

NAV680D

Dual-Antenna High-Precision Integrated Navigation System

Product Sheet



Forsense (Shanghai) Technology Co., Ltd

Please read this manual carefully before using this product.

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1 Product Description

1.1 Product List

When opening the package, please confirm the following products:


Name	Quantity	Diagram
① NAV680D Integrated Navigation System	1	
② Satellite Antenna	2	
③ Antenna Cable Primary antenna: TNC male head to fakra female head (Type C)(blue) Secondary antenna:TNC male head to fakra female head (Type D)(Purple)	2	
④ Antenna Suckers	2	
⑤ Antenna column	2	
⑥ Harness (include 3×RS232, 2×CAN, 1×PPS, and 1×Power Connector(9-24v)).	1	

Fig.1 Product Material Drawing

If there's anything missing, please contact salesperson in time.

1.2 Product Description

NAV680D is a multi-sensor integrated navigation system developed by Forsense based on automotive-grade IMU platform and full-system, full frequency dual antenna RTK. It has built-in high precision IMU module, which supports external odometer, thus providing accurate and continuous real-time information of attitude, speed and position in urban canyons, tunnels, elevated areas and other scenarios.

Applications:

High-precision scenarios such as Passenger Car, Commercial Car, Construction Vehicles and inspection Vehicles.

1.3 Product Features

- (1) Built-in full frequency RTK board with high precision - It can support BDS B1/B2/B3 +GPS L1/L2/L5+GLONASS L1/ L2+Galileo E1/E5b;
- (2) Built-in Forsense's high-precision IMU module - It can provide real-time accurate position, velocity and position through a sounding system of integrated algorithm and time-

synchronization;

(3) Internal storage of log data supported (2G storage);

(4) Recording RTK raw observations and ephemeris supported;

(5) External odometer supported.

1.4 Product Specifications

1. Performance Indicators

RTK Indicators:	Positioning Accuracy (RMS)	Single Point: 1.5m RTK: Horizontal: 1cm+1ppm Elevation: 2cm+1ppm
	Dual Antenna Positioning Accuracy (RMS)	0.1°/1M Baseline
	Velocity Accuracy (RMS)	0.03m/s
	PPS Accuracy (RMS)	20ns
	Update Rate	20hz
	RTK Initialization Time	<5s
IMU Indicators:	Gyroscope Measurement Range	±300°/s
	Gyroscope Bias Instability	XY:1.6deg/h Z:1.2deg/h
	Gyroscope Random Walk	XY:0.09 °/√hr Z:0.1 °/√hr
	Accelerometer Measurement Range	±6g
	Accelerometer Bias	0.015mg

	Instability					
	Update Rate	100Hz				
	Accelerator Random Walk	0.035 m/s/ $\sqrt{\text{hr}}$				
Performance of Integrated Navigation System	GNSS pause time	Position Accuracy	Roll angle	Pitch angle	Heading Accuracy	Velocity Accuracy
		(2 σ)	(2 σ)	(2 σ)	(2 σ)	(2 σ)
	0s	1cm	0.1°	0.1°	0.1°	0.02m/s
	60S (with wheel odometer)	2.0%.	0.15°	0.15°	0.15°	0.1m/s
Interface	3×RS232(Transmits serial data stream) 2×CAN 1×LAN 2×GNSS Antenna Interface 1×Power Connector 1×PPS Interface					

2. Electrical Properties

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Input	VIN	9	12	24	V
Ground	GND				
Power Consumption	P	1.5	2	2.5	W
Operating Temperature	T	-40	\	85	°C

Storage Temperature	T	-40	\	95	°C
Humidity	95% non-condensing				
Waterproof Rating	IP52				
Size	116*85.9*32mm				
Weight	263g				

1.5 Structure and size

Dimensions is shown in the figure below:

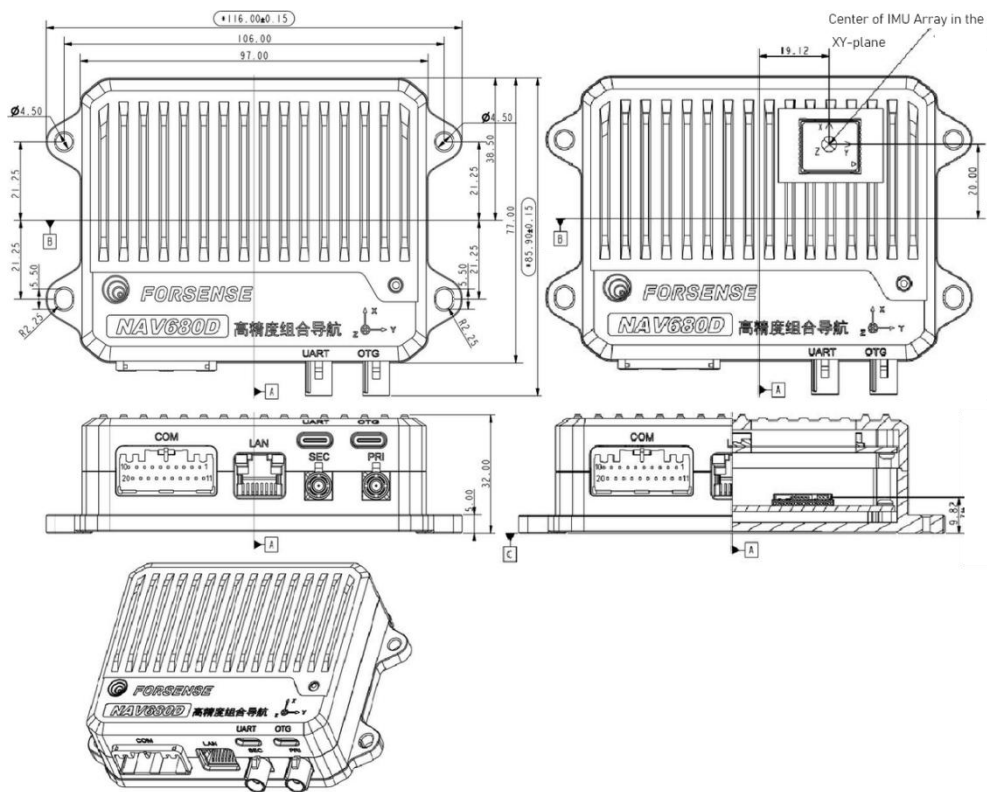


Fig 2 Dimensions of NAV680D

1.6 Connector and Pin Definitions

1.6.1 Customer Interface

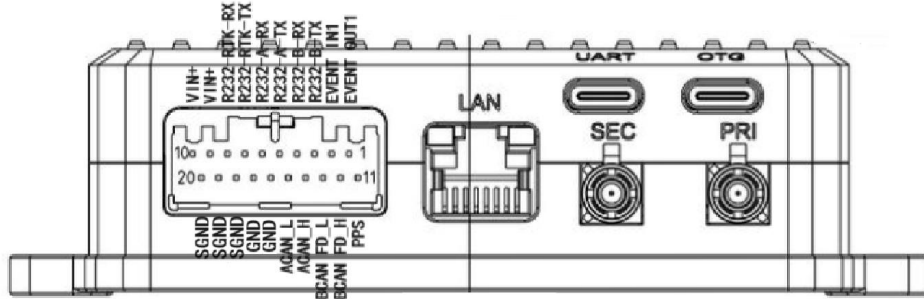


Fig 3 NAV680D Front Board

There are 6 interfaces in NAV680D front board, namely COM, LAN, UART, SEC, OTG, PRI (from left to right).

COM: 1× Power Supply, 3×RS232, 2×CAN, 1×PPS

LAN: Network Port

UART: connected to type-c;

SEC: connected to secondary antenna

OTG: connected to type-c;

PRI: connected to primary antenna.

The actual physical drawings are as follows:

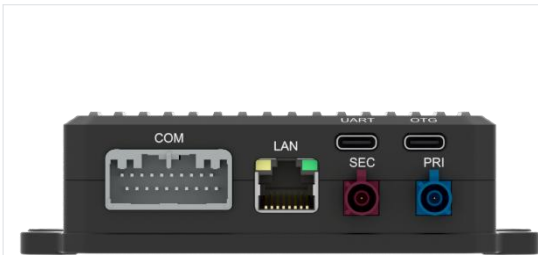


Fig.4 front view of the product
Six ports can be seen in the front view.



Fig.5 top view of the product
Product name (NAV680D) and the coordinate system are marked.

1.6.2 Definitions for Digital Interface

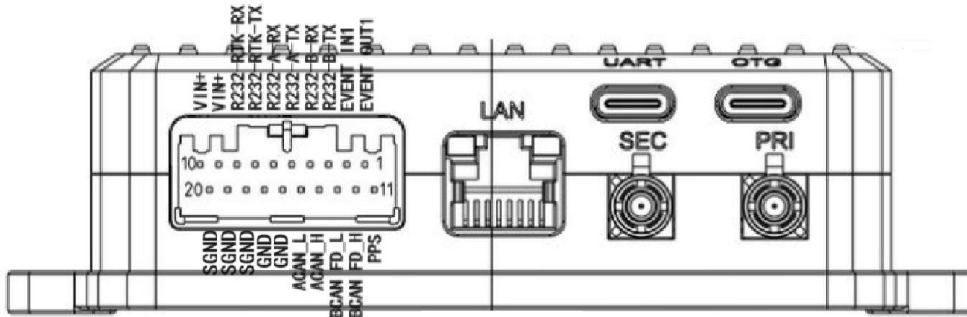
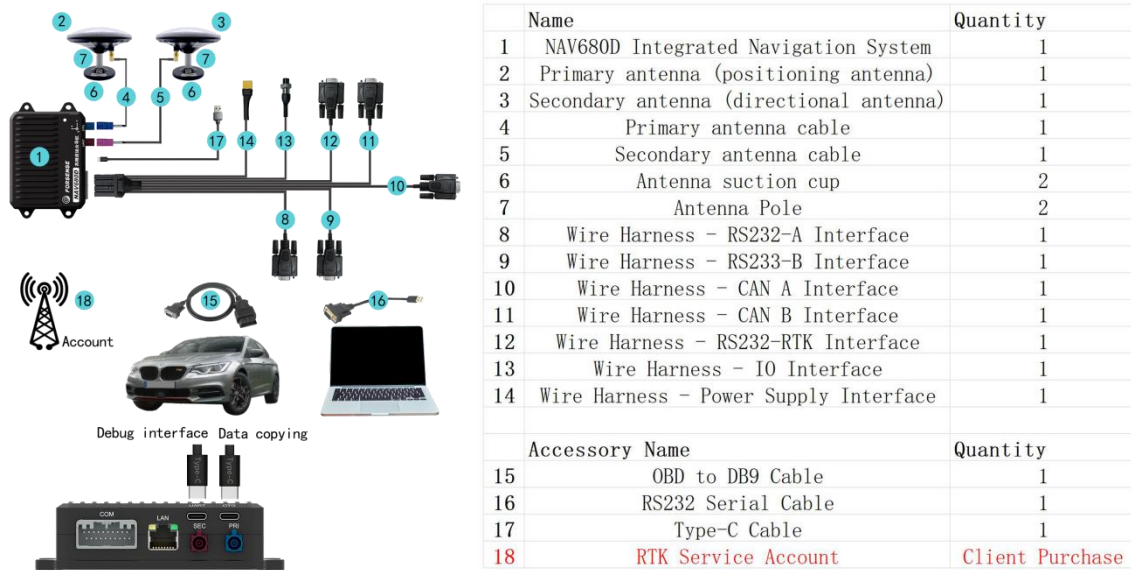


Fig. 6 Definitions for Digital Interface

The corresponding Pin are defined as follows

PIN No.	Definitions	Ports		
1	EVENT =OUT1	IO Port (Reserved)		
2	EVENT =IN1			
3	MCU TX3 232	RS232-B		
4	MCU RX3 232			
5	MCU TX2 232	RS232-A		
6	MCU RX2 232			
7	RTK TX1 232	RS232-RTK		
8	RTK RX1 232			
9	VIN+	Positive 9-24V		
10	VIN+	Positive 9-24V		
11	PPS	RTK PPS		
12	BCAN_FD_H	CAN_FD B (Default: Standard CAN, baud rate 500k)		
13	BCAN_FD_L			
14	ACAN_H	CAN_A (The default baud rate is 500k)		
15	ACAN_L			
16	GND	Ground		
17	GND			
18	SGND	Signal ground		
19	SGND			

20	PGND	Shield Ground	
----	------	---------------	--

Table 5 Harness Definitions

Fig. 7 Physical Connection Diagram

Here are instructions of each interface:

P2: CAN A: Input car's odometer and gear etc. signals using Motorola mode.

P3: CAN B Interface: Default baud rate 500k, outputs CAN protocol data.

P4: RS232-A: The default baud rate is 460800. It's parameter can be configured using AT command and output nmea protocol.

P5: RS232-B: The default baud rate is 460800. It's parameter can be configured when connecting to the PC software and using AT command, then output INS binary protocol.

P6: RS232-RTK: The default baud rate is 115200, please import differential data to upgrade satellite navigation module.

P7: Power supply: 9-24V power input

P8: PPS: output PPS, the default setting is triggered at rising edge, with an amplitude of 3.3v in a 1s cycle.

1.7 Signs of light

The status of the device can be judged by the signs of light, which are as follows:

Green light 1Hz blinking - No position

Green light 2Hz blinking - position status is 1

Green light 5Hz blinking - position status is 2

Green light 10Hz blinking - position status is 5

Green light constant on - position status is 4

Red light constant on - SD card free storage volume is below 20%

2 Examples of Use

In this chapter, a fundamental usage example of 680D is provided, please following the direction below to use this module.

2.1 Device Installation

2.1.1 Device Installation

1. Install requirements:

1) Single Antenna It needs to be installed on a carrier and connected to the integrated navigation system, with the satellite antenna in the air and the carrier unobstructed to the antenna. The antenna is connected to the PRI connector shown in Fig. 24 for positioning, and the installation schematic is shown in Fig. 20;

2) Dual Antenna If needed to use the dual-antenna directional function, two antennas (primary and secondary antennas) need to be installed on the carrier and connected to the integrated navigation system. There shall be no obstruction to the antenna and the carrier, the primary antenna shall be connected to the PRI for positioning, and the secondary antenna shall be connected to the SEC interface as shown in Fig. 21 for directional purposes. Baseline shall be greater than 0.5m, and the height of the two antennas shall be kept the same as Fig. 21 shows;

Note: After connection, the dual-antenna angle can be verified by the following methods:

Primary Antenna: When the primary antenna is obstructed or disconnected, the positioning status changes to 0, and latitude/longitude data is lost.

(In a strong signal environment, such as with a GPS signal repeater, unplugging the primary antenna may cause signal tracking phenomena, resulting in continued satellite reception. In this case, restart the device and observe again.)

