General Description

GT-1612F5DR-AGGB is made of the MediaTek AG3335AT series GNSS chip, and six axis acceleration 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, GT-1612F5DR-AGGB can use only inertial navigation technology to locate, measure the vehicle carrier accurately for a long time.

GT-1612F5DR-AGGB is a concurrent receiver module with built-in multiple positioning systems that support simultaneous reception of GPS, Glonass, Galileo, Beidou, and QZSS L1 bands. It has 33 tracking channels, 72 capture channels and 210 PRN channels, enable it to capture and track any multiple satellite signals. Compared with single GPS system, the multiple positioning system (GPS & GLONASS & GALILEO & BEIDOU & QZSS & SBAS) of GT-1612F5DR-AGGB makes a great increase in the number of visible and available satellites, at the same time, the first positioning time is greatly reduced, even in complex urban environment, it can achieve higher positioning precision and accuracy.

Applications

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

Figure：GT-1612F5DR-AGGB Top View

Features

- Build on high performance, low-power GNSS
- MediaTek AG3335AT chip set
- Built-in ST-LSM6DSRTR acceleration sensor to define various gravity algorithms
- Supports BDS-3 signals
- Simultaneously receiving multi-band multi-system satellite signals and all civil GNSS signals.
- Multipath signal detection and interference suppression.
- Passive or active antennas can be used
- Built-in high gain LNA to improve receiving sensitivity
- Software version : 20220707 L1+L5
- Support satellite systems: GPS,GLONASS,GALILEO,BEIDOU,QZSS,SBAS
- Ultra high track sensitivity: -167dBm
- Baud rate:115200
- Protocol compliant NMEA-0183, MTK, RTCM3.3
- Automatically inertial navigation positioning without GNSS signal
- Automatically save GNSS log information
- Operating voltage: 2.8V~3.6V
- Power consumption:70mA
- Product size：16x12.2x2.6mm
- Package type: SMD with stamp hole
- Communication type: UART/TTL
- Recommended operating temperature : -40to85℃
- RoHS compliant (Lead-free)

1. Performance Description

1.1 Features

item	Features	item	Features
Gyroscopic drift	High precision attitude heading information is obtained by eliminating gyro driftwo	Component selection	High performance three axis gyroscope and three axis accelerometer
Acceleration noise	Eliminate vibration acceleration and obtain high accurate velocity information	Error compensation	Complete quadrature error / temperature drift and other error compensation
Zero speed correction	Zero speed correction algorithm prevents navigation data drift	Preventing pirate	Each product calibration code is inconsistent for preventing pirate
Software algorithm	Adaptive extended Calman filtering algorithm	Physical Dimensions	Compact modular design saves user product space
Intelligent identification	Identify and isolate GNSS data with large errors	Communication protocol	Plug and use standard communication protocol NEMA-0183
Independent of odometer	High precision positioning by using inertial navigation	Engineering installation	No installation angle, convenient for users to install on board
Navigation technology	Switch between integrated navigation and inertial navigation technology	Sub - meter	Support RTCM2.3 protocol / sub-meter level navigation in complex environment

1.2 Technical Parameter

Item	Parameter	Specification
GNSS Receiver Type	Channels	135 tracking channel and DSP accelerator GPS/QZSS: L1 C/A, L5 GLONASS: L1OF GALILEO: E1(E1B+E1C), E5A BEIDOU: B1I, B2A SBAS: WAAS, EGNOS, MSAS, GAGAN
GNSS Sensitivity	Tracking Capture Re-capture	-167dBm -149dBm -161dBm
TTFF (Autonomous)	Cold start Warm start: Hot start:	28s （AVG）@-130 25s （AVG）@-130 <5s （AVG）@-130
Hot start function （Pin: VBAT）	Software RTC hot start only	
Horizontal Locating Accuracy	GNSS inertial navigation Without aid	<1.5m CEP @-130 dBm Sub-meter (3% CEP)
Acceleration Accuracy	Without aid: 0.1m/s²	
GNSS Dynamic Performance	Maximum altitude Maximum velocity Maximum Acceleration	18,000m 515m/s 4G

