YIC



YIC51612EBGGBL5

High Precision GNSS Module

Datasheet

www.yic.com.tw

Revision History

Date	Reversion	Description
2021/05/27	1.0	First Draft, Based on YIC51612EBGGB
2021/08/13	1.1	Upgrade version 1.1
2024/05/02	2.0	Add Design Note

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1. Product Information

1.1 Product Description

The YIC51612EBGGBL5 is a Multi-Constellation receiving module that supports dual frequency and multi-mode. It has built-in highly integrated GNSS receiver chip, supports multi band and multi system cm4f (main frequency 530MHz, 12NM Technology) chip of Third-generation BeiDou Navigation Satellite System (BDS-3). Besides, it is capable of tracking all global civil navigation systems (GPS, GLONASS, Galileo, BDS, QZSS and SBAS) in all bands.

YIC51612EBGGBL5 module is based on the state of art CYNOSURE III architecture, integrating multi-band and multi-system GNSS RF and baseband. This newly designed architecture makes this single chip achieve sub-meter level position accuracy without correction data from ground-based augmentation station and higher sensitivity, greater for improved jam resistance and multipath, provide a highly robust service in complicated environment.

YIC51612EBGGBL5 module contains MediaTek positioning engine inside, featuring high sensitivity, low power consumption, and fast TTFF. The superior cold start sensitivity allows it to acquire, track, and get position fix autonomously in difficult weak signal environment. The receiver's superior tracking sensitivity allows continuous position coverage in nearly all outdoor application environments. The high performance signal parameter search engine is capable of testing 16 million time-frequency hypotheses per second, offering superior signal acquisition and TTFF speed.

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
- Multi-Constellation reception of multi-band and multi-system satellite signals
- Supports all civil GNSS signals
- Supports BDS-3 signal
- Extremely fast TTFF at low signal level (Cold start ≤24s, Hot start ≤1s).
- Multipath detection and suppression
- Works with passive and active antenna
- Ultra low power consumption: Max 15mA@3.3V
- NMEA-0183 compliant protocol or custom protocol
- Operating voltage:3.0V to 3.6V
- SMD type with stamp holes
- Small form factor: 16x12x2.6mm
- Operating temperature -40 ~ +85°C
- RoHS compliant (Lead-free)

1.3 Product Specifications

GPS Receiver		
Chip	GNSS engine has 135 channels and DSP accelerators	
GNSS Reception	GPS/QZSS	L1 1575.42MHz, L5 1176.45MHz
	GLONASS	L1 1602 MHz
	Galileo	E1 1575.42MHz, E5 1191MHz
	BeiDou	B1 1561MHz,B2 1176.45MHz
	SBAS	WAAS, EGNOS, MSAS, GAGAN
Update Rate	GNSS	1Hz (10Hz on request)
Position Accuracy	GNSS	1m CEP
	SBAS	1m CEP
Velocity & Time Accuracy	GNSS	0.01m/s CEP
	SBAS	0.05 m/s
	1PPS	25 ns
Time to First Fix(TTFF)	Hot start	1 sec
	Cold start	24 sec
Sensitivity	Cold start	-148dBm
	Hot start	-155dBm
	Tracking & navigation	-165dBm
	Reacquisition	-158dBm
GNSS Operating limit	Velocity	515m/s
	Altitude	18,000m
Datum	Default WGS-84, User definable	
UART Port	UART Port: TXD and RXD 115200bps (default), Supports baud rate 9600bps to 921600bps.. NMEA 0183 Protocol Ver. 4.00/4.10,Cynosure GNSS Receiver Protocol	
Environment	Operation temperature	-40°C ~ +85°C
	Storage temperature	-55°C ~ +125°C
	Humidity	5% ~ 95%
Physical Characteristics	Size	16±0.15 ×12.2±0.15 × 2.6±0.1mm
	Weight	Approx. 2.0g

1.4 DC Electrical Characteristics

Parameter	Min.	Typ.	Max.	Units
Supply Voltage	3.0	3.3	3.6	Volt
Power Supplier Current				
Acquisition (exclude active antenna current)		12		mA
Tracking (exclude active antenna current)		14		mA
I /O port &UART Port Working Voltage				
Output Low Voltage			0.4	Volt
Output High Voltage	2.4			Volt
Input Low Voltage	0.3		0.7	Volt
Input High Voltage	2.1		3.6	Volt
Input Low Current	-10		10	uA
Input High Current	-10		10	uA
RF Input Impedance (RFIN)		50		ohm

Absolute Maximum Ratings

Parameter	Minimum	Maximum	Condition
Supply Voltage	-0.5	3.6	Volt
Input Pin Voltage	-0.5	VCC+0.5	Volt
Input Power at RF_IN		20	dBm
Storage Temperature	-55	100	degC

2. Block Diagram

The YIC51612EBGGBL5 is a high performance (BDS, GPS, GLONASS, Galileo, QZSS and SBAS) in all bands (L1, L5). satellite navigation receiver in a compact surface mount package. It is based on the MediaTek positioning technology, providing high performance signal acquisition and tracking. The simple UART serial interface and the standard NMEA-0183 protocol make usage of YIC51612EBGGBL5 very easy and straightforward.

The YIC51612EBGGBL5 module performs all the necessary system initialization, signal acquisition, signal tracking, data demodulation, and calculation of navigation solution autonomously.

