SinoGNSS

M30X Integrated Navigation Receiver

Use Manual

CNT-RCV-UM011, Rev 1.1

1 INTRODUCTION

1.1 OVERVIEW

Welcome to the user manual for the M30X Integrated Navigation Receiver. This manual describes the functions of the M30X receiver and provides operational guidance for installation and usage. Detailed explanations of each operation step and command are provided herein.

This manual also includes specifications for the product hardware and ComNav software. Some parameters may require supplementary information from the technical reference manual of the equipment being used.

This manual assumes you are familiar with Global Navigation Satellite System (GNSS) principles and terminology such as RTK, baud rate, PJK, etc.

1.2 USING THIS MANUAL

This manual is organized into eight main sections as follows:

Chapter 2 Product Overview

Introduces the features, interfaces, and wiring instructions of the M30X Integrated Navigation Receiver.

Chapter 3 Installation Instructions

Describes the installation methods for the receiver.

Chapter 4 Receiver Configuration

Describes the receiver configuration methods.

Chapter 5 Message Description

Describes the structure of the data messages.

Chapter 6 Coordinate System Description

Describes the usage of different coordinate systems.

Chapter 7 Troubleshooting

If you encounter issues while using the receiver, you can refer to the solutions in the troubleshooting section to resolve them.

Chapter 8 Precautions

Lists important notes for using the receiver.

1.3 DISCLAIMER

This warranty applies only to products and manuals that have not been modified or misused, and when products and software are installed, configured, connected, repaired, stored, and operated in compliance with ComNav's official manuals and specifications. ComNav shall not be liable for problems or performance issues caused by:

Use in combination with hardware, software, information, data, systems, interfaces, or devices not manufactured, supplied, or specified by ComNav;

Any operation of the product or software beyond ComNav's standard specifications;

Unauthorized modification or misuse of the product or software;

Normal wear of consumables (e.g., cables and other accessories).

1.4 CONTACT INFORMATION

From the date of purchase, users receive long-term technical support and upgrade services from ComNav Technology Ltd. For assistance, please contact us. You may also visit our official website for the latest software updates and technical documents.

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2 PRODUCT OVERVIEW

2.1 HOST APPEARANCE & MAIN FEATURES

The appearance of the M30X Integrated Navigation Receiver host is shown in Figure 1 below;

Figure 1. M30X Integrated Navigation Receiver

Key Features:

- Upgraded wireless transmission, supporting 4G and Bluetooth communication;
- Automotive-grade design, IMU meets ASIL B level requirements;
- Self-developed Integrated Navigation Algorithm 4.0, adaptable to multiple motion models;
- Rich interfaces, supporting Automotive Ethernet, CAN, Serial Port, PPS, USB, etc., and supports external wheel speed input;
- Supports high dynamic rate, with 100Hz data output and data storage.

2.2 PACKING LIST

Please inspect the package contents upon receipt. Contact ComNav if items are missing or damaged.

Table 1. M30X System Package Packing List

No.	Item Name	Qty	Picture
1	M30X Main Unit	1	
2	18-Pin Data Cable	1	
3	FAKRA GNSS Antenna Cable (Blue), 3 m	2	
4	4G Antenna (FAKRA), 1.5 m	1	
5	GNSS Antenna	2	
6	Strong Magnetic Mount	2	

2.3 INTERFACE DESCRIPTION

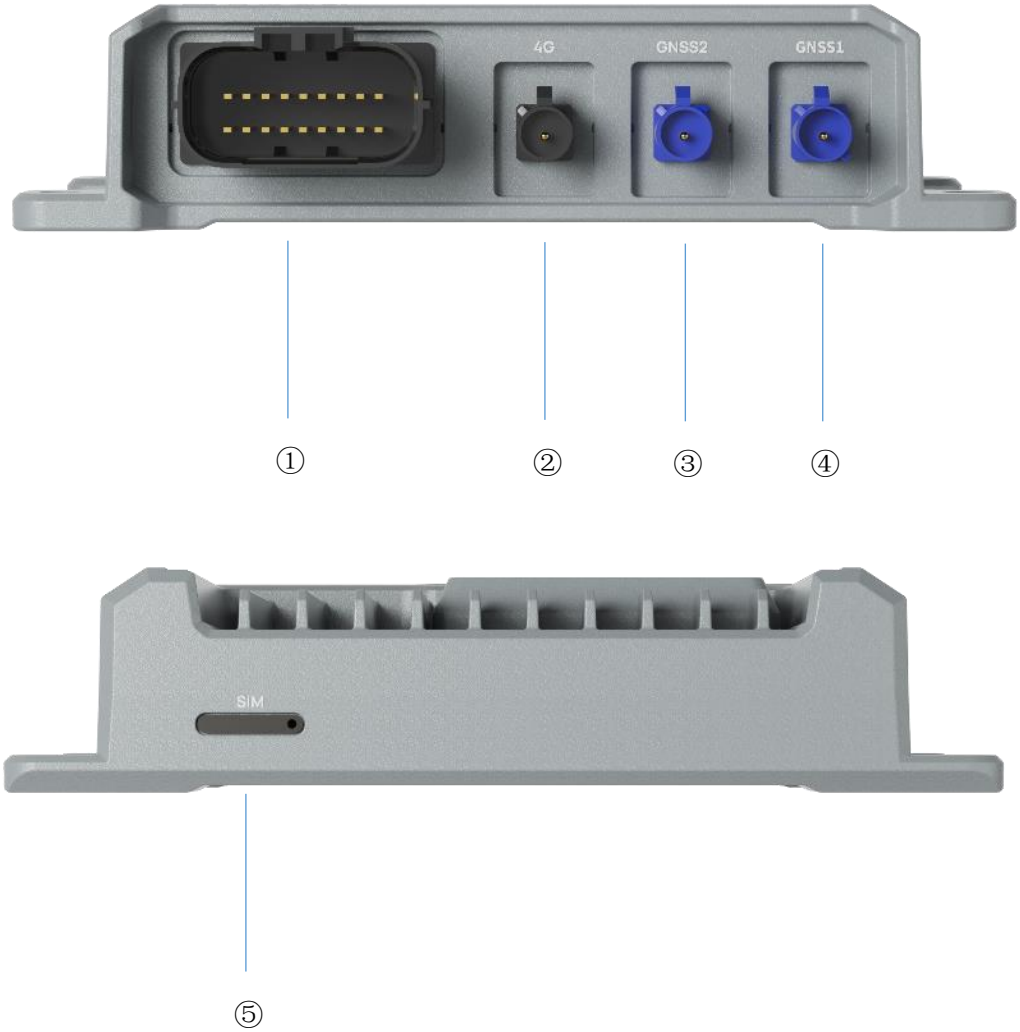


Figure 2. M30X Interface Description

① Data: 18PIN Data Interface (DC + RS232*2 + Automotive Ethernet + PPS + CAN/CAN FD*2 + USB)

② 4G: 4G Antenna Interface, Fakra-A

③ GNSS2: Secondary GNSS Antenna Interface, Fakra-C

④ GNSS1: Primary GNSS Antenna Interface, Fakra-C

⑤ SIM: NANO SIM Card Slot

2.4 INDICATOR DESCRIPTION

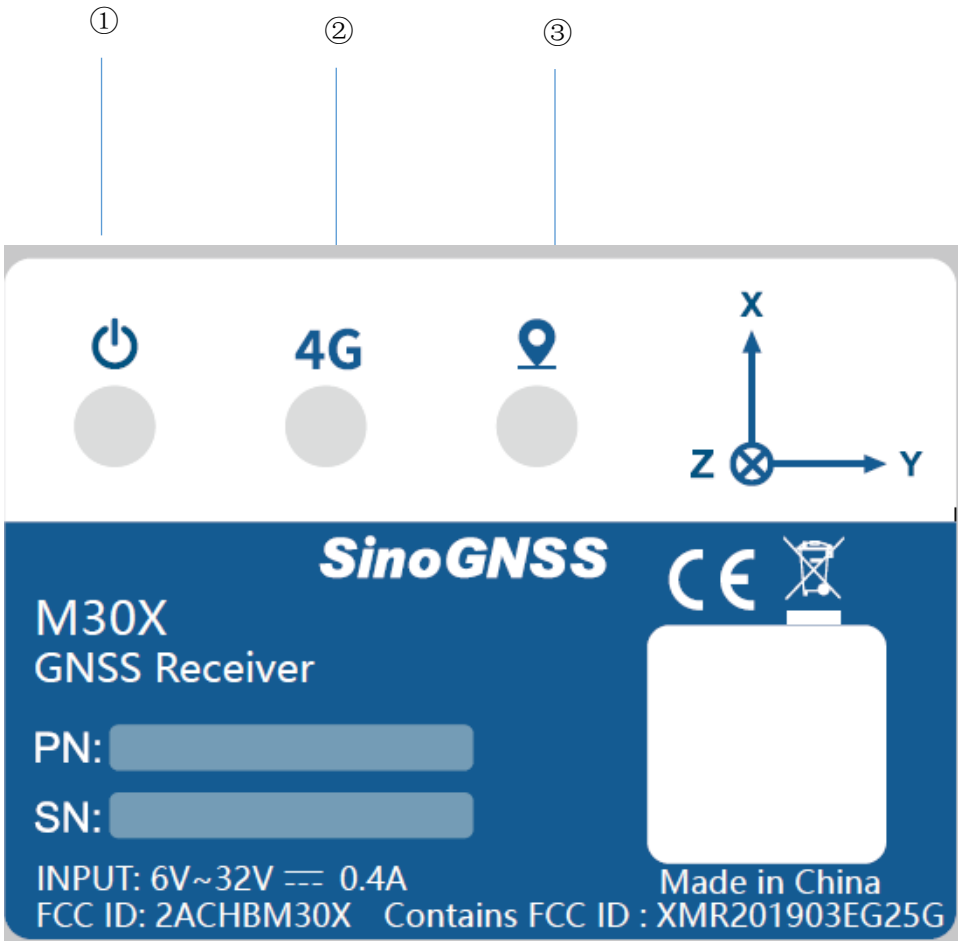


Figure 3. M30X Indicator Description

① Power Indicator: Red steady ON (Normal power supply status)

② 4G: 4G Indicator (Green):

Green blinking: No network / Dial-up failed;

Green fast blinking: 4G communication is normal.

③ Status Indicator (Red/Blue):

OFF: No IMU detected, no GNSS satellite signal detected;

Red blinking: IMU detected, but no GNSS satellite signal, no positioning;

Red steady ON: GNSS positioning available, but IMU abnormal, not detected;

Blue blinking: INS is initializing;

Blue steady ON: INS is in integrated navigation mode.

2.5 WIRING INSTRUCTIONS

This section describes the connection methods for the product. The connection of each accessory to the host is shown in the figure below:

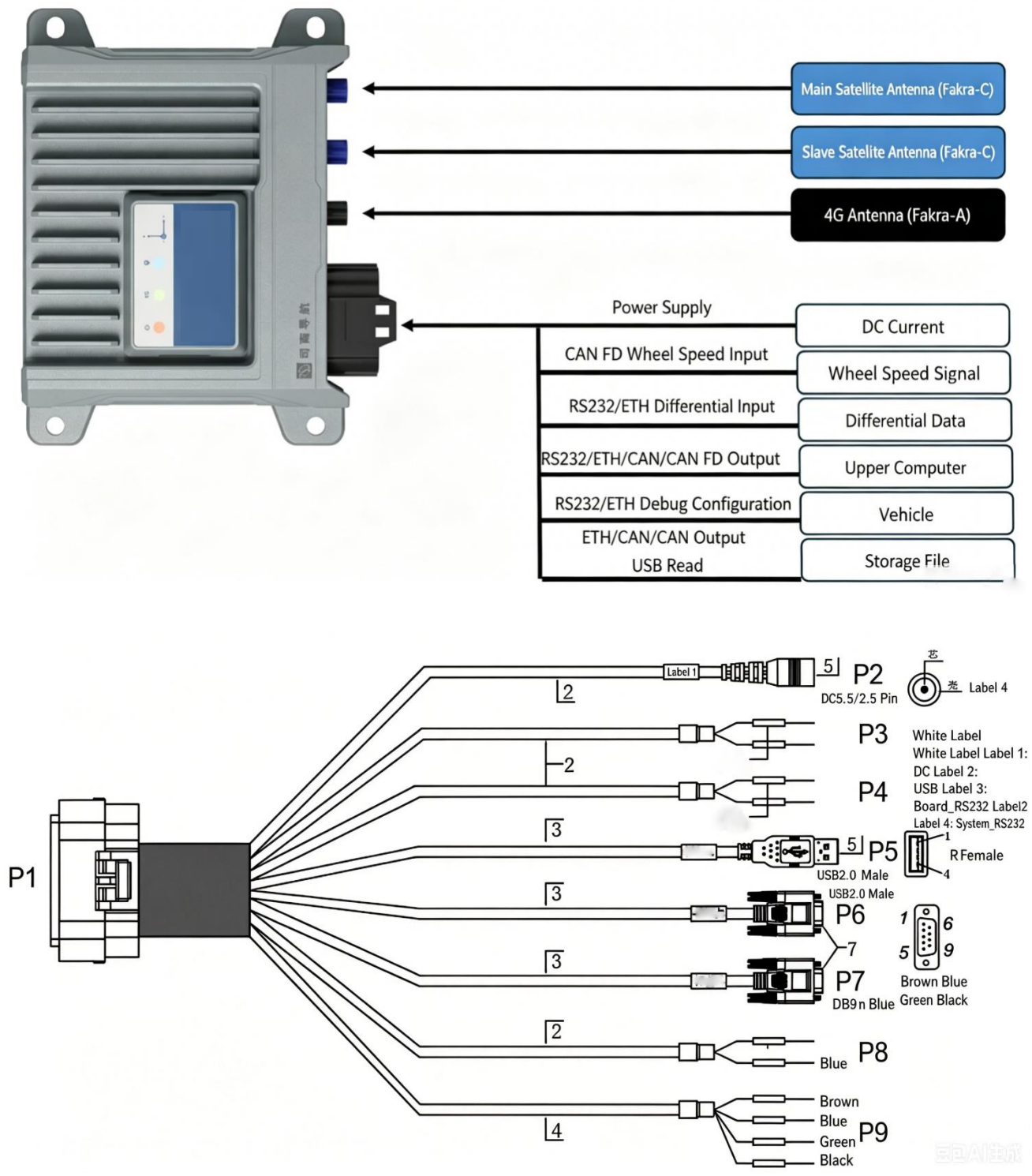


Figure 4. M30X Wiring Diagram

Table 2. Main Interface Pin Description

No.	Signal Definition		Description
1	P2		DC
2	P3	CAN1H	CAN1 High
		CAN1L	CAN1 Low
3	P4	CAN2H	CAN2 High
		CAN2L	CAN2 Low
4	P5	USB	USB
5	P6	COM1	Serial port 1
6	P7	COM2	Serial port 2
7	P8	PPS	PPS 5V
		GND	Power ground reference
8	P9	ENET_P	Etherne P
		ENET_N	Ethernet N
		VCC	12V_OUT
		GND	GND

The connection instructions for the M30X GNSS Receiver and accessories are as follows:

1. Connecting GNSS Antenna Cables: Connect the Fakra-C (Blue) antenna cable Fakra connector to the receiver's Fakra RF port respectively. Note the distinction between primary and secondary antennas.

