FORSENSE
原极科技

Dual-Antenna High-Precision Integrated Navigation System

NAV680D

Product manual



Forsense (Shanghai) Technology Co., Ltd

Please read this user manual carefully before using this product.

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Forsense (Shanghai) Technology Co., Ltd

1. Product Overview

1.1 Packing List

When you open the packaging box, please confirm the product in the packaging box:

Name	Quantity	Illustration
①NAV680DIntegrated Navigation System	1 pc	
②Satellite Antenna	2 pcs	
③Antenna Cable Primary antenna Model: TNC Male to FAKRA Female (Type C) (Blue) Secondary antenna Model: TNC Male to FAKRA Female (Type D) (Purple)	2 pcs	
④Antenna Suction Cup	2 pcs	
⑤Antenna Pole	2 pcs	
⑥Harness (including3 RS232, 2 CAN,1 PPS,1 Power Interface(9-24V).	1 pc	

Figure 1 Product Photo

If any items are missing, please contact the sales representative promptly

1.2 Product Introduction

NAV680D is a multi-sensor Integrated Navigation product launched by Forsense Technology, based on the Automotive Grade IMU platform and a full-system, all-frequency Dual antenna RTK.NAV680D Built-in high-precision IMU modules with Forsense, supports external odometer information, thereby providing accurate, continuous and real-time attitude, velocity and position information in scenarios such as urban canyons, tunnels and elevated roads.

Applications:

passenger vehicle, commercial vehicles, engineering vehicles, inspection vehicles and other high-precision scenarios



1.3 Product Features

(1) Built-in all-system all-frequency high-precision RTK board, supporting BDS B1/B2/B3 + GPS L1/L2/L5 + GLONASS L1/L2 + Galileo E1/E5b.

(2) High-precision IMU modules with built-in Forsense, through a sophisticated fusion algorithm and spatiotemporal synchronization mechanism,provides real-time accurate attitude/velocity/position information.

(3) SupportInternalStorageLog Data(2G Storage).

(4) Supports recording RTK raw observations and ephemeris.

Supports external odometer.

1.4 Product Specifications

1. Performance Specifications

RTK Specifications	**positioning accuracy (RMS)**	**Single point: 1.5 m RTK: Horizontal: 1 cm + 1 ppm Elevation: 2cm+1ppm**				
	Dual antenna Heading Accuracy (RMS)	0.1°/1m baseline				
	velocity accuracy (RMS)	0.03m/s				
	PPS Accuracy (RMS)	20ns				
	Update Rate	20hz				
	RTK initialize Time	<5s				
IMU Specifications	Gyro Range	±300°/s				
	Gyro Bias instability	XY:1.6deg/h Z:1.2deg/h				
	Gyro Random Walk	XY:0.09 °/√hr Z:0.1 °/√hr				
	Accelerometer Range	±6g				
	Accelerometer Bias instability	0.015mg				
	Update Rate	100Hz				
	Accelerometer Random Walk	0.035 m/s/√hr				
Integrated Navigation System Performance	GNSS pause time	Position Accuracy	Roll Accuracy	Pitch Accuracy	heading accuracy	velocity accuracy
		(2σ)	(2σ)	(2σ)	(2σ)	(2σ)
	0s	1cm	0.1°	0.1°	0.1°	0.02m/s
	60s (with wheel speed sensor integration)	2.0‰	0.15°	0.15°	0.15°	0.1m/s
Interfaces	3×RS232 (transmits Serial Port data stream) 2xCAN 1×LAN port 2×GNSS antenna interfaces 1×power interface 1×PPS interface					

2. ElectricalPhysicalCharacteristics

Parameter	Symbol	Min	Typical	Max	Unit
Power Input	VIN	9	12	24	V
Ground (GND)	GND				
Power Consumption	P	1.5	2	2.5	W
Operating Temperature (Tot)	T	-40	\	85	℃
Storage Temperature (Tstg)	T	-40	\	95	℃
Humidity	95% non-condensing				
Protection Rating	IP52				
Dimensions	116*85.9*32mm				
Weight	263g				

1.5 Structure and Dimensions

Dimensions are shown in the figure below.

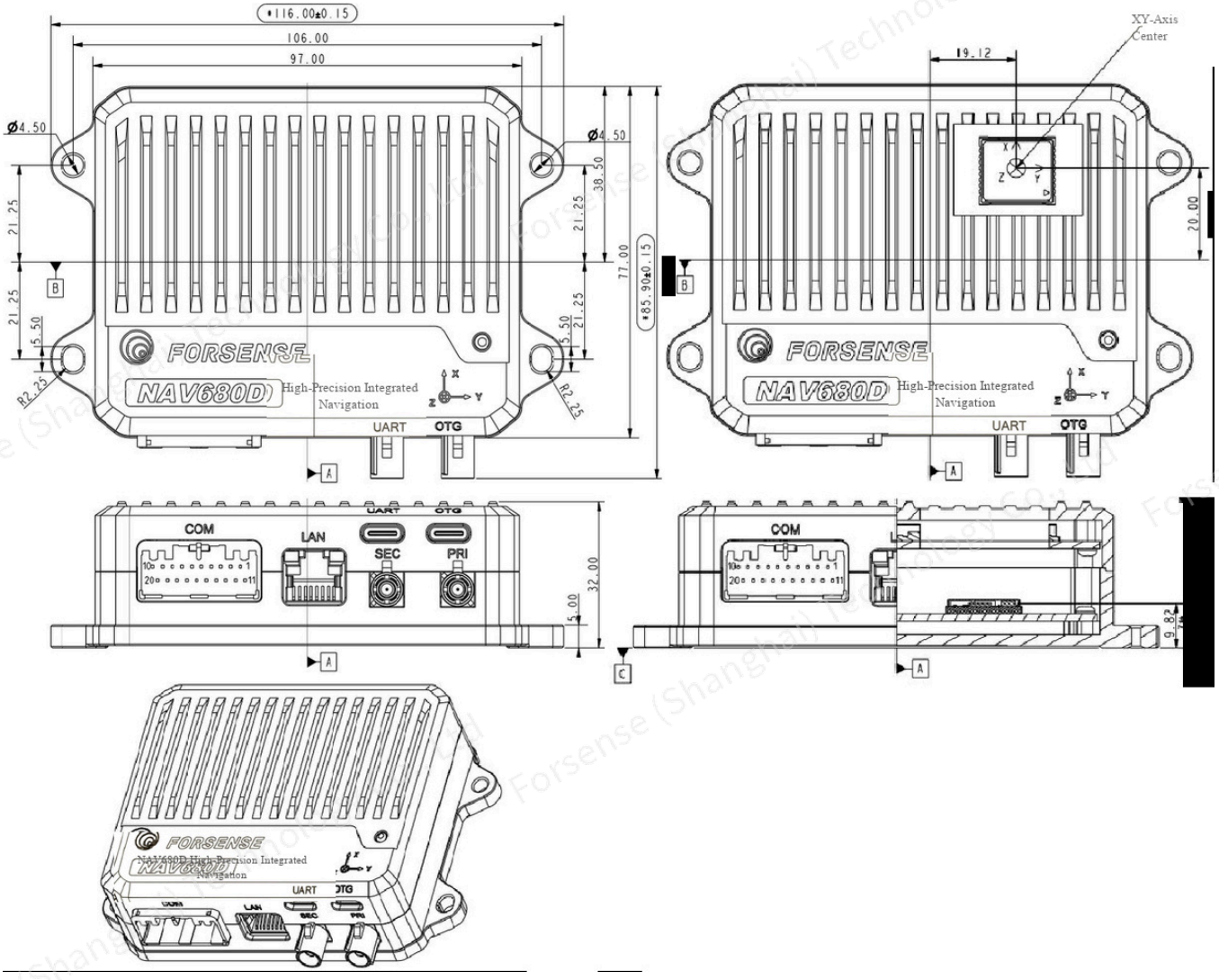


Figure 2NAV680DDimensions Diagram

1.6 Connector and Pin Definition

1.6.1 User Interface

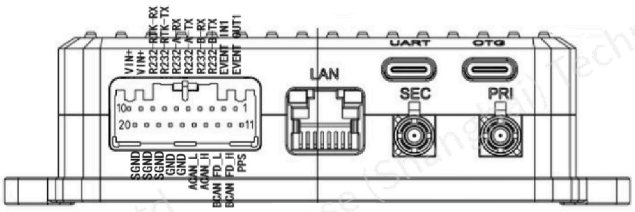


Diagram3 NAV680DFront Panel Diagram

NAV680DThe front panel has six ports in total, from left to right: COM port, LAN port, UART, SEC port, OTG, and PRI port.

COM: one power port, three RS232 ports, 2 CAN ports, and one PPS port;

LAN: network port;

UART: connect to Type-C;

SEC: connect to Secondary antenna;

OTG: connect to Type-C;

PRI: connect to Primary antenna.

The actual product is shown below, front view:



Figure15 Product Front View

The upper part of the front view isNAV680Dsix connectors.



Figure16 Product Top View

Top view, with the product name marked on the front faceNAV680D, and the X, Y, and Z coordinate axes are marked.

1.6.2 Data Cable Interface Definition

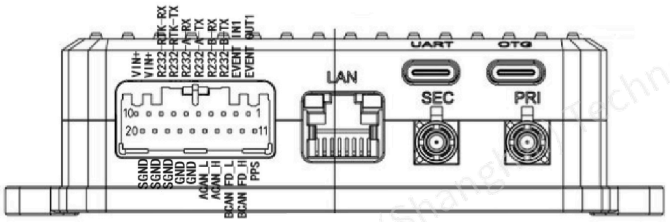


Figure4 Data Cable Interface Definition Diagram

The corresponding Pin definitions are as follows

PIN No.	Definition	Port
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+	Power Supply Positive 9-24V
10	VIN+	Power Supply Positive 9-24V
11	PPS	RTK PPS Signal
12	BCAN FD_H	CAN_FD B (Default standard CAN, baud rate 500k)
13	BCAN FD_L	
14	ACAN_H	CAN_ A (Default baud rate 500k)
15	ACAN_L	
16	GND	Ground (GND)
17	GND	
18	SGND	Signal Ground
19	SGND	
20	PGND	Shield Ground

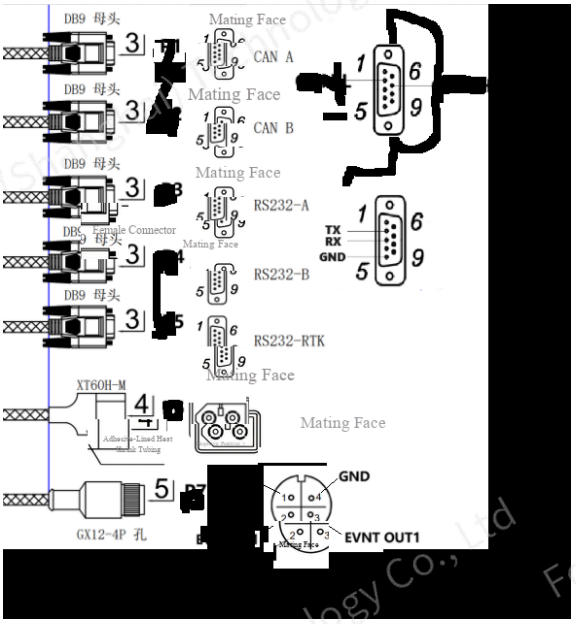
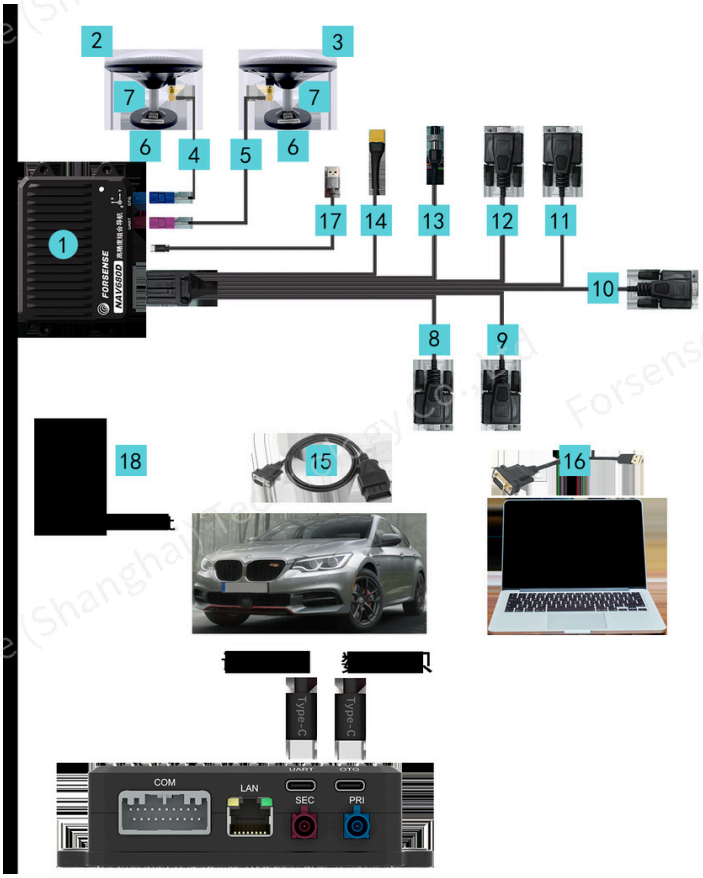


Figure5 Harness Definition



	Name	Quantity
1	NAV680-D Integrated Navigation System	1 pc
2	Primary antenna (positioning antenna)	1 pc
3	Secondary antenna (directional antenna)	1 pc
4	Primary antenna Cable	1 pc
5	Secondary antenna Cable	1 pc
6	Antenna Suction Cup	2 pcs
7	Antenna Pole	2 pcs
8	集线束-RS232-A接口	1 pc
9	集线束-RS232-B接口	1 pc
10	Harness - CAN A Interface	1 pc
11	Harness - CAN B Interface	1 pc
12	集线束-RS232-RTK接口	1 pc
13	Harness - I0 Interface	1 pc
14	Harness - Power Interface	1 pc
	Accessory Name	Quantity
15	OBD转DB9线	1 pc
16	RS232转USB串口线	1 pc
17	Type-C线	1 pc
18	RTK Service Account	Client Procurement

Figure6 Physical Connection Diagram

Descriptions of each interface of the harness:

P2: CAN A interface: Input vehicle signals (wheel speed, gear position, etc.), Motorola mode

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

P4: RS232-A Interface: The default baud rate is 460800; Parameter configuration can be performed using AT commands; outputs NMEA protocol

P5: RS232-B Interface: The default baud rate is 460800; PC software can be used for connection, and Parameter configuration can be performed using AT commands; outputs Integrated Navigation binary protocol

P6: RS232-RTK Interface: The default baud rate is 115200; feeds in differential data and upgrades the satellite navigation module

P7: Power Interface: 9-24V power supply

P8: PPS Interface: outputs PPS pulses, default Rising Edge trigger, amplitude 3.3V, period 1S

1.7 LED Indicator Signals

You can useLED indicationsto determine the device status; the LED indications are as follows:

Green LED flashes at 1Hz, no positioning.

Green LED flashes at 2Hz, positioning status is 1.

Green LED flashes at 5Hz, positioning status is 2.

Green LED flashes at 10Hz, positioning status is 5.

Green LED constantly on, positioning status is 4.

Red LED constantly on, SD card capacity less than 20%.

2. Basic Usage Example

This chapter provides basic usage examples for the 680D device. Follow the steps in this chapter in sequence to quickly set up the operating environment.

