BY_Connect Software
User Manual

Brief Introduction

The BY_Connect enables communication by serial ports and Ethernet ports. It provides real-time tagging of positioning data and displays graphical representation of observable satellite sky maps, signal-to-noise ratio and etc. It also allows configuration of receiver functions and saving of receiver output data through command transmission via the console.

CONTENTS

1 Brief Introduction

The BY_Connect enables communication by serial ports and Ethernet ports. It provides real-time tagging of positioning data and displays graphical representation of observable satellite sky maps, signal-to-noise ratio and etc. It also allows configuration of receiver functions and saving of receiver output data through command transmission via the console.

2 Home

The home of BY_Connect is constituted of function list, input window, output window and frequently used command list.

Figure 1 Home of BY_Connect

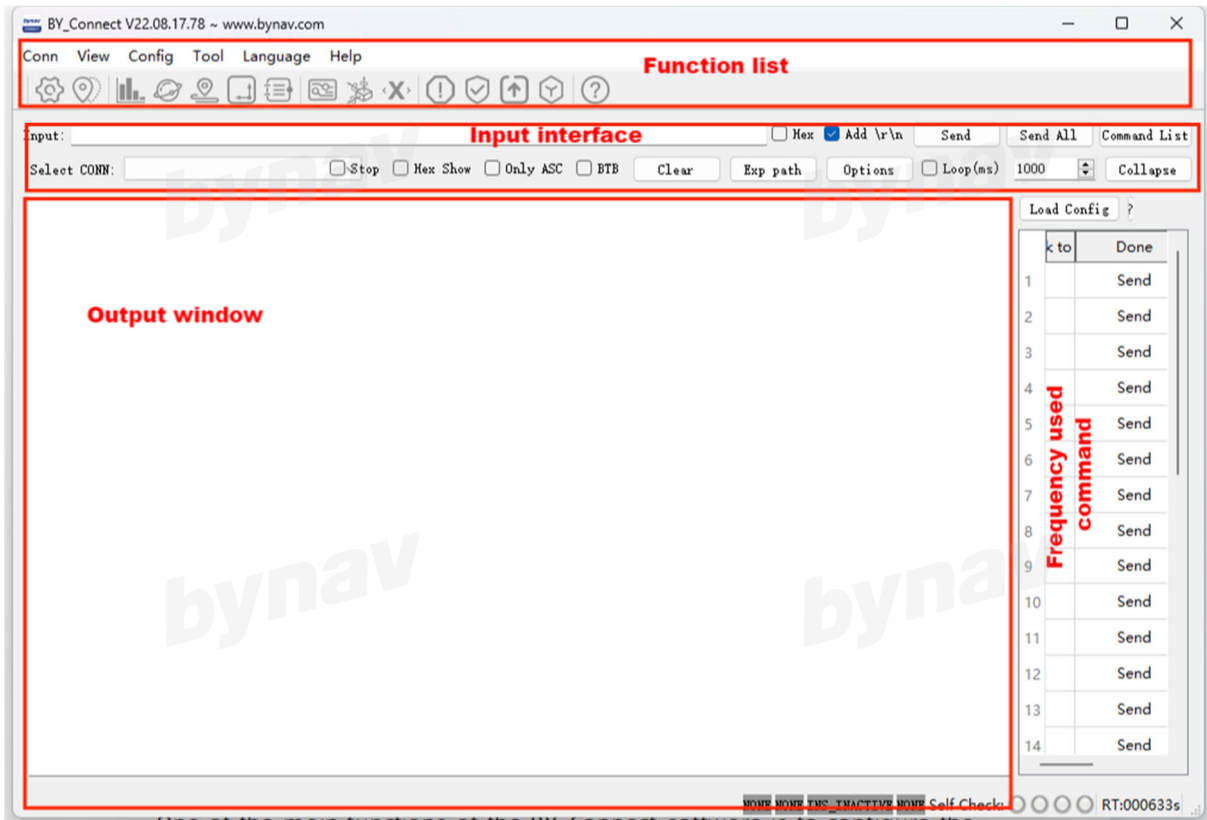## 2.1 Input Window

One of the main functions of the BY_Connect is to configure the receiver by sending commands. After communication is established between the PC and the device, the following operations can be performed:

☐ "**Input box**" is used for entering commands. Clicking "**Send**" completes the sending of a command.

☐ "**Exp path**" opens the directory where the software is located.

☐ You can check "**Loop (ms)**" to repeatedly send commands at the set time intervals (in milliseconds). And can click the "**Options**" button to open a dialog that single or looped command can be configured to send to multiple ports simultaneously.

☐ "**Command List**" stores commonly used commands for easy sending.