2.Application

2.1 Block Diagram

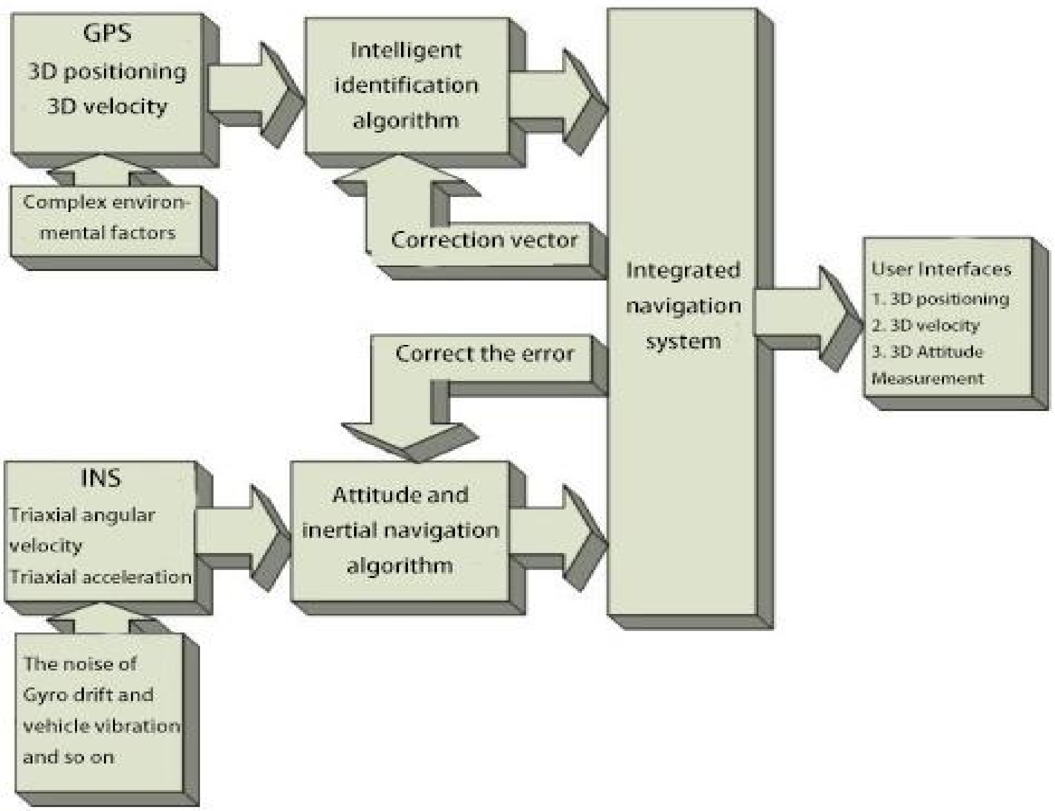


Figure 1: Block Diagram

2.2 System Introduction

2.2.1 Satellite navigation system：

Satellite navigation system has the advantages of global application, all-weather extension and high precision navigation; But satellite navigation systems are vulnerable to environmental influences, such as trees, buildings and so on, resulting in multi path effect to cause the accuracy of positioning result reduced or even lost, especially in the indoor environment, such as tunnels, satellite navigation system cannot be used.

In addition, even in an open environment, when the carrier speed is very low, the satellite navigation system will also be unable to get precise carrier azimuth information (heading angle).

2.2.2 Inertial navigation system:

The inertial navigation is based on Newton's laws of mechanics to conduct integrating to time and change it into navigation coordinates by measuring the acceleration of the carrier in the inertial reference frame, thus, it can get information about speed, yaw angle, and position in navigation coordinates, as well as the carrier information. However, due to the serious drift of gyro and the shock of vehicle, the inertial navigation system can not obtain high precise azimuth and velocity information by directly integrating acceleration, that is, existing micro inertial navigation systems are difficult to work independently for a long time.

2.2.3 Integrated navigation system：

Satellite / inertial integrated navigation takes full advantage of inertial navigation to obtain optimal navigation results based on he integration of optimal estimation algorithm and the kalman algorithm ; Especially when the satellite navigation system cannot work, the inertial navigation system is used to make the navigation system continue to work, to ensure the normal operation of the navigation system, and to improve the stability and reliability of the system.

