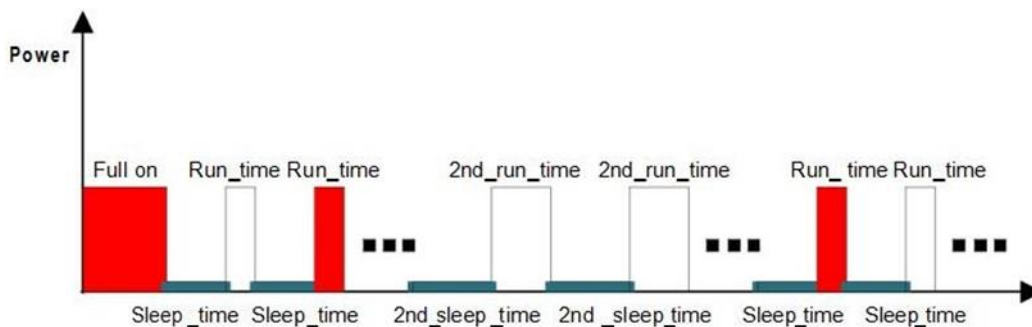

Figure 8: Periodic Mode

3.3.5 AlwaysLocate™ Mode

AlwaysLocate™ is an intelligent power saving mode. It contains AlwaysLocate™ backup mode and AlwaysLocate™standby mode.

AlwaysLocate™ standby mode allows the module to switch automatically between full on mode and standby mode. According to the environmental and motion conditions, the module can adaptively adjust the full on time and standby time to achieve a balance between positioning accuracy and power consumption. Sending"$PMTK225,8*23"and the module returning: "$PMTK001,225,3*35 "means the module accesses AlwaysLocate ™ standby mode successfully. It will benefit power saving in this mode. Sending "$PMTK225,0*2B" in any time will make the module back to full on mode.

AlwaysLocate™ backup mode is similar to AlwaysLocate™ standby mode. The difference is that AlwaysLocate™backup mode can switch between full on mode and backup mode automatically. The PMTK command to enter into AlwaysLocate ™ backup mode is "$PMTK225,9*22".The module can exit from AlwaysLocate ™ backup mode by command "$PMTK225,0*2B" sent just after the module has been waked up from previous backup cycle.

The positioning accuracy in AlwaysLocate ™ mode will be somewhat degraded, especially in high speed. The following picture shows the rough power consumption of YIC51616GMSGG-33 module in different daily scenes when AlwaysLocate™ mode is enabled.
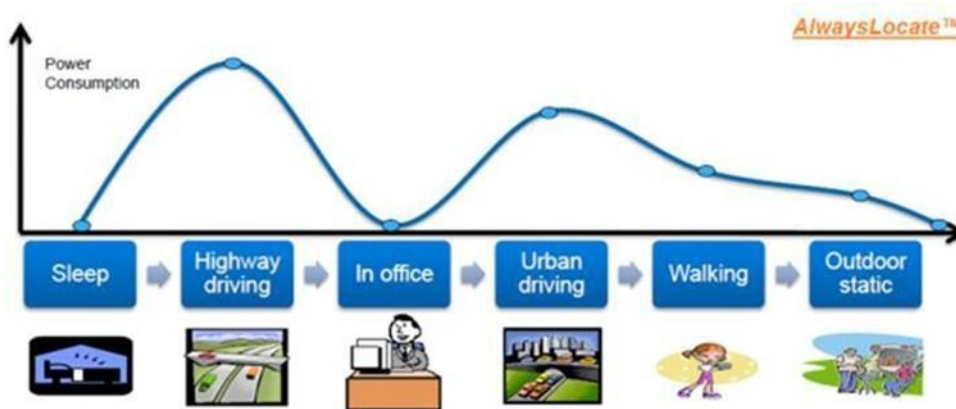

Figure 9: AlwaysLocate™ Mode

Example

   The typical average consumption is about 3.5mA in AlwaysLocate™ standby mode and 3.0mA in AlwaysLocate™backup mode.

- Power consumption is measured under outdoor static mode with patch antenna. Using external active antennawill increase the power consumption.
- Before entering into periodic backup mode, please ensure the GPS_EN signal is low and power supply forV_BCKP is alive.

3.3.6 FLP Mode

The Fitness Low Power (FLP) feature provides low power GPS&GLONASS solution for fitness application. FLP is a duty cycle concept to achieve low power target. It is specifically designed for walking/running/cycling applications.

FLP function is disabled by default. You can enable FLP by SDK or PMTK command. Sending "$PMTK262,1*29" will enable FLP function, and wait until YIC51616GMSGG-33 module gets a valid fix. Then wait at least 60s for YIC51616GMSGG-33 to enter FLP mode. FLP function will be disabled after sending "$PMTK262,0*28".

Average Current for FLP Mode and Tracking Mode of YIC51616GMSGG-33.

Scenario	In FLP Mode (mA)	In Tracking Mode (mA)
Static	21.1	31.5
Walking	20.7	31.5
Running	20.5	31.5
Driving	21.2	31.5

- The EASY and FLP function cannot work at the same time. When you enable FLP by SDK or PMTK command,the EASY function will be disabled automatically.
- SBAS data downloading will be influenced by FLP function. It is suggested that you should disable the SBASwhile enabling FLP mode.
- The power consumption is measured in the open sky under different states of motion.
- The current is the average of multiple measurements.