2.2 Output Window

There's a dropdown menu of "**Select CONN**" above the output window, it enables you to choose any established port to display its output content. Command execution results will also appear in the output window. Incorrect command inputs will result in execution failure and an error prompt. The following options are included:

☐ You can check "**Stop**" to stop content printing in the output window (does not affect data output of device).

☐ You can check "**Hex Show**" to display the output in hexadecimal format.

☐ You can check "**Only ASC**" to hide binary format data, showing data only in ASCII format.

☐ You can click "**Clear**" to empty the printed content in the output window.

2.3 Frequently Used Command

The "**Expand**" button can be clicked to reveal the list of commands you stored before. This list stores frequently used commands for convenient using. The button name will change to "**Collapse**", and clicking it will hide the list.

2.4 Function List

The symbols in the function list correspond to the following functions:

Conn Setting

CNR

Plot Control

Log Information

Inertial Navigation Configuration

E-code List

Firmware Update

Help

RTCM Configuration

SKY Map

IMU Configuration

Board Configuration

Lever Compute

Authorization

Tools

3 Function List

3.1 Conn

This menu contains two functions: "**Set**" and "**RTCM**". "**Set**" is used to configure Ethernet and serial port connection, while "**RTCM**" is used to configure differential signal transmission.

3.1.1 Conn Set

In the "**Set**" interface, the following three functions can be configured:

1. Serial Port Communication

When the IP and port of the hardware device are unknown, serial communication can be established. The specific method is as follows: You can click the symbol ⚙ in the upper-left list, and then click the "**Add Row**" button. In the newly added row, the "**Uart**" in the Type column should be selected and then choose the serial port number in the Input_1 dropdown, select the baud rate in the Input_2 dropdown, at last the "**Open**" button can be clicked to establish serial communication.

2. Ethernet Port Communication

If the IP and port of the hardware device are known, Ethernet communication can be selected. The specific steps are as follows: You can click the symbol ⚙ in the upper-left list, and then click the "**Add Row**" button. In the newly added row, the "**TCP Client**" in the Type column should be selected, and then enter the

IP address in the Input_1 dropdown, enter the port number in the Input_2 dropdown, at last the "**Open**" button can be clicked to establish Ethernet communication.

3. Data Saving

First, you can click the symbol 📁 in the "**File Path**" field to choose the file saving path. Then click "**Open**" for the port where you want to save data and enter the file name. At last, the "**To Save**" can be checked to start recording data, and uncheck it to stop recording.
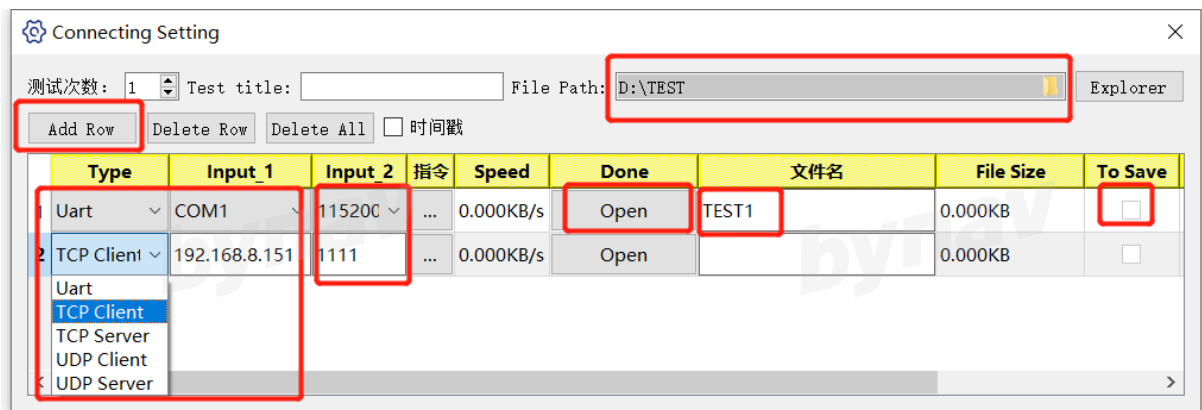

