Dead Reckoning GNSS Module

YIC51612EBGGBL5-DR

Datasheet

www.yic.com.tw

Revision History

Date	Reversion	Description
2022/2/15	1.0	First Draft, Based on YIC51612EBGGBL5-DR

Directory

1. Product Information

1.1 Product Description

The YIC51612EBGGBL5-DR made of the MediaTek series GNSS chip, and 6-axis MEMS sensor. It is a multiple function communication module which has integrated the advanced online adaptive integrated navigation algorithm and GNSS location engine, it can provide real-time, high-precision vehicle location, speed measurement and direction measurement information in any environment (such as indoor, tunnel, underground garage, etc.). When the signal accuracy is reduced and even satellite signals are lost in GNSS system, without using the odometer information, can use only inertial navigation technology to locate, measure the vehicle carrier accurately for a long time.

The YIC51612EBGGBL5-DR receiver module, it has 33 tracking channels, 72 capture channels and 210 PRN channels, enable it to capture and track any multiple satellite signals, at the same time, first positioning time is greatly reduced, even in complex urban environment, it can achieve higher positioning precision and accuracy.

Applications

- Vehicle High Precision Navigation
- Personal Positioning
- Vehicle Remote Monitoring
- ITS (Intelligent Traffic System)

1.2 Product Features

- Supports Dead Reckoning
- Supports L1 and L5 GNSS bands
- Supports Multi-Constellation
- Ultra High Track Sensitivity: -167dBm
- Multipath Detection and Suppression
- Automatically save GNSS log Information
- Protocol Compliant NMEA-0183, MTK, RTCM3.3
- Works With Passive and Active Antenna
- Built-in high gain LNA to Improve Receiving Sensitivity
- RoHS Compliant

1.3 Product Specifications

GPS Receiver		
Chip	MediaTek	
GNSS Reception	Channels	135 tracking channel and DSP accelerator
	Systems	GPS&QZSS L1 C/A, L5
		GLONASS L1
		GALILEO E1, E5a
		Beidou B1
		SBAS: WAAS, EGNOS, MSAS, GAGAN
Update Rate	GNSS	10Hz Max.
Position Accuracy	GNSS	<1.5m CEP @-130 dBm
	Without aid	Sub-meter (1% ~3% distance tolerance)
Hot start function	Software RTC hot start only	
Accuracy Time	Cold start	28 sec
	Warm start	25 sec
	Hot start	<5s sec
Sensitivity	Tracking	-167dBm
	Capture	-149dBm
	Reacquisition	-161dBm
GNSS Operating limit	Velocity	515m/s
	Altitude	18,000m
Protocol Support	UART Port: TXD and RXD 115200bps (default), Supports baud rate 9600bps to 921600bps NMEA 0183 Protocol	
Environment	Operation temperature	-40°C ~ +85°C
	Storage temperature	-40°C ~ +125°C
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
Input Voltage	2.8	3.3	3.6	Volt
Current		40		mA
Consumption		300		mW
Time required for the first valid data		<30		sec
UART Port Working Voltage				
Low Level Output Voltage (VOL)			0.4	Volt
High Level Output Voltage (VOH)	2.4			Volt
Low Level Input Voltage (VIL)			0.8	Volt
High Level Input Voltage (VIH)	2.1			Volt