2.1 Equipment Installation

2.1.1 Antenna Installation

1. Installation Requirements

1) single antenna Installation. It needs to be installed on a carrier and connected to Integrated Navigation. The satellite antenna should face the sky, and the carrier should not obstruct the antenna. The antenna is connected to the PRI interface shown in Figure 24 for positioning. The installation diagram is shown in Figure 20;

2) Dual antenna installation. If the Dual antenna direction finding function is required, you need to install two antennas (primary and Secondary antenna) on the vehicle and connect Integrated Navigation; the satellite antennas must face the sky and the vehicle must not block the antennas. Connect Primary antenna to PRI for positioning, and connect Secondary antenna to the SEC interface shown in Figure 21 for direction finding. The distance between the two antennas, that is, the baseline length, must be greater than 0.5 m, and the Dual antenna heights should be kept as consistent as possible. The installation diagram is shown in Figure 21;

Note: After connection, you can confirm the Dual antenna angle in the following ways

Primary antenna: After blocking Primary antenna or disconnecting Primary antenna, the positioning status becomes 0, and the latitude and longitude are lost

(In a strong-signal environment such as with a GPS signal repeater, unplugging Primary antenna may cause signal tracking, resulting in satellites still being visible; in this case, restart the device and check again.)

Secondary antenna: In an outdoor open environment, Orientation status is greater than 0 (typically 34 or 50) before obstruction or disconnection; after obstruction or disconnection, Orientation status becomes 0

3) Keep away from interference sources such as vehicle electrical devices or systems that may generate electromagnetic interference signals;

4) Screw the GNSS antenna onto the strong magnetic mount and fix it at the center of the test carrier; place it as high as possible on the test carrier to ensure good GNSS signal reception;

5) To obtain the best performance, minimize the distance between the GNSS Primary antenna and the device Master, especially the horizontal distance.

2. Installation Diagram



Figure7 single antenna Installation Diagram



Figure8Dual antenna Installation Diagram

2.1.2 Equipment Installation

1. Installation Requirements

1) The product mounting surface should be flat, rigidly connected to the vehicle body, installed horizontally, and must not easily become loose or wobble;

2) The installation location must be away from vibration sources, such as the engine, air conditioning compressor, etc.;

3) The product should be installed away from electromagnetic interference (EMI) equipment such as motors and cameras to reduce electromagnetic interference;

4) Mounting Recommendation: Secure with bolts and nuts. After the product installation and calibration are completed, do not remove or move the product; if moved, reinstallation and calibration are required.

2. Installation Diagram

The coordinate system plane marked on the Master nameplate should be as parallel as possible to the measured reference plane of the carrier. The X axis should be parallel to the central axis of the carrier's forward direction. The installation diagram is shown below, where positive X points toward the front of the vehicle, positive Y points to the right side of the vehicle body, and positive Z points toward the center of the Earth.



Figure9 Master Schematic Diagram

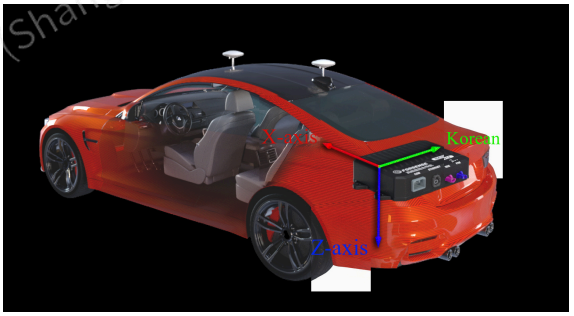


Figure10 Coordinate System Diagram

2.1.3 Removal and Installation Requirements

1. When installing the antenna feeder interface, insert the terminal in parallel; once the clip makes a "click" sound, it is properly installed.

2. When unplugging the antenna feeder connector, press down on the position shown in the red box in the figure, and then pull the terminal out in parallel.

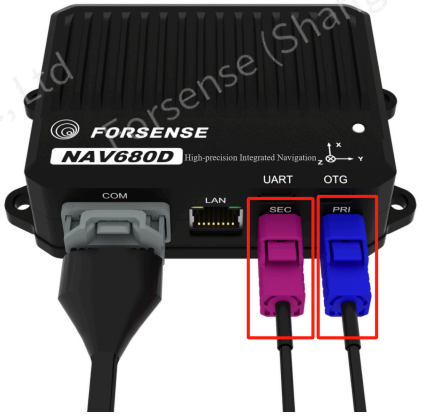


Figure11 Antenna feeder Plug and Unplug Diagram

2.2 PC software Download

The PC software software download address is:

https://data.forsense-imu.com/page/download.html

Figure 2 isNAV680DPC software software requires no installation; double-click to use. For usage, refer to Section 3, PC software Usage.



Figure12 PC software Software Diagram

2.3 Differential Data Acquisition

This product supports two ways to obtain differential data.

1. Differential data is directly fed in from an external source through the DTU or directly from a computer via RTK-232 Serial Port.

2. Connect to a router via the LAN port to access the Internet. After configuring the differential account information and IP address information, the built-in NTRIP program directly obtains differential data via the Internet..

The specific methods are as follows.

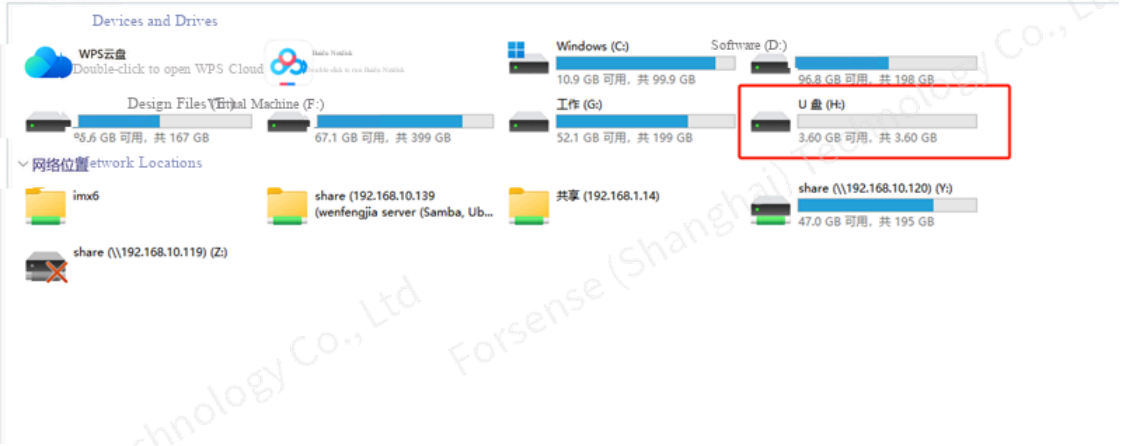
2.3.1 Connect the router via the LAN port to access the InternetObtain differential data

Note: Currently only static ID is supported.

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

2.3.1.1 Modify the internal storage CONFIG file configuration.

Configure differential account information and IP,Connect the computer using TYEP-COTGPort, find updateFolder



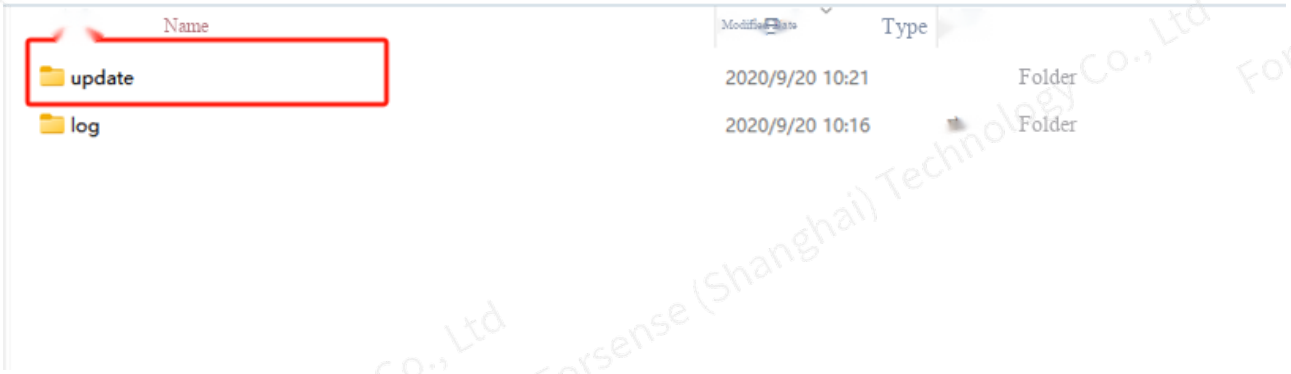


Figure13 updateFolder

Open the config.ini file.

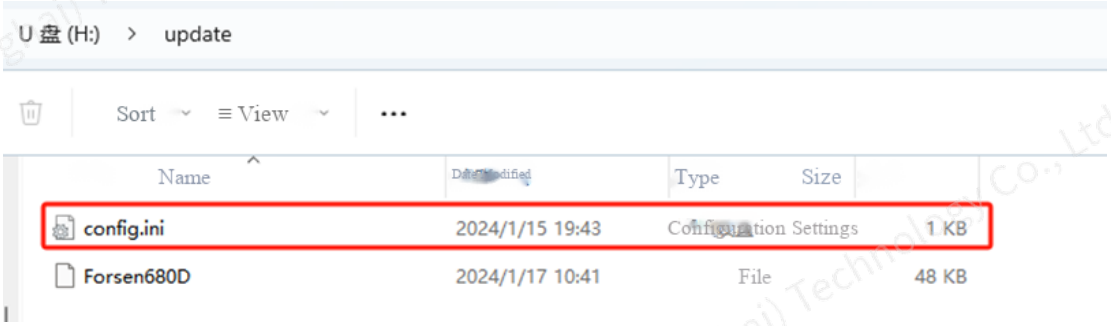


Figure14 config.ini file

Configure the following information.



Figure15 Configuration Information

Save the configuration,Wait 30 s to restartNAV680D, at this point the differential accountand IP addresstake effect.

Note: You can connect PC software via the Ethernet port and read the network Parameter configuration to confirm whether the configuration is successful.

2.3.1.2 Viathe Ethernet port, connect PC software to performconfiguration

For detailed methods, refer to Chapter 6. Use the network port to configure Parameter.

2.3.2 Directly input differential data from an external source.

Use a DTU, computer, or other device via RTK-232 Serial PortInputDifferential data, default baud rate 115200, Serial Port outputs GNGGA sentence by default.

2.4 Basic Parameter Configuration

First-Time UseNAV680DYou need to performthe following basic Parameter configuration.

1.Primary antennalever arm, rear axle center lever arm,

2.Dual antenna installation angle (must be configured when using Dual antenna),

3. Low-speed mode (applicable to carriers with a maximum speed not exceeding 20 km/h; enable it if so, otherwise leave it disabled),

4. Smoothing mode (depends on usage requirements; for example, when exiting a tunnel, disable it if the trajectory needs to be pulled to the correct position quickly, and enable it if the trajectory needs to be smoothed to the correct position),

5.Dual antenna Fusion Configuration (configure as needed; applicable to low-speed carriers; when enabled, Dual antenna is used throughout; when disabled, it is used only when stationary),

2.4.1 Set Lever Arm Parameter

2.4.1.1 Primary antenna Lever Arm Setting

The Primary antenna lever arm Parameter is the three-dimensional vector (x,y,z) of the Primary antenna phase center's position relative to the device center, in meters.

Along the X/Y/Z axes of the overall unit coordinate system, measure the distance from the antenna center to the device center,

Obtain the three values X1 Offset/Y1 Offset/Z1 Offset, and note the sign.

Confirmation of positive/negative (front-right-down coordinate system):

If RTK Primary antenna is in front of the device, it is positive; otherwise, it is negative;

If RTK Primary antenna is to the right of the device, it is positive; otherwise, it is negative;

If the RTK Primary antenna is above the device, it is**a negative number**, otherwise it is a positive number (the antenna is generally above the device).

Forward-Right-DownThe coordinate system schematic is shown below.



Figure16 Coordinate System Diagram

Example:If the RTK Primary antenna is 0.9 m in front of the device, 0.4 m to its right, and 1.2 m above it, thenThe XYZ values are: X:0.9;Y: 0.4;Z:-1.2

then configure it as: (0.9,0.4,-1.2)

If using AT commands, configure it as: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 using PC software, configure it as shown in Figure 27

1. Install and configure the device, antenna, and differential data properly.

2. OpenNAV680DPC software, on the IMU settings page set in PC software Parameter, click Refresh, fill in the measured lever arm values, and after clicking Set a pop-up window will appear. Click OK, then click Refresh again to confirm that the entered Parameter is correct. After confirmation, power off and restart, then reconnect to PC software.

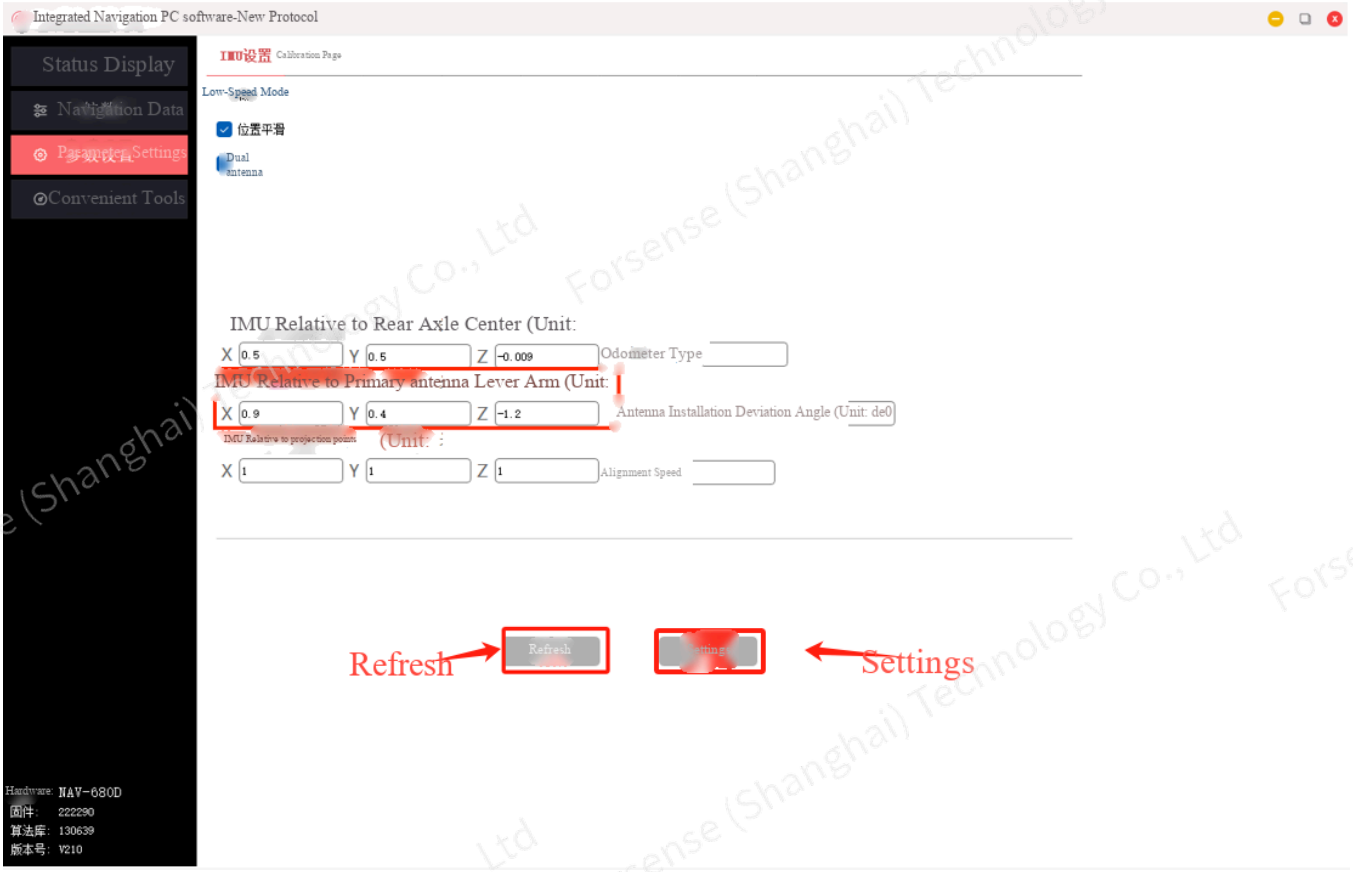


Figure17 Lever Arm Configuration Page

2.4.1.2 Device-to-Rear Axle Center Lever Arm Settings

Device-to-Rear Axle Center Lever Arm, same as the Primary antenna lever arm measurement method; measure the three-dimensional vector distance (x, y, z) from the vehicle rear axle center to the device center position, in meters.