Figure 2 Conn Setting Interface

3.1.2 RTCM Configuration
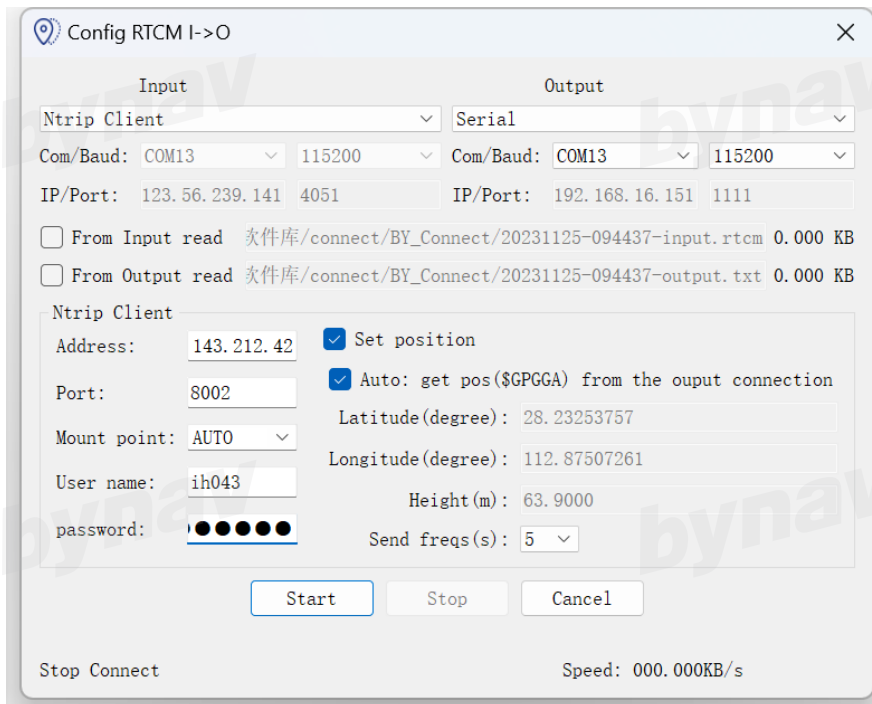
Figure 3 RTCM Configuration Interface

The BY_Connect supports the access of external differential signals. In the RTCM Configuration interface, on the left side, you can configure the IP and port number of the signal input source, and on the right side, you can configure the IP and port number of the output end (PC's local IP). It also allows you to save input and output information. After setting the file path, you can click the "**Start**" button to initiate the RTCM data transmission.

3.2 View

There are five modules available in "**View**": **CNR** (Carrier-to-Noise Ratio Chart), **Sky** (Sky Chart), **Plot** (Trajectory Chart), **IMU** (Inertial Measurement Unit) and **Log** (Log Information). You can click them to use the function.

3.2.1 CNR

Figure 4 Carrier-to-Noise Ratio Interface

As the figure shows above, different colors represent different frequency, and there will be explanations above the subsystem displays indicating the frequency represented by each color. The x-axis represents the satellite identifier, while the y-axis represents the carrier-to-noise ratio value.

On the interface, you can modify the receiving antenna positions as follows: **Rover Master** (main antenna on the rover station), **Rover Slave** (secondary antenna on the rover station) and **Base** (base station).
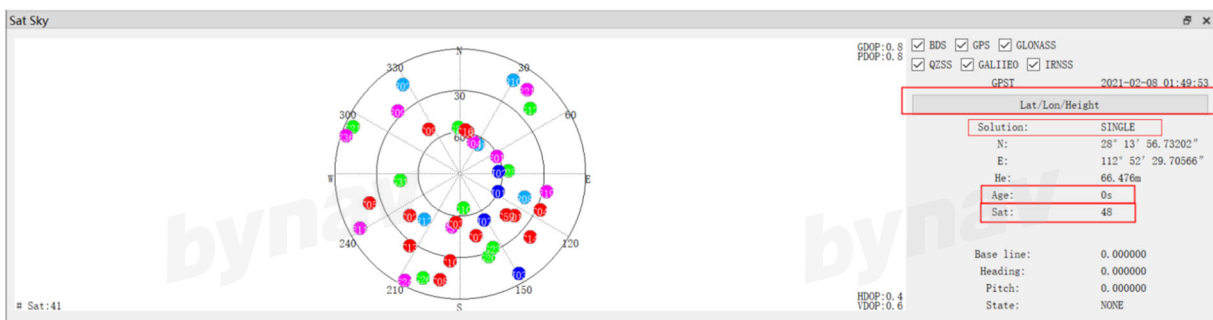
3.2.2 Sky Map

Figure 5 Sky Map Interface

The color correspondence to constellation in the sky map: red indicates BeiDou, green indicates GPS, blue indicates GLONASS and purple indicates Galileo. Repeatedly clicking the "**Lat/Lon/Height**" button toggles the display

between three coordinate representations: LLA (in degrees), LLA (in degrees, minutes, seconds format) and ECEF coordinates. "**Solution**" indicates the current positioning status, "**Age**" indicates differential age and "**Sat**" represents the total number of tracking satellites.

