Qtalis

M30X Integrated Navigation Receiver

User Manual

Version 1.1
Jun. 2026

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Technical Assistance

If you have any question and can't find the answer in this manual, please contact viawebsite: https://www.qtalisgnss.com/ or technical support forum: https://www.qtalisgnss.com/community/forum. Your feedback about this Guide willhelp us to improve it with future revisions.

Safety Information

Before using the receiver, please make sure that you have read and understood this user Guide, as well as the safety requirements.

- Connect your devices strictly based on this User guide
- Install the GNSS receiver in a position that minimizes vibration and moisture
- Avoid falling to ground, or colliding with other items
- To reduce radiation, please keep above 2 meters away from the radio station
- Change the cable if damaged

Related Regulations

The receiver contains integral Bluetooth® wireless technology and 4G. Regulations regarding the use of the datalink vary greatly from country to country. In some countries, the M30X can be used without obtaining an end-user license. But in some countries the administrative permissions are required. For license information, please consult your local dealer.

Use and Care

The receiver can withstand the rough treatment that typically occurs in the field. However, the receiver is high-precision electronic equipment and should be treated with reasonable care.

Warning and Caution

An absence of specific alerts does not mean that there are no safety risks involved. A Warning or Caution information is intended to minimize the risk of personal injury and/or damage to the equipment.

WARNING-A Warning alerts you to a potential risk of serious injury to your person and/or damage to the equipment, because of improper operations or wrong settings of the equipment.
CAUTION-A Caution alerts you to a possible risk of damage to the equipment and/or data loss.

Warranty Notice

We warrants the M30X receiver for one (1) year from the date of purchase unless otherwise specified.
We guarantees the product only when it is properly installed, configured, and operated in accordance with the User Guide and product specifications.

Revision History

Revision Version	Modification Content	Date
1.1	Version 1.0 Update	2026.06.12

CONTENTS

1 Introduction

The appearance of the M30X integrated navigation receiver M30X is shown in Figure 1.

Figure 1. M30X Integrated navigation receiver

Main features:

- The wireless transmission method has been upgraded to support 4G and Bluetooth communication;
- Automotive-grade design, IMU conforms to ASIL B Level requirements;
- Self-developed integrated navigation algorithm 4.0, adaptable to multiple motion models;
- It offers a rich array of interfaces, supporting automotive Ethernet, CAN, serial port, PPS, USB, etc., and supports external wheel speed input;
- It supports high dynamic range and 100 Hz data output and data storage.

1.1 Packing list

Upon receiving the equipment, please check whether all items in the packaging box are intact. If any item is missing or damaged, please contact our staff immediately.

Table 1. The M30X System Package List

Serial Number	Item Name	Quantity	Picture
1	M30X M30X	1	
2	18-Pin Data Cable	1	

3	FAKRA Satellite Antenna Cable (Blue) 3 m	2	
4	4G Antenna (FAKRA) 1.5 m	1	
5	Satellite Antenna	2	
6	High-Strength Magnetic Mount	2	

1.2 Interface Description

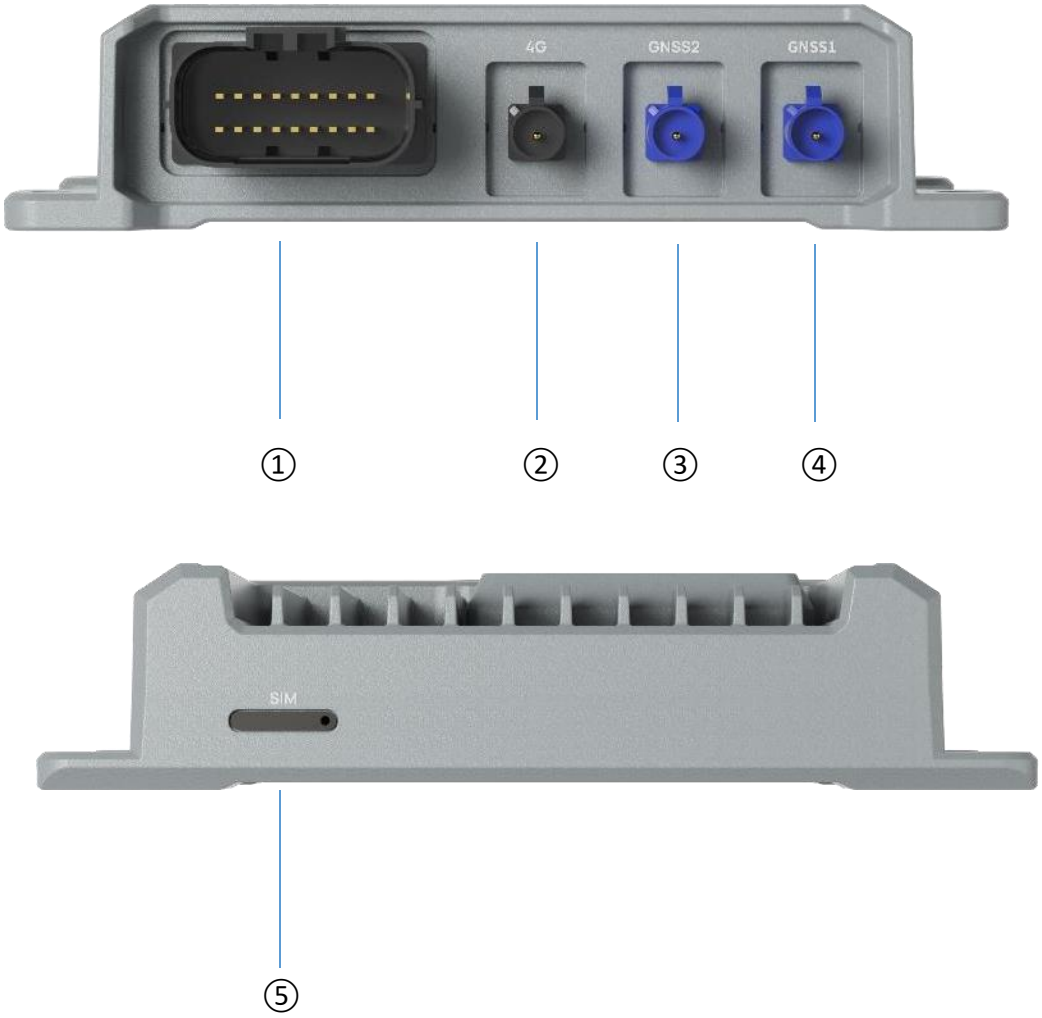


Figure 2. M30X Interface Descriptions

① Data: 18-pin data interface (DC + RS232*2 + Automotive Ethernet + PPS + CAN/CAN FD*2 + USB)

② 4G: 4G antenna interface, FAKRA-A

③ GNSS2: Secondary satellite antenna interface, FAKRA-C

④ GNSS1: Primary satellite antenna interface, FAKRA-C

⑤ SIM: Nano SIM card slot

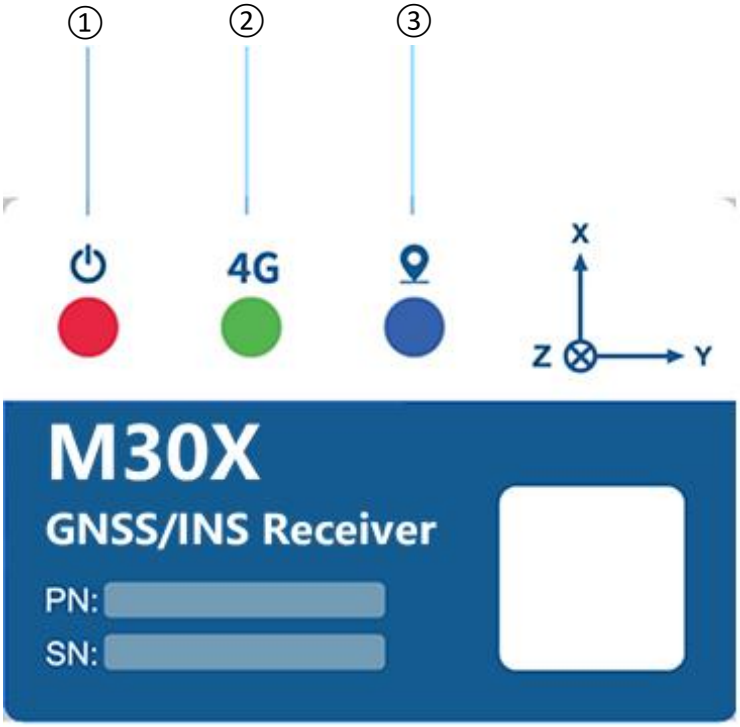


Figure 3. M30X Indicator light description

1. Power indicator light: Solid red light indicates normal power supply.
2. 4G : 4G Indicator light (green):

   Flashing green light: No network / Dial failed

   Fast flashing green light: 4G communication transmission is normal
3. Status indicator lights (red / blue):

   Not lit: No IMU or GNSS detected. Searching for satellites.

   Red light always on: GNSS satellite positioning provides positioning data, but IMU error occurs; no IMU detected.

   Blue light flashing: INS is initializing.

   Solid blue light: INS is currently in integrated navigation mode.

1.2 Wiring Description

This section describes the connection methods used in the product. The connection between each accessory and the M30X is shown in the following diagram.

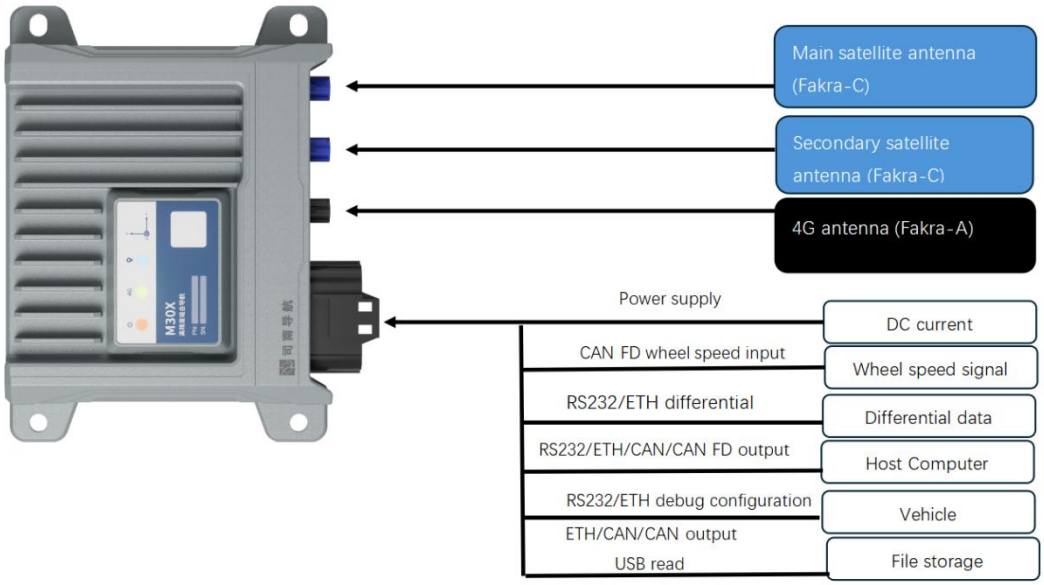


Figure 4. The M30X Wiring diagram

The connection instructions for the integrated navigation receiver and its components are as follows:

1. Connect the satellite antenna cable: Connect the supplied Fakra-C (blue) antenna cable. Connect the antenna connector to the receiver's Fakra RF port, ensuring that the master and slave antennas are connected to the correct ports.

2. Connect 18-pin data cable: Connect the 18-pin data cable to the receiver. Align the latch on the male connector with the corresponding slot on the receiver connector, then insert it fully and tighten it securely.

3. Connect the power supply: After connecting the 18-pin data cable to the receiver, connect the DC power connector on the cable to an external DC power source or battery. The receiver will automatically power on. (Note: Do not reverse the positive and negative terminals of the external power supply. The input voltage must be within the range of DC 6 V to 32 V.)

4. Connect to serial port: The M30X is equipped with two serial ports: COM1 and COM2. Connect the DB9 female connector of the data cable to a computer or other communication device to receive integrated navigation messages. (Note: The baud rate of the external device must match the baud rate configured on the receiver.)

5. Connect to the vehicle's Ethernet network: After connecting the 18-pin cable to the receiver, connect the automotive Ethernet wires at the other end of the cable to the

in-vehicle Ethernet communication device. To connect to a PC or standard industrial Ethernet device, an automotive Ethernet-to-industrial Ethernet converter is required. The Ethernet interface supports IPv4 as well as TCP and UDP communication protocols. It can be used for remote debugging, receiving differential correction data, outputting positioning and attitude information, or upgrading firmware.

6. Connect CAN/CAN FD: After connecting the 18-pin cable to the receiver, connect the CAN/CAN FD wires at the other end of the cable to the user's CAN device. The GND wire must be connected to the ground of the external device. The M30X provides a PPS signal for time synchronization, which can be used as required by the application. By default, the device outputs a 1PPS signal with the rising edge synchronized to GPS time. Under good GNSS signal conditions, the synchronization accuracy can reach 20 ns.

7. Odometer connection: The M30X supports connection to a vehicle odometer through the CAN interface. Configure the odometer connection according to the DBC definition. Wheel speed information can then be transmitted to the M30X to improve integrated navigation positioning accuracy when GNSS signals are unavailable. Select and configure this function according to your actual application requirements.

8. USB connection: The M30X supports data file export through the USB interface. After connecting the 18-pin data cable to the receiver, connect the USB interface to a computer to copy the message files stored in the device.

2 Installation Instructions

Please read the installation instructions in this section carefully before installing the M30X integrated navigation receiver to avoid affecting the positioning performance.

2.1 Antenna Installation

First, install the satellite antenna from the kit onto the suction cup bracket. Then, rigidly attach the suction cup bracket to the carrier, ensuring that the antenna does not shift or shake when the carrier is in motion. The GNSS antenna should be placed horizontally. If tilting is unavoidable, the tilt angle should not exceed 15°. The area above the GNSS antenna must remain unobstructed. Finally, tighten the TNC connector of the RF cable to the TNC connector of the antenna.

2.2 M30X Installation

The M30X should be mounted securely and reliably, with a rigid connection to the carrier. The relative positions of the M30X, antenna, and carrier must remain constant. The requirements for the installation area are as follows:

1. The M30X should be mounted on a rigid structural surface. The flatness of the surface (i.e., the pitch and roll angles between the rigid structural surface and the horizontal plane) should be less than 1°.

2. The temperature of any interference sources surrounding the M30X must be kept below 85°C.

3. There should be no vibration interference sources within 50 cm of the M30X. The unit must be kept away from vibration sources such as engines and subwoofers, as well as any other locations where strong vibrations may occur. The IMU should avoid vibration at the following frequency ranges: 15.8 kHz-17.8 kHz, 28 kHz-35.6 kHz, 44 kHz, 18.3 kHz-20.3 kHz, 1.9 kHz-2.1 kHz.

4. The M30X should be installed as far as possible from locations with complex electromagnetic environments, such as near Lidar, instrument panels, and other electronic equipment.

The recommended installation method is as follows:

1. Install the M30X horizontally, with a horizontal angle of less than 5°.

2. The X-axis of the M30X should point in the direction of carrier movement. The Y-axis should be perpendicular to the direction of movement, pointing to the right. The Z-axis should point downward.

3. The X-axis of the M30X should be parallel to the longitudinal centerline of the vehicle body. The distance between them should be as small as possible, ideally no more than 70 cm.

4. The M30X should be installed at or near the center of the carrier's rear axle.

If the orientation of the M30X cannot meet the above installation requirements, a horizontal offset arrangement may be adopted. It is recommended that the offset angle should be an integer multiple of 90°.

