New version of WTGPS-300P product manual

WTGPS-300P inertial navigation module manual

Product Specification:SPECIFICATION

Model: WTGPS-300P

Description: Inertial navigation

Production execution standard reference

Enterprise quality system standard: ISO9001:2016 standard

Tilt switch production standard: GB/T191SJ 20873-2016

Product testing and testing standards: GB/T191SJ 20873-2016

Revision date: 2023.8.1

Contents

1. System introduction

1.1 Product Overview

The WTGPS-300 module is a vehicle-mounted dead reckoning module. This module integrates a GNSS receiver and a 6-axis inertial sensor to provide continuous high-precision 3D positioning for road vehicles. This module product is based on the fourth generation low-power consumption of Zhongke Micro. The GNSS SOC single-chip AT6558 design supports a variety of satellite navigation systems, including China's BDS (Beidou Satellite Navigation System), the United States' GPS, Russia's GLONASS, Japan's QZSS and the satellite augmentation system SBAS. The WT5S31 series modules have the advantages of high sensitivity, low power consumption, and low cost. They are suitable for vehicle navigation, handheld positioning, and wearable devices, and can directly replace Ublox NEO series modules.

图 1. WTGPS-300

1.2 Product features

1. Standard micro interface, directly connected to the PC to view data. Keep the serial port output for GPS+BD/GPS+Glonass inertial navigation, which can be used in underground parking lots, poor satellite signals, and tunnels to ensure accurate driving. Modular structure, compact size, easy to embed in car navigation system.

2. Communication protocol: plug-and-play standard communication protocol NEMA0183;

3. Engineering installation: There is no installation angle requirement, which is convenient for users to install on the vehicle;

4. Sub-meter level: supports RTCM2.3 protocol/sub-meter level navigation in complex environments;

5. Navigation technology: autonomous switching between integrated navigation and pure inertial navigation technology. Excellent positioning and navigation function, high sensitivity, 32 channels, supports single system positioning of BDS/GPS/GLONASS satellite navigation system, and any combination of multi-system joint positioning.

6. Dual interfaces: 1. TYPE-C interface, plug and play to directly connect to PC to view data. 2.XH2.54x4Pin interface, convenient for embedding user system equipment.

7. Built-in antenna detection circuit, antenna overcurrent protection, front SAW, external LNA, 3D sensor

8. PPS pin: 3.3-5V

9. Note: The baud rate is currently the default 115200. If you want to modify it, please contact us and go through the customization process.

1.3 Basic parameters

Serial number	Parameter	Parameter
1	Supply voltage	Voltage (3.3-5V)
2	Current	45mA
3	Baud rate	115200
4	Update rate	10Hz
5	Working temperature	-30---85℃
6	Module size	36*25*4 with ceramic Antenna: thickness 13mm

1.4 Product advantages

1. Excellent positioning and navigation function, supporting single system positioning of BDS/GPS/GLONASS satellite navigation system, and any combination of

2. Integrated multi-system joint positioning, and supports QZSS and SBAS systems.

3. Gyro drift: eliminate gyro drift to obtain high-precision attitude and heading information;

4. Acceleration noise: eliminate vibration acceleration and obtain high-precision speed information;

5. Software algorithm: adaptive extended Kalman filter algorithm;

6. Get rid of the odometer: use pure inertial navigation to achieve high-precision positioning;

7. Intelligent identification: Identify and isolate GNSS data with large errors.

8. Cold start capture sensitivity: -148dBm

9. Tracking sensitivity: -162dBm

10. First positioning time: 32 seconds

11. Low power consumption: continuous operation <29mA

12. Built-in antenna detection and antenna short circuit protection function

13. Navigation technology: autonomous switching between integrated navigation and pure inertial navigation technology.

1.5 Product Application

1. Vehicle positioning and navigation mobile phone.

2. Tablet positioning.

3. Embedded positioning of handheld devices.

4. The device is wearable.

2. How to use

2.1 Install driver

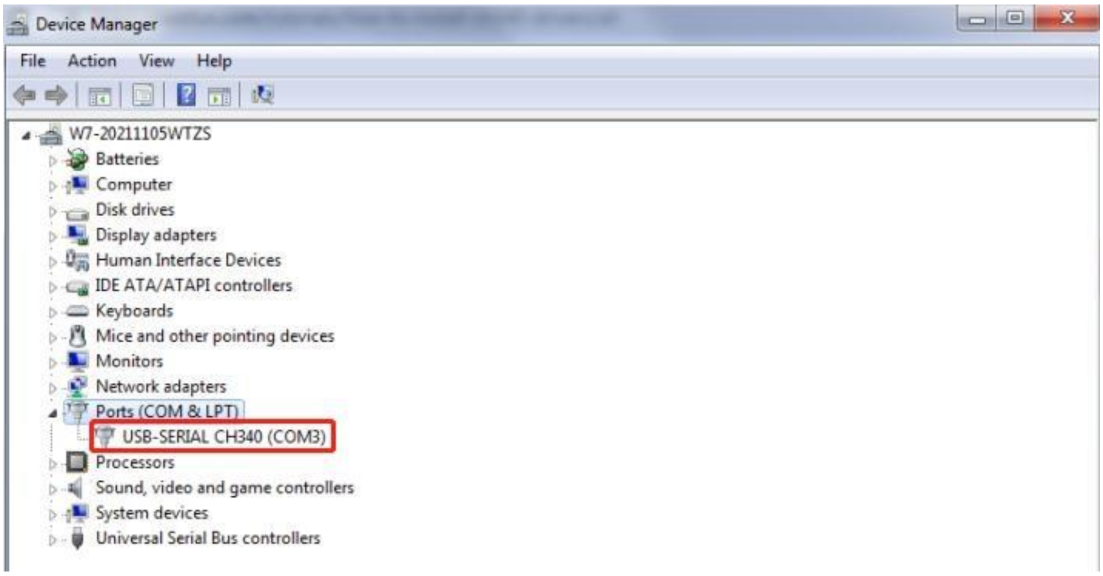
When using USB-TTL and three-in-one modules, the USB data connection module needs to install the C340 driver. When purchasing a six-in-one module, you need to install the C340 driver.

