MENU

1. A BRIEF INTRODCTION

RUIDE dedicates to offer the most advanced and reliable GNSS positioning solutions to surveyors.

RTK surveying technology, as a cutting-edged and efficient surveying technology, has been playing a more and more important role in surveying work. RUIDE R93i, the new generation integrated RTK system with design for intelligent positioning, provides high efficiency and intelligent surveying experience to surveyors, which is suited for nowadays demands of precision, reliability and user-friendliness.

This manual is to explain how to install, set up and use RTK system with R93i receiver, as well as the use of the accessories. We recommend you to read this manual carefully before or during using the system

.

1.1 APPLICATOINS

Control Survey

Dual-band (dual-frequency) system static measurements can accurately complete the high-precision deformation observation, photo-control point measurement.

Highway Survey

Quickly completes the encryption of the control points, road topographic mapping, cross-section measurement, profile measurement.

CORS

Provides stable and convenient data link for field operations. It is seamlessly compatible with all types of CORS applications.

Data Collect

Perfectly matches various field software to realize quick and easy data acquisition.

Stakeout Shot

Large-scale point, line, plane lofting.

Electric Power Measurement

Power line measurement orientation, ranging, angle calculation.

Marine Application

Oceanographic research, dredging, piling, inserted row, making the marine operations more convenient and easy.

1.2 FEATURES

Linux OS

Powered by the new generation of Linux operating system, R93i has a greatly improved RTK performance and efficiency, able to response to more than one command at one time.

1598 Channels, All Constellations

Seamlessly track all available constellation signal: GPS, GLONASS, BEIDOE, GALILEO.

WiFi and Web Server

R93i's integrated Wi-Fi, it not only can be used as data link to access to internet, but also can be as a hotspot which can be accessed by any other smart devices to configure the receiver. All status monitoring and parameter settings can be achieved wirelessly on the browser of your phone or computer.

Radio Data Link

Compatible with current radio protocols in the market, and realizes the random switching of the radio range 410MHZ-470MHZ and the power level as well.

Voice Prompt

Without looking at the controller, you can hear the working status of R93i in real time.

Memory

4GB SSD internal memory. Extendable to maximum 32GB external memory. Cyclic Storage program allows overwriting automatically the old data when the disk is full. Supports more raw data format: Rinex2.01, Rinex3.02.

OTG

One easier way to download data anywhere anytime.

Tilt & Bubble

Built-in E-bubble shows you the leveling status on the controller vividly.

Industrial proof

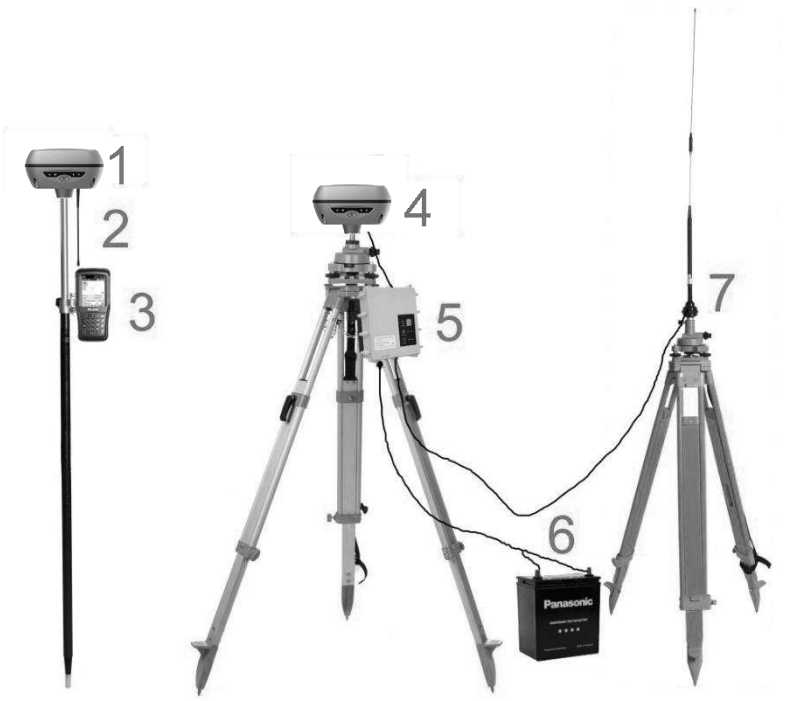
Outstanding design of housing made of Magnesium alloy provides excellent proof shock dust and water, as well as electromagnetic.