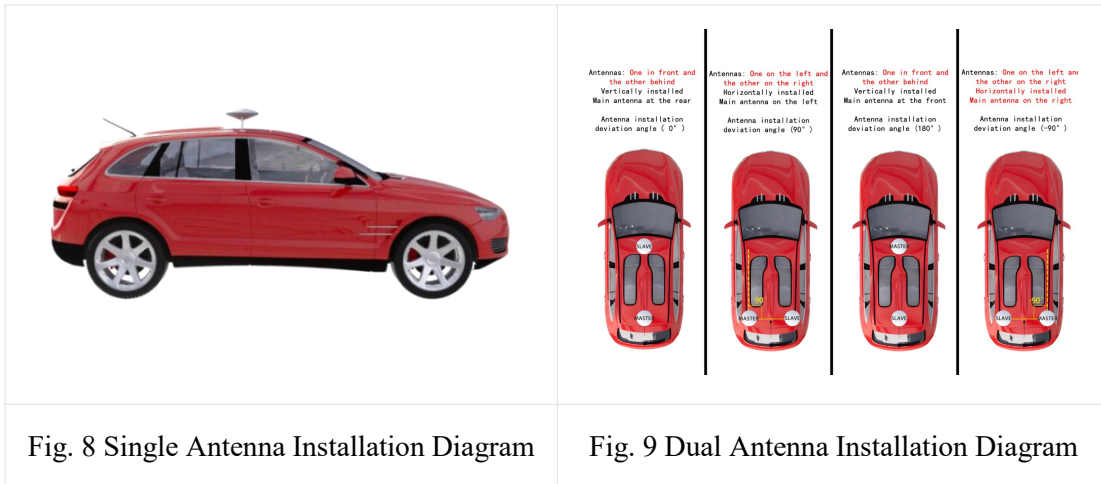
Secondary Antenna: In an open outdoor environment, the orientation status is greater than 0 (typically 34 or 50) before obstruction or disconnection. After obstruction or disconnection, the orientation status changes to 0.

3) The installation should be away from sources of interference, such as electrical devices or systems that generate electromagnetic interference signals.

4) The GNSS antenna is screwed onto a strong magnetic plate and positioned at the center of test carrier. Place the antenna on the highest point of the vessel possible to ensure good GNSS signal reception.

5) To ensure optimum performance, the distance between GNSS primary antenna and the master should be shortened, especially the horizontal distance.

Fig. 2 Module Installation Diagram



2.1.2 Device Installation

1. Install requirements:

- 1) The installing surface of the product should be flat and rigidly connected to the vehicle body, when horizontally mounted, it cannot be easily loosened or shaken;
- 2) The installation position should be far away from the source of vibration, such as the engine, air conditioning compressor and other positions;
- 3) Product installation should avoid electromagnetic interference (EMI) equipments, such as motors, cameras, etc., to reduce electromagnetic interference.
- 4) Fixing recommendations: the use of bolts and nuts for fixing, the product can not be disassembled and moved after the installation and calibration is complete, if moved, it need to be re-installed and calibrated.

2. Module Installation Diagram

The coordinate system surface indicated on the nameplate of the main unit is as parallel as possible to the measured datum surface of the carrier, and the X-axis is parallel to the center axis of the forward direction of the carrier, and the installation schematic is as follows, where X pointing to the direction of the front of the vehicle is positive, Y pointing to the right side of the body is positive, and Z pointing to the center of the earth is positive.



2.1.3 Disassembly and Assembly Requirements

1. When the antenna feeder interface is installed, the terminals are inserted parallel to each other. The installation is complete after a click.
2. When unplugging the antenna feeder connector, hand should be pressed at the red box shown below, and then the terminals should be pulled out parallel to each other.

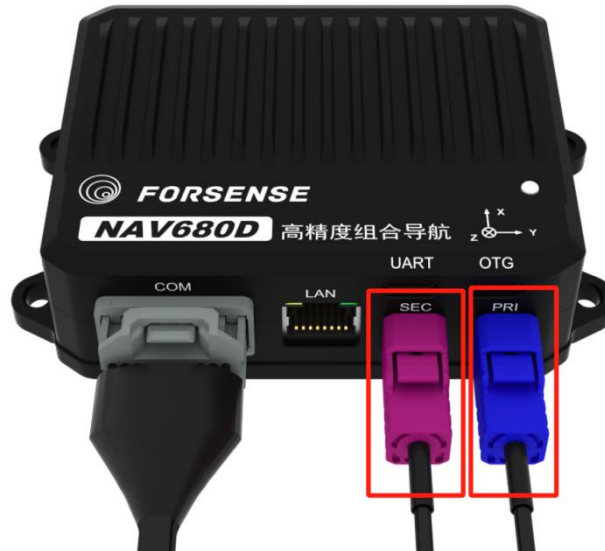


Fig. 12 Antenna Feeder Plugging Diagram

2.2 PC Software Download

The downloading page for PC software is: <https://data.forsense-imu.com/ProductFile/en/link/Upper%20computer%20software/NAV680D%20testing%20upper%20computer/download.php>

For usage instructions, refer to Section 3, "PC Software Usage."

2.3 Differential Data Acquisition

This product supports two methods for acquiring differential data.

1. External devices (DTU or computer) directly inject differential data via the RTK-232 serial port.
2. Connect to the internet via the LAN port and router. After configuring the differential account information and IP address, the built-in NTRIP program directly acquires differential data through the internet.

The specific methods are as follows:

2.3.1 Acquiring Differential Data via LAN Port

Note: Now only static ID is supported

Currently, two methods are supported for configuring IP and differential account-related information.

2.3.1.1 Modifying Internal Storage CONFIG File Configuration

Configure the differential account information and IP. The computer use TYPE-C to connect OTG, then find the update folder.

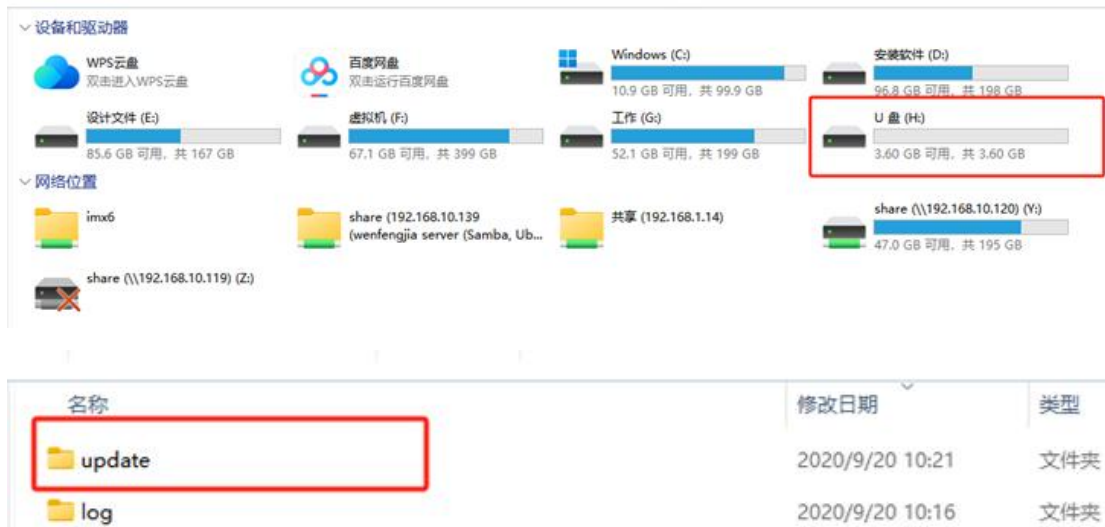


Fig. 13 update folder

Open config.ini

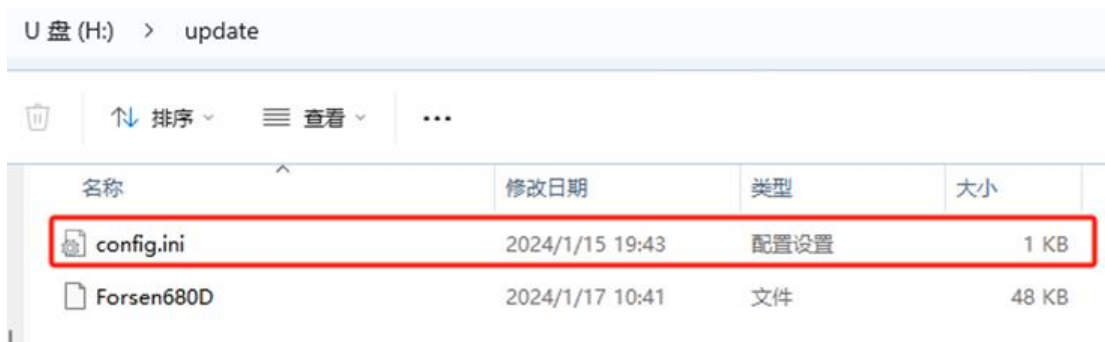


Fig. 14 config. ini

Configure the following:

```

[EquipmentConfigInfo]
#差分账号配置
host=vrs.sixents.com 1
port=8002 2
mountpoint=RTCM32_GRECJ2 3
user=c 4
password=r 5
ip=192.168.10.11 6
netmask=255.255.255.0 7
gateway=192.168.10.1 8
    
```

差分服务器地址
端口号
挂载点
差分账号
差分密码
IP地址. (配置成与电脑或路由器相同网段)
子网掩码 (固定为255.255.255.0)
网关地址 (配置成电脑或路由器相同网关地址)

Fig. 15 Configuring Information

Save the configuration. Please wait for 30s to reboot NAV680D, so that the modification of differential account number and IP address takes effect.

Note: The network parameter configuration can be verified by connecting to the PC software via the Ethernet port.

2.3.1.2 Configuration via PC Software Connection Through Ethernet Port

For detailed methods, refer to Section 6: Parameter Configuration via Ethernet Port.

2.3.2 Differential Data Input from External Directly

Please use Data Transfer Unit(DTU), computer or other equipment to input differential data through RTK-232 Serial Port. The default baud rate is 115200 and the serial port will default output GNGGA statement.

2.4 Basic Parameters Setting

When first using NAV680D, parameters should be configured as follows:

1. Primary antenna lever arm, rear axle center lever arm,
2. Dual antenna mounting angle (must be configured with dual antenna)
3. Low-speed mode (applicable to carriers with a maximum speed not exceeding 20 km/h; enable if applicable, otherwise disable).
4. Smoothing mode (Depending on the needs of the autopilot system, e.g. if the trajectory needs to get to the right position quickly when exiting a tunnel, it will not be turned on; if it needs to get to the right position smoothly, it will be turned on.)
5. Dual-antenna fusion configuration (configure as needed, suitable for low-speed carriers; if enabled, dual antennas are used throughout; if disabled, used only when stationary).

2.4.1 Configure Lever Arm Parameter

2.4.1.1 Configuration of the Primary Antenna Lever Arm

The lever arm vector is the 3D vector (X,Y,Z) of the RTK main antenna phase center relative to the IMU center. (unit: m)

Measure the distance from the center of the antenna to the center of the device along the X/Y/Z axis of the boat's coordinate system, and get the three values of X1 Offset/Y1 Offset/Z1 Offset, please pay attention to the positive and negative values.

Positive and Negative Recognition (Front-Right-Down coordinate system):

if the RTK main antenna is in front of the IMU, the value is positive, otherwise is negative;

if the RTK main antenna is on the right side of the IMU, the value is positive, otherwise is negative;

if the RTK main antenna is above the IMU, the value is **negative**, otherwise is positive. (Usually the antenna lies above the equipment.)

The Front-Right-Down coordinate system are as follows:



Fig. 16 Coordinate System Diagram

E.g.: The main RTK antenna is 0.9 meters in front of the device, 0.4 meters to the right, and 1.2 meters above the device, then the XYZ values are: X = 0.9; Y = 0.4; Z = -1.2)

If using AT command, please enter: AT+CLUB_VECTOR=0.9,0.4,-1.2\r\n

Response: GPS_POS_X=0.9,GPS_POS_Y=0.4,GPS_POS_Z=-1.2/r/n

If configured with PC software, please configure the parameters as shown in Fig. 27:

1. Please successfully install and configure the module, antenna and the differential data
2. Open the NAV680D PC Software, and click “刷新”(refresh) on the IMU settings page of the upper computer parameter setup. Please input the measured lever arm and then click Setup, then a window will pop up. Please click OK then “刷新”(refresh) to confirm the input parameters are correct, the power-off and reboot to reconnect the upper computer.

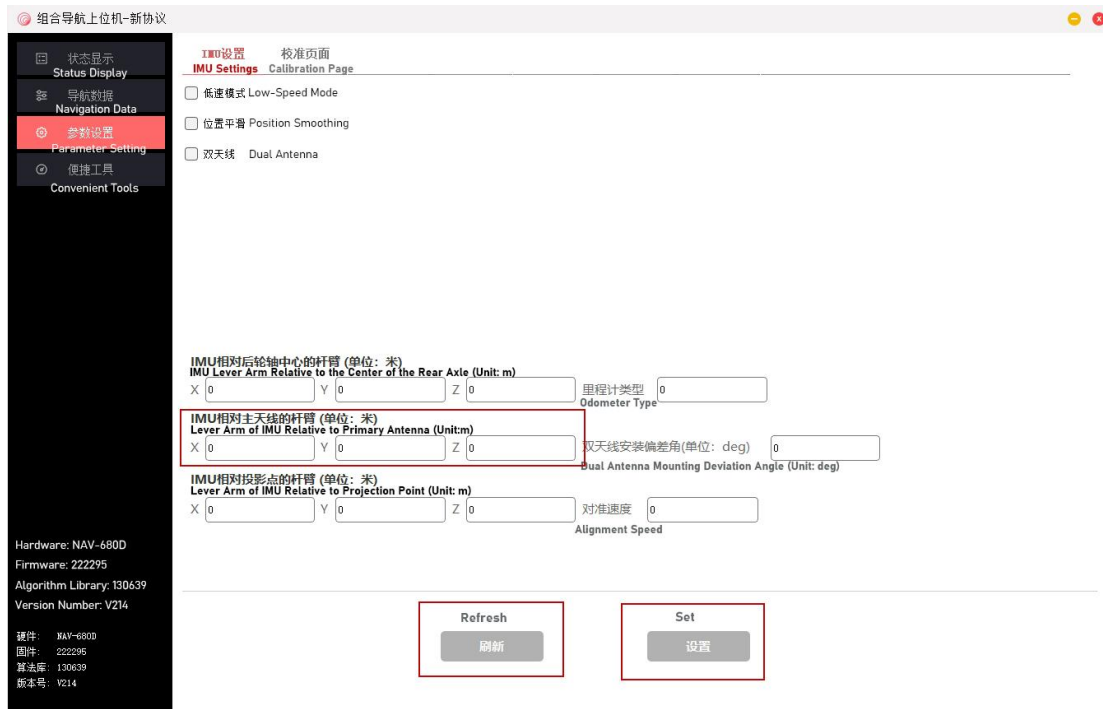


Fig. 17 Page for Configuring Lever Arms

2.4.1.2 Configuration of the Device Lever Arm Relative to the Rear Axle Center

The module - the rear axle center lever arm: the 3D vector (X,Y,Z) of the rear axle center relative to the IMU center can be measured with the same method as above.

if the rear axle center is in front of the IMU, the value is positive, otherwise is negative;

if the rear axle center is on the right side of the IMU, the value is positive, otherwise is negative;

If the rear axle center is below the IMU, the value is positive, otherwise is negative. (Usually it places below the equipment)

The coordinate system are as follows.