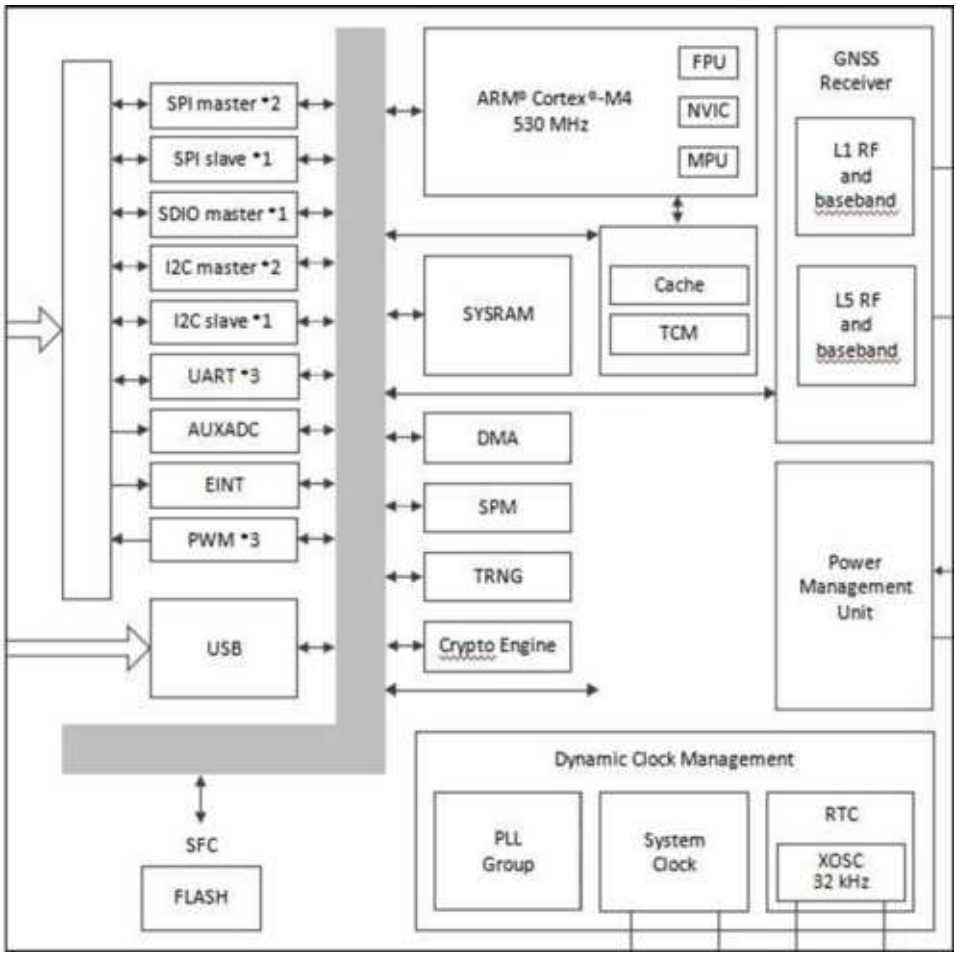


Figure 1: Block Diagram

3. Module Pin Assignment

The module is equipped with a 24-pin SMT pad that connects to your application platform. Sub-interfaces included inthe pad are described in details in the following chapters

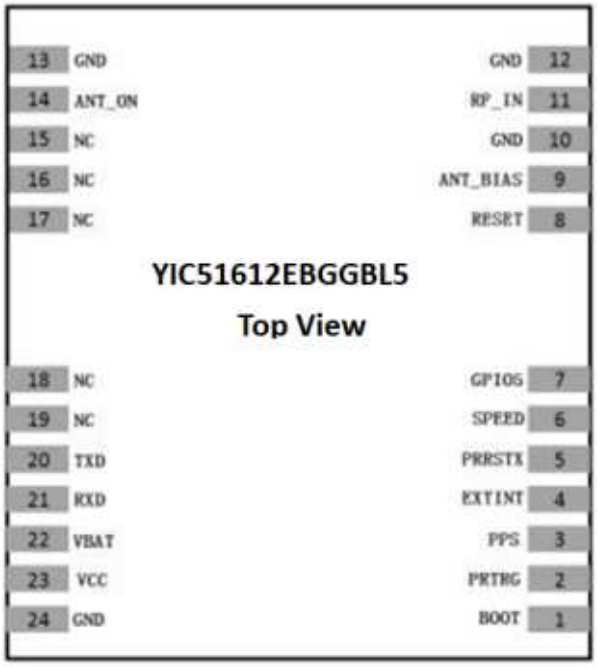


Figure 2: Pin Assignment

3.1 Pin Descriptions

Pin NO.	Pin Name	Remark
1	BOOT	No connection for normal use. Pull-low for loading firmware into empty or corrupted Flash memory from ROM mode by the module maker.
2	PRTRG	Multi-Function Port: System Wakeup Input, Pin unassociated Peripherals or GPIO
3	1PPS	One-pulse-per-second (1PPS) time mark output, 3.3V LVTTL. The rising edge synchronized to UTC second when getting 3D position fix. The pulse duration is about 800usec at rate of 1 Hz.
4	EXTINT	External Interrupt Pin
5	PRRSTX	Active "L" with internal Pull-up resistor
6	SPEED	MUX IO: GPIO, UART 1 Serial Data Transmit (UOUT1)
7	GPIO5	MUX IO: GPIO, SQI data 3 (SQI3), UART 1 Serial Data Receive(UIN1)
8	RESET	Leave it Open if not used
9	ANT_BIAS	Output power supply for external LNA or active antenna
10	GND	Ground
11	RF_IN	RF signal input
12	GND	Ground
13	GND	Ground
14	ANT_ON	Antenna status of antenna supervisor
15	NC	No connection, empty pin
16	NC	No connection, empty pin
17	NC	No connection, empty pin
18	NC	No connection, empty pin
19	NC	No connection, empty pin
20	TXD	MUX IO: GPIO, UART 0 Serial Data Transmit (UOUT0)
21	RXD	MUX IO: GPIO, UART 0 Serial Data Receive (UIN0)
22	VBAT/NC	3.3V Backup Domain I/O power supply Backup LDO input (Requires program to use a program). External battery backup is not supported by default.
23	VCC	Main power supply, 3.3V +/- 10%
24	GND	Ground

3.2 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 9600bps to 921600bps.

UART port:

TXD: Send data to the RXD1 signal line of DTE.

RXD: Receive data from the TXD1 signal line of DTE.

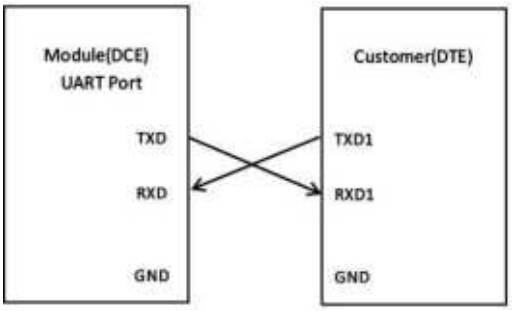


Figure 3 : Serial Port Connection

This UART port has the following features:

- UART port can be used for NMEA Protocol output and proprietary commands input.
- The default output NMEA type setting is GGA, GLL, GSA, GSV, VTG, RMC, and ZDA.
- UART port supports the following data rates: 9600, 14400, 19200, 38400, 57600,……. 921600bps. 115200bps by default, 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.

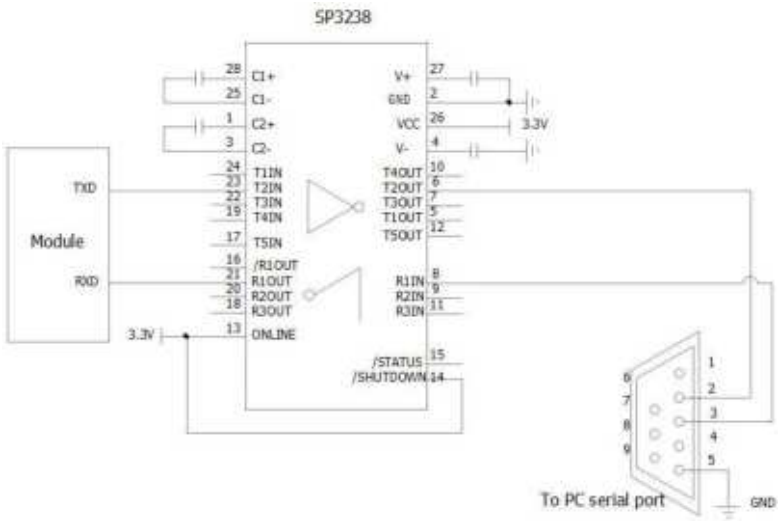


Figure 4 **:** RS-232 Level Shift Circuit

3.3 Evaluation Kit (YIC EVK–1612EB)

In order to help engineers to use YIC 51612EBGGBL5 module in the design stage, YIC supplies the EVK Kit including Evaluation Board (EVB) with micro USB serial cable, Adaptor board and GNSS External Active Antenna.