3.2.3 Plot
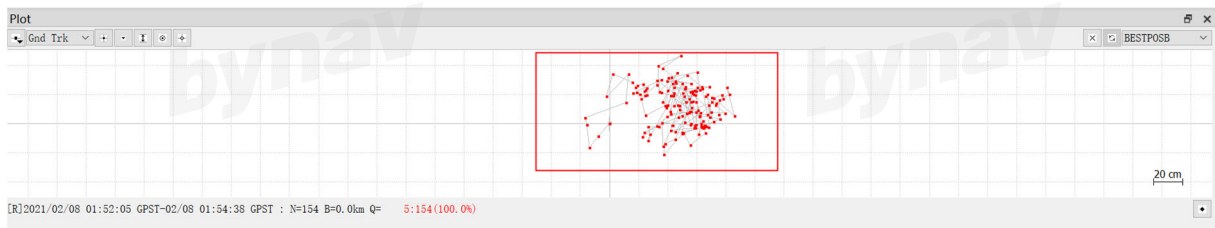
Figure 6 Plot Interface

The BY_Connect offers a graphical interface for users to conveniently view receiver's positioning data. After enabling serial/Ethernet communication, you can open the Plot interface and it should display real-time positioning points. If not, the connection status (like) and positioning output in the console should be ensured. The functions on the top list are: connect/disconnect, display content selection (draw trajectory, positioning, speed, acceleration, satellites), positioning status filtering, align to origin, scale, vertical alignment (adaptive height), show tracking points and real-time centering. The bottom status list shows time (GPST), latitude and longitude.

3.2.4 IMU

Figure 7 IMU Analysis Interface

BY_Connect supports real-time display of inertial navigation system status information. In the "**View**" tab, you can click the "**IMU**" option to open the IMU analysis interface. The upper part of the interface displays gyroscope information, while the lower part displays accelerometer information.

3.2.5 Log
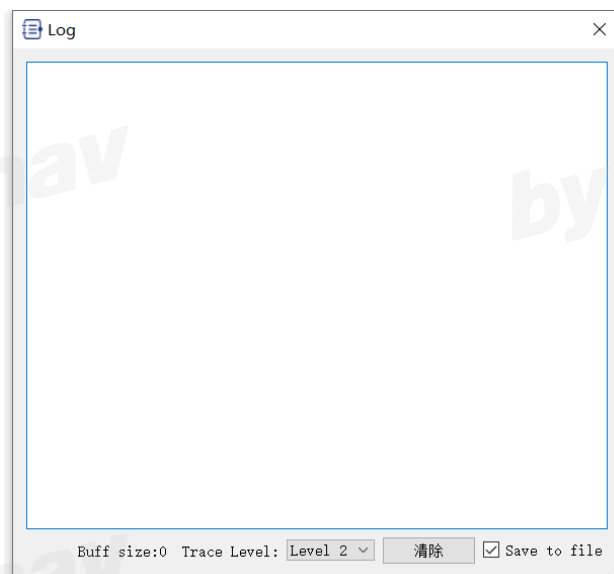
Figure 8 Log Interface

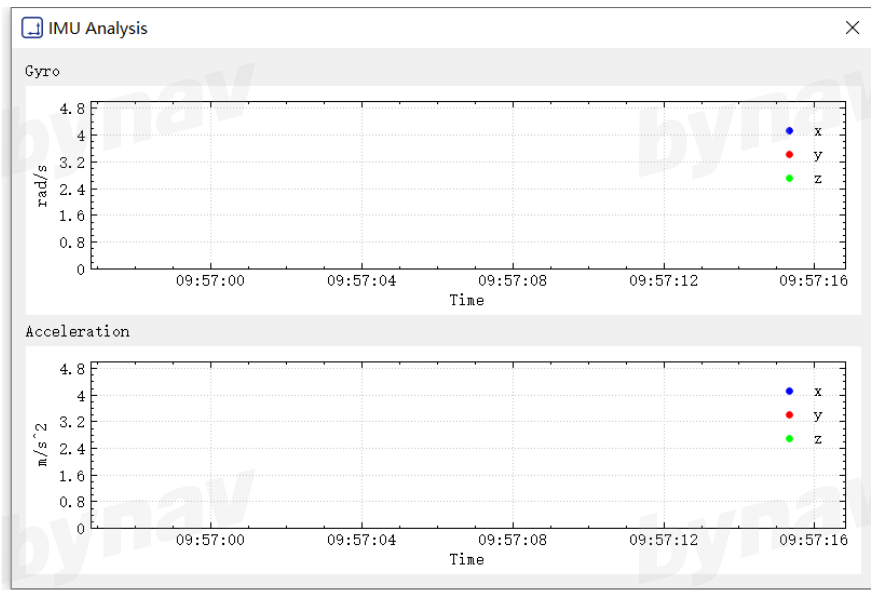In the "**View**" tab, you can click the "**Log**" option to display log information in the pop-up window and view the output records.

3.3 Configuration

The "**Configuration**" tab allows for quick setup of inertial navigation, including the functional modules: **Board Config**, **Inertial Navigation** and **ByOffset**. Below is the explanation of these three functions.

3.3.1 Board Config

After enabling serial/Ethernet communication, you can click the "**Board Config**" option to display some configuration information about the receiver.