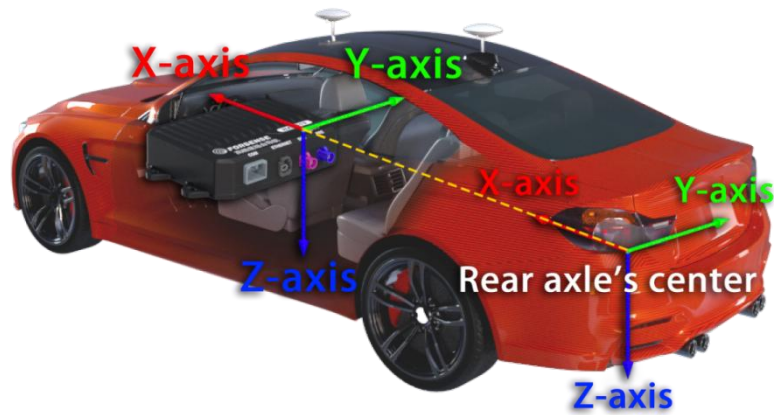


Fig. 18 Coordinate System Diagram

E.g.: The main RTK antenna is **-0.3 meters in front of the device, 0.4 meters to the right, and 1.2 meters above the device**, then the XYZ values are: **X = 0.9; Y = 0.4; Z = 1.2**

If using AT command, please enter: `AT+CLUB_VECTOR=-0.3,0.4,1.2\r\n`

Response: `GPS_POS_X=-0.3,GPS_POS_Y=0.4,GPS_POS_Z=1.2\r\n`

PC Software Usage:

Open the NAV680D PC Software, and click “刷新”(refresh) on the IMU settings page of the upper computer parameter setup. Please input the measured lever arm and then click Setup, then a window will pop up. Please click OK then “刷新”(refresh) to confirm the input parameters are correct, then power-off and reboot to reconnect the upper computer. Click “刷新”(refresh) again, and verify whether the read parameters match the configured values. If they match, the configuration is successful.

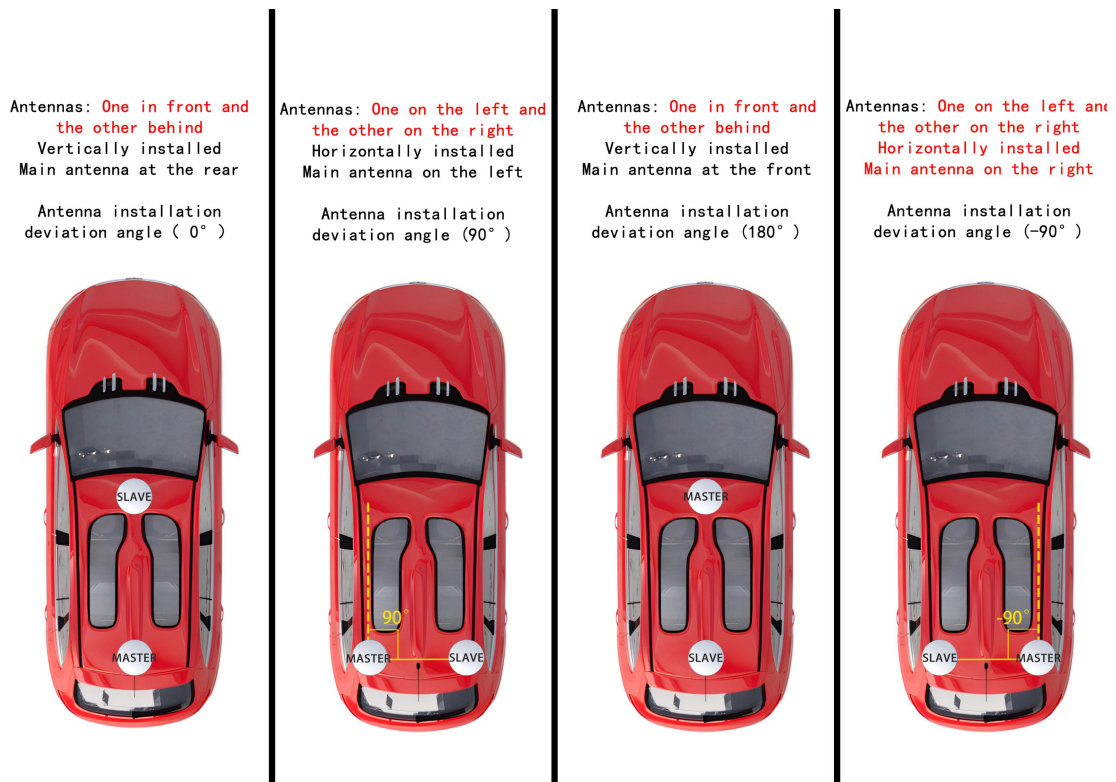


Fig. 19 Configuring Lever Arms

2.4.1.3 Configuration of RTK Dual Antenna Mounting Angle

If connected to single antenna, the value should be set at 0; if connected to dual antenna, the angle between the ray of the primary antenna pointing to the secondary antenna and the direction of the front end of the vehicle should be measured, with clockwise motion is positive, counterclockwise motion is considered negative.(unit: degree)

For installation methods and corresponding angles, refer to the figure below.



If configuring the RTK dual-antenna installation angle to 90 degrees, use AT commands.

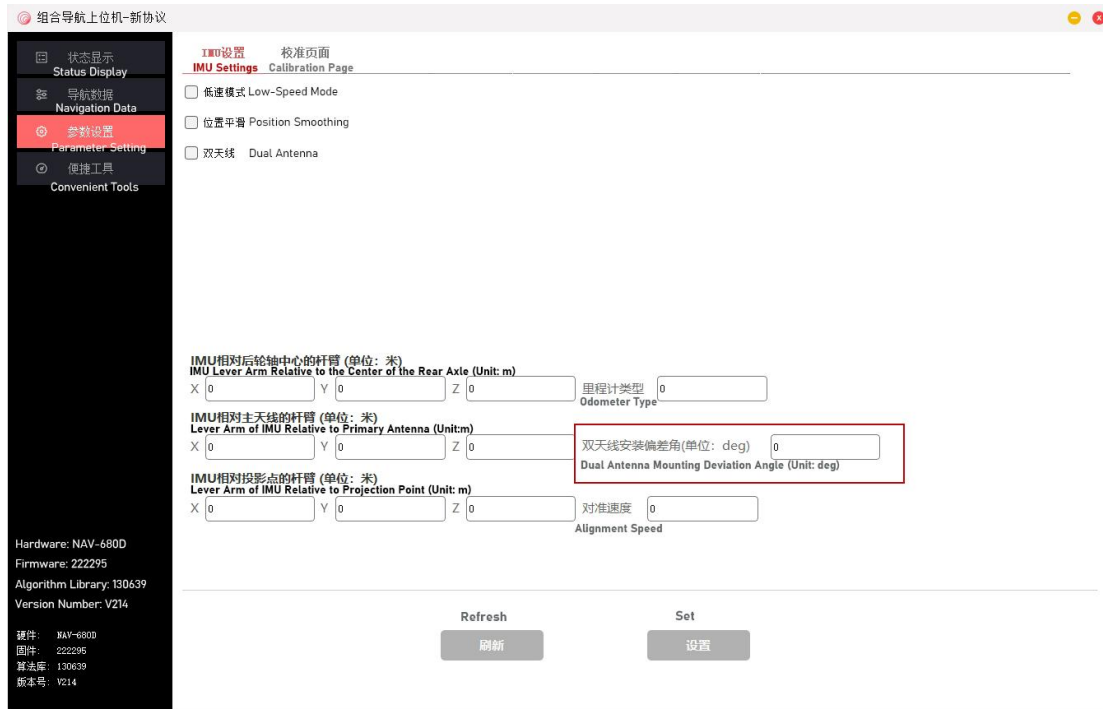
Configuration command is:

Command: `AT+RTK_ANGLE=90\r\n`

Response: `ANGLE=0\r\n`

Note: After saving the configuration commands, power off and restart are necessary. The distance between the two antennas should be more than 50cm.

If using the PC software for configuration, open the NAV680D PC Software, and click “刷新”(refresh) on the IMU settings page of the upper computer parameter setup. Please input the measured lever arm and then click Setup, then a window will pop up. Please click OK then “刷新”(refresh) to confirm the input parameters are correct, the power-off and reboot to reconnect the upper computer. Click “刷新”(refresh) again, and verify whether the read parameters match the configured values. If they match, the configuration is successful.



2.4.2 Opening Position Smoothing

Note: If it is turned on, the trajectory will be smoothed when the signal is restored after the lock is lost, if it is turned off, the trajectory will be pulled back to the correct position quickly and the trajectory will appear jagged, please configure it according to the specific requirements.

Please turn on/off according to the requirement.

Command: AT+POS_SMOOTH=1\r\n

Response: OK\r\n

To close position smoothing:

Command: AT+POS_SMOOTH=0\r\n

Response: OK\r\n

2.4.3 Turn on the Low-speed Mode

Note: This mode is suitable for carriers that running at low speeds for long periods of time (speed lower than 20km/h), e.g. Automated Guided Vehicle(AGV)

Command: AT+LOW_SPEED_MODE=1\r\n

Response: OK\r\n

To close Low-speed Mode:

Command: AT+LOW_SPEED_MODE=0\r\n

Response: OK\r\n

2.4.4 Open the Dual Antenna Heading Constraints

Note: When opened, dual antenna heading will be used in full scenario, otherwise it will only be used in static state.

Command: AT+USE_GNSS_HEADING=1\r\n

Response: OK\r\n

To close dual antenna heading constraints:

Command: AT+USE_GNSS_HEADING=0\r\n

Response: OK\r\n

2.4.5 Calibration of Lever Arm

After the configuration, it is necessary to calibrate primary antenna lever arm to reduce measuring error and improve positioning accuracy.

It is worth noting that this calibration is targeted at the optimization of manual measurement, hence it is vital to keep the data as accurate as possible, with error controlled in 8cm, otherwise it will not assume accuracy.

If the lever arm data is not manually measured, but from the 3D datagram of a car module (determined primary antenna and integrated navigation position), then there's no need for lever arm calibration.

The calibration can start after it is successfully configured. If the subsequent product and antenna mounting position do not change, only one calibration is required.

The calibration process is as follows:

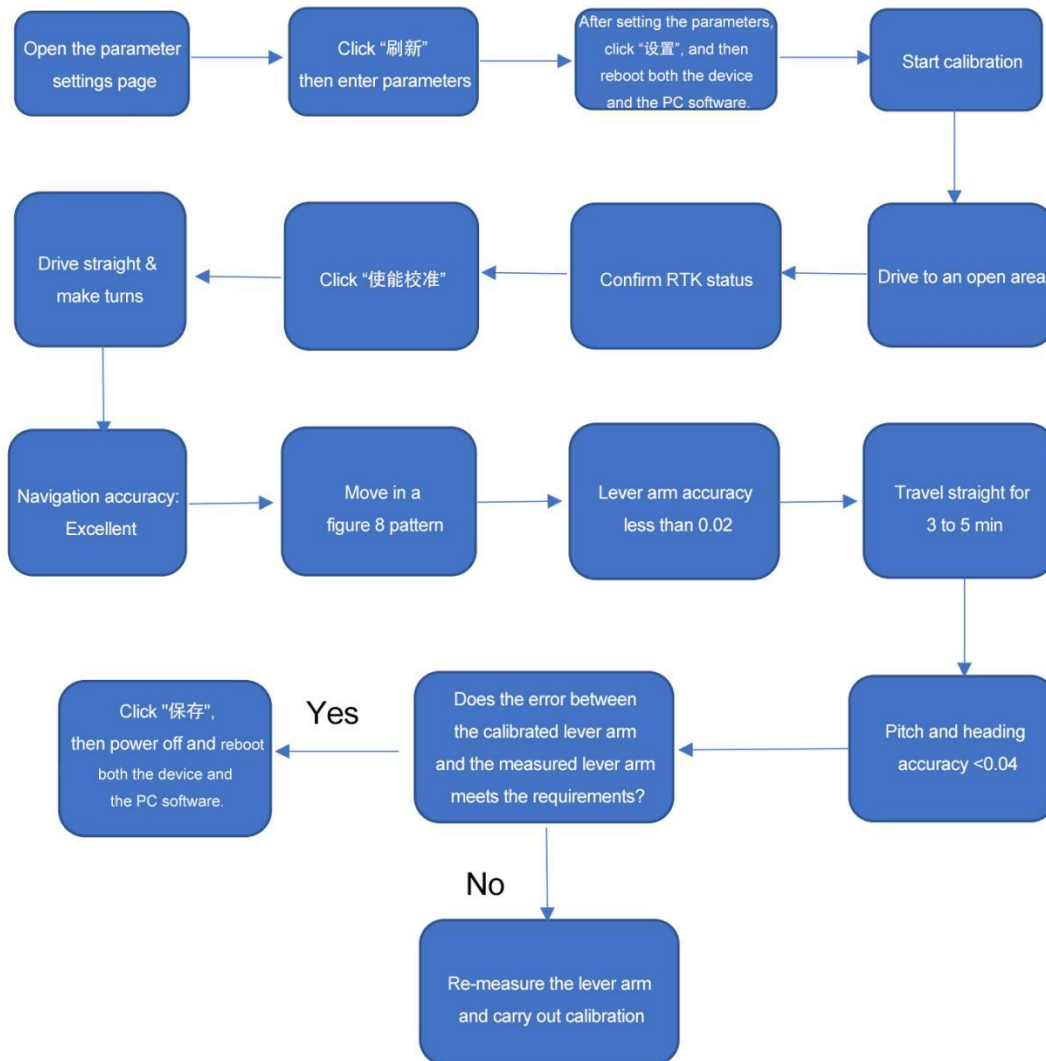


Fig. 20 Calibration Process

Calibration steps are as follows:

1. Drive the car to an open area, open the NAV680 PC Software and click “导航数据”(Navigation Data)

As shown in the figure below,where're 3 conditions needed:

- (1). RTK must at a fixed solution state, i.e. “窄巷固定”(Narrow-lane fixation)
- (2). “星数”(Satellites) more than 30
- (3). “差分延时”(Differential delay) as small as possible (must below 5)

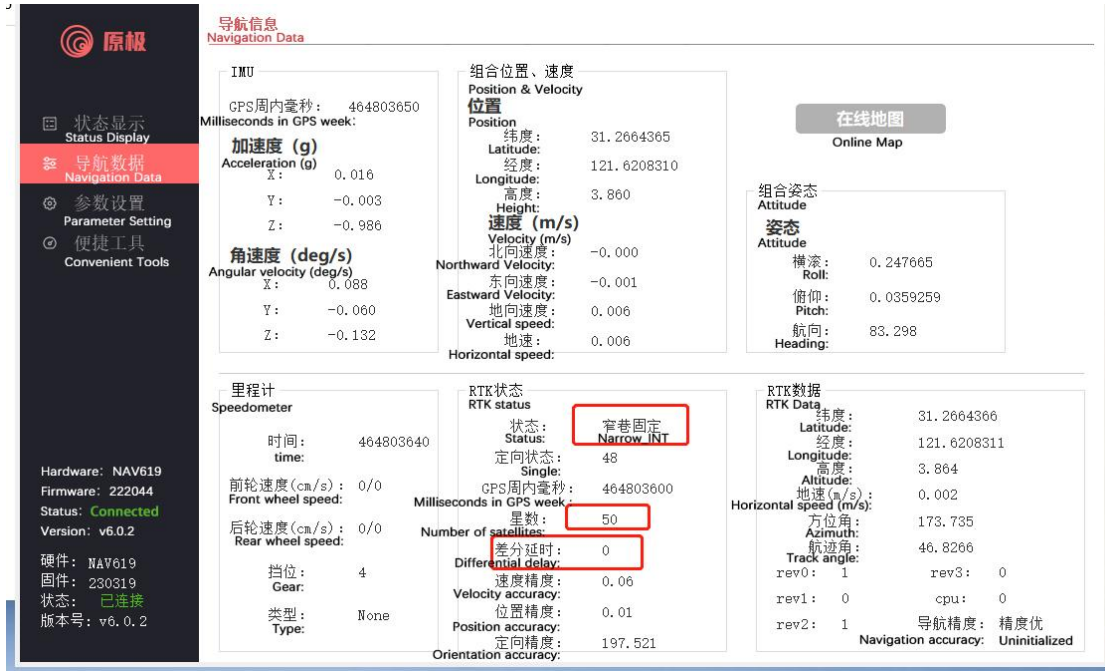


Fig. 21 “导航数据”(Navigation Data) page

2. When the above conditions are met, open “参数设置”(Parameters Setting) - “校准页面”(Calibration), click “使能校准”(enable calibration) as shown in the figure below.