The main function of EVK is to assist engineers to immediately test and optimize software and hardware designs in order to accelerate the completion of the best product.



Main Board



Adaptor Board



USB Cable



ATGGBL54138M-SMA-3

(GPS L1+L5, QZSS, GLONASS, BDS, Galileo and SBAS and GNSS External Active Antenna)

4. Antenna Consideration

The YIC 51612EBGGBL5 is designed to use with active antenna, and passive antenna with higher antenna gain. Passive ceramic patch antenna is low-cost and provides good sensitivity. 50-ohm output larger size ceramic patch antenna with higher antenna gain can be connected directly to RF input of the module. Usually the ceramic patch antenna and YIC 51612EBGGBL5 are mounted on opposite side of the PCB to reduce possibility of picking up digital noise. To improve signal reception performance, use larger ground plane under the patch antenna if possible; larger the ground plane, larger the overall antenna gain. The center frequency of the ceramic patch antenna changes with ground plane size. For optimal L1+L5 operation, frequency bandwidth of the antenna needs to cover 1174MHz ~ 1179MHz and 1573MHz ~ 1606MHz respectively when mounted on the PCB. It is usual to ask the ceramic patch antenna vendor to select or tune a patch antenna that best matches the customer PCB.

Active antenna is essentially a passive antenna with built-in LNA and a coaxial cable to connect the antenna to the module. It has the flexibility of being located remotely from the module, but requires antenna power. Active antenna usually costs more than passive patch antenna, but the performance in low signal environments is usually better. Active antenna with gain of 10 ~ 20dB and noise figure less than 1.5dB can be used with YIC 51612EBGGBL5.

Antenna Type	Passive	Active
GPS&QZSS Frequency (MHz)	1575.42 +/- 2 (L1) 1176.45 +/- 12(L5)	1575.42 +/- 2 (L1) 1176.45 +/- 12(L5)
BDS Frequency (MHz)	1561 .098+/- 2(B1) 1176.45+/- 2(B2)	1561 .098+/- 2(B1) 1176.45+/- 2(B2)
GLONASS Frequency (MHz)	1602MHz +/- 4(L1)	1602MHz +/- 4(L1)
GALILEO Frequency (MHz)	1559-1592(E1) 1176.45 +/- 12(E5)	1559-1592(E1) 1176.45 +/- 12(E5)
VSWR	< 2 (typical)	< 2 (typical)
Polarization	RHCP	RHCP
Antenna Gain	> 0dBi	> -2dBi
LNA Gain		20dB (typical)
Noise Figure		< 1.5dB
Total Gain		> 13dBi

4.1 Recommended Antenna

4.1.1 External Active Antenna : ATGGB series

ATGGBL54138M-SMA-3



4.1.2 Internal Active Antenna : ATIGGB series

ATIGGBL52580-100



4.1.3 Internal Patch Antenna :

ATPGGBL5R2580A

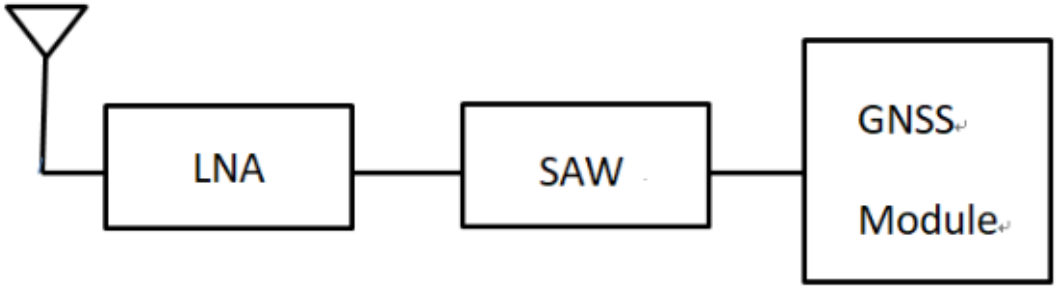


4.1.4 FPC antenna

ATIFGGBL5-4020



FPC Ant.



5. Power Supply Requirement

YIC51612EBGGBL5 requires a stable power supply, avoid ripple on VCC pin (<50mVpp). Power supply noise can affect the receiver's sensitivity. Bypass capacitors of 10uF and 0.1uF is recommended to be placed close to the module VCC pin; the values could be adjusted according to the amount and type of noise present on the supply line.

6. Backup Supply

The purpose of backup supply voltage pin (VBAT) is to keep the SRAM memory and the RTC powered when the module is powered down. This enables the module to have a faster time-to-first-fix when the module is powered on again. The backup current drain is less than 12µA. In normal powered on state, the internal processor access the SRAM and current drain is higher in active mode.

7. 1PPS Output

When using four or more satellites for 3D positioning, the rising edge of the pulse generating 1 pulse per second (Duration: 800u seconds) on 1PPS pins is aligned with the UTC seconds, and the accuracy is about 20nS. When it is not positioned, it outputs a constant low pulse.

8. PCB Layout Guidelines

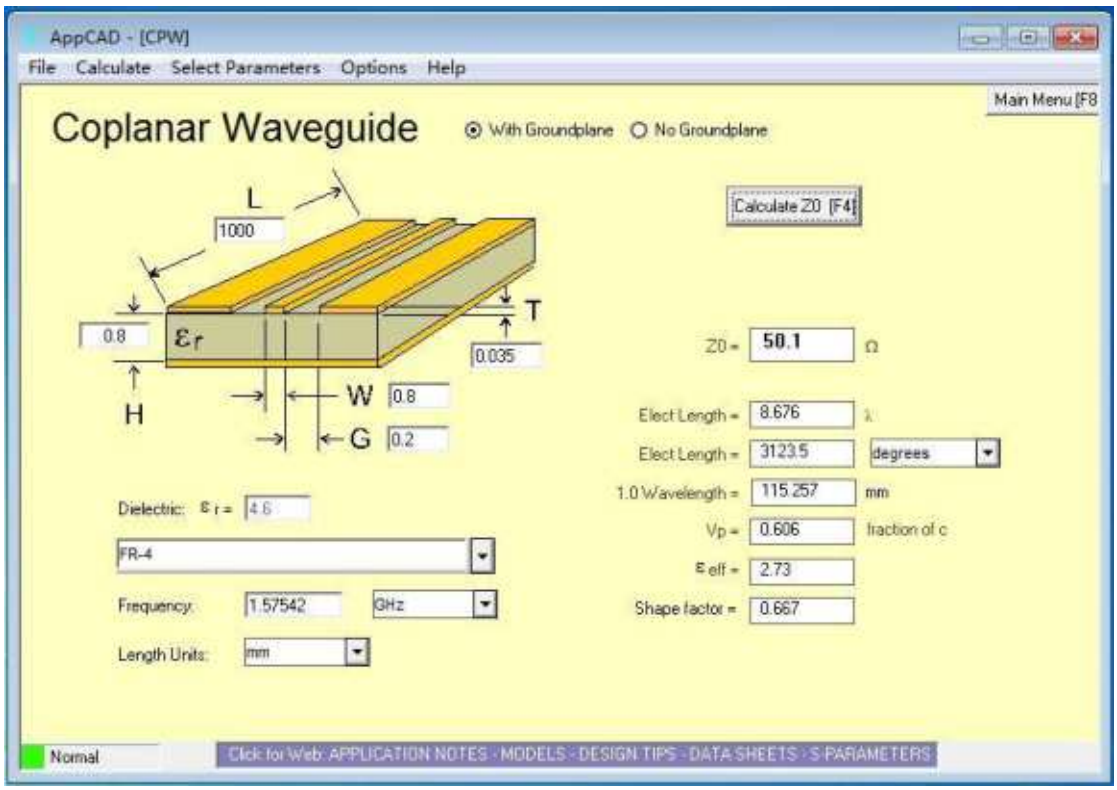
8.1 Separate RF and digital circuits into different PCB regions.