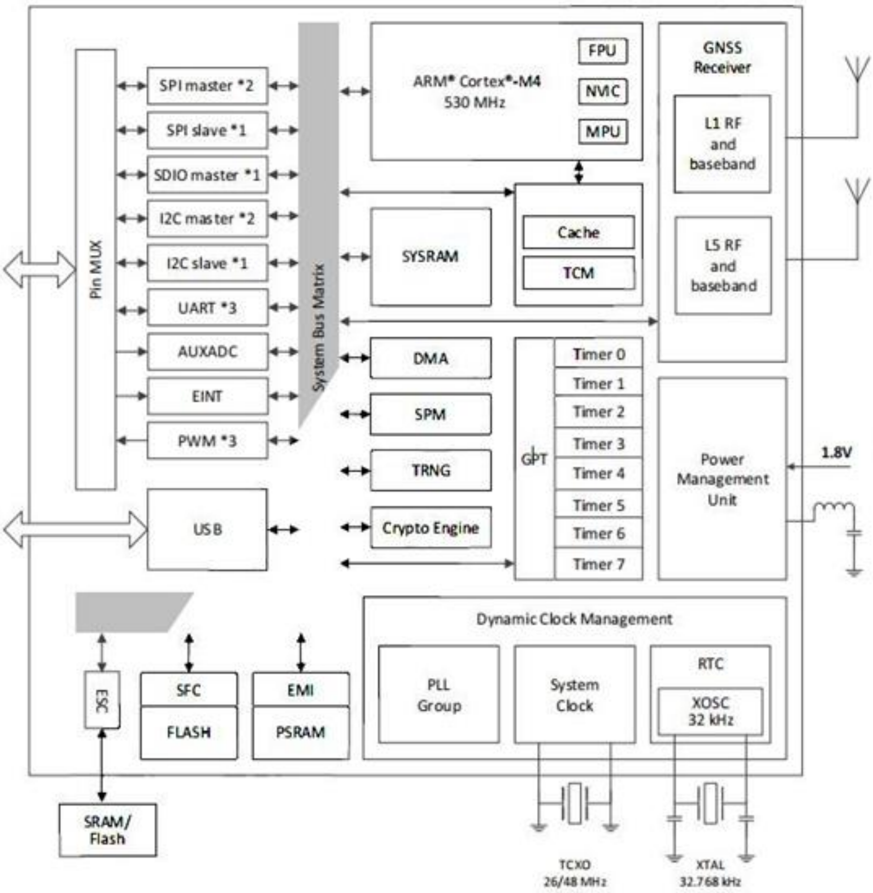
Mileage timing

GNSS signal loss time	Receiver positioning mode	Horizontal position1	Horizontal velocity1	Pitch roll Angle	Heading angle1
5 sec	Standard	1.0-2.0m	0.05m/s	0.3deg	1.0
	Standard	1.5-5.5m	N/A	N/A	N/A
	Standard	3.0m	N/A	N/A	N/A
	Standard	5.0m	0.30m/s	0.4deg	1.0deg

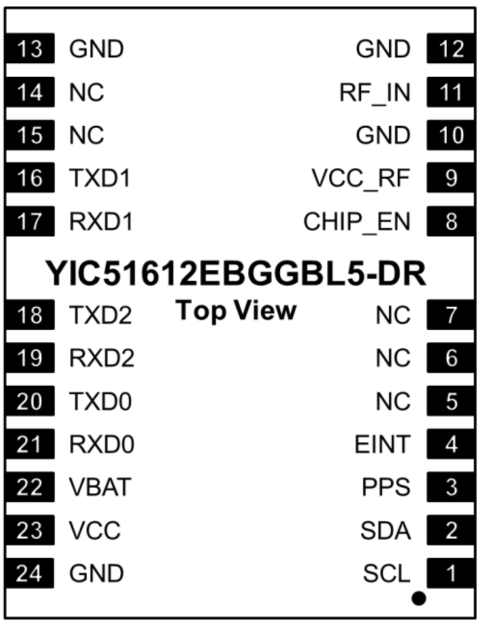
No Mileage timing

GNSS signal loss time	Receiver positioning mode	Horizontal position1	Horizontal velocity1	Pitch roll Angle	Heading angle1
5 sec	Standard	2.0-3.5m	0.05m/s	0.5deg	1.0
10 sec	Standard	10.0m	N/A	N/A	N/A
60 sec	Standard	25.0m	N/A	N/A	N/A
120 sec	Standard	60.0m	0.5m/s	1.0deg	2.0deg