1.3 ITEM LIST

Standard Configuration of Rover		
UHF Antennas	QT450A	1
Controller	Need to be purchased separately	1
Bracket for Controller	Need to be purchased separately	1
Rover Receiver	R93i	1
Carbon Fiber Pole	CLS-25	1
TYPE-C cable		1
5-pin LEMO to RS232 cable	L5930B	1
Supporting Pole		
Charger		1
Measuring Tape		1
Height measuring plate	SA5003	1

Standard Configuration of Base		
UHF Antennas	QT450A	1
Rover Receiver	R93i	1
Supporting Pole		
Charger		1
Measuring Tape		1
Height measuring plate	SA5003	1
External Radio	HX-U202 *Need to be purchased separately	1
Transmission Antenna	TQX-450DIV	1
Communication cable	LE52X-00-01	1
Frequency cable	F9440	1

2. CONFIGURATION OF GNSS SYSTEM



1. Rover Receiver
2. UHF Antenna
3. Controller
4. Base Receiver
5. External Radio
6. Power Supply for Radio
7. Transmission Antenna

2.1 INTRODUCTION OF RECEIVER

2.1.1 Appearance

1. Top Cover
2. Rubber Ring
3. Indicator Lights
4. Power Button
5. Beeper of Voice Broadcast
6. UHF Antenna Socket
7. 5-pin Port--- External power supply port, external radio port, serial port for data output and debug
8. Type-C Port--- USB port, OTG interface and Ethernet port

2.1.2 Indicator Lights

R93i indicator light panel has 4 LED indicators, clearly indicates various status, and one physical buttons for powering on/off and configurations.

Indicator	Status	Meaning
Power	On	Normal voltage.
	Flash	Low battery.
Satellite	Flash	Number of satellite locked, indicating every 5s.
Bluetooth	Off	Controller disconnected.
	On	Controller connected.
Signal/Data	Flash	Static mode: Flashing in accordance with the setting sampling interval when recording data.
	Flash	Base/rover mode: Transmitting/Receiving signal.
	Off	Base/rover mode: No signal transmitting/receiving.

Button	Function
I key	Power on/off,

2.1.3 Power on/off

Power on

Press the power button for once, all the indicators glow in red, after few seconds (around 10 seconds), the instrument completes initializing along with voice prompt about the working mode (for example, “Rover, internal radio mode”). After a while, instrument starts to track satellites

Power off

Press the power button and hold for a while, after 3 beeps and the “Power off” voice prompt at the third beeping, release power button, the instrument will switch off.

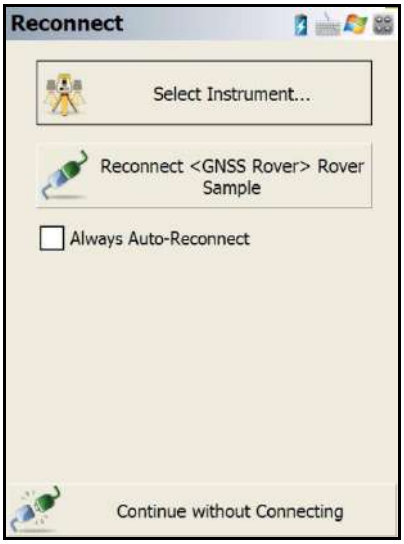
2.1.4 Mode Checking & Switching

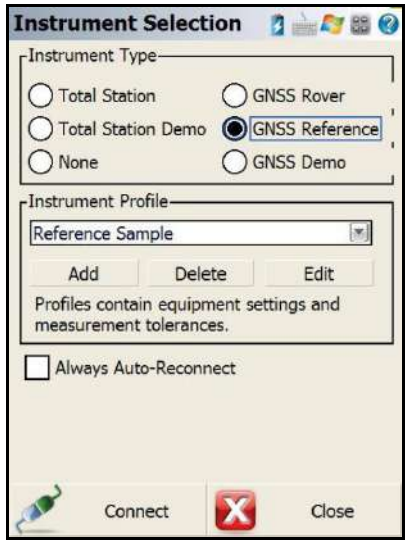
Mode Checking

Press ⏻ once, there is a voice broadcast reminding current working mode, for example, Rover, internal radio mode.

Mode Switching

After receiver is turned on, use controller to connect to the receiver, then configure the working mode and data link mode. This part will be described with more detail later.