2.2.4 Independence to odometer

Conventional vehicle navigation systems often rely on GT-1612F5DR-AGGB schemes of odometer and gyroscopes to realize high precision navigation and positioning in complex environment of vehicle, for many automotive aftermarket, the connection of odometer signal is extreme complex, and it involves auto safety. After years of research and development, when the signal accuracy in GNSS system is reduced and even satellite signals are lost, only by using pure inertial navigation technology, the vehicle carrier can be accurately positioned, measured in a long time. Compared with the existing products on the market, the performance has been greatly improved.

Of course, the GT-1612F5DR-AGGB system can also connect with odometer signals and will achieve better performance indicators.

2.2.5 Vehicle attitude angle

GT-1612F5DR-AGGB navigation system achieves filtering of gyro drift and acceleration vibration signals using research experience in MEMS inertial devices for many years by adaptive filtering algorithm, and furthermore, it can get high precision attitude information, so as to meet various needs of vehicle monitoring and navigation applications in ramp detection.

2.2.6 GGM navigation system

GT-1612F5DR-AGGB navigation system provides intelligent recognition algorithm for satellite navigation accuracy to identify the positioning accuracy of satellite navigation based on the high precision navigation information provided by integrated navigation, if the satellite navigation accuracy is better, integrated navigation will be carried out, once satellite navigation signals are found to be very poor and even lost, pure inertial navigation is carried out, in a word, GT-1612F5DR-AGGB navigation system realizes autonomous switching between integrated navigation and pure inertial navigation.

2.3 Product feature

2.3.1 Maximum parameter

Parameter	Index	Unit
Power Supply		
Voltage Supply	3.6	V
Temperature Range		
Operation Temp	-40 to + 85	℃
Storage Temp	-40 to + 125	℃

2.3.2 Electrical feature

Parameter	Index	Unit
Power Supply		
Input voltage	2.8-3.6	V
Current	70【1】	mA
Consumption	300	mW
Time		
The time required for the first valid data	<30	S

2.4 Performance Index

2.4.1 Mileage timing

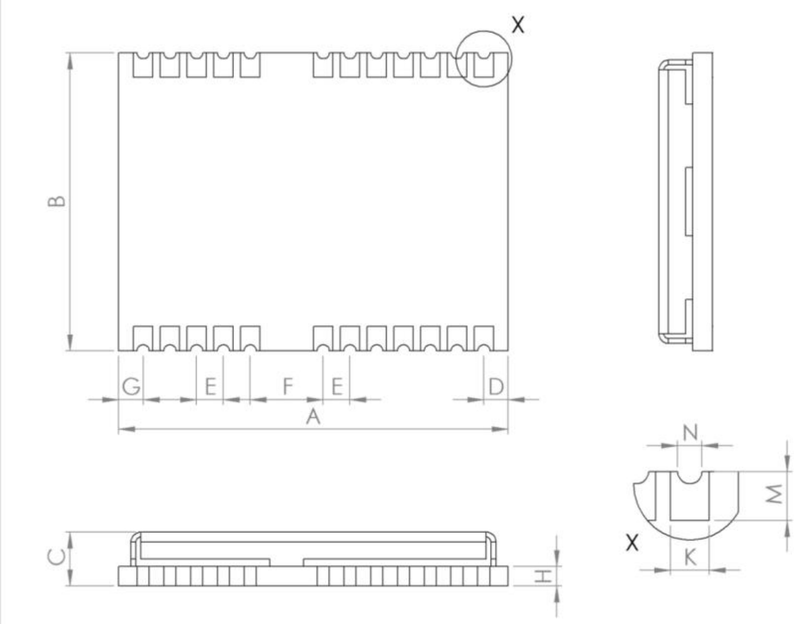
GNSS signal loss time	Receiver positioning mode	Horizontal position[1]	Horizontal velocity[1]	Pitch roll Angle	Heading angle1
5 s	Standard	1.0-2.0m	0.05m/s	0.3deg	1.0
	Standard	1.5-5.5m	N/A	N/A	N/A
	Standard	3.0m	N/A	N/A	N/A
	Standard	5.0m	0.30m/s	0.4deg	1.0deg