3.3.1.1 Status Tab
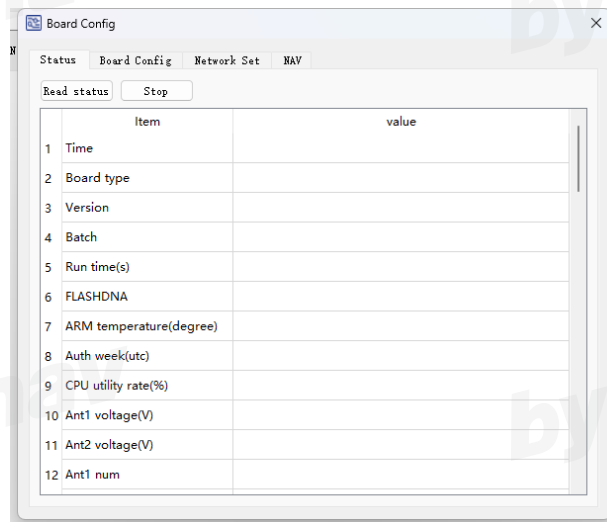
Figure 9 Status Tab

In the "**Status**" tab, you can click "**Read Status**" to retrieve the board's configuration. The corresponding parameters from top to bottom are: GPS time, board type, version, batch number, program run time, ARM temperature,

expiration date, GPS week, CPU usage, antenna 1 supply voltage, antenna 2 supply voltage, antenna 1 tracked satellites count, antenna 2 tracked satellites count, current operating constellation, current operating frequency, operating mode, RTK solution status, heading solution status, INS solution status, observation frequency, solution frequency, FPGA solution frequency, IMU data frequency, base station operating frequency, GLONASS calibration status, differential age, base station tracked satellites count, latitude and longitude, elevation, base station distance, differential station count, baseline length. You can click "**Stop**" to halt reading.

3.3.1.2 Board Config Tab

In the "**Board Config**" tab, you can read and write configuration files by selecting a configuration file.
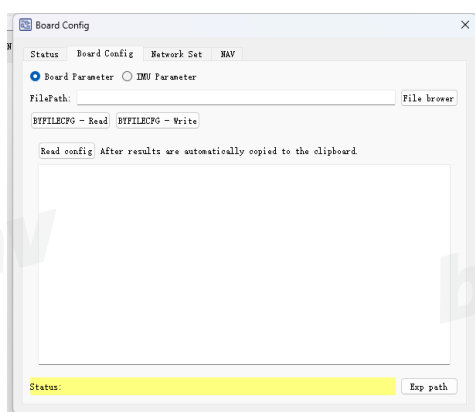
Figure 10 Board Config Tab

3.3.1.3 Network Set Tab

In the "**Network Set**" tab, you can configure the receiver's interface name, IP mode, IP address, subnet mask and gateway parameters.

Figure 11 Network Set Tab

3.3.1.4 NAV Tab
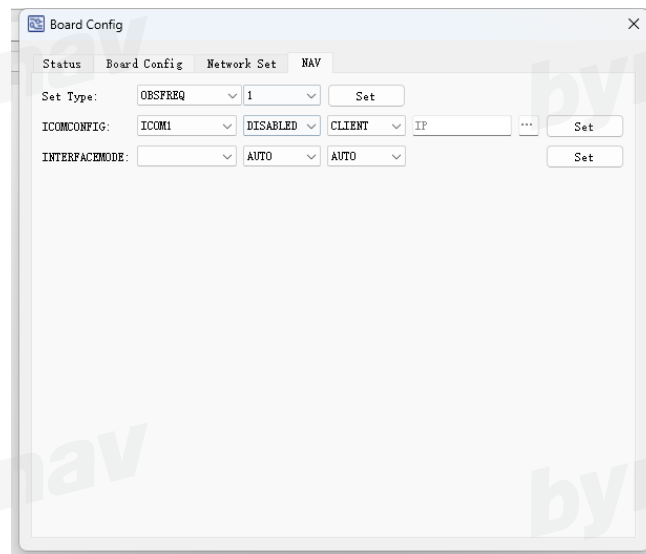
Figure 12 BYNAV Tab

In the "**NAV**" tab, you can configure the observation frequency and solution

frequency, as well as set up communication protocols.

3.3.2 Inertial Navigation

The BY_Connect supports to set up the lever arm angles and other general

configuration of inertial navigation. The inertial navigation configuration interface will be opened by clicking on the "**INS**" option in the "**Config**" tab. In the "**Lever Arm**" tab, you can configure the position parameters for Lever Arm 1, Lever Arm 2 and User Lever Arm. In the "**DMI Arm**" tab, you can configure the NHC lever arm, and after entering the NHC lever arm along with vehicle wheelbase and track width, the DMI lever arm can be automatically calculated. In the "**General Set**" tab, you can configure the inertial navigation mode.