Start driving. First drive in a straight line for more than 150m with speed higher than 40km/h; Then U-turn or turn the vehicle and drive in a straight line again for more than 150m with speed higher than 40km/h. Check if “参数设置”(Parameters Setting) - “导航精度”(Navigation Accuracy) is “优”(optimal). If is, please proceed the next step; if not, please continue to drive in a straight line until the navigation accuracy is optimal.

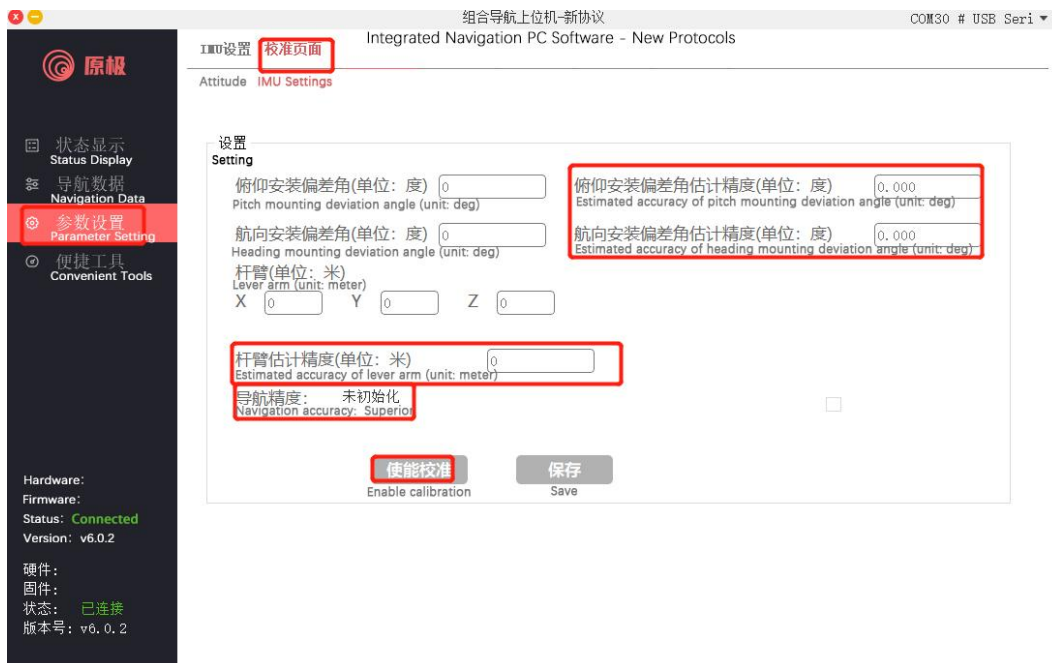


Fig. 22 “校准页面”(Calibration)

When the navigation accuracy is optimal, please drive in “8” form like in Fig. 32. Check the “杆臂估计精度”(estimated lever arm accuracy), when it is less than 0.02, drive straight for 3-5 minutes in an open area until “俯仰角安装偏差角估计精度” (Estimated accuracy for pitch mounting deviation angle) and “航向安装偏差角估计精度” (Estimated accuracy for Heading mounting deviation angle) are both less than 0.04, then the calibration is complete.

Please check value of “杆臂（单位：米）”(Lever arm(unit: m)) in Fig. 31. If the margin between this value and the manual measured result is within 5cm, it can be saved and re-power up; if this margin is larger than 5cm, recalibration is needed until this margin is below 5cm.

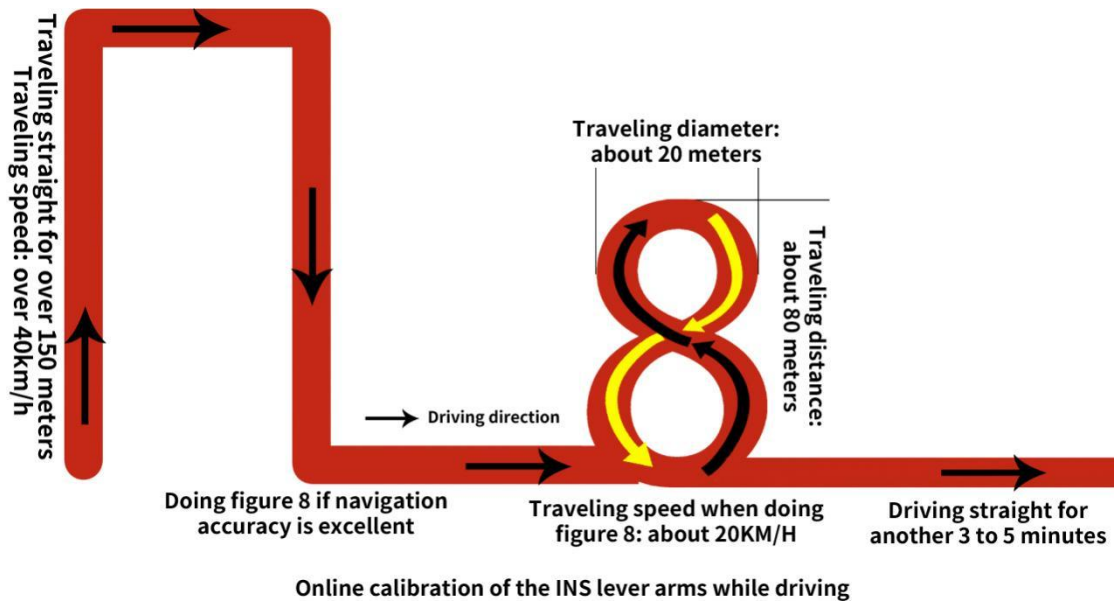


Fig. 23 Vehicle Route Maps

3 Downloading and using PC Software

3.1 Downloading

The downloading page for PC software is: <https://data.forsense-imu.com/ProductFile/en/link/Upper%20computer%20software/NAV680D%20testing%20upper%20computer/download.php>

Note: After connecting to the PC software, the serial port will automatically switch to the log data stream. Since this data stream protocol is not open to the public, it needs to be decoded using the MATLAB decoding script on the official website of Forsense. The downloading page is: <https://data.forsense-imu.com/ProductFile/en/link/Driver%20and%20sample%20code/SD%20unpacking%20program%20%28MATLAB%20script%29/download.php>

3.2 Usage of NAV680D PC Software

3.2.1 PC Software Connection

Fig.4 shows the page when first opening the PC software.

Click box 1 to select serial port numbers, please use USB to RS232 serial cable to connect NAV680D, serial port number will appear once correctly powered up NAV680D;

Click box 2 to connect;

Click box 3 to choose functions. Currently “状态显示”(Status Display) is not supported.

Check box 4 for “硬件”(Hardware), “版本号”(Corresponding firmware version number), “状态”(connecting status, “离线”means disconnected while “已连接” means connected) and “版本号”(version number).

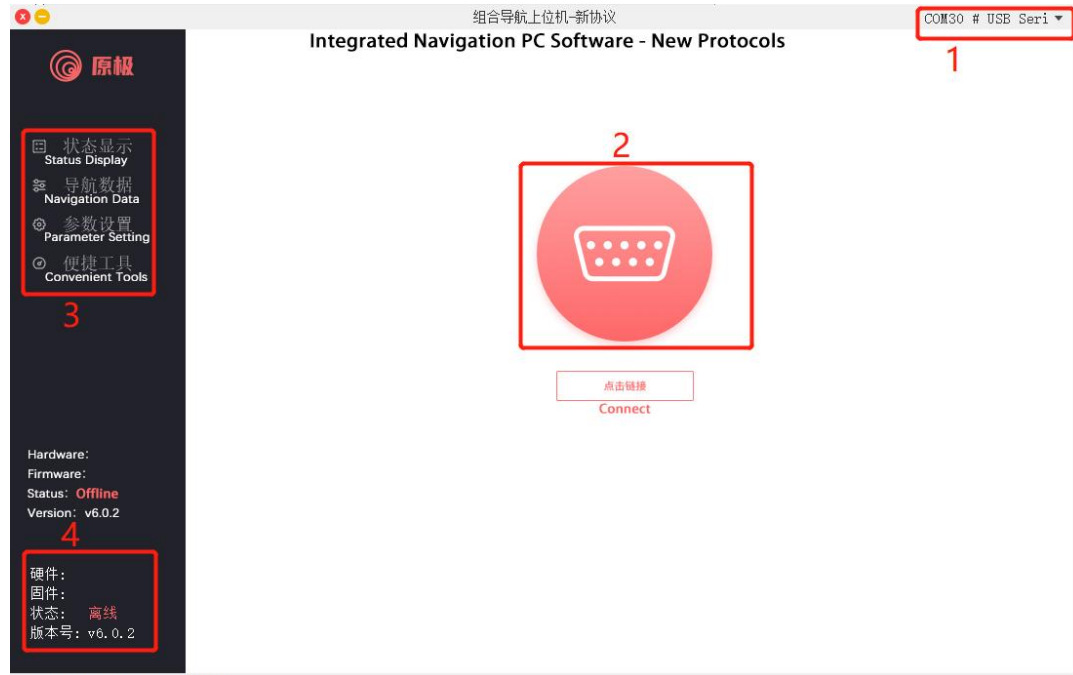


Fig. 24 Software display page

3.2.2 Navigation Data Page

Fig. 6 displays navigation data, it shows informations of IMU, “组合导航位置/速度/姿态”(integrated navigation position/ velocity/ attitude), “RTK 状态/数据信息”(RTK status / data informations). “里程计信息”(odometer informations) will be shown after it has been connected. “在线地图”(Online Map) is currently not supported.

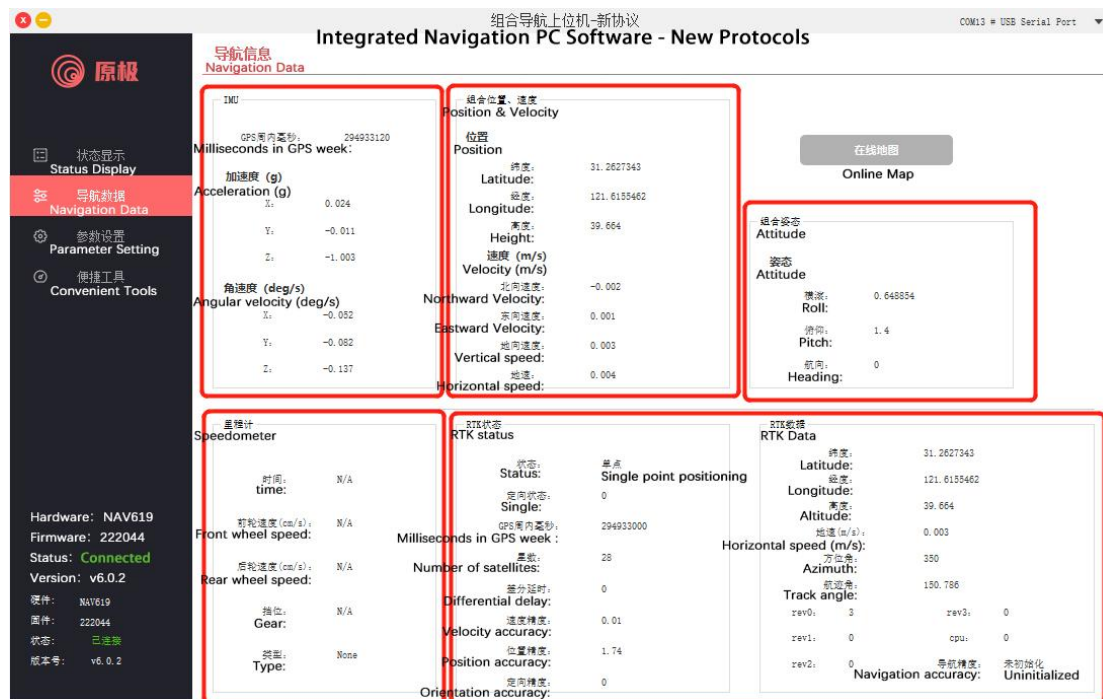


Fig. 25 Navigation Data Page

3.2.3 Parameters Setting

3.2.3.1 Configuration of the Primary Antenna Lever Arm

The main antenna lever arm measurement: Take the center of NAV680D mainframe as the coordinate origin, establish a three-axis coordinate system, with the X-axis positively pointing to the front of the vehicle, the Y-axis positively pointing to the right side of the body, and the Z-axis positively pointing to the center of the earth. Please use a tool to accurately measure the distance from the projection point of main antenna phase center to the origin of the coordinate point in the direction of the X, Y, and Z-axis (unit: m).

3.2.3.2 Configuration of the Rear Axle Center Lever Arm

Module - Rear Axle Center Lever Arm: Using the same measurement method as the primary antenna lever arm, measure the three-dimensional vector distance (x, y, z) from the vehicle's rear axle center to the device center (unit: m).

3.2.3.3 Setting Dual Antenna Mounting Deviation Angle

If connected to single antenna, the value should be set at 0; if connected to dual antenna, the angle between the ray of the primary antenna pointing to the secondary antenna and the direction of the front end of the vehicle should be measured, with clockwise motion is positive, counterclockwise motion is considered negative.(unit: degree) Fig.8 displays different deviation angle in different setting method.