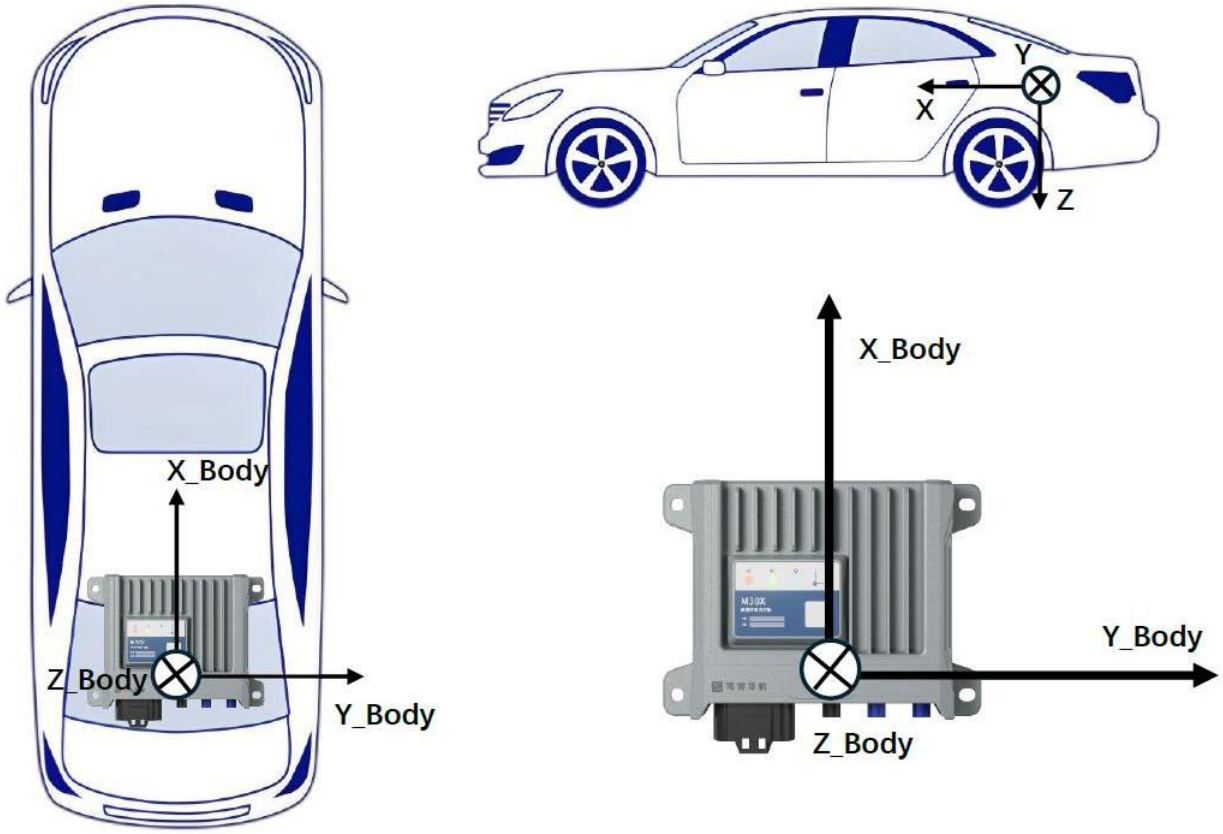


Figure 5. M30X Installation diagram

3 Receiver Configuration

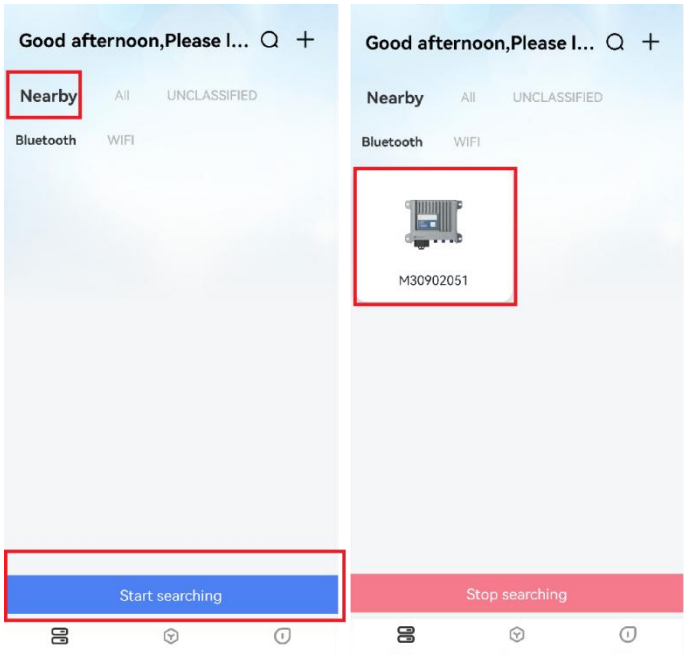
The M30X integrated navigation receiver can be configured via the Navigation Master APP. Navigation Master is a high-precision GNSS application for Android. It supports viewing M30X receiver status and configuring parameters. Users can scan the QR code below or download the latest installation package and related technical documents from our official website: https://www.qtalisgnss.com/pages/resource-hub.

Figure 6. Navigation Master APP Icon and Download QR Code

3.1 Configuration by Navigation Master

3.1.1 Bluetooth Connection

1. Open the Navigation Master application, select [Nearby], and click [Start Search] (This function requires Bluetooth to be enabled on your phone).
2. Device Search: Available devices are displayed normally, as shown in the figure.
3. Connect Device: Click on a device in the list to initiate a connection
4. Connection Successful: After successful connection, the APP enters the main interface, as shown in the figure below.



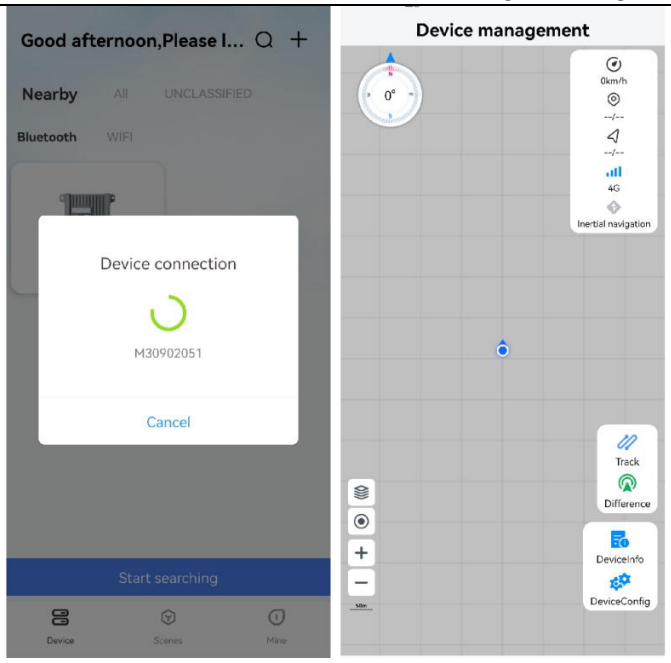


Figure 7. Bluetooth Connection

3.1.2 Main Interface Description

Icon	Description
Heading Angle Icon	Displays the device's heading angle value.
Speed Icon	Displays the device's speed.
Positioning Icon	Displays the positioning solution status and the number of satellites searched. Clicking it quickly takes you to the satellite radar page.
Heading Icon	Displays the orientation solution status and the number of satellites searched. Clicking it quickly takes you to the satellite radar page.
4G Icon	Displays 4G signal strength; click to quickly access the 4G page.
Inertial Navigation System (INS) Icon	Indicates the INS initialization status. The icon is gray when not initialized and blue when successfully initialized. Clicking it takes you to the installation and configuration page.
Track Icon	Track button; click to enter the track recording page.
Differential Icon	Displays the differential identifier: green indicates differential active, gray indicates no differential. Clicking it quickly takes you to the differential configuration page.
Device Information Icon	Click to select the device information you wish to view, including host Info, status Info, satellite radar, and posture.
Device Configuration Icon	Click to select parameters to be configured, including 4G, port configuration, data transmission, installation configuration, data storage, and host control.
Map Control Icons	"+" button zooms in on the map; "-" button zooms out; "◎" button locks the device position; "▤ " button switches map modes

	(satellite map / standard map).

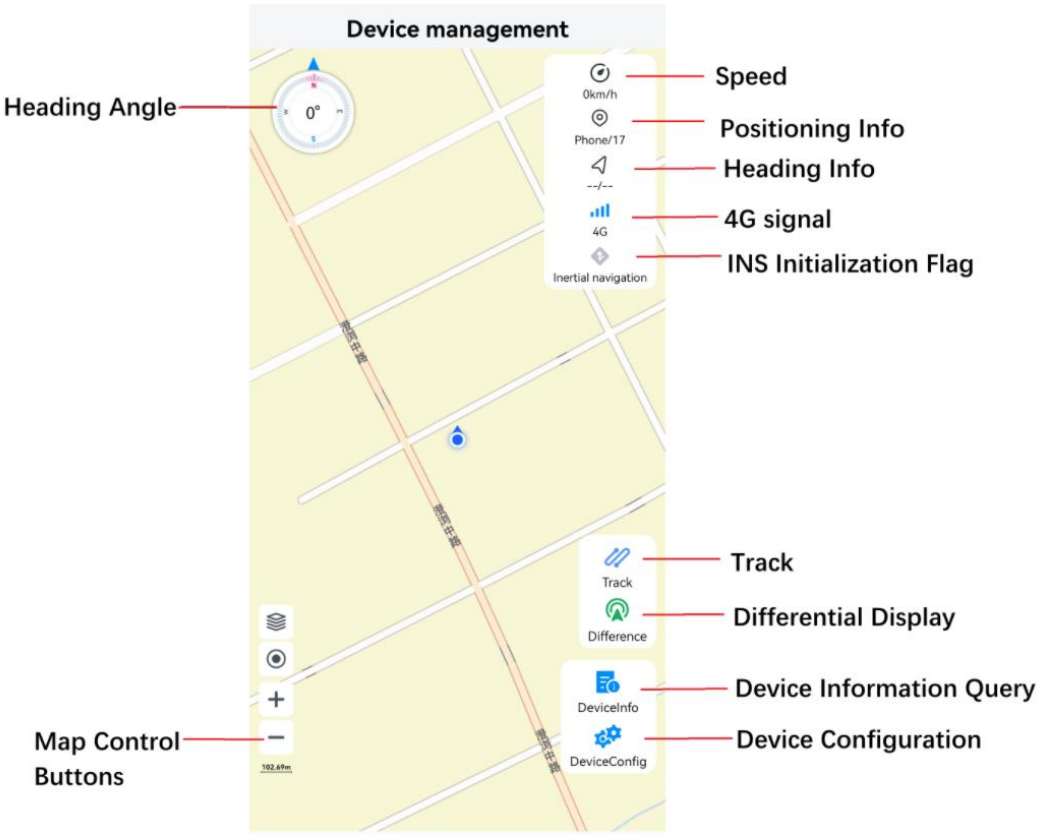


Figure 8. Main Interface Description

3.1.3 Host Information

1. Click [Device Info].
2. Click [Host Info].
3. Query and verify the following are displayed correctly: device model, device serial number, system firmware version, board firmware version, hardware version, INS driver, and Ethernet MAC address.

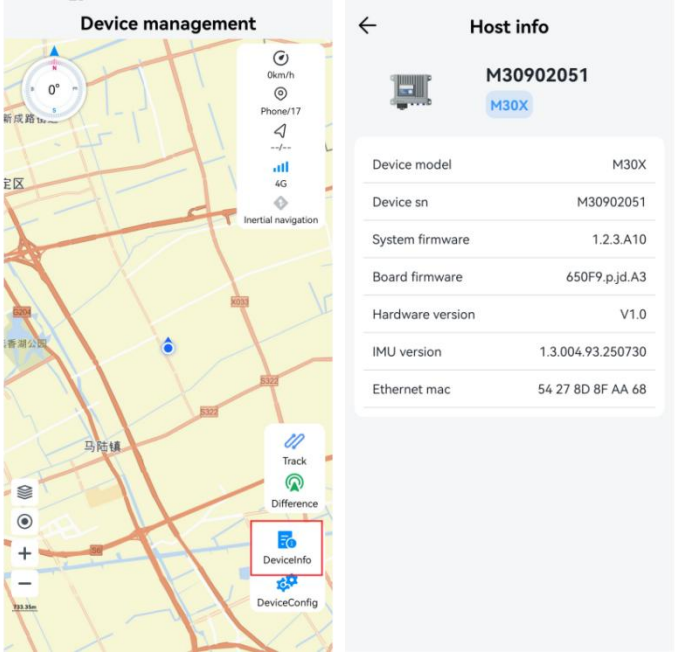


Figure 9. Host Info

3.1.4 Status Information

1. Click [Status Info].
2. Query the enable status and storage capacity of Data Storage 1 and 2, differential source, INS self-check status, INS status (initialized/uninitialized), and 4G startup status.

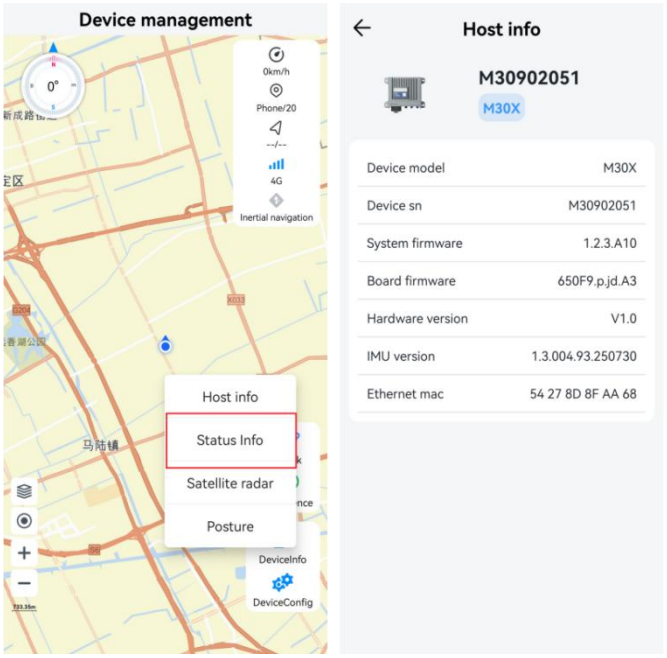


Figure 10. Status Information

3.1.5 Satellite Radar

1. Click [Satellite Radar]: Displays UTC time, satellite sky chart, and positioning information. positioning information includes latitude/longitude, positioning status, angle, speed, antenna signal quality, and HDOP.
2. In the Satellite Radar interface, click [Signal-to-Noise Ratio]to view the satellite SNR bar

chart, which clearly indicates satellite search quality.

3. In the Satellite Radar interface, click [Satellite Info]to view satellite search status: Sat Number -Satellites found (G = GPS, B = BDS, R = GLONASS, E = GALILEO); Azi -Azimuth angle; Ele -Elevation angle; L1/L2/L5 -Signal to noise ratio at each frequency; B1C/B2a -Signal to -noise ratio specific to BD-3

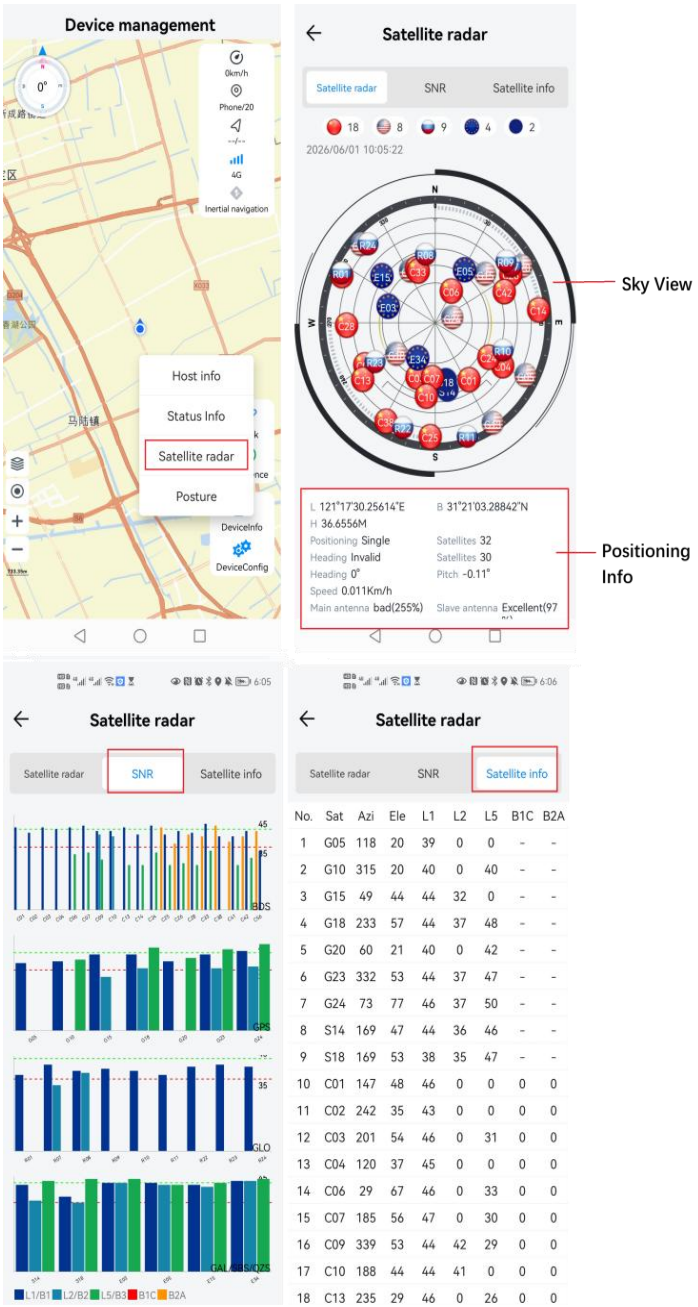


Figure 11. Satellite Radar

3.1.6 Posture

1. Click [Posture].

2. Query the value changes of the IMU accelerometer and gyroscope. The data can be displayed as dynamic curves. Scroll down to view the gyroscope curve information, as shown in the figure below.

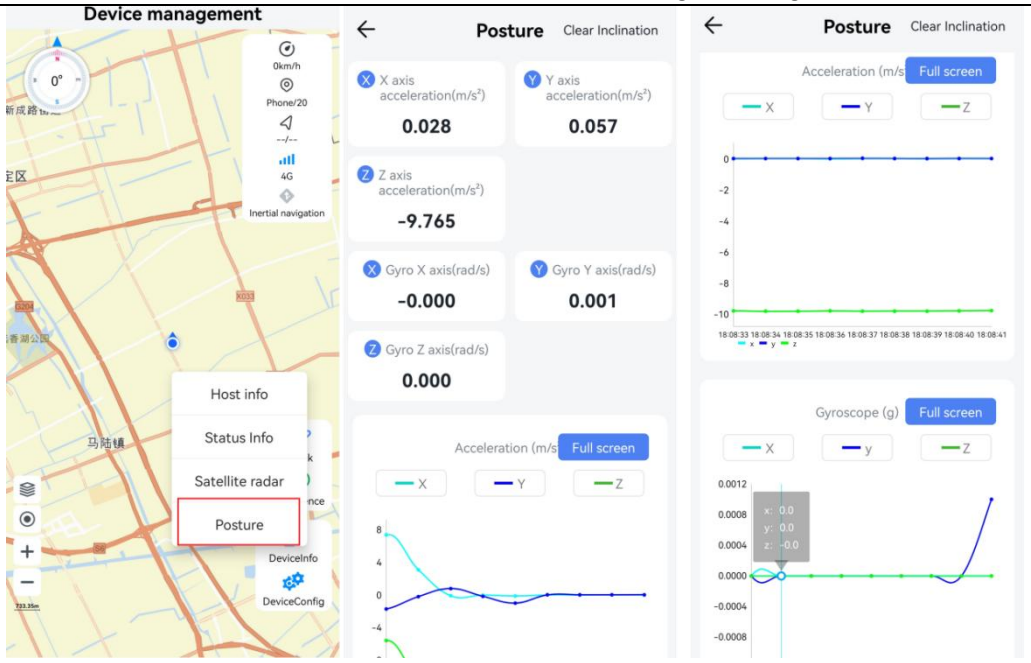


Figure 12. Posture

3.1.7 4G Configuration

1. Click [Device Configuration], then click [4G].
2. Turn on the mobile data switch and tap OK.
3. If the 4G connection is normal, signal strength and SIM card information (card status, network status) will be displayed correctly.
4. Signal Strength: When the signal is displayed as 20–30, the strength is normal. SIM Card Status: "Normal" when a card is inserted; "SIM not detected" when no card is inserted. Network Status: "Normal" when connected successfully; "Not connected" when connection fails.
5. If your 4G card is an intranet or dedicated card, you must configure the APN separately. The settings dialog box is shown in the figure (you need to turn off the 4G network switch before clicking Settings).
6. Note: The receiver does not support hot-swapping of the 4G SIM card. Please ensure the 4G card is inserted before powering on.