2. Connecting 18-core Data Cable: Align the clip on the 18-pin male connector of the data cable with the receiver's female port, then insert it.

3. Connecting Power: After connecting the 18-core data cable to the receiver, connect the DC power connector on the data cable to an external power supply or battery. The receiver will power on automatically. (Note: Do not reverse the polarity of the external power supply. The input voltage must be DC 6V~32V)

4. Connecting Serial Port: The M30X is equipped with two serial ports, COM1 and COM2. Connect the DB9 female end of the data cable to a computer or other communication device to transmit

integrated navigation messages via commands. (Note: The baud rate of the external sensor must match that of the receiver)

5. Connecting Automotive Ethernet: After connecting the 18-core data cable to the receiver, connect the automotive Ethernet wires at the other end of the cable to other automotive Ethernet communication devices. If you need to connect to a computer or other industrial Ethernet devices, you need to use an Automotive Ethernet to Industrial Ethernet converter. The Ethernet port supports IPv4 network layer, TCP/UDP transmission, which can be used for remote debugging, receiving differential data, outputting position and attitude information, or firmware upgrade.

6. Connecting CAN/CAN FD: After connecting the 18-core data cable to the receiver, connect the bare wires at the other end to your synchronization device. The GND signal must be connected to the ground of your device. The M30X provides PPS as a time synchronization signal, which can be used as needed. The device outputs PPS pulse signal by default, whose rising edge is synchronized with GPS time, with a synchronization accuracy of 20ns when GNSS signal is good.

7. Connecting Odometer: The M30X supports odometer connection. Wheel speed information can be forwarded to the M30X according to the DBC protocol, which improves the integrated navigation positioning accuracy when satellite signal is lost. Please configure this as needed.

8. Connecting USB: You can copy the message files stored on the M30X via the USB interface. After connecting the 18-core data cable to the receiver, connect the USB interface to a computer to perform data copy operations.

3 INSTALLATION INSTRUCTIONS

Please read this section carefully before installing the M30X Integrated Navigation Receiver to avoid affecting positioning results.

3.1 ANTENNA INSTALLATION

First install the GNSS antenna from the package onto the suction cup mount, then rigidly connect the suction cup mount to the carrier to ensure the antenna does not shift or shake when the carrier moves. The GNSS antenna should be placed horizontally; if tilting is required, the angle should not exceed 15°. Meanwhile, the area above the GNSS antenna should be open and unobstructed. Finally, screw the TNC connector of the RF cable to the antenna's TNC port tightly.

3.2 MAIN UNIT INSTALLATION

The device should be installed stably and rigidly connected to the carrier, ensuring the relative positions of the device, antenna, and carrier remain fixed. The requirements for the installation area are as follows:

1. The device should be installed on a rigid structural surface, which requires the flatness of the surface to be less than 1° (flatness refers to the pitch and roll angle of the rigid surface relative to the horizontal plane);
2. The heating temperature of interfering units around the device must be lower than 85℃;
3. There should be no vibration interference units within 50cm around the device. Keep away from vibration sources such as engines, subwoofers, and other locations with strong vibration. The frequency bands that the IMU needs to avoid are: 15.8kHz-17.8kHz, 28-35.6kHz, 44kHz, 18.3-20.3kHz, 1.9-2.1kHz;
4. The device should be kept away from locations with complex electromagnetic environment, such as near lidar, instrument panel, etc.

The recommended installation method is shown in Figure 5 below:

1. Horizontal installation, with horizontal angle less than 5°;

2. The X-axis of the device points to the forward direction of the carrier, the Y-axis is perpendicular to the forward direction to the right, and the Z-axis points downward;
3. The X-axis of the device should be parallel to the longitudinal central axis of the vehicle, with the distance as small as possible, less than 70cm;
4. Install the device at or near the center of the carrier's rear axle;

If the device orientation does not meet the above requirements, you can also use horizontal deflection arrangement. It is recommended that the deflection angle be an integer multiple of 90°.

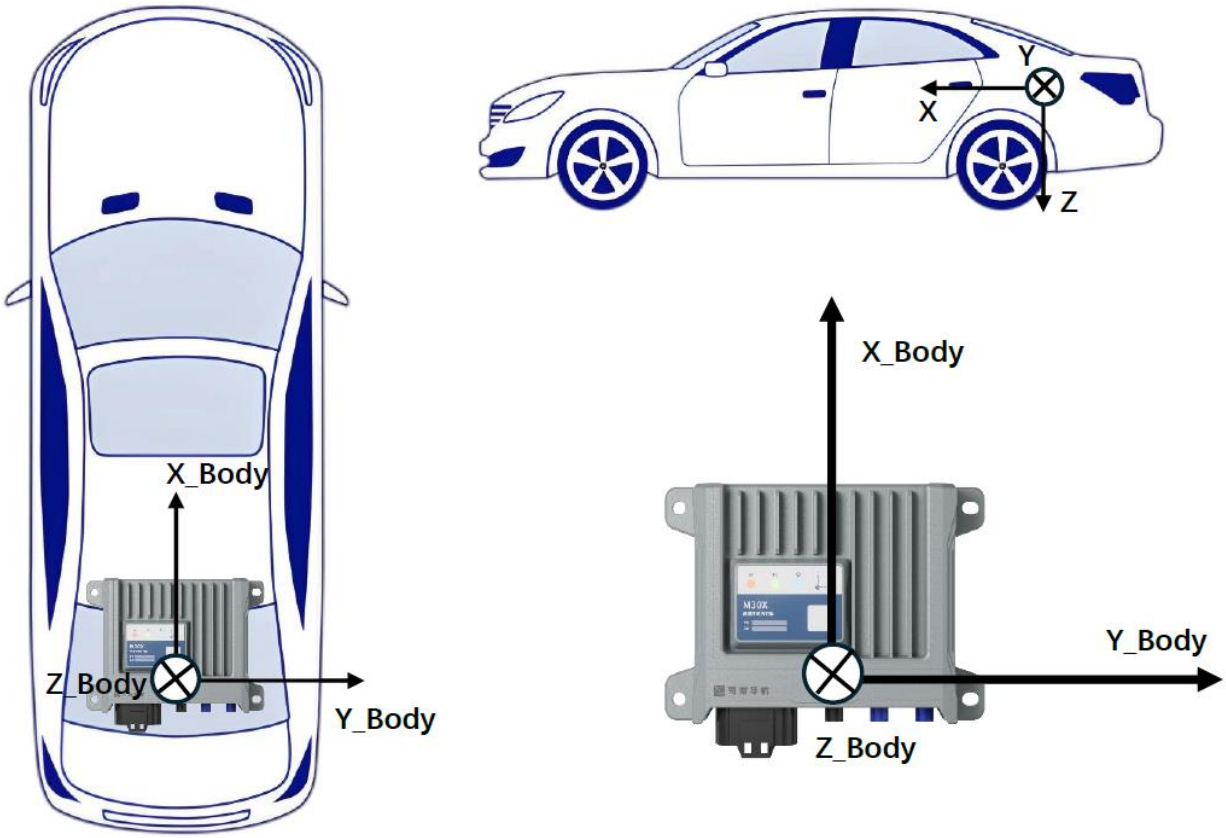


Figure 5. M30X Installation Diagram

4 RECEIVER CONFIGURATION

The M30X Integrated Navigation Receiver can be configured via the NavMaster APP.

4.1 APP CONFIGURATION

NavMaster APP is an Android application for high-precision GNSS navigation, which supports status monitoring and parameter configuration for the M30X receiver. You can scan the QR code below or visit our official website https://www.sinognss.com to download the latest installation package and technical documents.

Figure. NavMaster APP Icon & Download QR Code

4.1.1 Bluetooth Connection

Operation Steps:

1. Open the APP, select [Nearby], then click [Start Search] (this function requires enabling Bluetooth on your phone).
2. Search Devices: Available devices will be displayed as shown in the figure.
3. Connect Device: Click the device in the list to initiate connection.
4. Connection Successful: After successful connection, the APP will enter the main interface as shown below.

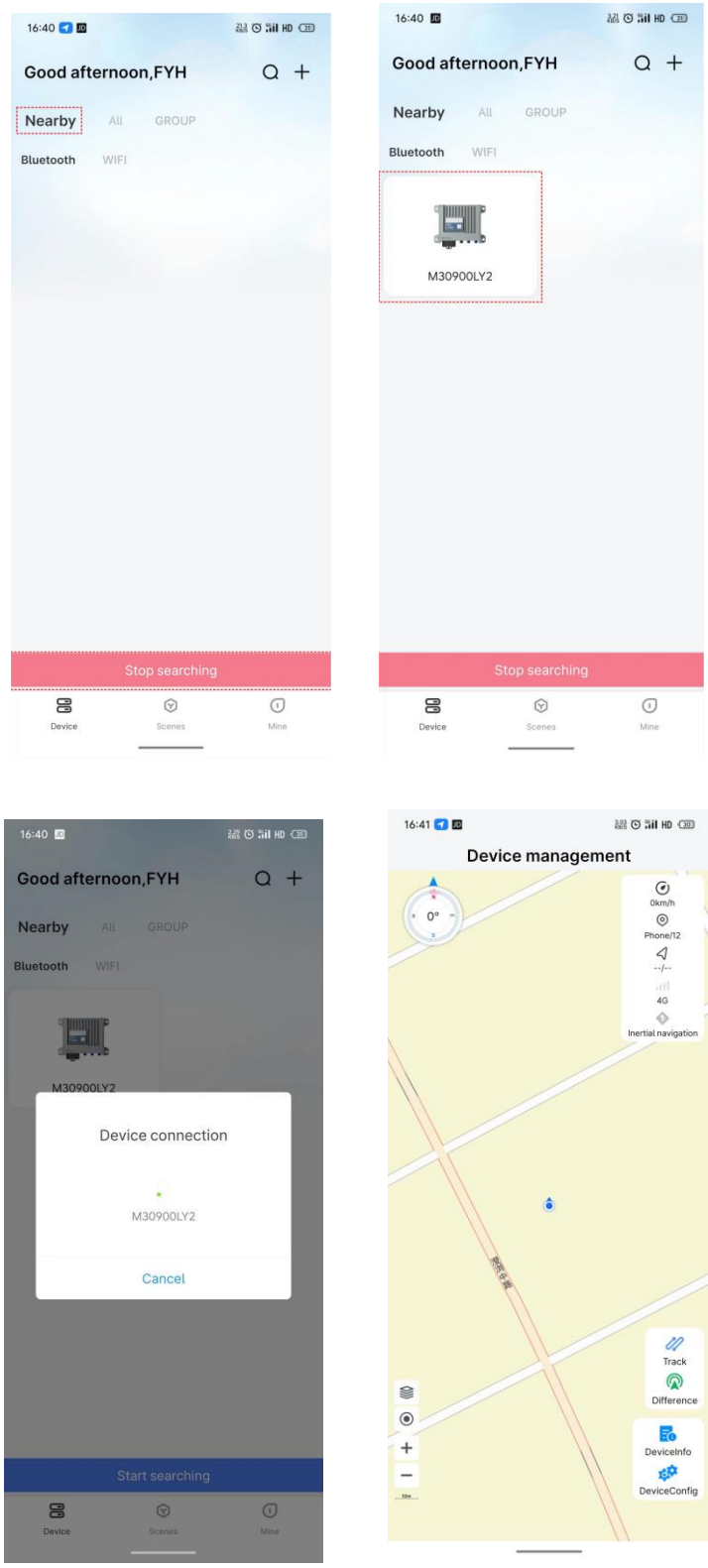


Figure. Bluetooth Connection

4.1.2 Main Interface Description

1. Heading Icon: Displays the device's heading value.
2. Speed Icon: Displays the device's moving speed.
3. Positioning Icon: Displays the positioning solution status and satellite count. Click to quickly enter the Satellite Radar interface.
4. Orientation Icon: Displays the orientation solution status and satellite count. Click to quickly enter the Satellite Radar interface.
5. 4G Icon: Displays 4G signal strength. Click to quickly enter the 4G interface.
6. INS Icon: Displays the INS initialization status. The icon is gray when uninitialized, and blue when initialization is successful. Click to quickly enter the Installation Configuration interface.
7. Trajectory Icon: Trajectory button, click to enter the trajectory recording interface.
8. Differential Icon: Displays differential status. The icon is green when differential is available, gray when not. Click to quickly enter the Differential Configuration interface.
9. Device Info Icon: Click to select the device information to view, including Host Info, Status Info, Satellite Radar, and Attitude.
10. Device Config Icon: Click to select the parameters to configure, including 4G, Port Configuration, Data Transmission, Installation Configuration, Data Storage, and Host Control.
11. Map Control Icon: Button '+' zooms in the map, button '-' zooms out the map, button '◎' locks the device position, button '▤' switches map mode: Satellite Map / Standard Map.