3.4 Reset

YIC51616GMSGG-33 module can be restarted by driving the RESET to a low level voltage for a certain time and then releasing it. This operation will reset the digital part of the GPS&GLONASS receiver. Note that Non-Volatile Backup RAM content is not cleared an d thus fast TTFF is possible. An OC driver circuit shown as below is recommended to control the RESET.
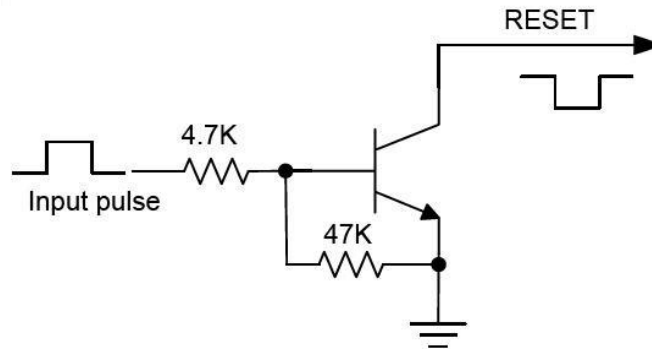

Figure 10: Reference Reset Circuit Using OC Circuit

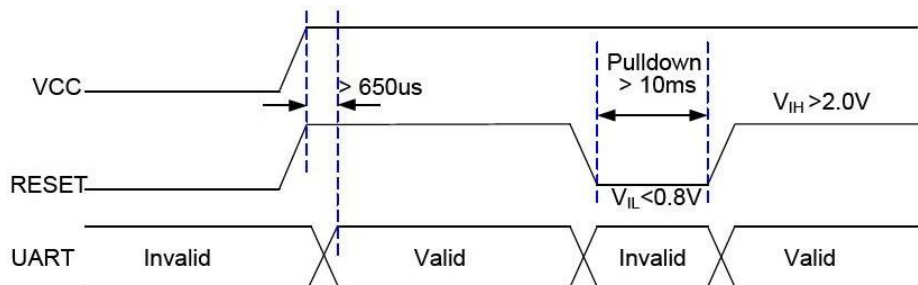● The restart timing of YIC51616GMSGG-33 has been illustrated bellow.

Figure 11: Restart Timing

3.5 UART Interface

The module provides one universal asynchronous receiver& transmitter serial port. The module is designed as DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the signals shown in the following figure. It supports data baud-rate from 4800bps to 115200bps.

UART port:

TXD: Send data to the RXD1 signal line of DTE.
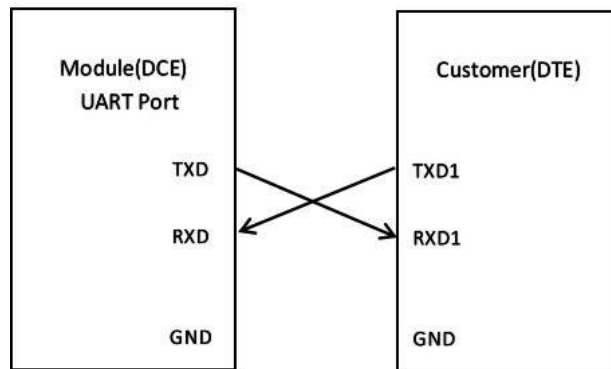RXD: Receive data from the TXD1 signal line of DTE.

Figure 12: Connection of Serial Interfaces

This UART port has the following features:

- UART port can be used for firmware upgrade, NMEA output and PMTK proprietary commands input.
- The default output NMEA type setting is RMC, VTG, GGA, GSA, GSV, GLL and GPTXT (MTK proprietaryprotocol).
- UART port supports the following data rates:
  4800, 9600, 14400, 19200, 38400, 57600, 115200bps.
  The default setting is 9600bps, 8 bits, no parity bit, 1 stop bit.
- Hardware flow control and synchronous operation are not supported.

The UART port does not support the RS-232 level but only CMOS level. If the module's UART port is connected to the UART/RS-232 port of a computer, it is necessary to add a level shift circuit between the module and the computer. Please refer to the following figure.
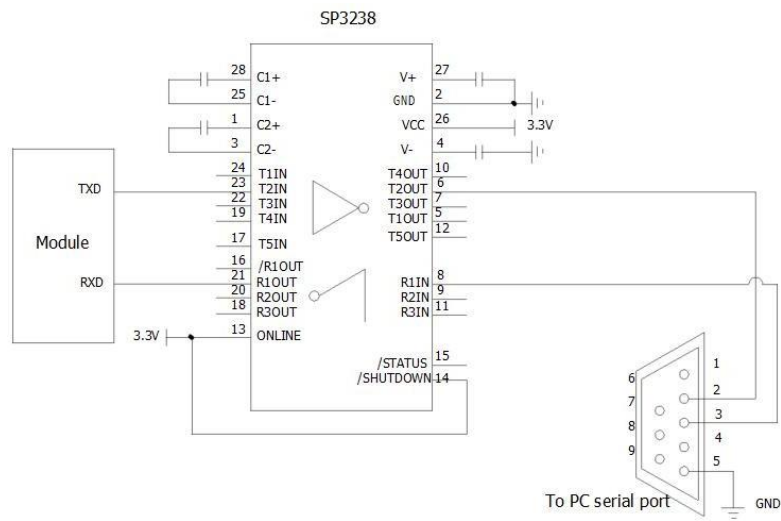
Figure 13 : RS-232 Level Shift Circuit

3.6 EASY Technology

EASY technology works as embedded software which can accelerate TTFF by predicting satellite navigation messages from received ephemeris. The GPS&GLONASS engine will calculate and predict orbit.

information automatically up to 3 days after first receiving the broadcast ephemeris, and then save the predicted information into the internal memory. GPS&GLONASS engine will use the information for positioning if no enough information from satellites, so the function is helpful for positioning and TTFF improvement.

The EASY function can reduce TTFF to 5s in warm start. In this case, RTC domain should be valid. In order to get enough broadcast ephemeris information from GPS&GLONASS satellites, the GPS&GLONASS module should receive the information for at least 5 minutes in good signal conditions after fixing the position.

EASY function is enabled by default. Command "$PMTK869,1,0*34" can be used to disable EASY.

3.7 Multi-tone AIC

YIC51616GMSGG-33 module provides an advanced technology called multi-tone AIC (Active Interference Cancellation) to reject RF interference which comes from other active components on the main board.

Up to 12 multi-tone AIC embedded in the module can provide effective narrow -band interference and jamming elimination. The GPS&GLONASS signal could be recovered from the jammed signal, which can ensure better navigation quality. AIC is enabled by default, closing it will save about 1mA @VCC=3.3V consumption. The following commands can be used to set AIC.

Enable AIC function: "$PMTK 286,1*23".
Disable AIC function: "$PMTK 286,0*22".