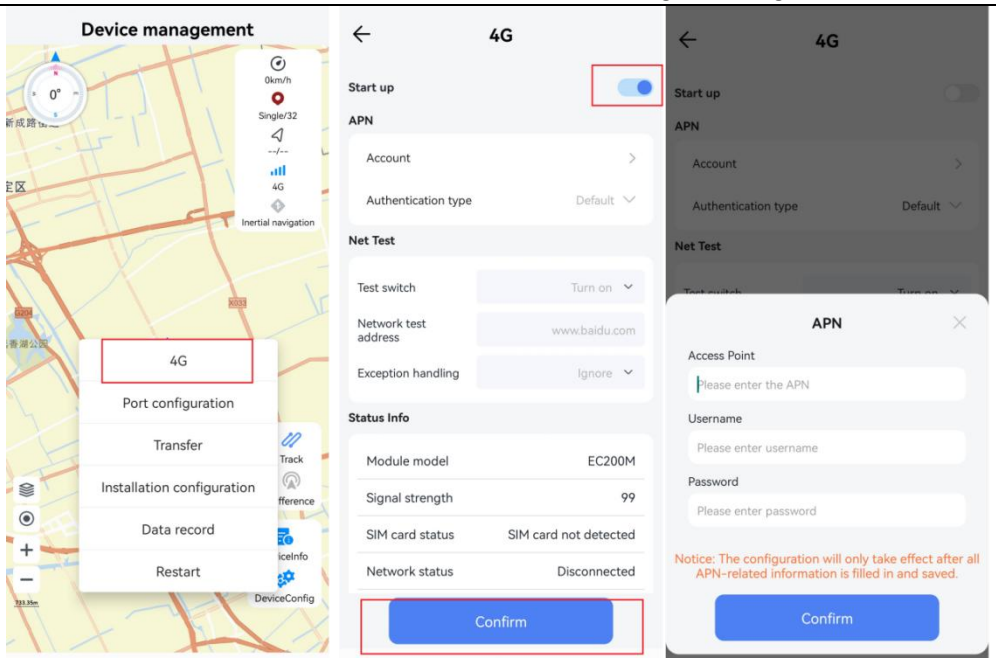


Figure 13. 4G Configuration

3.1.8 Differential Configuration

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

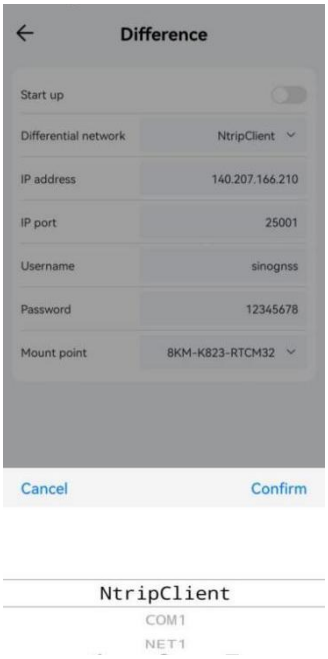


Figure 14. Differential Configuration

3.1.9 Port Configuration

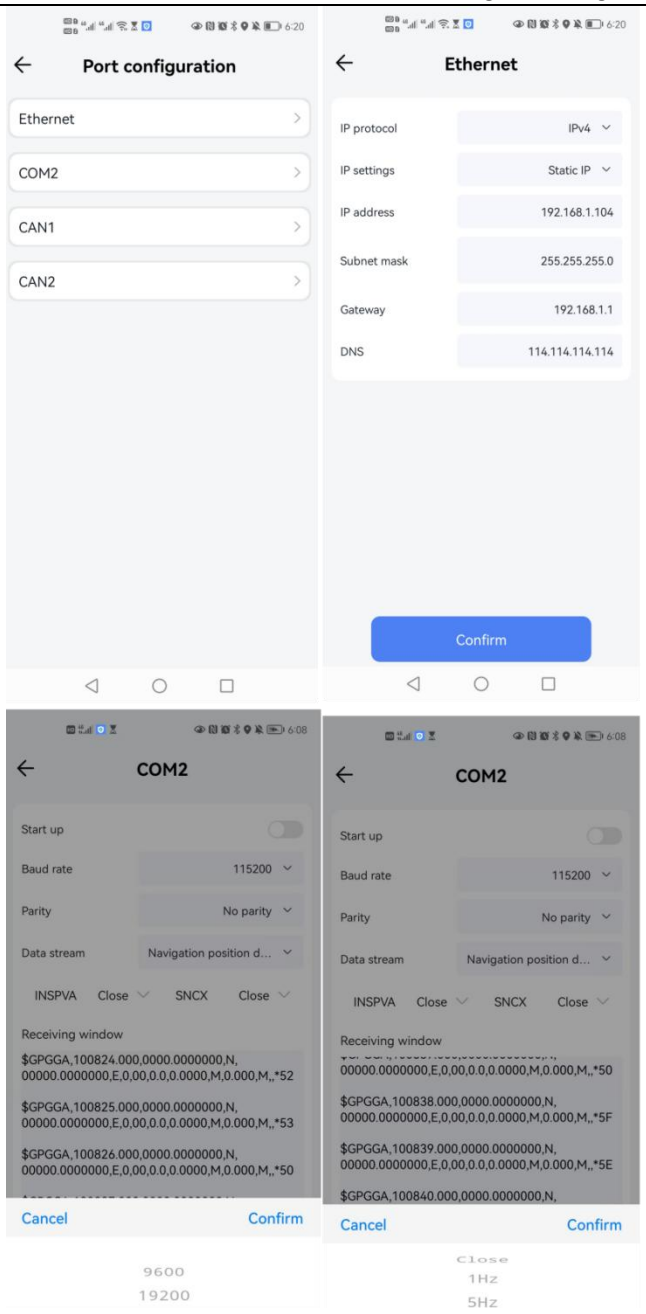
1. Click [Device Configuration], then click [Port Configuration] to enter the port configuration interface.

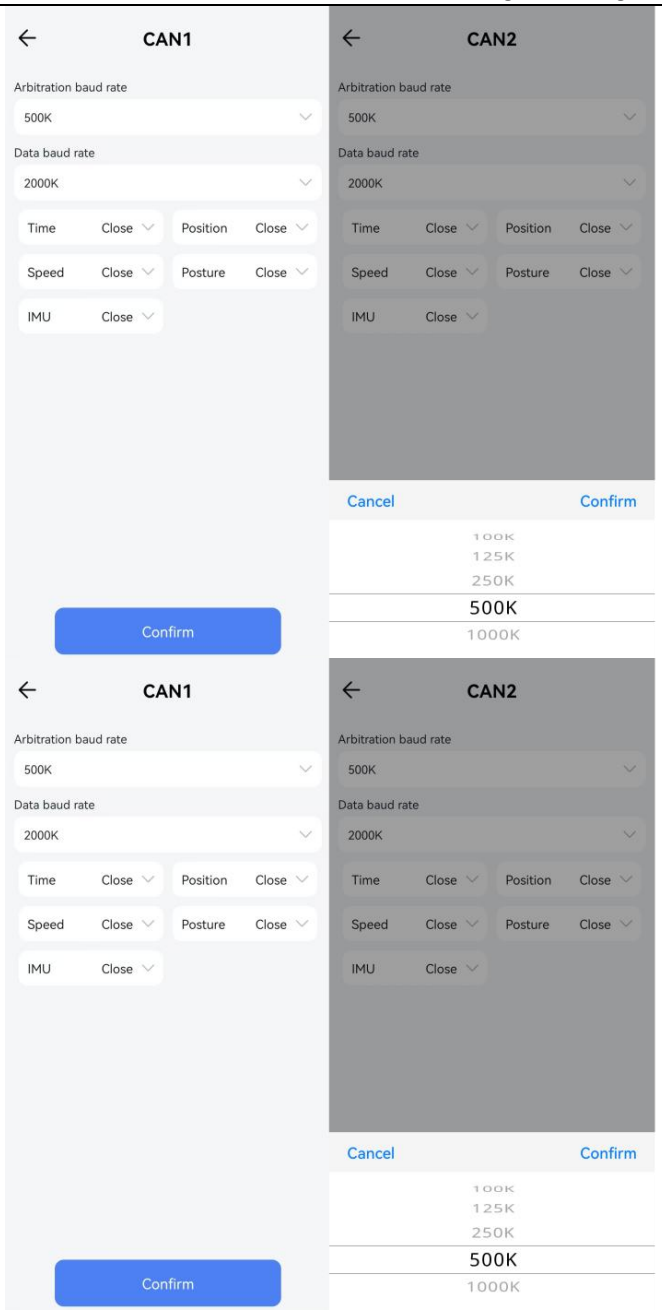
2. Click [Ethernet] to configure the device's Ethernet IP address, subnet mask, gateway, DNS, and other information. Additionally, because the computer cannot recognize automotive Ethernet directly, a suitable interface converter is required after configuring the automotive Ethernet via the Navigation Master application to enable communication between the computer and the device.

3. Click [COM2] to configure COM2. Configure the serial port baud rate and output messages, including navigation and positioning data (INSPVA and SNCX), as well as raw data from IMU and GNSS. Baud rate options include 9600, 19200, 115200, 460800, and 921600. The data frequency for INSPVA and SNCX can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz. The default raw data frequencies are IMU 100Hz / GNSS 5Hz / PVAST 100Hz. Commands can be transmitted, and output responses can be displayed in the receive window.

4. Click [CAN1] to configure CAN1. You can set the baud rate and select data types, including time, position, speed, posture, and IMU data. The arbitration baud rate can be selected from 100K, 125K, 250K, 500K, or 1000K. The data baud rate can be selected from 125K, 250K, 500K, 1000K, 2000K, 4000K, or 8000K. The output frequency for each data type can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz.

5. Click [CAN2] to configure CAN2. You can set the baud rate and select data types, including time, position, speed, posture, and IMU data. The arbitration baud rate can be selected from 100K, 125K, 250K, 500K, or 1000K. The data baud rate can be selected from 125K, 250K, 500K, 1000K, 2000K, 4000K, or 8000K. The output frequency for each data type can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz.


Port configuration
Ethernet
COM2
CAN1
CAN2
Ethernet
IP protocol
IPv4
IP settings
Static IP
IP address
192.168.1.104
Subnet mask
255.255.255.0
Gateway
192.168.1.1
DNS
114.114.114.114
Confirm
COM2
Start up
Baud rate
115200
Parity
No parity
Data stream
Navigation position d...
INSPVA
Close
SNCX
Close
Receiving window
$GPGGA,100824.000,0000.0000000,N,
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*52
$GPGGA,100825.000,0000.0000000,N,
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*53
$GPGGA,100826.000,0000.0000000,N,
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*50
Cancel
Confirm
9600
19200
COM2
Start up
Baud rate
115200
Parity
No parity
Data stream
Navigation position d...
INSPVA
Close
SNCX
Close
Receiving window
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*50
$GPGGA,100838.000,0000.0000000,N,
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*5F
$GPGGA,100839.000,0000.0000000,N,
00000.0000000,E,0,00,0.0,0.0000,M,0.000,M,,*5E
$GPGGA,100840.000,0000.0000000,N,
Cancel
Confirm
Close
1Hz
5Hz


CAN1
Arbitration baud rate
500K
Data baud rate
2000K
Time Close
Position Close
Speed Close
Posture Close
IMU Close
Confirm
CAN2
Arbitration baud rate
500K
Data baud rate
2000K
Time Close
Position Close
Speed Close
Posture Close
IMU Close
Cancel
Confirm
125K
250K
500K
1000K
CAN1
Arbitration baud rate
500K
Data baud rate
2000K
Time Close
Position Close
Speed Close
Posture Close
IMU Close
Confirm
CAN2
Arbitration baud rate
500K
Data baud rate
2000K
Time Close
Position Close
Speed Close
Posture Close
IMU Close
Cancel
Confirm
125K
250K
500K
1000K

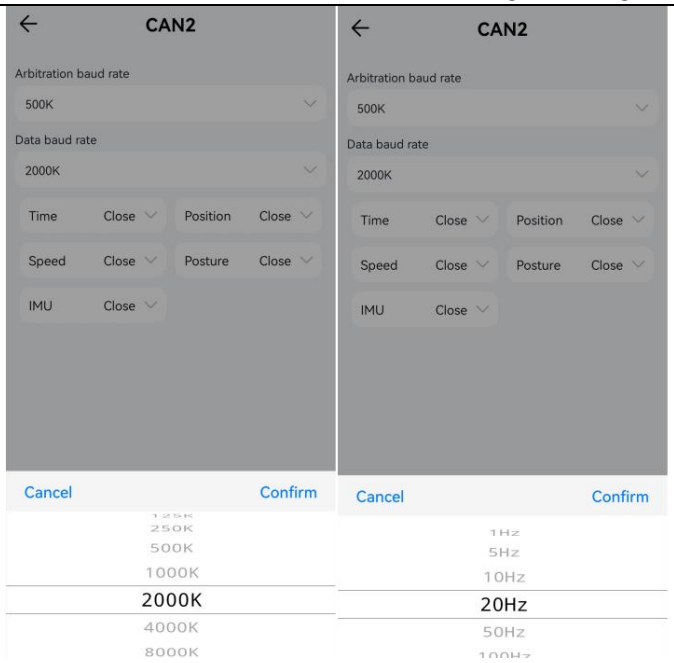


Figure 15. Port Configuration

3.1.10 Data Transmission

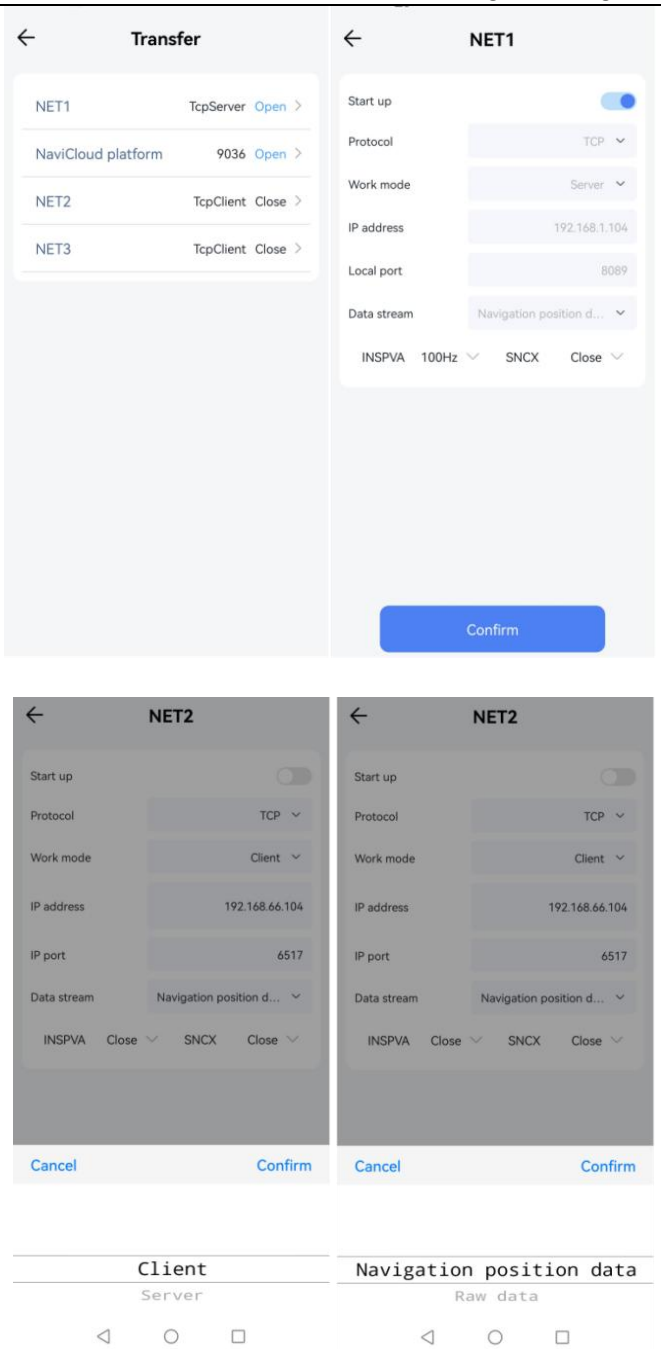
1. Click [Data Transfer]to set up 3 network transmission channels and the NaviCloud Platform address.

2. Click [NET1], then select either TCP or UDP protocol. For TCP protocol, you can configure the device as either a client or a server, and set its IP address and port. Select either navigation/positioning data or raw data. For navigation and positioning data (INSPVA and SNCX), the data frequency can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz. Raw data is output by default at IMU 100Hz / GNSS 5Hz / PVAST 100Hz.

3. Click [NET2], then select either TCP or UDP protocol. For TCP protocol, you can configure the device as either a client or a server, and set its IP address and port. Select either navigation/positioning data or raw data. For navigation and positioning data (INSPVA and SNCX), the data frequency can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz. Raw data is output by default at IMU 100Hz / GNSS 5Hz / PVAST 100Hz.

6. Click [NET3], then select either TCP or UDP protocol. For TCP protocol, you can configure the device as either a client or a server, and set its IP address and port. Select either navigation/positioning data or raw data. For navigation and positioning data (INSPVA and SNCX), the data frequency can be selected from 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, or 100Hz. Raw data is output by default at IMU 100Hz / GNSS 5Hz / PVAST 100Hz.