2.4.2 No Mileage Timing

GNSS signal loss time	Receiver positioning mode	Horizontal position[1]	Horizontal velocity[1]	Pitch roll Angle	Heading angle1
5 S	Standard	2.0-3.5m	0.05m/s	0.5deg	1.0
10 S	Standard	10.0m	N/A	N/A	N/A
60 S	Standard	25.0m	N/A	N/A	N/A
120 S	Standard	60.0m	0.5m/s	1.0deg	2.0deg

3. Mechanical Dimensions and Pin Assignment

3.1 This chapter describes the mechanical dimensions of the module.



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	15.9	16.0	16.6
B	12.1	12.2	12.3
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H		0.82	
K	0.7	0.8	0.9
M	0.8	0.9	1.0
N	0.4	0.5	0.6
Weight		1.6g	

Figure2：Mechanical Dimensions (Unit：mm)

3.2 Pin Definition

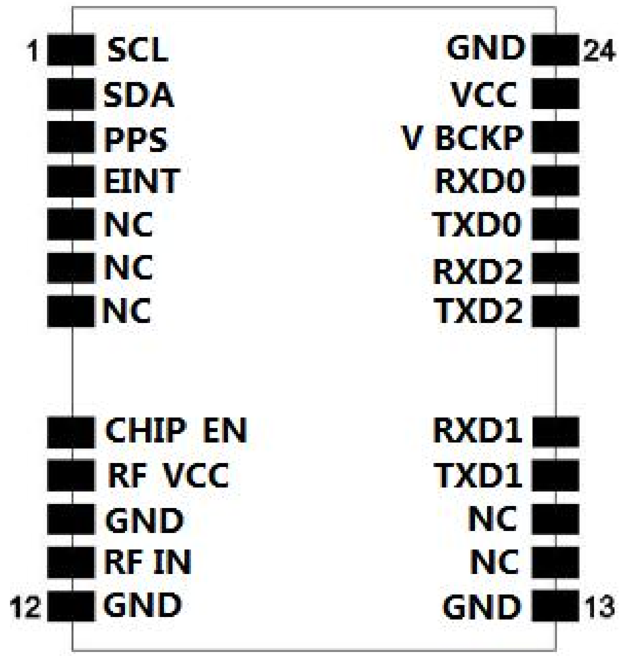


Figure3: Pin Assignment

Table: CON Pin Description

Pin	Pin name	Description	Pin	Pin name	Description
1	SCL	Serial Clock	13	GND	Power GND
2	SDA	Serial data	14	NC	
3	PPS	Pulse output(seconds)	15	NC	
4	EINT	Interrupt pin, low level, suspended it when module enters dormant state & not use it	16	TXD1	Reserved Debugging port (Idle)
5	NC		17	RXD1	Reserved Debugging port (Idle)
6	NC		18	TXD2	Standby serial port output

7	NC		19	RXD2	Standby serial port input
8	CHIP_EN	Reset; Low level reset (low level & GT; 100ms) when not in use	20	TXD0	Serial port TX port
9	RF_VCC	Active antenna power supply	21	RXD0	Serial port RX port
10	GND	Power GND	22	V_BCKP	backup battery 2.8V--3.3V. leave it vacant when not in use
11	RF_IN	GPS_RF Input	23	VCC	Working voltage：2.8-3.6V Recommended use：3.3V
12	GND	Power GND	24	GND	Power GND