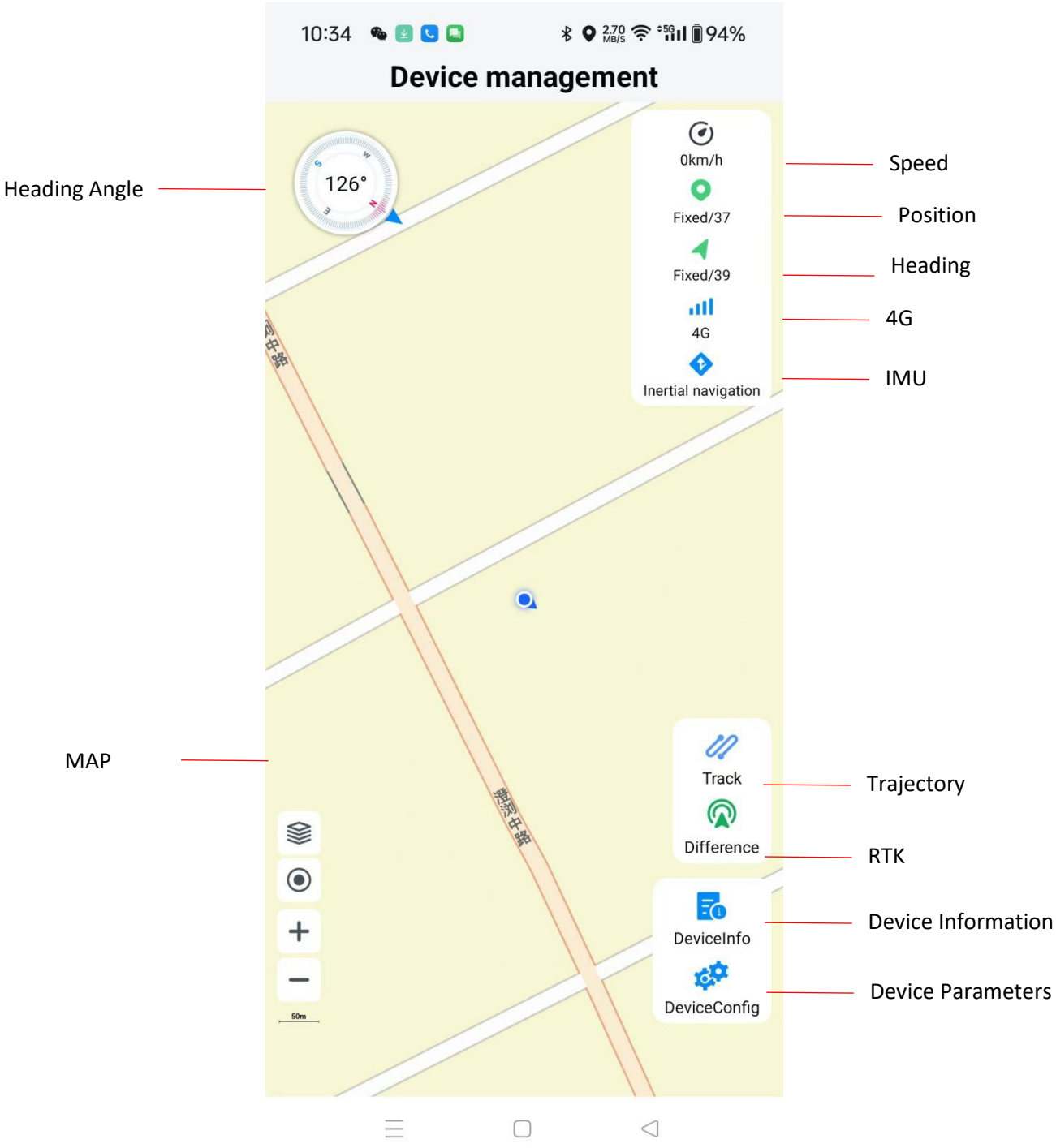


Figure. Main Interface Description

4.1.3 Host Information

Operation Steps:

1. Click [Device Info].
2. Click [Host Info].

3. View device model, device SN, system firmware version, board firmware version, hardware version, INS driver, and Ethernet MAC. The normal display is as shown in the figure.

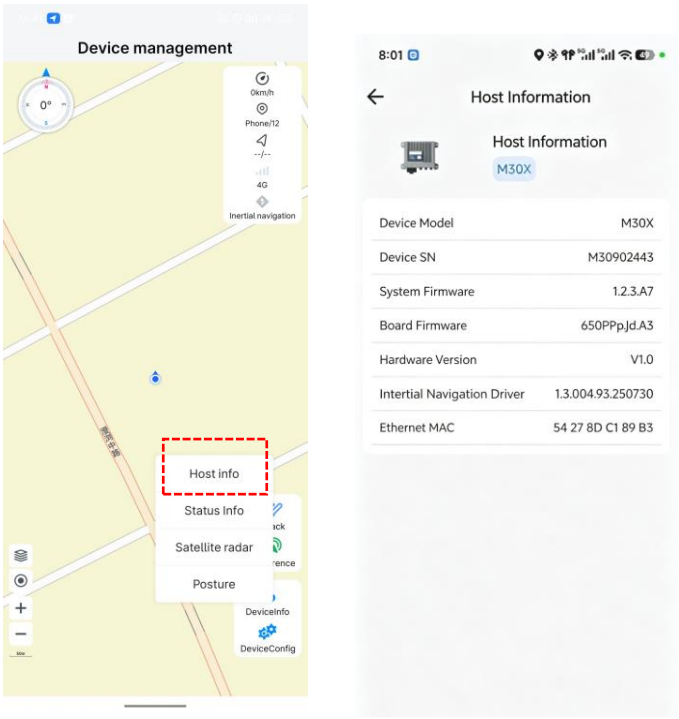


Figure. Host Information

4.1.4 Status Information

Operation Steps:

1. Click [Status Info].
2. View the status of Data Storage 1 and 2, storage capacity, differential source, INS self-test status, INS status (Initialized / Uninitialized), and 4G startup status.

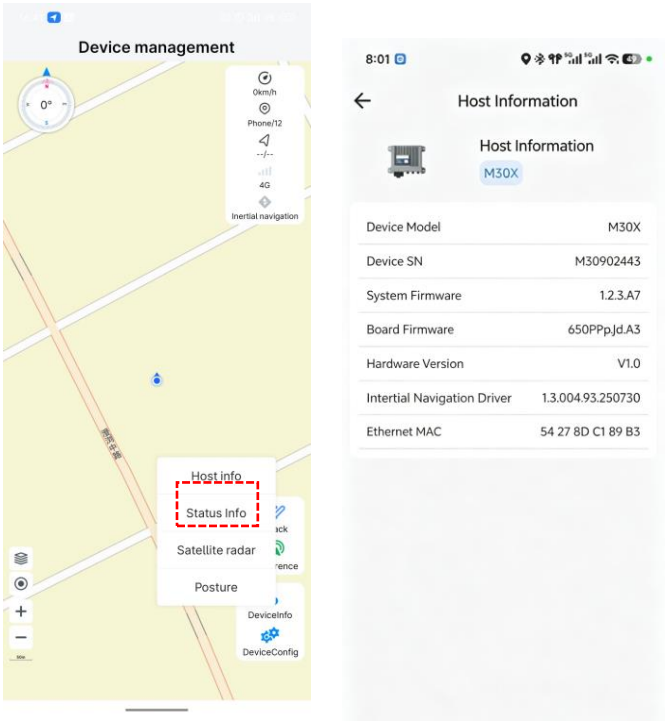


Figure. Status Information

4.1.5 Satellite Radar

Operation Steps:

1. Click [Satellite Radar]: Displays UTC time, sky plot, and positioning information. Positioning information includes latitude and longitude, positioning status, angle, speed, antenna signal quality, and HDOP, as shown in the figure.
2. In the [Satellite Radar] interface, click [SNR] to view the satellite SNR bar chart, which intuitively reflects the satellite signal quality.
3. Click [Satellite Information] on the [Satellite Radar] page to view the satellite search status: Sat indicates the number of searched satellites (G for GPS, B for BDS, R for GLONASS, and E for GALILEO). Azi stands for azimuth angle, Ele stands for elevation angle. L1/L2/L5 represent the signal-to-noise ratio of corresponding frequency points, and B1C/B2a refer to the exclusive signal-to-noise ratio of BDS-3.

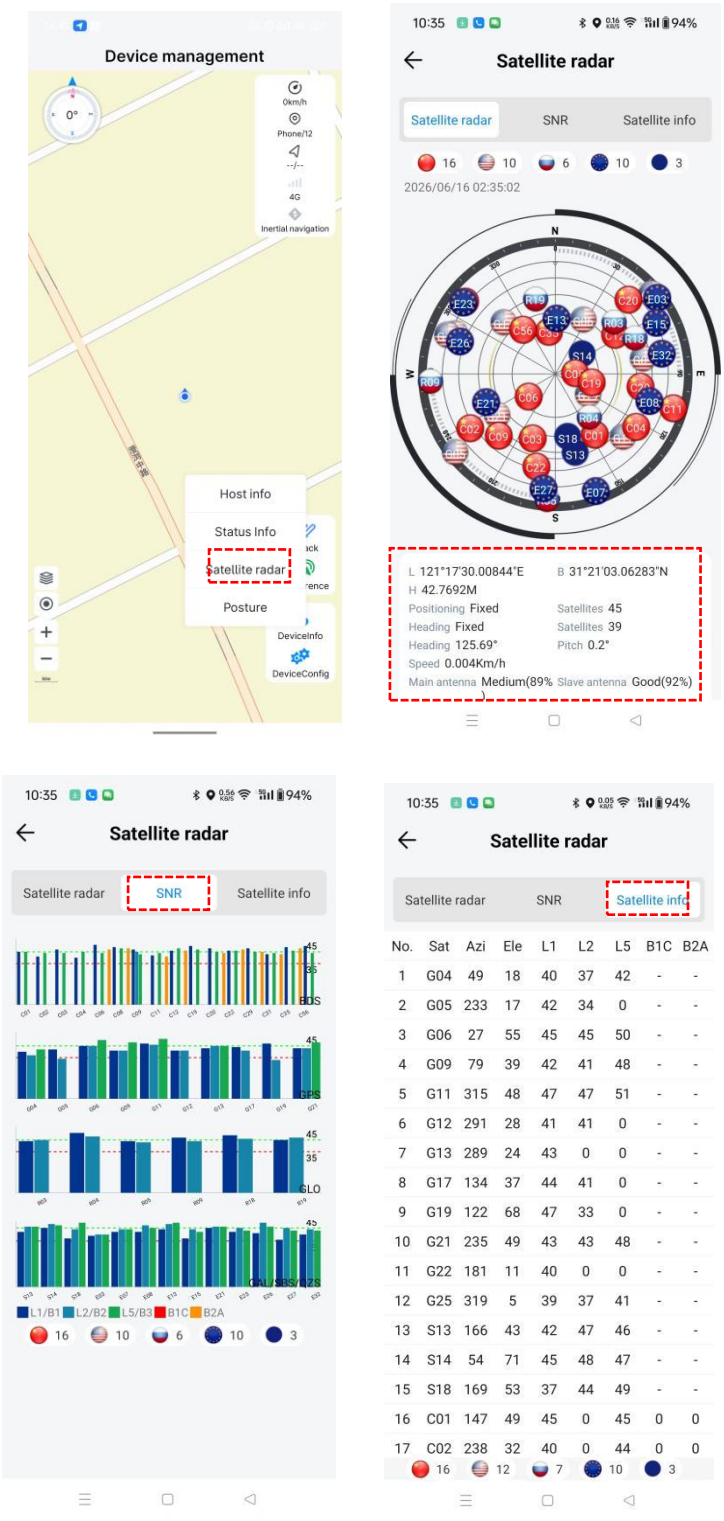


Figure. Satellite Radar

4.1.6 Attitude

Operation Steps:

1. Click [Attitude].
2. View the changes of IMU acceleration and gyroscope values, which can be displayed as dynamic curves. Swipe down to view the gyroscope curve information, as shown in the figure.

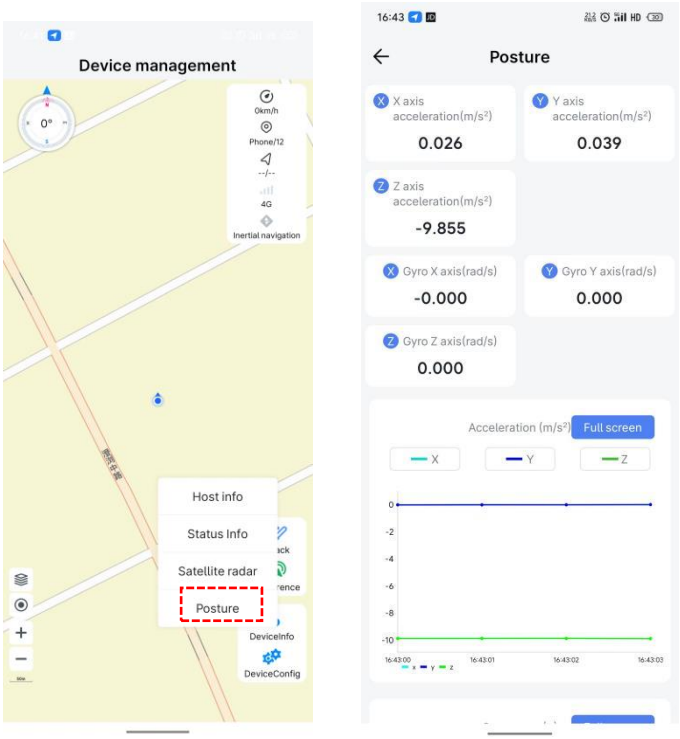


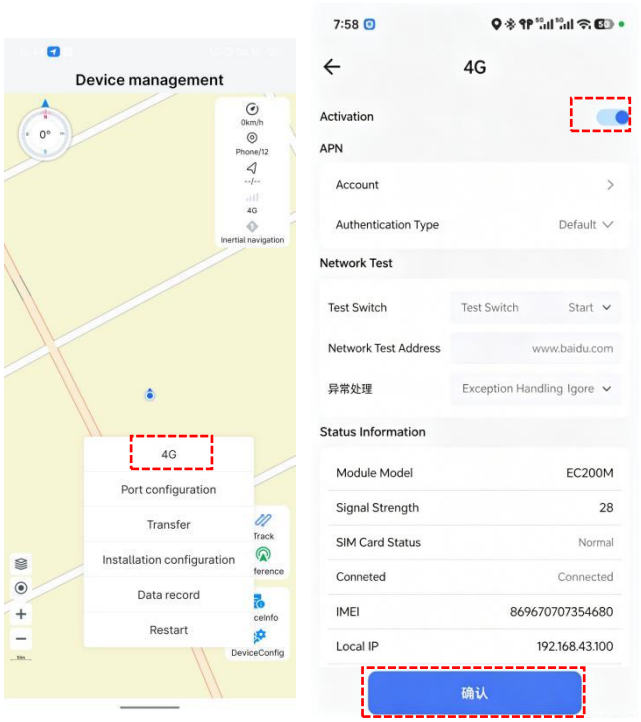
Figure. Attitude

4.1.7 4G Configuration

Operation Steps:

1. Click [Device Config], then click [4G].
2. Turn on the [Switch] for Mobile Network and click Confirm.
3. If 4G connection is normal, the signal strength, SIM status, and network status will be displayed correctly.
4. Signal Strength: When the signal is between 20 and 30, the strength is normal. There are two SIM status: Normal when SIM is inserted, No SIM detected when no SIM is inserted. There are two network status: Normal when network is connected, Not connected when connection failed.
5. If your 4G card is an intranet or private card, you need to set the [APN] separately. The setting dialog is shown in the figure (you need to turn off the 4G switch first before clicking settings).