2.1.5 Self-check

If the receiver is abnormal or not working properly, you can use the self-check function. Power on the receiver, hold ⏻ for 10s and pass over the state of power off and mode selection (do not release the button even the instrument says power off and start to set work mode), then R93i will say “start to self-check”, at this moment, release power button, the instrument will perform self-check automatically for the modules one by one.

The sequence of modules checking is:

OEM board checking
UHF module checking
Sensors checking
WiFi module checking
Bluetooth module checking

If all the modules are normal during self-check, the instrument will get into the state of power-on.

2.1.6 Factory Reset

Power on the receiver, hold ⏻ for 20s and pass over the foregoing states (power off, mode selection, self-check, USB mode setting), R93i will get into factory reset progress with voice

message saying “start to restore factory default”, at this moment, release power button, the instrument will perform factory reset automatically. After this progress complete, the instrument will restart automatically with the factory default settings.

2.2 EXTERNAL RADIO

2.2.1 Features

HX-U202 is a classified UHF radio modem with a switchable power (5/35W) transmitter and wide tuning range (410-470 MHz). It is designed for easy mobile use in demanding field conditions.

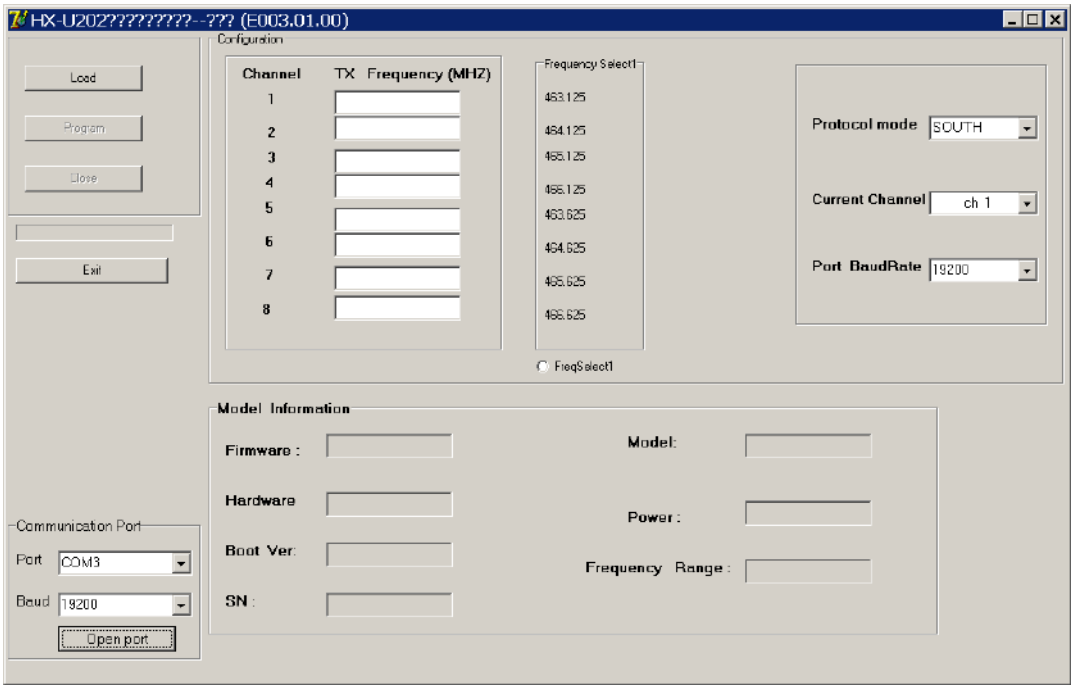
In addition, the channel spacing is also selectable from 12.5 or 25 kHz. And the protocol can be changed between TrimTalk and South. HX-U202 is equipped with a digital tube, 4 LED and three keys, which are used to indicate the current operating status, as well as changing the operating channel and remaining battery.