It is necessary to maintain 50-ohm impedance throughout the entire RF signal path. Try keeping the RF signal path as short as possible.

Do not route the RF signal line near noisy sources such as digital signals, oscillators, switching power supplies, or other RF transmitting circuit. Do not route the RF signal under or over any other components (including YIC51612EBGGBL5), or other signal traces. Do not route the RF signal path on an inner layer of a multi-layer PCB to minimize signal loss. Avoid sharp bends for RF signal path. Make two 45-deg bends or a circular bend instead of a single 90-degree bend if needed.

Avoid vias with RF signal path whenever possible. Every via adds inductive impedance. Vias are acceptable for connecting the RF grounds between different layers. Each of the module's ground pins should have short trace tying immediately to the ground plane below through a via.

The bypass capacitors should be low ESR ceramic types and located directly adjacent to the pin they are for.



Antenna Design

- The RF Front End part generally needs to be placed in a different mask cover (separated) from the Transceiver chip. If other PAs are used, the above requirements must also be followed.

- Inductors should be placed to avoid mutual coupling as much as possible

- The complementary paths of each group of I/O differential pairs can be as symmetrical as possible to ensure excellent phase balance and common mode rejection.

- If necessary, it is recommended to clear the metal layers under all devices and traces to ensure smaller parasitic capacitance.

- RF matching components and traces should be isolated from other circuits and traces as much as possible using GND copper.

- In addition to ensuring 50 ohm impedance control, the layout of the TX and RX lines should also be as short as possible. This can minimize line losses, which is also very important. In addition (for example), in terms of Layer distribution, the TX line can go through the TOP layer, refer to the GND of Layer 2. The RX line can go through Layer 4, refer to the GND plane of Layer 3 and Layer 5

8.2 Antenna Placement on PCB Design Guide (If the design uses patch antenna)

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.

- The module should be at least 6mm away from the nearest edge of the motherboard, that is, it is best to place it in the center of the motherboard. The antenna should be at least 6mm away from the edge of the motherboard.

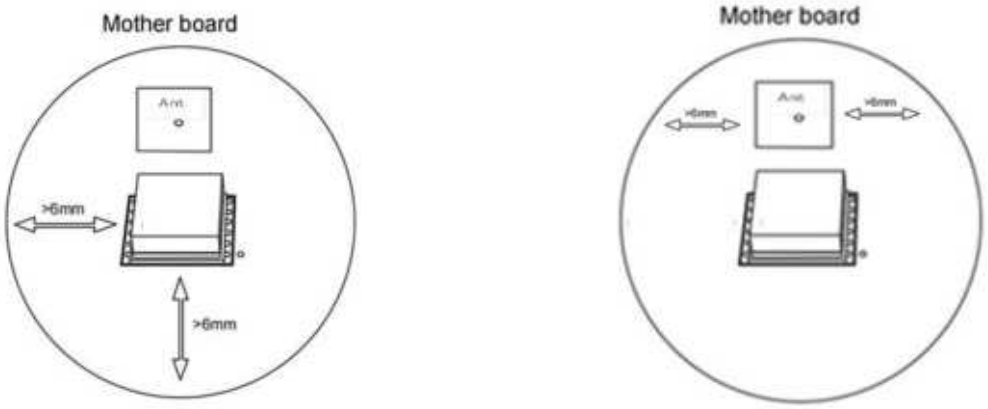


Figure 6: Recommended Distance between Module and Mother Board Edges

- 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).

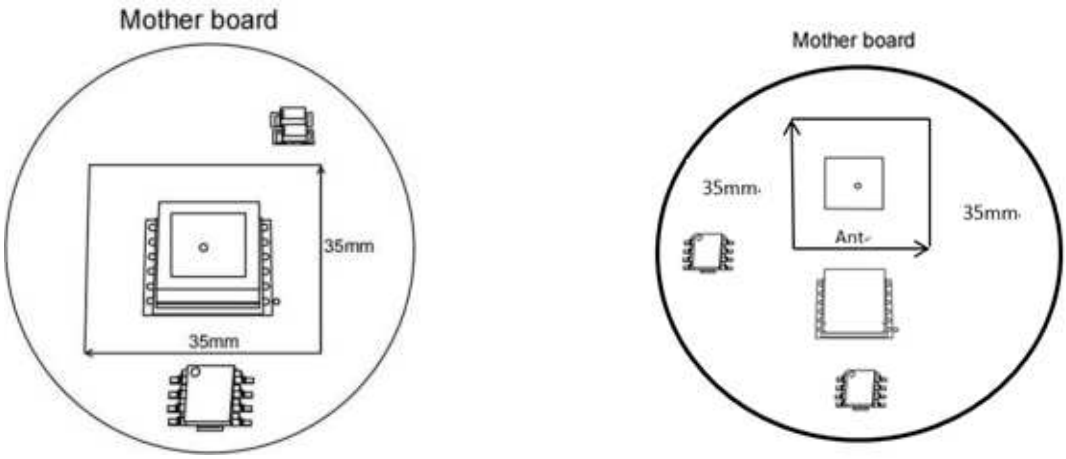


Figure 7: Recommended Ground Plane

- Because antennas are easily affected by metal, the distance between patch antennas and modules and other tall metal parts should be at least 13mm. Otherwise, the antenna performance will be affected.

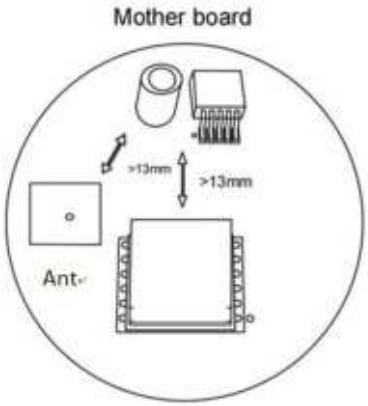


Figure 8: Recommended Distance between Module(Antenna) and Tall Metal Components

- Make sure the microcontroller, crystal, and other high speed components and interfaces are placed on the opposite side of the module and GPS antenna, and keep them away from the module as far as possible, such as in diagonal position of the mother board.