7. Click [NaviCloud platform] to set the IP address and port of the remote maintenance platform.


Transfer
NET1 TcpServer Open
NaviCloud platform 9036 Open
NET2 TcpClient Close
NET3 TcpClient Close
NET1
Start up
Protocol TCP
Work mode Server
IP address 192.168.1.104
Local port 8089
Data stream Navigation position d...
INSPVA 100Hz SNCX Close
Confirm
NET2
Start up
Protocol TCP
Work mode Client
IP address 192.168.66.104
IP port 6517
Data stream Navigation position d...
INSPVA Close SNCX Close
Cancel Confirm
NET2
Start up
Protocol TCP
Work mode Client
IP address 192.168.66.104
IP port 6517
Data stream Navigation position d...
INSPVA Close SNCX Close
Cancel Confirm
Client
Server
Navigation position data
Raw data

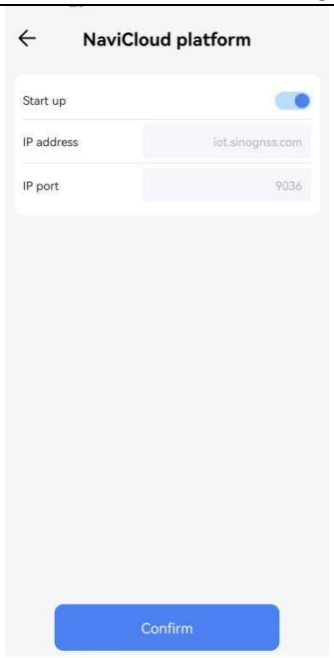


Figure 16. Data Transmission

3.1.11 Installation Configuration

1. Click [Installation Configuration] to enter the device installation parameter configuration interface, where you can configure the device installation method, antenna installation method, carrier model, antenna Lever Arm, and rear wheel axle center mast arm.

2. Device status: Not initialized, Initialization completed. This reminds the customer of the initialization status.

3. INS status: INS inactive, INS aligning, INS alignment completed but convergence not yet achieved due to insufficient vehicle dynamics, INS accuracy degraded (GNSS signal quality may be poor), INS in navigation mode with high accuracy, and INS accuracy degraded due to GNSS signal loss. Under normal operating conditions, once INS convergence is completed, the status will indicate "INS accuracy is high".

4. Initialization speed: Sets the minimum speed required for the INS to complete initialization. The minimum value can be set to 0.1, and the maximum value must be less than 500, in m/s.

5. Equipment installation methods: There are 8 installation methods. Please select the corresponding method based on the actual installation direction of the equipment relative to the vehicle's travel direction. The X and Y axes represent the INS's orientation. Custom installation methods are also supported. If you select a customize method, you will need to enter the specific X/Y/Z axis rotation angles on the main interface.

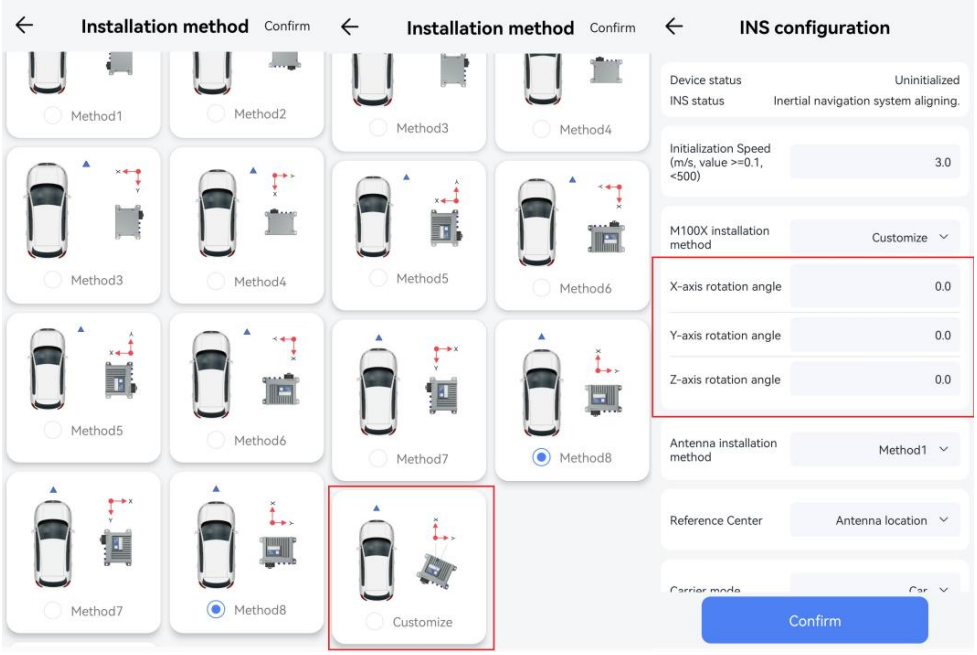


Figure 17. Equipment Installation Method

3.1.12 Instructions for custom installation

Instructions for custom installation angles of theM30X:

The angular deviation between the M30X coordinate system and the vehicle coordinate system is defined as the mounting angle, which is essentially the Euler angle of rotation from the M30X coordinate system to the vehicle coordinate system. The figure below shows the rotation parameter from the M30X coordinate system to the vehicle coordinate system.

Among them, X/Y/Z Indicates along X/Y/Z The rotation angle of the axis, in degrees (deg). The rotation rules are as follows:

1. From the vehicle coordinate system (Vehicle_Frame) to the body coordinate system (Body_Frame) ;
2. According to Z → Y → X Rotate in sequence;
3. The direction of rotation of the coordinate axes follows the right-hand rule.

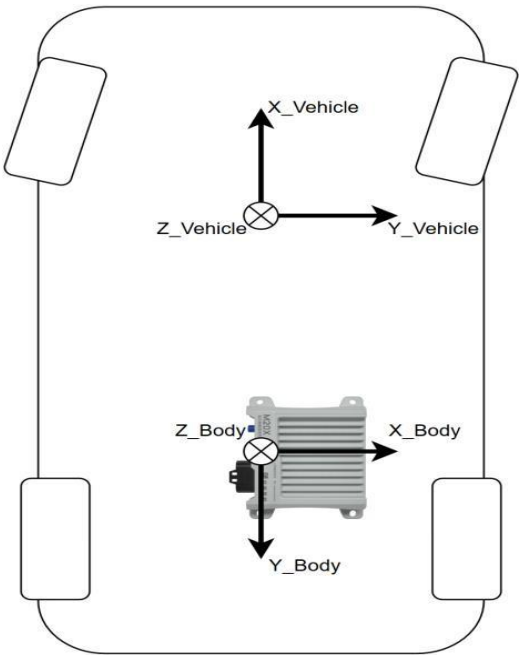


Figure 18. Top view of the vehicle and the M30X

Taking the diagram as an example, under this mounting method, rotating from the vehicle coordinate system to the M30X coordinate system requires a 90° rotation around the positive Z-axis. Therefore, the Euler angles of rotation from the M30X coordinate system to the vehicle coordinate system are: X : 0 , Y : 0 , Z : 90 .

Note: The Euler angle of rotation from the M30X coordinate system to the vehicle coordinate system should be measured as accurately as possible. If there are errors in the set machine rotation parameters, online calibration is required.

1. Antenna Installation Methods: There are four installation methods. Please select the corresponding option based on the actual installation location of the master and slave antennas . Custom installation methods are also supported. After selecting custom, you need to fill in the specific installation angle on the main interface. This angle is the clockwise rotation angle of the slave antenna relative to the master antenna.

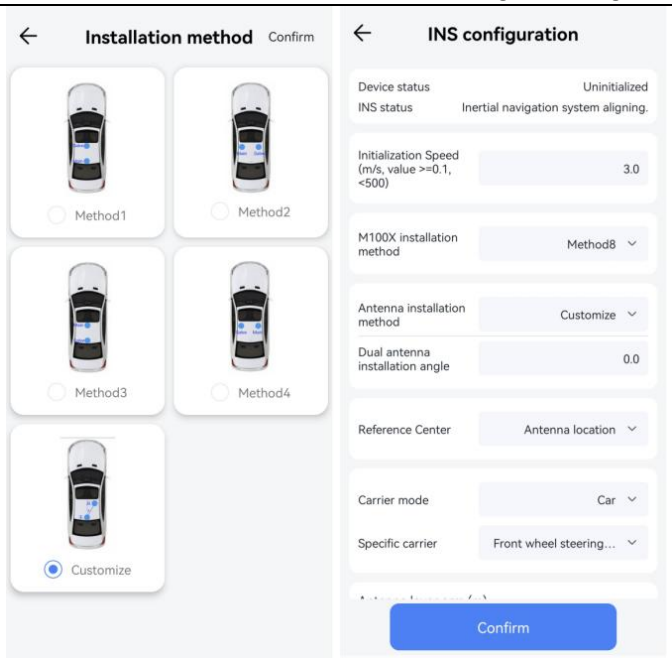


Figure 19. Antenna mounting method

2. Reference Center: The reference center is the latitude and longitude coordinates output by the actual device for that location. Options include the master antenna position, rear wheel center, and a custom option (customized as the distance of the customer-selected point relative to the origin of the M30X Coordinate System's X/Y/Z axes). For example, if the master antenna position is selected, the latitude and longitude coordinates output by the device will actually be the latitude and longitude of the master antenna position. If the custom coordinates are set to 0, 0, 0, then the M30X will output the origin position of the M30X Coordinate System.

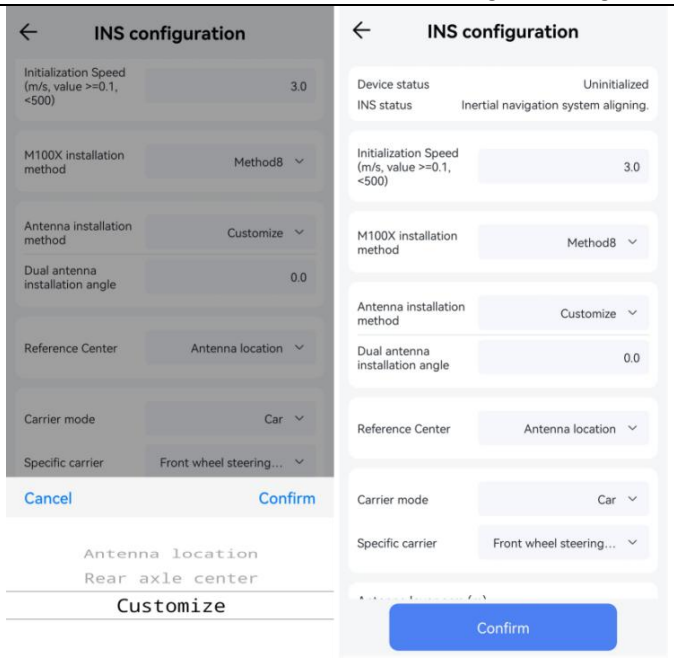


Figure 20. Reference Center

3. Platform mode: You can choose from three modes: vehicle-mounted, airborne, and shipborne. Please select the corresponding model option for your actual platform.

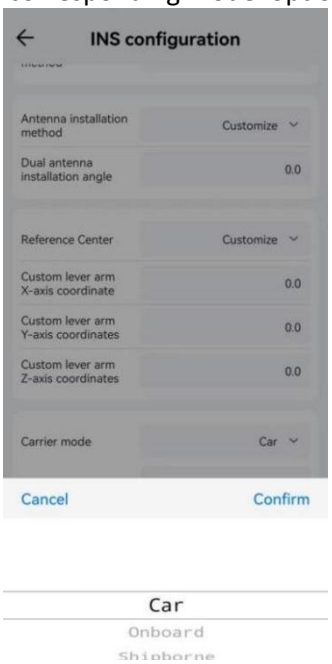


Figure 21. Carrier Mode

4. Specific vehicle types: Passenger vehicles, front-wheel steering low-speed autonomous vehicles, multi-wheel steering low-speed autonomous vehicles, two-wheel steering low-speed autonomous vehicles, and four-wheel steering low-speed autonomous vehicles are available. Selecting the appropriate model for your actual vehicle type will yield better results .

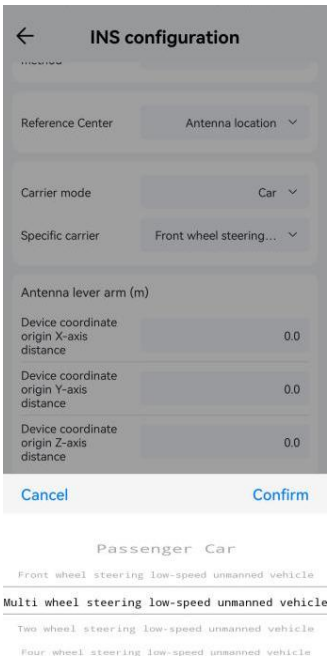


Figure 22. Vehicle Type Selection

5. Antenna Lever Arm: The vector from the origin of the M30X coordinate system to the phase center of the main GNSS antenna is defined as the GNSS antenna lever arm.Take the center of the M30X coordinate system as the origin, with the X, Y and Z axes aligned with those of the vehicle body coordinate system, and measure the X/Y/Z coordinate values of the antenna phase center. Note: Errors of the antenna lever arm will directly affect the position output accuracy of the integrated navigation system. It is necessary to keep the error within 2 cm as far as possible. If precise measurement equipment is unavailable, online calibration can be performed after configuration to refine the lever arm parameters.

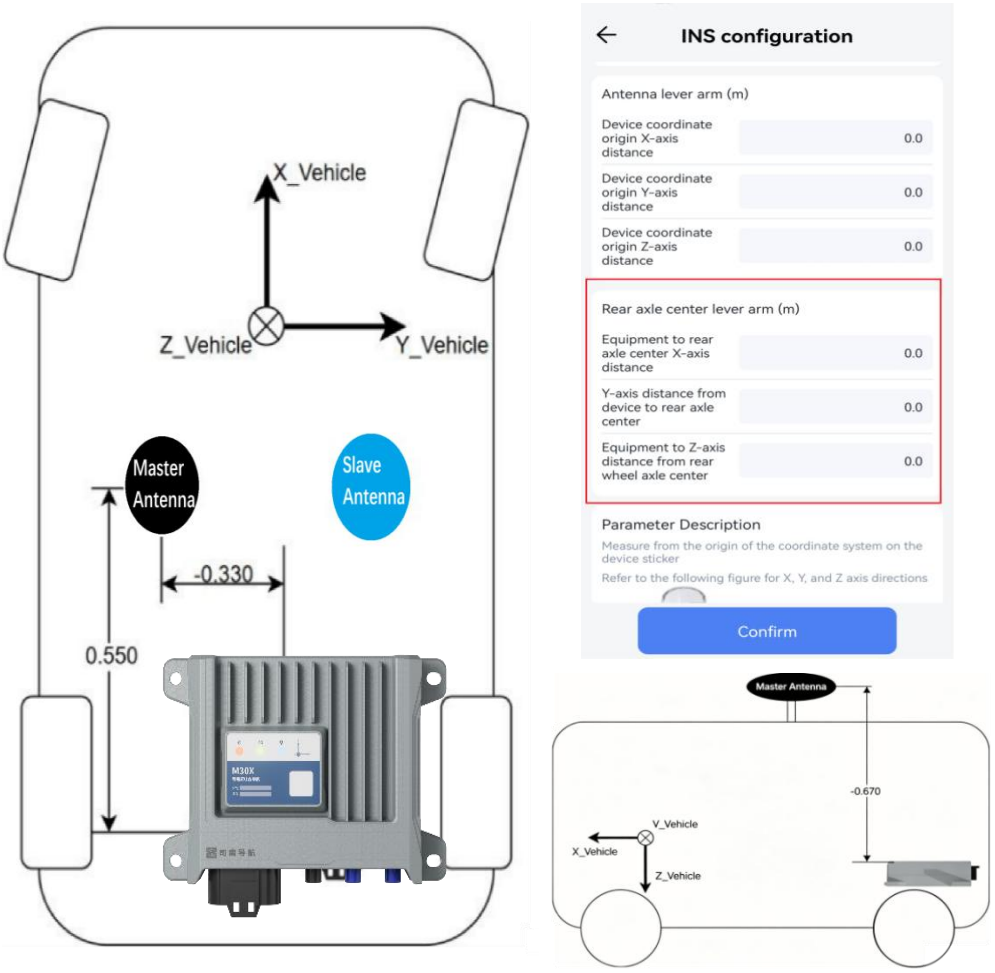


Figure 23. Lever Arm from the M30X to the GNSS Master Antenna

6. Rear Axle Center Lever Arm: Under the normal driving condition of the vehicle, the lateral velocity and ground velocity at the rear axle center are zero. To effectively utilize constraint information and improve the Dead Reckoning performance of the vehicle, it is required to manually measure the lever arm values from the origin of the M30X coordinate system to the rear axle center after the M30X is fully installed. The measurement method may refer to that of the GNSS antenna lever arm. Herein, X/Y/Z denote the coordinate values of the rear axle center lever arm along the X, Y and Z axes, with the M30X of meter. When wheel speed data is accessed by the vehicle, this parameter shall be configured correctly; otherwise, abnormal calculation results may occur.