If the rear axle center is in front of the device, it is positive; otherwise, it is negative;

If the rear axle center is to the right of the device, it is positive; otherwise, it is negative;

If the rear axle center is on the device'slowerside, it is positive; otherwise it is negative (generally the rear axle center is below the device).

The coordinate system diagram is shown below.

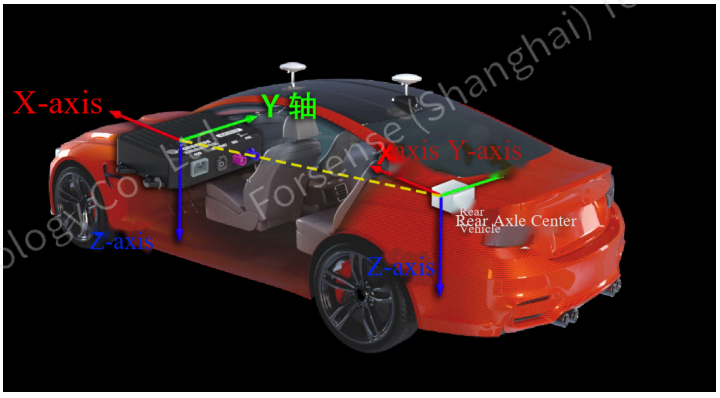


Figure18 Coordinate System Diagram

Example: If the rear axle center is 0.3 m behind the device, 0.4 m to its right, and 1.2 m below it, the XYZ values are as follows: X:-0.3; Y: 0.4; Z:1.2

If AT commands are used, configure as: AT+OD_VECTOR=-0.3,0.4,1.2\r\n

Response: OD_POS_X=-0.3,GPS_POS_Y=0.4,GPS_POS_Z=1.2/r/n

such aswhatUse PC software:

Open PC software. On the IMU Settings page under PC software Parameter Settings, click Refresh, enter the measured rear axle center lever arm values, and click Set. After clicking Set, a pop-up window will appear. Click OK, then click Refresh to confirm the entered Parameter is correct. After confirmation, power off and restart, reconnect to PC software, and click Refresh again to confirm whether the read-back Parameter matches the configured Parameter. If yes, the configuration is successful.



Figure19 Lever Arm Settings

2.4.1.3 Configure the RTK Dual antenna Installation Angle

If single antenna is connected, no configuration is required;

If Dual antenna is connected, measure the angle between the ray from Primary antenna to Secondary antenna and the vehicle front direction; clockwise is positive and counterclockwise is negative, in degrees. Refer to the figure below for the installation method and corresponding angle.



If the RTK Dual antenna installation angle is configured to 90 degrees,

If AT commands are used, the configuration command is:

Command: AT+RTK_ANGLE=90\r\n

Response: ANGLE=0\r\n

Note: After the configuration command is saved, a power cycle is required for it to take effect; the spacing between Dual antenna must be greater than 50cm

If configuring with PC software, open PC software, go to the IMU settings page set in PC software Parameter, click Refresh, fill the measured Dual antenna angle into the red box, click Set and a pop-up will appear; after clicking OK, click Refresh to confirm the entered Parameter is correct; after confirmation, power off and restart, reconnect PC software and click Refresh again to check whether the read Parameter matches the configured Parameter; if yes, the configuration is successful.



2.4.2 Enable Position Smoothing

Note: If enabled, after signal recovery following loss of lock, the trajectory will be smoothed; if disabled, in this scenario it will quickly pull back to the correct position, and the trajectory will appear jagged. Please configure according to specific requirements.

Please select enable or disable as required.

Command: AT+POS_SMOOTH=1\r\n

Response: OK\r\n

If the position smoothing function is disabled:

Command: AT+POS_SMOOTH=0\r\n

Response: OK

2.4.3 Enable Low-Speed Mode

Note:Applicable to carriers operating at low speed for long periods(below 20KM/H), e.g., unmanned vehicle

Command: AT+LOW_SPEED_MODE=1\r\n

Response: OK\r\n

To disable low-speed mode:

Command: AT+LOW_SPEED_MODE=0\r\n

Response: OK\r\n

2.4.4 Enabling Dual antenna heading constraint

Note: When enabled, Dual antenna heading is used in all scenarios; when disabled, Dual antenna heading is used only when stationary

Command: AT+USE_GNSS_HEADING=1\r\n

Response: OK\r\n

If Dual antenna heading constraint is disabled

Command: AT+USE_GNSS_HEADING=0\r\n

Response: OK\r\n

2.4.5 Lever Arm Calibration

After the lever arm configuration is complete,The Primary antenna lever arm must be calibrated to reduce measurement errors and improve positioning accuracy,

Note: Lever arm calibration is optimized for manual measurement. Make the manual measurement data as accurate as possible, with the error controlled within 8cm; otherwise, calibration accuracy cannot be guaranteed.

If the lever arm data is not from manual measurement but from the vehicle model 3D data diagram (both the Primary antenna position and the Integrated Navigation position are confirmed), lever arm calibration is not required.

Once configured, calibration can begin,If the product and antenna installation positions do not change afterward, calibration only needs to be performed once.

The calibration procedure is as follows

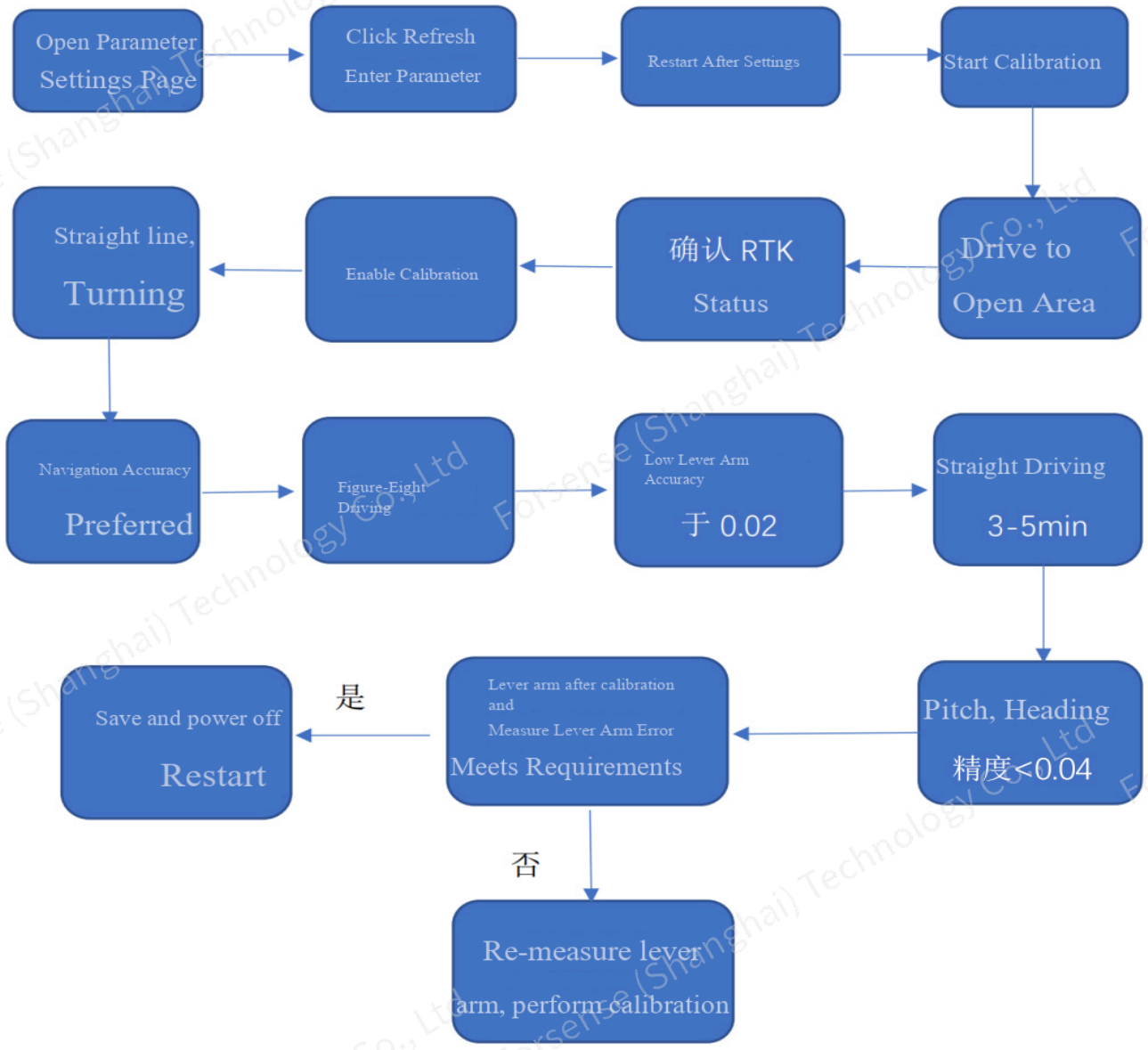


Figure 20Calibration Flowchart

The steps are as follows:

1. Drive the vehicle toan openarea, openNAV680DPC software, and switch to the Navigation Data page.

As shown in the figure below, 3 conditions must be met

- The RTK status must befixed solutionstatus, i.e.:Narrow-lane fixation
- The number of satellites is 30 or more

- differential delay should be as small as possible (less than 5)

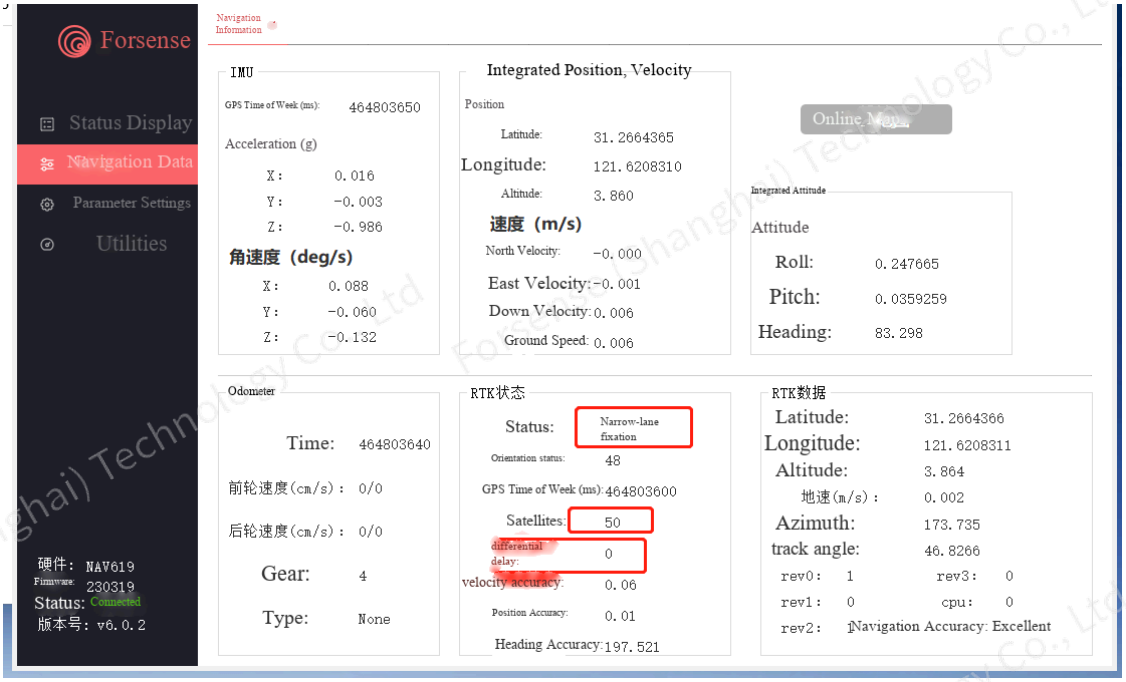


Figure21 Navigation Data page

2. After all the above conditions are met, open the calibration page in PC software Parameter settings and click to enable calibration, as shown in the figure below.

Start driving. Drive straight for more than 150 m at a speed above 40 km/h, then make a U-turn or turn, and drive straight for more than 150 m at a speed above 40 km/h. At this point, check whether the navigation accuracy in Parameter settings is Good. If it is Good, proceed to the next step; otherwise, continue driving straight until the navigation accuracy is Good.