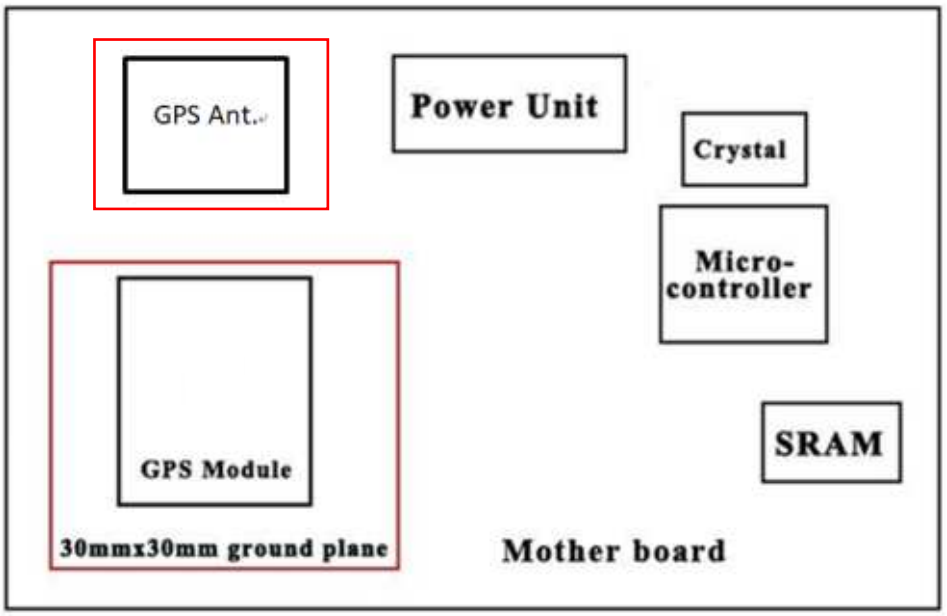


Figure 9: Recommended Placement of GNSS Antenna and Module

- 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 from the module & Antenna as far as possible, such as in diagonal position of the board.

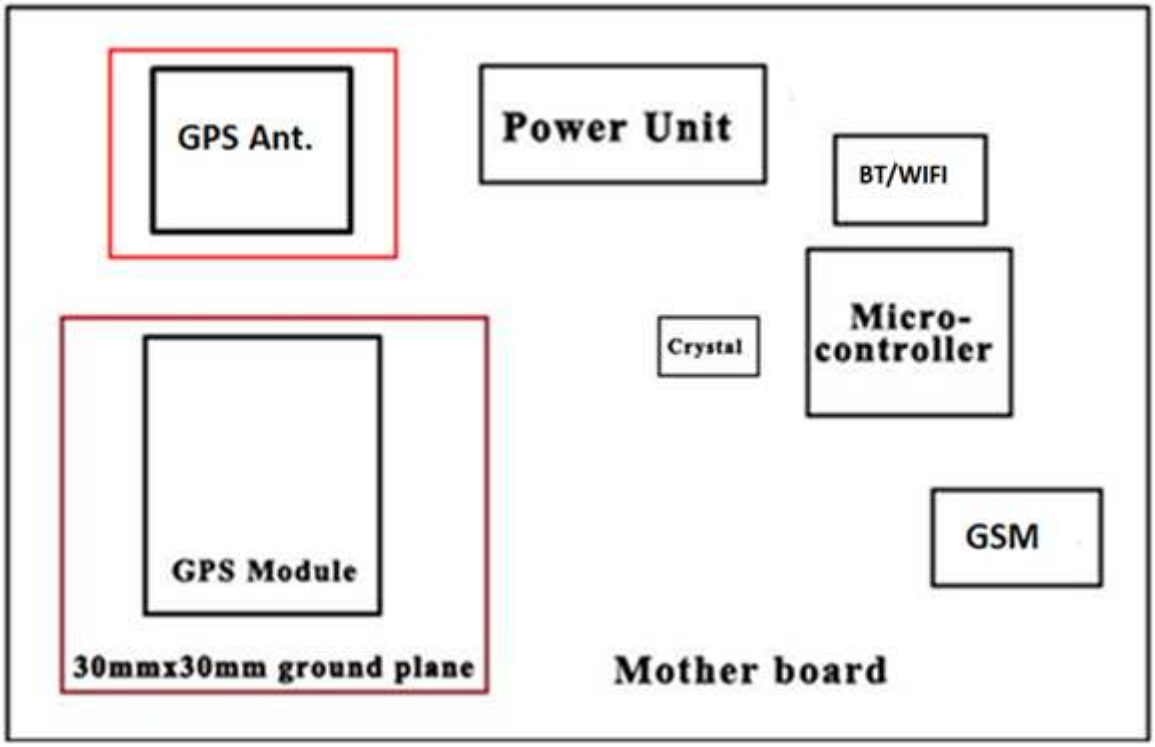


Figure 10: Recommended Placement of GNSS Module with RF System

- 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. The minimum distance between antenna and enclosure is 3mm.

- The RF part of GPS & GLONASS & Beidou 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 & Beidou module from others.

- Module's enclosure material choice has a significant impact on module's performance. Any metallization or conductive materials as flat cables above module antenna or at close vicinity can degrade GPS signals significantly or eliminate it completely. Plastic materials with high dielectric constant and dielectric loss affect antenna frequency response and its return loss. Preferable materials are those used for RADOMs and special plastics for RF applications.

8.3 External Active Antenna Circuit

The following figure is a typical reference design with active antenna. In this mode, DC on the RF_IN pin is powered by VCC_RF Pin and supplies power to the external active antenna.

π model match network :

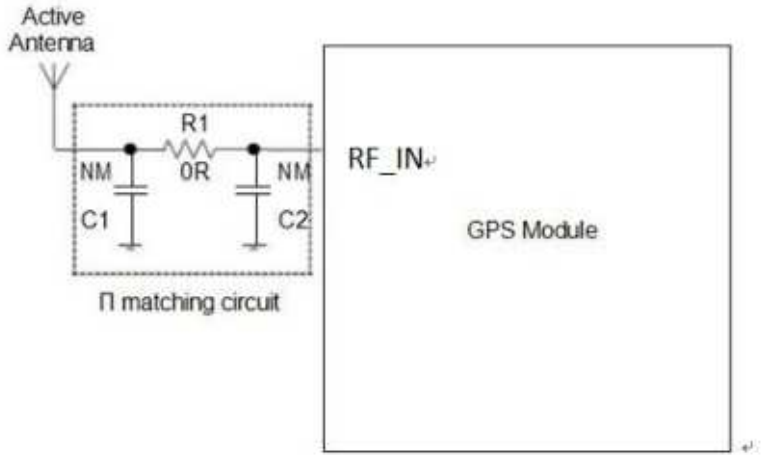


Figure 11: Reference Design for Active Antenna

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.

The following figure is a typical reference design with active antenna. In this mode, DC on the RF_IN pin is powered by VCC_RF Pin and supplies power to the external active antenna.