3.8 LOCUS

YIC51616GMSGG-33 module supports the embedded logger function called LOCUS. It can log position information to the internal flash memory automatically when this function is enabled by sending PMTK command "$PMTK183,0*22".Due to this function, the host can go to sleep to save power consumption and does not need to receive the NMEA information all the time. The module can provide a log capacity of more than 16 hours.

The detail procedures of this function are illustrated bellow:

- The module has fixed the position (only 3D_fixed is available);
- Sending PMTK command "$PMTK184,1*22" to erase internal flash;
- Sending PMTK command "$PMTK185,0*22" to start log;
- Module logs the basic information (UTC time, latitude, longitude and height) every 15 seconds to internal flashmemory;
- Stop logging the information by sending "$PMTK185,1*23";
- Host can get the data from the module via UART by sending"$PMTK622,1*29".

The raw data which host gets has to be parsed via LOCUS parser code provided by YIC. For more details, please contact YIC technical supports.

3.9 PPS VS. NMEA

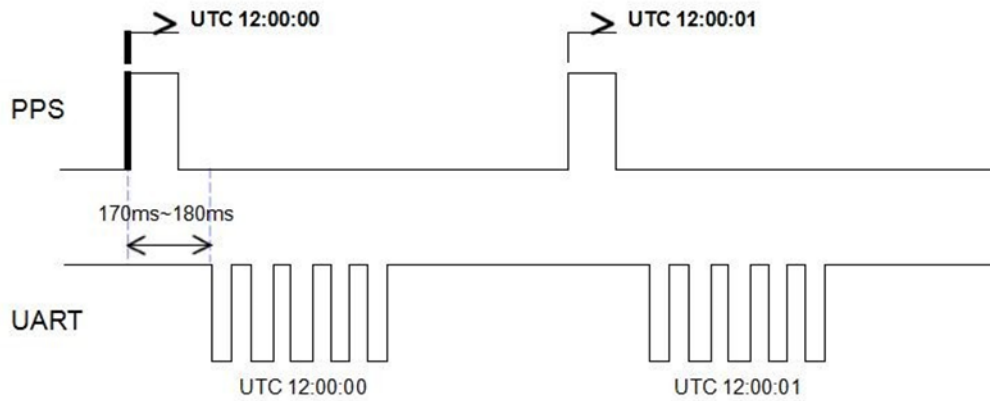Figure 14: PPS VS. NMEA Timing

This feature only supports 1Hz NMEA output and baud rate at 14400~115200bps. At baud rate of 9600 and 4800bps, it only supports RMC NMEA sentence. Because at low baud rate, per second transmission may exceed one second if there are many NMEA sentences output. You can enable this function by sending "$PMTK255,1*2D", and disable the function by sending "$PMTK255,0*2C".

4. Antenna Interfaces

YIC51616GMSGG-33 module receives L1 band signal from GPS&GLONASS satellites at a nominal frequency of 1575.42MHz&1602MHz. The LNA is embedded for better performance. It is an ultra-compact module with embedded 15.0 × 15.0 × 4.0mm patch antenna. In addition, YIC51616GMSGG-33 can also support external active antenna, and the RF signal is obtained from the EX_ANT pin. Both internal patch signal and external active antenna signal are intelligently switched through SPDT.

4.1 Antenna Supervisor

Antenna Supervisor is designed to detect different external active antenna status including external active antenna connection, open circuit for antenna and antenna short-circuited, and then notify the module. The detections and notifications of external active antenna are listed in the following table.

✧   Need to confirm that the firmware version is supported

Status of the Antenna

Status of the Antenna	EXT./Patch Antenna	NMEA Message
External Active Antenna is not Inserted	Patch	OPEN
External Active Antenna is Inserted and Worked Normally	EXT.	OK
External Active Antenna is Inserted but Short-circuited	Patch	SHORT

4.2 Internal Patch Antenna
4.2.1 15×15×4 Patch Antenna

The quality of the embedded GPS&GLONASS antenna is crucial to the overall sensitivity of the GPS&GLONASS system. YIC51616GMSGG-33 offers an on-module patch antenna. A high-performance patch antenna is chosen for reducing product size. This antenna is specially designed for satellite reception applications,and it has excellent stability and sensitivity to consistently provide high signal reception efficiency. The specification of the antenna used by YIC51616GMSGG-33 is described in following table.

Antenna Specification for YIC51616GMSGG-33 Module with Ground Plane 50mm ×50mm

Antenna Type	Parameter	Specification	Notes
Patch Antenna	Size	15.0 × 15.0 × 4.0mm	
	Range of receiving Frequency	GPS: 1575.42MHz±1.023MHz GLONASS: 1602MHz+0.5625*k(MHz)	
	Impendence	50 Ohm	
	Band Width	6MHz minimum	Return Loss ≤ -7dB
	Frequency Temperature Coefficient (TF)	0±20ppm/°C	-40°C~+85°C
	Polarization	RHCP	Right Hand Circular Polarization
	Gain at Zenith	3.4dBi typ.	Centre frequency
	VSWR	2.5 max	
	Axial ratio	3 dB max	

The test result of the antenna is shown as the following figure. This embedded GPS&GLONASS antenna provides good radiation efficiency, right hand circular polarization and optimized radiation pattern. The antenna is insensitive to surroundings and has high tolerance against frequency shifts.
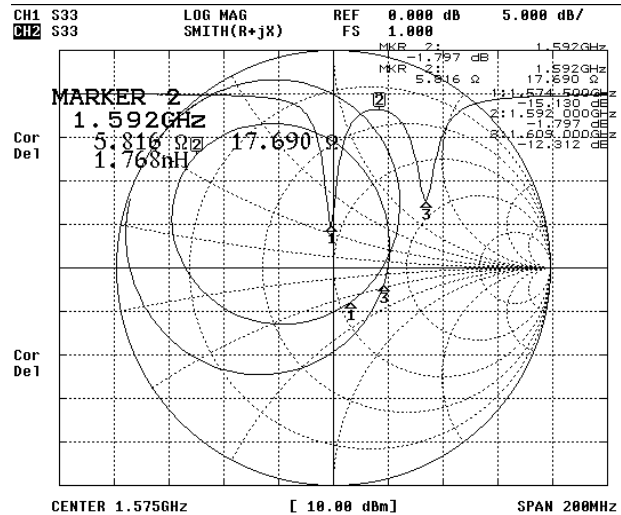
Figure 15: Patch Antenna Test Result with Ground Plane 50mm X 50mm

4.2.2 PCB Design Guide

The radiation characteristic of antenna depends on various factors, such as the size, shape of PCB and dielectric constant of components nearby. It is recommended to follow the rules listed below.