2.2.2 Interface Introduction

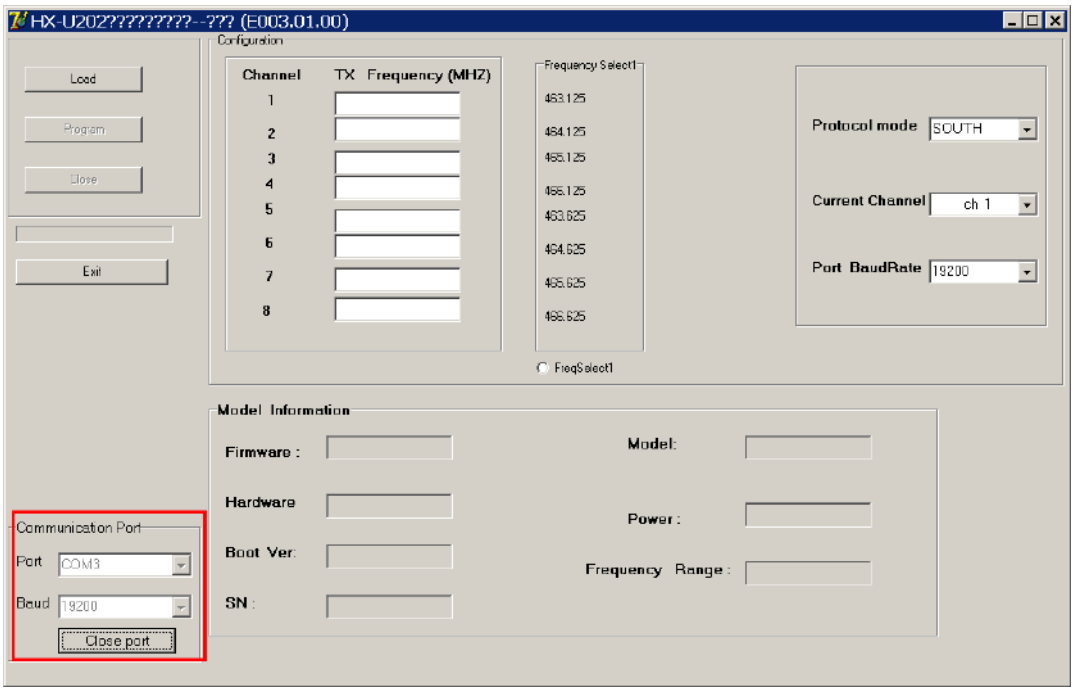
1. Channel Switch Button
2. Output Switch Button
3. Power Button
4. Channel Screen
5. Low-output Indicator
6. High-output Indicator
7. Power Indicator
8. Transmitting Indicator

2.2.3 How to Set the Radio

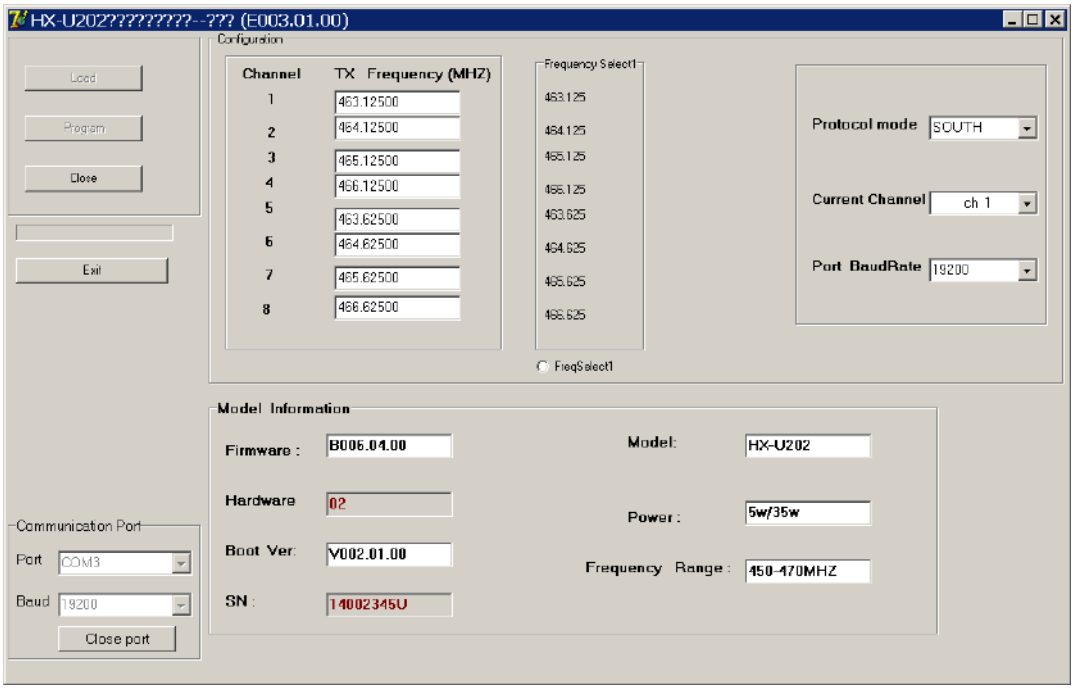
a. Connect the radio to PC with the frequency changing cable F9440.
b. Run configuration software.