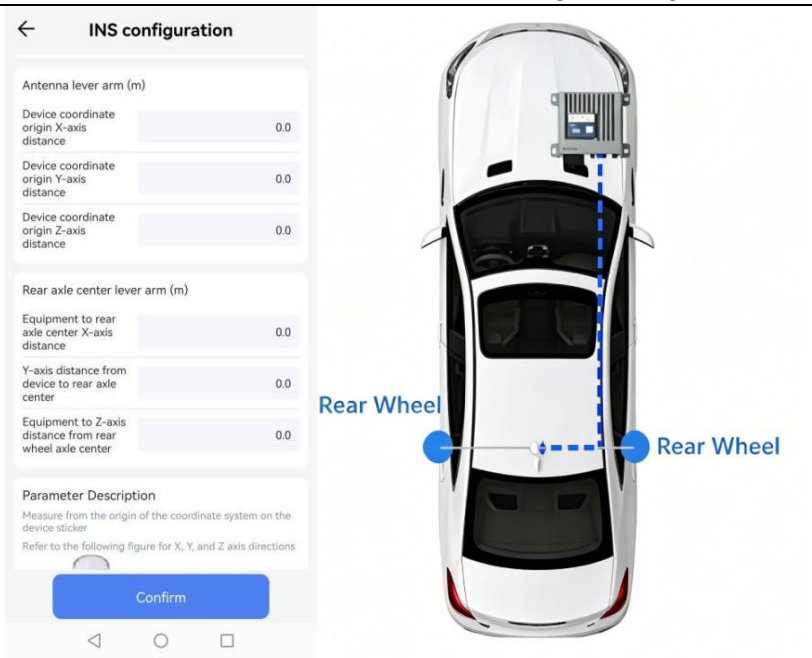


Figure 24. Lever from the center of the rear wheel axle of the M30X

3.1.13 Data Storage Operation

1. Click [Data Storage] to enter the data storage configuration interface, where you can view the storage capacity and configure two-way storage.

2. Click on the first storage path. By default, the first storage path can only store navigation messages (INSPVA). With SNCX, select the desired message frequency, supporting 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz, and allocate storage space and file intervals according to the frequency. Note that a single message at 100 Hz occupies approximately 2 GB of storage per day, and two messages both logged at 100 Hz require about 4 GB of storage space per day. If the allocated storage space is insufficient, cyclic storage may overwrite the historical data.

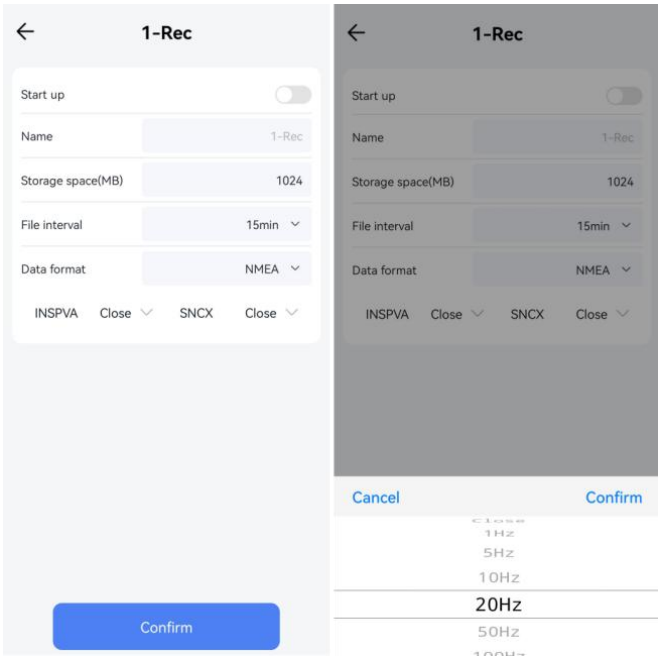


Figure 25. First-way storage settings

3. Click on the second-channel storage. By default, the first-channel storage only stores raw messages. The default frequency of IMU data is 100 Hz, GNSS data is 5 Hz, and PVAST data is 100 Hz. Supported configurable frequencies are 1Hz/5Hz/10Hz/20Hz/50Hz/100Hz. The file interval can be set to 15min/1h/4h/24h. ODOM indicates the wheel speed access status. The indicator light turns green when wheel speed is accessed; otherwise, it remains gray. Note: If the allocated storage space is insufficient, circular storage may overwrite the previous data.

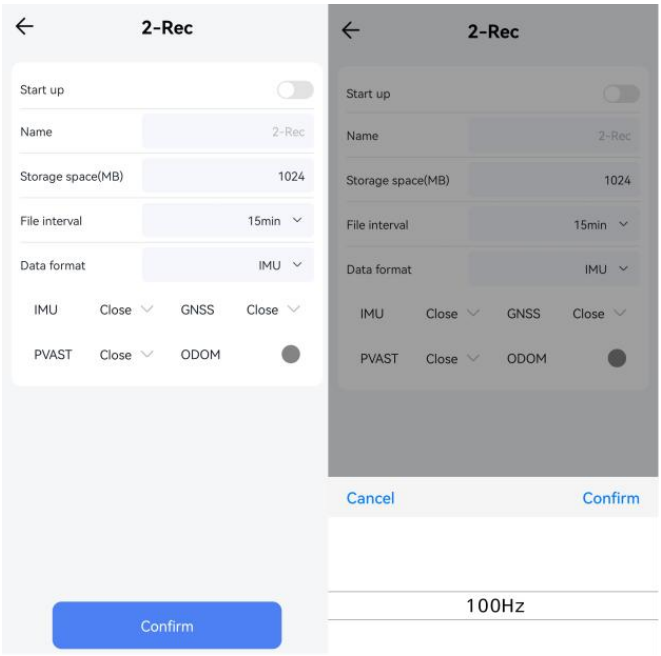


Figure 26. Second-way storage setup

4. Click [Data Storage], then click the Format button to format the storage. The M30X will restart after formatting.

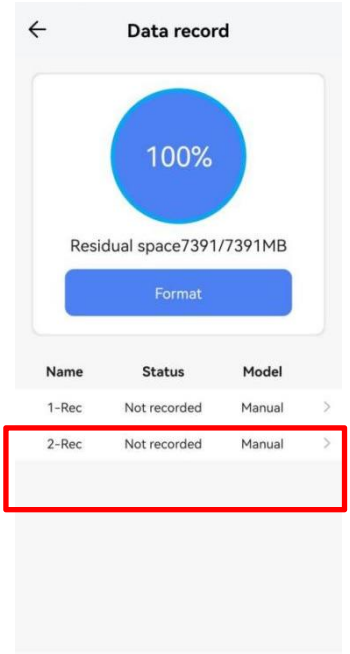


Figure 27. Formatted storage3.1.14

3.1.14 Host control operation

1. Click [Host Control] to enter the host control interface, where you can restart the M30X or restore factory settings.

2. Restoring factory defaults will erase all user configurations and restart the M30X. Proceed with caution.

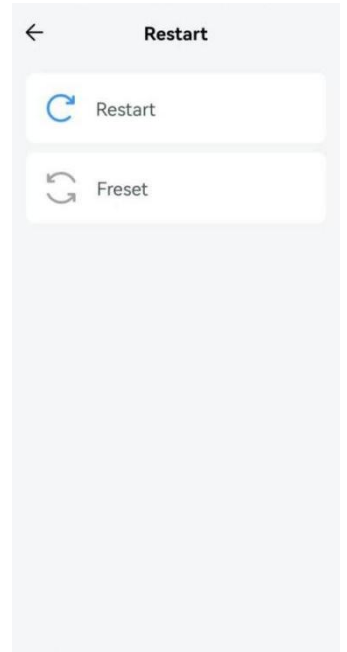


Figure 28. Host Control

3.2 Operating Instructions

Starting to use the M30X Previously, please ensure that you have followed section 3.1. And 3.2 As described in this section, the antenna and the M30X have been installed, and the M30X is now powered on. You can verify that the M30X has been correctly powered on and is running by performing the following steps:

1. Check the M30X indicator lights to see if the power light is constantly red.
2. Check if the status light is constantly red;
3. Use the Navigation Master application to search for devices via Bluetooth and see if you can find and connect to them normally.
4. Use the Navigation Master application to check the satellite tracking status.

3.2.1 Inertial navigation settings

Click on the Navigation Master APP [Installation Configuration], and follow the steps in version 3.1.11. As described in this section, the initialization speed settings, equipment installation method selection, antenna installation method selection, reference center, carrier mode, antenna Lever Arm settings, and rear axle center mast arm settings are completed . See section 3.1.11 for detailed instructions.

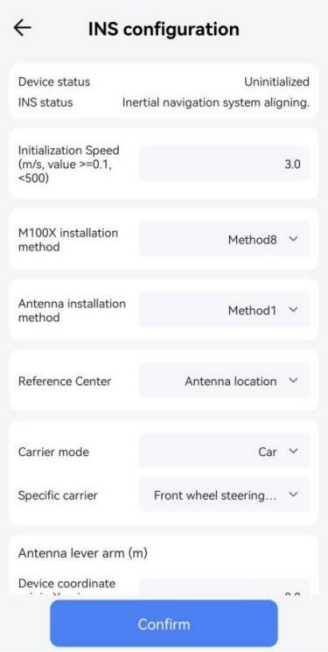


Figure 29. Installation and Configuration

3.2.2 Differential data input

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

A GNSS receiver installed at a fixed and known location acts as the base station. The receiver broadcasts differential data in some way. The rover, on the other hand, needs to

continuously acquire differential data from the base station to calculate its current accurate position.

Users can set up a base station by themselves or subscribe to commercial base station services. In either case, a data link is required between the base station and the rover for transmitting differential data. In application scenarios, the data link can be established via the device's built-in 4G module, or by connecting wireless data transmission units, DTU and other equivalent devices. As a rover station, the M30X generally receives differential data through its internal 4G function, serial port COM1, or Ethernet port.

If accessing differential services through its own 4G, a SIM card needs to be inserted before the device is powered on. After booting up, connect to the device via the Navigation Master application, click the [4G] function, and turn the 4G switch on/off. Click the [Differential] function, then select the differential network [NTRIP] [Client] or [NET1]or [NET2]or [NET3]. Selecting [NTRIP][Client]represents the NTRIP link protocol, while [NET]represents TCP as the link protocol. Select [NET] for the protocol. The relevant IP settings will be mapped to the corresponding settings in [Data Transmission]. Refer to Section 3.1.7 for details.

If differential data is obtained through the network port, turn the device's 4G switch off, open [Port Settings]-[Ethernet], and configure the Ethernet IP address. After configuration, click the [Differential]function and select the differential network [NTRIP][Client]or [NET1]or [NET2] or [NET3]. Selecting [NTRIP][Client]represents the NTRIP link protocol, while [NET]represents TCP as the link protocol. Select [NET]for the protocol. The relevant IP settings will be mapped to the corresponding settings in [Data Transmission]. See Section 3.1.9 for details.

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

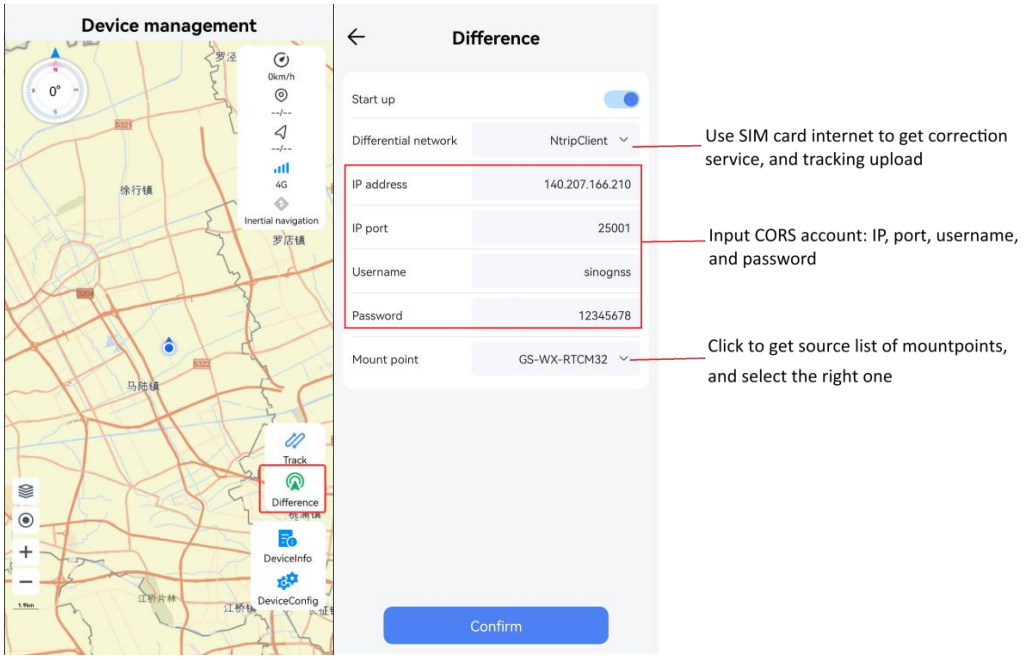


Figure 30. NTRIP Client Setup

After completing differential data access, you can use the Navigation Master application to monitor positioning status. On the Navigation Master application main interface, check whether the positioning status is fixed.

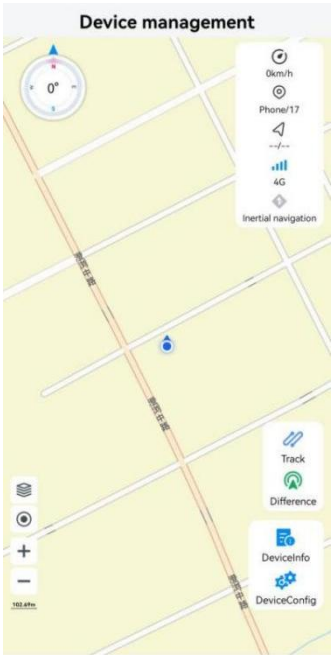


Figure 31. Fixed solution

Tip: Once the tracking server address is successfully configured or the device connects to a correction service, the GPRS/Differential LED on the front panel will flash once per second.

3.2.3 Wheel speed access

After the integrated navigation receiver receives vehicle wheel speed data, it can effectively assist the system in dead reckoning when satellite signals are severely obstructed or unavailable, thereby improving the accuracy of the integrated navigation system in environments with poor satellite signal coverage. Integrated navigation systems typically use CAN/CAN FD to receive vehicle wheel speed signals. Before inputting wheel speed data, please ensure that the wheel axle linkage configuration is complete.

Typically, a wheel speed update frequency of at least 20 Hz (50 Hz recommended), an accuracy better than 0.1 m/s (0.01 m/s recommended), a resolution higher than 0.02 m/s, and a latency of no more than 10 ms are required. The device does not have a built-in terminating resistor; matching must be performed at the input end during use.

After wheel speed is connected, you can check the wheel speed information indicator lights via the Navigation Master application through [Data Transmission]-[Raw Data]-[Data Stream], or use the RAWODOMA statement to verify whether the device has received the wheel speed information. The specific method is to send the following command via serial port or Ethernet:

LOG RAWODOMA ONNEW

Continuously receiving the RAWODOMA message indicates that the device has received the

wheel speed information.

Figure 32. Wheel speed input

3.2.4 Real-time data output

The device can be configured to output real-time message information via the Navigation Master application or serial port. The following points should be noted during real-time operation:

Please ensure that the environment in which the device is located can receive satellite signals normally. If satellite signals cannot be received, or if the satellite signal quality is poor, the position, velocity, and posture information output by the device may not meet the usage requirements.

INS navigation information and GNSS navigation information can be retrieved independently. Integrated Navigation information is typically obtained through INS output of the relevant statements.

Configuration can be performed using the Navigation Master application or commands. Messages can be output via network or serial port. For Navigation Master application configuration details, please refer to Sections 3.1.8 and 3.1.9.

For serial port command configuration, taking INSPVA message printing as an example, the command to print the INSPVA message at 100 Hz in ASCII format is as follows:
LOG INSPVAA ONTIME 0.01

When frequently outputting INS-related messages, the data volume is large. To ensure data integrity, it is recommended to transmit messages in binary format via Ethernet. If using serial port transmission, it is recommended to set the serial port baud rate to 921600.

Commonly used integrated Navigation messages are shown in Table 2

Table 2. Common Integrated Navigation Messages

Classification	Related Messages
Position	INSPOS, INSPVA, INSPVAX
Speed	INSVEL, INSSPD, INSPVA, INSPVAX
Posture	INSATT, INSPVA, INSPVAX
Solution Reliability	INSSTDEV, INSPVAX

3.2.5 System alignment

The process by which an integrated navigation system acquires current position, velocity, and posture information to complete system initialization is called system alignment. This can be achieved via the Navigation Master application. The INS status display or the status field in the INSPVA/INSPVAX statement allows real-time confirmation of system alignment progress.

When the M30X is powered on, the M30X will align according to the following procedure:

When the M30X is powered on, the system is in an inactive state, corresponding to INACTIVE. The INS is not activated at this time. The Navigation Master application shows that the system is not initialized, and the INS is being aligned.

When satellite signal reception is good, the device will enter alignment mode, and the status will switch to ALIGNING, indicating that the INS is aligning. In alignment mode, the device will determine the initial position, velocity, and heading of the vehicle based on GNSS data. At this time, the Navigation Master application will display "Uninitialized, INS Aligning".

If the device is connected to dual antennas and the dual antenna installation angles are correctly configured, system alignment can be completed in a stationary state. If dual antennas are not connected or the quality of dual antenna observations is poor, it is necessary to maintain a straight-line travel at a threshold speed to complete system alignment. The default threshold speed is 3 m/s.

Once system alignment is complete, the status switches to ALIGNMENT_COMPLETE, indicating that INS alignment is complete. At this time, the APP displays that alignment is complete, but the vehicle dynamics are insufficient, and calibration is not yet complete.

The M30X continues to correct the integrated navigation results using GNSS data. After the vehicle undergoes a certain turning maneuver, the accuracy successfully converges. At this time, the status will switch to SOLUTION_GOOD, which means that the integrated navigation accuracy is high. The Navigation Master application will then display that initialization was successful and navigation accuracy is high.

When the integrated navigation system has a large error, the entire system will switch to

HIGH_VARIANCE status. When GNSS navigation results are unavailable, it will switch to SOLUTION_FREE status. Table 3 summarizes and briefly describes the above states.