● keep the module at least 6mm away from the nearest edge of the mother board, that is, it is better to be placed in the center of the mother board.
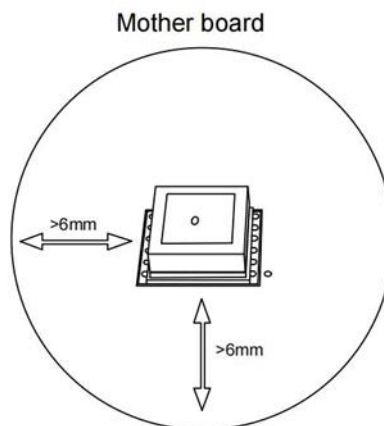

Figure 16: Recommended Distance between Module and Mother Board Edges

● The position on the mother board corresponding to the feed point of the patch antenna should be kept out on eachlayer, and the diameter of the keepout area should be not less than 2.5mm.
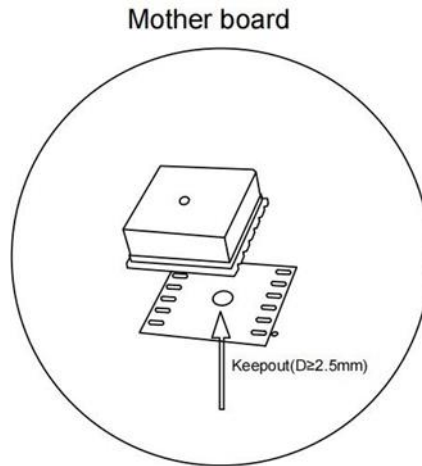
Mother board

Keepout(D≥2.5mm)

Figure 17: Recommended Treatment for the Feed Point of the Patch Antenna

- Make sure the antenna points to the sky.
- The performance of embedded patch antenna depends on the actual size of he ground plane around the module. It is recommended to design a 35mm×35mm ground plane as shown below. Meanwhile, do not put any components especially tall components in the areas whenever possible. (Interfering vias is not allowed either).

Mother board

35mm

35mm
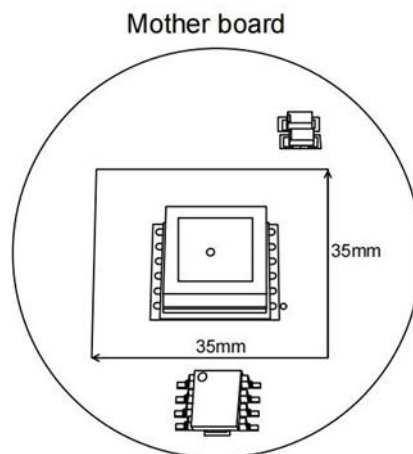
Figure 18: Recommended Ground Plane

- Keep the patch antenna at least 13mm away from other tall metal components. Otherwise, the antenna performance will be affected.
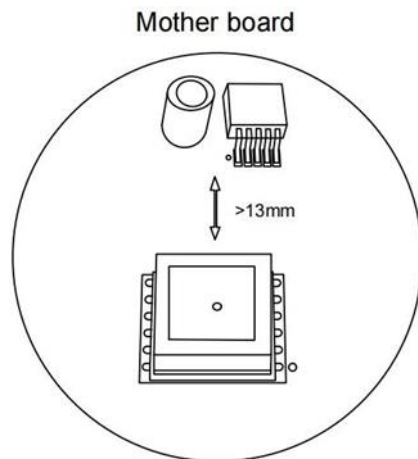
Figure 19: Recommended Distance between Module and Tall Metal Components

● Make sure the microcontroller, crystal, and other high speed components and interfaces are placed on the opposite side of the module, and keep them away from the module as far as possible, such as in diagonal position of the mother board.
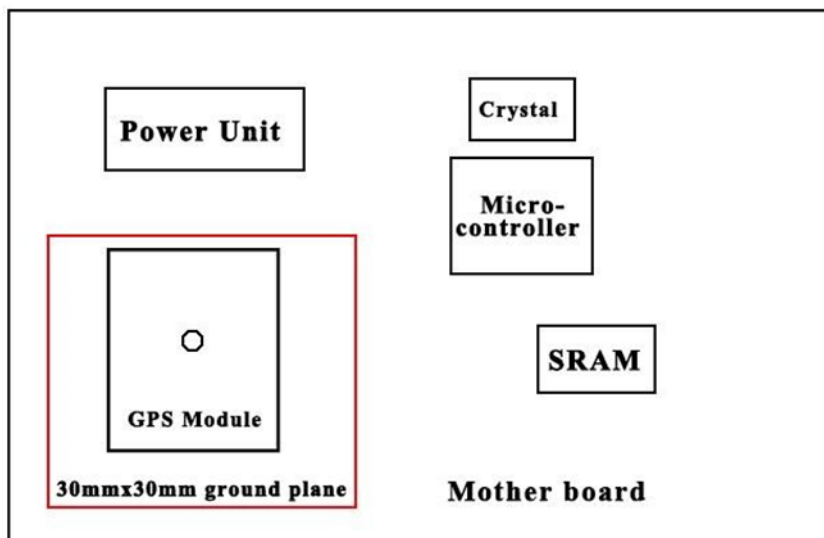
Figure 20: Recommended Placement of GNSS Module

● Make sure interfering signals (USB, Crystal, etc.) are in inner layer and shielded by ground plane, and keep them and their vias far away from the module.