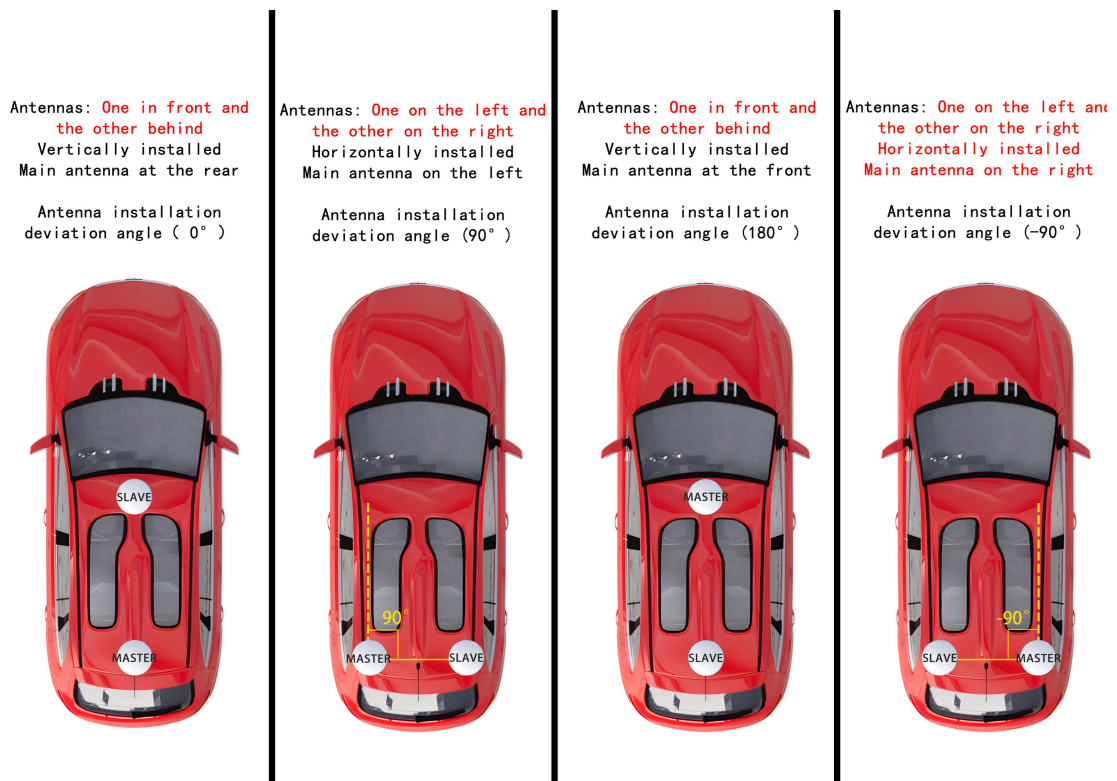


Fig. 26 Dual Antenna Installation Diagram

Deviation Angle Definition: With the primary antenna position as the center and the secondary antenna direction as the radius, an arc is drawn. The forward direction is defined as the 0-degree reference direction. The angle between the secondary antenna and this reference direction is the installation deviation angle.

3.2.3.4 Projection Point Lever Arm

The default output latitude and longitude coordinates of this product are the latitude and longitude coordinates of the main antenna position. To change the latitude and longitude coordinates to the coordinates of other positions of the vehicle body, please set up the projection point pole arm.

The projection point pole arm can be measured in the same way as the main antenna pole arm, which is measuring the three-digit vector distance (x,y,z) from the projection point to the center position of the device.(unit: m)

As is shown in fig. 6, before setting all the parameters, refresh and filling in the corresponding parameters and positional benchmarks should be clicked, and then clicking on setup, there will be a pop-up window prompting the success of the setup after completion.



Fig.27 IMU Setup Page

2. Calibration Page

The calibration page is shown as follows. When calibrating the lever arm, this page is required. The specific process can be found in section 4.2 Lever Arm Calibration

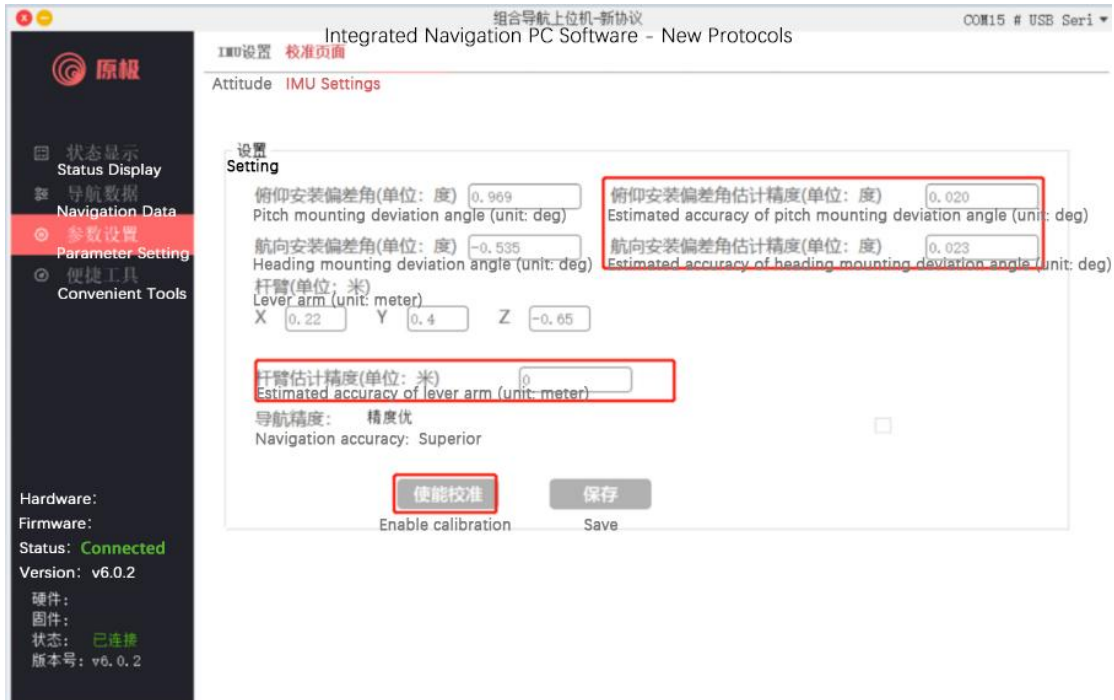


Fig. 28 Calibration Page

3.2.4 Firmware Upgrading

3.2.4.1 Upgrade Integrated Navigation Algorithms through PC Computer

Firmware can be upgraded in “便捷工具”(convenient tools). Please click “打开文件”(Open files), choose the firmware that needed to be upgraded and click “升级”(Upgrade). During the process the computer can't power off. When the upgrade is successful, firmware backup should be done. Please power off for 10 seconds and reconnect PC software again.

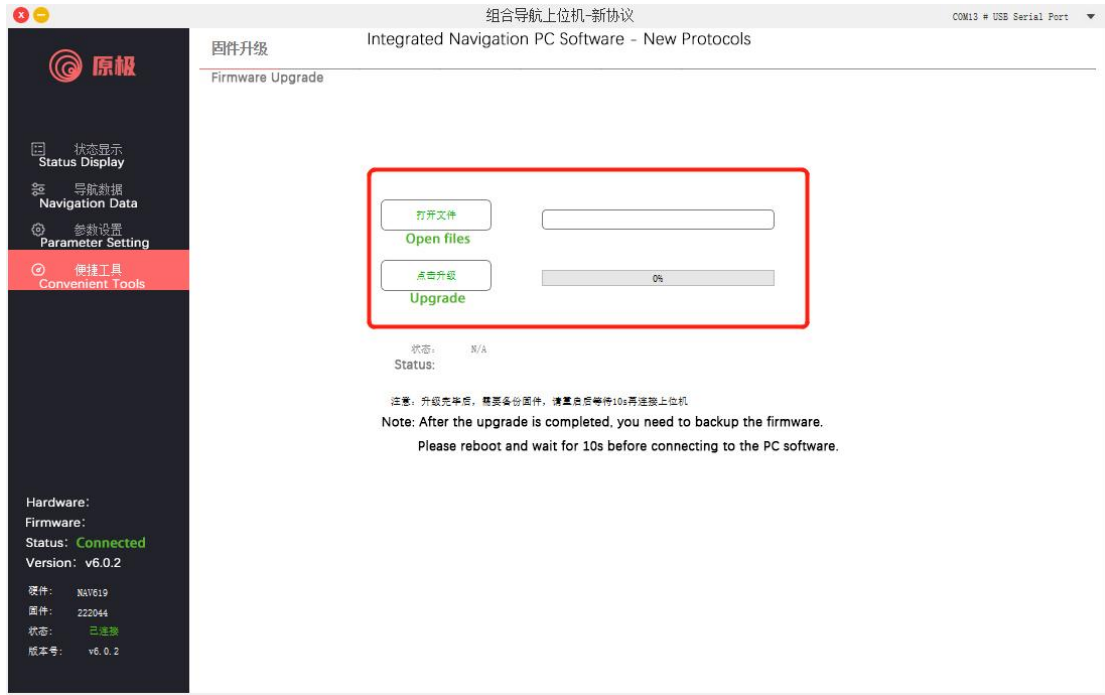


Fig. 29 “便捷工具”(Convenient Tools) Page

3.2.4.2 Upgrade Firmware through OTG Interface

Currently the firmware has two upgrade package:

“Forsense680D” File is internal storage and network port driver running firmware;

“NAV680D” File is integrated navigation Algorithm Firmware.

Upgrade method: After power on the device, please use type-c harness to connect the computer and OTG interface. Please open update file and put internal storage and network port driver running firmware, integrated navigation Algorithm firmware in this file.

Modify file name to be “Forsen680D” and “NAV 680D#”, Restart the device, wait for 3-5 min until the upgrade is complete. During this time, the light will blinking in blue and green alternately. The upgrade is complete when the blinking is stop.(If the upgrade doesn’t include algorithm firmware, the time is roughlt 1 minutes.)

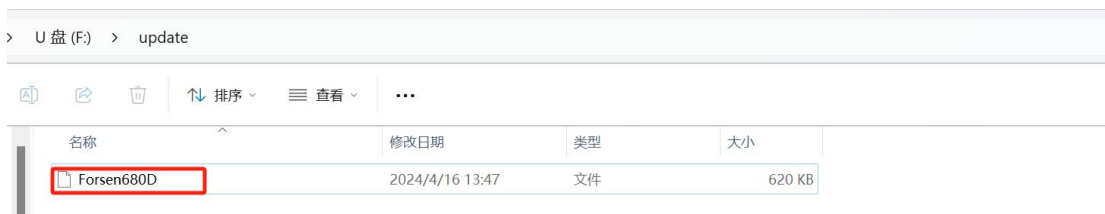


Fig. 30 6ul Firmware name

3.2.5 Data Storage

3.2.5.1 Save Data through PC Software

After connecting to the PC software, data will be stored automatically.

By default, the integrated navigation data stream is output and stored in the "nav680D" folder under the "log" directory in the software package.

For content reference, see Section 4.1 "Integrated Navigation Data Stream". Data can be parsed manually or decoded using the Data Decoding page in the PC software toolkit. The system generates .dat files named by timestamp, as shown in the following example:

After connecting to the PC Software, the data will be stored automatically in the "nav680D_test" folder in the "log" folder of the software package, and dat files named according to the time will be generated, as shown in the following example:

E.G.: 2024_0416_1400_42.dat, When the PC Software is disconnected, the data will stop saving, this data is a log data stream, the protocol content is not open to the public for the time being, and analysis needs to be done by using the MALTB script on the official website of Forsense.As is shown in Fig.33. After the analysis, a CSV file can be obtained, in the format of Figure 13



Fig.31 PC Software Data Storage Place

3.2.5.2 Internal Storage Data

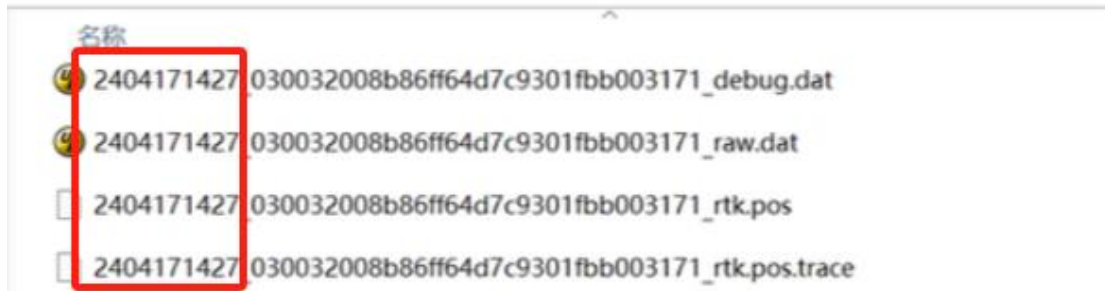
Note: Internal storage space bit 2GB, power on will be self-test, if the remaining storage space is less than 500M, it will clean up the data that from two days ago. If needed to use the internal storage data, please copy in time!

Once the device is powered on and successfully read satellite signal, it will store data

automatically. When the testing is done, please use type-c harness to connect the computer and OTG interface. Enter the log folder to copy the day's file.

File Description:

The filename header indicates the data recording start time. The example below shows a recording time of 14:27 on April 17, 2024.



.dat file: integrated navigation data (internal-debugging data stream, which protocol is not open to the public at the moment, please use the MALTb script on the official website of Forsense to decode.)

.rtcm file: RTK base station differential data acquired in this power-up.

.raw file: RTK raw data acquired in this power up.

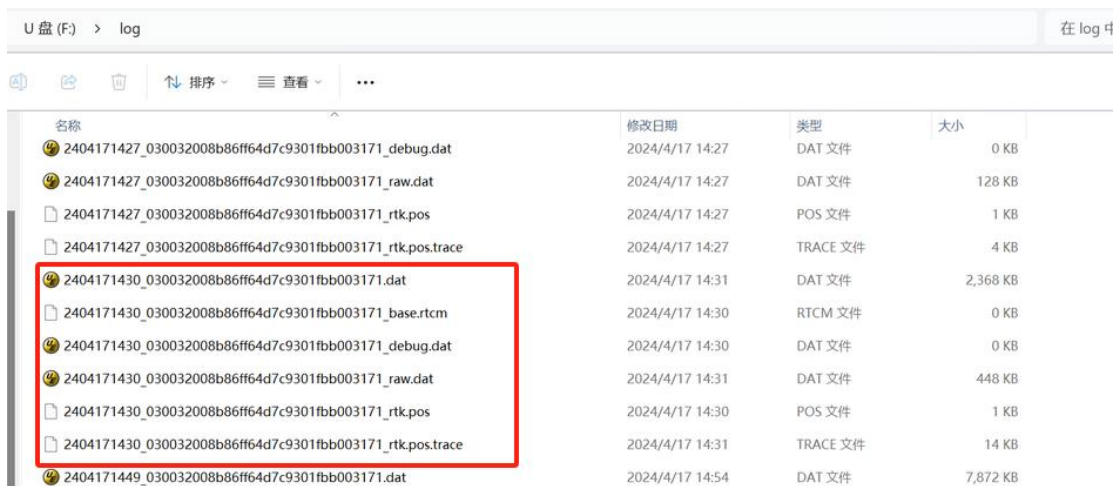


Fig. 32 Internal Storage Data

4 Integrated Navigation Output Protocols

4.1. Integrated Navigation Data Stream

Serial Port R232-B input supported, Baud rate: 460800, Network port output supported, serial number 6100

Note:

- CRC checksum starts from the frame header covering all bytes of the frame except the CRC checksum bit itself. See “Integrated navigation data decoding routine” for calculation methods and routines.
- The frame length is the total number of data bytes excluding frame header, frame ID, frame length and byte count, which is 104.
- In little-endian mode, and the low byte is sent first.
- The output attitude angle is the attitude in the vehicle coordinate system.