2. Block Diagram



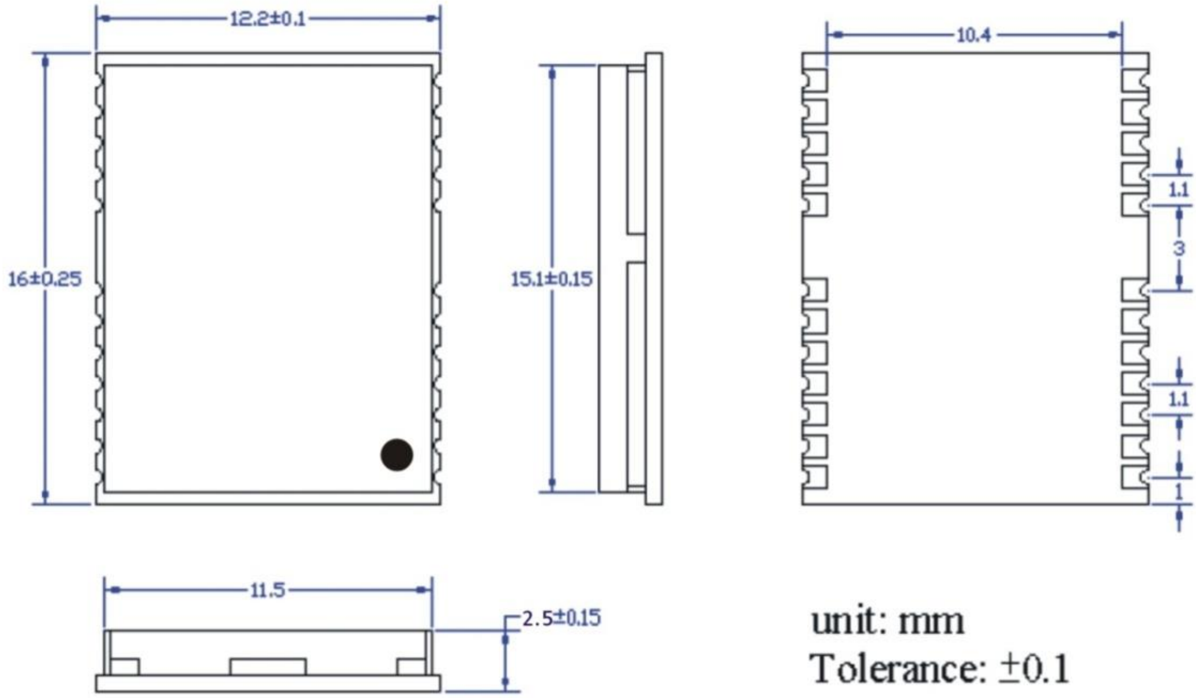
3. Module Pin Assignment



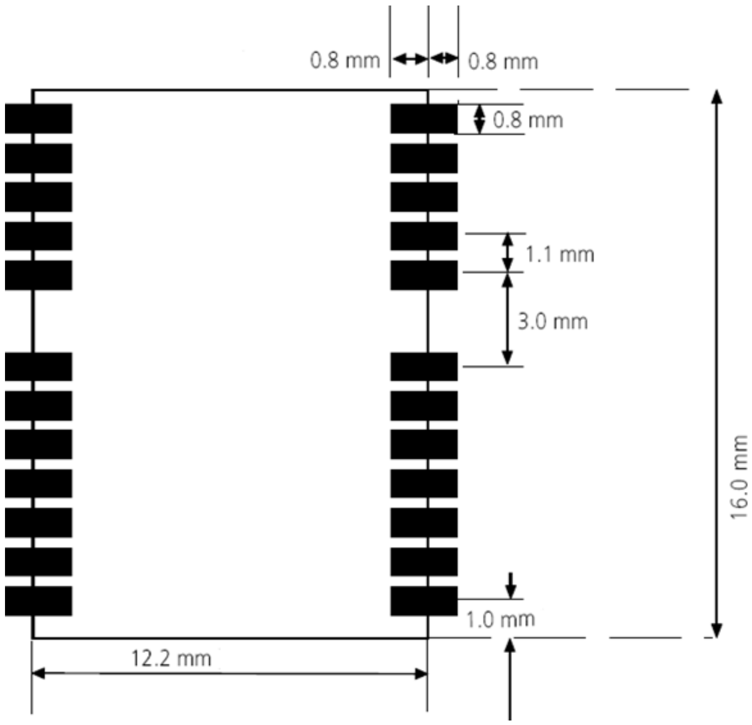
3.1 Pin Descriptions

Pin NO.	Pin Name	Remark
1	SCL	Serial clock
2	SDA	Serial data
3	PPS	Time pulse (1PPS) (if not used, must be left floating)
4	EINT	Interrupt pin, low level, suspended it when module enters dormant state & not use it
5	NC	No connection
6	NC	No connection
7	NC	No connection
8	CHIP_EN	Reset Low level reset (low level & 100ms) when not in use
9	VCC_RF	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	NC	No connection
15	NC	No connection
16	TXD1	Reserved Debugging port
17	RXD1	Reserved Debugging port
18	TXD2	Standby serial data output
19	RXD2	Standby serial data input
20	TXD0	UART serial data output
21	RXD0	UART serial data input
22	VBAT	backup battery supply voltage 2.8V ~ 3.3V
23	VCC	Main power supply, 3.3V Typical
24	GND	Ground