3.3.3 ByOffset

"**ByOffset**" is used to calculate the lever arm values in the vehicle coordinate system.
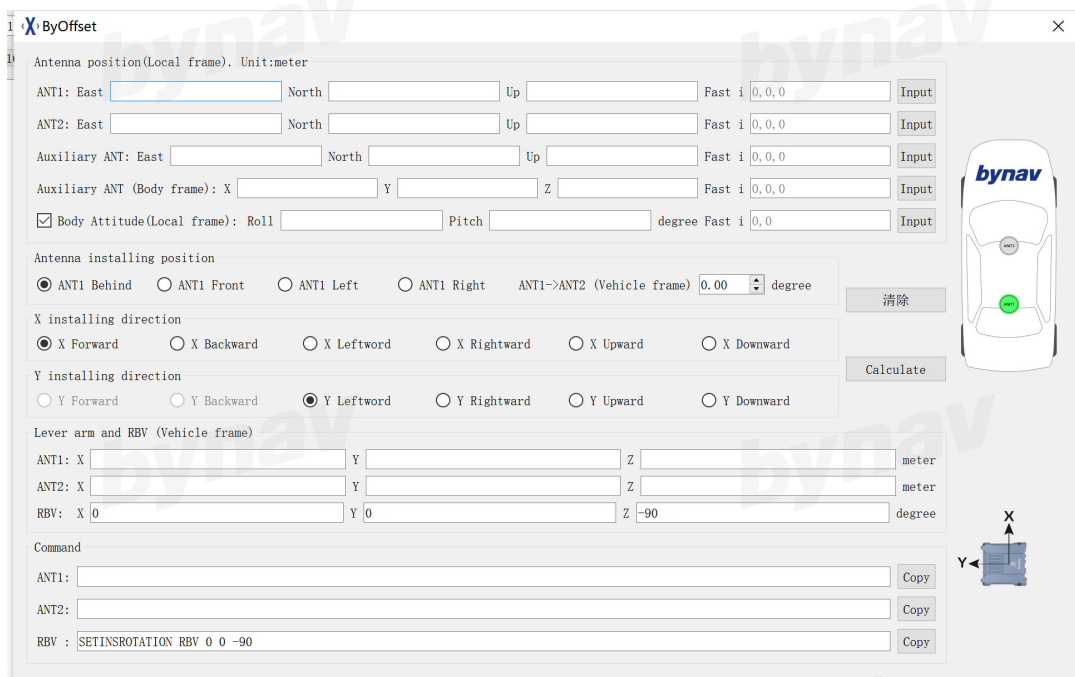
Figure 13 ByOffset Interface

3.3.3.1 Antenna Installing Position

With the vehicle coordinate system's Y-axis positive direction parallel to the forward direction of the vehicle, there are two antenna installation methods: front-back installation and left-right installation. Front-back installation further divides into: ANT1 being installed on the front or back side of the vehicle. Left-right installation further divides into: ANT1 being installed on the left or right side of the vehicle. As shown in Figure 14 , from left to right, the options are: ANT1 at the back, ANT1 at the front, ANT1 at the left and ANT1 at the right.

Depending on the antenna installation method, you should select the corresponding option in the software interface, as shown in Figure 15.

If the two antennas are installed diagonally, you can adjust the parameter "**ANT1->ANT2 (Vehicle frame)**" to rotate the vehicle's orientation to the horizontal angle where ANT1 points to ANT2's vector, counterclockwise rotation is considered positive. For example, if the vector from ANT1 to ANT2 points to the right front of the vehicle at a 45° angle, the parameter should be set to -45.

Figure 14 Antenna Installation Method

Figure 15 Antenna Installing Position Option

3.3.3.2 Receiver Installation Method

There are 24 installation methods for the receiver, determined by selecting the installation orientation of the receiver's X-axis and Y-axis. Based on the receiver installation method, you can select the corresponding option in the software interface, as shown in Figure 16 .
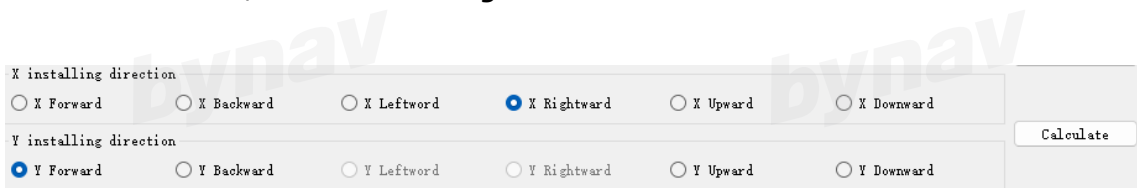

Figure 16 Receiver Installing Position Option

3.3.3.3 Dual-antenna Position Measurement

In the condition of keeping the vehicle stationary, you can use the ENUAVR command (e.g., **LOG COM1 ENUAVR ONTIME 1**) to simultaneously obtain the

mean position in the ENU frame of reference for both antennas relative to the same reference point.