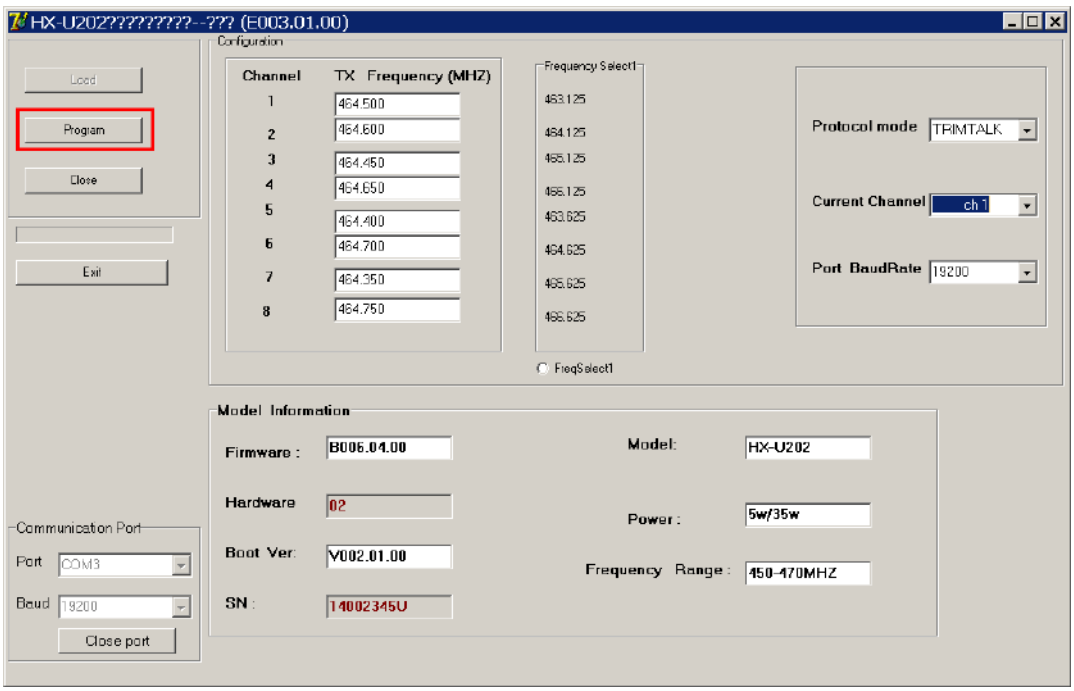
c. Select the right port and baud rate as 19200, click open.



d. Power on the radio and click load ASAP, and then the software will get the radio parameters



e. In the interface, we can change the protocol, SOUTH\TRIMTALK (TrimTalk 450S) and frequencies, after that, click program to confirm.



After configuration, click exit to exit the software.

2.2.4 Radio Transmitting Antenna

The UHF transmitting antenna is particularly suitable for field use, the receiving antenna is Omni-directional antenna.

2.2.5 Application Notice

Low Power: When the power indicator flashing, it means lower power. Replace the external battery in time, otherwise the data link would be data link unstable or unable to launch.

Radio Transmitting Output: It is based on the voltage of the power supply. Check the voltage before use.

High and low Output: Use low-output transmitter when low-output can satisfy the operation because high-output transmitter will consume extra battery power. Excessive use will reduce battery life.

Install the radio station as high as possible.
Power Corrugated Coefficient: Power ripple coefficient must be less than 40mV. The smaller the ripple factor is, the smaller will be the beam spectrum and the higher communication quality.

Power Connection: Positive and negative should be connected correctly.

Electromagnetic Environment: Before using the radio, it is better to perform electromagnetic environment measurement, to avoid the communications blackout.

Suitable Antenna: The fundamental parameters to select the antenna refer to the band width, frequency, gain, directivity, impedance, VSWR and other factors. Usually the effective bandwidth of the antenna is 3-5MHz. It should be based on the frequency bands used by the channel to be defined. For the long-distance transmission, it is better to use a directional antenna and high-gain antenna.