Note: The receiver does not support hot-swapping of 4G SIM cards. Please confirm the SIM card is inserted before powering on.



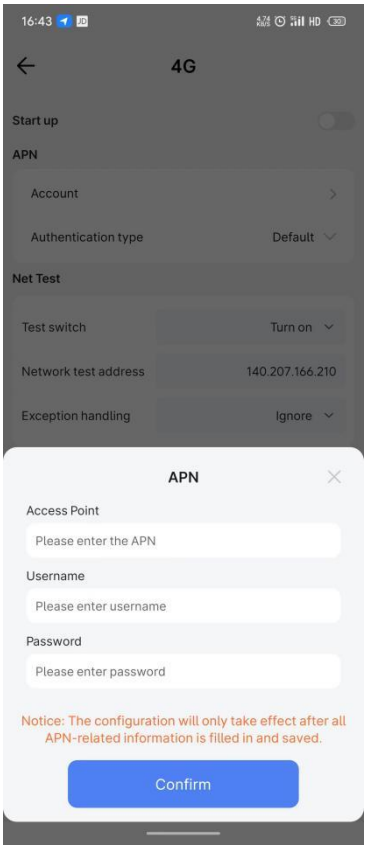


Figure. 4G Configuration

4.1.8 Differential

Operation Steps:

1. Click [Differential] on the main interface.
2. Select the network differential source. For network transmission, you can select [Ntrip Client] or [NET]. For serial transmission, you can select [COM1].
3. When selecting [Ntrip Client], you need to enter the IP address, port, username, password, and mount point.

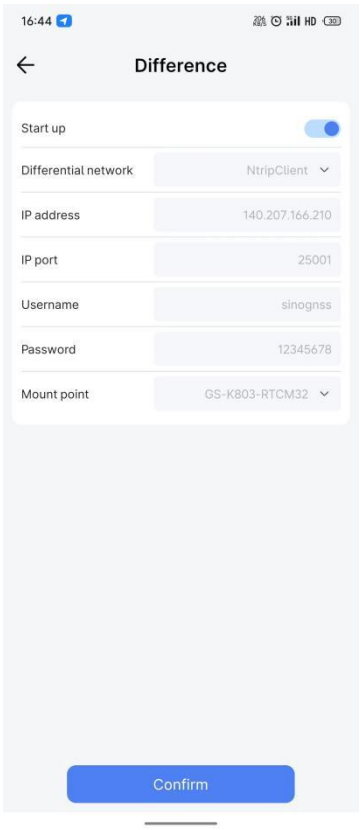


Figure. Differential Configuration

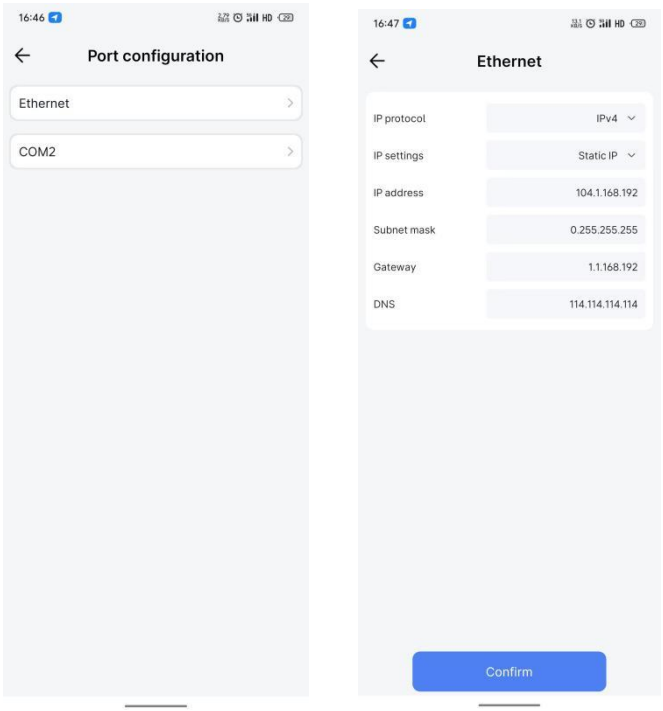
4.1.9 Port Configuration

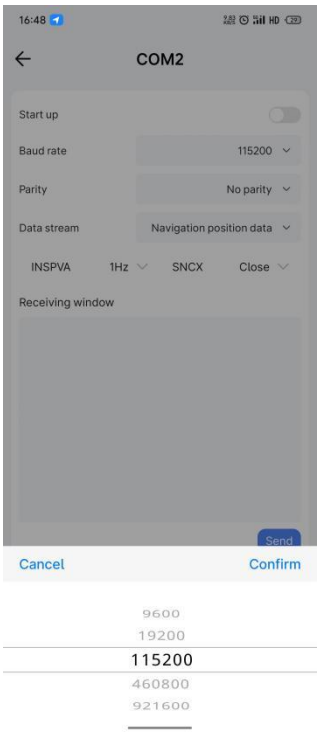
Operation Steps:

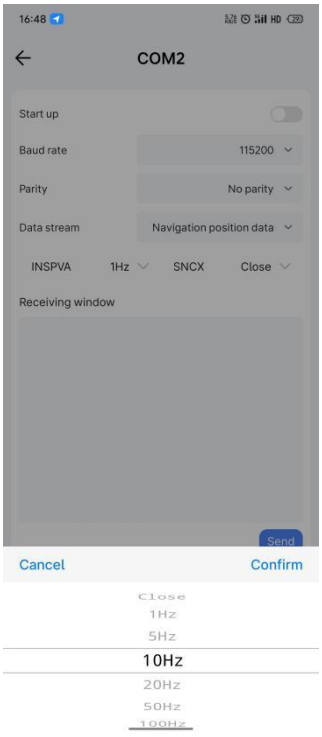
1. Click [Device Config], then click [Port Config] to enter the port configuration interface.
2. Click [Ethernet] to configure the device's Ethernet IP address, subnet mask, gateway, DNS, etc. In addition, since computers cannot recognize Automotive Ethernet, you need to use a corresponding

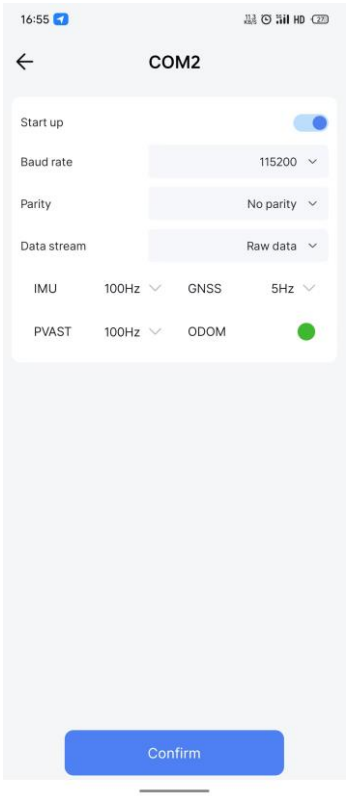
interface converter to enable communication between the computer and the device after configuring the Automotive Ethernet via the APP.

3. Click [COM2] to configure the COM2 serial port baud rate and output messages, including navigation positioning data INSPVA and SNCX, and raw data IMU and GNSS. The baud rate can be selected from 9600/19200/115200/460800/921600. The data rate for INSPVA and SNCX can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The default rate for raw data is IMU 100Hz / GNSS 5Hz / PVAST 100Hz. You can send commands and view the output response in the receive window.
4. Click [CAN1] to configure the CAN1 baud rate and data types, including time, position, velocity, attitude, and IMU. The arbitration baud rate can be selected from 100K/125K/250K/500K/1000K, and the data baud rate can be selected from 125K/250K/500K/1000K/2000K/4000K/8000K. The data rate can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz.
5. Click [CAN2] to configure the CAN2 baud rate and data types, including time, position, velocity, attitude, and IMU. The arbitration baud rate can be selected from 100K/125K/250K/500K/1000K, and the data baud rate can be selected from 125K/250K/500K/1000K/2000K/4000K/8000K. The data rate can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz.




16:48
COM2
Start up
Baud rate
115200
Parity
No parity
Data stream
Navigation position data
INSPVA
1Hz
SNCX
Close
Receiving window
Send
Cancel
Confirm
9600
19200
115200
460800
921600


16:48
COM2
Start up
Baud rate
115200
Parity
No parity
Data stream
Navigation position data
INSPVA
1Hz
SNCX
Close
Receiving window
Send
Cancel
Confirm
Close
1Hz
5Hz
10Hz
20Hz
50Hz
100Hz


16:55
COM2
Start up
Baud rate
115200
Parity
No parity
Data stream
Raw data
IMU
100Hz
GNSS
5Hz
PVAST
100Hz
ODOM
Confirm

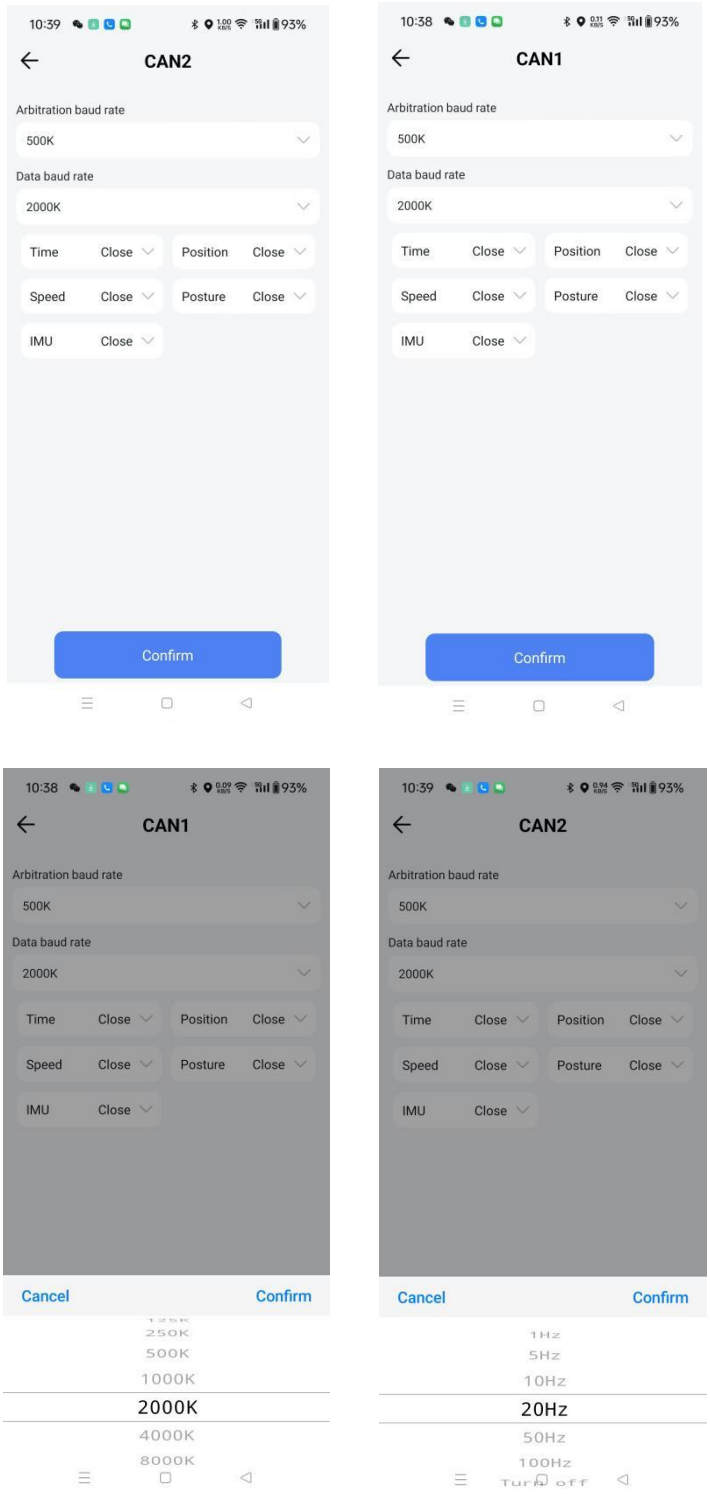
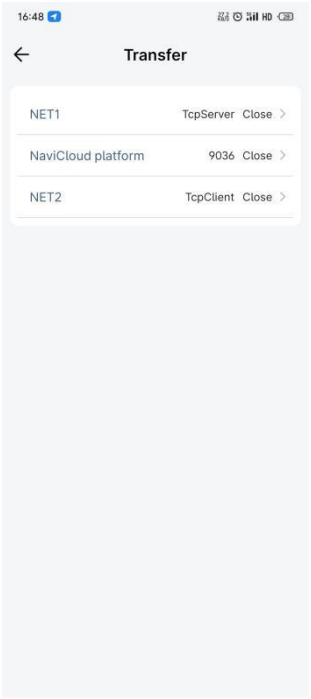