Install CP210X driver.

Connect to the computer through the USB serial port module, open the host computer, and install the driver CP210X or CH340 corresponding to the serial port module.

Later, you can query the corresponding port number in the device manager. The following figure shows the CH340 driver device manager display.

Shown as follows:



When installing the CP210X driver, the device manager displays as follows:

The three-in-one driver is CH340 andThe six-in-one driver is CP2102 as follows:

https://drive.google.com/file/d/1JidopB42R9EsCzMAYC3Ya9eJ8JbHapRF/view?usp=drive_link

2.2 Serial port connection

There is a reserved serial port interface on the module. The GND TXD RXD VCC of the WTGPS-300 module is connected to the GND RXD TXD 3.3V/5V of the USB serial port module. After connecting to the computer, you can check whether there is a serial port display in the device manager. If not, you need to install the CH340 driver or CP210X driver.

2.3. USB connection

The module and computer can be directly connected using a USB data cable. The USB cable must be a data cable, i.e. capable of transferring data and files.

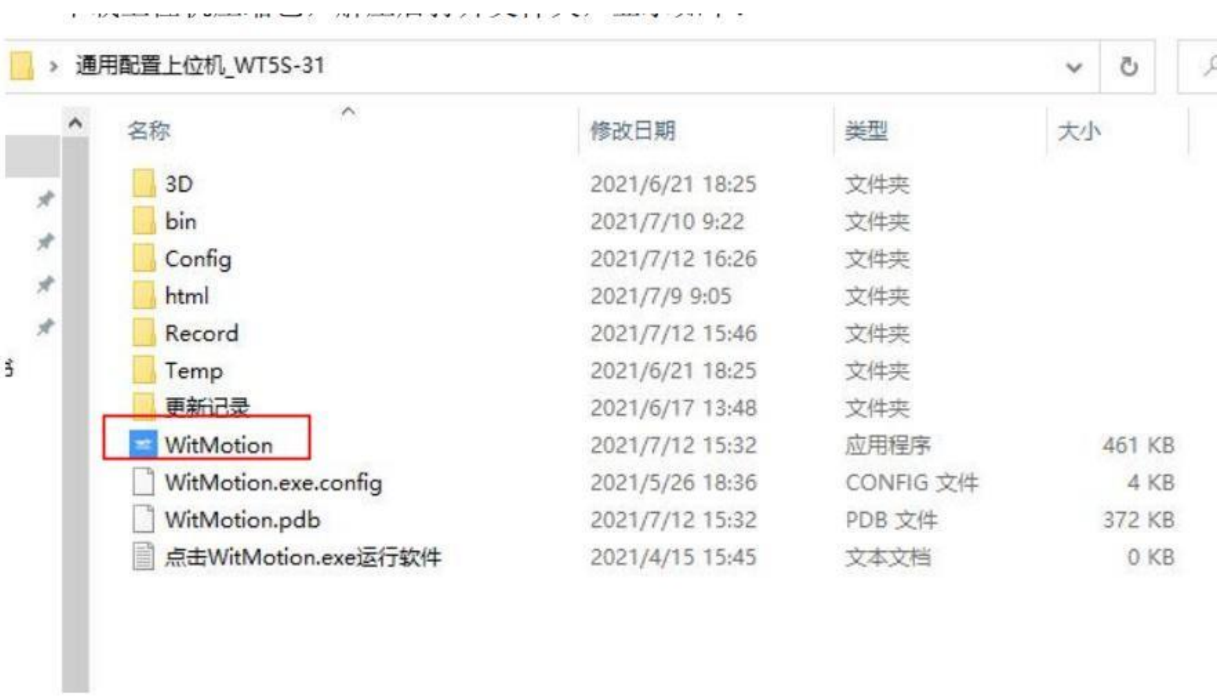
After connecting to the computer, you can check whether there is a serial port display in the device manager. If not, you need to install the CH340 driver.