Under fixed solution, when speed is above 20km/h, Integrated Navigation can accomplish initialization and start working.

Parameter	Type	Relative position
Frame header 1: 0xAA	UInt8	0
Frame header 2: 0x55	UInt8	1
Frame ID: 0x0166	UInt16	2
Frame length: 0x005E	UInt16	4
Seconds in GPS week (ms)	UInt32	6
GPS week number count	UInt16	10
Latitude (deg x 10,000,000)	Int32	12
Longitude (deg x 10,000,000)	Int32	16
Height (mm) (Ellipsoidal height)	Int32	20
Northward velocity(m/s)	Float	24
Eastward velocity(m/s)	Float	28
Ground velocity(m/s)	Float	32
Roll angle(°)	Float	36
Pitch angle(°)	Float	40
Yaw angle (°)	Float	44
Dual antenna yaw angle(°)	Float	48
Reserved	Float	52
Accelerometer X-axis (g)	Float	56
Accelerometer Y-axis (g)	Float	60

Accelerometer Z-axis (g)	Float	64
Gyroscope X-axis (deg/s)	Float	68
Gyroscope Y-axis (deg/s)	Float	72
Gyroscope Z-axis (deg/s)	Float	76
IMU temperature (°C)	Float	80
RTK positioning status (detailed in the table below) 0:No positioning 16:Single point positioning 17:Pseudorange differential positioning 34:Floating solution 50:Fixed solution	Uint8	84
Number of satellites	Uint8	85
Differential delay	Uint8	86
Dual Antenna Orientation Status, 50 means oriented, otherwise means not oriented	Uint8	87
Position accuracy factor (cm) Effective INS after the initialization	Uint16	88
Status bits: Bit0: means the RTK data is valid, 0 is invalid; Bit1:1 means PPS signal is valid, 0 is invalid; Bit2:1 means the integrated navigation has been initialized, 0 means otherwise. The initialization requires the following condition: Single antenna: Fixed solution + with access to odometer, when speed is above 2m/s, it can be initialized. Single antenna: Fixed solution + without access to odometer, when speed is above 5m/s, it can be initialized. Dual antenna: Fixed solution + Orientation status 50 for more than 20s, it can be initialized. Bit3: reserved Bit4: reserved Bit5: reserved Bit6: reserved	Uint16	90
GNSS Dual antenna heading milliseconds in GPS week	Uint32	92
Reserved 2	Uint32	96
CRC verification	Uint32	100

4.2 NMEA Protocol

- The product Supports output of combined data in nmea format.
- Binary data stream can not output at the same time with the nmea data stream. Before switching the data stream, please stop the current data stream output following the 5.4 instruction.
- Currently following statement are supported: See section 5.3 for the configuration method.
- Supports output via Serial Port RS232-A, baud rate 460800.
- Supports output via Ethernet port, port number 6000. Serial port configuration of output messages is required first.

GPGGA

GPRMC

GPHDT (Heading information)

GPVTG (Ground velocity information)

GPZDA (UTC time and date)

GPATT (Forsense Customized message)

GPYJ (Forsense Customized message: GPYJ Data Protocol)

The format of GPATT are as follows

<i>Name</i>	<i>Unit</i>	<i>Format</i>	<i>Example</i>	<i>Description</i>
Sentence Identifier		String	\$GNATT	
Time		hhmmss.sss	170834.000	17:08:34 UTC
Status		Character	1	0: invalid 1: valid
Roll Angle	degree	3 decimal places	-4.891	range ± 90 , right side down defined as positive
Indicator for roll		character	R	Roll indicator
Pitch Angle	degree	3 decimal places	3.122	range ± 90 , head up defined as positive
Indicator for Pitch		character	P	Pitch indicator
Heading Angle	degree	3 decimal places	124.005	range 0~360, to true North, counter clockwise defined as positive
Roll Angle uncertainty	degree	3 decimal places	0.432	range 0~360
Pitch Angle uncertainty	degree	3 decimal places	0.811	range 0~360
Heading Angle uncertainty	degree	3 decimal places	1.202	range 0~360
Checksum		Hex	*68	Used by program to check for transmission errors

The format of GPYJ are as follows

\$GPYJ,GPSTime,Heading,Pitch,Roll,gyrox,gyroy,gyroz,accx,accy,accz,Latitude, Longitude,Altitude,Ve,Vn,Vu,V,NSV1,NSV2,Status,Age,WarmingCs<CR><LF>

Note: If the system status is not initialized, the output is GNSS results, including position, velocity, and attitude (Status low nibble: 0 and 1 indicate GNSS data; 2 and 3 indicate integrated data).

1	Header	GPYJ Protocol header	\$GPYJ	\$GPYJ
2	GPSWeek	Week number since 1980-1-6 (GPS Time)	www	1980
3	GPSTime	Seconds since this Sunday at 0:00:00 (GPS Time)	sssss.ss	16897.68
4	Heading	Yaw angle(0 to 359.99)	hhh.hh	289.19
5	Pitch	Pitch angle (-90 to 90)	+/-pp.pp	-0.42
6	Roll	Roll angle(-180 to 180)	+/-rrr.rr	0.21
7	gyro x	Gyro X-axis, unit (°/s)	+/-ggg.gg	-0.23
8	gyro y	Gyro Y-axis, unit (°/s)	+/-ggg.gg	0.07
9	gyro z	Gyro Z-axis, unit(°/s)	+/-ggg.gg	-0.06
10	acc x	Accel X-axis, unit (G)	+/-a.aaaa	0.0009
11	acc y	Accel Y-axis, unit (G)	+/-a.aaaa	0.0048
12	acc z	Accel Z-axis, unit (G)	+/-a.aaaa	-1.0037
13	Latitude	Latitudes (-90° to 90°)	+/-ll.lllllll	38.8594969
14	Longitude	Longitudes (-180° to 180°)	+/-ll.lllllll	121.5150073
15	Altitude	Altitudes, unit: m	+/-aaaaa.aa	121.51
16	Ve	Eastward Speed, unit: m/s	+/-eee.eee	-0.023
17	Vn	Northward Speed, unit:m/s	+/-nnn.nnn	0.011
18	Vu	Skyward Speed, unit: m/s	+/-uuu.uuu	0.000
19	V	Car Speed, unit: m/s	+/-uuu.uuu	1.500
20	NSV1	Primary antenna 1 Satellite number	nn	14
21	NSV2	Secondary antenna 2 Satellite number	nn	6
22	Status	System Status (low half byte): 0: Initialization; 1: Satellite Navigation Mode; 2: Integrated Navigation mode; 3: Native inertial sensor mode; Native inertial sensor mode ;Satellite status(high half byte): 0: no position and orientation; 1: Single point position and orientation; 2: Pseudo-range differential positioning and orientation; 3: integrated calculation; 4:RTK stationary solution position and	ss	4

		orientation; 5: RTK floating position and orientation; 6: Single point position and without orientation; 7: Pseudo-range differential positioning and without orientation; 8: RTK stationary solution positioning and without orientation; 9: RTK floating solution positioning and without orientation;		
23	Age	Differential delay	aa	0
24	Warning	bit0: 1: No GPS message, 0: Normal bit1: 1: No vehicle message, 0: Normal bit3: 1: Gyroscope error, 0: Normal bit4: 1: Accelerometer error, 0: Normal	ww	2
25	Cs	Verification	*hh	*47
26	<CR><LF>	Fixed datagram tail		<CR><LF>

4.3 CAN Output Protocols

The default output frequency of the integrated navigation system is: 100HZ

The default baud rate is 500K

4.3.1 CAN DBC File

Note: There are corresponding DBC file in Forsense official website which can provide real-time decoding, the downloading page is: https://data.forsense-imu.com/ProductFile/en/link/product/NAV680-D/nav680D_can.dbc/download.php



4.3.2 CAN Protocols

INS_Acc(0x500), the default being 100hz, with the coordinate system being the shell coordinate system, bias compensation supported.

The X-axis indicates that the vehicle is moving forward positively; the Y-axis means that the vehicle is moving rightward positively; and the Z-axis refers that the vehicle is moving downward positively.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
ACC_X	8	16	Unsigned	Motorola	[-4,4]	8/65536	-4	g	D=N*8/65536-4
ACC_Y	24	16	Unsigned	Motorola	[-4,4]	8/65536	-4	g	D=N*8/65536-4
ACC_Z	40	16	Unsigned	Motorola	[-4,4]	8/65536	-4	g	D=N*8/65536-4

INS_GYRO(0x501), the default being 100hz, the coordinate system being the shell coordinate system, bias compensation supported.

GYRO_X: Taking the car's moving direction to be X-Axis, Using the right-hand rule, placing the thumb forward, please estimate the direction the other four finger point (when rotates clockwise around the X-axis, is positive).

GYRO_Y: Taking the car's vertical moving direction to be Y-Axis, Using the right-hand rule, placing the thumb towards right, please estimate the direction the other four finger point (when rotates clockwise around the Y-axis, is positive).

GYRO_Z: Taking the direction at right angles to the horizontal line of the vehicle as the Z-axis, Using the right-hand rule, placing the thumb downward, please estimate the direction the other four finger point (when rotates clockwise around the Z-axis, is positive)

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
GYRO_X	8	16	Unsigned	Motorola	[-250, 250]	0.0076 293	-250	deg/s	D=N*0.0076 293-250
GYRO_Y	24	16	Unsigned	Motorola	[-250, 250]	0.0076 293	-250	deg/s	D=N*0.0076 293-250
GYRO_Z	40	16	Unsigned	Motorola	[-250, 250]	0.0076 293	-250	deg/s	D=N*0.0076 293-250

INS_HeadingPitchRoll(0x502), with the default being 100hz, the coordinate system being the shell coordinate system.

Pitch angle: when rotates clockwise around the Y-axis, is positive; Roll angle: rotates clockwise around the X-axis, is positive; rotates clockwise around the Z-axis, is positive. As is shown in Fig.33.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
Pitch	8	16	Unsigned	Motorola	[-90, 90]	0.010 986	-360	deg/s	D=N*0.0109 86-360
Roll	24	16	Unsigned	Motorola	[-90, 90]	0.010 986	-360	deg/s	D=N*0.0109 86-360
Heading	40	16	Unsigned	Motorola	[-180, 180]	0.010 986	-360	deg/s	D=N*0.0109 86-360

INS_HeightAndTime(0x503), the default being 100hz with a high altitude: The default output is the phase center height of primary antenna.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
High altitude	24	32	Unsigned	Motorola	[-10000, 10000]	0.0 01	- 100 00	m	D=N*0.001- 10000
Milliseconds in GPS week	56	32	Unsigned	Motorola	[0, 604799 999]	1	0	ms	D=N*1

INS_LatitudeLongitude(0x504), the default is 100hz.

The equipment has adopted the WGS84 Coordinated System, with the default output of latitude and longitude is the phase center position of the primary antenna;

Latitudes: Taking equator as 0°, when latitude is greater than 0°, it means northern hemisphere, otherwise is southern hemisphere;

Longitudes: Taking the prime meridian as 0°, Longitude greater than 0° is the Eastern Hemisphere, while the opposite is the Western Hemisphere.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
Latitude	24	32	Unsigned	Motorola	[-90,90]	1.00E-07	-180	deg	D=N*1e-7-180
Longitude	56	32	Unsigned	Motorola	[-180,180]	1.00E-07	-180	deg	D=N*1e-7-180

INS_Speed(0x505), the default is 100hz, Take the northward/eastward velocity as true north/east speed, and groundward velocity as downward speed.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Unit	Conversion
Northward velocity	8	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100
Eastward velocity	24	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100
Groundward velocity	40	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100

INS_Std(0x507), the default is 100hz.

NAME	Start Bit	Length Bit	Value Type	Byte Order	Range	factor	offset	Conversion
Latitudes Standard Deviation	8	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001
Longitudes Standard Deviation	24	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001
Altitude Standard	40	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001

d Deviation								
Heading standard deviation	56	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001

GNSS.UTC(0x508), the default is 5hz.

Note: GPS Time - leap second= UTC Time, currently leap second is 18s, UTC time is slower than GPS time by 18s.

NAME	Start Bit	Length Bit	ValueType	ByteOrder	Range	factor	offset	Conversion
UTC_year	0	8	Unsigned	Motorola	[2000,2255]	1	2000	D=N*1+2000
UTC_month	8	8	Unsigned	Motorola	[0,12]	1	0	D=N*1
UTC_day	16	8	Unsigned	Motorola	[0,31]	1	0	D=N*1
UTC_hour	24	8	Unsigned	Motorola	[0,24]	1	0	D=N*1
UTC_min	32	8	Unsigned	Motorola	[0,60]	1	0	D=N*1
UTC_sec	40	8	Unsigned	Motorola	[0,60]	1	0	D=N*1
UTC_msec	56	16	Unsigned	Motorola	[0,999]	0.001	0	D=N*0.001

INS_DataInfo(0x506), the default is 100hz.