3.3 Reference Charging Size for PCB (unit: mm)

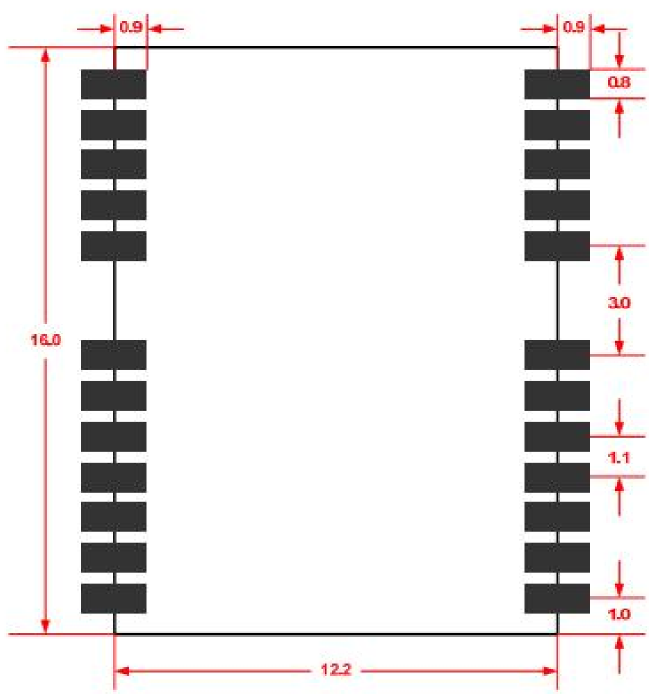


Figure 4: Reference Charging Size for PCB (unit: mm)

3.4 Block Diagram

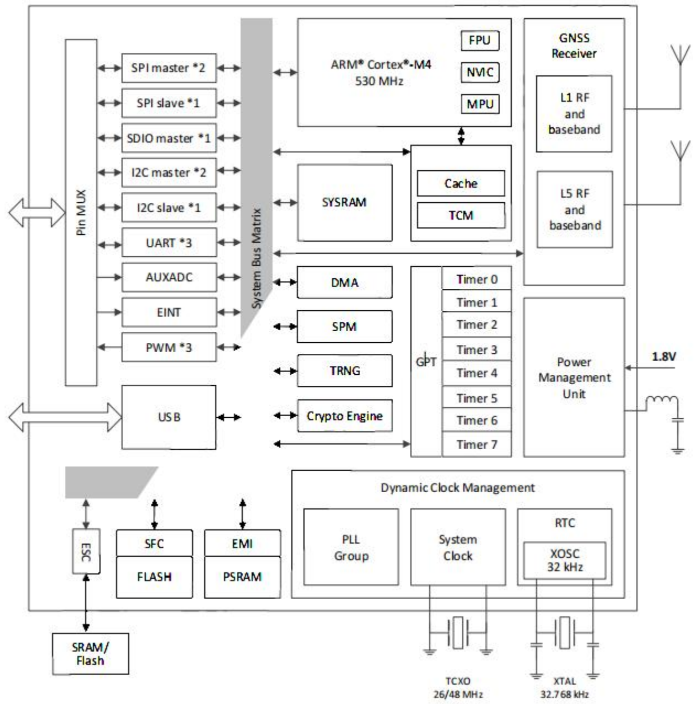


Figure 5:Block Diagram

4. Coordinate System and Installation Direction

4.1 Attentions

As a high-performance vehicle integrated navigation system, GT-1612F5DR-AGGB system also requires users to pay attention to some matters during application.

Figure 6: Coordinate System

Installation Direction

No	Initialization process of integrated navigation	Importance
1	No installation Angle requirements.Refer to **Figure 6**	
2	Before power on， Fixed connected GT-1612F5DR-AGGB and vehicle	Required
3	After power on， don't move GT-1612F5DR-AGGB	Required
4	Before the vehicle moves， please make sure the GPS/BD system output the correct protocol	Required

No	Initialization process of integrated navigation	Importance
1	After power on, make static at least 5-10 seconds to complete the attitude initialization of the navigation system;	Required
2	In the course of the vehicle, it is necessary to keep the GT-1612F5DR-AGGB navigation system moves in an open area for some time, for the algorithm convergence of integrated navigation system, and then test it in complex environments such as tunnels.	Required

Further Explain：

Summary: In integrated navigation system initialization, it is suggested that the vehicle drive under unobst ructed environment for about a few minutes, then go into obstructed environment, the positioning effect will b e better .

5. Instructions

5.1 Sensor Calibration

Because the chip manufacturing process, each sensor element of GT-1612F5DR-AGGB (three axis gyroscope, three axis accelerometer), sensitivity and zero temperature drift parameters are not the same, in order to make each GT-1612F5DR-AGGB reach the same performance, before leaving the factory, various error compensation has been made for each sensor element of GT-1612F5DR-AGGB.