3. Software use

3.1 PC download:

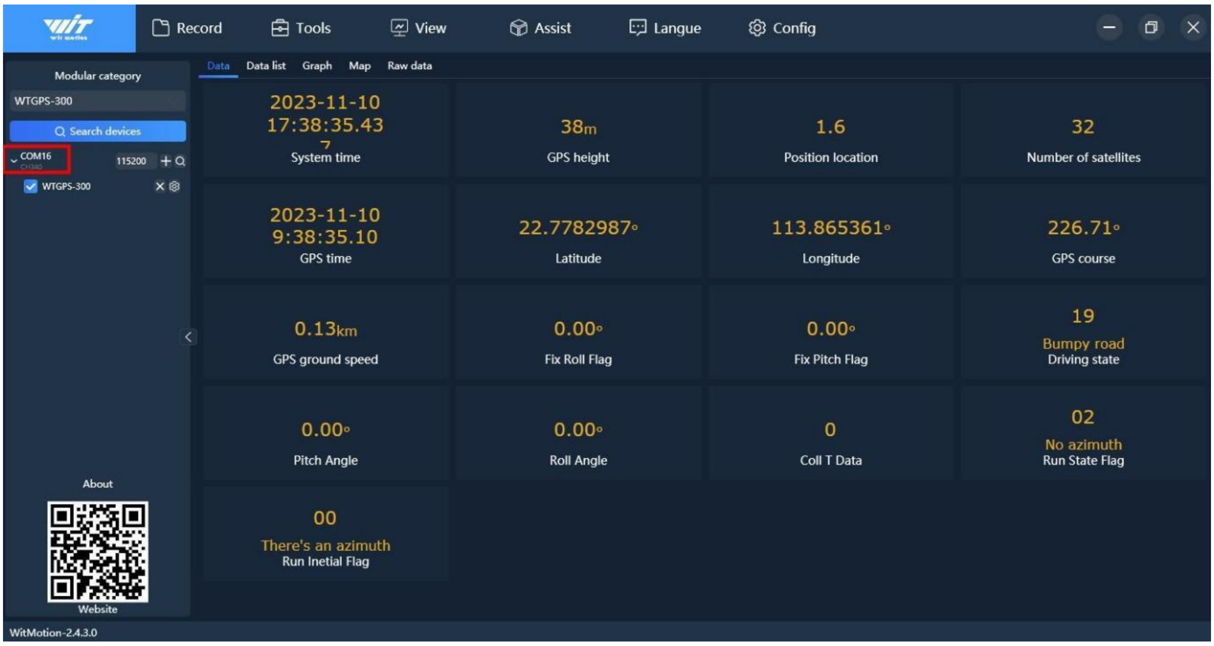
https://drive.google.com/file/d/16Z5ax3ad3koQrJLPZoPRcV6G-J63zmfm/view?usp=drive_link

3.2 Open the host computer



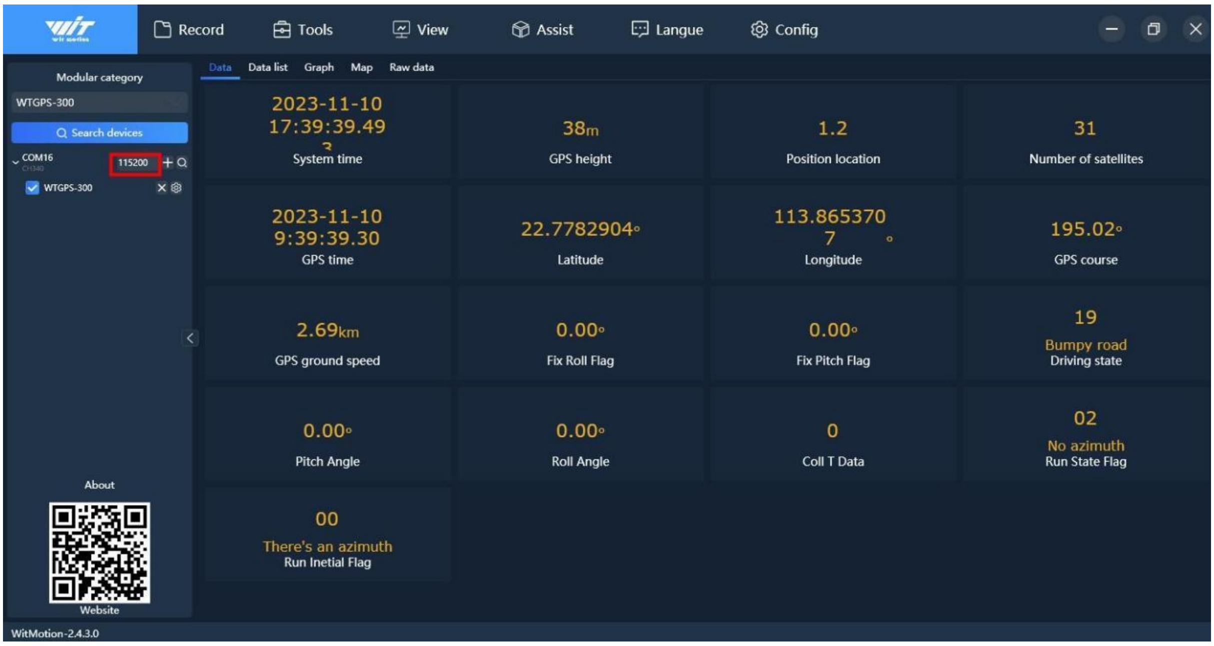
3.3 Select the corresponding port

The port number is the port number displayed on the device manager interface. The host will search for the corresponding port and baud rate by itself. If the search is not successful, you can select the port number and baud rate yourself. The port is the serial port displayed on the device manager interface. If not Make sure you can plug and unplug the serial port module or USB data cable and see if the corresponding port displayed on the device manager port interface disappears.