4. Dimensions

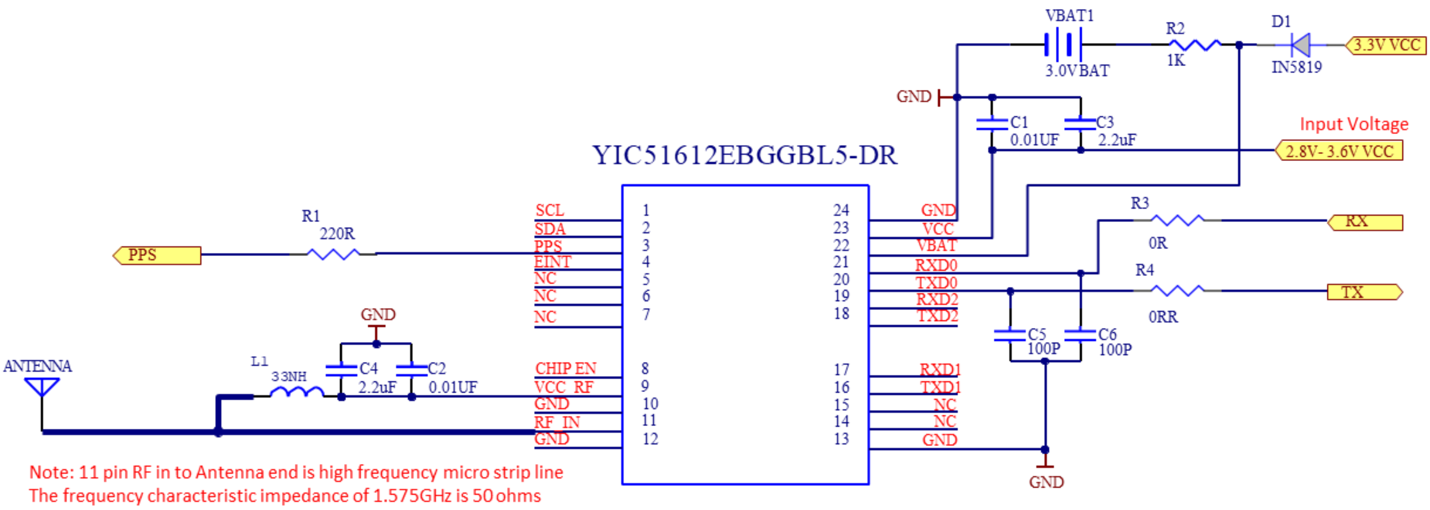


5. Recommended Footprint



6. Application Circuit

6.1 Application Circuit of YIC51612EBGGBL5-DR



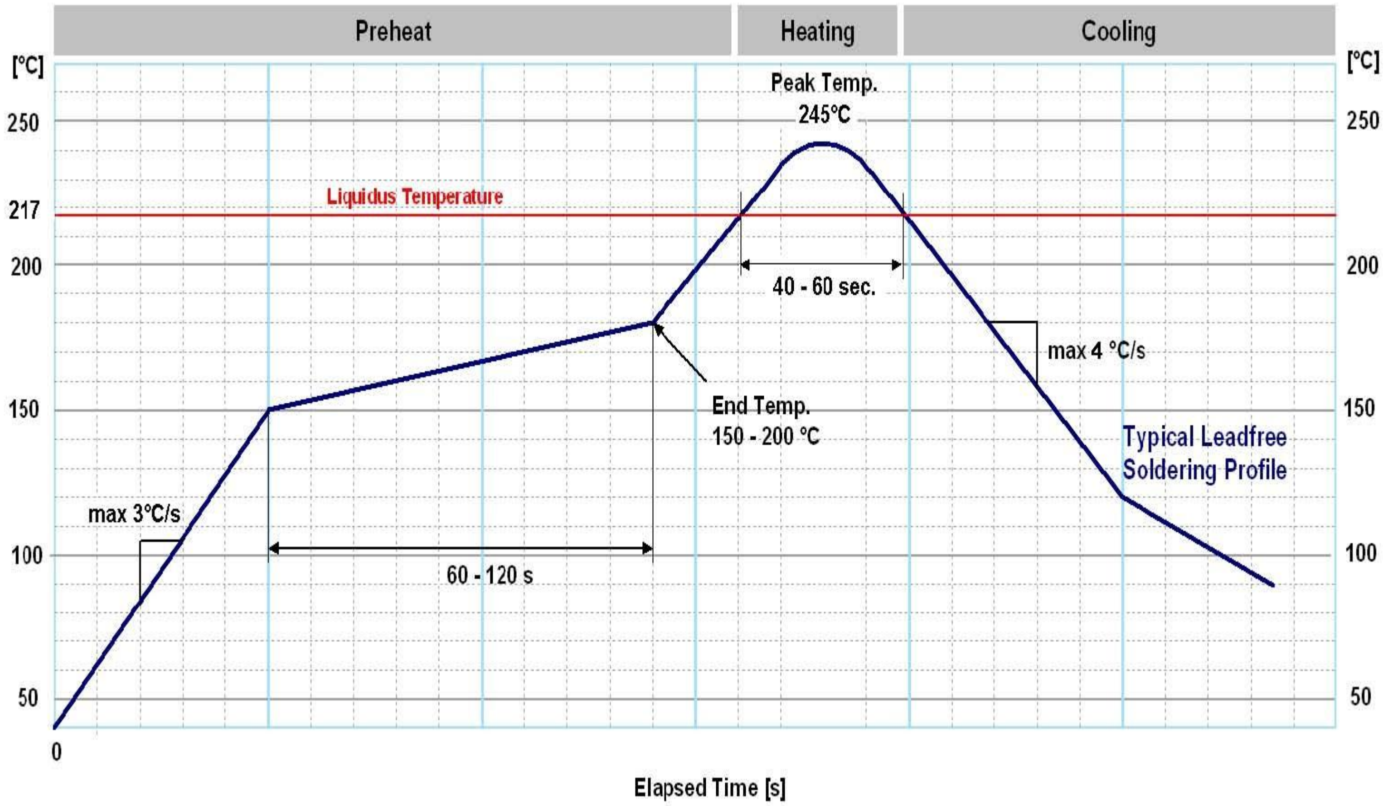
6.2 Layout Notes

1. A decoupling capacitor should be placed close to VDD pin of the module, and the width of power routing should be more than 0.5mm.