T model match network :

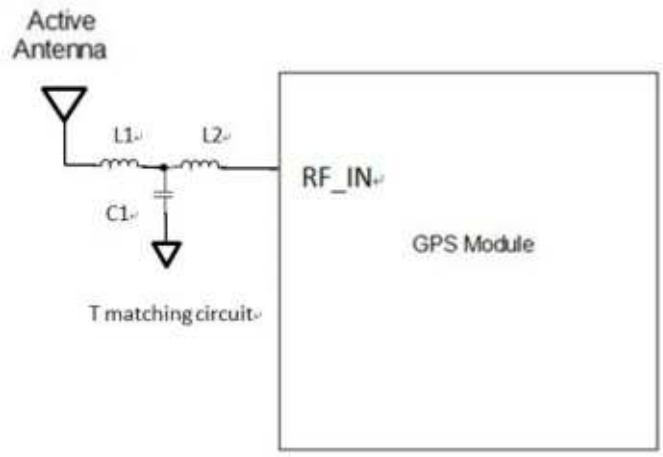
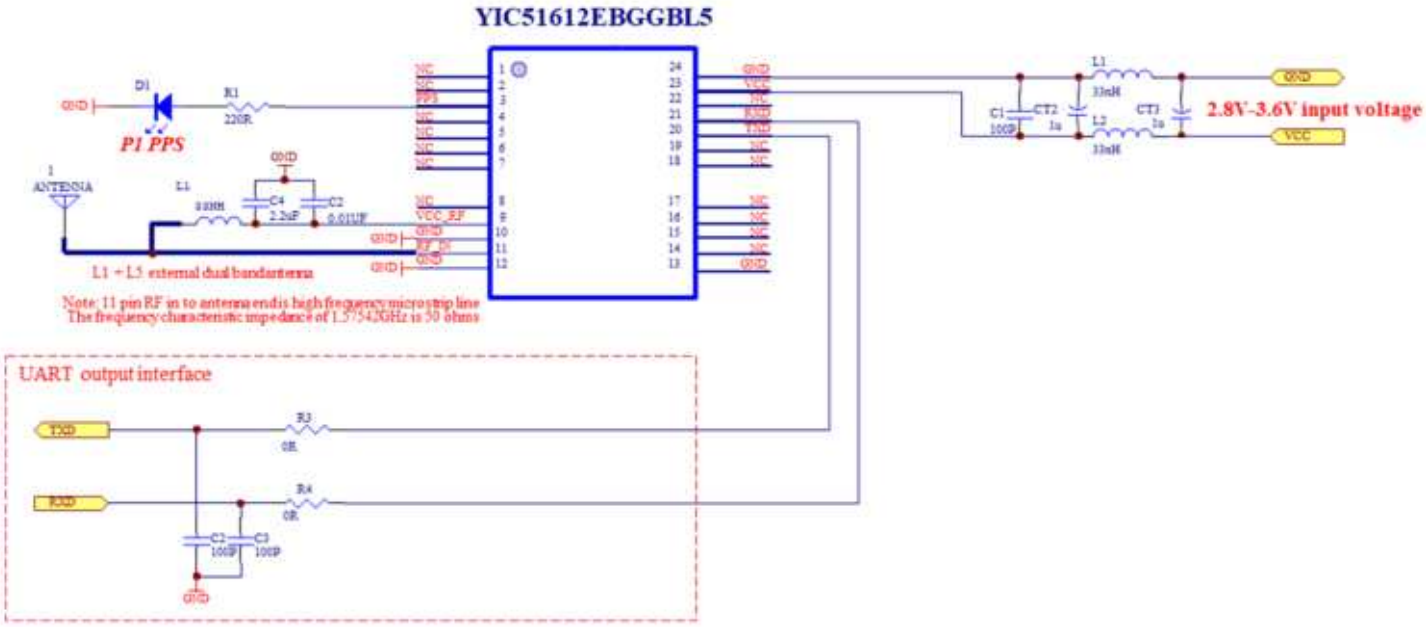


Figure 12: Reference Design for Active Antenna

L1, C1, L2 are reserved matching circuit for antenna impedance modification. By default, C1 is not mounted; L1 and L2 are 0 H.

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.

9. Application Circuit



- Patch Antennas larger than 18×18 may not require an additional LNA/ SAW Filter

10. ESD handling precautions and Reliability

10.1 Electrostatic Discharge

YIC51612EBGGBL5 series modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GPS receiver!

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

- Unless there is a galvanic coupling between the local GND(i.e.the work table) and the PCB GND, then the first point of contact when handling the PCB must always be between the local GND and PCB GND.



- Before mounting antenna patch, connect ground of the device When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10pF, coax cable ~50-80pF/m, soldering iron.....)



- To prevent electrostatic discharge through the RF input, do nottouch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non ESD protected work area, implement proper ESD protection measures in the design.

- When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron (tip).

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

Pin	Contact Discharge	Air Discharge
RF_IN	±5KV	±10KV
VCC	±5KV	±10KV
UART	±3KV	±6KV
Others	±2KV	±4KV

11. Mechanical Dimensions

This chapter describes the mechanical dimensions of the module

Recommended land pattern dimensions

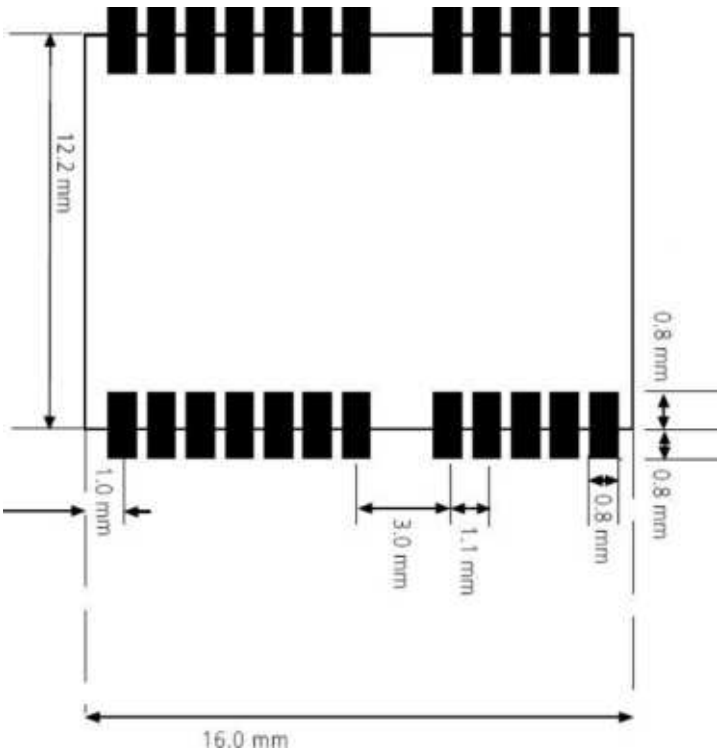


Figure 13 : Top view Dimensions

12. Manufacturing, Packaging and Ordering Information

12.1. Assembly and Soldering

YIC51612EBGGBL5 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 220~240°C (for SnAg3.0Cu0.5 alloy). The absolute maximum reflow temperature is 260°C . 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:

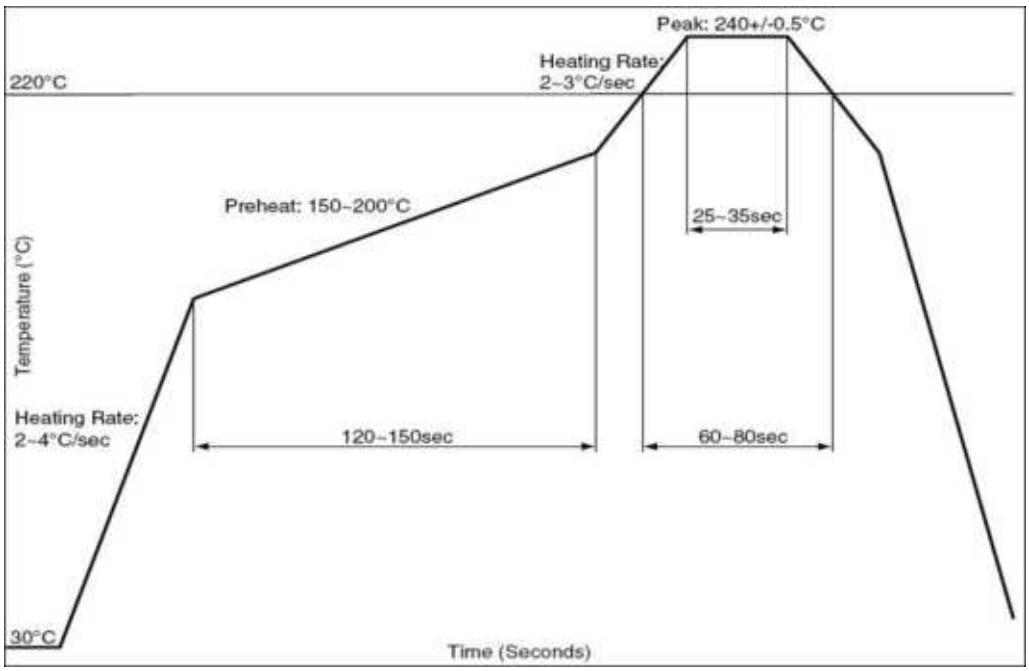


Figure 14 : Recommended Reflow Soldering Thermal Profile

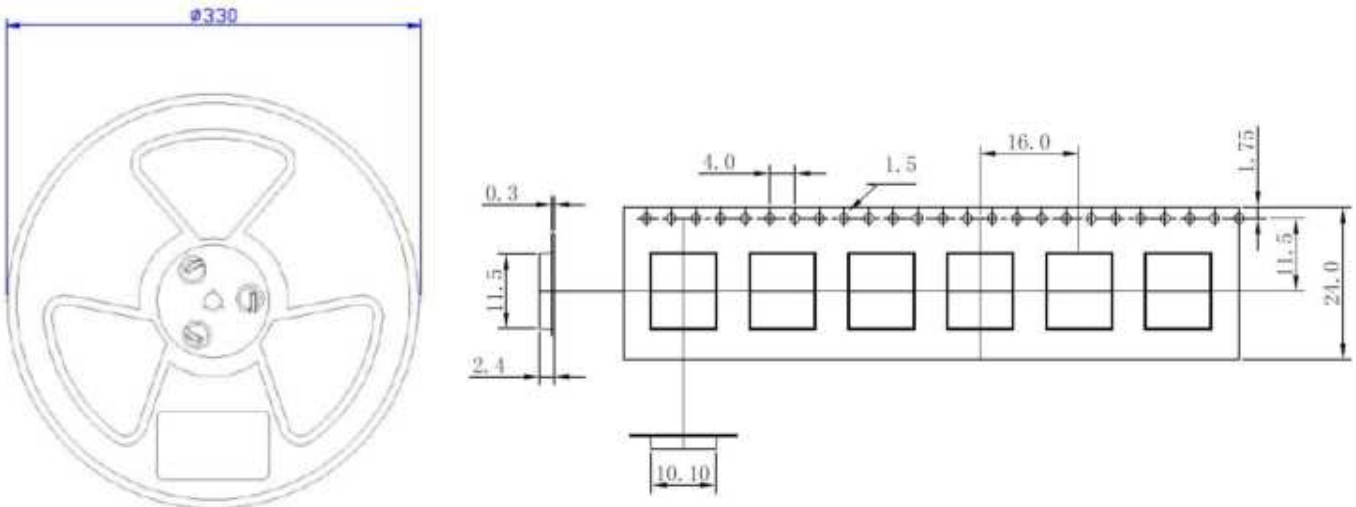
12.2. Moisture Sensitivity

YIC51612EBGGBL5 module is sensitive to moisture. To prevent YIC51612EBGGBL5 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.

YIC51612EBGGBL5 shall be baked for 192 hours in a cryogenic environment at 40°C+5°C/-0°C and <5%RH, or for 24 hours in a high-temperature environment at 125°C±5°C.As the plastic packaging tape is not heat-resistant, the module should be removed from the tape before baking, otherwise, the tape will be damaged due to high temperature heating, you can also refer to the actual production technology of the SMT factory.

12.3 Tape and Reel Packaging



Unit: mm
Quantity per reel: 1000pcs
Lengh per reel: 16m

Figure 15 : Tape and Reel Specifications

13. NMEA 0183 Protocol

The output protocol supports NMEA-0183 standard. The implemented messages include GGA, GLL, GSA, GSV, VTG, RMC, GST and ZDA messages. The NMEA message output has the following sentence structure: $AACCC, c-c*hh

The detail of the sentence structure is explained in Table 1.

Table 1: The NMEA sentence structure

character	HEX	Description
"$"	24	Start of sentence.
Aaccc		Address field. "aa" is the talker identifier. "ccc" identifies the sentence type.
","	2C	Field delimiter.
C–c		Data sentence block.
"*"	2A	Checksum delimiter.
Hh		Checksum field.
<CR><LF>	0D0A	Ending of sentence. (carriage return, line feed)

Overview of NMEA messages

NMEA	Description
$GNGGA	Time, position, and fix related data of the receiver.
$GNGLL	Position, time and fix status.
$GNGSA	Used to represent the ID of satellites which are used for position fix. When GPS & GLONASS & Galileo & BDS satellites are used for positioning solutions, the ID of available positioning satellites is counted and output with multiple statements.
$GPGSV **$GLGSV** **$GAGSV** **$GBGSV**	Satellite information about elevation, azimuth and CNR, satellites are used in position solution, $GPGSV sentence is used for GPS satellites, a $GLGSV sentence is used for GLONASS satellites, $GAGSV sentence is used for GALILEO satellites. And $GBGSV sentence is used for BDS satellites.
$GNRMC	Time, date, position, course and speed data.
$GNVTG	Course and speed relative to the ground.
$GNZDA	UTC, day, month and year and time zone.