3.4 Select baud rate

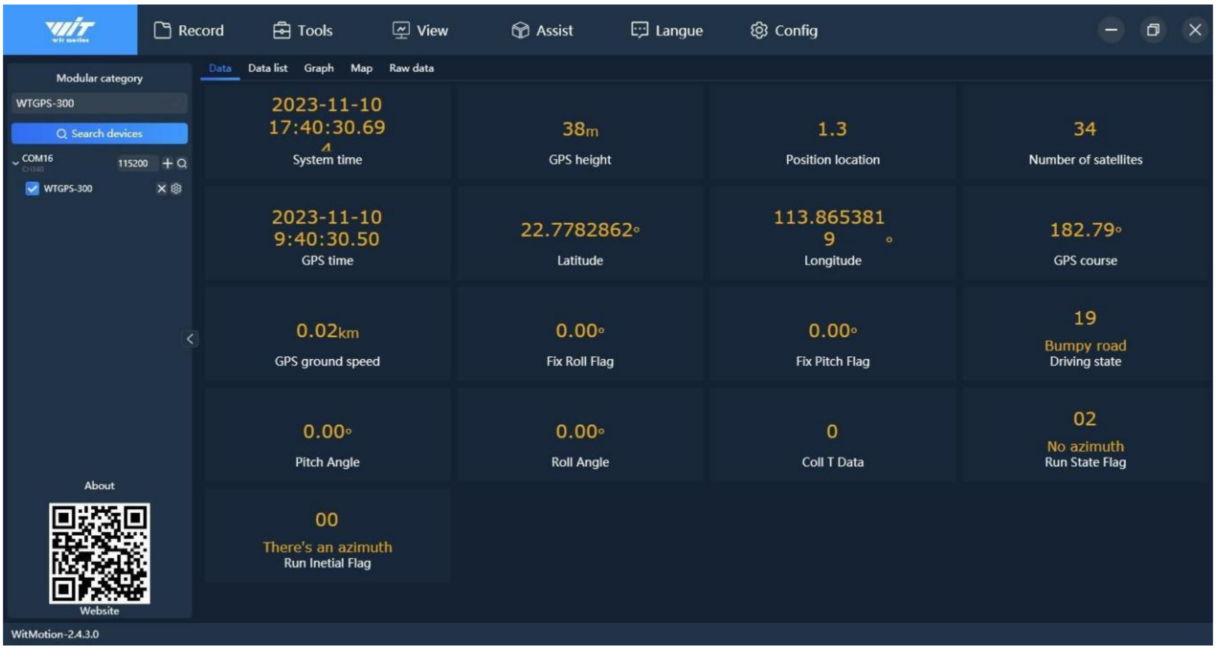
The default baud rate is 115200



3.5 View raw data

Through the main interface of the host computer, you can get the current time, GPS altitude, number of connected satellites, meridian time (GPS time), and module

The longitude, latitude and heading of the block, as well as the current speed are shown in the figure.



Main interface data display

1. GPS altitude: refers to the current altitude.

2. Position accuracy: unit is meters.

3. Number of satellites: the number of satellites that the module can search.

4. GPS time: The time at which the meridian is located.

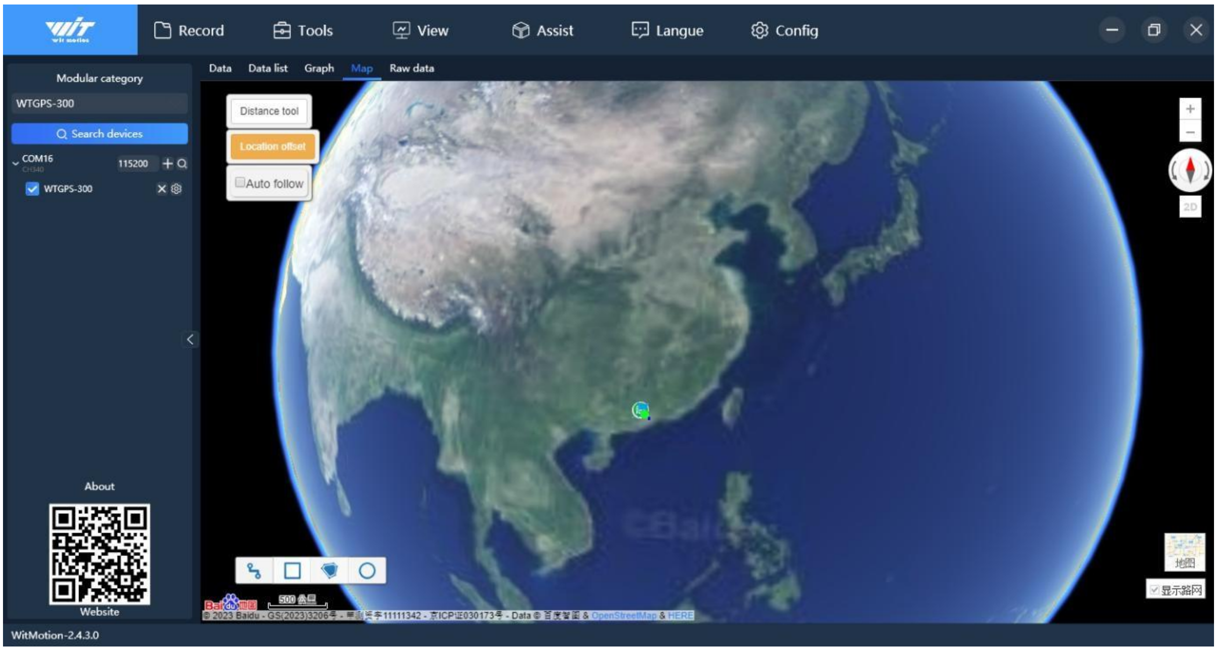
5. Latitude and longitude: the latitude and longitude of satellite positioning, the unit is degree.