We recommend:
Use battery which is more than 12/36Ah, and maintain a regular current of 10A during operation.
Charge it in time. Do not overuse the battery, otherwise it will reduce battery life.
Replace the batteries after 6-12 months, to ensure the radio working performance.

2.3 ACCESSORIES

2.3.1 Instrument Case

The carrying case of R93i is ideal for surveyors. It has strong abrasive resistance and waterproof.

The inner layer of the black soft bag is filled with anti-collision foam. The receiver and other accessories can be dispersed and embedded.

2.3.2 Antenna

UHF differential antenna is needed in UHF built-in radio base station mode and UHF built-in radio rover station mode.

2.3.3 Multi-function Data Cable

Multi-function cable is a "Y" shaped cable used to connect the base receiver (5-pin red jack), transmitting stations (black jack) and external battery (red and black clip) for power supply and data transmission.

Type-C cable: Connect the receiver to the computer, for the transmission of static data and the receiver firmware upgrade.

5-pin cable: It is a serial RS232 cable for setting receiver parameters (need to be purchased separately)

7-pin OTG cable: For connecting an external storage directly to R93i for static data storage and copy (need to be purchased separately)

3. WEB SERVER

Powered by the new generation of embedded Linux operating system, you can log onto a user-friendly management platform through the browse of your mobile phone or computer to monitor the status and configure the parameters of R93i. Such management platform, referring as WEB SERVER, can be accessed via WiFi connection or USB interface.

3.1 WiFi Connection

The WIFI hotspot of R93i is broadcasted by default.

Search the WIFI hotspot named RUIDE_xxxx with a smartphone, tablet or laptop, click "Connect" to establish the WIFI connection directly, such step will not require password.

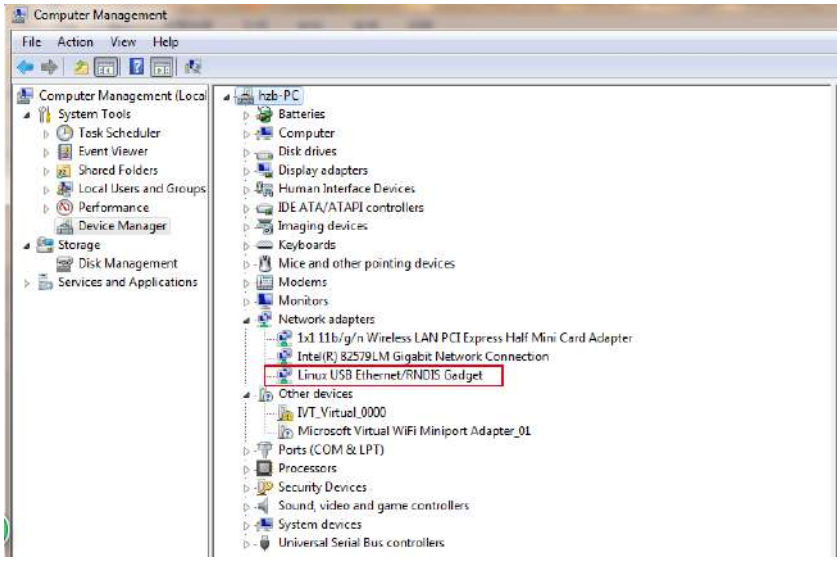
Input the default IP (10.1.1.1) on the browser, log in the WEB SERVER with username "admin" and password "admin".

3.2 USB Network Interface

WEB SERVER can also be accessed through USB connection of R93i with computer. By this mode, the USB port (7-pin) of R93i must work as an Ethernet port.

First, a corresponding driver is required to be installed onto the computer. As to different OS type, bugvista64.inf is for 64-bit operating system, and linux.inf is for 32-bit operating system. Make sure the USB port (7-pin) is switched into USB network port, please refer to chapter 2.1.7 for more details.

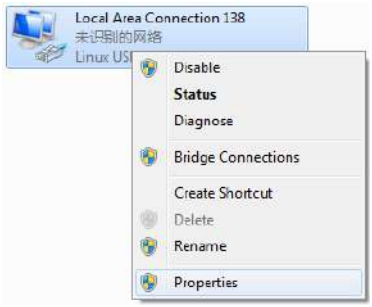
Connect R93i to computer via USB cable. Activate Device Manager, right click on **Remote NDIS based Device** (Under the category of Network adapters) to update the driver manually. Choose the folder which contains the driver.