- Make sure RF system such as BT/WIFI/GSM is on the opposite side of the module, and keep them away fromthe module as far as possible, such as in diagonal position of the board.
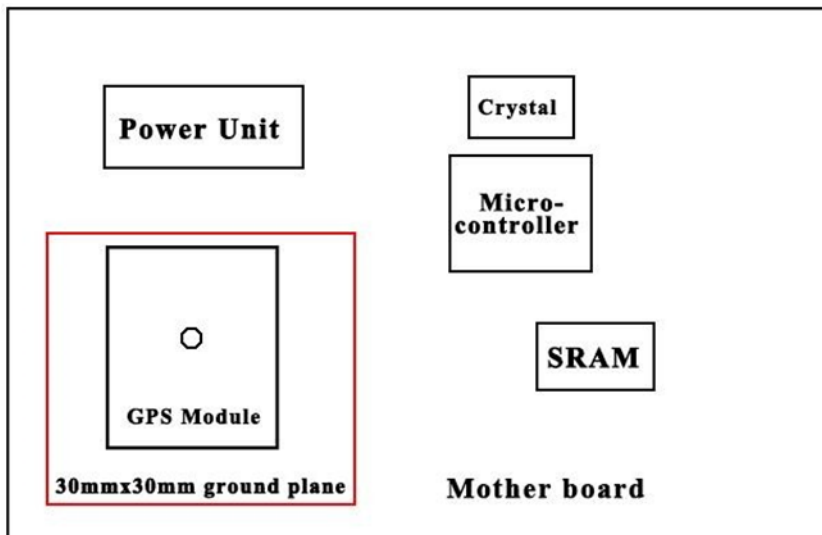
Figure 21: Recommended Placement of GNSS Module with the RF System

- Keep DC/DC far away from the module

- Device enclosure should be made of non-metal materials especially for those which are around antenna area. Theminimum distance between antenna and enclosure is 3mm.

- The RF part of GPS&GLONASS module is sensitive to temperature. please keep them away from heat-emitting circuit.

- It is recommended to reserve an integrate ground layer to isolate GPS&GLONASS module from others.

4.3 External Active Antenna

The following figure is a typical reference design with active antenna. In this mode, DC on the EX_ANT pin ispowered by VCC and supplies power to the external active antenna.
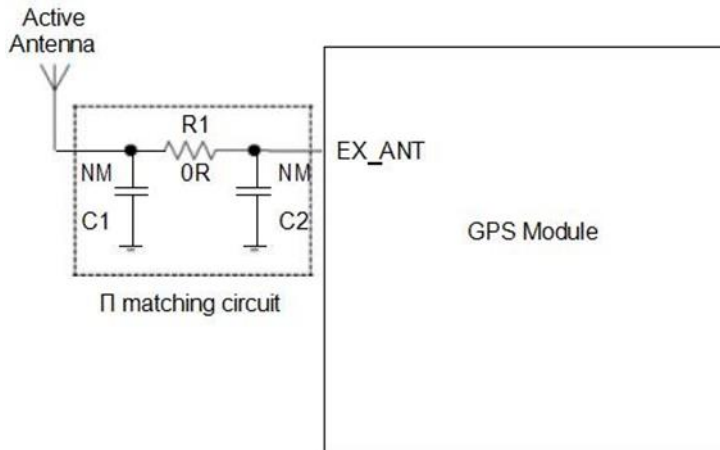
Figure 22: Reference Design for Active Antenna

C1, R1, C2 are reserved matching circuit for antenna impedance modification. By default, C1 and C2 are not mounted; R1 is 0 ohm. In this mode, R1 must not be capacitance, as current will stream through R1 to the active antenna. C1 and C2 must not be inductance or resistance to avoid short circuit.

The impedance of RF trace line in main PCB should be controlled as 50 Ohm, and the trace length should be kept as short as possible.

Recommended Active Antenna Specification

Antenna Type	Specification
Active Antenna	Center frequency: 1575.42MHz of 1602MHz
	Band width: >5MHZ
	VSWR: <2 (Typ.)
	Polarization: RHCP or Linear
	Noise figure: <1.5dB
	Gain (antenna): >-2dBi
	Gain (embedded LNA): 20dB (Typ.)
	Total gain: >18dBi(Typ.)

- In order to ensure the short protection function can work effectively, please select a DC-open (DC-impedance between the SMA's inner signal needle and outside ground) GPS&GLONASS active antenna. You can measure the DC-impedance with a common and simple multimeter on few samples, and the value is generally in M ohm level.

The pin "AADET_N" also can be used to indicate the status of active antenna. When active antenna is not connected to EX_ANT or has poor contact with antenna feeding point, AADET_N will keep a high level to indicate the active antenna absent. AADET_N will change to a low level when active antenna is connected well.

- Active antenna is ONLY available when the voltage of AADET_N is less than or equal to 0.7V.

5. Electrical, Reliability and Radio Characteristics

5.1 Electrostatic Discharge

YIC51616GMSGG-33 module is an ESD sensitive device. ESD protection precautions should still be emphasized. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application.

The ESD bearing capability of the module is listed in the following table. Note that you should add ESD components to module pins in particular applications.

ESD Endurance Table (Temperature : 25°C, Humidity: 45%)

Pin	Contact Discharge	Air Discharge
EX_ANT	±5KV	±10KV
Patch Antenna	±5KV	±10KV
VCC	±5KV	±10KV
UART	±3KV	±6KV
Others	±2KV	±4KV

5.2 Reliability Test

Test Item	Conditions	Standard
Thermal Shock	-30°C...+80°C, 144 cycles	GB/T 2423.22-2002 Test Na IEC 68-2-14 Na
Damp Heat, Cyclic	+55°C; >90% Rh 6 cycles for 144 hours	IEC 68-2-30 Db Test
Vibration Shock	5~20Hz, 0.96m2/s3; 20~500Hz, 0.96m2/s3-3dB/oct, 1hour/axis; no function	2423.13-1997 Test Fdb IEC 68-2-36 Fdb Test
Heat Test	85°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Cold Test	-40°C, 2 hours, operational	GB/T 2423.1-2001 Ab IEC 68-2-1 Test
Heat Soak	90°C, 72 hours, non-operational	GB/T 2423.2-2001 Bb IEC 68-2-2 Test B
Cold Soak	-45°C, 72 hours, non-operational	GB/T 2423.1-2001 A IEC 68-2-1 Test