6. GPS heading: refers to the heading angle

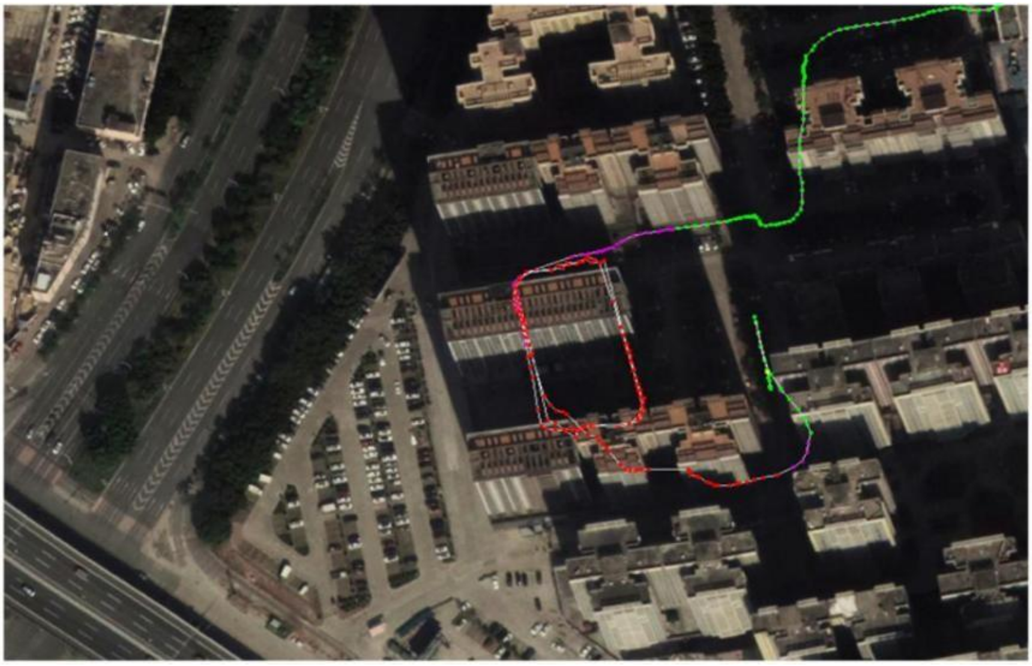
7. GPS ground speed: Refers to GPS positioning to display ground speed

8. Status: Initialization refers to the initialization of inertial navigation. To enter the inertial navigation state, the module needs to be turned on and positioned in an open environment; and the vehicle must drive at a speed of more than 30km/h for more than 4 minutes in an open environment.

Select the map on the main interface to clearly locate the location of the module, as shown in the figure



You can clearly confirm the specific location by zooming in and out, and you can also switch to the actual map in the upper right corner, as shown in the picture:



3.6 Other functions of the host computer

1. Zoom in and out function

Click the "Zoom In" or "Zoom Out" tab to zoom in or out of the positioning map. Or slide the mouse

The scroll wheel can zoom in and out of the positioning map.

2. Satellite images and basic images

The positioning map displayed by the host computer by default is the satellite image. The basic map shows the main streets, which is similar to the mobile APP navigation software

Positioning pictures.

3. The host computer can also upgrade the firmware, monitor the host computer data source, and record data play files, switching between Chinese and English languages.

and other functions.

4. Basic principles

4.1 Satellite navigation system

Satellite navigation systems have the advantages of achieving global, all-weather, high-precision navigation; however, satellite navigation systems are easily affected by the surrounding environment, such as trees and buildings, etc., resulting in multi-path effects that reduce or even lose the positioning accuracy, especially in tunnels, etc. In indoor environments, satellite navigation systems are basically unusable. In addition, even in an open environment, when the carrier speed is very low, the satellite navigation system will produce large errors in obtaining the carrier's orientation information (heading angle).