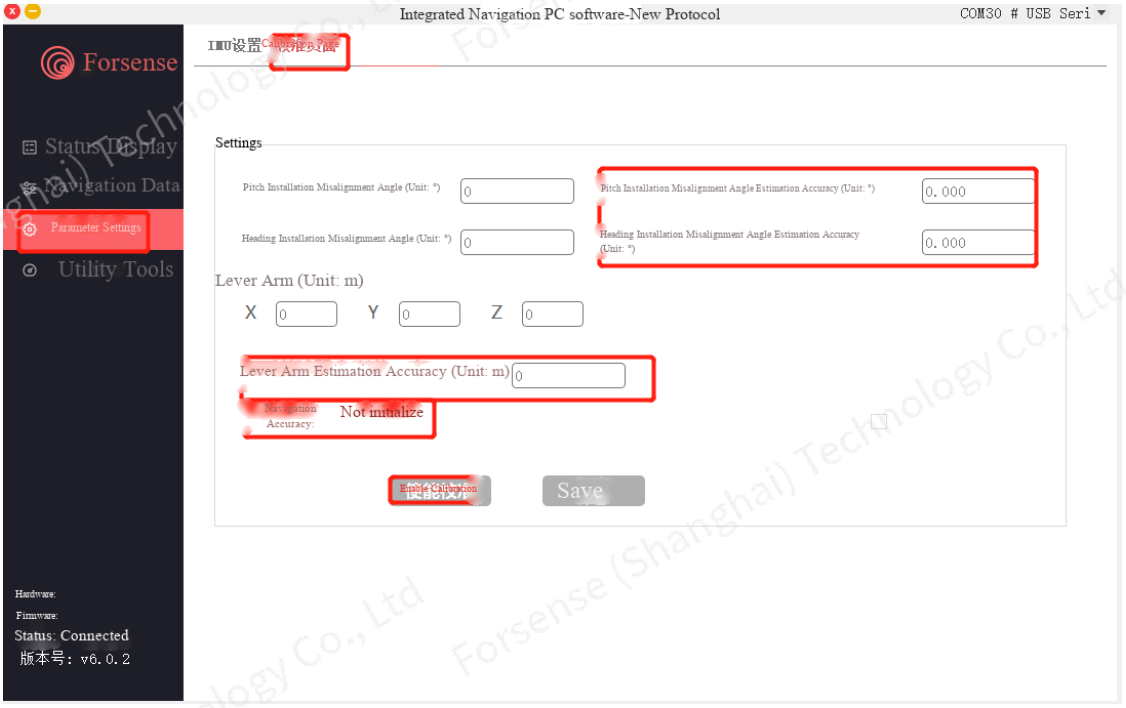
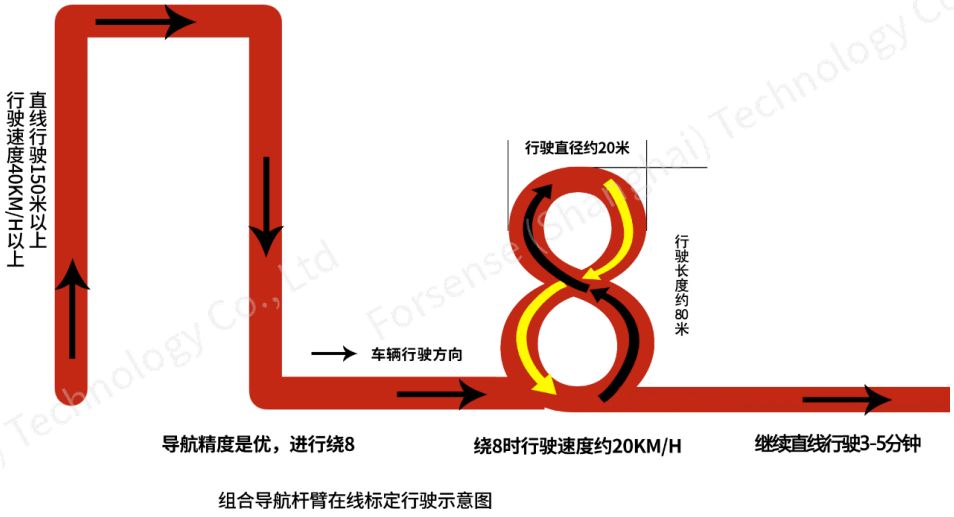


Figure22 Calibration Page

After the navigation accuracy is excellent, drive the vehicle in a figure-eight pattern, asFigure32shown. At this time, check the lever arm estimation accuracy in the figure above. When the lever arm estimation accuracy is less than 0.02, drive the vehicle straight in an open area for 3-5 minutes until both the Pitch angle installation misalignment angle estimation accuracy and the heading installation misalignment angle estimation accuracy are less than 0.04. At this point, the lever arm calibration is complete.

ViewFigure31The lever arm value on the page shown. If the difference from the manually measured result is within 5 cm, click Save, then power on again; if the difference exceeds 5 cm, recalibrate until the difference between the calibration result and the measurement result is within 5 cm.



组合导航杆臂在线标定行驶示意图

Figure23 Vehicle Driving Schematic Diagram

3. PC softwareSoftware Download and Usage

3.1 Software Download

The software download address of PC software is:

https://data.forsense-imu.com/page/download.html

Figure 2 showsNAV680DPC software software requires no installation; double-click to use.



Figure24 PC software Software Diagram

Note: After connecting PC software, Serial Port automatically switches the log data stream. The protocol of this data stream is not externally open and must be decoded using the MATLAB decoding script provided on the Forsense official website, as shown in Figure 5, link:

https://data.forsense-imu.com/page/download.html



Figure25 Log Data Stream Decoding Script

3.2 NAV680DPC software Usage

3.2.1 PC softwareConnect

Figure 4 shows the page display when PC software is first opened

At position 1, select Serial Port number, and connect using a USB-to-RS232 Serial Port cableNAV680D, and supplyNAV680Dcorrect power, then the Serial Port number will be displayed;

Click at position 2 to connect;

Function selection at position 3, where the status display function is not supported yet;

Position 4 shows the connected hardware name, the corresponding firmware version number, the connection status (offline/connected), and the PC software version number.



Figure26 PC software Display Page Diagram

3.2.2 Navigation Data Page

The navigation data interface is shown in Figure 6 , displaying IMU, Integrated Navigation position/velocity/attitude, RTK status/data information; after the odometer is connected, odometer information is displayed; the online map function is not currently supported.

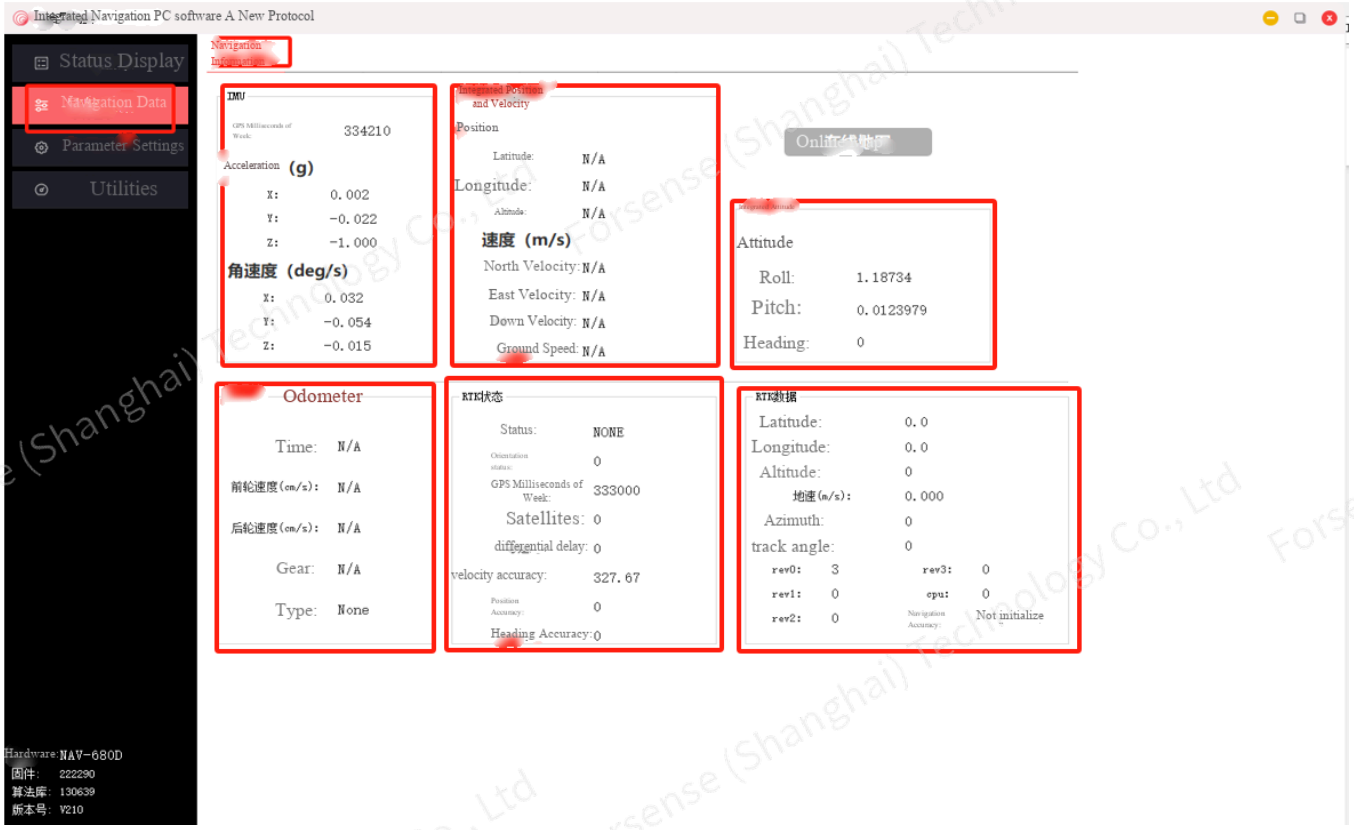


Figure27 Navigation Data Page Diagram

3.2.3 Parameter Settings Page

The Primary antenna lever arm measurement is performed by takingNAV680Dthe center of Master as the coordinate origin and establishing a three-axis coordinate system, with the positive X-axis pointing to the front of the vehicle, the positive Y-axis pointing to the right side of the vehicle body, and the positive Z-axis pointing to Earth's center, and using a tool to accurately measure the distance from the Primary antenna phase center projection points to the coordinate origin along the X, Y, and Z axes, in units of:meters.

3.2.3.1 Set Rear Axle Center Lever Arm

Device-to-rear-axle-center lever arm: using the same lever arm measurement method as Primary antenna, measure the three-dimensional vector distance (x, y, z) from the vehicle rear axle center to the device center, with the unit of:meters.

3.2.3.2 Dual antenna Installation Misalignment Angle Settings

If single antenna is connected, set it to 0 here; if Dual antenna is connected, measure the angle between the ray from Primary antenna to Secondary antenna and the vehicle head direction, with clockwise as positive,counterclockwise as negative, in degrees. As shown in Figure 7, the left-side installation is +90°, and the right-side installation is 0°.



Figure28 Dual antenna Installation Diagram

Definition of deviation angle: With the position of Primary antenna as the center and the direction of Secondary antenna as the radius, draw an arc. The directly forward direction is defined as the 0-degree reference direction. The angle between Secondary antenna and this reference direction is the installation deviation angle.

3.2.3.3 projection points Lever Arm

The latitude and longitude coordinates output by default by this product are the latitude and longitude coordinates of the position of Primary antenna. If the latitude and longitude coordinates need to be changed to the coordinates of another position on the vehicle body, this can be achieved by setting the projection points lever arm.

projection points lever arm, using the same lever arm measurement method as Primary antenna, measure the three-dimensional vector distance (x,y,z) from projection points to the device center, in units of:meters.

Before setting all Parameter, click Refresh, then fill in the corresponding Parameter and position reference selection, as shown in Figure 6, and then click Set. After the setting is completed, a setting success pop-up prompt will appear.

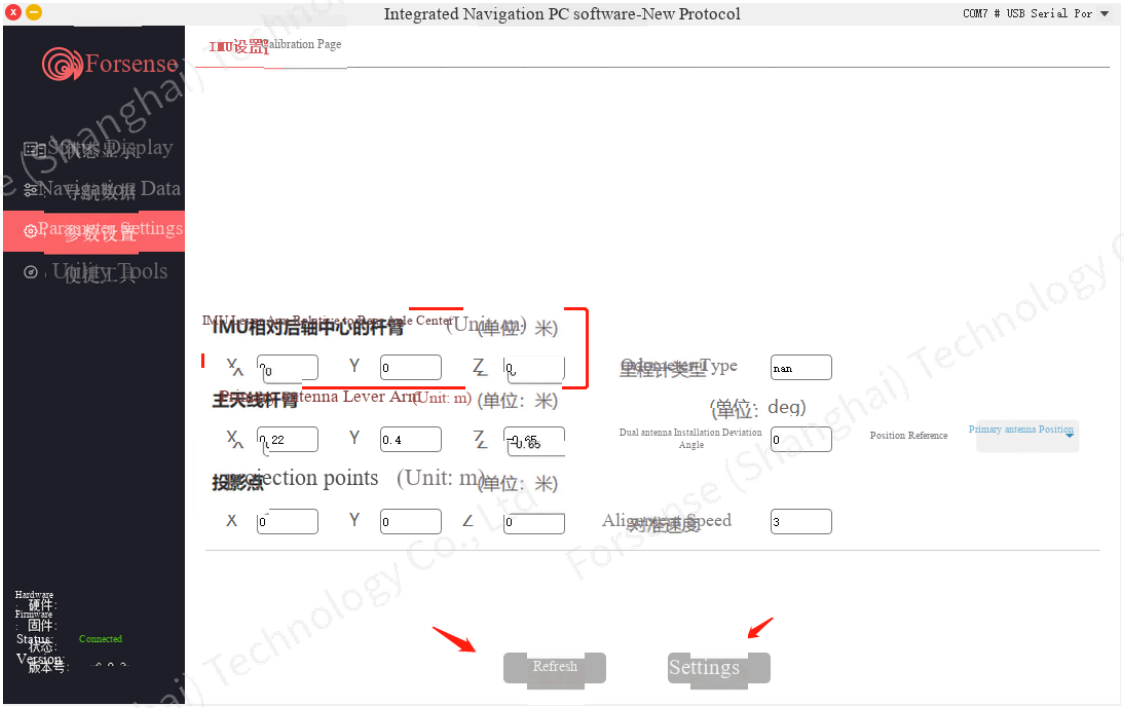


Figure29 IMU Settings Page Diagram

2. Calibration Page

The calibration page is shown in the figure below. This page is required when performing lever arm calibration. For the specific procedure, refer to Section 4.2 Lever Arm Calibration.

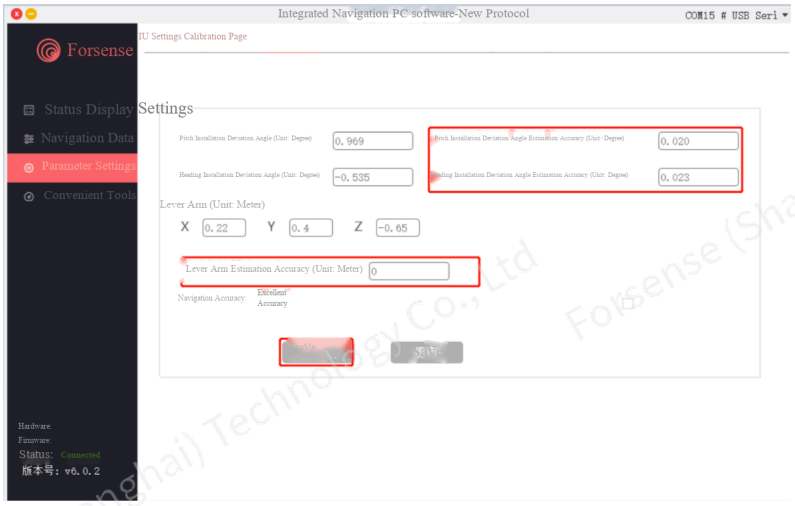


Figure30 Calibration Page Schematic

3.2.3.4 Firmware Update

3.2.4 Upgrade Integrated Navigation algorithm via PC software

Firmware can be upgraded on the Convenient Tools page. Click "Open File", select the firmware to be upgraded, and click "Upgrade". Do not power off during the upgrade. After a successful upgrade, back up the firmware. Power off and restart, wait 10S, then connect to PC software.



Figure31 Convenient Tools Page

3.2.4.1 Via OTG InterfaceUpgradeFirmware

Currently, the firmware has two upgrade packages,

"Forsen680D"The file name starts with the internal storage and network port driver runtime firmware,

"NAV680DThe file name starts with Integrated Navigation algorithm firmware,

Upgrade Method:After the device is powered on, use a Type-C cable to connect one end to the computer and the other end to the device's OTG port, then open the update folder.Put the internal storage and Ethernet port driver runtime firmware and the Integrated Navigation algorithm firmware into the update folder.

Then modify the file names to "Forsen680D", "NAV680D#", then restart the device and wait 3-5 minutes for the upgrade to complete. During the upgrade, the indicator light flashes alternately blue and green; when the flashing stops, the upgrade is complete (if there is no algorithm firmware, it takes about 1 minute).