6. Application Circuit:(Example)
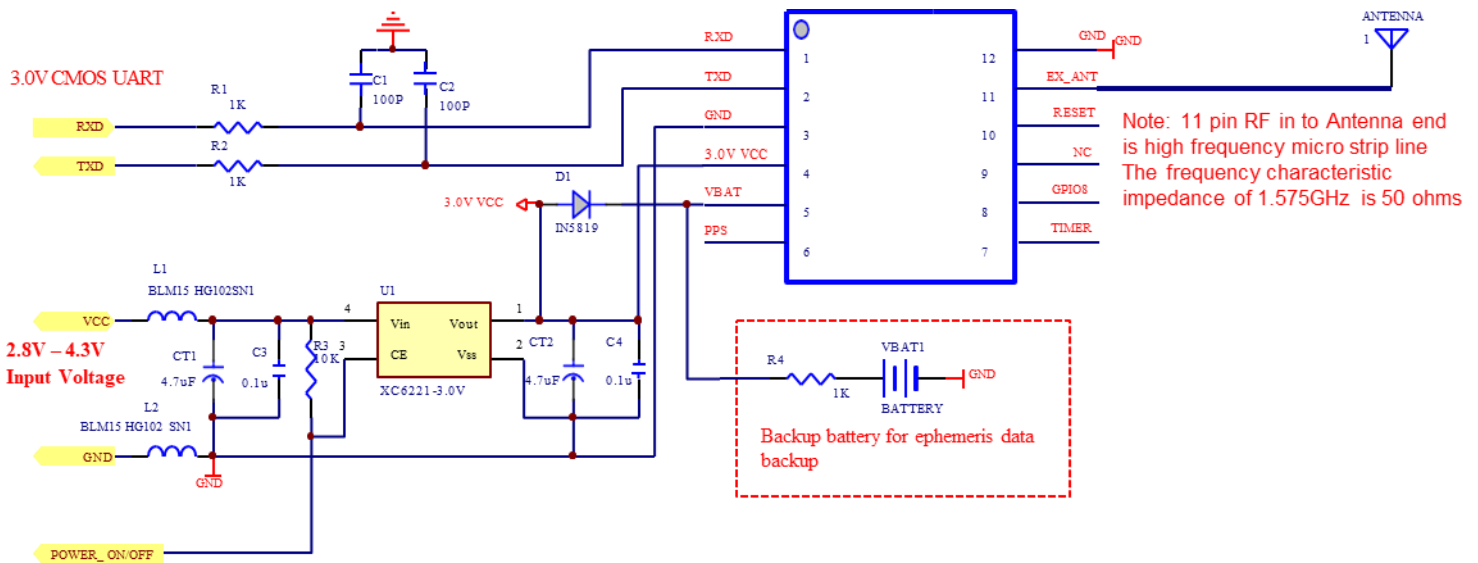
7. Mechanical Dimensions

This chapter describes the mechanical dimensions of the module

7.1 Mechanical Dimensions of the Module
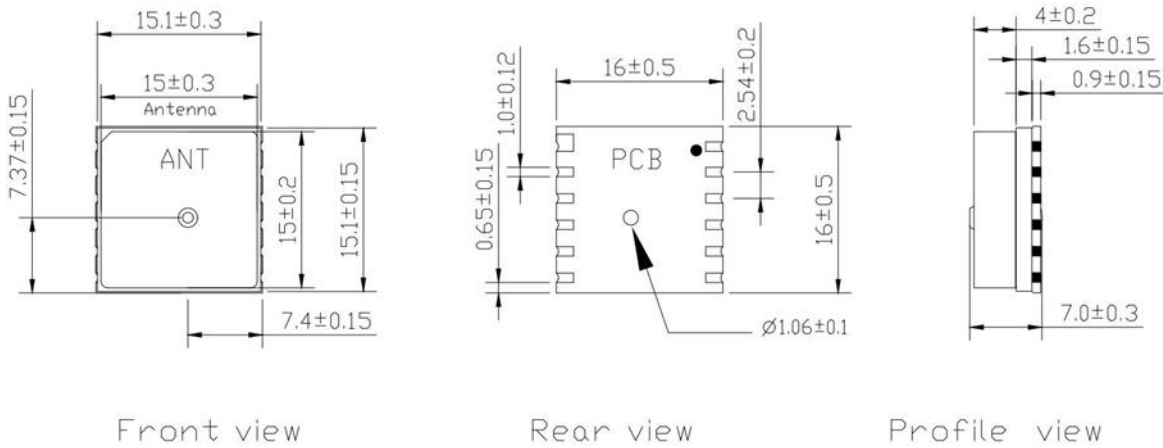
Figure 23: Mechanical Dimensions (Unit: mm)

7.2 Bottom View Dimensions and Recommended Footprint
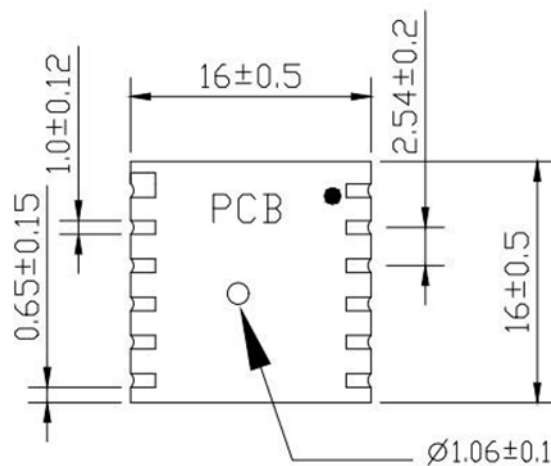
Figure 24: Bottom View Dimensions (Unit: mm)
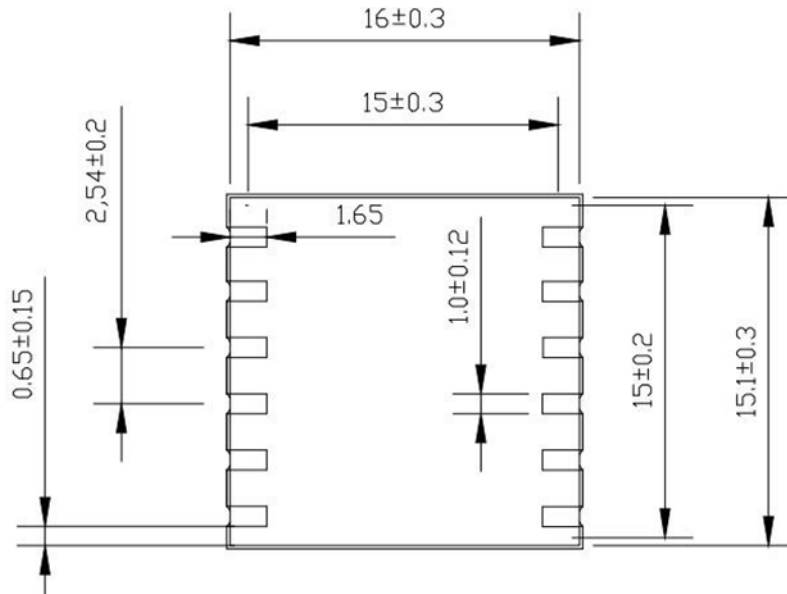
Figure 25: Recommended Footprint (Unit: mm)