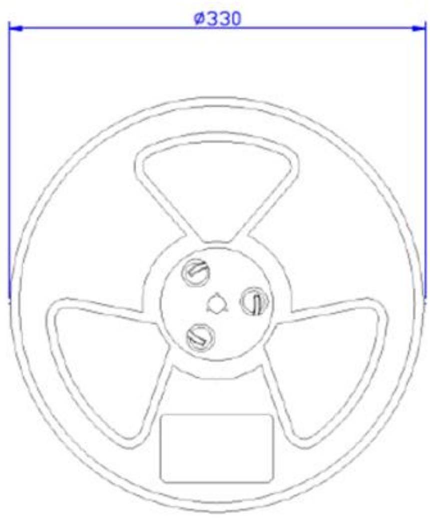
2. The characteristic impedance of RF routing between RF port to antenna should be controlled to 50 Ω.

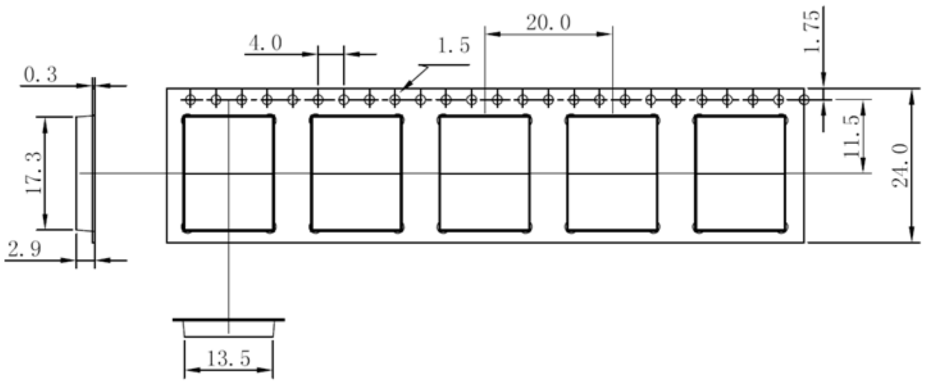
3. Do not place the module close to any EMI source, RF routing, clock signal or other high-frequency switching signal, etc.

7. Reflow Profile



8. Tape & Reel





Unit : mm

9. Coordinate System and Installation Direction

9.1 Coordinate System

The coordinate system is show in figure 1, XYZ (front side) axis is follow the right-hand rule.

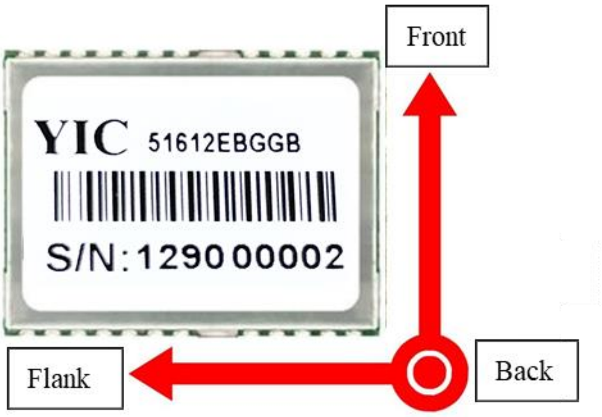


Figure 1

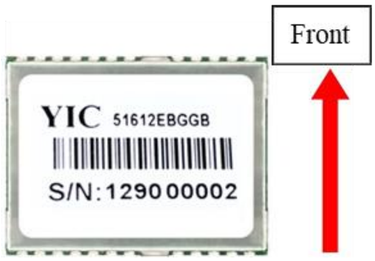
9.2 Installation Direction

Since the inertial navigation algorithm requires directional installation, however, considering that the installation of user products has different requirements, in order to facilitate the installation of users, as show in the figure below, can be set up in four different ways.