ENUAVR Example

#ENUAVR,COM1,0,0.0,FINESTEERING,2095,127522.000,00000000,0000,25;-1075.1430,-98.4608,-8.6259,-1075.1430,-98.4610,-8.6258,-3.1407,-0.0016,58*2865555d

ENUAVR Note

It is recommended to record the **ENUAVR** information after 60s of output.

3.3.3.4 Lever Arm Values Calculation

After completing the above steps, you can fill in the recorded antenna positions in their corresponding positions on the software interface, then click the "**Calculate**" button to obtain the lever arm values and RBV for the dual antennas in the vehicle coordinate system. The software will also generate configuration command.

3.3.3.5 Data Verification

After clicking the "Calculate" button, if a warning "If the combined navigation system is not installed on the front side of the carrier, the two antennas position may be reversed. Please check!" pops up, you should verify whether the combined navigation system is installed on the front side of the antenna in the vehicle coordinate system. If the combined navigation system is on the rear side

of the antennas, it suggests that the entered dual antenna positions might be reversed. In such cases, the schematic on the right will estimate the relative position between the combined navigation system and the vehicle based on the calculation result. If a warning "Antenna position error!" appears, it indicates abnormal dual antenna positions, and you should check for measurement or input errors.

3.3.3.6 Vehicle Attitude Accurate Measurement (Optional)

While using the above method, the chosen installation method for the combined navigation system might have some deviation to the actual situation. This deviation can be corrected through RBV calibration. However, this method requires both antennas to be installed at the same height on the vehicle and the vehicle to be stationary on level ground. The software takes these as conditions to determine the vehicle's attitude.

If the chosen installation method for the combined navigation system closely matches the actual situation (deviation less than 1°), you can input the Roll and Pitch angles of the combined navigation system in the ENU frame to the software by using the **ENUAVR** information, for achieving a more accurate measurement of the vehicle's attitude. This method is more demanding in terms of the installation requirements of the combined navigation system but does not require both antennas to be at the same height on the vehicle or the vehicle to be stationary on level ground.

3.3.3.7 Error Control (Optional)

If the GNSS RTK positioning results have relatively large elevation errors, laser distance measuring calibration can be employed. This involves using a laser ranger finder with an incline sensor (e.g., BOSCH GLM 500 professional laser ranger finder, which can directly measure horizontal and vertical distances) to measure the heights of antennas from the same starting plane (e.g., the ground) and accurately replace the elevations in the ENU frame. This method can significantly reduce Z-axis lever arm errors.

3.3.3.8 Total Station Measurement (Optional)

Similar to the previous methods that used RTK positioning results in the ENU frame, you can utilize a total station to determine the coordinate of antennas' phase centers and the origin of the combined navigation system in the total station's coordinate system (or another coordinate system with a stationary origin and axes relative to the ground). You can enter these coordinates into the software for ANT1, ANT2 and the auxiliary antenna and set the position of the auxiliary antenna in the body frame of the combined navigation system to 0, and then the lever arm values of the dual antennas in the vehicle coordinate system will be calculated.

3.4 Tool

BY_Connect provides several frequently used tools, including **Command List**,

E-code, **Authorization**, **Firmware Upgrade** and **Tools**.

3.4.1 Command List

Commands are commonly used to configure receivers. For details of commands, please refer to _UG017_Interface Protocol_. BY_Connect offers a list of frequently used commands for receivers. To use this, you can click the "**Tool**" tab and select "**Command List**" to open a list of commands. You can double-click the command to send it to the receiver.

3.4.2 E-code

"**E-code**" displays a list of common fault codes for the receiver. You can troubleshoot issues based on the self-diagnostic results.

3.4.3 Authorization

You can click "**Authorization**" in the "**Tool**" tab to open the authorization interface. You can click the "**Read**" button to read the receiver's unique ID, and input the authorization code in the "**Authorization**" box and click "**Send**" to complete the receiver's authorization.