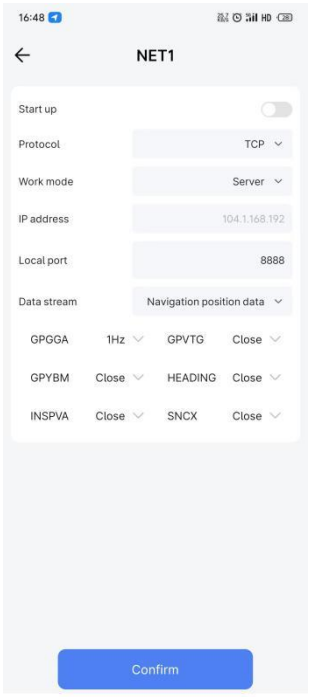
Figure. Port Configuration

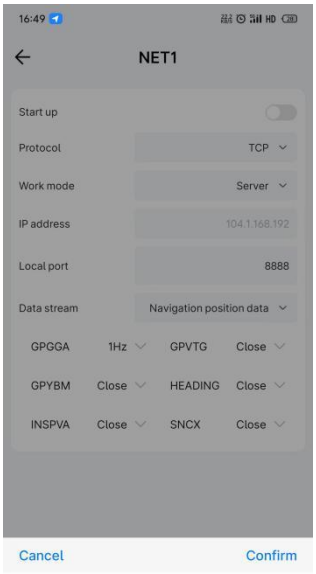
4.1.10 Data Transmission

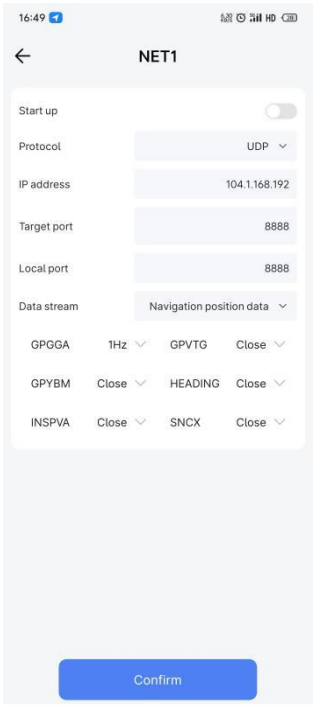
Operation Steps:

1. Click [Data Transmission] to configure 3 channels of network transmission and the NavCloud address.
2. Click [NET1], select the protocol TCP or UDP. Under TCP protocol, you can set the device as client or server, configure the IP address and port, and select the data stream as navigation positioning data or raw data. The data rate for INSPVA and SNCX can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The default rate for raw data is IMU 100Hz / GNSS 5Hz / PVAST 100Hz.
3. Click [NET2], select the protocol TCP or UDP. Under TCP protocol, you can set the device as client or server, configure the IP address and port, and select the data stream as navigation positioning data or raw data. The data rate for INSPVA and SNCX can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The default rate for raw data is IMU 100Hz / GNSS 5Hz / PVAST 100Hz.
4. Click [NET3], select the protocol TCP or UDP. Under TCP protocol, you can set the device as client or server, configure the IP address and port, and select the data stream as navigation positioning data or raw data. The data rate for INSPVA and SNCX can be selected from 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The default rate for raw data is IMU 100Hz / GNSS 5Hz / PVAST 100Hz.
5. Click [NavCloud] to configure the IP address and port of the remote maintenance platform.


16:48
Transfer
NET1 TcpServer Close
NaviCloud platform 9036 Close
NET2 TcpClient Close


16:48
NET1
Start up
Protocol TCP
Work mode Server
IP address 104.1.168.192
Local port 8888
Data stream Navigation position data
GPGGA 1Hz GPVTG Close
GPYBM Close HEADING Close
INSPVA Close SNCX Close
Confirm


16:49
NET1
Start up
Protocol TCP
Work mode Server
IP address 104.1.168.192
Local port 8888
Data stream Navigation position data
GPGGA 1Hz GPVTG Close
GPYBM Close HEADING Close
INSPVA Close SNCX Close
Cancel
Confirm
TCP
UDP


16:49
NET1
Start up
Protocol UDP
IP address 104.1.168.192
Target port 8888
Local port 8888
Data stream Navigation position data
GPGGA 1Hz GPVTG Close
GPYBM Close HEADING Close
INSPVA Close SNCX Close
Confirm

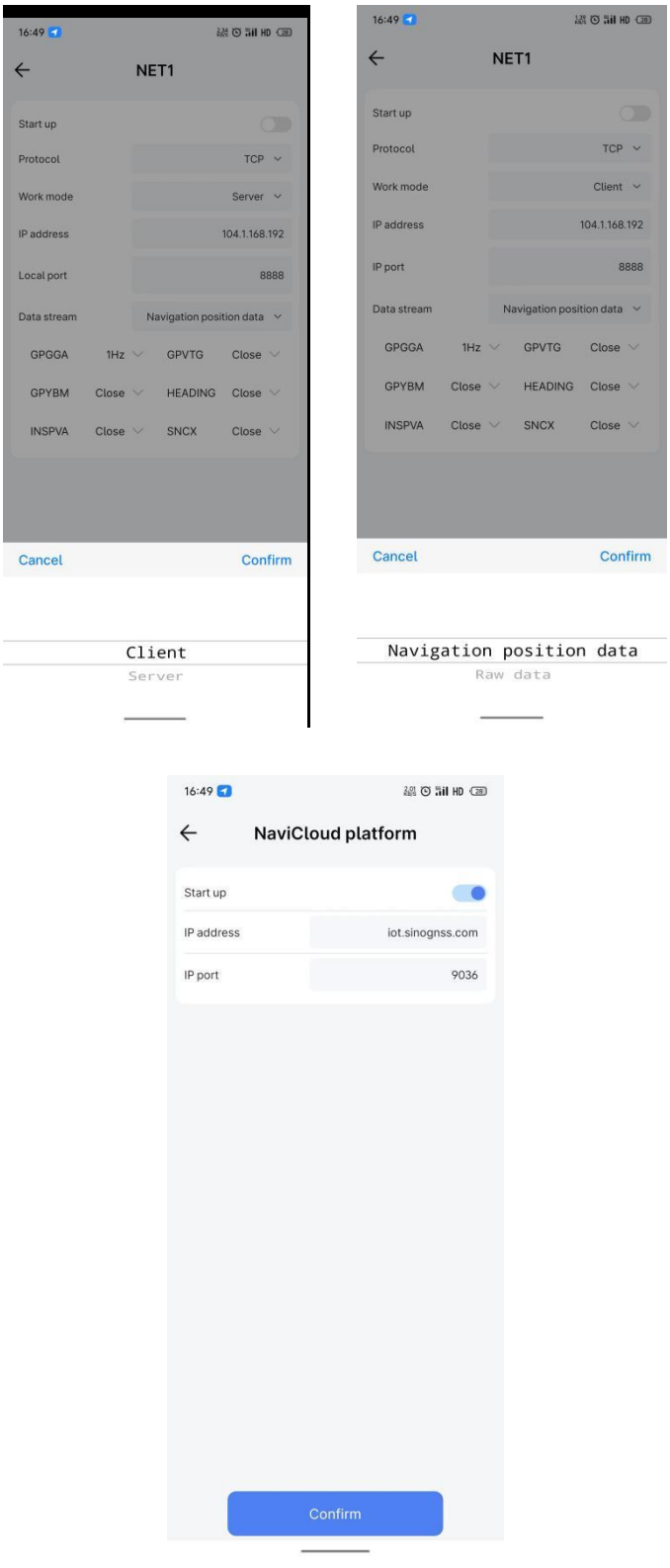


Figure. Data Transmission

4.1.11 Installation Configuration

Operation Steps:

1. Click [Installation Configuration] to enter the device installation parameter configuration interface. You can configure the device installation method, antenna installation method, carrier model, antenna lever arm, and rear axle center lever arm.
2. Device Status: Uninitialized, Initialization Complete. Reminds you of the initialization status.
3. INS Status: INS system inactive, INS system aligning, INS alignment complete but insufficient dynamics for convergence, INS accuracy poor (GNSS signal may be poor), INS in navigation mode with high accuracy, INS accuracy poor (GNSS signal lost). Normally, after INS convergence is complete, the INS status will indicate that the INS system has high accuracy.
4. Initialization Speed: Set the minimum speed for INS initialization. The minimum value is 0.1, the maximum value is less than 500, unit: m/s.
5. Device Installation Method: There are 8 installation methods. Please select the corresponding method according to the actual installation direction of the device relative to the vehicle's driving direction. The X/Y axes are the INS reference directions. It also supports custom installation method. After selecting custom, you need to fill in the specific X/Y/Z axis rotation angles on the main interface.

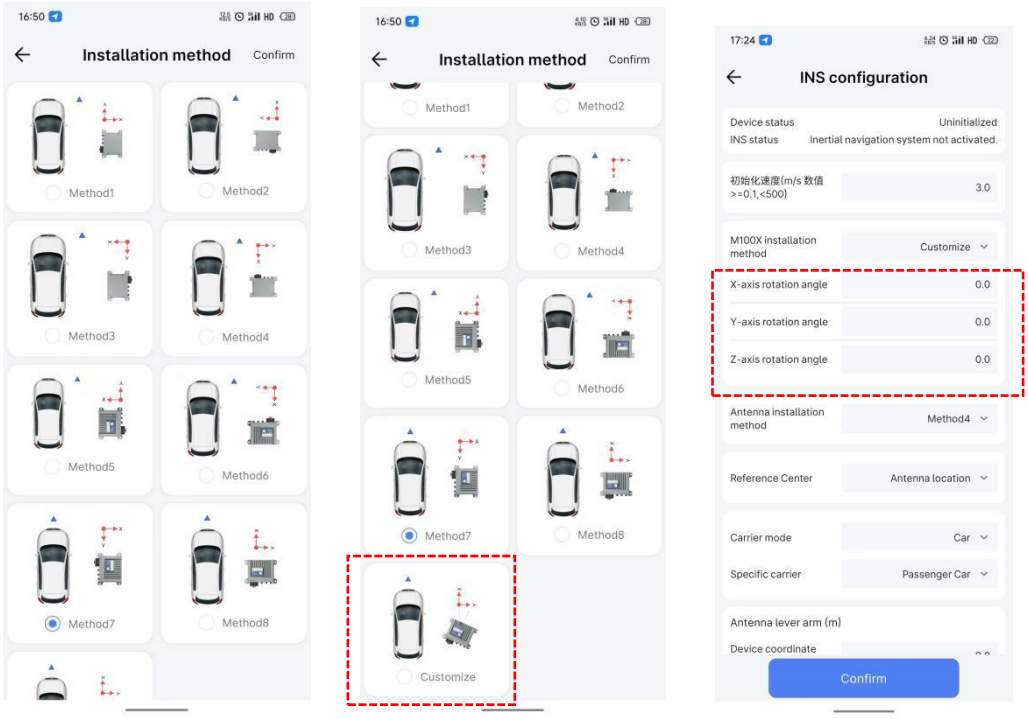


Figure. Device Installation Method

Custom Installation Angle Description:

The attitude deviation between the device coordinate system and the vehicle coordinate system is called the device rotation parameter or device installation angle, which is essentially the Euler angle rotation from the device coordinate system to the vehicle coordinate system. The figure below shows the rotation parameters from the device coordinate system to the vehicle coordinate system.

Where, X/Y/Z represent the rotation angles around the X/Y/Z axes, unit: deg.

The rotation rules are as follows:

1. Rotate from the Vehicle Frame coordinate system to the Body Frame coordinate system;
2. Rotate in the order Z → Y → X;
3. The rotation direction of the coordinate axes follows the right-hand rule.

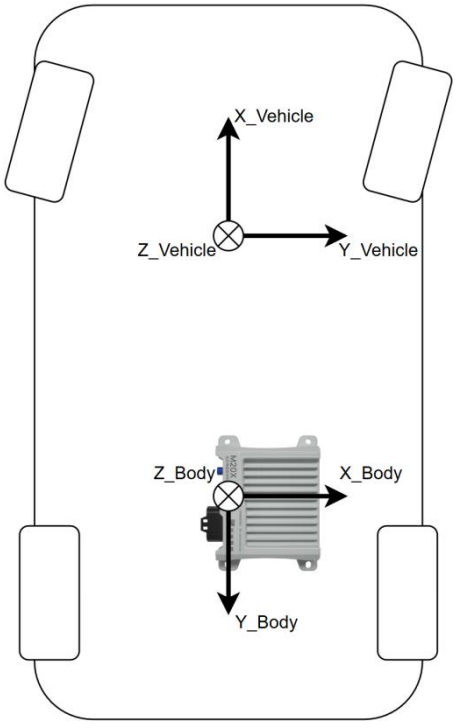


Figure. Top View of Vehicle and Device

Take the figure as an example. For this installation method, rotating from the vehicle coordinate system to the device coordinate system requires rotating 90 degrees around the positive Z axis. Therefore, the Euler angles from the device coordinate system to the vehicle coordinate system are:

X: 0, Y: 0, Z: 90.

Note: The Euler angles from the device coordinate system to the vehicle coordinate system should be measured as accurately as possible. If there is an error in the configured rotation parameters, online calibration is required.

6. Antenna Installation Method: There are 4 installation methods. Please select the corresponding option according to the actual installation position of the primary and secondary antennas. It also supports custom installation method. After selecting custom, you need to fill in the specific installation angle, which is the clockwise rotation angle of the secondary antenna relative to the primary antenna.

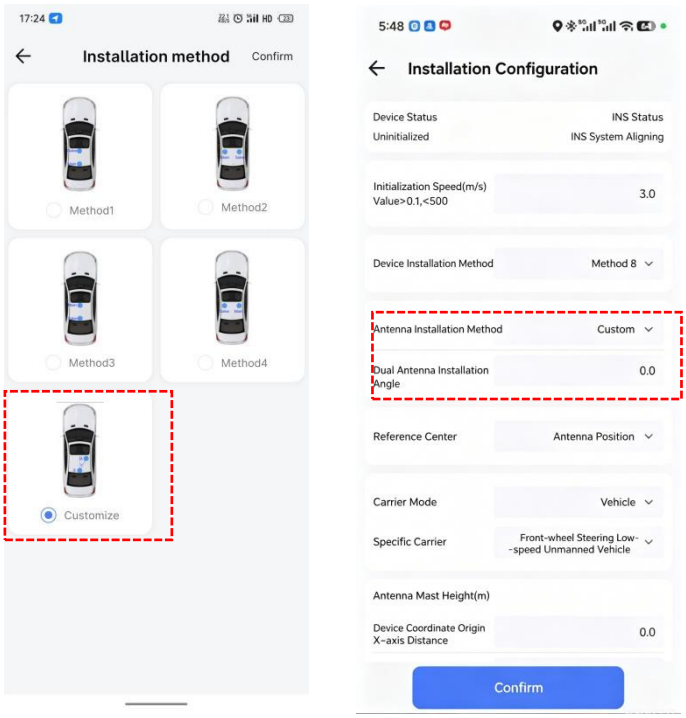


Figure. Antenna Installation Method

7. Reference Center: The reference center is the actual position where the device outputs the latitude and longitude coordinates. You can select Primary Antenna Position, Rear Axle Center, or Custom (Custom means the distance of the selected point relative to the origin of the device coordinate system along the X/Y/Z axes). For example, if you select Primary Antenna Position, the latitude and longitude output by the device is actually the position of the primary antenna. If you set the custom coordinates to 0,0,0, the device will output the position of the origin of the device coordinate system.