The calibration parameters of sensor components are different for each product, if using the same parameters, it will lead to greater navigation error. This uniqueness can be used to prevent system piracy, thereby improving the reliability of the products for users.

5.2 Communication interface

The GT-1612F5DR-AGGB system provides two serial ports, wherein the serial port 1 is used for transmitting satellite information and receiving differential information, and the serial port 2 is used for receiving the odometer information.

Both serial ports do not provide a hardware handshake, and the use of 8 bit data bits, 0 bit parity bit, 1 bit stop bit (8-N-1) mode, baud rate default is 9600bps, and according to user requirements, it can be modified to 115200bps.

5.3 Communication frequency

The system supports the output of 1hz、5hz、10Hz、20Hz data refresh frequency, the default frequency is 10HZ.

5.4 Communication protocol

At present, the GT-1612F5DR-AGGB system outputs common NMEA0183 protocols, such as $GPATT,$GNGGA, $GNRMC,$SPEED,$GNGSA; in addition, in order to output vehicle attitude information, the GT-1612F5DR-AGGB system also defines a set of communication protocols GPATT.

5.5 Control command

GT-1612F5DR-AGGB system supports users to send control command via serial ports to achieve following functions, but, GT-1612F5DR-AGGB cannot save the setting. That means, every time the GT-1612F5DR-AGGB is 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

Remarks：

（1） All instructions are lowercase letters；

（2） There is a space key behind Log and unlog;

（3） GPATT protocol contains a lot of product information, it is recommended that users retain the output of the protocol to facilitate query problems;

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

（5） GT-1612F5DR-AGGB has two default baud rates 9600bps/115200bps. Please specify the baud rate required when make ordering.

（6） The specific details of required execution time for GT-1612F5DR-AGGB to 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 BD/Glonass	500ms
7	Baud rate setting	20ms

6. NMEA Data Analysis

The communication statements specified in the NMEA protocol are based on ASCII coding, the data format of the NMEA-0183 protocol statement is as follows: "$" is the statement start symbol; "," is the domain delimiter; "*" is the checksum identifier, the two digits behind it are checksum, which represent the bitwise XOR value of all characters between ($) and * (excluding these two characters); "/" is the terminator, all statements must end using it, that is, the ASCII character "return" (hexadecimal 0D) and "line feed" (hexadecimal 0A).

The default output NMEA data of GT-1612F1DR-AGGB is $GPATT,$GNGGA, $GNRMC,$SPEED,$GNGSA and users can also specify the output data according to personal needs.

6.1 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

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

6.2 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

No	Name	Description	code	Example
1	$GNRMC	Log header		$GNRMC
2	utc	UTC time (H/M/S)	hhmmss.ss	143550.00
3	Pos status	Solution state: A= effective positioning V= invalid positioning	A	A
4	lat	Latitude: -90~90 degrees	llll.lllllll	3110.4854911
5	latdir	Latitude direction: N: North; S: South	a	N
6	lon	Longitude: -180~180 degrees	yyyyy.yyyyyyy	12123.9129278
7	londir	Longitude direction: E:east; W:west	b	E
8	SPEED IN	Ground speed	q	0.29

9	Track Ture	Ground course angle	n	108.5
10	Date	UTC date	ddmmyy	010909
11	Mag var	Magnetic declination (000.0~180.0 degrees, adding o if lack of leading digit)	0.0	0.0
12	Vardir	Declination direction, E (East) or W (West)	M	M
13	Mode ind	Mode indication (only NMEA0183 3 version output, A= self localization, D= difference, E= estimation, N= data invalid)	a	A
14	*xx	Checksum	*hh	*57
15	[CR][LF]	Sentence terminator		[CR][LF]

✧ After the inertial navigation module is powered on, the installation Angle is the installation Angle identified by the previous module. If there is a big difference between the current installation Angle and the last installation Angle, it is recommended to clear it by sending the command log clear.The inertial navigation derivation should be avoided due to the error of installation Angle.