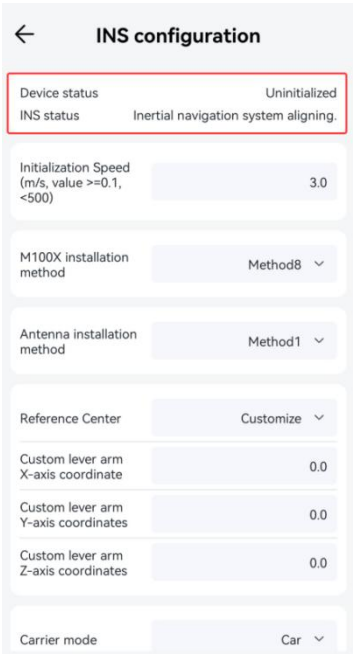


Figure 33. INS Status Display

Table 3. INS Status

Status indicator	Description
INACTIVE	INS is in an inactive state
ALIGNING	INS In alignment mode
HIGH_VARIANCE	INS is in an abnormal state due to high variance
SOLUTION_GOOD	INS is in navigation mode with good solution
SOLUTION_FREE	INS filter is in navigation mode, but GNSS contains errors
ALIGNMENT_COMPLETE	INS filter is in navigation mode, but the vehicle dynamics are insufficient, and the INS does not meet the accuracy requirements.

3.2.6 Online calibration

Once the initial installation of the equipment is finished and the overall rotation parameters, GNSS antenna lever arm, and dual-antenna mounting angle parameters are configured, more accurate parameter values can be estimated via online calibration to further enhance the accuracy of integrated navigation outputs.

The on-line calibration parameters are as follows: 1. System rotation parameters; 2. GNSS antenna lever-arm parameters; 3. Dual-antenna installation angle parameters. The online calibration process is as follows:

1. When the device is powered on, a calibration parameter clear command is sent to clear the existing parameters: *CLEARDRCLBPARAM*

2. Send the device restart command RESET and wait for the device to complete the

restart;

3. Complete system alignment;

4. The vehicle should maintain a certain speed (5 m/s recommended). The above (at a speed not less than 1 m/s) takes approximately 5 minutes to travel. See the map for the recommended route in Figure 34 ; If the requirement of a figure-eight route cannot be met, it must be ensured that the vehicle's driving status includes both straight and turning during the online calibration period , such as driving in a "日" shape along urban roads, as shown in Figure 35 ;

5. Via LOG/UNLOG The command can enable/disable online calibration status message printing:

   LOG INSCALIBSTATE ONTIME 1 UNLOG INSCALIBSTATE

6. After the command is issued, the serial port will continuously output messages containing the online calibration status and estimated parameter values. This message only indicates the status of the current calibration, and historical calibration records cannot be queried. The message format is shown below:

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

7. Among them, The STATE field represent the current online calibration status, and the status of each calibration parameter is shown in Table 4. As shown, when the corresponding parameter calibration is complete, The STATE fields will accumulate according to the corresponding calibration status. For example, when the antenna Lever Arm, equipment mounting angle, and dual antenna mounting angle are calibrated, the STATE field will be 0x07 .

Table 4. Calibration parameter status information

Calibration parameters	Calibration completion status
Antenna Lever Arm	0x01
Equipment installation corner	0x02
Dual antenna mounting angle	0x04

8. Each time the device is powered on, it will read the calibration status and parameters. If the corresponding parameters have been calibrated, the calibrated parameters will be automatically configured .

9. To view the previous calibration status of the M30X, you can send *READDRCLBPARAM* Command query.

Figure 34. Recommended route 1 for online calibration

Figure 35. Recommended route 2 for online calibration

3.2.7 Data post-processing

The raw data output from the M30X can be post-processed using specialized software. Through bidirectional processing and smoothing, the software delivers higher-accuracy positioning results post-mission, serving as a ground-truth reference for testing.

3.2.8 Firmware upgrade

The device can upgrade its firmware via serial port and NaviCloud Platform.

1. Serial port upgrade: Power on the receiver, connect the serial port to COM2 , open the serial port upgrade tool QinT_Pbox_Update.exe, click Setting, select the corresponding recognized port number, and click Link. Connect to the port; normally, the serial port will print information about the current device version. Click Select. Select firmware upgrade package BIN File, click Update Upgrade begins. The upgrade process will take approximately 20 seconds to begin, during which time the progress bar will start to move.

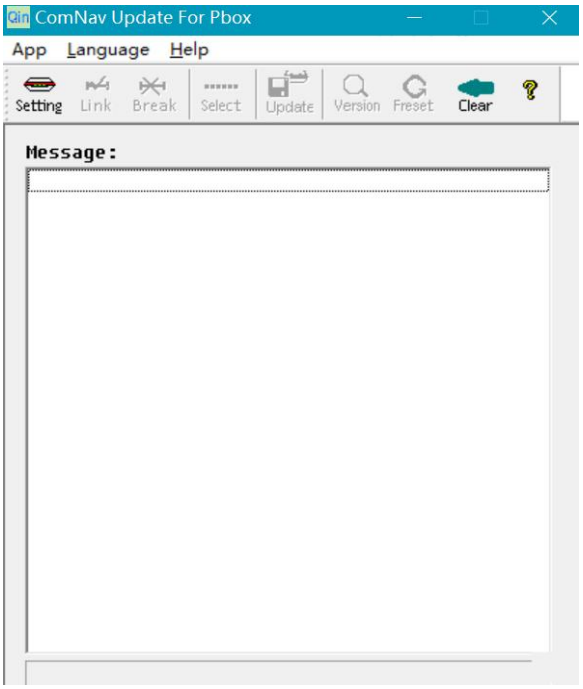


Figure 36. Serial port upgrade tool

2. Remote upgrade: M30X Remote upgrades are supported, but you need to log in to the NaviCloud Platform to perform the operation. Before remote upgrades, please ensure that the [Device configuration]-[NaviCloud platform]setting is enabled and that you are connected via 4G or a network.

(1) Setup for 4G

Enable mobile network, input APN account, and check the 4G status.

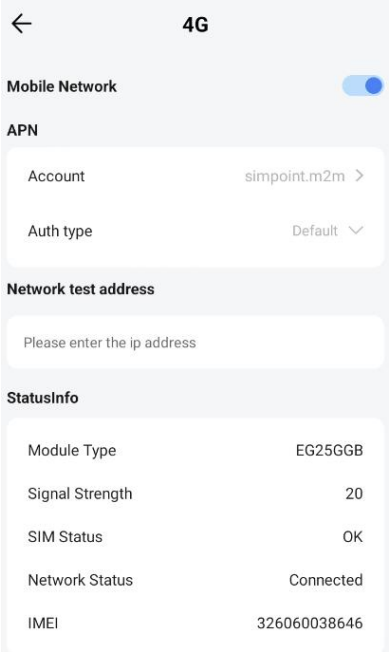


Figure 37. 4G setting

(2) Connecting the Device to NaviCloud Platform

Once connected via Bluetooth, navigate to DataTransfer to manage the data stream:

NaviCloud: Input the NaviCloud platform address to enable remote device management. Server Address: iot.sinognss.com:9036

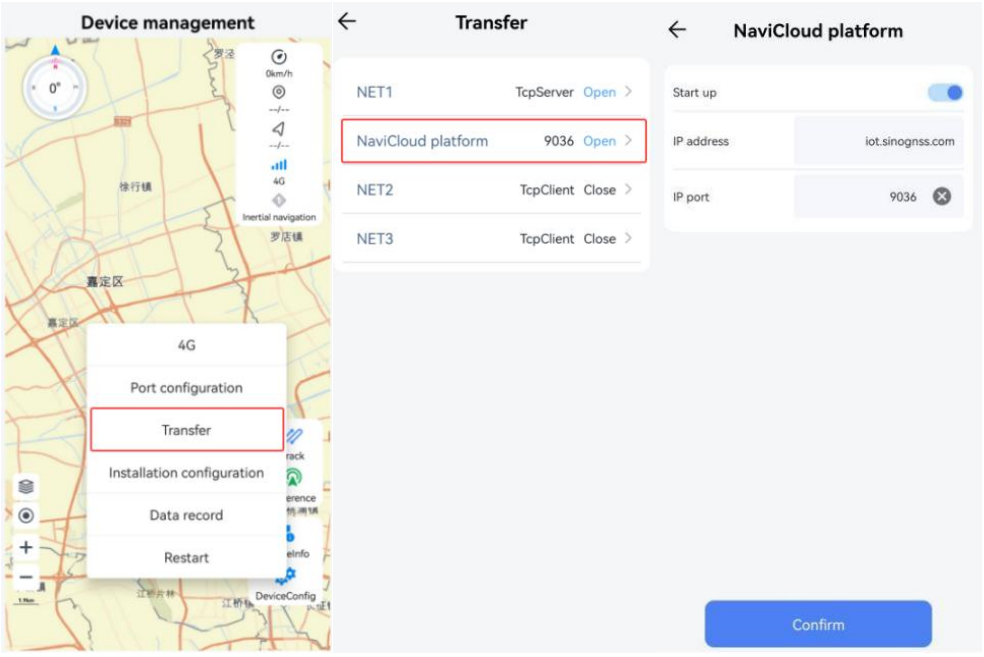


Figure 38. Upload Device to Navicloud

(3) Account Registration and Login

Open your web browser and navigate to the NaviCloud platform: https://cloud.sinognss.com/#/home, then choosing the CTMGR application within the NaviCloud platform.

Register a NaviCloud account, then log in using your username and password.

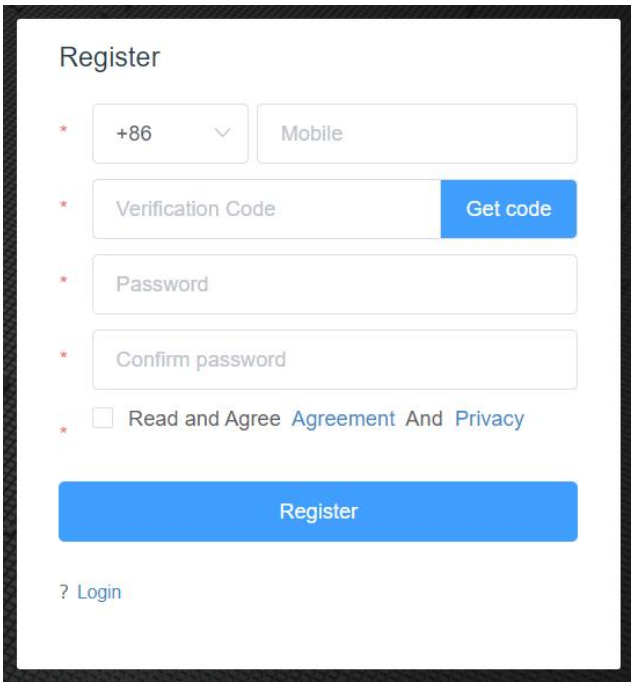


Figure 39. register in NaviCloud Platform

(4) Adding a New Device

Click [Device list], enter the device name and SN. Click [Save].

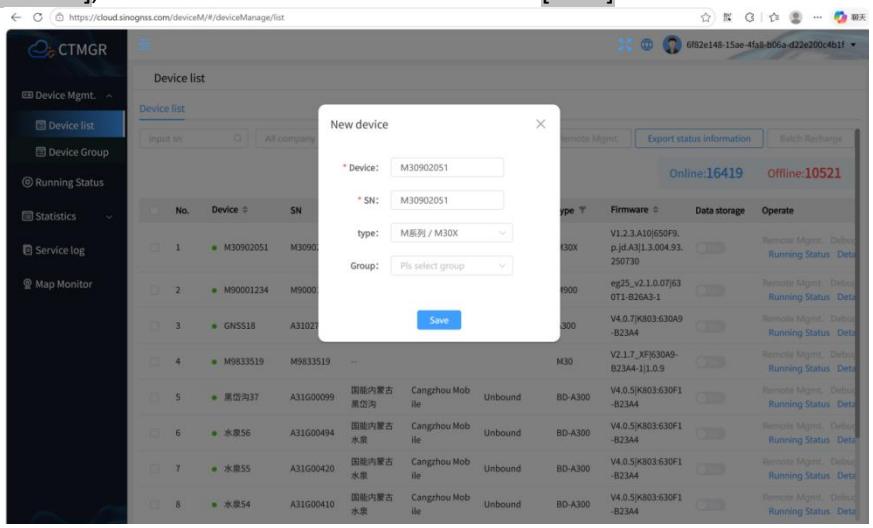


Figure 40. New Device

(5) Remote Management & Upgrading

After creating a new device, if the device communication is normal, it will show as online. Click [Remote Mgmt.], select [Upgrade], select the corresponding version type (official version / test board), firmware version, upgrade method (board upgrade / system upgrade), and click [Upgrade Now].

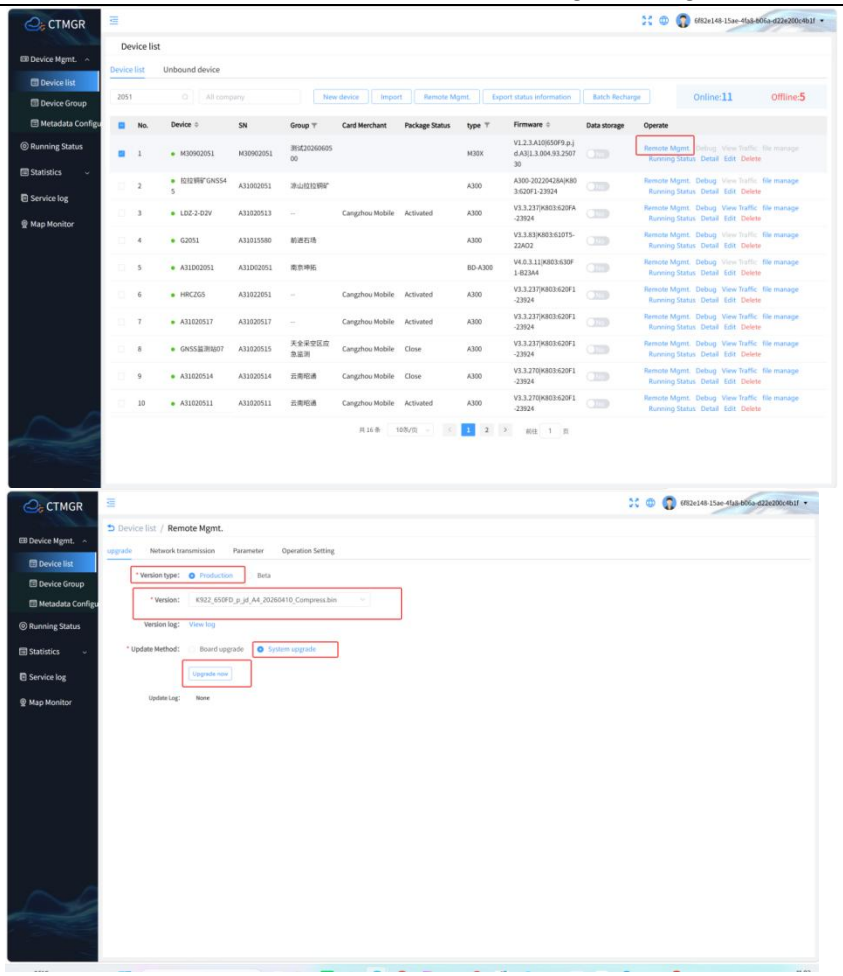


Figure 41. Remote Upgrade

3.3 Management in CTTrack

This chapter will introduce the CTTrack in NaviCloud platform.

Note: A SIM card must be inserted into the device. Please refer to the "Setup for 4G" and "Connecting the Device to NaviCloud Platform" subsections in Section 3.2.8 Firmware Upgrade before proceeding.

3.3.1 Register and Login

Open your browser and go to the NaviCloud platform address: http://cloud.sinognss.com. If you do not have an account yet, follow the "Account Registration" instructions in Section 3.2.8 to create one. After registration, return to the login page, enter your username and password, and click Login.

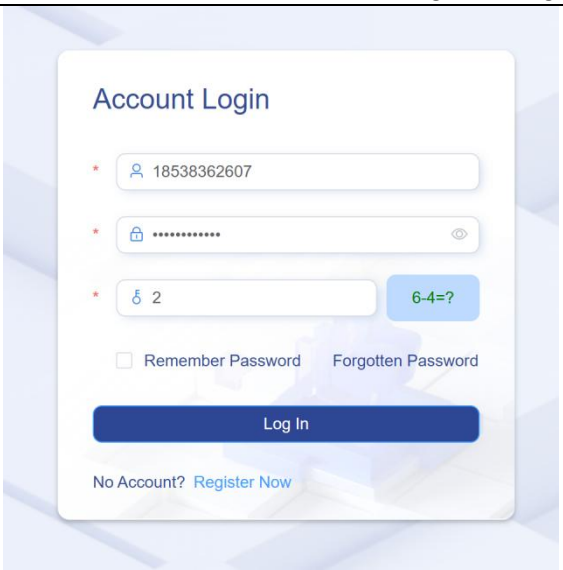


Figure 42. login in NaviCloud Platform

3.3.2 CTTrack

On the main page, our products—CTTrack.

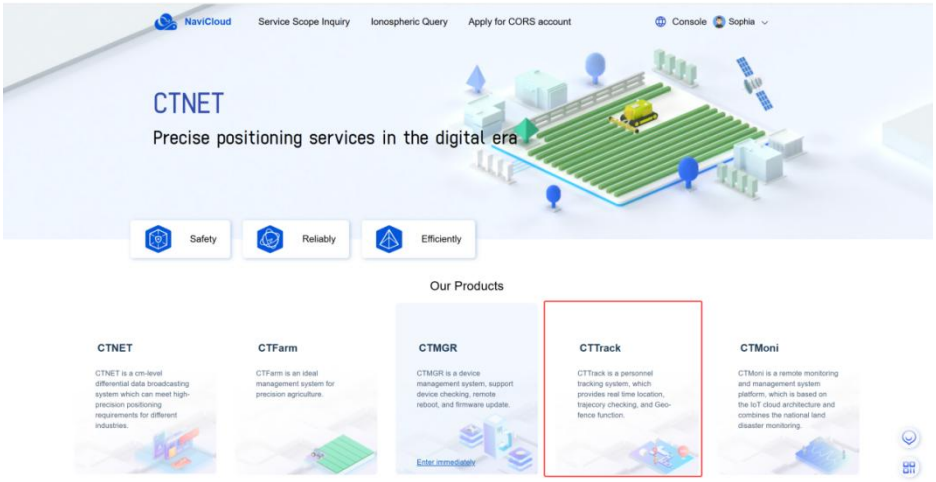


Figure 43. CTTrack

There are three main functions, monitoring, tracking and rescue.