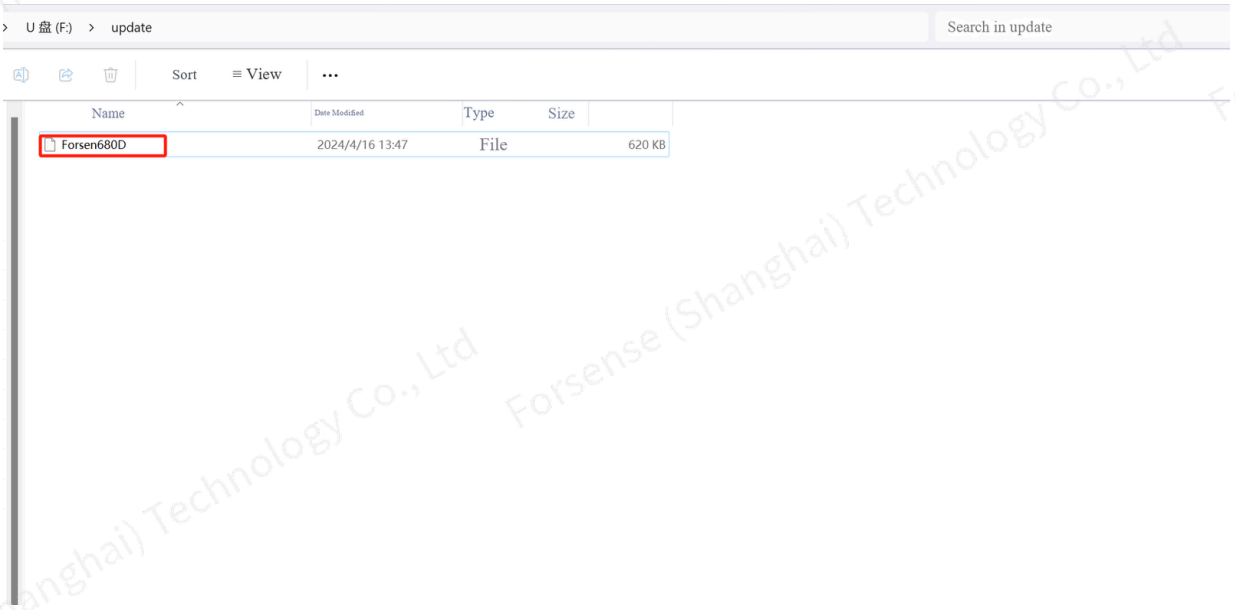


Figure32 6ul Firmware Name

3.2.4.2 Data Storage

3.2.5 Use PC software to save data

After connecting to PC software, data is automatically stored,

By default, outputs the Integrated Navigation data stream, stored in the "log" folder in the software package, in the "NAV680D" folder,

For details, refer to section 4.1 Integrated Navigation Data Stream. You can parse the data yourself or use the data decoding page in the PC software development tool for decoding, generating a dat file named by time, as shown in the following example:

After starting the debug data stream, the debug data stream datais stored in the "log" folder in the software package, in the "NAV680D_test" folder, generating a dat file named by time, as shown below:

Example 2024_0416_1400_42.dat', when PC software is disconnected, data saving will end, this data is a log data stream; the protocol content is temporarily not externally open, and parsing must be performed using the MALTB script from the Forsense official website. As shown in the figure33. After parsing, a CSV file can be obtained, with the format shown in Figure 13

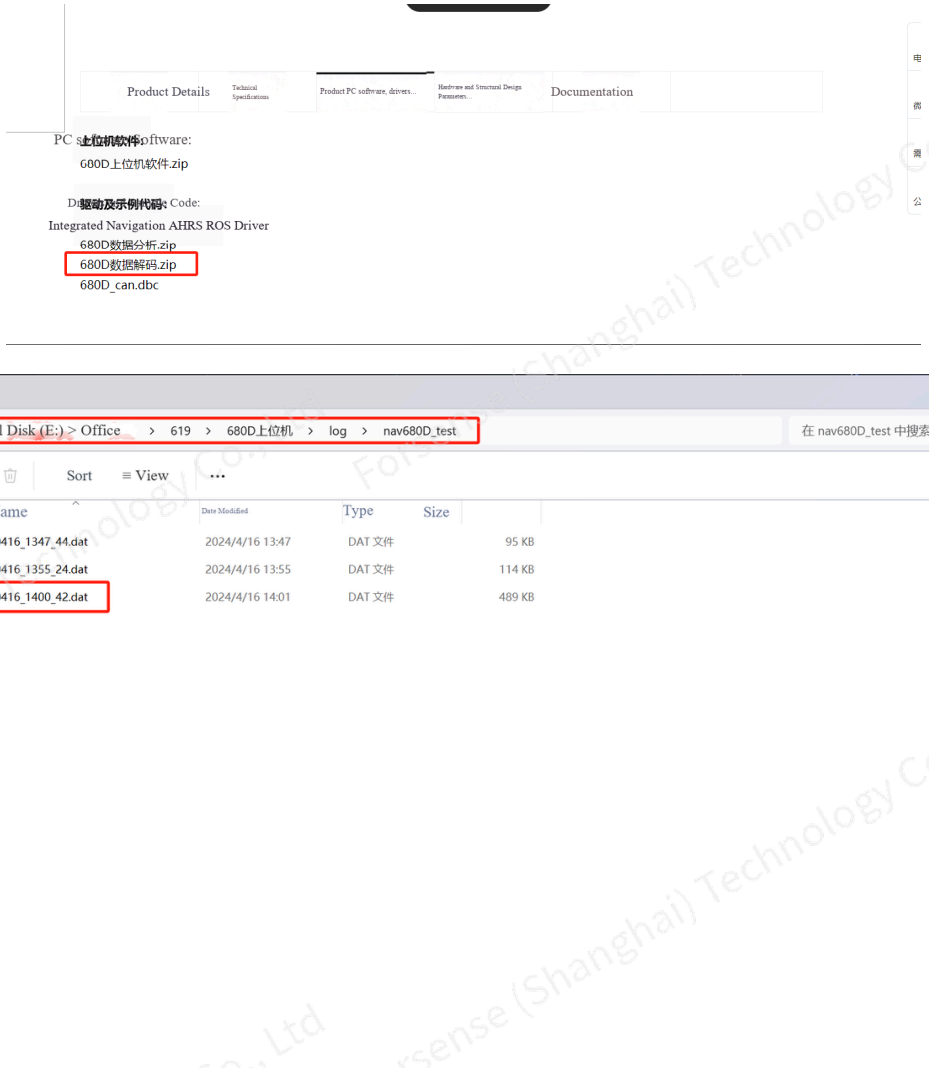


Figure33PC software Data Storage Location

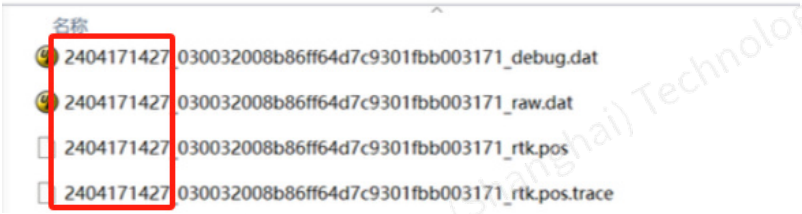
3.2.5.1 Internal Data Storage

Note: The internal storage capacity is 2GB. A self-check is performed on power-up. If the remaining storage space is less than 500M, data from 2 days ago will be cleared. If you need to use the internal storage data, please copy it in time.

After the device is powered on and satellite signals are acquired, the device automatically stores data internally. After the test is completed, use a Type-C cable, connect one end to the computer and the other end to the device's OTG port, go to the log folder, and copy.corresponding test timerecorded file

File Description:

The filename prefix indicates the time when data recording starts. As shown in the example below, the recording time is 24/4/17 14:27.



.dat file: Integrated Navigation data (internal debug data stream; the protocol content is not externally open; you can decode it with the matlab data decoding script from the official website, or with the data decoding tool in the PC software portable tool)

.rtcm file: RTK base station differential data obtained after this power-on

.raw file: RTK Raw Data of this power-on

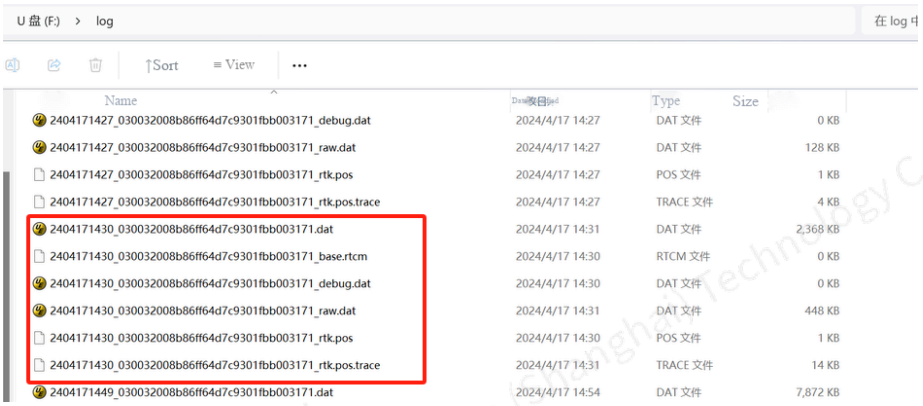


Figure34 Internal Storage Data

3.2.5.2 Integrated Navigation Output Protocol

4. Integrated Navigation Data Stream (Hex Protocol)

Supports Serial Port R232-B output, baud rate 460800, supports Ethernet output, port number 6100

Note:

- The CRC is calculated over all bytes of the frame starting from Frame header, excluding the CRC field itself. For the calculation method and example routines, refer to the folder "Integrated Navigation Data Decoding Routines".
- The frame length is the total number of all data bytes excluding Frame header, frame ID, frame length, and check bits, and the byte count is 104.
- little-endian mode, the low byte is sent first.
- The output attitude angles are in the vehicle body coordinate system. Only when in the fixed solution state and the speed is greater than 20km/h can Integrated Navigation complete initialize and enter the working state.

Content	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 (°×10000000)	Int32	12
Longitude (°×10000000)	Int32	16
Altitude (mm)(Ellipsoidal height)	Int32	20
North Velocity (m/s)	Float	24
East Velocity (m/s)	Float	28
Down Velocity (m/s)	Float	32
Roll angle (deg)	Float	36
Pitch angle (deg)	Float	40
Yaw angle (deg)	Float	44
Dual antenna Heading (deg)	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 (see table below) 0:No Fix 16:single point positioning 17:Pseudo-range differential positioning34:floating solution 50:fixed solution	Uint8	84
Satellite Count	Uint8	85
differential delay	Uint8	86
Dual antenna Orientation status 50 indicates heading determinedOther values indicate heading not determined	Uint8	87
Position Dilution of Precision (DOP) (cm) Valid after Integrated Navigation initialize	Uint16	88
Status bits: Bit0: 1 indicates RTK data is valid, 0 indicates invalid Bit1: 1 indicates PPS signal is valid, 0 indicates invalid Bit2: 1 indicates Integrated Navigation is initialize, 0 indicates Integrated Navigation is not initialize (initialize conditions: single antenna, positioning fixed solution + odometer connected, speed greater than 2 m/s can initialize single antenna, positioning fixed solution + odometer not connected, speed greater than 5 m/s can initialize, Dual antenna, positioning fixed solution + Orientation status 50 for more than 20 seconds can initialize) Bit3: Reserved Bit4: Reserved Bit5: Reserved Bit6: Reserved	Uint16	90
GNSS Dual antenna Heading Time of Week in ms	Uint32	92
Reserved 2	Uint32	96
CRC Check	Uint32	100

4.1 NMEA Protocol

- Supports outputting integrated data in NMEA format.
- The NMEA data stream cannot be output simultaneously with the binary data stream. If the NMEA data stream is output, the binary data stream cannot be output. Before switching data streams, you must first execute:5.4 command to stop the current data stream output.
- The following statements are currently supported. For configuration, refer to5.3 section
- Supports Serial Port R232-A output, baud rate 460800,
- Supports Ethernet output, port number 6000; the output sentence must first be configured using Serial Port

GPGGA

GPRMC

GPHDT (Heading Information)

GPVTG (Ground Speed Information)

GPZDA (UTC Time and Date)

GPATT (Forsense Custom Message)

GPYJ (Forsense Custom Message: GPYJ Data Protocol)

The GPATT format is shown in the table below.

Name	*Unit*	*Format*	*Example*	*Description*
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 GPYJ format is shown in the table below.

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

Note: If the system status has no initialize, the result is GNSS, including position, velocity, and attitude (lower nibble of Status: 0 and 1 are GNSS data; 2 and 3 are integrated data).

1	**Header**	**GPYJ Protocol Header**	**$GPYJ**	**$GPYJ**
2	GPSWeek	Week number from 1980-1-6 to current (GPS time)	www	1980
3	GPSTime	Seconds from 0:00:00 on Sunday of this week to current (GPS time)	ssssss.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	Accelerometer X-axis, unit (G)	+/-a.aaaa	0.0009
11	acc y	Accelerometer Y-axis, unit (G)	+/-a.aaaa	0.0048
12	acc z	Accelerometer Z-axis, unit (G)	+/-a.aaaa	-1.0037
13	Latitude	Latitude (-90° to 90°)	+/-ll.lllllll	38.8594969
14	Longitude	Longitude (-180° to 180°)	+/-ll.lllllll	121.5150073
15	Altitude	Altitude, unit (m)	+/-aaaaa.aa	121.51
16	Ve	East velocity, unit (m/s)	+/-eee.eee	-0.023
17	Vn	North velocity, unit (m/s)	+/-nnn.nnn	0.011
18	Vu	Up velocity, unit (m/s)	+/-uuu.uuu	0.000
19	V	Vehicle speed, unit (m/s)	+/-uuu.uuu	1.500
20	NSV1	Primary antenna 1 satellite count	nn	14
21	NSV2	Secondary antenna 2 satellite count	nn	6
22	Status	System Status (Lower Nibble): 0: initialize ; 1: GNSS Mode ; 2: Integrated Navigation Mode ;3: Pure Inertial Navigation Mode ; Satellite status (high nibble): 0: No positioning, no heading; 1: single point positioning heading; 2: Pseudo-range differential positioning heading; 3: Combined dead reckoning; 4: RTK fixed solution positioning and heading; 5: RTK floating solution positioning and heading; 6: single point positioning no heading; 7: Pseudo-range differential positioning no heading; 8: RTK fixed solution positioning, no heading;9: RTK floating solution positioning, no heading;	ss	4
23	Age	differential delay	aa	0
24	Warning	bit0:1:No GPS message, 0:Normal bit1:1:No vehicle message, 0:Normal bit3:1Gyro error, 0:Normal bit4:1 Accelerometer error,0:Normal	ww	2
25	Cs	Checksum	*hh	*47
26	<CR><LF>	Fixed Packet Tail		<CR><LF>

4.2 CAN Output Protocol

Default output rate of Integrated Navigation information: 100HZ

Default baud rate 500K

4.3 CAN DBC file

Note: The corresponding DBC file is available on the official website for real-time decoding. Download link:

https://data.forsense-imu.com/page/download.html



4.3.1 CAN protocol

INS_Acc(0x500), default 100hz, the coordinate system is the housing coordinate system, with Bias compensation applied

Positive X-axis indicates the vehicle's forward direction; positive Y-axis indicates the vehicle's right direction; positive Z-axis indicates the vehicle's downward direction.

NAME	StartBit	Length Bit	ValueType	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), default 100hz, the coordinate system is the housing coordinate system, with Bias compensation applied

GYRO_X takes the vehicle's forward direction as the X axis, right-hand rule, thumb pointing forward, direction of the four fingers (clockwise around the X axis is positive);

GYRO_Y takes the direction perpendicular to the vehicle's forward direction as the Y axis, right-hand rule, thumb pointing right, direction of the four fingers (clockwise around the Y axis is positive);

GYRO_Z takes the direction perpendicular to the vehicle's horizontal plane as the Z axis, right-hand rule, thumb pointing down, direction of the four fingers (clockwise around the Z axis is positive).