As show in figure 9.2-1, the installation status flag of GPAAT is "2" (factory default)

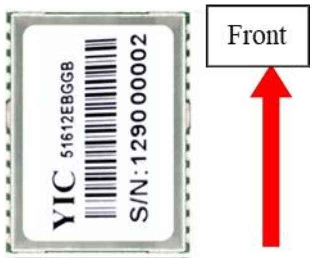
9.2-1 Installation mode

As show in figure 9.2-2, the installation status flag for GPAAT is "5"



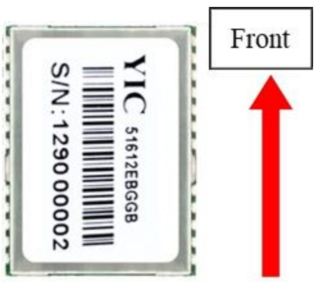
9.2-2 Installation mode

As show in figure 9.2-3, the installation status flag for GPAAT is "4"



9-2-3 Installation mode

As show in figure 9.2-4, the installation status flag for GPAAT is "3"



9.2-4 Installation mode

Note:

1. "Front" in the figure below represents the forward direction of the vehicles.
2. All the above installation methods of the module are horizontal installation.
3. Indicate the direction of module installation through the installation status flag in the custom protocol GPATT.

For example:

$GPATT,-0.00,p,-0.01,r,0.000,y,20170217,s,00220073510D343439373239,ID,1,INS,401,02,5,2,G*33

The red font of the above protocol is' 2 ', that is, the first installation method is adopted. Please refer to GPATT's message parsing for details.

10. Control Command

System supports users to send control command via serial ports to achieve following functions, but, cannot save the setting. That means, every time the powered on, it is output data by default.

Table 1: Inertial navigation enabling

Type	Attribute	Communication Protocol	Default Value	Remarks
1	log gpins	Open inertial navigation	Default	For results, please see protocol GPATT
2	unlog gpins	Close inertial navigation		

Table 2: Output frequency setting

Type	Attribute	Communication Protocol	Default Value	Remarks
1	log ghigh	Achieve 10HZ output		For results, please see output protocol
2	unlog ghigh	Achieve 1HZ output	Default	For results, please see output protocol

Table 3: ATT protocol

Type	Attribute	Communication protocol	Default Value	Remarks
4	log gpatt	Open GPATT	Default	For results, please see output protocol
8	unlog gpatt	Close GPATT		For results, please see output protocol

Table 4: ZDA protocol

Type	Attribute	Communication Protocol	Default Value	Remarks
1	log gpzda	Open GNZDA		For results, please see output protocol
2	unlog gpzda	Close GNZDA	Default	For results, please see output protocol

Table 5: GSV protocol

Type	Attribute	Communication Protocol	Default Value	Remarks
1	log gpgsv	Open GPGSV		For results, please see output protocol
2	unlog gpgsv	Close GPGSV	Default	For results, please see output protocol

Table 6: BD/GLONS Option

Type	Attribute	Communication Protocol	Default Value	Remarks
1	log gpgbd	Choose GPS+BD		For results, please see protocol GPATT
2	unlog gpgbd	Choose GPS+GLONASS	Default	For results, please see protocol GPATT

Table 7: Baud rate setting

Type	Attribute	Communication Protocol	Default Value	Remarks
4	log g4800	Set as 4800		For results, please see output protocol
5	log g9600	Set as 9600	Default 1	For results, please see output protocol
6	log g1920	Set as 19200		For results, please see output protocol
7	log g3840	Set as 38400		For results, please see output protocol
8	log g115200	Set as 115200	Default 2	For results, please see output protocol

Note:

1. All instructions are lowercase letters, there is a space key behind Log and unlog.

2. GPATT protocol contains a lot of product information, it is recommended that users retain the output of the protocol to facilitate query problems.

3. GPGSV, GPGSA take serial port resources, and, it is recommended that users to close two groups of protocols when using the inertial navigation function.

4. The specific details of required execution time execute various user commands are shown in following table. If the user sends a command, please make sure that the command is executed.

No	Command type	Required Time
1	Inertial navigation enabling	20ms
2	Output frequency setting	20ms
3	ATT protocol enabling	20ms
4	ZDA protocol enabling	20ms
5	GSV protocol enabling	500ms
6	Choose GLONASS/BeiDou	500ms
7	Baud rate setting	20ms

11. Protocol

11.1 GGA Data Format

For example:

$ GNGGA,062938.00,3110.4700719,N,12123.2657056,E,1,25,0.6,58.9666,M,0.000,M,99,AAAA*50

Field	Name	Example	Code	Description
1	$GNGGA	$GNGGA		Log header
2	utc	202134.00	hhmmss.ss	UTC time (H/M/S)
3	lat	3110.4693903	llll.lllllll	Latitude: -90~90 degrees
4	latdir	N	a	Latitude direction: N: North; S: South
5	lon	12123.2621695	yyyyy.yyyyyyy	Longitude: -180~180 degrees
6	londir	W	b	Longitude direction: E:east; W:west
7	QF	1	q	Solution State 0: invalid solution 1: single point positioning solution 2: pseudo range difference 6: inertial navigation
8	sat No.	14	n	Satellite Number
9	GPS precision	0.6	x.x	GPS precision
10	alt	50.22	h.h	Altitude
11	a-units	M	M	Altitude unit
12	age	1	dd	Differential delay
13	stn ID	1	xxxx	Base station number: 0000-1023, In single: AAAA
14	*xx		*hh	Checksum
15	[CR][LF]	[CR][LF]		Sentence terminator