Figure 44. Main page in CTTrack

(1) Add device

In Device--New Device, add your M30X information (the SN must be same with your device)

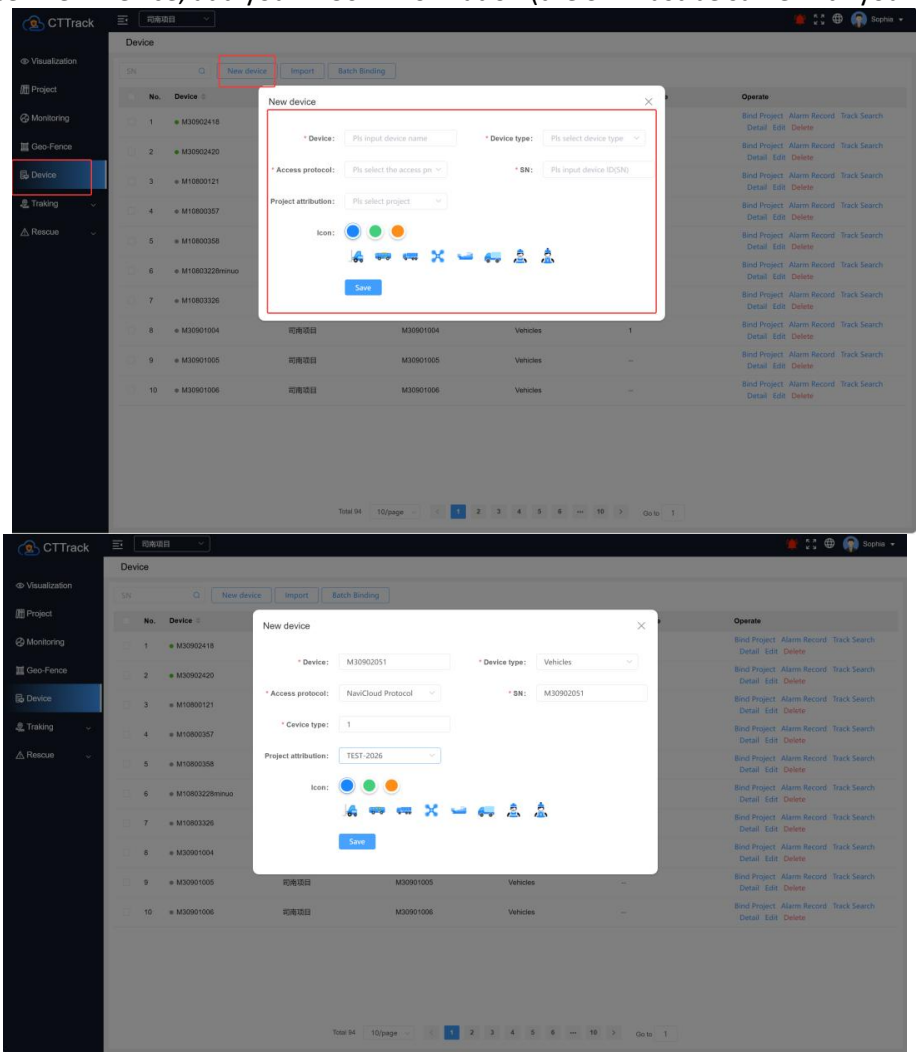


Figure 45. Add device

After you add the device succeed, you can check the device status.

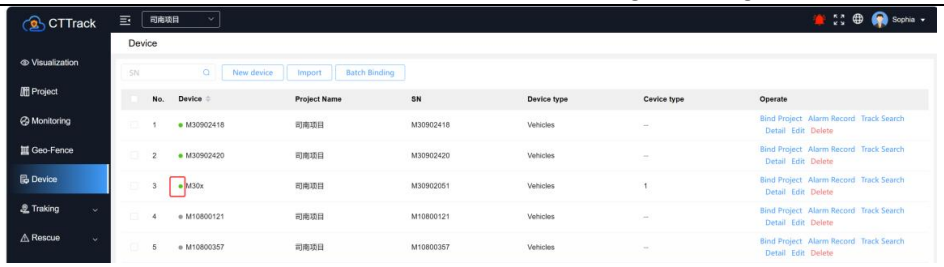


Figure 46. Check device status

(2) Monitoring

Go monitoring, you can monitor all devices on map. And on bottom of right interface, it shows real time status for devices.

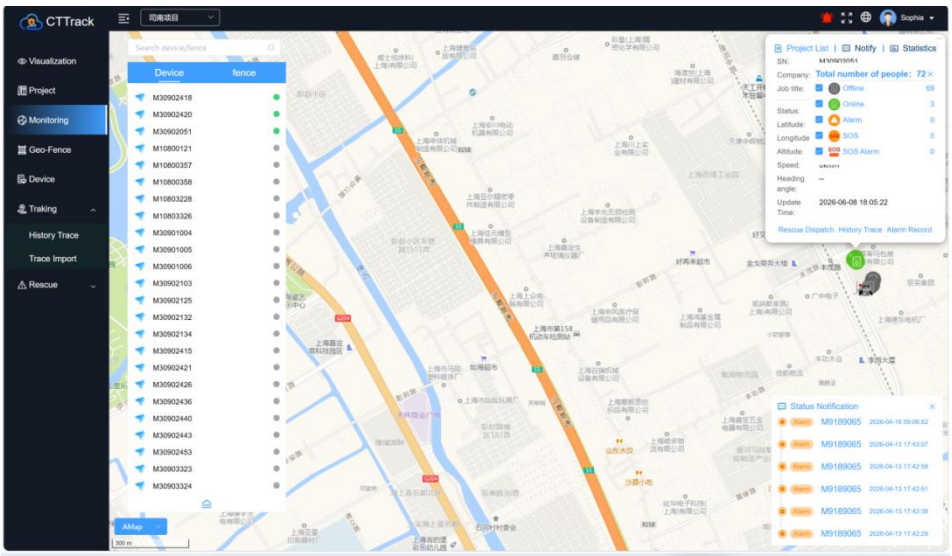


Figure 47. Monitoring the device

(3) Tracking

NaviCloud support check tracking for the selected period of time. Select the device and date you want to check the tracking, you can also download the tracking as KML format, so that you can open with google map.

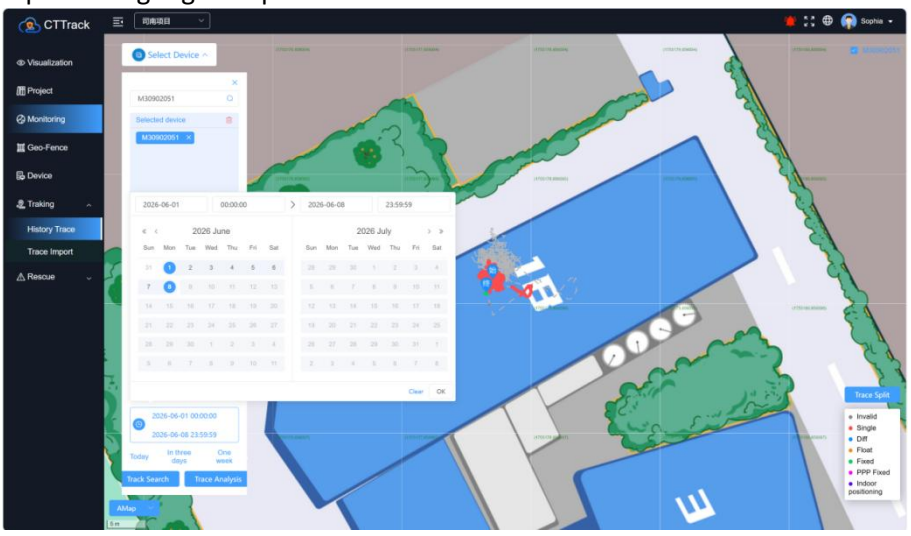


Figure 48. Select the device and tracking time

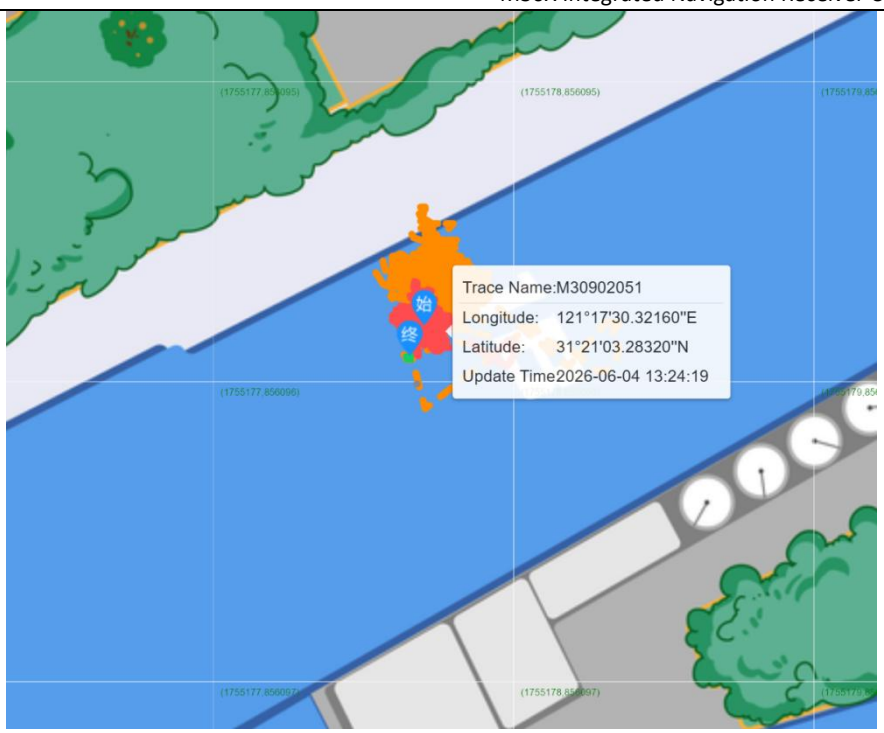


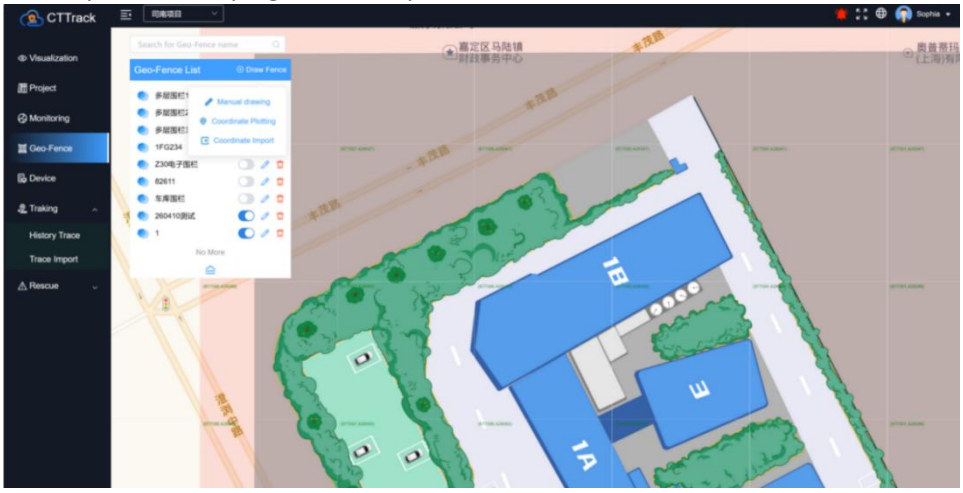
Figure 49. Download the track

(4) Electronic Fence

With electronic fence, M30X can remind the workers in real time with beep sound. The manager build the electronic fence and active it in NaviCloud, once the workers outside of the area, the M30X will warning, and NaviCloud also will receive message.

Here shows how to build an electronic fence:

Click Geo-Fence, then Click [Draw Fence], add the electronic fence by click on map. Note to click the first point on map again to complete the fence.



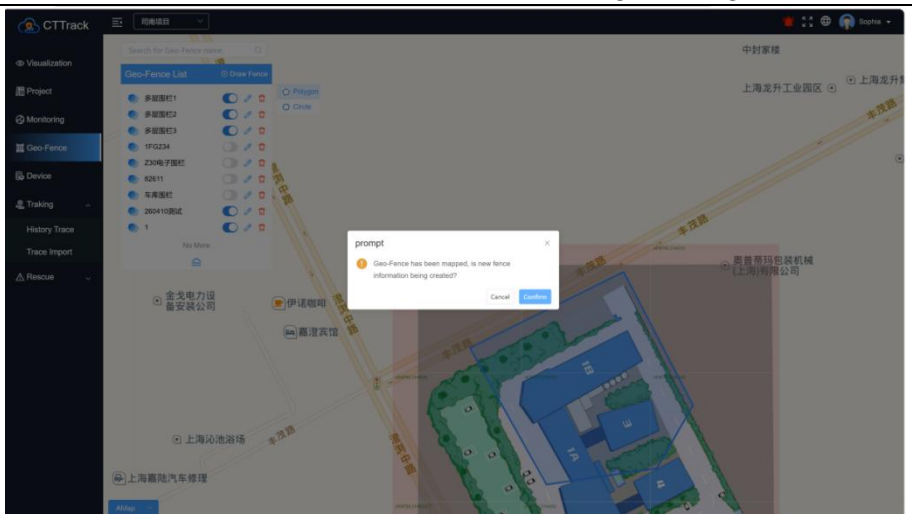


Figure 50. Draw the Geo-Fence

It will prompt below interface, give a name of the fence, and select a manager, active the device which need work in the fence.

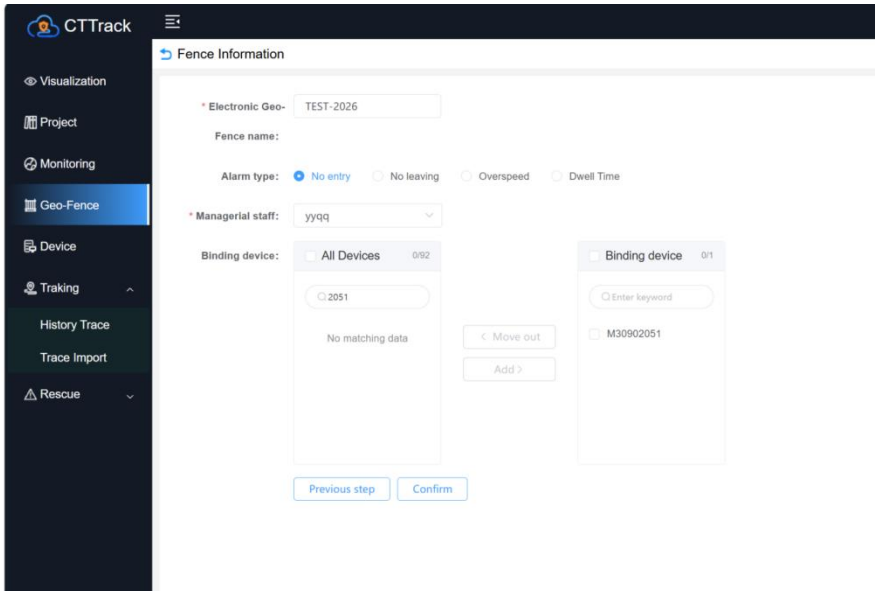


Figure 51. Information of Geo-Fence

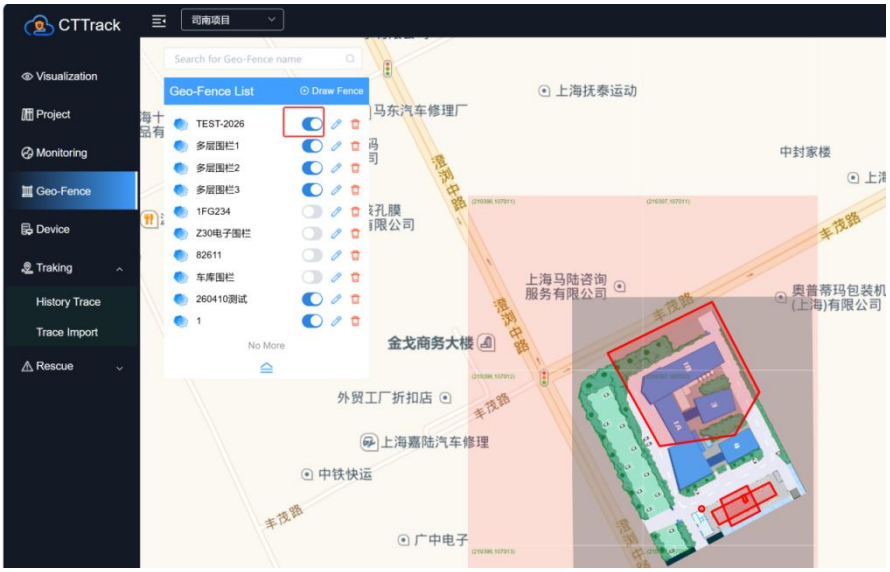


Figure 52. Activate the Geo-Fence

4 Appendix A Message Description

4.1 INSPVA Inertial navigation position, velocity and posture

*#INSPVAA,USB1,0,67.5,FINESTEERING,2209,490558.000,02000020,18bc,16809;2209,490558.000000000,51.15043714042,-114.03067871718,1080.3548,0.0051,-0.0014,-0.0012,-0.29640 2993,0.311887972,157.992156267,SOLUTION_GOOD*cc698020*

Serial Number	name	meaning	Data Class type	Binary Byte	Binary Offset
1	Header	message header	--	H	0
2	week	GPS Weeks (GPS) hour)	Ulong	4	H
3	Seconds	GPS Weekly seconds (GPS) hour)	Double	8	H+4
4	Latitude	Latitude (WGS84) [degrees]	Double	8	H+12
5	Longitude	Longitude (WGS84) [degrees]	Double	8	H+20
6	Height	Ellipsoid height [metres]	Double	8	H+28
7	North Velocity	Northward velocity (negative values indicate the direction is north) (South) [m/s]	Double	8	H+36
8	East Velocity	Eastward velocity (negative values indicate direction) West) [m/s]	Double	8	H+44
9	Up Velocity	Upward velocity [m/s]	Double	8	H+52
10	Roll	Around X The rotation angle of the axis, in the positive direction, follows Right-hand rule [degrees]	Double	8	H+60
11	Pitch	Around Y The rotation angle of the axis, in the positive direction, follows Right-hand rule [degrees]	Double	8	H+68
12	Azimuth	Around Z The rotation angle of the axis, in the positive direction, follows Right-hand rule (0-360) [degrees]	Double	8	H+76
13	Status	INS status indication	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Fixed ending (ASCII only) Only then)	--	--	--

Table 5. INS solution state

binary	Fields	Data Description
0	INACTIVE	INS Inactive, alignment not started
1	ALIGNING	INS In alignment mode
2	HIGH_VARIANCE	The INS results may not meet the accuracy

		specifications.
3	SOLUTION_GOOD	The INS filter is in navigation mode, INS High accuracy
6	SOLUTION_FREE	The INS filter is in navigation mode, but GNSS is unavailable
7	ALIGNMENT_COMPLETE	The INS filter is in navigation mode, yet the vehicle lacks sufficient dynamics and fails to meet the accuracy specifications.