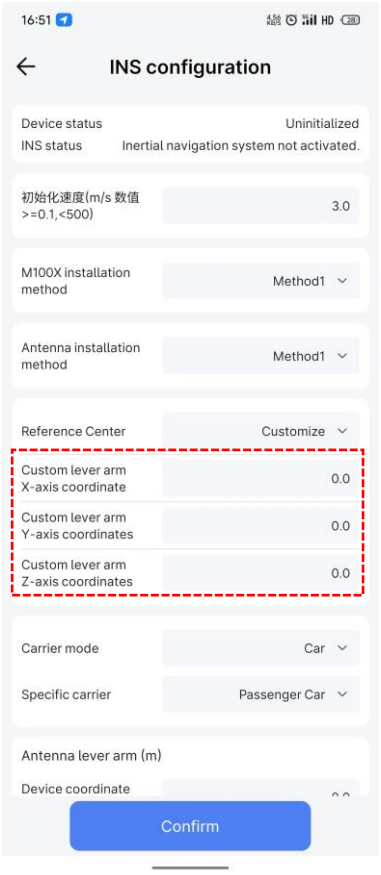


Figure. Reference Center

8. Carrier Mode: You can select from three modes: Vehicle, Aircraft, and Ship. Please select the corresponding model according to your actual carrier.

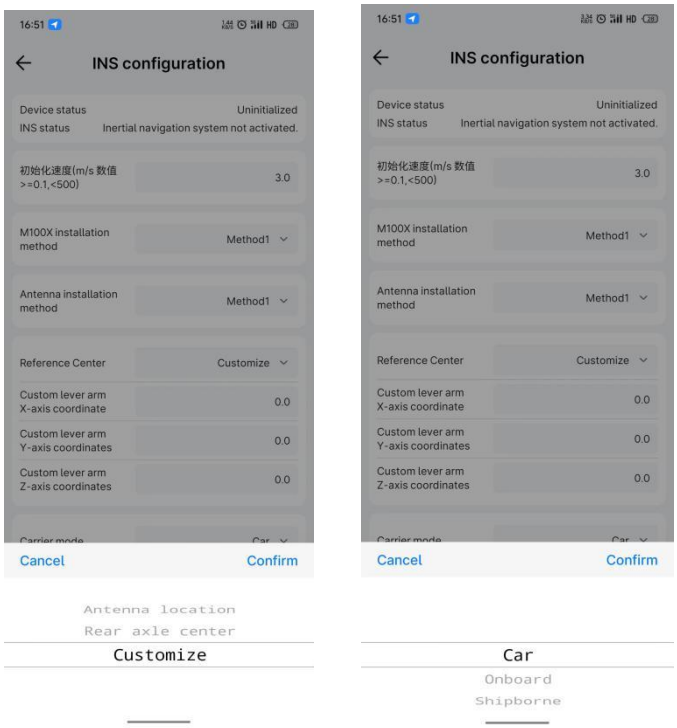


Figure. Carrier Mode

9. Specific Carrier: You can select from Passenger Car, Front-wheel Steering Low-speed UGV, Multi-wheel Steering Low-speed UGV, Two-wheel Steering Low-speed UGV, Four-wheel Steering Low-speed UGV. Selecting the corresponding model according to your actual carrier will achieve better results.

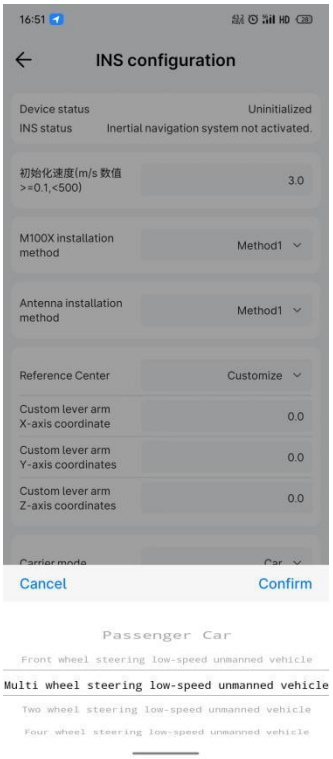
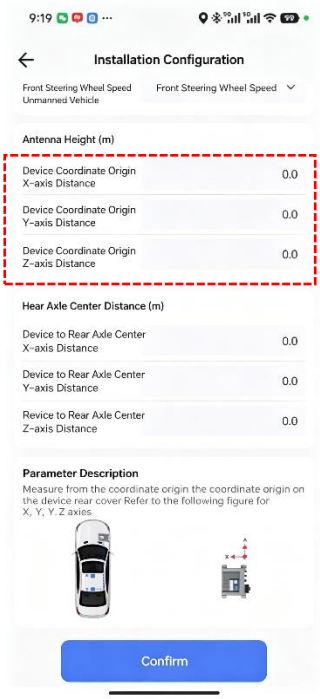


Figure. Specific Carrier

10. Antenna Lever Arm: The vector from the origin of the device coordinate system to the phase center of the primary GNSS antenna is called the GNSS antenna lever arm. With the center of the device coordinate system as the origin, the X/Y/Z axes are consistent with the vehicle coordinate system. Measure the X/Y/Z coordinates of the antenna phase center. Note: Antenna lever arm error will directly affect the positioning accuracy of the integrated navigation system, so the error should be less than 2cm as much as possible. If you do not have accurate measurement methods, you can perform online calibration on the device after configuration.



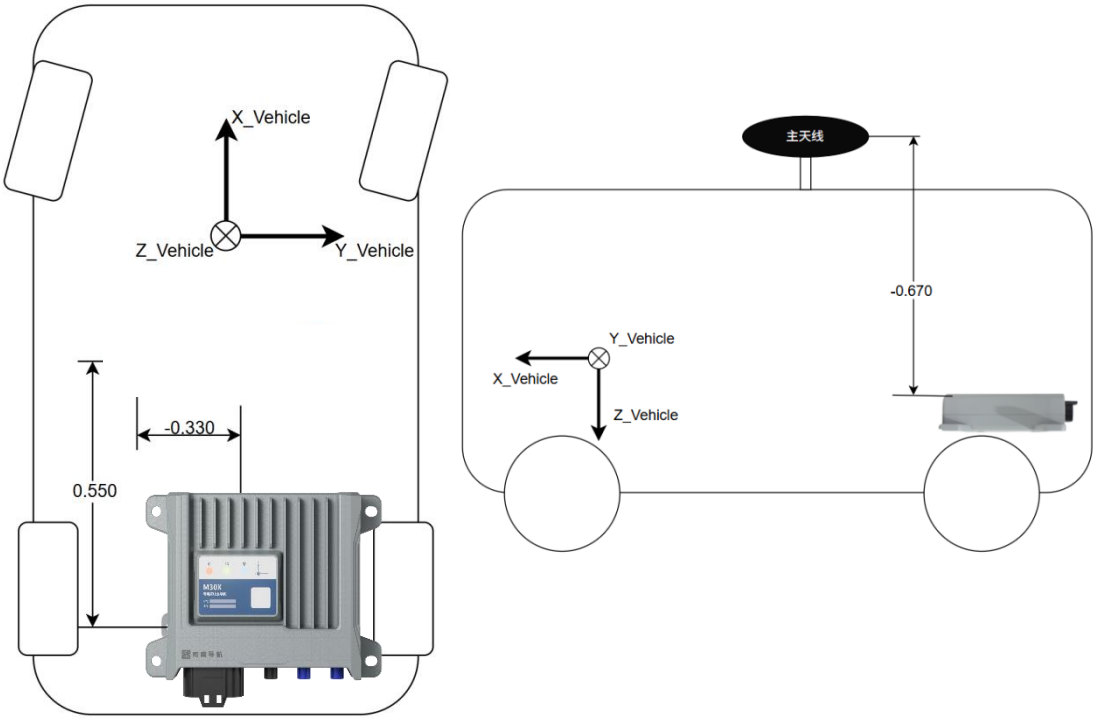


Figure. Lever Arm from Device to Primary GNSS Antenna

11. Rear Axle Center Lever Arm: Under normal driving conditions, the lateral and vertical velocity at the rear axle center are 0. To correctly use the constraint information and improve the vehicle DR

performance, you need to manually measure the lever arm from the origin of the device coordinate system to the rear axle center after installing the device. The measurement method can refer to the GNSS antenna lever arm measurement. Where, X/Y/Z represent the X/Y/Z coordinates of the rear axle center lever arm, unit: m. After the vehicle is connected with wheel speed data, this configuration must be set correctly, otherwise it may cause abnormal results.

Figure. Lever Arm from Device to Rear Axle Center

4.1.12 Data Storage

Operation Steps:

1. Click [Data Storage] to enter the data storage configuration interface. You can view the storage capacity and configure two storage channels.
2. Click the first storage channel. By default, the first channel can only store navigation messages INSPVA and SNCX. Select the required message rate, which supports 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The storage space and file interval will be allocated according to the rate. Note: Storing a single 100Hz message for one day requires about 2G storage, and storing both messages at 100Hz for one day requires about 4G storage. If the storage space is insufficient, cyclic storage may overwrite the earlier data.

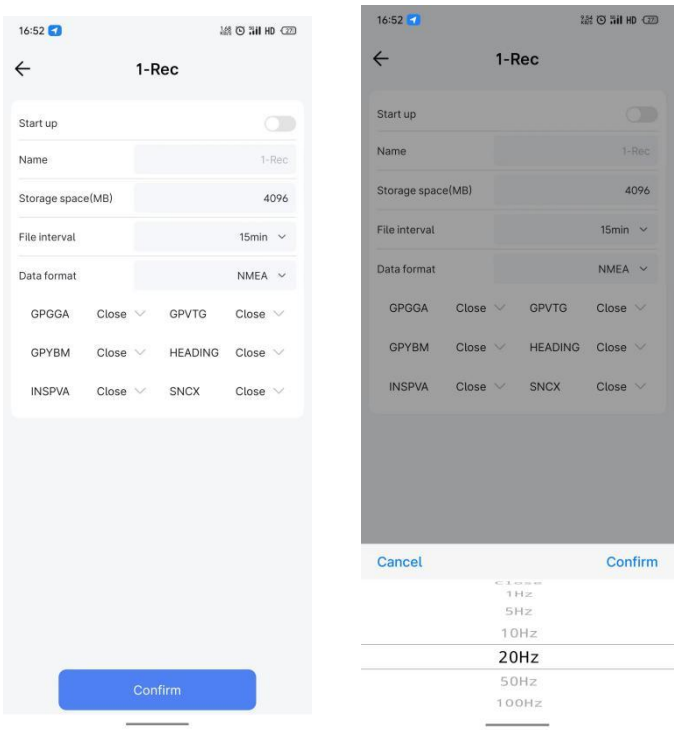


Figure. First Storage Channel Configuration

3. Click the second storage channel. By default, the second channel can only store raw messages. The default rate for IMU data is 100Hz, GNSS data is 5Hz, and PVAST data is 100Hz. It supports 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The file interval can be selected from 15min/1h/4h/24h. ODOM indicates wheel speed access: the indicator is green if wheel speed is connected, otherwise gray.

   Note: If the storage space is insufficient, cyclic storage may overwrite the earlier data.

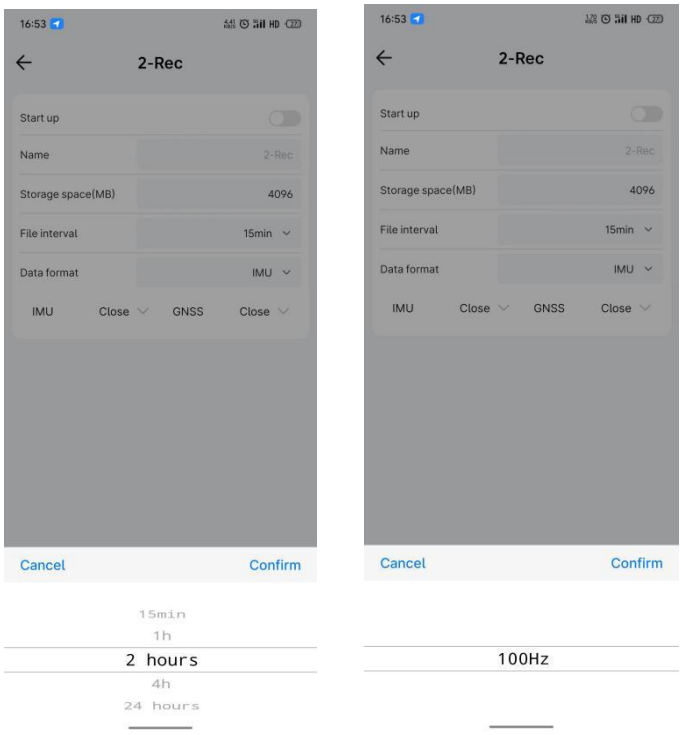


Figure. Second Storage Channel Configuration

4. Click [Data Storage], then click the Format button to format the storage. The device will restart after formatting.

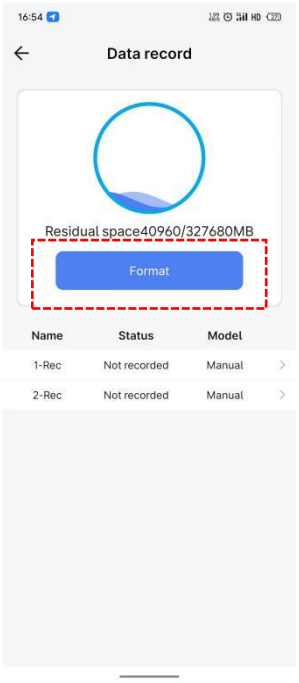


Figure. Format Storage

4.1.13 Host Control

Operation Steps:

1. Click [Host Control] to enter the host control interface. You can restart the device or restore factory settings. Restoring factory settings will clear all previous configurations and restart the device, please operate with caution.