11.2 RMC Data Format

For example:

$ GNRMC,064401.65,A,3110.4706987,N,12123.2653375,E,0.604,243.2,300713,0.0,W,A*3E

Field	Name	Example	Code	Description
1	$GNRMC	$GNRMC		Log header
2	utc	143550.00	hhmmss.ss	UTC time (H/M/S)
3	Pos status	A	A	Solution state: A= effective positioning V= invalid positioning
4	lat	3110.4854911	llll.lllllll	Latitude: -90~90 degrees
5	latdir	N	a	Latitude direction: N: North; S: South
6	lon	12123.9129278	yyyyy.yyyyyyy	Longitude: -180~180 degrees
7	londir	E	b	Longitude direction: E:east; W:west
8	SPEED IN	0.29	q	Ground speed
9	Track Ture	108.5	n	Ground course angle
10	Date	010909	ddmmyy	UTC date
11	Mag var	0.0	0.0	Magnetic declination (000.0~180.0 degrees, adding o if lack of leading digit)
12	Vardir	M	M	Declination direction, E (East) or W (West)
13	Mode ind	A	a	Mode indication (only NMEA0183 3 version output, A= self localization, D= difference, E= estimation, N= data invalid)
14	*xx	*57	*hh	Checksum
15	[CR][LF]	[CR][LF]		Sentence terminator

11.3 ATT Data Format

For example:

$ GPATT,0.00,p,0.00,r,0.00,y,20211129,S,003E009,ID,1,INS,3335,02,0,0.00,0,M,01,3.35,0,1,F,00,7,A, 0.000,0,1,00,B,-1,1,1,4,0*44

Field	Name	Example	Code	Description
1	$GPATT	$GPATT		Log header
2	Pitch	1.34 (unit：degree)	Float	pitch angle
3	Angle Channel	P	Char	PP: pitch, r: roll, y: yaw
4	Roll	2.56	Float	Roll angle
5	Angle Channel	Y	Char	P: pitch, r: roll, y: yaw
6	Yaw	132.45	Float	Yaw angle
7	Angle Channel	Y	Char	P: pitch, r: roll, y: yaw
8	Soft Version	20211021	CString	S: software version number
9	Version Channel	S	Char	S: software version number
10	Produtct ID	003E0038510D343439373239	CString	96 bit unique ID
11	ID Channel	ID	ID	ID: product ID
12	INS	1: open，0: close	X	Default open inertial navigation
13	INS Channel	INS	CString	INS: whether inertial navigation open
14	Hardware version	3335	CString	Named after the master chip
15	Run_State_Flag	1->3 Please refer to table A below for details	d	Algorithm status flag
16	Mis_Angle_Num	9	Byte	number of Installation Angle identification
17	Custom flag	X	Float	Custom flag
18	Custom flag	X	Byte	Custom flag
19	Separating character	M	Char	Separating character
20	Static Flag	1: Static 0: dynamic	Byte	Static Flag

21	Custom flag	X	Float	User Code
22	Custom flag	X	Byte	Custom flag
23	Line Flag	1: straight driving，0: curve driving	d	Straight line flag
24	Separating character	F	Char	Separating character
25	Custom flag	X	Byte	Custom flag
26	IMU_Kind	0->BIM055 1->BMI160 2->LSM6DS3TR-C 3->LSM6DSOW 4->ICM-40607 5->ICM-40608 6->ICM-42670 7->LSM6DSR	d	Sensor Type
27	Separating character	A	Char	Separating character
28	Mileage	21.547 (unit：KM)，The maximum is 9999 kilometers	Float	Mileage
29	Custom flag	X	Byte	Custom flag
30	Custom flag	X	Byte	Custom flag
31	Run_Inetial_Flag	1->4 Please refer to table B below for details	D	Inertial navigation converged flag
32	Separating character	B	Char	Separating character
33	Custom flag	X	Byte	Custom flag
34	Custom flag	X	Byte	Custom flag
35	Custom flag	X	Byte	Custom flag
36	GPS accuracy grade	Accuracy： 0: extremely low ; 1: low ; 2: medium ; 5: high ; 4: Very high	Byte	Gps Stauts
37	Times of ephemeris input	The number is incremented by 1 each time an ephemeris is inputed	Byte	Eph_Num
38	*xx	*2c	*hh	Checksum
39	[CR][LF]	[CR][LF]		Sentence terminator

Note: the conditions for inertial navigation to work normally

1. GPATT protocol 12 field INS is 1

2. GPATT protocol 15 field State Flag is 03/04

If the user wants to obtain good inertia performance, such as speed, UBI alarm and other parameters, In addition to the above two results, it is recommended to wait for inertial navigation convergence.