NAME	StartBit	Length Bit	ValueType	Byte Order	Range	factor	offset	Unit	Conversion
GYRO_X	8	16	Unsigned	Motorola	[-250,250]	0.0076293	-250	deg/s	D=N*0.0076293-250
GYRO _Y	24	16	Unsigned	Motorola	[-250,250]	0.0076293	-250	deg/s	D=N*0.0076293-250
GYRO _Z	40	16	Unsigned	Motorola	[-250,250]	0.0076293	-250	deg/s	D=N*0.0076293-250

INS_HeadingPitchRoll(0x502), default 100hz, the coordinate system is the housing coordinate system

Pitch is positive clockwise around the Y axis; Roll is positive clockwise around the X axis; Heading is positive clockwise around the Z axis, as shown in Figure 33.

NAME	StartBit	Length Bit	ValueType	Byte Order	Range	factor	offset	Unit	Conversion
Pitch	8	16	Unsigned	Motorola	[-90,90]	0.010986	-360	deg/s	D=N*0.010986-360
Roll	24	16	Unsigned	Motorola	[-90,90]	0.010986	-360	deg/s	D=N*0.010986-360
Heading	40	16	Unsigned	Motorola	[-180,180]	0.010986	-360	deg/s	D=N*0.010986-360

INS_HeightAndTime(0x503), default 100hz, altitude: outputs the Primary antenna phase center height by default

NAME	StartBit	Length Bit	ValueType	Byte Order	Range	factor	offset	Unit	Conversion
Altitude	24	32	Unsigned	Motorola	[-10000,10000]	0.001	-10000	m	D=N*0.001-10000
Milliseconds Within GPS Week	56	32	Unsigned	Motorola	[0,604799999]	1	0	ms	D=N*1

INS_LatitudeLongitude (0x504), default 100hz

The device uses the WGS84 coordinate system, and the latitude/longitude output is the position of the Primary antenna phase center;

Latitude takes the equator as 0°; a Latitude greater than 0° indicates the Northern Hemisphere, otherwise the Southern Hemisphere;

Longitude takes the prime meridian as 0°; a Longitude greater than 0° indicates the Eastern Hemisphere, otherwise the Western Hemisphere.

NAME	StartBit	Length Bit	ValueType	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), default 100hz; the north and east velocities are the velocities in the true north/true east directions, and the down velocity is the velocity vertically downward relative to the horizontal plane

NAME	StartBit	Length Bit	ValueType	Byte Order	Range	factor	offset	Unit	Conversion
North velocity	8	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100
East velocity	24	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100
Down velocity	40	16	Unsigned	Motorola	[-100,100]	200/65536	-100	m/s	D=N*200/65536-100

INS_Std (0x507), default 100hz

NAME	StartBit	Length Bit	ValueType	ByteOrder	Range	factor	offset	Conversion
Latitude standard deviation	8	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001
Longitude standard deviation	24	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001
Altitude standard deviation	40	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001
Heading standard deviation	56	16	Unsigned	Motorola	[0,65.535]	0.001	0	D=N*0.001

GNSS_UTC (0x508), default 5hz

Note: GPS time - leap second = UTC time; currently leap second is 18S, and UTC time is 18S slower than GPS time

NAME	StartBit	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), default 100hz

NAME	StartBit	LengthBit	ValueType	ByteOrder	Conversion
GNSS Positioning Status	0	8	Unsigned	Motorola	0_NONE_No Solution 16_SINGLE_ single point positioning 17_PSRDIFF_ Pseudo-range differential 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-lane fixation Solution
GNSS Satellite Count	8	8	Unsigned	Motorola	D=N*1
GNSS Orientation status	16	8	Unsigned	Motorola	0_NONE_No Solution 16_SINGLE_ single point positioning 17_PSRDIFF_ Pseudo-range differential 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-lane fixation Solution
differential delay(S)	24	8	Unsigned	Motorola	D=N*1
Vehicle Wheel Speed Flag	32	8	Unsigned	Motorola	0_No Wheel Speed Information 1_Wheel Speed Information Available
Integrated Navigation Status bits	40	8	Unsigned	Motorola	0_ NONE1 _Attitude initialize (Heading not initialize) 2_ Integrated Navigation

Roll, pitch, and Yaw angle schematic diagram as follows:

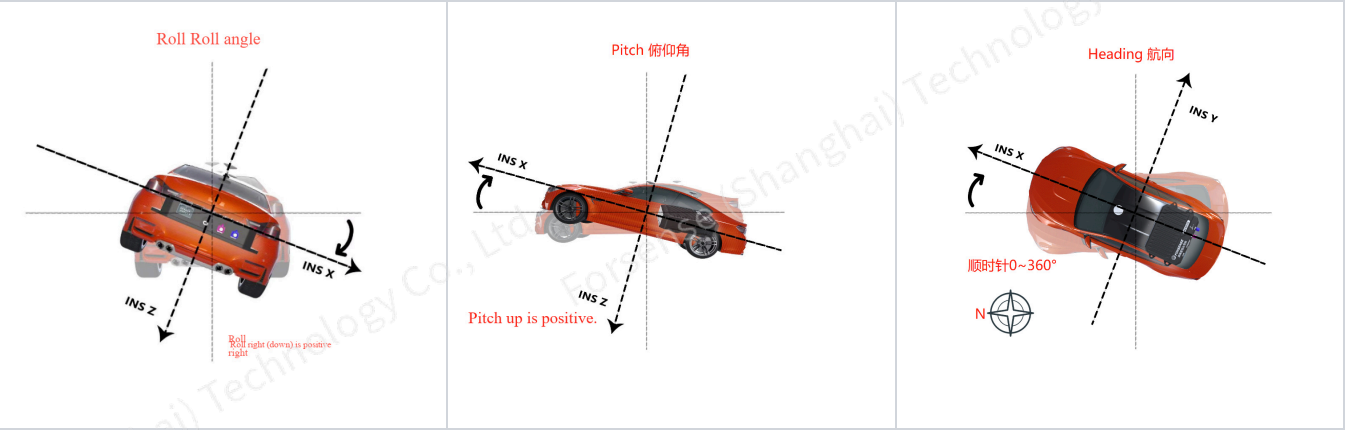


Figure 35 Roll, Pitch, and Yaw angle Schematic Diagram

4.3.2 RTK Positioning Status Table

Binary	ASCII	Description
0	NONE	No Solution
1	FIXEDPOS	Position is specified by the FIX POSITION command
2	FIXEDHEIGHT	Not Supported Yet
8	DOPPLER_VELOCITY	Velocity is derived from instantaneous Doppler information
16	SINGLE	single point positioning
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-lane fixation Solution

4.4 UseATcommand to performSerial PortParameter Configuration

In addition to Parameter configuration via PC software, the product can also be configured by sending commands via Serial Port

5. ConfigurationDevice Relative Primary antennaLever Arm

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

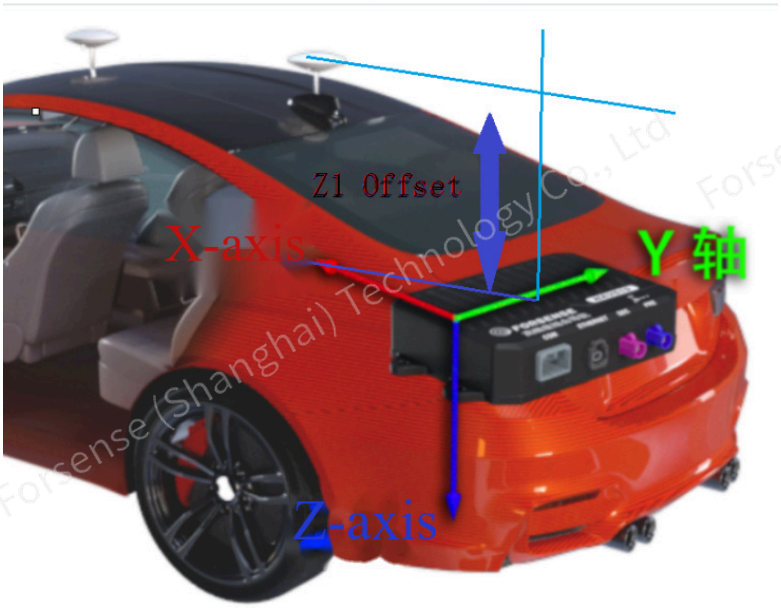
Command: AT+CLUB_VECTOR=1.2,0.2,-1.0\r\n

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

Note: After saving the configuration command, power off and restart for it to take effect

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





5.1 Configure the lever arm of the device relative to the rear axle center

For example, rear axle center lever arm vector X=0.2m, Y=1.2m, Z=-1.0m

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

Response: OD_POS_X=0.2,GPS_POS_Y=1.2,GPS_POS_Z=-1/r/n

5.2 Configure binary data stream output

Command: AT+SETNAV\r\n

Response: OK\r\n

If configured to stop output

Command: AT+SETNO\r\n

Response: OK\r\n

5.3 Configure NMEA format data stream output

If NEMA sentence output is configured, then4.1Integrated Navigation data stream is not output

If you need to switch to4.1Integrated Navigation data stream output, you must first use5.5the command to stop the current data stream output

The NMEA protocol only supports Serial Port A output

The configuration command is as follows

GPGGA

Example: Output GPGGA sentence at 5hz: AT+GPGGA=5\r\n

Response: OK\r\n

GPRMC

Example: Output GPRMC sentence at 1hz: AT+GPRMC=1\r\n

Response: OK\r\n

GPHDT (heading information)

Example: Output GPHDT sentence at 1hz: AT+GPHDT= 1\r\n

Response: OK

GPVTG (Ground Speed Information)

Example: Output GPVTG sentence at 1 Hz: AT+GPVTG= 1

Response: OK

GPZDA (UTC Time and Date)

Example: Output GPZDA sentence at 1 Hz: AT+GPZDA= 1

Response: OK

GPATT (Custom Message)

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

Response: OK\r\n

GPYJ (Custom Sentence)

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

Response: OK\r\n

If configured to stop output

Command: AT+SETNO\r\n

Response: OK\r\n

5.4 Configure the current data stream to stop output

Command: AT+SETNO\r\n

Response: OK\r\n

5.5 Configure the position and velocity projection points output by Integrated Navigation

To configure output of the projection points result set by Integrated Navigation (unit: m), 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

Note: The Integrated Navigation output defaults to the antenna phase center projection points result. If you need to output results for another position, configure the lever arm vector for this position; the configuration method is the same as the lever arm configuration in 4.1.

Note: The configuration command takes effect after a power-off restart once saved.

5.6 Configure Data Output Rate

If the data output rate is configured as 10hz, the configuration command is:

Note: Maximum supported rate is 100HZ

Command: AT+OUTRATE=10\r\n

Response: OK\r\n

5.7 Configure RTK Dual antenna Installation Angle

If the RTK Dual antenna installation angle is configured as 0 degrees, the configuration command is:

Command: AT+RTK_ANGLE=0\r\n

Response: ANGLE=0\r\n

Description: The installation angle is the angle between the ray from Primary antenna pointing to Secondary antenna and the vehicle front direction; clockwise is positive, counterclockwise is negative; the angle input range is -180°~180°

Note: After the configuration command is saved, a power cycle is required for it to take effect; the distance between Dual antenna must be greater than 50cm

Refer to the figure below for the specific angle.



5.8 Configure CAN Interface Baud Rate

The default baud rate of the CAN interface is 500K. To change it to another baud rate, configure it using the following command.

Example: To configure the baud rate to 250K, the configuration command is:

Command: AT+CAN_BAUD=250

Response: OK

Note: The configuration command takes effect only after being saved and a power-off restart; currently supported baud rates are 250K, 500K, 1M

5.9 Enable Position Smoothing

Note: If enabled, in the event of signalloss of lock followed by signal recovery (for example, entering or exiting a tunnel) the trajectory will be smoothed; if disabled, in such scenarios it will quickly pull back to the correct position, and the trajectory will appear jagged

Enable or disable as required

Command: AT+POS_SMOOTH=1\r\n

Response: OK\r\n

To disable position smoothing:

Command: AT+POS_SMOOTH=0\r\n

Response: OK\r\n

5.10 Enable Low-Speed Mode

Note: Applicable to carriers operating at low speed for extended periods, such as unmanned vehicles.

Command: AT+LOW_SPEED_MODE=1

Response: OK

To disable low-speed mode:

Command: AT+LOW_SPEED_MODE=0

Response: OK

5.11 Enable Dual antenna HeadingConstraints

Note: When enabled, Dual antenna heading is used in all scenarios; when disabled, Dual antenna heading is used only when stationary

Note: Suitable for carriers operating at low speed for extended periods

Command: AT+USE_GNSS_HEADING=1\r\n

Response: OK\r\n

If the Dual antenna heading constraint is disabled

Command: AT+USE_GNSS_HEADING=0\r\n

Response: OK\r\n

5.12 Coordinate System Adjustment

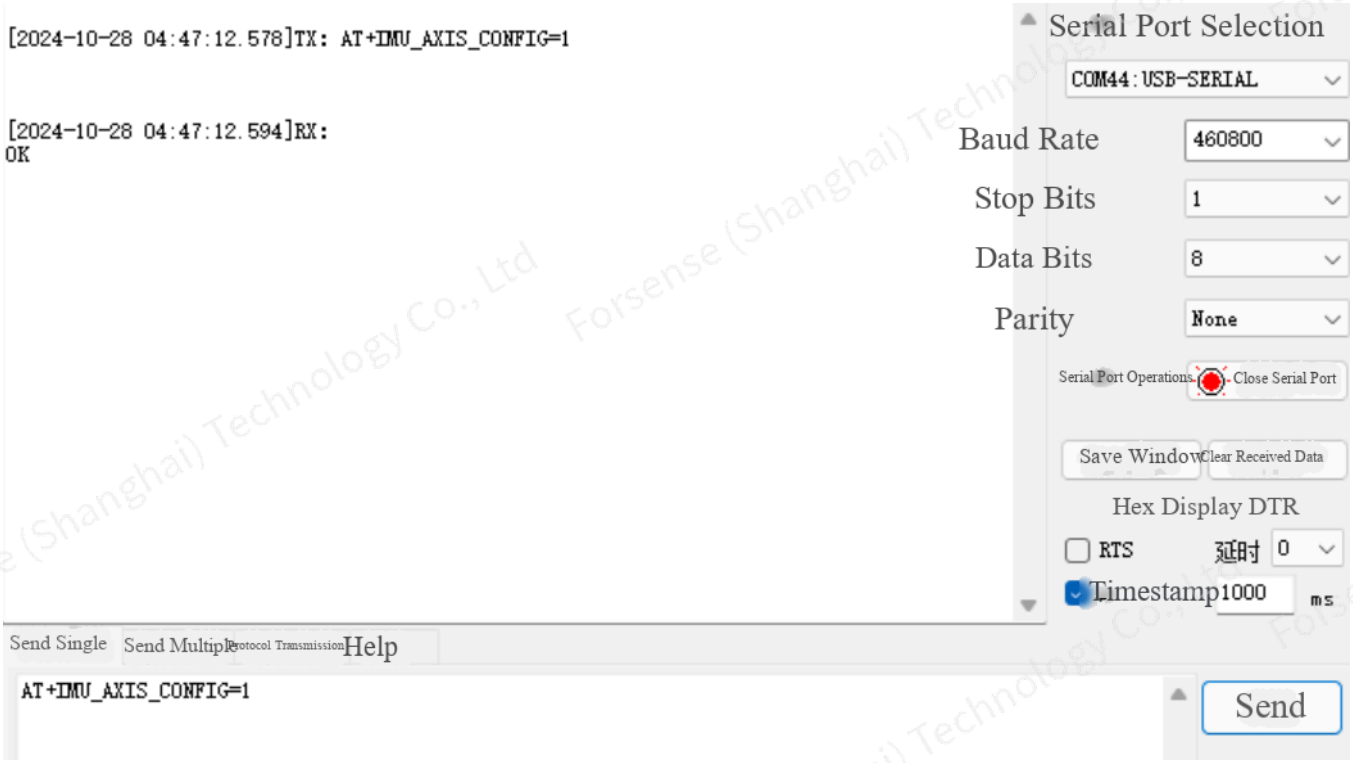
When using Integrated Navigation, if the positive X-axis does not point toward the front of the vehicle, you can adjust the coordinate system according to the current mounting orientation by configuring the corresponding command via Serial Port. After determining the mounting orientation, enter the corresponding command. If configuration succeeds, OK is returned; otherwise, config failed is returned. After successful configuration, send the save command.