4.2 INSATT Inertial navigation posture

*#INSATTA,USB2,0,14.5,FINESTEERING,1541,487970.000,02040000,5b35,37343;1541,487970.000549050,1.876133508,4.053672765,328.401460897,SOLUTION_GOOD*ce4ac533*

No.	Name	Description	Data Type	Binary Byte	Binary Offset
1	Header	Message header	--	H	0
2	week	GPS week number (GPS time)	Ulong	4	H
3	Seconds	Seconds within GPS week (GPS time)	Double	8	H+4
4	Roll	Rotation angle around the X-axis, positive direction follows the right-hand rule [degrees]	Double	8	H+12
5	Pitch	Rotation angle around the Y-axis, positive direction follows the right-hand rule [degrees]	Double	8	H+20
6	Azimuth	Rotation angle around the Z-axis, positive direction follows the right-hand rule, i.e., clockwise rotation angle from true north [degrees]	Double	8	H+28
7	Status	INS status indicator	Double	4	H+36
8	xxxx	32-bit CRC	Hex	4	H+40
9	[CR][LF]	Fixed ending (ASCII only)	--	--	--

4.3 INSSPD Inertial navigation horizontal and vertical velocity

*#INSSPDA,USB2,0,20.0,FINESTEERING,1541,487969.000,02040000,7832,37343;1541,487969.000549050,329.621116190,14.182070674,-0.126606551,SOLUTION_GOOD *c274fff2*

No.	Name	Meaning	Data Type	Binary Byte	Binary Offset
1	Header	Message Header	--	H	0
2	week	GPS Week Number (GPS Time)	Ulong	4	H
3	Seconds	Seconds within GPS Week (GPS Time)	Double	8	H+4
4	Trk gnd	Angle of actual ground motion direction relative to True North (ground track) [degrees]	Double	8	H+12
5	hor spd	Horizontal speed [m/s]	Double	8	H+20
6	vert spd	Vertical speed [m/s]. Positive value indicates increasing altitude (upward), negative value indicates decreasing altitude (downward)	Double	8	H+28
7	Status	INS status indicator	Enum	4	H+36
8	xxxx	32-bit CRC	Hex	4	H+40
9	[CR][LF]	Fixed ending (ASCII only)	--	--	--

4.4 INSPOS Inertial navigation position

*#INSPOSA,USB2,0,18.0,FINESTEERING,1541,487977.000,02040000,17cd,37343;1541,487977.000549050,51.121315135,-114.042311349,1038.660737046,SOLUTION_GOOD *2fffd557*

No.	Name	Meaning	Data Type	Binary Byte	Binary Offset
1	Header	Message Header	--	H	0
2	week	GPS Week Number (GPS Time)	Ulong	4	H
3	Seconds	Seconds within GPS Week (GPS Time)	Double	8	H+4
4	Latitude	Latitude (WGS84) [degrees]	Double	8	H+12
5	Longitude	Longitude (WGS84) [degrees]	Double	8	H+20
6	Height	Ellipsoidal height [meters]	Double	8	H+28
7	Status	INS status indicator	Enum	4	H+36
8	xxxx	32-bit CRC	Hex	4	H+40
9	[CR][LF]	Fixed ending (ASCII only)	--	--	--

4.5 INSSTDEV Inertial navigation PVA standard deviation

*#INSSTDEVA,USB1,0,66.0,FINESTEERING,2209,491004.000,02000020,2396,16809;0.1813,0.1813,0.1806,0.0018,0.0018,0.0017,0.0292,0.0291,0.0577,13000045,0,0,7fd1bf,0*b490dde*

No.	Name	Meaning	Data Type	Binary Byte	Binary Offset
1	Header	Message Header	--	H	0
2	Latitude σ	Latitude Standard Deviation [m]	Float	4	H
3	Longitude σ	Longitude Standard Deviation [m]	Float	4	H+4
4	Height σ	Height Standard Deviation [m]	Float	4	H+8
5	North Velocity σ	North Velocity Standard Deviation [m/s]	Float	4	H+12
6	East Velocity σ	East Velocity Standard Deviation [m/s]	Float	4	H+16
7	Up Velocity σ	Up Velocity Standard Deviation [m/s]	Float	4	H+20
8	Roll σ	Roll Standard Deviation [degrees]	Float	4	H+24
9	Pitch σ	Pitch Standard Deviation [degrees]	Float	4	H+28
10	Azimuth σ	Azimuth Standard Deviation [degrees]	Float	4	H+32
11	Ext sol stat	Extended Solution Status	Ulong	4	H+36
12	Time Since Update	Time elapsed since the last ZUPT or position update [s]	Ushort	2	H+40
13	Reserved	Reserved	Ushort	2	H+42
14	Reserved	Reserved	Ulong	4	H+44
15	Reserved	Reserved	Ulong	4	H+48
16	xxxx	32-bit CRC	Hex	4	H+52
17	[CR][LF]	Fixed ending (ASCII only)	-	--	--

4.6 INSVEL Inertial navigation Northeast speed

*#INSVELA,USB1,0,19.0,FINESTEERING,1543,236173.000,02000000,9c95,37343;1543,236173.002500000,14.139471871,-0.070354464,0.044204369,SOLUTION_GOOD*3c37c0fc*

No.	Name	Meaning	Data Type	Binary Byte	Binary Offset
1	Header	Message Header	--	H	0
2	week	GPS Week Number (GPS Time)	Ulong	4	H
3	Seconds	Seconds within GPS Week (GPS Time)	Double	8	H+4
4	North Velocity	North Velocity [m/s]	Double	8	H+12
5	East Velocity	East Velocity [m/s]	Double	8	H+20
6	Up Velocity	Up Velocity [m/s]	Double	8	H+28
7	Status	INS Status Indicator	Enum	4	H+36
8	xxxx	32-bit CRC	Hex	4	H+40
9	[CR][LF]	Fixed Ending (ASCII only)	--	--	--

4.7 RAWIMU Inertial navigation raw observations

*#RAWIMUA,COM2,0,57.0,FINESTEERING,2004,28212.750,00000000,000e,6480;2004,28212.750,00000000,433,-19,-114,1,-16,-20*67518841*

No.	Name	Meaning	Data Type	Binary Byte	Binary Offset
1	Header	Message Header	--	H	0
2	week	GPS Week Number (GPS Time)	Ulong	4	H
3	Seconds	Seconds within GPS Week (GPS Time)	Double	8	H+4
4	IMU Status	1 = IMU valid, 2 = IMU invalid, Currently defaults to 0	Hex	4	H+12
5	Z Accel Output	Acceleration in the Z-axis direction. Scale factor depends on the IMU device.	Long	4	H+16
6	-(Y Accel Output)	Negative of the acceleration in the Y-axis direction. Scale factor depends on the IMU device.	Long	4	H+20
7	X Accel Output	Acceleration in the X-axis direction. Scale factor depends on the IMU	Long	4	H+24

		device.			
8	Z Gyro Output	Angular rate about the Z-axis, following the right-hand rule. Scale factor depends on the IMU device.	Long	4	H+28
9	-(Y Gyro Output)	Negative of the angular rate about the Y-axis, following the right-hand rule. Scale factor depends on the IMU device.	Long	4	H+32
10	X Gyro Output	Angular rate about the X-axis, following the right-hand rule. Scale factor depends on the IMU device.	Long	4	H+36
11	xxxx	32-bit CRC	Hex	4	H+40
12	[CR][LF]	Fixed ending (ASCII only)	--	--	--

Note: M30X Scaling factors for inertial navigation: angular velocity is 1600 LSB/(° /s) , acceleration is 3200 LSB / (m/s²).

5 Appendix B Description of Common Coordinate Systems

5.1 Definition of Common Coordinate Systems in Integrated Navigation System

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

5.1.1 Local navigation coordinate system

The local navigation coordinate system, also known as the NED (North-East-Down) coordinate system, is defined as follows:

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

E -axis: pointing east (the right-handed orthogonal axis obtained from the N-axis and D -axis)

D Axis: Points downward (refer to the direction of the ellipsoid normal).

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

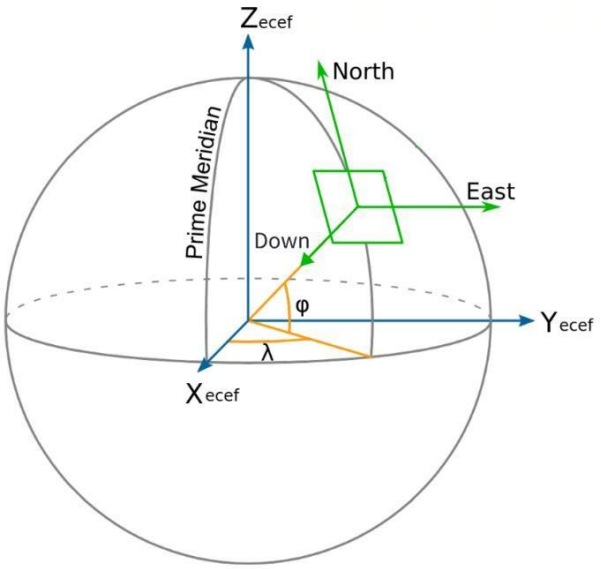


Figure 53. Local navigation coordinate system

5.1.2 M30X coordinate system

The origin and axis of the device coordinate System have been marked on the machine casing, and the navigation center is the origin of the coordinate system.

Figure 54. Device Coordinate System

5.1.3 Vehicle coordinate system

The origin of the vehicle coordinate system is the navigation center marked on the entire casing.

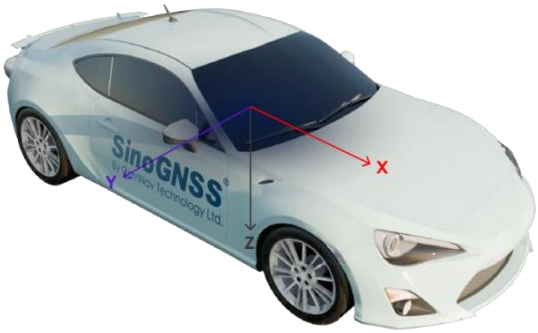


Figure 55. Vehicle coordinate system

The definition of the axes of the vehicle body coordinate system is as follows:

Z-axis: perpendicular to the vehicle floor, pointing toward the bottom of the vehicle body

X-axis: pointing in the forward direction of the vehicle

Y-axis: a right-hand orthogonal axis derived from the X and Z axes

If using a land model, please strictly configure the antenna mast and rotation parameters

according to this vehicle coordinate system.

5.1.4 User-defined coordinate system

The origin and the orientation of the three axes are defined by the user in a right-handed coordinate system, which is called the user-defined coordinate system. The system outputs the position and velocity information of the M30X's navigation center (i.e., the origin of the M30X's coordinate system) by default , which can be viewed using an app. Set the [Reference Center], select [Customize], enter custom XYZ coordinates, and set the origin of the coordinate system to any point.

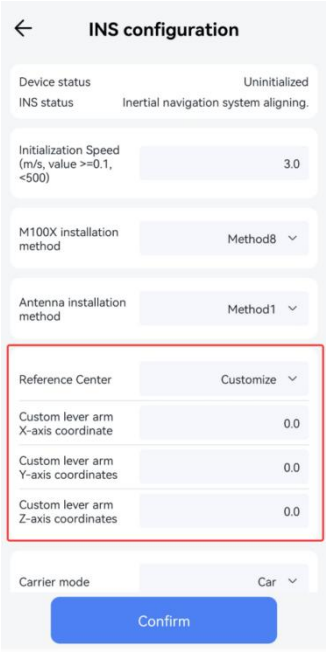


Figure 56. Customize coordinate system

6 Appendix C Description of Wire Harness and Connector

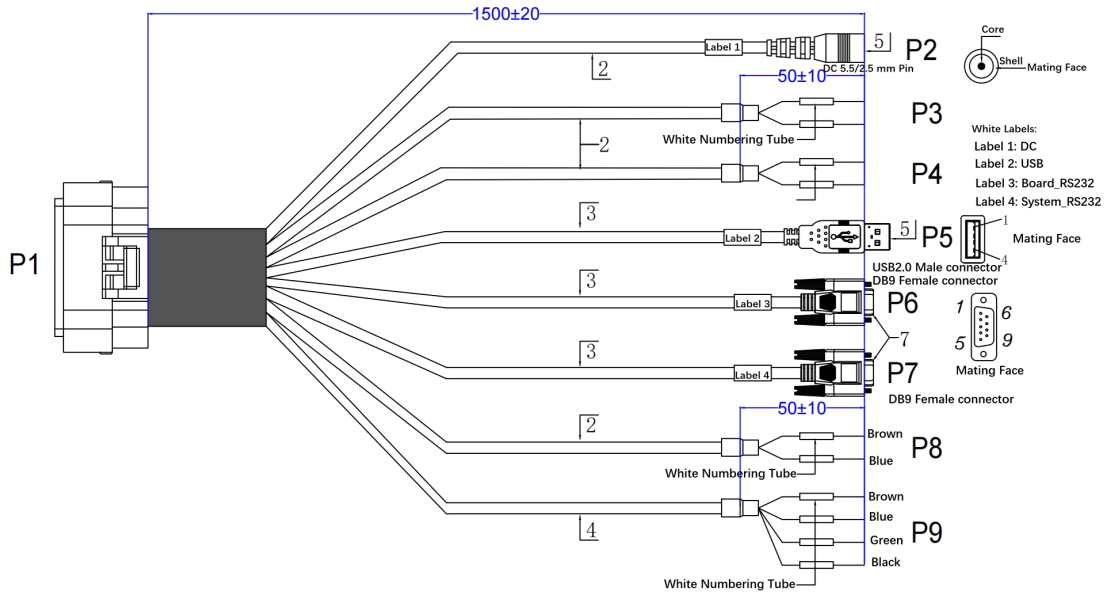


Figure 57. Wire Harness and Connector Description

Table 6. Main Connector Pin Description

Pin	Definition		Description
1	P2		Power input
2	P3	CAN1H	CAN1 High
		CAN1L	CAN1 Low
3	P4	CAN2H	CAN2 High
		CAN2L	CAN2 Low
4	P5	USB	USB interface
5	P6	COM1	Serial Port 1
6	P7	COM2	Serial Port 2
7	P8	PPS	PPS 5V Signal
		GND	Power ground
8	P9	ENET_P	Automotive Ethernet positive data cable (P)
		ENET_N	Automotive Ethernet negative data cable (N)
		VCC	12V power supply Output
		GND	Power ground

7 Troubleshooting Common Issues

Using M30X If the problems listed in this section occur when using the integrated navigation receiver, you can troubleshoot them using the following methods. If the problem persists, please contact our technical support personnel promptly.

7.1 Troubleshooting for device startup failure

1. Check if the power supply voltage is normal. If the power supply voltage is abnormal, please disconnect the power and replace it with a normal power supply before using the product.
2. Check the power cord connection to ensure it is correct and secure.
3. Use a multimeter to measure the connector voltage and check if the connecting cable is intact. If the cable is faulty, replace it.
4. If the above reasons are ruled out, the equipment may be damaged. Please contact our technical support.

7.2 Troubleshooting serial port not responding

1. Please verify that the serial port number and serial port baud rate are correct. Please read the communication protocol carefully to ensure that the serial port can be configured correctly.
2. Check if the data cable is damaged;
3. Check if the serial port driver is installed;
4. Check that the data cable is connected reliably.

7.3 Troubleshooting for position anomalies

1. Ensure that the GNSS antenna has a clear view of the sky;
2. Is the connectivity of the communication system equipment reliable?
3. Is there radio frequency interference at the navigation antenna frequency?
4. Confirm that the INS has been successfully initialized;
5. Confirm whether the coordinates of the base station deviate too much from the actual coordinates.

7.4 4G Disconnection solutions

1. Ensure the SIM card has available balance and activated data service.

2. Confirm that the equipment is powered normally;

3. If your carrier's network is unstable in the area.If the local cellular network is unstable, try using a SIM card from a different carrier.

8 Precautions

1. Disassembling any components of the system equipment is strictly prohibited. In case of malfunction, the relevant details should be carefully recorded and our technical support personnel should be contacted promptly .

2. Please note the operating voltage of each device in the system. Please use the power adapter and data cable provided by our company to avoid damaging the equipment .

3. When connecting the power cord, make sure the positive and negative terminals are not reversed;

4. Please strictly follow the installation and wiring methods in the installation manual to connect the equipment, and make sure that all connectors are firmly plugged in.

5. Do not continue to use the device if any connecting cables or other accessories are damaged. Replace them with new ones promptly to avoid unnecessary damage.