4.2 Inertial navigation system

Inertial navigation is based on Newton's laws of mechanics. By measuring the acceleration of the carrier in the inertial reference system, integrating it over time, and transforming it into navigation coordinates, the speed, yaw angle and yaw angle in the navigation coordinates can be obtained. Location and other information, and at the same time, the carrier information of the carrier can be obtained. However, due to factors such as severe gyroscope zero point drift and vehicle vibration, the inertial navigation system cannot obtain high-precision information such as orientation and speed by directly integrating acceleration. That is, the existing micro-inertial navigation system is difficult to work independently for a long time.

4.3 Integrated navigation system

Satellite/inertial integrated navigation makes full use of the advantages of inertial navigation systems and satellite navigation systems, and integrates two navigation algorithms based on the optimal estimation algorithm-Kalman filter algorithm to obtain the optimal navigation results; especially when the satellite navigation system cannot work, use The inertial navigation system allows the navigation system to continue working, ensuring the normal operation of the navigation system and improving the stability and reliability of the system.

4.4 Get rid of the odometer

Conventional vehicle navigation systems often rely on DR solutions for odometers and gyroscopes to achieve high-precision navigation and positioning in complex automotive environments. For many automotive aftermarket markets, the connection of odometer signals is very complex and involves vehicle safety issues. After years of research and development, when the signal accuracy of the GNSS system decreases or even the satellite signal is lost, the WTGPS-300 system completely gets rid of the dependence on the odometer. It only uses pure inertial navigation technology and can also perform high-speed navigation on the vehicle carrier alone for a long time. Compared with existing related products on the market, the performance of precision positioning, speed measurement and attitude measurement has been greatly improved. Of course, the WTGPS-300 system can be connected to the odometer signal and will obtain better performance indicators.

4.5 Vehicle attitude angle

The WTGPS-300 navigation system uses years of research experience in MEMS inertial devices to filter gyroscope drift and acceleration vibration signals through adaptive filtering algorithms, and further obtains high-precision attitude information, which can satisfy slope detection, etc. Various needs for vehicle monitoring and navigation applications.

4.6 GI navigation system

The WTGPS-300 navigation system proposes an intelligent identification algorithm for satellite navigation accuracy. Based on the high-precision navigation information provided by integrated navigation, the positioning accuracy of satellite navigation is identified. If the satellite navigation accuracy is better, integrated navigation will be performed. Once satellite navigation is found If the signal is very poor or even lost, pure inertial navigation will be performed. In short, the WTGPS-300 navigation system realizes autonomous switching between combined navigation and pure inertial navigation.

4.7 Technical solutions

The combined positioning method based on inertial navigation realizes vehicle navigation and positioning in complex environments, so that high-precision navigation and positioning of buses can be achieved under elevated highways, densely populated by tall buildings, and blocked by trees.

4.8 Plan description

Inertial navigation is the same as satellite navigation. The inertial navigation system is always working. Inertial navigation outputs 15-dimensional vehicle information such as three-dimensional position, three-dimensional velocity, three-dimensional attitude, three-dimensional acceleration, and three-dimensional angular velocity; the satellite navigation system outputs three-dimensional position and three-dimensional velocity, etc. 6-dimensional information.

(1) Initialization process of integrated navigation: Inertial navigation has no initial information, and information such as initial position and speed direction must be copied to the inertial navigation through satellite navigation. Therefore, the vehicle needs to run to form the direction of the vehicle and complete the initialization.

(2) Error solution for integrated navigation: The integrated navigation system uses the difference between the three-dimensional position and the three-dimensional velocity output by the satellite and inertial navigation to solve the three-dimensional attitude, three-dimensional acceleration and three-dimensional angular velocity of the inertial navigation, and simultaneously solves the three-axis accelerometer and various errors of the three-axis gyroscope. These errors are white noise, that is, they do not have any statistical rules and change randomly with time. They must be solved and updated in real time through the Kalman filter algorithm to obtain the optimal solution.

(3) Training time for integrated navigation: According to the above analysis, the integrated navigation system needs to solve various errors of inertial navigation through satellite navigation. Therefore, there must be a training process, that is, using high-quality satellite navigation to train the performance of inertial navigation. This allows inertial navigation to estimate its own error. If the training time is short, good performance cannot be achieved.

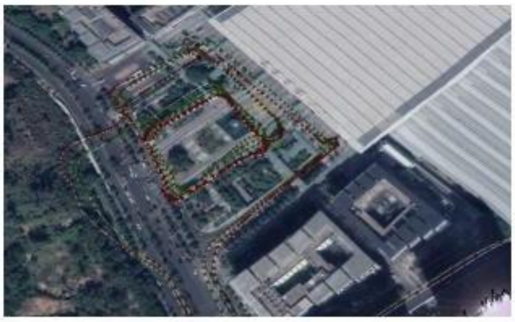
(4) Adaptive algorithm for integrated navigation: When the vehicle is driving in the city, there are open environments, complex environments, tunnel garages and other environments. The integrated navigation algorithm has a set of satellite quality assessment algorithms to perform integrated navigation based on satellite quality. In layman's terms, it is determined based on the quality of the satellite, the proportional coefficient between satellites and inertial navigation. For example, in an open environment, 100% trust satellite navigation, garage tunnels, 100% trust in inertial navigation, and so on.