Default Coordinate System: Front Right Down

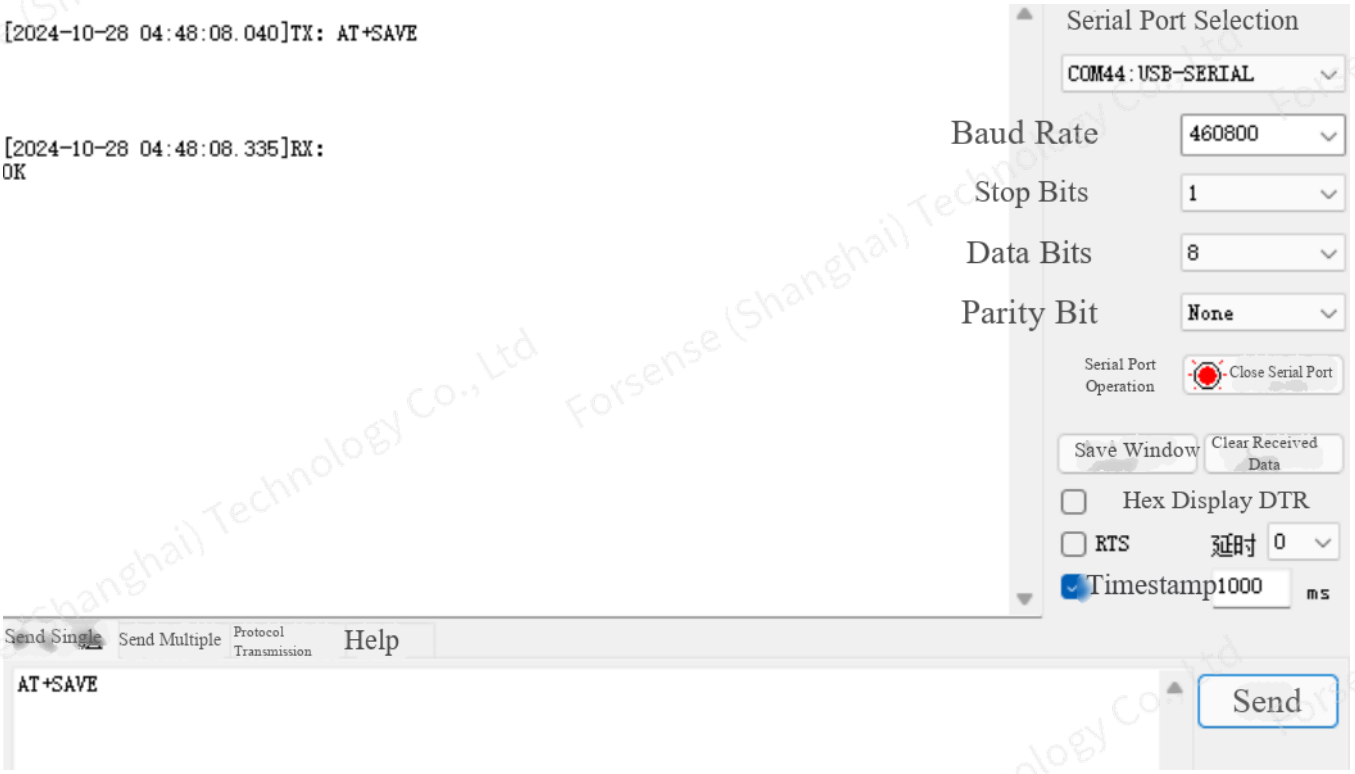
- Front Left Up Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=1
- Left Rear Up Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=2
- Rear Right Up Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=3
- Right Front Up Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=4
- Front Right Down Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=5
- Right Rear Down Mounting Orientation, Configuration Command: AT+IMU_AXIS_CONFIG=6
- Rear Left Down installation orientation, configuration command: AT+IMU_AXIS_CONFIG=7
- Left Front Down installation orientation, configuration command: AT+IMU_AXIS_CONFIG=8

Example: If the installation orientation is Front Left Up, perform the following operations:

Connect Serial Port RS232-B, use Serial Port assistant to send the command: AT+IMU_AXIS_CONFIG=1,



After OK is returned,thensend the save command:



After OK is returned, power cycle the device.

5.13 PrintCurrentAll Configuration Information

Query all configured information, the command is:

AT+CONFIG\r\n

5.14 Query version number

AT+VERSION\r\n

5.15 Calibrate Dual antenna installation angle

During calibration, keep the vehicle driving straight with a speed greater than 1 m/s

Command: AT+EST_GNSS_ANGLE

When calibration succeeds, Serial Port returns GNSS angle calibration is successed

After successful calibration, send the save command

5.16 Save Parameter

Command: AT+SAVE\r\n

Response: OK\r\n

5.17 Use via Ethernet PortParameter Configuration

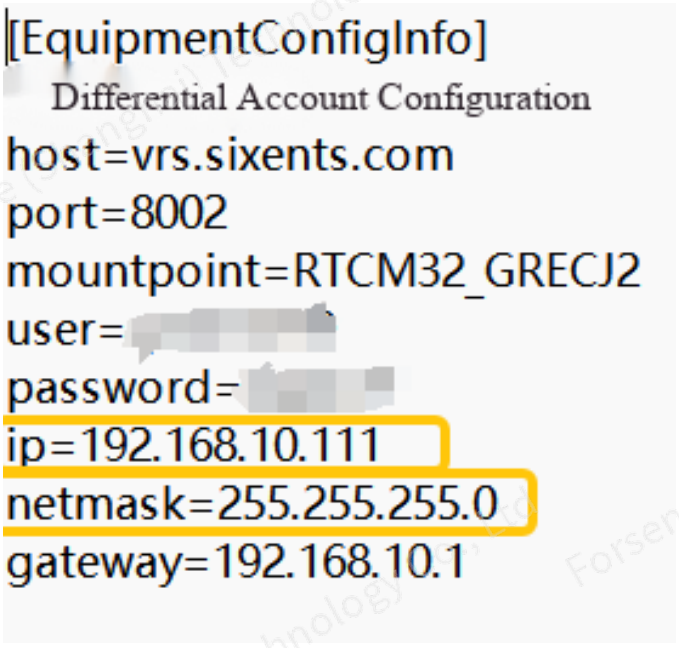
6. Connect PC software using an Ethernet cable

The IP address of the computer must be in the same subnet asNAV680DThe IP address must be in the same subnet,NAV680DThe IP address can be viewed in the config of update in internal storage.

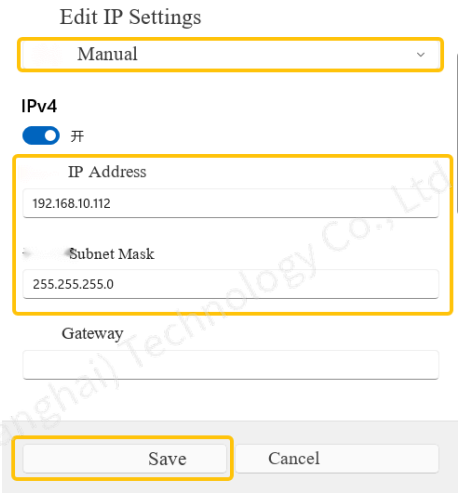
Note: If encryption software is present on the computer, it may affectNAV680Dthe TCP connection between the device and the computer.

Note: Do not unplug or plug the Ethernet cable during use; otherwise,NAV680Dthe IP configuration will be lost, and a restartNAV680Dis required to restore it.

Note:If the ping failsNAV680Dthe device's IP address, first use an Ethernet cable toNAV680Dconnect the device to the computer, thenNAV680Drestart the device.

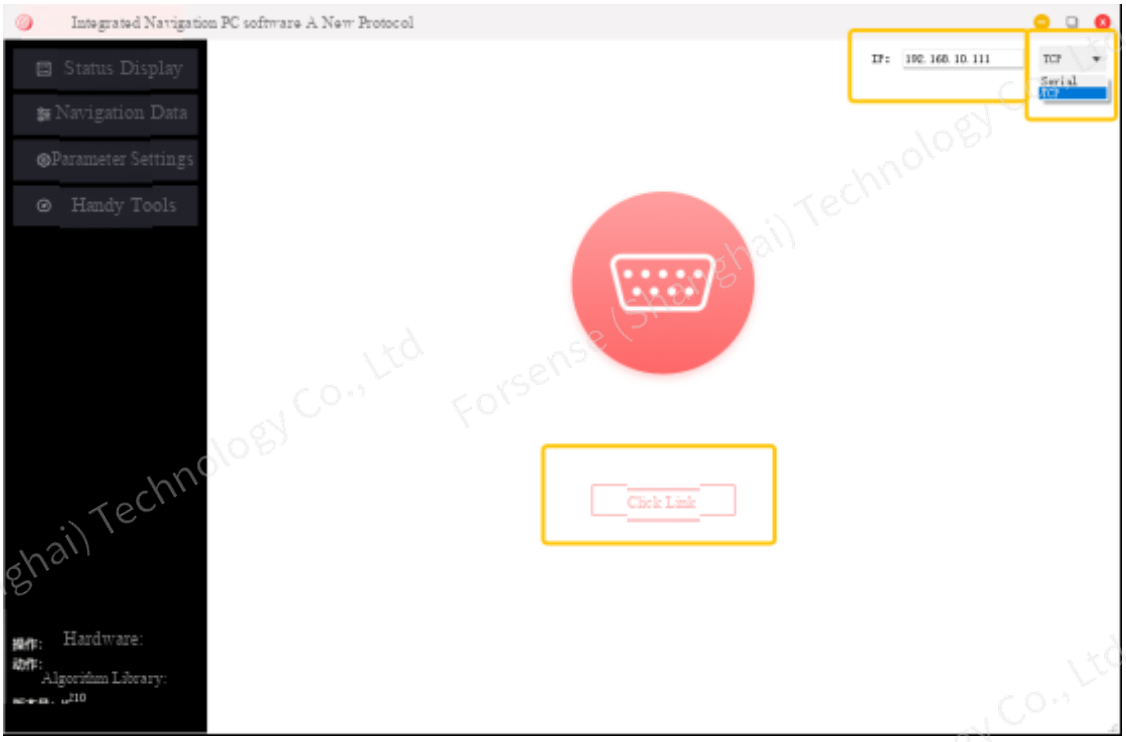


NAV680DConfig Settings in PC Software

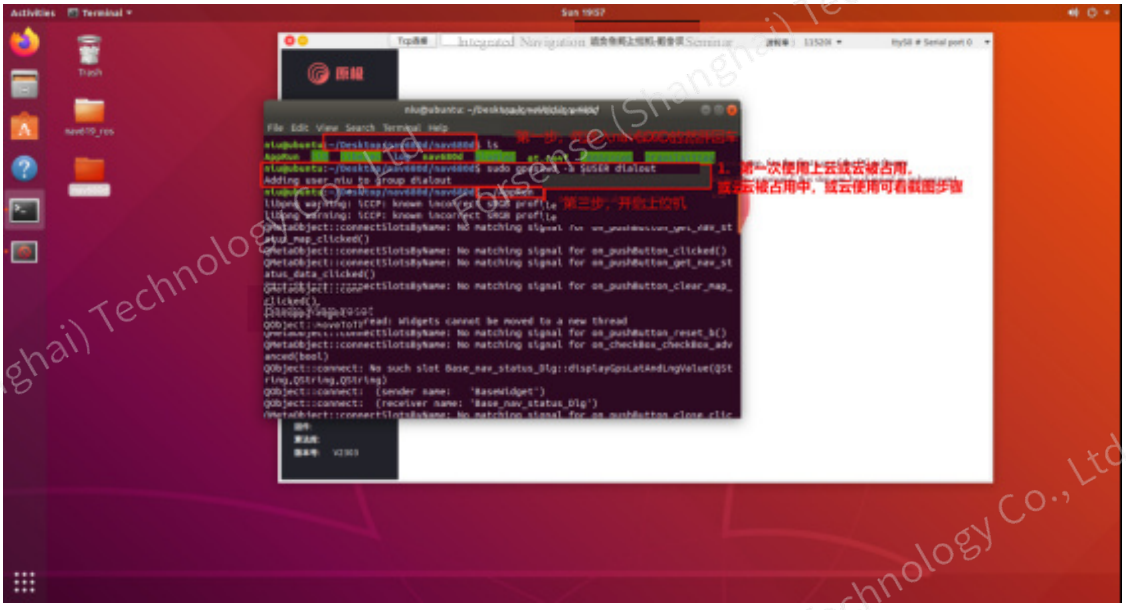


PC IP Configuration

After opening PC software, enter the device IP address in the corresponding input box, and click TCP Connect in PC software.



Open PC software on Windows



Open PC software on Ubuntu

Ubuntu First Step: EnterNAV680Dthe folder

Ubuntu Step two: If it is a newly created Ubuntu system, you need to run sudo gpasswd -a $USER dialout

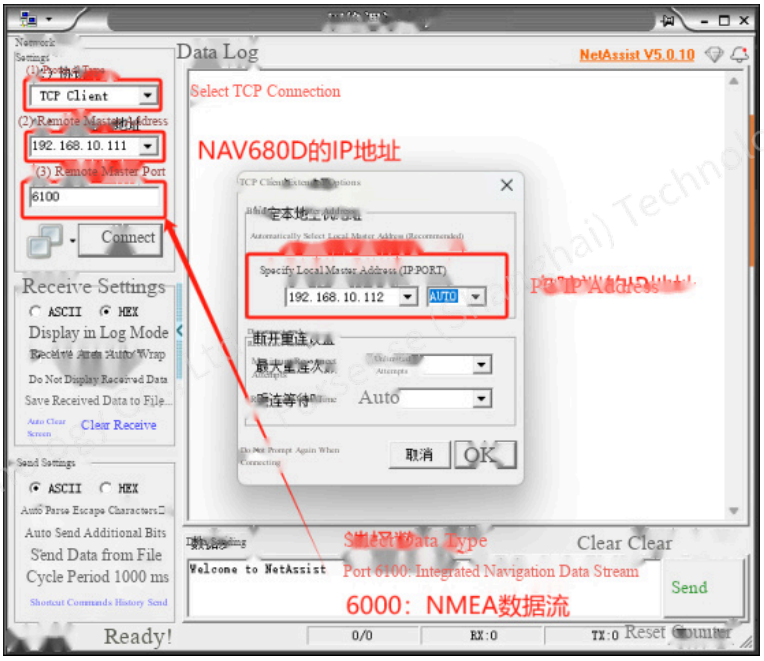
Ubuntu third step: Enter ./AppRun to run PC software

After connection, you can view navigation data, configure Parameter, and use convenient tools, for usage refer to section 3.2 PC software Usage

6.1 Ethernet port output Integrated Navigation data stream

Note: Currently only static ID is supported

For Ethernet connection, use Serial Port Assistant, enter the corresponding IP address in Serial Port Assistant; port number 6100 outputs Integrated Navigation data,port number 6000 outputs the NMEA data stream


Data Log
NetAssist V5.0.10
Select TCP Connection
TCP Client
192.168.10.111
6100
Connect
NAV680D的IP地址
Specify Local Master Address (IP:PORT)
192.168.10.112
AUTO
Auto
取消
OK
Receive Settings
ASCII
HEX
Display in Log Mode
Clear Receive
Send Settings
Auto Send Additional Bits
Send Data from File
Cycle Period 1000 ms
Clear Clear
Welcome to NetAssist
Port 6100: Integrated Navigation Data Stream
6000：NMEA数据流
Send
Ready!
0/0
RX:0
TX:0

6.2 ROS driver

Note: You first need to NAV680D configure the output as a 0x166 data stream. For details, refer to NAV680D product sheet 5Section .2.