● For easy maintenance, please keep a distance of no less than 3mm between the module and other components onhost board.

7.3 Top and Bottom View of the Module
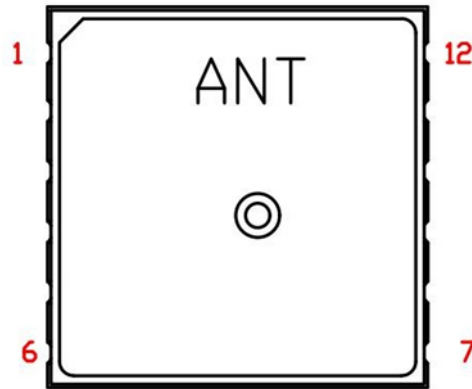
Figure 26: Top View of the Module
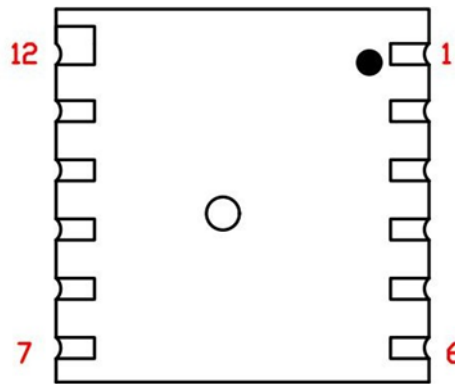
Figure 27: Bottom View of the Module

- The incision of the patch antenna does not indicate the position of pin 1.

8. Meanufacturing, Packaging and Ordering Information

8.1 Assembly and Soldering

    YIC51616GMSGG-33 module is intended for SMT assembly and soldering in a Pb-free reflow process on the top side of the PCB. It is suggested that the minimum height of solder paste stencil is 100um to ensure sufficient solder volume. Pad openings of paste mask can be increased to ensure proper soldering and solder wetting over pads. It is suggested that the peak reflow temperature is 235~245ºC (for SnAg3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260ºC. To avoid damage to the module when it is repeatedly heated, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below:
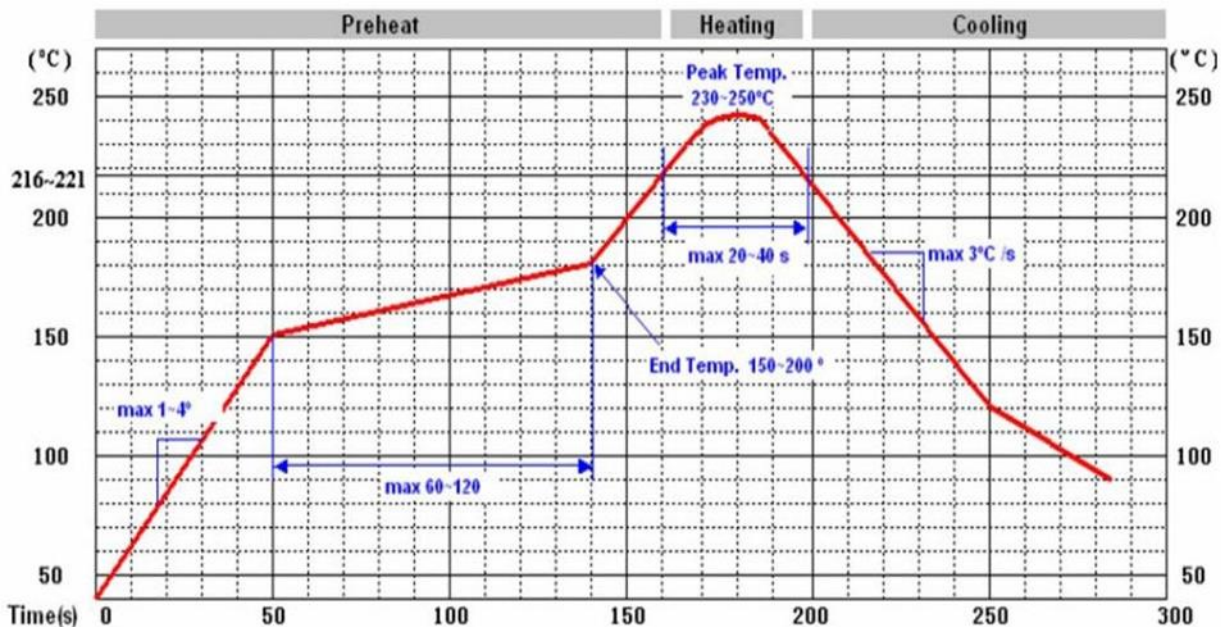
Figure 28: Recommended Reflow Soldering Thermal Profile

8.2 Moisture Sensitivity

YIC51616GMSGG-33 module is sensitive to moisture. To prevent YIC51616GMSGG-33 from permanent damage during reflow soldering, baking before reflow soldering is required in following cases:

- Humidity indicator card: One or more indicating spots are no longer blue.
- The seal is opened and the module is exposed to excessive humidity.