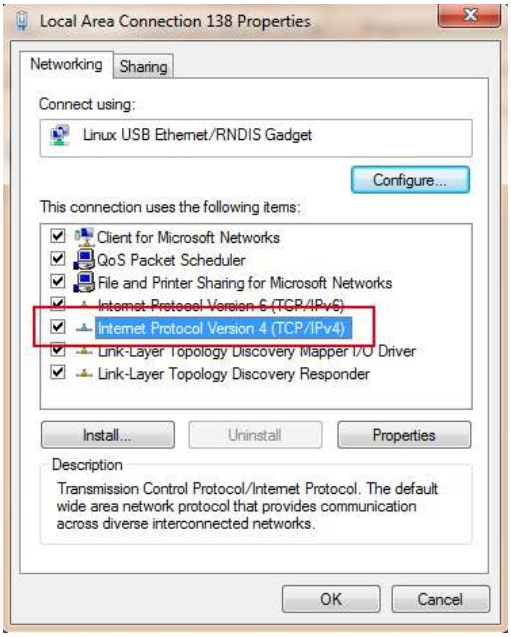
After installation, the USB port of R93i will be recognized as Linux USB Ethernet/RNDIS Gadget, and a local area connection will be generated in Network Connections of the computer. For example, Local Area Connection 138 has been generated after connecting R93i receiver to computer via USB Ethernet port.

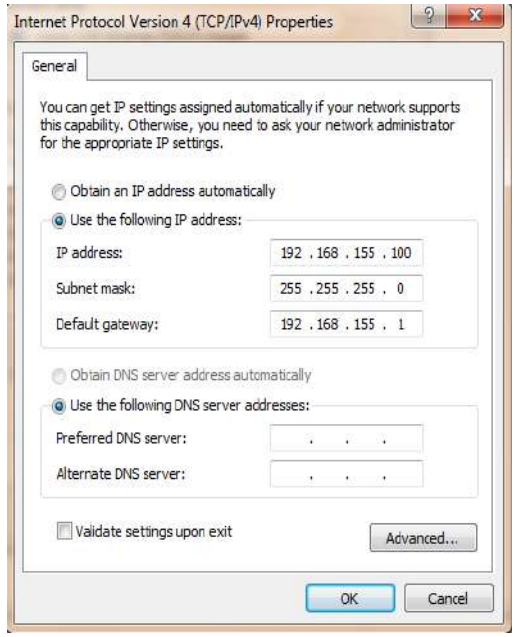
However, sometimes the computer cannot detect the receiver by USB Ethernet port as there might be something wrong with acquiring IP automatically, therefore, we need to set a fixed LAN IP for the connection.

Right click on the local area connection which was newly generated, and choose properties

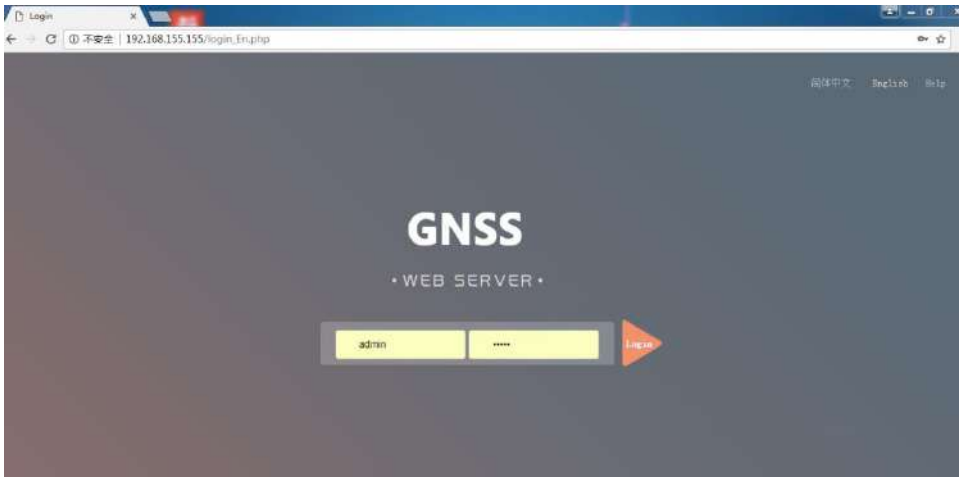


Then double click on Internet Protocol Version 4 (TCP/IPv4) option, set the fixed LAN IP address as shown in following.