6.3 ATT Data Format

For Example ：

$GPATT,1.05,p,1.72,r,179.41,y,20220625,S,003E009,ID,1,INS,3335,04,20,-1.61,2,7,01,1.20,4,1,D,00,7,1,56.299,0,0,04,B,-3,-3,-1,5,2,2,F,0*0F

No	Name	Description	Code	Example
1	$GPATT	Log header		$GPATT
2	Pitch	pitch angle	Float	-0.29（unit：degree）
3	Angle Channel	P: pitch, r: roll, y: yaw	Char	P
4	Roll	Roll angle	Float	0.29
5	Angle Channel	P: pitch, r: roll, y: yaw	Char	R
6	Yaw	Yaw angle	Float	251.70
7	Angle Channel	P: pitch, r: roll, y: yaw	Char	Y
8	Soft Version	S: software version number	CString	20220503
9	Version Channel	S: software version number	Char	S
10	Produtct ID	96 bit unique ID	CString	003E009
11	ID Channel	ID:product ID	ID	ID
12	**INS**	Default open inertial navigation	**X**	1：open，0：close

13	INS Channel	INS: whether inertial navigation open	CString	INS
14	Hardware version	Named after the master chip	CString	3335
15	**Run_State_Flag**	**Algorithm status flag**	**d**	**1->3 Please refer to table A below for details**
16	Mis_Angle_Num	number of Installation Angle identification	d	9
17	Custom flag	Custom flag	Float	X
18	Custom flag	Custom flag	B	X
19	MTK version	flag bit	Char	M:MTK1.6.0Version 7: MTK1.7.0Version
20	Static Flag	Static Flag	d	1:Static 0：dynamic
21	Uer_Code	User_Code	d	1：Normal user X：Custom user
22	GST_Data	User satellite accuracy	dd	04
23	Line Flag	Straight line flag	d	1：straight driving，0：curve driving
24	Custom flag	Custom flag	F	F:Full Update D:Full Update and Part Update
25	Custom flag	Custom flag	d	00
26	IMU_Kind	Sensor Type	d	0->BIM055; 1->BMI160; 2->LSM6DS3TR-C; 3->LSM6DSOW 4->ICM-40607; 5->ICM-40608 6->ICM-42670; 7->LSM6DSR
27	SUBI_Car_Kind	UBI Vehicle Type	d	1: small car, 2: big car
28	Mileage	Mileage	ddd.mm	21.547（unit：KM），The maximum is 9999 kilometers
29	Custom flag	Custom flag	d	D
30	ANG_DGet_Flag	established angle	d	1: The Flash has an installation Angle. 0: The Flash has no installation Angle
31	**Run_Inetial_Flag**	**Inertial navigation converged flag**	D	1->4 **Please refer to table B below for details**
32	Custom flag	Custom flag	c	B
33	Custom flag	Custom flag	d	
34	Custom flag	Custom flag	d	
35	Custom flag	Custom flag	d	
36	Custom flag	Custom flag	d	
37	Tim_Save_Num	Tim_Save_Num	d	Ephemeris stored times
38	Fix_Angle_Flag	Fixed installation	c	F：Fix

		channel		
39	ANG_Lock_Flag	Fixed installation Flag	d	1：fixed setting， 0：Self adaptive installation
40	Extensible			
41	*xx	Checksum	*hh	*2c
42	[CR][LF]	Sentence terminator		[CR][LF]

Remarks : 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. As the (1) Table A and Table B shows

(1) GPATT protocol 31field Run_Inetial_Flag is 4；

Table A 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 B 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**

7.4 GSA Data Format

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

No	Name	Description	code	Example
1	$GNGSA	Log header		$GNGSA
2	Positioning mode	Positioning mode flag		Please refer to table B below for details
3				
4	Satellite used	First channel	SV	07
5			SV	08
6	…	…	…	…

7	PDOP	Position Dilution Of Precision		3.01
8	HDOP	Horizontal Dilution of Precision		1.25
9	VDOP	Vertical Dilution of Precision		2.74
10	*xx	Checksum	*hh	*1A
11	[CR][LF]	End of message termination		[CR][LF]