5. 2Configure Output Binary Data Stream

Command：AT+SETNAV\r\n

Response：OK\r\n

By default, the 0x166 data stream is output. You can configure it first and then save Parameter. For details, see NAV680D product sheet 5.13 section.

5.13 Save Parameter

Command：AT+SAVE\r\n

Response：OK\r\n

ROS Driver Download Address:https://data.forsense-imu.com/page/download.html, currently supports ROS1, ROS2



7. Install ROS serial

Install the ROS serial package. This example relies on the serial package provided by ROS to implement serial communication.

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

sudo apt-get install ros -melodic-serial

Then run the roscd serial command to enter the serial installation location. If the installation is successful, the following information appears:

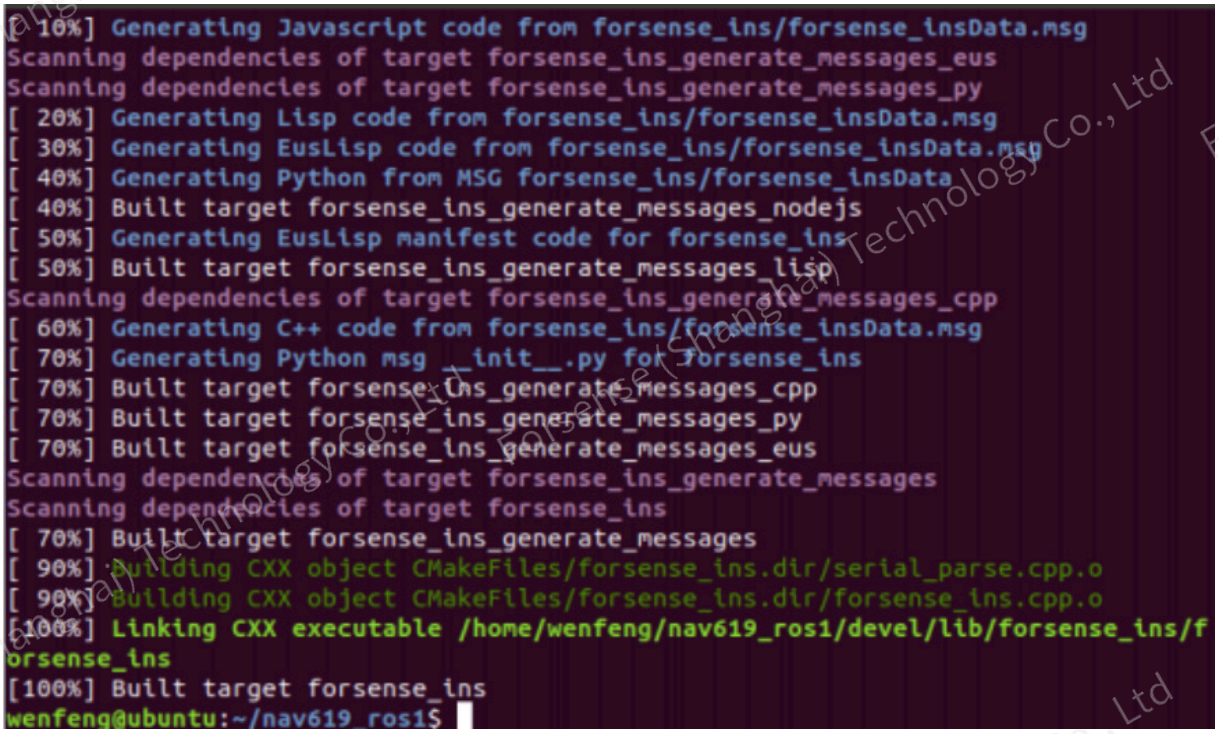
the following information:

/opt/ros/melodic/share/serial

7.1 Compile the code

cd NAV680D_ROS/

catkin_make

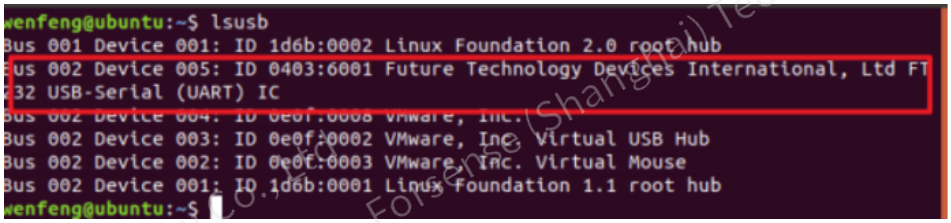


Compilation complete

7.2 Connect the IMU to the system via USB

Check whether connected:

lsusb



Check USB port number:

ls /dev/ttyU*



Configure and open USB to serial port privileges:

sudo chmod 777 /dev/ttyUSB0

7.3 View Data

Run roscore to start ROS

Return to the serial_imu_ws folder and run

source devel/setup.bash

Run rosrun to start

rosrun forsense_ins forsense_ins

```
wenfeng@ubuntu:~/nav619_ros1$ rosrun 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 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: -0.109113516808
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
---
```

7.4 FAQs

Question	Answer
PC software Cannot Connect	Please check whether Serial Port is occupied and whether the product is properly powered on. If PC software disconnects during connection, Serial Port may be loose; unplug and plug the Serial Port cable, then reopen PC software.
It disconnects after running for a while following power-on.	Check the following factors: 1. Whether the power supply is within the 9-32V range, 2. Whether supply voltage is stable 3. Whether the Serial Port cable or network cable is securely connected and whether there is any interruption issue
The binary data cannot be parsed using the protocol in the installation manual.	Check whether after connecting PC software, you switched the data stream to the debug data stream and performed a configuration save operation. Note: This data stream is not open externally and is for debugging only. It can only be decoded using the MATLAB script on the official website or the data decoding page in PC software. Please use AT commands to switch to the Integrated Navigation data stream or NMEA data stream.
No data output after the Integrated Navigation data stream is configured	Send the AT+CONFIG\r\n command to print the current configuration and check whether the data output rate (OUTRATE) is set to 0 or -1. If it is, resend the AT+OUT_RATE=100\r\n command to configure the output rate, and send AT+SAVE\r\n to save the configuration so that it remains effective after the device restarts.
The device cannot acquire satellites	Troubleshoot by following these steps: 1. Must be outdoors, or indoors with a GPS signal repeater. 2. Check whether the physical connection of Primary antenna is normal, whether it is loose, whether there are problems such as cable damage. Troubleshooting method: 1: Connect RTK Serial Port, raw positioning information of Primary antenna: enter GNGGA 1 to print positioning information of Primary antenna. Raw positioning information of Secondary antenna: enter GNGGAH 1 to print positioning information of Secondary antenna. 2. If Secondary antenna positioning is normal but Primary antenna positioning is abnormal, it indicates that the test environment and antenna power supply are normal; the cause is a physical connection issue with Primary antenna, such as cable damage.
Serial Port output data is all garbled characters or all dots	Check whether the baud rate is correct. The default baud rates for each interface are as follows 1.RS232-A 460800 2.RS232-B 460800 3.RS232-RTK 115200
The CAN protocol Elevation has a fixed error compared with the reference value	Currently, navigation protocols mainly have two Elevation formats: altitude and Ellipsoidal height. The CAN protocol outputs Elevation data as altitude. Confirm whether the reference value is altitude. If not, you can change the Elevation output of the reference value to altitude.
The positioning status is always 1	If using the LAN port to connect a computer or router to access the Internet for differential data, check whether the differential account information and IP address in the config.ini file are correctly configured. If using RTK-232 Serial Port for differential data input, check whether the baud rate matches. The default for Serial Port is 115200. Then check whether Serial Port normally outputs the GNGGA sentence (output is enabled by default; the differential server sends differential data only after receiving the gga sentence sent by the device). If there is no output, enter the following commands in sequence to configure sentence output for RTK-232 Serial Port: log gngga ontime 0.1 saveconfig
Data trajectory deviation is too large	Troubleshoot the following factors 1. Confirm whether the lever arm and Dual antenna deviation angle configuration are configured correctly. 2. Check whether the algorithm is initialize. Troubleshooting method: observe whether the initialize status in Status bits in the data stream protocol is 1 3. When Dual antenna is connected, confirm whether the Dual antenna installation deviation angle is configured correctly. An incorrect Dual antenna installation deviation angle will cause initialize heading errors and trajectory abnormalities.
Unable to initialize	1. Check whether the positioning status has entered the Narrow-lane fixation solution. If it never enters the Narrow-lane fixation solution, drive the vehicle to a more open location. 2. single antenna, when an odometer is connected, the driving speed must be greater than 2m/s to initialize. 3. single antenna, when no odometer is connected, the driving speed must be greater than 5m/s to initialize. 4. Under Dual antenna, the positioning status and Orientation status both require being in the Narrow-lane fixation solution state simultaneously for more than 30 seconds to initialize.

How to Copy Internal Storage Files	Use a type-C cable to connect the device's OTG Serial Port; the computer will display the corresponding virtual USB drive. Open the USB drive, and in the log folder, the recorded file names are based on Beijing time. Every 6 folders form one group.
Dual antenna Orientation status never reaches 50	Troubleshoot the following factors: 1. If Orientation status is always 0, check whether Secondary antenna is properly connected and whether the antenna feeder is damaged. 2. If Orientation status is not 0 but never reaches 50, confirm whether the test environment is open and whether the Dual antenna distance is more than 50CM.
Signal is normal when active antenna is connected, no signal when passive antenna is connected	passive antenna feeder must not exceed 1.5M.
The signal is normal when the antenna is connected to active power splitter, but there is no signal when the device supplies power to the antenna	Confirm whether the antenna feeder has short-circuited, or whether plugging and unplugging the antenna while powered on causes static electricity and other issues that make the antenna power supply circuit abnormal. The current circuit design already includes a fuse, and it can recover after powering on again.
Serial Port packet loss	Troubleshoot the following factors: 1. The Serial Port cable must support at least 460800 baud rate 2. The computer Serial Port delay must be set to 2ms
When the signal recovers after exiting a tunnel, the trajectory convergence is not smooth	When smoothing mode is not enabled, fixed solution recovers under RTK and the trajectory is quickly pulled back to the correct position; enabling smoothing mode or having the autonomous driving control system perform smoothing can solve the problem
Large trajectory error compared with LiDAR	Troubleshoot by following these steps 1. In an open-sky scenario, the RTK fixed solution trajectory can reach centimeter-level accuracy, which can serve as a reference to determine whether the issue is with the LiDAR or Integrated Navigation.
Can the NMEA protocol and the binary protocol be output simultaneously?	Not supported. Only one of the protocols can be output at a time.
Why is there still a satellite count when the antenna is unplugged?	The UM982 has strong signal tracking capability. If there is a signal source nearby, when the antenna is unplugged, it will continue tracking for a period of time through coupling. In an actual satellite loss-of-lock scenario, the antenna remains connected, external signals cannot enter, and usage is not affected.
Use a metal object to shield the antenna and simulate loss of lock; the status still fixed solution	Incorrect test method: A metal pot lid can only shield signals directly above. Side signals reflect off the vehicle roof to the underside of the pot lid and then to the antenna, causing a false fix.
The ROS driver cannot read data	The device is not configured to output the combined data stream by default at power-on. Configuring the default output combined data stream at power-on can solve this.
Attitude error relative to the reference benchmark exceeds the limit.	Possible causes: 1. Lever arm and wheelbase configuration error; the unit is scaled up by 10 times. 2. Confirm whether it is rigidly mounted 3. Whether it is far from strong vibration sources 4. Heading: There is installation error under Dual antenna; confirm whether Dual antenna has been calibrated. 5. Roll angle: The onboard algorithm cannot estimate the Roll angle installation error. Generally, when calculating the Roll angle error, the installation error must be deducted. Generally, after initialize under open sky, the mean error relative to the reference is deducted as the installation error.
When differential data is input through the Ethernet port, fixed solution is never reached.	There may be several reasons as follows: 1. Differential account-related information is configured incorrectly. You can use the same account to verify on a computer with the NTRIPClient software. 2. Whether the network port is properly provided with network access; a router with routing function is required. 3. Whether the router has permission setting issues that prevent 680D 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 it consistently fails to reach fixed solution, it is a satellite signal issue. Generally, if no fixed solution is achieved for more than 2 minutes, check whether the environment has severe obstruction.
When using a DTU connected to the RTK-232 port to input differential data, fixed solution is never achieved.	There may be several reasons as follows: 1. Differential account-related information is configured incorrectly. You can use the same account to verify on a computer with the NTRIPClient software. 2. Whether the DTU network is normal. 3. The default baud rate of RTK-232 is generally 115200. Check whether DTU serial port baud rate matches. You can connect RTK-232 Serial Port to a computer and use the NTRIPClient software for comparison verification. 4. If the GGA positioning status is greater than or equal to 2, it indicates that differential data has been received. If fixed solution cannot be reached consistently, it is a satellite signal issue. Generally, if no fixed solution is achieved for more than 2 minutes, check whether the environment is severely obstructed. 5. For some brands such as Yitang DTU, the 232 Serial Port RX TX need to be crossed. Confirm whether the connecting harness is RX TX straight-through or crossed.

After configuring projection points, the position of the PC software debug data stream page has not changed.	The projection points configuration only takes effect for the Serial Port Integrated Navigation data stream, NMEA data stream, and CAN protocol. The debug data stream is also for internal debugging use, and projection points does not take effect.
Related Parameter cannot be configured through commands on the Ethernet port.	The Ethernet port does not support command-based configuration; it only supports PC software configuration.

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8. Accessories

Standard accessories:

	
Wiring Harness	

	
Primary antenna (positioning antenna)	Secondary antenna (Directional Antenna)

	
Primary antenna Connection Cable	Secondary antenna Connecting Cable

Optional accessories:

	
Type-C Cable	RS232 Serial Port Cable
	
OBD to DB9 Cable(Used with Odometer)	

9. Revision History

Latest Manual Version: NAV680D _Datasheet_Product Manual（en）

Version	Date	Status/Notes
Version 1.0	2024.01.20	Initial Release
Version 1.1	2024.04.17	Added 6ul firmware update method
Version 1.2	2024.07.18	Added quick start procedure, added FAQs list
Version 1.3	2025.01.08	Added GPYJ protocol

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