NAME	StartBit	LengthBit	ValueType	ByteOrder	Conversion
GNSS positioning status	0	8	Unsigned	Motorola	0_NONE_无解 16_SINGLE_单点定位 17_PSRDIFF_伪距差分定位 32_L1_FLOAT_L1_浮点解 33_IONOFREE_FLOAT_电离层浮点解 34_NARROW_FLOAT_窄巷浮点解 48_L1_INT_L1_固定解 49_WIDE_INT_宽巷固定解 50_NARROW_INT_窄巷固定解
GNSS Satellite number	8	8	Unsigned	Motorola	D=N*1
GNSS orientation status	16	8	Unsigned	Motorola	0_NONE_无解 16_SINGLE_单点定位 17_PSRDIFF_伪距差分定位 32_L1_FLOAT_L1_浮点解

					33_IONOFREE_FLOAT_消电离层浮点解 34_NARROW_FLOAT_窄巷浮点解 48_L1_INT_L1_固定解 49_WIDE_INT_宽巷固定解 50_NARROW_INT_窄巷固定解
Differenti al delay (s)	24	8	Unsig ned	Motor ola	D=N*1
Vehicle wheel- speed marker position	32	8	Unsig ned	Motor ola	0_无轮速信息 1_有轮速信息
Integrated Navigatio n Status bits	40	8	Unsig ned	Motor ola	0_NONE1_姿态初始化（航向未初始化） 2_组合导航

The diagram of roll, pitch, and yaw Angles are as follows:

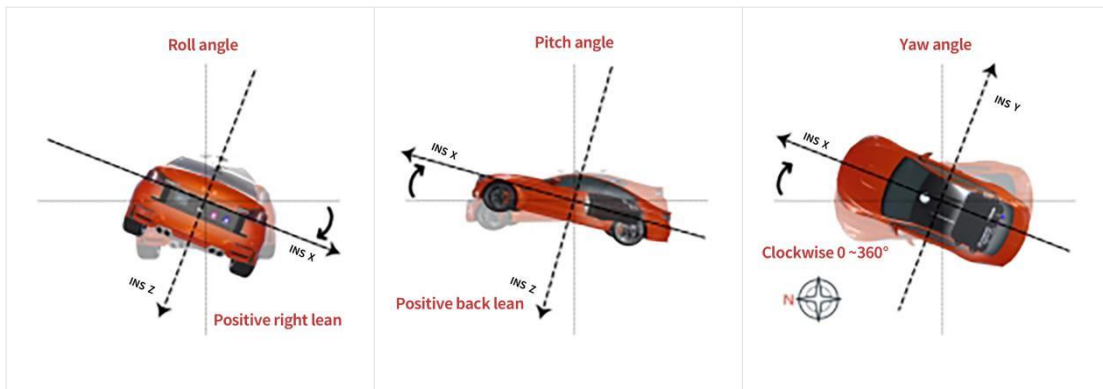


Fig. 33 Diagram of Roll, Pitch, and Yaw Angles

4.4 RTK Positioning Stats Diagram

Binary	ASCII	Descriptions
0	NONE	unsolvable
1	FIXEDPOS	The position is fixed by FIX POSITION command.
2	FIXEDHEIGHT	Not supported
8	DOPPLER_VELOCITY	The velocity is exported by real-time Doppler information.
16	SINGLE	Single Point:
17	PSRDIFF	Pseudo-range differential positioning
18	WAAS	SBAS positioning
32	L1_FLOAT	L1 floating solution
33	IONOFREE_FLOAT	Floating solution for mitigating ionospheric effects
34	NARROW_FLOAT	Narrow lane floating solution
48	L1_INT	L1 fixed solution
49	WIDE_INT	Wide lane fixed solution
50	NARROW_INT	Narrow land fixed solution

5 Use AT Commands to configure serial parameters

There're two ways to configure parameters, one is through PC computer, the other is through sending commands through serial port.

5.1 Configuration of the Primary Antenna Lever Arm

For example, configure the lever arm vector as X=1.2m, Y=0.2m, Z=-1.0m.

Command: AT+CLUB_VECTOR=1.2,0.2,-1.0\r\n

Response: GPS_POS_X=1.2,GPS_POS_Y=0.2,GPS_POS_Z=-1.0\r\n

Note: It is necessary to power off and restart after configuring and saving the commands.

AT+CLUB_VECTOR=2.5,-1.2,-1.5\r\n

5.2. Configuration of the Module Relative to the Rear Axle Center Lever Arm

For example, configure the lever arm vector as X=0.2m, Y=1.2m, Z=-1.0m.

Command: AT+OD_VECTOR=0.2,1.2,-1\r\n

Response: GPS_POS_X=0.2,GPS_POS_Y=1.2,GPS_POS_Z=-1\r\n

5.3 Configuration of Binary Data Stream

Command: AT+SETNAV\r\n

Response: OK\r\n

If configured to stop output,

Command: AT+SETNO\r\n

Response: OK\r\n

5.4 Configuration of Data Stream in NMEA Format

If the NEMA statement is configured for output, the 6.2 Integrated Navigation data stream will not be output.

If needed to switch to 5.2 Integrated Navigation data stream output, please stop the current data stream with 5.2 command.

NMEA protocol only supports Serial Port A output.

The configuration commands are as follows

GPGGA

Example: Output GPGGA at 5Hz Statement: AT+GPGGA=5\r\n

Response: OK\r\n

GPRMC

Example: Output GPRMC at 1Hz Statement: AT+GPRMC=1\r\n

Response: OK\r\n

GPHDT (Heading information)

Example: Output GPHDT at 1Hz Statement: AT+GPHDT= 1\r\n

Response: OK\r\n

GPVTG (Ground velocity information)

Example: Output GPVTG at 1Hz Statement: AT+GPVTG= 1\r\n

Response: OK\r\n

GPZDA (UTC time and date)

Example: Output GPZDA at 1Hz Statement: AT+GPZDA= 1\r\n

Response: OK\r\n

GPATT (Customized message)

Example: Output GPATT at 1Hz Statement: AT+GPATT= 1\r\n

Response: OK\r\n

GPYJ (Customized message)

Example: Output GPATT at 1Hz Statement: AT+GPYJ= 1\r\n

Response: OK\r\n

If the data output stops

Command: AT+SETNO\r\n

Response: OK\r\n

5.5 Stop Current Data Stream Output

Command: AT+SETNO\r\n

Response: OK\r\n

5.6 Configuration of the Integrated Navigation to Output Projection Points of Position and Velocity

If the Integrated navigation is configured to output projection points, the configuration command is:

Command: AT+PROJ_VECTOR=1.0,2.0,3.0\r\n

Response: PROJ_VECTOR_X=1.0, PROJ_VECTOR_Y=2.0, PROJ_VECTOR_Z=3.0/r/n

Explanation: The integrated navigation default output is the result of projection points of the antenna phase center. If other positions is needed, please configure their lever arm vectors, and the configuration method the same as 4.1 lever arm configuration.

Note: It is necessary to power off and restart after configuring and saving the commands.

5.7 Configuration of the Data Output Frequency

If the configuration data output frequency is 10Hz, the configuration command is:

100HZ Supported

Command: AT+OUTRATE=10\r\n

Response: OK\r\n

5.8 Configuration of RTK Dual Antenna Mounting Angle

If the RTK dual antenna mounting angle is configured to be 0°, the configuration command is:

Command: AT+RTK_ANGLE=0\r\n

Response: ANGLE=0\r\n

Explanation: Installation angle is the angle between the ray of the primary antenna pointing to the secondary antenna and the direction of the front end of the vehicle. Clockwise motion is positive, while counterclockwise motion is considered negative. The angle input range is -180° to 180°.

Note: After saving the configuration commands, power off and restart are necessary steps. The distance between the two antennas should be more than 50cm.

For specific angles, refer to the figure below.

Antennas: One in front and the other behind
Vertically installed
Main antenna at the rear

Antenna installation deviation angle (0°)



Antennas: One on the left and the other on the right
Horizontally installed
Main antenna on the left

Antenna installation deviation angle (90°)



Antennas: One in front and the other behind
Vertically installed
Main antenna at the front

Antenna installation deviation angle (180°)



Antennas: One on the left and the other on the right
Horizontally installed
Main antenna on the right

Antenna installation deviation angle (-90°)



5.9 Configuration of CAN Serial Baud Rate

The CAN interface default baud rate is 500k, if needed to change to other baud rate, please configure as follows:

Example: If configured the CAN serial baud rate to 250K, the command is:

Command: AT+CAN_BAUD=250

Response: OK

Note: It is necessary to power off and restart after configuring and saving the commands; currently only following baud rate is supported: 250k, 500k, 1M.

5.10 Open Position Smoothing

Note: If turned on, the trajectory will be smoothed if the signal is lost and then recovered, but if turned off, the trajectory will be quickly pulled back to the correct position in such a scenario and the trajectory will appear jagged.

Please turn on/off according to needs.

Command: AT+POS_SMOOTH=1\r\n

Response: OK\r\n

To close position smoothing:

Command: AT+POS_SMOOTH=0\r\n

Response: OK\r\n

5.11 Turn on the Low-speed Mode

Note: This mode is suitable for carriers that running at low speeds for long periods of time (speed lower than 20km/h), e.g. Automated Guided Vehicle(AGV)

Command: AT+LOW_SPEED_MODE=1\r\n

Response: OK\r\n

To close Low-speed Mode:

Command: AT+LOW_SPEED_MODE=0\r\n

Response: OK\r\n

5.12 Open the Dual Antenna Constraints

Note: When opened, dual antenna heading will be used in full scenario, otherwise it will only be used in static state.

Note: This mode is suitable for carriers that running at low speeds for long periods of time.

Command: AT+USE_GNSS_HEADING=1\r\n

Response: OK\r\n

To close dual antenna heading constraints:

Command: AT+USE_GNSS_HEADING=0\r\n

Response: OK\r\n

5.13 Adjustment of the Coordinate System

In using this module, if the X-axis direction is not pointing to the direction of the front of the car, the coordinate system can be adjusted according to the current installation mode by configuring the corresponding instructions through the serial port. After determining the installation mode, enter the corresponding instructions, and the configuration will return “OK” if it is successful, or “config failed” if not. After the configuration is successful, send the instructions to save it.

The default coordinate system: the Front-Right-Down system

- For a Front-Left-Up system, configure command: AT+IMU_AXIS_CONFIG=1
- For a Backward-Left-Up system, configure command: AT+IMU_AXIS_CONFIG=2
- For a Backward-Right-Up system, configure command: AT+IMU_AXIS_CONFIG=3
- For a Front-Right-Up system, configure command: AT+IMU_AXIS_CONFIG=4
- For a Front-Right-Down system, configure command: AT+IMU_AXIS_CONFIG=5
- For a Backward-Right-Down system, configure command: AT+IMU_AXIS_CONFIG=6
- For a Backward-Left-Down system, configure command: AT+IMU_AXIS_CONFIG=7

- For a Front-Left-Down system, configure command: AT+IMU_AXIS_CONFIG=8

Example: If setting the system to be Front-Left-Up, follow the instructions below:

Connect serial port RS232-B, Send command through serial port assistant:

AT+IMU_AXIS_CONFIG=1

[2024-10-28 04:47:12.578]TX: AT+IMU_AXIS_CONFIG=1

[2024-10-28 04:47:12.594]RX:
OK

串口选择

COM44: USB-SERIAL

波特率: 460800

停止位: 1

数据位: 8

校验位: None

串口操作: ● 关闭串口

保存窗口 清除接收

16进制显示 DTR

RTS 延时: 0

时间戳 1000 ms

单条发送 多条发送 协议传输 帮助

AT+IMU_AXIS_CONFIG=1

发送

Send the saving command after clicking return and OK:

[2024-10-28 04:48:08.040]TX: AT+SAVE

[2024-10-28 04:48:08.335]RX:
OK

串口选择

COM44: USB-SERIAL

波特率: 460800

停止位: 1

数据位: 8

校验位: None

串口操作: ● 关闭串口

保存窗口 清除接收

16进制显示 DTR

RTS 延时: 0

时间戳 1000 ms

单条发送 多条发送 协议传输 帮助

AT+SAVE

发送

Power off and reboot after clicking return and OK.

5.14 Print all Configuration Information

Command the following to show every configured information:

AT+CONFIG\r\n

5.15 Querying Version Numbers

Command: AT+VERSION\r\n

5.16 Calibration of Dual-Antenna Installation Angle

During calibration, the vehicle must maintain straight-line movement at a speed greater than 1 m/s.

Command: AT+EST_GNSS_ANGLE

Calibration successful. Serial port returns: "GNSS angle calibration is successful."

After successful calibration, the save command must be sent.

5.17 Save Parameters

Command: AT+SAVE\r\n

Response: OK\r\n

6 Use Network Port to Configure Parameters

6.1 Connecting PC software

The computer's IP address should be in the same network segment as that of NAV680D. The IP address of NAV680D can be found in update-config.

Note: If there is encryption software in the computer, it may affect the connection between the NAV680D and the computer's TCP.

Note: Don't unplug the network cable when using it, otherwise the IP configuration of NAV680D will disconnect which requires reboot to recover.

Note: If unable to set NAV680D's IP address through Ping, please first use the network cable to connect the module and the computer, then reboot NAV680D.

```

[EquipmentConfigInfo]
#差分账号配置
host=vrs.sixents.com
port=8002
mountpoint=RTCM32_GRECJ2
user=
password=
ip=192.168.10.111
netmask=255.255.255.0
gateway=192.168.10.1
    
```

config setting in NAV680D



编辑 IP 设置

手动

IPv4 开

IP 地址
192.168.10.112

子网掩码
255.255.255.0

网关

保存 取消

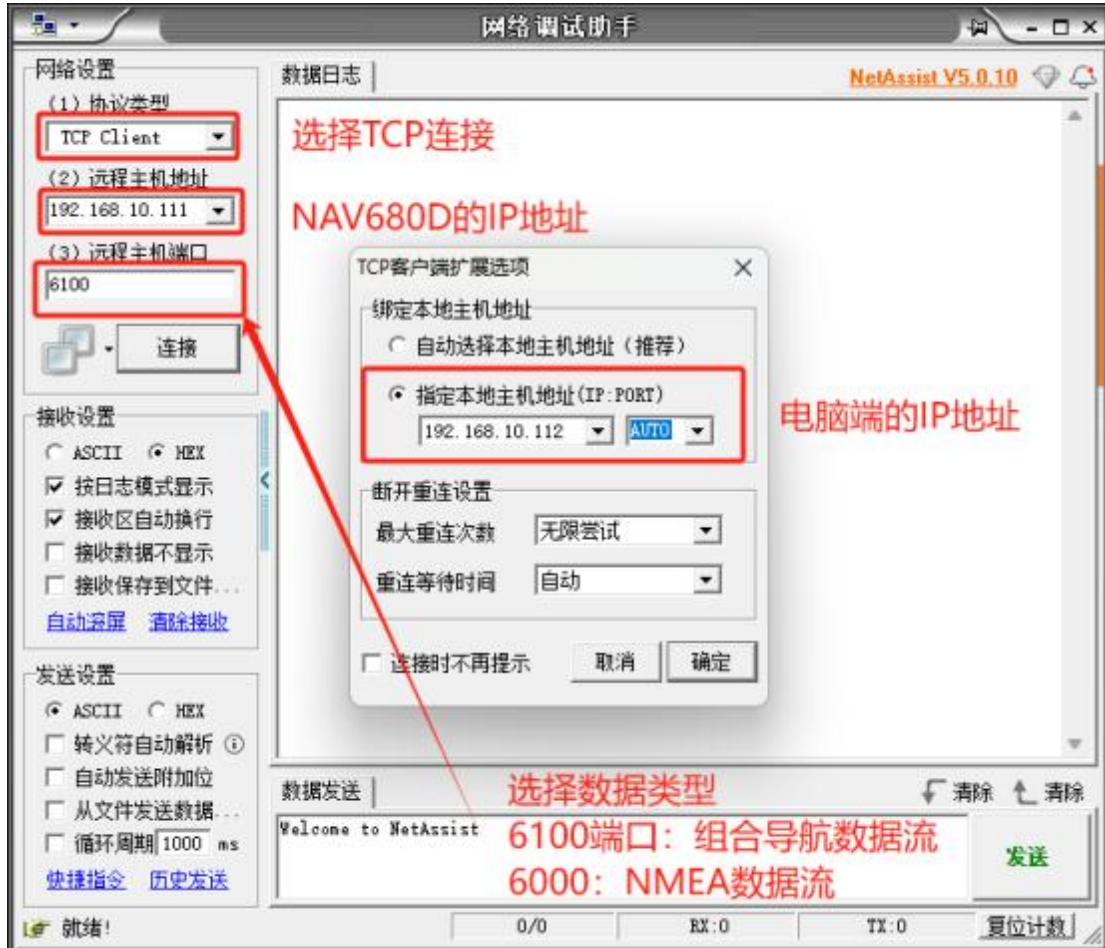
Configure PC IP

After opened PC software, please enter module's IP address in corresponding input box, click tcp to connect PC software.