Table B: 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 C： Physical meaning description of State_Flags

Flag	description
1	Not positioning
2	2D positioning
3	3D positioning

6.9 SPEED Data Format

For Example：$SPEED,020406.10,20.96,2,A,-0.44,-1.15,-9.48,G,-0.11,S,0,0,0.000*52

No	Name	Description	code	Example
1	$SPEED【1】	Log header		$SPEED
2	Utc	UTC time (H/M/S)	hhmmss.ss	143550.00
3	Speed	Ground speed(bit)	dd.mm	20.96
4	Status【2】	Solution State： 0=data invalid 1=converging 2=data valid	D	2
5	A	separator	A	Acceleration
6	Acc_X	X axis acceleration	ddd.mm	-0.26（m/s/s）
7	Acc_Y	Y axis acceleration	ddd.mm	0.075（m/s/s）
8	Acc_Z	Z axis acceleration	ddd.mm	-9.8（m/s/s）
9	G	separator	G	Represents angular velocity
10	Gyr Z【3】	Z axis acceleration	ddd.mm	0.42 Radian per second
11	S	separator	S	status
12	UBI_State_Flag	UBI_State_Flag	D	0: smooth driving 1: non-smooth driving
13	UBI_State_Kind	UBI_State_Kind	D	See table L

14	UBI_State_Value	UBI_State_Value	d.mmm	See table L
15	*xx	Checksum	*hh	*57
16	[CR][LF]	Sentence terminator		[CR][LF]

✧ **Remarks :**

(1) The speed unit of SPEED protocol is the same as that of GNRMC

(2) The output frequency of SPEED protocol is 10Hz

(3) 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.

Initialization under adaptive installation: 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, then 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 nertial 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.

(4) The unit of angular velocity is radian per second, if converted to degrees per second, please multiply by the coefficient 180/3.14;

Table L: SPEED Log header 13 field UBI_State_Kind 和 UBI_State_Kind Description

UBI_State_Kind[1]	Domain Status	UBI_State_Value[2]	Data source [3]	default	unite
0	Normal driving condition	0			
1	Ordinary acceleration	YZ_Acce_Peta	BS_Acce_Peta/10.0	1.2	m/s/s
2	rapid acceleration	YZ_Acce_Deta	BS_Acce_Deta/10.0	1.6	m/s/s
3	Ordinary decelerate	YZ_Dcce_Peta	BS_Dcce_Peta/10.0	-2.2	m/s/s
4	abrupt deceleration	YZ_Dcce_Deta	BS_Dcce_Deta/10.0	-3.2	m/s/s
5	abrupt change lane	YZ_Lane_Deta	BJ_Y_Lane_Deta/10.0	1.2	m/s/s
6	Normal turning	YZ_Rate_Peta	BS_Turn_Deta/10.0	2.2	d/s
7	Abrupt turning	YZ_Rate_Deta	BS_Turn_Deta*4/10.0	8.8	d/s
8	Abnormal posture condition	YZ_Atti_Deta	BJ_Att_Min_D	10	d

Note 1:

(1) When UBI_State_Kind value is 1,2,3, and 4, the state is obtained by comparing the vertical axis acceleration with the UBI_State_Value threshold value;

(2) When the UBI_State_Kind value is 5, the state is obtained by comparing the horizontal axis acceleration with the UBI_State_Value threshold value;

(3) When the UBI_State_Kind value is 6 or 7, the state is obtained by comparing the vertical angular velocity with the UBI_State_Value threshold value;

(4) When the UBI_State_Kind value is 8, the state is obtained by comparing the pitch Angle and roll Angle with the UBI_State_Value threshold value;

Note 2:

UBI_State_Value indicates that the acceleration unit of the acceleration threshold is consistent with that of SPEED, and the angular velocity threshold is inconsistent with that of SPEED.

Gotop Technology Co. ， LTD

Add:AreaC,4th layer,A1 building,QingHu Silicon Valley Power,LongHua district ,Shenzhen ,China
Phone: 86-755-23804156
fax: 86-755-23804155
N 22° 32' 17", E 114° 07' 07“
http://www.gotop-zzu.com