YIC51616GMSGG-33 should be baked for 192 hours at temperature 40°C+5°C/-0°C and <5% RH in low-temperature containers, or 24 hours at temperature 125°C±5°C in high-temperature containers. Care should be taken that the plastic tape is not heat resistant. YIC51616GMSGG-33 should be taken out from the tape before preheating; otherwise, the tape maybe damaged by high-temperature heating.

8.3 ESD Protection

YIC51616GMSGG-33 module is sensitive to ESD and requires special precautions when handling. Particular care must be exercised when handling patch antenna, duo to the risk of electrostatic charges.

8.4 Packaging

● Packaging

Plastic tray
Quantity per tray : 90 pcs

9. NMEA 0183 Protocol

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

9.1 Location mode configuration instructions

Pattern	Instructions	NMEA Output
GPS	$PMTK353,1,0*36	GPRMC.GPGGA.GPGSV.GPGSA.GPGLL.GPVTG
GLONASS	$PMTK353,0,1*36	GLRMC.GLGGA.GLGSV.GLGSA.GLGLL.GLVTG
GPS+GLONASS	$PMTK353,1,1*37	GNRMC.GNGGA.GPGSV.GLGSV.GPGSA.GLGSA.GNGLL.GNVTG

Single system or dual system positioning mode can be selected through the configuration instructions:

Instruction configuration instructions
- The YIC51616GMSGG-33 Initialization location mode for GPS+GLONASS dual mode,
  Output data：$GNRMC. $GNGGA. $GPGSV. $GLGSV. $GPGSA. $GLGSA.$GNGLL. $GNVTG

9.2 GGA-Global Positioning System Fixed Data

$xxGGA, 161229.487,3723.2475,N, 12158.3416,W, 1,07,1.0,9.0,M.0000*18

Table 1: GGA Data Format

Name	Example	Units	Description
Message ID	$xxGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2457		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 1-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoids Separation		meters	
Units	M	meters	
Age of Diff.Corr.		second	Null fields when DGPS is not Used
Diff.Ref.Station ID	0000		
Check sum	*18		
<CR> <LF>			End of message termination

Table 1-1: Position Fix Indicators

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

9.3 GLL-Geographic Position – Latitude/Longitude

$xxGLL , 3723.2475, N,12158.3416, W,161229.487, A*2C

Table 2: GLL Data Format

Name	Example	Units	Description
Message ID	$xxGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Check sum	*2C		
<CR> <LF>			End of message temination

9.4 GSA-GNSS DOP and Active Satellite

$xxGSA , A, 3, 07, 02, 26,27, 09, 04,15, , , , , , 1.8,1.0,1.5*33

Table 3: GSA Data Format

Name	Example	Units	Description
Message	$xxGSA		GSA protocol header
Mode 1	A		See Table 3-2
Mode 2	3		See Table 3-3
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
…	…		…
Satellite Used			Sv on Channel 66
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Check sum	*33		
<CR> <LF>			End of message termination

Table3-2: Mode 1

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

Table 3-3: Mode 2

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

9.5 GSV-GNSS Satellites in View

$xxGSV , 2, 1, 07, 07, 79,048, 42, 02, 51,062, 43, 26, 36,256, 42, 27, 27, 138,42*71

$xxGSV, 2, 2, 07, 09, 23,313, 42, 04, 19, 159, 41, 15,12,041, 42*41.

Table 4: GSV Data Format

Name	Example	Units	Description
Message ID	$xxGSV		GSV protocol header
Number of Message	2		Range 1 to 3
Message Number	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 66)
Elevation	79	degrees	Channel 1(Maximum 90)
Azinmuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR(C/NO)	42	dBHz	Range 0 to 99,null when not tracking
...			...
Satellite ID	27		Channel 4(Range 1 to 66)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR(C/NO)	42	dBHz	Range 0 to 99, null when not tracking
Check sum	*71		
<CR> <LF>			End of message termination

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

9.6 RMC-Recommended Minimum Specific GNSS Data

$xxRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13,309.62, 120598,, *10

Table 5: RMC Data Format

Name	Example	Units	Description
Message ID	$xxRMC		RMC protocol header
UTS Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	Knots	
Course Over	309.62	Degrees	True
Ground			
Date	120598		Dummy
Magnetic variation		Degrees	E=east or W=west
Check sum	*10		
<CR> <LF>			End of message termination

9.7 VTG-Course Over Ground and Ground Speed

$xxVTG, 309.62, T, M, 0.13, N, 0.2, K*6E

Table 6: VTG Data Format

Name	Example	Units	Description
Message ID	$xxVTG		VTG protocol header
Course	309.62	Degrees	Measured heading
Reference	T		True
Course		Degrees	Measured heading
Reference	M		Magnetic
Speed	0.13	Knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	Km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Check sum	*6E		
<CR> <LF>			End of message termination

10. Appendix References

Terms and Abbreviations

Abbreviation	Description
AGNSS	Assisted GNSS
AIC	Active Interference Cancellation
CEP	Circular Error Probable
DGPS	Differential GPS
EASY	Embedded Assist System
EGNOS	European Geostationary Navigation Overlay Service
EPO	Extended Prediction Orbit
ESD	Electrostatic Discharge
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GGA	GNSS Fix Data
GLL	Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System
GSA	GNSS DOP and Active Satellites
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
I/O	Input / Output
Kbps	Kilo Bits Per Second
LNA	Low Noise Amplifier
MSAS	Multi-Functional Satellite Augmentation System
MOQ	Minimum Order Quantity
NMEA	National Marine Electronics Association
PDOP	Position Dilution of Precision
PMTK	MTK Proprietary Protocol
PPS	Pulse Per Second
PRN	Pseudo Random Noise Code
QZSS	Quasi-Zenith Satellite System
RHCP	Right Hand Circular Polarization
RMC	Recommended Minimum Specific GNSS Data
SBAS	Satellite-based Augmentation System
SAW	Surface Acoustic Wave
SPDT	Single-Pole Double-Throw
TTFF	Time To First Fix
UART	Universal Asynchronous Receiver & Transmitter
VDOP	Vertical Dilution of Precision
VTG	Course over Ground and Ground Speed, Horizontal Course and Horizontal Velocity
WAAS	Wide Area Augmentation System
Inom	Nominal Current
Imax	Maximum Load Current
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value

Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value