6.2 Configure Output Integrated Navigation Data Stream

Note: Now only static ID is supported

Connect the network port to the serial port assistant, enter the corresponding IP address in the serial port assistant, port number 6100 is to output the combination of navigation data, port number 6000 is to output the NMEA data flow.



7 ROS Driver

Note: Please configure NAV680D output to be 0x166 data stream before use. For detailed operation, please refer to section 5.2 in this product sheet.

5.2 配置输出二进制数据流

指令 : AT+SETNAV\r\n

应答 : OK\r\n

The default output is 0x166 data stream, which can first configure and then save the parameters. For detailed operation, please refer to section 5.13 in this product sheet.

5.13 保存参数

指令 : AT+SAVE\r\n

应答 : OK\r\n

ROS driver download address: <https://data.forsense-imu.com/ProductFile/en/link/Upper%20computer%20software/NAV%20ROS2%20dirve/download.php>



7.1 Install ROS Serial

Install the ROS serial package. This routine relies on the serial package provided by ROS to realize serial communication.

First, execute the following command to download and install the serial package:

```
sudo apt-get install ros -melodic-serial
```

Then enter the roscd serial command to find the serial download location. If the installation is successful, the following message will appear:

```
/opt/ros/melodic/share/serial
```

7.2 Compile Code

```
cd NAV680D_ROS/
```

```
catkin_make
```

```
[ 10%] Generating Javascript code from forsense_ins/forsense_insData.msg
Scanning dependencies of target forsense_ins_generate_messages_eus
Scanning dependencies of target forsense_ins_generate_messages_py
[ 20%] Generating Lisp code from forsense_ins/forsense_insData.msg
[ 30%] Generating EusLisp code from forsense_ins/forsense_insData.msg
[ 40%] Generating Python from MSG forsense_ins/forsense_insData
[ 40%] Built target forsense_ins_generate_messages_nodejs
[ 50%] Generating EusLisp manifest code for forsense_ins
[ 50%] Built target forsense_ins_generate_messages_lisp
Scanning dependencies of target forsense_ins_generate_messages_cpp
[ 60%] Generating C++ code from forsense_ins/forsense_insData.msg
[ 70%] Generating Python msg __init__.py for forsense_ins
[ 70%] Built target forsense_ins_generate_messages_cpp
[ 70%] Built target forsense_ins_generate_messages_py
[ 70%] Built target forsense_ins_generate_messages_eus
Scanning dependencies of target forsense_ins_generate_messages
Scanning dependencies of target forsense_ins
[ 70%] Built target forsense_ins_generate_messages
[ 90%] Building CXX object CMakeFiles/forsense_ins.dir/serial_parse.cpp.o
[ 90%] Building CXX object CMakeFiles/forsense_ins.dir/forsense_ins.cpp.o
[100%] Linking CXX executable /home/wenfeng/nav619_ros1/devel/lib/forsense_ins/forsense_ins
[100%] Built target forsense_ins
wenfeng@ubuntu:~/nav619_ros1$
```

Compilation completed

7.3 Connect the IMU to Linux System via USB

Check if it is connected:

```
lsusb
```

```
wenfeng@ubuntu:~$ lsusb
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 005: ID 0403:6001 Future Technology Devices International, Ltd FT
32 USB-Serial (UART) IC
Bus 002 Device 004: ID 0e0f:0008 VMware, Inc.
Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 002 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
wenfeng@ubuntu:~$
```

Check the USB port number:

```
ls /dev/ttyU*
```

```
wenfeng@ubuntu:~$ ls /dev/ttyU*
/dev/ttyUSB0
wenfeng@ubuntu:~$
```

Turn on and configure USB to serial port privileges:

```
sudo chmod 777 /dev/ttyUSB0
```

7.4 Check Data

Execute roscore to start ROS

Go back to the serial_imu_ws folder and run

```
source devel/setup.bash
```

Start rosrn

```
roslaunch forsense_ins forsense_ins
```

```
wenfeng@ubuntu:~/nav619_ros1$ roslaunch forsense_ins forsense_ins  
[ INFO] [1695457979.128623440]: /dev/ttyUSB0 is opened.
```

Open a new window

```
source devel/setup.bash
```

```
rostopic list
```

```
wenfeng@ubuntu:~/nav619_ros1$ rostopic list  
/nav619Data  
/rosout  
/rosout_agg
```

Enter a command to view IMU data

```
rostopic echo /nav619Data
```

```
frame_id: "WGS84"  
itow: 549636980  
week_num: 2280  
lat: 312627286  
lon: 1216155393  
hgt: 38859  
vn: 0.00240602344275  
ve: 0.000262897461653  
vd: 0.00270945159718  
roll: -0.169113516808  
pitch: -0.286453634501  
yaw: 0.0  
rtk_yaw: 359.766906738  
wheel_angle: 0.0  
imu: [-0.005366197787225246, 0.0035326573997735977, -1.004271149635315, -0.04756  
217822432518, -0.11066819727420807, -0.06515973061323166, 35.8017578125]  
fix_type: 16  
sv_num: 28  
diff_age: 0  
heading_type: 0  
pos_acc: 0  
status: 3  
---
```

8 Frequent Questions

Question	Solution
Unable to connect PC software	Please check the following: whether the serial port is occupied and the product is properly powered up. If PC software is disconnected during the connection process, possible reason may be loose COM, solution is re-plug the serial cable and turn on PC software again.
Disconnect after running for a while after power up	Please check the following: 1. Supply voltage is between 9-32v; 2. Supply voltage is stable; 3. Serial port cable is solid connected without interruption.
Unable to resolute binary data installation protocol	After connecting to the PC software, confirm whether the data stream has been switched to the debug data stream and if the configuration save operation has been performed. Note: This data stream is not publicly available and is for debugging purposes only. It can only be decoded using Forsense's official MATLAB script or the data decoding page in the PC software. Please use AT commands to switch to the integrated navigation data stream or NMEA data stream.
No data output after configuring the integrated data stream.	Send the AT+CONFIG\r\n command to print the current configuration. Check if the data output frequency (OUTRATE) is set to 0 or -1. If so, resend the AT+OUT_RATE=100\r\n command to configure the output frequency, and send AT+SAVE\r\n to save the configuration so that it remains effective after device restart.
Unable to search stars	Please follow the steps to debug:1. It has to be an outdoor scenario, or an indoor scenario with a GPS signal interpolator;2. Please check if the primary antenna physical connection is normal;3. When physical connection of the secondary antenna is normal, connect the RTK serial port and input GNGGAH·1 to print the positioning information of the secondary antenna for comparison and confirmation. 2. If the secondary antenna positioning is normal, and the main antenna positioning is not normal, it means that the test environment and antenna power supply are normal. Then try to locate the main antenna and find out whether there is any problem in the physical connection of the main antenna, such as broken cables, etc.
Serial output data are all garbled/dots	Please make sure the baud rate are all round down. Here are the default baud rate in various interfaces:1. RS232-A 2. RS232-B 3. RS232-RTK 115200



<p>An error between CAN agreed elevation and reference value.</p>	<p>Currently there are two main elevation formats for navigation protocols, elevation and ellipsoidal height, CAN protocol outputs elevation data as elevation, confirm whether the reference value is elevation, if not please change the reference value output elevation to elevation.</p>
<p>Positioning status bit is always 1</p>	<p>If using the LAN port to connect to a computer or router for internet access to obtain differential data, check whether the differential account information and IP address in the config.ini file are correctly configured. If using the RTK-232 serial port for differential data injection, verify that the baud rate matches (the default for this port is 115200). Also, check whether the port is outputting GNGGA statements normally (by default, it should output; the differential server requires the device to send GGA statements to transmit differential data). If there is no output, enter the following commands in sequence to configure the RTK-232 serial port for statement output:</p> <pre style="text-align: center;">log gngga ontime 0.1 saveconfig</pre>
<p>Excessive deviation of the data trajectory</p>	<p>Please check the following:</p> <ol style="list-style-type: none"> 1. Please confirm whether the lever arm and dual-antenna deviation angle are configured correctly. 2. Whether the algorithm is initialized. Troubleshooting method: Observe if the initialization status in the status bits of the data stream protocol is 1. 3. In the case of dual-antenna connection, check whether the dual-antenna installation deviation angle is configured correctly. An incorrect dual-antenna installation deviation angle will lead to erroneous initial heading and cause abnormal trajectories.
<p>Unable to initialize</p>	<ol style="list-style-type: none"> 1. Confirm whether the positioning status has entered narrow-lane fixed solution. If it consistently fails to achieve narrow-lane fixed solution, move the vehicle to a more open area. 2. For a single antenna with an odometer connected, a driving speed greater than 2 m/s is required for initialization. 3. For a single antenna without an odometer connected, a driving speed greater than 5 m/s is required for initialization. 4. For dual antennas, both the positioning status and orientation status must simultaneously be in narrow-lane fixed solution and maintained for over 30 seconds to initialize.
<p>How to copy internal storage files</p>	<p>Please use type-C harness to connect OTG serial port, then the computer will show the corresponding virtual USB drive. Open it and the file is under the log folder, which is recorded in Beijing Time(BST). 1 Group contains 6 folders.</p>
<p>Dual antenna directional status can't reach 50</p>	<p>Please check the following:</p> <ol style="list-style-type: none"> 1. If directional status is always 0, please check if the secondary antenna is properly connected and if the antenna feeder is damaged. 2. If directional status is not 0 but can't reach 50, please check if the testing environment is open and if the distance between two antenna is over 50cm.

When connecting active antenna, the signal is normal; while connecting passive antenna, the signal can't be found.	The feeder of passive antenna can't exceed 1.5M
When connecting active power splitter (OPS), the antenna has a normal signal; while using the equipment to power the antenna, the signal can't be found.	Please check the following: 1. Whether the antenna's feed line is short-circuited; 2. Whether there's an abnormal power supply circuit caused by static electricity or other issue due to plugging and unplugging the antenna when powering-on. The current circuit design has already equipped with a fuse, and can be restored after re-powering up the antenna.
Serial Port packet loss	Please check the following: 1. The serial cable needs to support at least 460800 Baud Rates. 2. Computer's serial delay needs to be configured to 2ms
Trajectory convergence is not smooth when signal is restored after tunnel exit.	When the smoothing mode is off and the RTK has restored to fixed solution, it will quickly be pulled back to normal. To solve this issue, please turn on the smoothing mode or autopilot system to do the smoothing.
Large error with LIDAR trajectory	Please check the following: 1. If RTK fixed solution trajectory in the open scene can reach the centimeter level, it can be used as a reference to confirm whether it is the problem of LIDAR or the problem of integrated navigation.
Is it possible to synchronize the output of NMEA protocol and binary protocol?	No, only one of the protocols can be output at the same time.
The satellite number still exists after unplug the antenna.	The tracing ability of UM982 is rather strong, if there's signal source surrounds, it will continue to trace it through coupling. However, in actual satellite lockout scenario, the antenna is still in connection, the external signal can't enter, hence doesn't effect the usage.
When using a metal pot to cover the antenna to simulate loss of lock, the status is still fixed solution.	This is a wrong examine method because: The metal pot can only cover the signal from direct above, while lateral signal are reflected from the roof to the bottom of the lid and back to the antenna, causing false fixation.
ROS driver unable to read the data	The device has not configured with default power-on integrated data stream, the problem can be solved after the default power-on integrated data stream is configured.
Excessive attitude error with reference frame	Possible reasons may include: 1. Wrong configuration in lever arm and wheelbase, which unit has amplified by 10 times. 2. Please make sure if it's rigidly fixed. 3. Please make sure if it's away from strong vibrant source. 4. Course: Installation error exists in the case of dual antennas; confirm whether the dual antennas have been calibrated. 5. Roll Angle: Vehicle-mounted algorithms cannot estimate roll angle installation errors. When calculating roll angle errors, installation errors must generally be deducted. Typically, the mean error relative to the baseline after initialization under open-sky conditions is used as the installation error deduction.




<p>Fixed solution cannot be achieved when using Ethernet port for differential data.</p>	<p>Possible reasons may include:</p> <ol style="list-style-type: none"> 1. Incorrect configuration of differential account information. You can use the same account to verify on a computer using NTRIPClient software. 2. Whether the Ethernet port is provided with normal network connectivity requires using a router with routing functionality. 3. Whether there are permission settings on the router that prevent the NAV680D from accessing the network. 4. If the GGA positioning status is greater than or equal to 2, it indicates that differential data has been received. If a fixed solution cannot be achieved, it is typically due to satellite signal issues. If it cannot be fixed for more than 2 minutes, check if the environment has severe obstructions.
<p>Fixed solution cannot be achieved when using DTU connected to the RTK-232 port for differential data.</p>	<p>Possible reasons may include:</p> <ol style="list-style-type: none"> 1. Incorrect configuration of differential account information. You can use the same account to verify on a computer using NTRIPClient software. 2. Whether the DTU network is normal 3. The default baud rate for RTK-232 is typically 115200. Check whether the DTU's serial port baud rate matches. You can connect the RTK-232 serial port to a computer and use NTRIPClient software for comparative verification. 4. If the GGA positioning status is greater than or equal to 2, it indicates that differential data has been received. If a fixed solution cannot be achieved, it is typically due to satellite signal issues. If it cannot be fixed for more than 2 minutes, check if the environment has severe obstructions. 5. For some brands, such as eTung's DTU, the RX and TX of the 232 serial port need to be crossed. Confirm whether the connecting harness is straight-through (RX to RX, TX to TX) or crossed (RX to TX, TX to RX).
<p>After configuring the projection point, the position on the PC software debug data stream page shows no change.</p>	<p>The projection point configuration only takes effect for the serial port integrated navigation data stream, NMEA data stream, and CAN protocol. The debug data stream is for internal debugging use only, and the projection point does not take effect in it.</p>
<p>The network port cannot configure relevant parameters through commands.</p>	<p>The network port does not support command configuration, and only supports host computer configuration.</p>

9 Accessories

Standard accessories:

	
<p>Harness</p>	
	
<p>Primary antenna (for positioning)</p>	<p>Secondary antenna (for orientation)</p>
	
<p>Primary antenna connector</p>	<p>Secondary antenna connector</p>

Standard accessories:

	
<p>Type-C Cable</p>	<p>RS232 Serial Cable</p>
	
<p>OBD to DB9 harness (to connect odometer)</p>	

10 Revision History

Latest Manual Version: FSS-NAV680D_Datasheet_产品手册

Version	Date	Status/Notes
Version 1.0	01/20/2024	First release
Version 1.1	04/17/2024	Added the updating method of 6ul firmware
Version 1.2	07/18/2024	Added quickuse process and spreadsheet for frequent questions
Version 1.3	01/08/2025	Added GPYJ protocol