The formats of the supported NMEA messages are described as follows:

13.1 GGA – Global Positioning System Fix Data

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

Structure: $GNGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh

For example: $GNGGA,175258.000,2447.0870,N,12100.5221,E,2,15,0.7,95.2,M,19.6,M,,0000*72

Field	Name	Example	Description
1	UTC Time	175258.000	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
2	Latitude	2447.08700	Latitude in ddmm.mmmmm format Leading zeros transmitted
3	N/S Indicator	N	Latitude hemisphere indicator, 'N' = North, 'S' = South
4	Longitude	12100.52210	Longitude in dddmm.mmmmm format Leading zeros transmitted
5	E/W Indicator	E	Longitude hemisphere indicator, 'E' = East, 'W' = West
6	Quality Indicator	2	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 6: Estimated (dead reckoning) Mode
7	Satellites Used	15	Number of satellites in use, (00 ~ 56)
8	HDOP	0.7	Horizontal dilution of precision, (0.0 ~ 99.9)
9	Altitude	95.2	mean sea level (geoid), (-9999.9 ~ 17999.9)
10	Geoidal Separation	19.6	Geoidal separation in meters
11	Age of Differential GPS data		Age of Differential GPS data NULL when DGPS not used
12	DGPS Station ID	0000	Differential reference station ID, 0000 ~ 1023
13	Checksum	72	

13.2 GLL – Latitude/Longitude

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

Structure: $GNGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh

For example: $GNGLL,2447.0870,N,12100.5221,E,175258.000,A,D*42

Field	Name	Example	Description
1	Latitude	2447.08700	Latitude in ddmm.mmmmm format Leading zeros transmitted
2	N/S Indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
3	Longitude	12100.52210	Longitude in dddmm.mmmmm format Leading zeros transmitted
4	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
5	UTC Time	175258.000	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
6	Status	A	Status, 'A' = Data valid, 'V' = Data not valid
7	Mode Indicator	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
8	Checksum	42	

13.3 GSA – GNSS DOP and Active Satellites

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

Structure: $GNGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,x*hh

For example:

$GNGSA,A,3,21, 12,15,18,20,24,10,32,25,13,,,1.2,0.7,1.0,1*18

$GNGSA,A,3,03,04,05,07,,,,,,,,1.2,0.7,1.0,4*34

$GNGSA,A,3,76,86,71,72,65,85,87,77,,,,,1.0,0.5,0.9,2*32

$GNGSA,A,3,76,44,13,15,66,23,45,28,,,,,1.0,0.5,0.9,2*32

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 1~12	21, 12, 15, 18, 20, 24, 10, 32,25, 13	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 65 ~ 88 are for GLONASS (GL PRN) ; 01 ~ 36 are for GALILEO (GA PRN); 01 ~ 37 are for BDS (BD PRN). GPS, GLONASS, GALILEO and BDS satellites are differentiated by the. GNSS system ID in table 1. Maximally 12 satellites are included in each GSA sentence.
4	PDOP	1.2	Position dilution of precision (0.0 to 99.9)
5	HDOP	0.7	Horizontal dilution of precision (0.0 to 99.9)
6	VDOP	1.0	Vertical dilution of precision (0.0 to 99.9)
7	GNSS System ID	1	1 for GPS, 2 for GLONASS, 3 for GALILEO, 4 for BDS
8	Checksum	18	

13.4 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，xx，xx，...，xx，xx，xx，xx，xx，x*hh

For example:

$GPGSV，4,1，13，02,72，109，43,24，69,035，48,18，52,330，42,21，49,246，43，1*69

$GPGSV，4,2，13，20,47，118，42,15，39,046，44,41，39,242，41,12，28,129，42，1*68

$GBGSV，4,3，13，10,25，321，38,25，15,170，35,32，14,278，36,136，063，35，1*64

$GBGSV，4,4，13，05,04，126，36，1*57

$GBGSV，2,1，07，67,63，158，46,05，61,202，44,04，57,199，44,03，39,243，42,4*7f

$GAGSV，2,2，07，01，00,000，39,02，00,000，24,06，00,266，4*44

$GAGSV，3,1，09，72,60，135,48，71,40，047，50,86，37,048，50,87，30,336，49，1*7b

$GLGSV，3,2，09，65,24，184,477，23,278，43,76，16,218，44,85，05,095，40，1*7e

$GLGSV，3,3，09，78,00，000，31,1*4c

Field	Name	Example	Description
1	Number of message	4	Total number of GSV messages to be transmitted (1-5)
2	Sequence number	1	Sequence number of current GSV message
3	Satellites in view	13	Total number of satellites in view (00 ~ 20)
4	Satellite ID	02	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 65 ~ 88 are for GLONASS (GL PRN) ; 01 ~ 36 are for GALILEO (GA PRN); 01 ~ 37 are for BDS (BD PRN). GPS, GLONASS, GALILEO and BDS satellites are differentiated by the GNSS system ID in table 1. Maximally 12 satellites are included in each GSA sentence
5	Elevation	72	Satellite elevation in degrees, (00 ~ 90)
6	Azimuth	109	Satellite azimuth angle in degrees, (000 ~ 359)
7	SNR	43	C/No in dB (00 ~ 99) Null when not tracking
8	Signal ID	1	1 for L1/CA, 4 for L5/CA
9	Checksum	69	

13.5 RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.
Structure: $GNRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,,,a*hh
For example: $GNRMC,175258.000,A,2447.0870,N,12100.5220,E,000.0,000.0,220617,,,D*75

Field	Name	Example	Description
1	UTC time	175258.000	UTC time in hhmmss.sss format (000000.00 ~ 235959.999)
2	Status	A	Status 'V' = Navigation receiver warning 'A' = Data Valid
3	Latitude	2447.08700	Latitude in dddmm.mmmmm format Leading zeros transmitted
4	N/S indicator	N	Latitude hemisphere indicator 'N' =North 'S' = South
5	Longitude	12100.52210	Longitude in dddmm.mmmmm 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	220617	UTC date of position fix, ddmmyy format
10	Mode indicator	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
11	checksum	75	

13.6 VTG – Course Over Ground and Ground Speed

The actual course and speed relative to the ground.

Structure:

$GNVTG,x.x,T,,M,x.x,N,x.x,K,a*hh

For example:

$GNVTG,000.0,T,,M,000.0,N,000.0,K,D*16

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	000.0	Speed over ground in kilometers per hour (000.0 ~ 1800.0)
4	Mode	D	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' =Differential mode 'E' = Estimated (dead reckoning) mode
5	Checksum	16	

13.7 ZDA – TIME AND DATE

UTC, day, month, year and local time zone

Structure:

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

For example:

$GNZDA,175258.000,30,08,2022,00,00*46<CR><LF>

Field	Name	Example	Units	Description
1	UTC time	175258.000		UTC time in hhmmss.ss format (000000.00 ~ 235959.99)
2	UTC Day	30		UTC time: day (01 ~ 31)
3	UTC Month	28		UTC time: month (01 ~ 12)
4	UTC Year	2022		UTC time: year (4 digit format)
5	Local zone hour	00		Local zone hours (00 ~ +/- 13)
6	Local zone minutes	00		Local zone minutes (00 ~59)
7	Checksum	46		Checksum

14. 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