3.4.4 Firmware Upgrade

You can click "**Firmware Upgrade**" in the "**Tool**" tab to open the firmware update interface as shown in Figure 17 . Please refer to _AN049_Firmware Update_Bynav_ for detailed steps and methods of firmware updates.
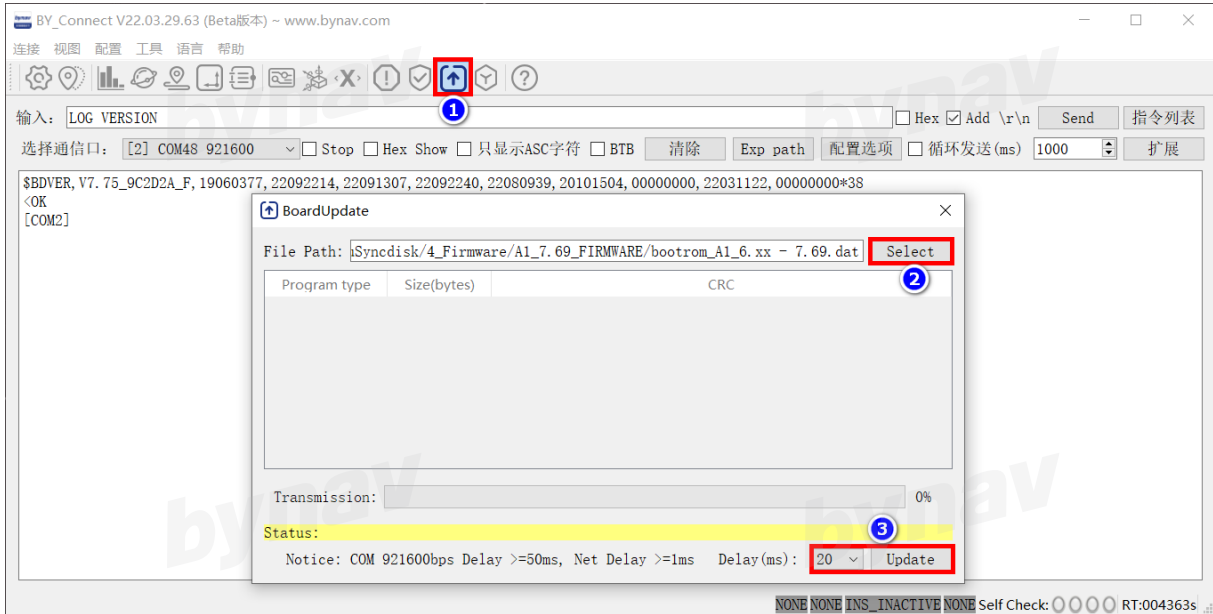
Figure 17 Firmware Update Interface

3.4.5 Tool

You can click "**Tool**" in the "**Tool**" tab to open the tool interface. You can input the statement to be verified in the "**CRC**" tab, click the "**Check Sum**" and "**32-bit CRC**" buttons to perform XOR checksum and 32-bit CRC verification.

3.5 Language

You can switch the software's display language between Chinese and English in the "**Language**" tab.

3.6 Help

You can click "**About**" in the "**Help**" tab to display some information about the BY_Connect, including contact information of office and support, fax, email, company website and address.

4 Quick Start Guide

After opening the BY_Connect, first you should follow the methods in the "**Set Conn**" section to establish communication between the software and hardware. The steps to output positioning results:

☐ You can enter the command "**LOG COM1 BESTPOSA ONTIME 1**" in the command input interface to configure the positioning results output.

☐ You can enter the command "**SAVECONFIG**" to save the configuration. The output result at this point is a single-point solution.

If the improvement of positioning accuracy to be needed, you should use the RTK positioning mode by accessing differential data. COM2 is the default port for accessing differential data, the differential data can be received by the network, which is then forwarded to the computer port corresponding to COM2.

If the integrated navigation is used, you should first measure accurate lever arm values and approximate RBV values by using ByOffset or precise instruments such as total stations.

☐ You can input "**INSCALIBRATE NEW**" to start calibration.

☐ You can input "**LOG INSCALSTATUSA ONCHANGED**" to monitor the calibration status. It will be completed when the status displays "**CALIBRATED**", and the estimated RBV will be automatically configured.

☐ You can input "**SAVECONFIG**" to save the configuration.

Disclaimer

This manual provides information about products of Hunan BYNAV Technology Co., Ltd. (hereinafter referred to as BYNAV). It does not transfer any rights or licenses of the company or third parties, including but not limited to patents, copyrights, trademarks, and proprietary rights in any form. At the same time, BYNAV makes no warranties, express or implied, regarding the sale or use of its products, including but not limited to the suitability, marketability or infringement liability for intellectual property rights in copyrights, patents, etc. None of them is guaranteed. BYNAV is exempt from liability for problems arising from connection or operation that are not required by the manual. BYNAV may modify product specifications and descriptions without prior notice if necessary.

Certain design deficiencies or inadequacies that may exist in products may be improved by version iterations and may result in differences between the product and published specifications. The latest product specifications are available upon request.

HUNAN BYNAV TECHNOLOGY CO., LTD

Add.: Building 12, Phase 1, Zhongdian Software Park, No.39 Jianshan Road, High-tech Zone, Changsha, Hunan 410205, China

Tel：+86-731-85058117

Email：en@bynav.com