3. GPATT protocol 31 field Run_Inetial_Flag is 4

Table 1 GPATT protocol 15 field RUN_STATE_FLAG each physical meaning description

Flag	**Description**	**Required conditions**
0	Prepare initialization	System power on
1	Attitude initialization completed	Vehicle Static for 5-10S
2	Position initialization completed	Get Position Info
3	Get the installation angle，Enter the integrated navigation	Driving over 5m/s for a period of time
4	The installation Angle has been identified	Keep driving for a while

Table 2 GPATT protocol 31 field Run_Inetial_Flag each physical meaning description

Flag	Description	Required conditions
0	Prepare initialization	
1	Inertial navigation start converged	Copy satellite positioning only, Run_State_Flag=01
2	Initial convergence of inertial navigation	Inertial navigation is training, Run_State_Flag=02
3	Inertial navigation is converging	Inertial navigation is training, Run_State_Flag=03
4	Inertial navigation converges completed	Inertial navigation completed training, Run_State_Flag=04

11.4 GSA Data Format

For example：

$GNGSA,A,3,07,08,09,11,01,23,27,,,,,,3.01,1.25,2.74*1A

Field	Name	Example	Code	Description
1	$GNGSA	$GNGSA		Log header
2	Positioning mode	Please refer to table 3 below for details		Positioning mode flag
3				
4	Satellite used	07	SV	First channel
5		08	SV	
6	...	...	...	...
7	PDOP	3.01		Position Dilution Of Precision
8	HDOP	1.25		Horizontal Dilution of Precision
9	VDOP	2.74		Vertical Dilution of Precision
10	*xx	*1A	*hh	Checksum
11	[CR][LF]	[CR][LF]		End of message termination

Table 3: Physical meaning description of State_Flags

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

Table 4: Physical meaning description of State_Flags

Flag	Description
1	Not positioning
2	2D positioning
3	3D positioning

11.5 SPEED Data Format

For example:
$SPEED,020406.10,20.96,2,A,-0.44,-1.15,-9.48,G,-0.11*52

Field	Name	Example	Code	Description
1	$SPEED【1】	$SPEED		Log header
2	Utc	143550.00	hhmmss.ss	UTC time (H/M/S)
3	Speed	20.96	dd.mm	Ground speed(bit)
4	Status【2】	2	D	Solution State： 0=data invalid 1=converging 2=data valid
5	A	Represents for acceleration	A	separator
6	Acc_X	-0.26（m/s/s）	ddd.mm	X axis acceleration
7	Acc_Y	0.075（m/s/s）	ddd.mm	Y axis acceleration
8	Acc_Z	-9.8（m/s/s）	ddd.mm	Z axis acceleration
9	G	Represents angular velocity	G	separator
10	Gyr Z【3】	0.42 Radian per second	ddd.mm	Z axis acceleration
11	*xx	*57	*hh	Checksum
12	[CR][LF]	[CR][LF]		Sentence terminator
13	$SPEED【1】	$SPEED		Log header

Note:

1. The speed unit of SPEED protocol is the same as that of GNRMC, and output frequency is 10Hz.

2. Since the inertial navigation system supports arbitrary installation, the value of the sensor can be converted to the vehicle coordinate system only after the installation Angle is determined, so as to obtain the acceleration and angular velocity data of X/Y/Z axis. Otherwise, the inertial sensor data will be installed arbitrarily, resulting in the data cannot be converted to the vehicle's XYZ axis.

The inertial navigation module must be rigidly linked to the vehicle. Then, there are two situations:

Situation 1. If it is installed for the first time, when the inertial navigation module is powered on, there is no installation Angle in the Flash, and the status value is 0. After the vehicle runs, through the vehicle acceleration deceleration and other vehicle movement, it identifies the installation Angle, then Status will change to 1, and it will change to 2 about 3 minutes after the vehicle runs again and the inertial navigation training is completed. In this case, acceleration and angular velocity are reliable values.

Situation 2. If it is not the first installation, after the inertial navigation module is powered on, there is already an installation Angle in the Flash, and the value of Status is 1. The vehicle runs for about 3 minutes again, and the Status changes to 2 after the inertial navigation training is completed. In this case, acceleration and angular velocity are reliable values.

3. The unit of angular velocity is radian per second, if converted to degrees per second, please multiply by the coefficient 180/3.14.