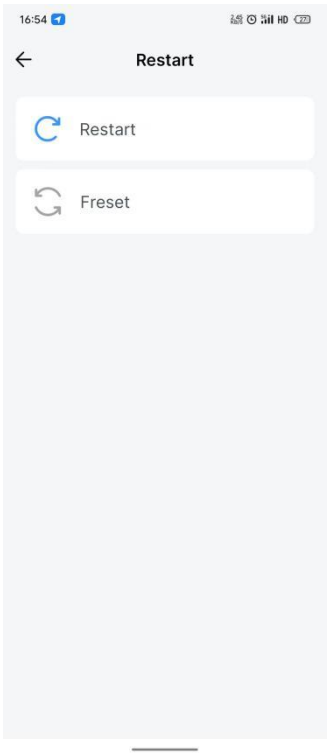


Figure. Host Control

4.2 USAGE INSTRUCTIONS

Before using the M30X, please ensure that you have completed the antenna installation and device installation as described in Section 3.1 and 3.2, and the device is powered on. You can confirm whether the device is powered on and running correctly via the following steps:

1. Check the device indicators: Is the power indicator red steady ON?
2. Is the status indicator red steady ON?
3. Search for the device via Bluetooth in the APP, can you find and connect to it normally?
4. Check the satellite status of the device in the APP.

4.2.1 INS Configuration

Click [Installation Configuration] in the NavMaster APP, and complete the configuration of initialization speed, device installation method, antenna installation method, reference center, carrier mode, antenna lever arm, and rear axle center lever arm as described in Section 4.1.10. For details, please refer to Section 4.1.10.

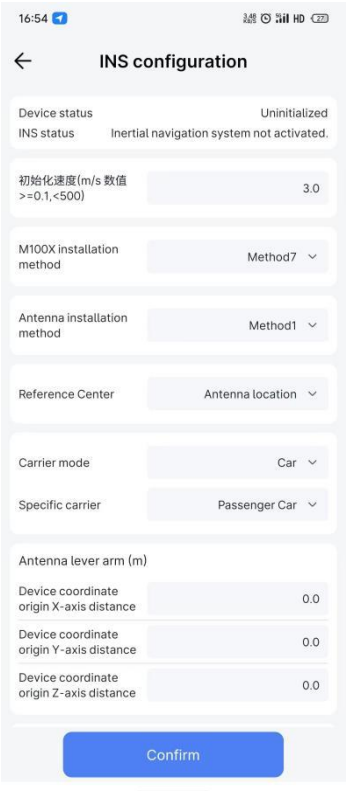


Figure. Installation Configuration

4.2.2 Differential Data Input

Differential data is transmitted from the base station to the rover to improve the rover's positioning accuracy. The data format usually uses the RTCM protocol (RTCM 3.x version).

The base station is a fixed GNSS receiver with known coordinates, which broadcasts differential data. The rover needs to continuously obtain differential data from the base station to calculate its own accurate current position.

You can build your own base station or rent a commercial base station. Either way, a link is required between the base station and rover to transmit differential data. In use, you can build the data link via the device's 4G function, or with wireless data transmission, or DTU and other devices. As a rover, the M30X usually obtains differential data via its own 4G function, serial port COM1, or Ethernet port.

If you obtain differential service via the device's 4G function, you need to insert the SIM card before powering on the device. After powering on, connect the device via the APP, click the [4G] function, turn on the 4G switch, click the [Differential] function, and select the differential network [Ntrip Client] or [NET1] or [NET2] or [NET3]. Selecting [Ntrip Client] means the link uses NTRIP protocol, selecting [NET] means the link uses TCP protocol. The related IP settings will be mapped to the corresponding items in [Data Transmission]. For details, please refer to Section 4.1.7.

If you obtain differential data via Ethernet, you need to turn off the device's 4G switch, open [Port Config]-[Ethernet], and configure the Ethernet IP. After configuration, click the [Differential] function, select the differential network [Ntrip Client] or [NET1] or [NET2] or [NET3]. Selecting [Ntrip Client] means the link uses NTRIP protocol, selecting [NET] means the link uses TCP protocol. The related IP settings will be mapped to the corresponding items in [Data Transmission]. For details, please refer to Section 4.1.9.

If you obtain differential data via serial port COM1, click the [Differential] function, select the differential network [COM1].

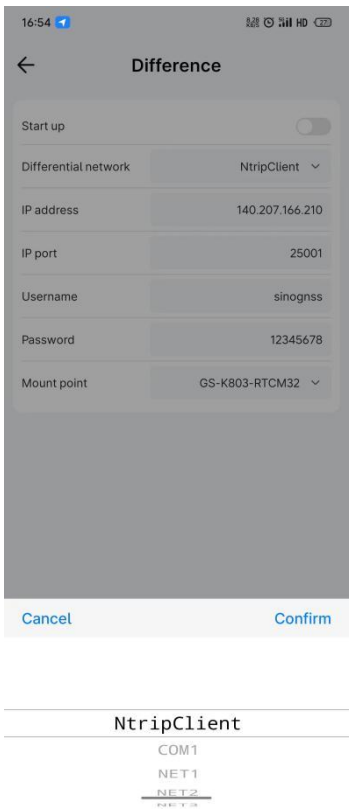


Figure. Differential Configuration

After connecting the differential data, you can use the APP to monitor the positioning status. Check if the positioning status is Fixed Solution on the APP main interface.

Figure. Fixed Solution

4.2.3 Wheel Speed Input

After the integrated navigation receiver is connected to vehicle wheel speed data, it can effectively assist the system in dead reckoning under severe satellite signal occlusion or satellite signal loss, and improve the positioning accuracy of integrated navigation in harsh satellite signal environments. The integrated navigation system generally receives vehicle wheel speed signals via CAN / CAN FD. Before enabling wheel speed input, please confirm that the rear axle lever arm configuration has been completed.

Usually, the wheel speed update rate is required to be no less than 20Hz (recommended no less than 50Hz), accuracy better than 0.1m/s (recommended better than 0.01m/s), resolution higher than 0.02m/s, and delay no more than 10ms. The device does not have a built-in terminal matching resistor, so you need to match it at the access end when using.

After connecting wheel speed, you can check if there is wheel speed information via the ODOM indicator in [Data Transmission]-[Raw Data]-[Data Stream] in the APP, or use the RAWODOM message to verify if the device has received wheel speed information. The specific method is to send the command via serial port or Ethernet:

LOG RAWODOMA ONNEW

If you can continuously receive RAWODOMA messages, it means the device has received the wheel speed information.

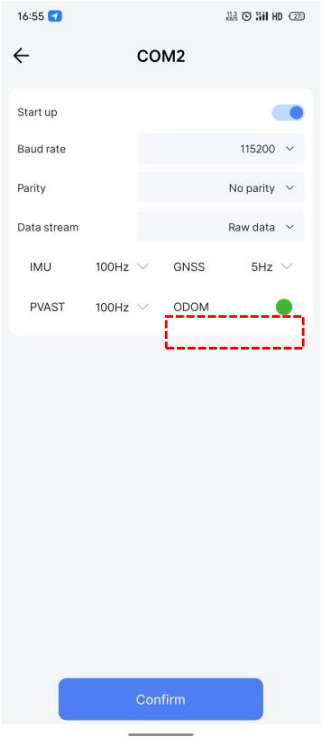


Figure. Wheel Speed Input

4.2.4 Real-time Result Output

You can configure the device to output real-time messages via APP or serial port. Please note the following during real-time operation:

1. Please ensure that the environment where the device is located can receive satellite signals normally. When satellite signal is unavailable or poor, the position, velocity, and attitude information output by the device may not meet the requirements;
2. INS navigation information and GNSS navigation information can be obtained independently. Integrated navigation information is usually output via INS-related messages.

You can use APP or commands to configure the device to output position, attitude, and other information. Messages can be output via network or serial port. For APP configuration operations, please refer to Section 4.1.8 and 4.1.9.

For serial command configuration, take the INSPVA message printing as an example. The command to print 100Hz INSPVA message in ASCII format is as follows:

LOG INSPVAA ONTIME 0.01

When outputting INS-related messages at high frequency, the data volume is large. To ensure data integrity, it is recommended to use Ethernet to transmit binary messages. If using serial port transmission, it is recommended to set the serial baud rate to 921600.

Common integrated navigation messages are shown in Table 3:

Table 3. Integrated Navigation Related Messages

Classify	Related Information
Position	INSPOS、INSPVA、INSPVAX
Velocity	INSVEL、INSSPD、INSPVA、INSPVAX
Attitude	INSATT、INSPVA、INSPVAX
Calculation Reliability	INSSTDEV、INSPVAX

4.2.5 System Alignment

System alignment is the process where the integrated navigation system obtains the current position, velocity, and attitude information to complete system initialization. You can confirm the system alignment progress in real time via the INS status display in the APP, or the Status field in the INSPVA/INSPVAX message.

After the M30X is powered on, the device will perform alignment according to the following process:

1. Device powered on, the system is in INACTIVE state, the INS system is inactive. At this time, the APP displays Uninitialized, and the INS system is aligning;
2. When the satellite signal is good, the device will enter alignment mode, the status switches to ALIGNING, and the INS system is aligning. In alignment mode, the device will determine the initial position, velocity, and heading of the carrier based on GNSS data. At this time, the APP displays Uninitialized, and the INS system is aligning;
3. If the device is connected with dual antennas and the dual antenna installation angle is configured correctly, system alignment can be completed in static state. If there is no dual antenna access or the

dual antenna observation quality is poor, you need to drive straight for a period of time with a speed meeting the threshold to complete system alignment, the default threshold is 3m/s;

4. After system alignment is complete, the status switches to ALIGNMENT_COMPLETE, the INS alignment is complete. At this time, the APP displays Alignment complete, but insufficient vehicle dynamics, calibration not complete;
5. The device continues to correct the integrated navigation results via GNSS data. After the carrier performs certain turning maneuvers, the accuracy converges successfully. At this time, the status switches to SOLUTION_GOOD, which means the integrated navigation accuracy is high. At this time, the APP displays Initialization successful, navigation accuracy is high;
6. When the error of the integrated navigation system is large, the device will switch to HIGH_VARIANCE state. When the GNSS navigation result is unavailable, it will switch to SOLUTION_FREE state. Table 4 summarizes and briefly describes the above states.

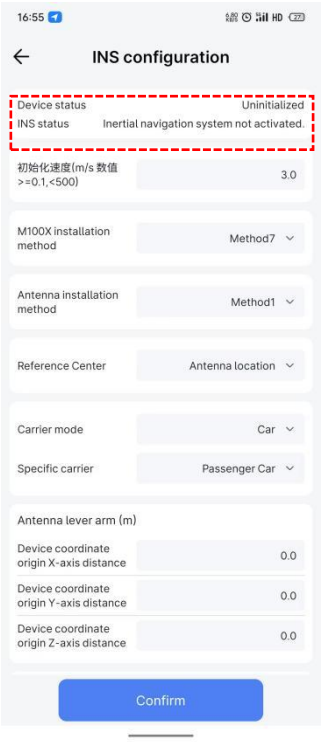


Figure. INS Status Display

Table 4. Inertial Navigation Status

State Identifier	Describe
INACTIVE	INS is inactive

ALIGNING	ALIGNING INS is in alignment mode
HIGH_VARIANCE	INS solution may not meet accuracy specifications
SOLUTION_GOOD	INS is in navigation mode with high accuracy
SOLUTION_FREE	INS filter is in navigation mode, but GNSS is unavailable
ANLIGNMENT_COMPLETE	INS filter is in navigation mode, but vehicle dynamics are insufficient and the system does not meet accuracy specifications

4.2.6 Online Calibration

After the initial installation and configuration of the device rotation parameters / GNSS antenna lever arm / dual antenna installation angle parameters, you can use the online calibration function to estimate more accurate parameters, improving the accuracy of the integrated navigation results.

The online calibration parameters are: 1. Device rotation parameters; 2. GNSS antenna lever arm parameters; 3. Dual antenna installation angle parameters.

The online calibration process is as follows:

1. Power on the device, send the command to clear calibration parameters, clear the original parameters:

   CLEARDRCLBPARAM
2. Send the device restart command RESET, wait for the device to restart;
3. Complete system alignment;
4. Drive the vehicle at a certain speed (recommended above 5m/s, no less than 1m/s) for about 5 minutes. The recommended route is shown in the figure; if you cannot use the figure-8 route, you need to ensure that during the online calibration, the vehicle's driving status includes straight driving and turning, such as driving in a daily shape along urban roads;
5. You can enable/disable the online calibration status message printing via LOG/UNLOG commands:

   LOG INSCALIBSTATE ONTIME 1

   UNLOG INSCALIBSTATE
6. After the command is issued, the serial port will continuously send messages containing the online parameter calibration status and estimated values. These messages only reflect the

current calibration status, and previous calibration statuses cannot be viewed. The message format is as follows:

%INSCALIBSTATES,WEEK,GPST;GPST,STATE,LeverArmX,LeverArmY,LeverArmZ,MisAngleX,MisAngleY,MisAngleZ,HeadingDiff;

Where, the STATE field represents the current online calibration status. The status of each calibration parameter is shown in Table 5. When the corresponding parameter calibration is complete, the STATE parameter will add the corresponding calibration status. For example, when the antenna lever arm, device installation angle, and dual antenna installation angle are all calibrated, the STATE field is 0x07.

Table 5. Calibration Parameter Status Information

Calibration Parameters	**Calibration Completion Status**
Antenna Lever Arm	0x01
Device Mounting Angle	0x02
Dual Antenna Installation Angle	0x04

7. Each time the device is powered on, it will read the calibration status and parameters. If the corresponding parameters are calibrated, it will automatically configure the calibrated parameters;
8. If you want to view the previous calibration status of the device, you can send the READDRCLBPARAM command to query.