4.9 Positioning performance

(1) Positioning performance of integrated navigation: People use high-precision integrated navigation modules and hope to obtain very precise positioning effects anywhere. Although inertial navigation is not affected by the environment, inertial navigation is a navigation and positioning technology in which errors accumulate over time. Currently, based on the positioning effect of garages and tunnels, the positioning accuracy of the inertial navigation module we developed is 1%-2 %, that is, the error for walking 100 meters is 1-2 meters. From a global perspective, the positioning accuracy of such pure inertial navigation is also very high.

武汉东湖隧道

（蓝色为组合导航定位效果，红色曲线为卫星定位效果）



深圳某地下车库

（红色曲线为组合导航模块 1 定位效果，黄色曲线为组合导航模块 2 定位效果）

(2) Anti-drift performance of integrated navigation: In complex environments, the position of satellite navigation will drift when the vehicle is stationary. After adding inertial navigation, the positioning information output by the integrated navigation can completely suppress the drift, making the vehicle positioning effect more ideal.

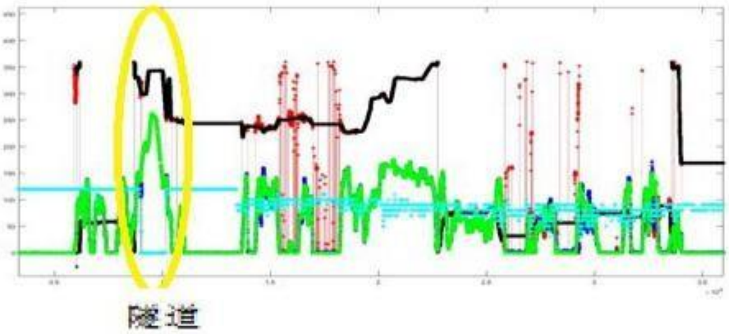
上海陆家嘴

（蓝色为组合导航定位效果，红色曲线为卫星定位效果）

上海沪闵高架下

（黄色为组合导航定位效果，红色曲线为卫星定位效果）

(3) Speed and direction accuracy of integrated navigation: In addition to providing high-precision positioning information, the integrated navigation system also provides more accurate speed and direction information than satellite navigation, especially in situations such as garages or tunnels.

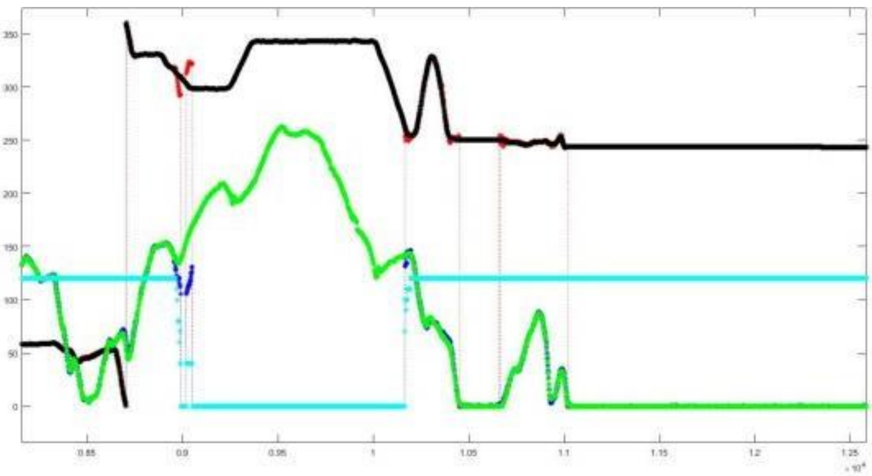


图中：红色为 GPS 提供的方向信息，黑色为组合导航提供的方向，蓝色为卫星提供的速度

In the picture: red is the direction information provided by GPS, black is the direction provided by the integrated navigation, and blue is the speed provided by the satellite.

Ten times magnification, green is the ten times magnification of the speed information provided by the integrated navigation, and cyan is the ten times magnification of the satellite provided by the satellite. It can be seen that when the vehicle is moving at low speed, the direction error provided by satellite navigation is very large. When the vehicle is stationary, there is no direction information.

In the process in the above picture, the yellow area is the information of the tunnel process. After zooming in, it is as shown in the following picture:



As can be seen from the above figure, during the tunnel process, inertial navigation provides very high-precision speed and direction information. On this basis, high-precision position information can be obtained.

5 Electrical Characteristics

Electrical characteristics of WTGPS-300 navigation product:：

5.1 Maximum parameter

Parameter	Index	Unit
Power supply		
Voltage	5	V
Environment		
Operating temperature	-30-85	℃
Storage temperature	-40-125	℃

5.2 Electrical characteristics

Power parameters	Index	Unit
Input voltage Vdd	3.3-5	V
Current	150	mA
Power consumption	30mA@3.3V	mW
Time		
Power on to the first valid data time	<30	S

6 performance indicators

Operating temperature	-30℃-85℃
Update rate	10Hz
index	Technical Parameters
Signal reception	BDS/GOS/QZSS
Cold start TTFF	≤32s
Hot start TTFF	≤1s
Recapture TTFF	≤2s
Cold start capture sensitivity	-148dBm
Hot start capture sensitivity	-156dBm
Recapture sensitivity	-160dBm
Tracking sensitivity	-168dBm
positioning accuracy	<1.5m(CEP50)
Speed measurement accuracy	<0.1m/s

Location update rate	10Hz
Serial port characteristics	Baud rate range: 115200bps; default 115200; 8 data bits, no parity bit, 1 stop bit
protocol	NMEA0183protocol
Maximum height	18000m
Maximum speed	515m/s
Maximum acceleration	2g
Power supply	5V
Working current	45mA&5V
Operating temperature	-45---+80℃
Storage temperature	-45---+145℃
Size	39.9*32.9*15.9(mm)
Weight	50g

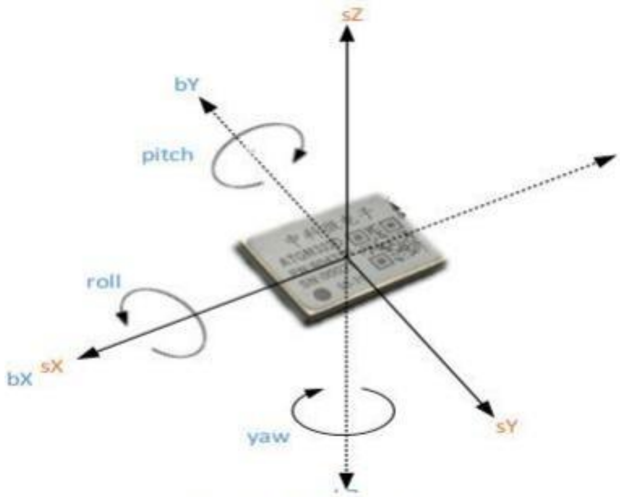
Parameter		Description	Performance numerical value	Parameter	Unit Remarks
GNSS	First location time	Cold start	32	s	
		Hot Start	1	s	
		Assisted start	3	s	
	Sensitivity	Track	-162	dBm	
		Recapture	-160	dBm	
		Start up	-148	dBm	

	Positioning accuracy	Single point positioning	2.5	m	CEP50
	Speed measurement accuracy		0.2	m/s	
	Data update rate		1	Hz	
INS	Positioning accuracy			3%	Positioning error estimated distance
Electrical Characteristics	Power consumption		45	mA	Continuous operation power consumption

7 Coordinate system and initialization

7.1 Coordinate system

The coordinate systems associated with the inertial navigation module include the sensor coordinate system (s) and the body coordinate system (b). The XYZ axis of the s coordinate system coincides with the XYZ axis of the inertial sensor inside the module. The X axis of the b coordinate system coincides with the X axis of the s coordinate system; the Y axis of the b coordinate system points in the opposite direction of the Y axis of the s coordinate system; the Z axis of the b coordinate system points in the opposite direction of the Z axis of the s coordinate system. The relative relationship between the two and the inertial navigation module is shown in the figure below



WTGPS-300 的坐标系

7.2 Adaptive installation method

The WTGPS-300 module is only suitable for vehicle use (acceleration less than 2g) and requires rigid body connection. Installation and use require meeting the following requirements:

1. The module needs to be fixedly connected to the vehicle before powering on. It is prohibited to move the module during operation after powering on.

2. There are no specific requirements for the installation direction of the module relative to the vehicle.

7.3 Inertial navigation initialization

The performance of combined navigation is greatly affected by the initial state. In order to obtain better positioning effects during the test,

The following steps are recommended for initialization:

1. Turn on the computer in an open environment and locate it;

2. Driving in an open environment at a speed of more than 30km/h for more than 4 minutes;

7.4 Backup power supply startup

The integrated navigation module supports the function of starting immediate positioning and starting dead reckoning when powered on in an environment without signal.

Yes, the following conditions must be met for this function to work properly:

1. The integrated navigation module is connected to the backup power supply. When the main power supply is turned off, the backup power supply maintains power;

2. The device carrier (vehicle) has not moved during the main power outage.

This function is turned off by default. For how to turn it on, please refer to the "CASIC Multi-mode Satellite Navigation Receiver Protocol Specification".

8 Communication protocol

The GPS-300 module outputs the NMEA0183 protocol, such as: GNGGA, GNRMC, GNGSV, GNGSA, etc.

8.1 Control commands

The GPS-300 module supports users to send control commands through the serial port for settings, and the settings can be maintained.

Output frequency setting

Serial number	Type attribute	Letter of agreement	Default value	Remark
1	log g01hz	Achieve 1HZ output		Implementing command feedback
2	log g05hz	Achieve 5HZ output		Implementing command feedback
3	log g10hz	Achieve 10HZ output		Implementing command feedback
4	log g20hz	Achieve 20HZ output		Implementing command feedback

Notes:

(1) All commands are in lowercase letters;

(2) There is a space after log and g01hz-.

(3) All commands with "default values" will be restored to default values after power-on or sleep.

(4) It takes 20ms to execute the command to modify the output rate. If multiple commands are to be sent, a 20ms delay must be added after sending the command.