Figure. Recommended Route 1 for Online Calibration

Figure. Recommended Route 2 for Online Calibration

4.2.7 Data Post-processing

The raw data output by the M30X can be post-processed with professional software. The post-processing software can obtain more accurate positioning results after the fact through bidirectional solution and smoothing, which can be used as a test benchmark.

4.2.8 Firmware Upgrade

The device can be upgraded via serial port or remote NavCloud.

1. Serial Upgrade: Power on the receiver, connect COM2 via serial port, open the serial upgrade tool QinT_Pbox_Update.exe, click Setting, select the identified port number, click Link to connect the port. Normally, the serial port will print the information of the device's current version. Click Select to select the firmware BIN file, click Update to start the upgrade. Wait for about 20s after starting the upgrade, the progress bar will start to move.

Figure. Serial Upgrade Tool

2. Remote Upgrade: The M30X supports remote upgrade, you need to log in to the ComNav NavCloud platform to operate. Before remote upgrade, please ensure that [Data Transmission]-[NavCloud] is enabled, and the device is connected via 4G or network.

   ① Log in to NavCloud: Login address: , enter your account and password.

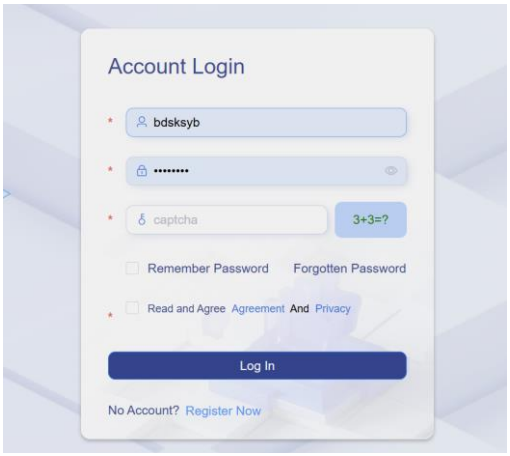


Figure. Log in to NavCloud Platform

② Create Device: Click [Create Device], enter the device name and SN, click [Save].

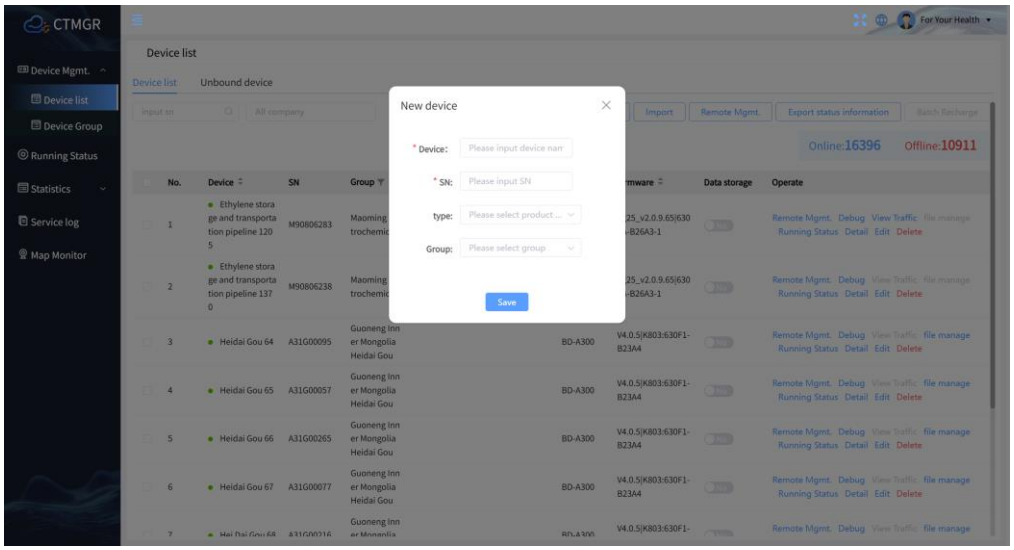
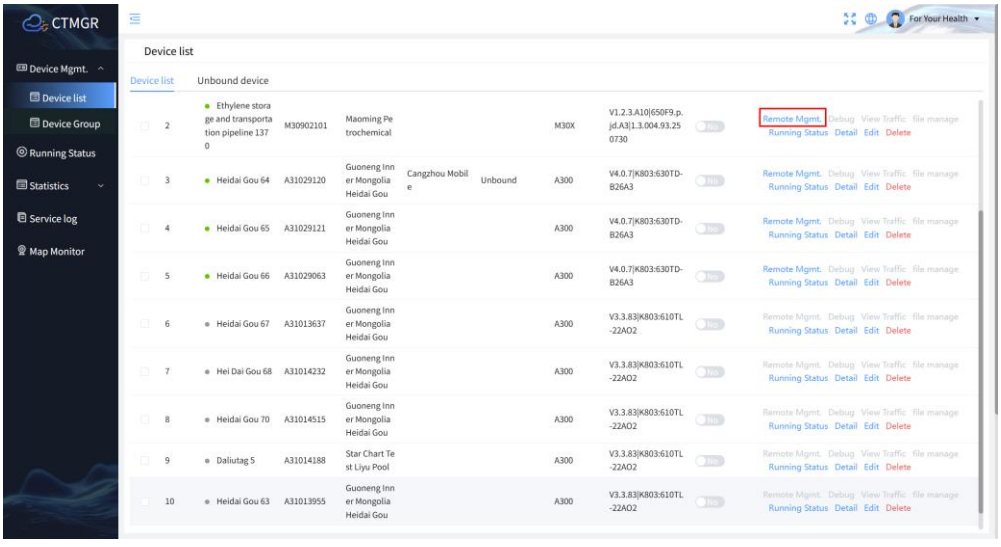


Figure. Create Device

③ Remote Management: After creating the device, if the device communication is normal, it will show online. Click [Remote Management], select [Online Upgrade], select the corresponding version type (Official / Beta), firmware version, upgrade method (Board Upgrade / System Upgrade), click [Upgrade Now].



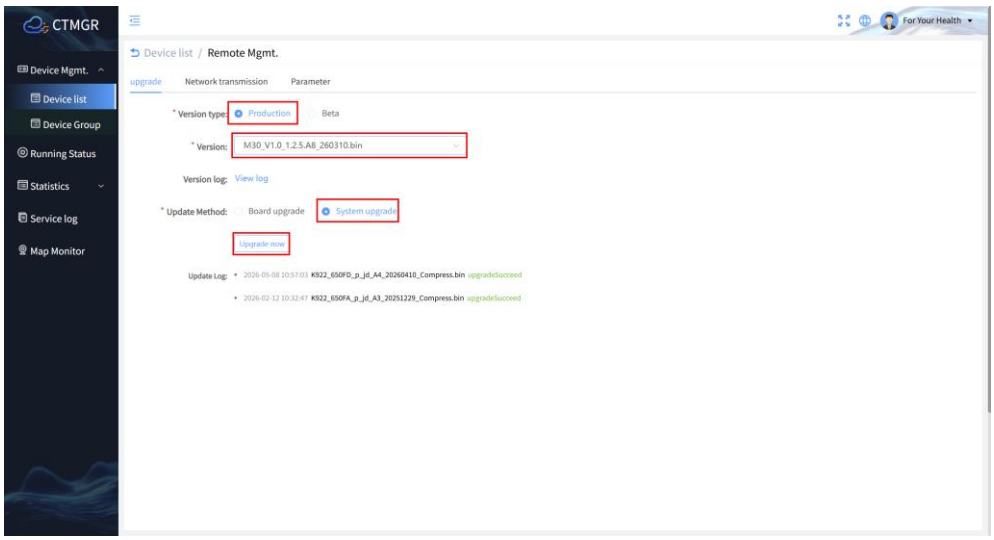


Figure. Remote Upgrade

5 APPENDIX B COMMON COORDINATE SYSTEM DESCRIPTION

5.1 DEFINITION OF COMMON COORDINATE SYSTEMS IN INTEGRATED NAVIGATION SYSTEM

In the integrated navigation system, commonly used coordinate systems include the local navigation coordinate system, body coordinate system, vehicle coordinate system and user-defined coordinate system.

5.1.1 Local Navigation Coordinate System

The local navigation coordinate system, also known as N-E-D (North-East-Down) coordinate system, is defined as follows:

N-axis: Points to the North (in the plane perpendicular to the D-axis, the direction from the user to the North Pole)

E-axis: Points to the East (the right-handed orthogonal axis derived from N-axis and D-axis)

D-axis: Points Down (the normal direction of the reference ellipsoid)

The origin of the local navigation coordinate system is the navigation center marked on the device housing.

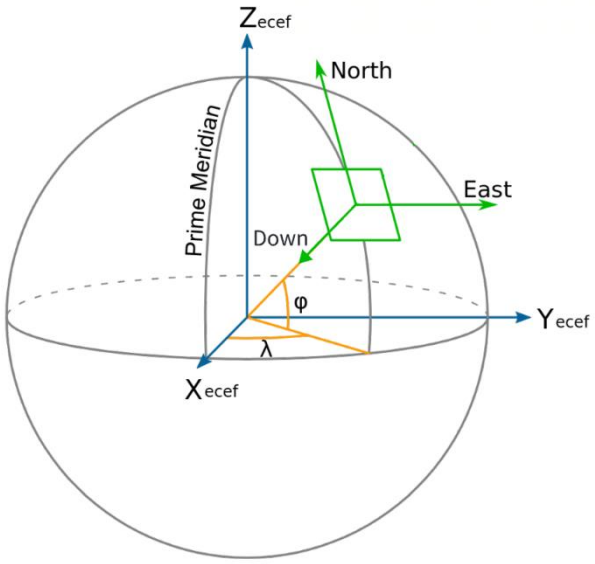


Figure. Local Navigation Coordinate System

5.1.2 Device Coordinate System

The origin and axes of the device coordinate system are marked on the device housing, the navigation center is the origin of the coordinate system.

Figure. Device Coordinate System

5.1.3 Vehicle Coordinate System

The origin of the vehicle coordinate system is the navigation center marked on the device housing.

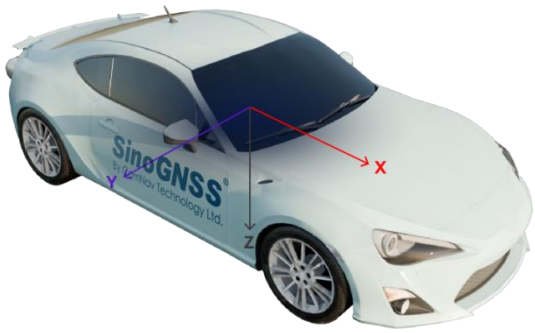


Figure. Vehicle Coordinate System

The axes of the vehicle coordinate system are defined as follows:

Z-axis: Perpendicular to the vehicle floor, pointing to the bottom of the vehicle

X-axis: Points to the forward direction of the vehicle

Y-axis: The right-handed orthogonal axis derived from X-axis and Z-axis

If you use the land vehicle model, please configure the antenna lever arm and rotation parameters strictly according to this vehicle coordinate system.

5.1.4 User-defined Coordinate System

The right-handed coordinate system with origin and axes specified by the user is called the user-defined coordinate system. By default, the device outputs the position and velocity information of the device navigation center (the origin of the device coordinate system). You can use the APP to set [Reference Center], select [Custom] to enter custom XYZ coordinates, and set the coordinate system origin to any point.

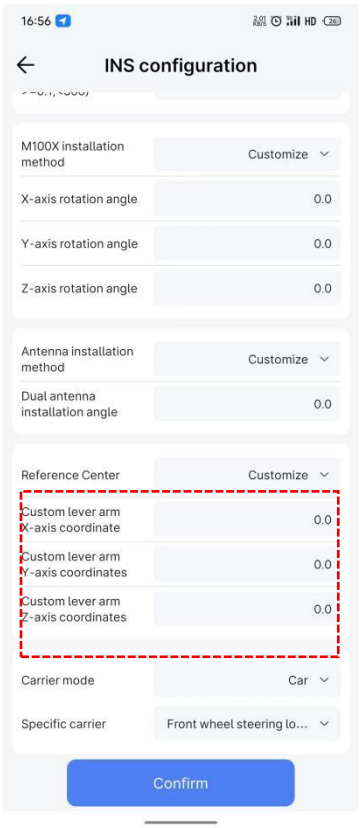


Figure. User-defined Coordinate System

6 TROUBLESHOOTING

If you encounter the problems listed in this section when using the M30X integrated navigation receiver, troubleshoot them according to the following methods. If the issue cannot be resolved, please contact our technical support personnel in a timely manner.

1. Device fails to power on

Solutions:

1) Check if the power voltage is normal. If the power supply is faulty, power off, replace it with a normal power supply before using the product;
2) Check if the power cable connection is correct and secure;
3) Use a multimeter to measure the connector voltage, check if the connection cable is intact. If the cable is faulty, replace it.
4) If the above causes are excluded, the device may be damaged. Please contact our technical support.

2. No Serial Response

Solutions:

1) Check if the serial port number and baud rate are correct. Please read the communication protocol carefully to ensure correct configuration of the serial port;
2) Check if the data cable is damaged;
3) Check if the serial port driver is installed;
4) Check if the data cable is connected securely.

3. Abnormal Positioning

Solutions:

1) Check if the receiver is obstructed;
2) Check if the connectivity of the communication system is reliable;
3) Check if there is RF interference on the GNSS antenna frequency;
4) Confirm if the INS initialization is successful;

5) Confirm if the base station coordinates have too large deviation from the real coordinates.

4. 4G Disconnection

Solutions:

1) Confirm if the 4G SIM card is overdue;
2) Confirm if the device power supply is normal;
3) If the operator's network is unstable in this area, please replace the 4G SIM card of another operator.

7 PRECAUTIONS

1. It is strictly prohibited to disassemble any parts of the system device. If a fault occurs, please record the relevant situation and contact our technical support staff in time;
2. Pay attention to the working voltage of each device. Please use the standard power adapter and data cable provided by our company to avoid damage to the device;
3. When connecting the power cable, do not reverse the polarity of the power supply;
4. Please connect the devices strictly according to the installation and wiring methods in the manual, make sure all connectors are plugged in tightly;
5. Do not continue to use damaged cables or accessories, please replace them with new ones in time to avoid unnecessary injury.

FCC Statement
Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interferenc
(2) This device must accept any interference received, including interference that may cause unde operation.

Note : This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates,uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment .This equipment should be installed and operated with minimum distance 20cm between the radiator& your body.

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