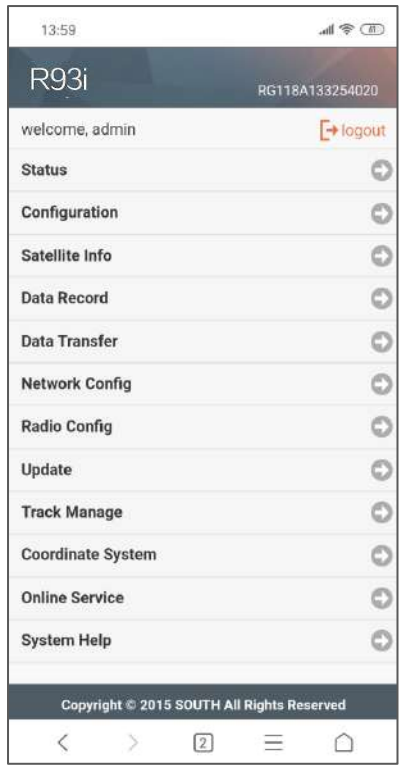


On the IE browser, apply the IP address 192.168.155.155 to access the WEB SERVER.



3.3 WEB SERVER main interface

After logging in the WEB SERVER of R93i by WIFI or USB connection, the main interface will be displayed on mobile phone as below image shows.



Description of all the configuration items listed in WEB SERVER.

Menu	Content
Status	Positioning information, satellite tracking and the others will be displayed in this page
Configuration	It contains registration for receiver, base configuration, antenna configuration, satellite configuration, receiver configuration and system configuration.
Satellite Information	Display and control the satellites are used or not
Data Record	Configure the parameters for static mode and raw data download
Data Transfer	Contains NTRIP configuration, TCP/IP configuration and data transferring with PC
Network Config	Contains network parameters configuration, WIFI configuration and the other functions
Radio Config	Configure the parameters and frequency for radio modem

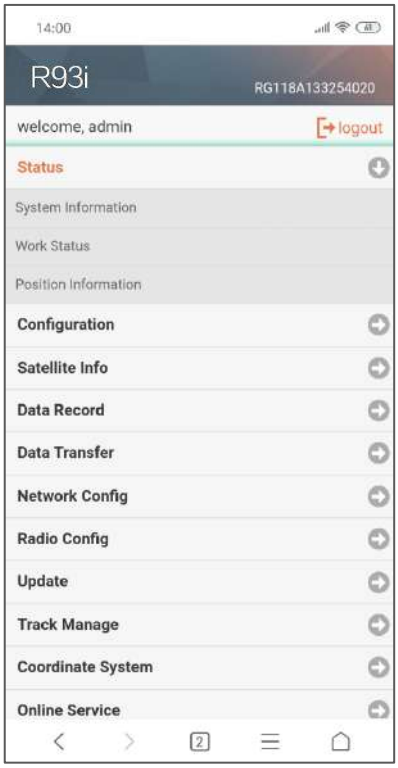
Firmware Update	It is used to upgrade the firmware for receiver and each modem
Track Manage	Record track file while doing measurement
Coordinate System	Setup a local coordinate system for R93i
Online Service	Upload data onto a server in real-time
User Management	Add and manage the WEB SERVER users
System Help	Offers solutions

3.3.1 Status

System Information, Working Status and Position Information are listed under Status menu.

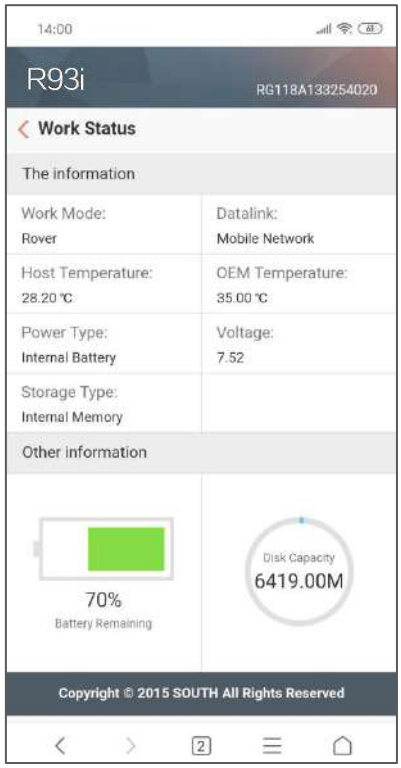
System Information

Display all the system information of the current R93i, such as serial number, hardware ID, MAC address, firmware version, etc.



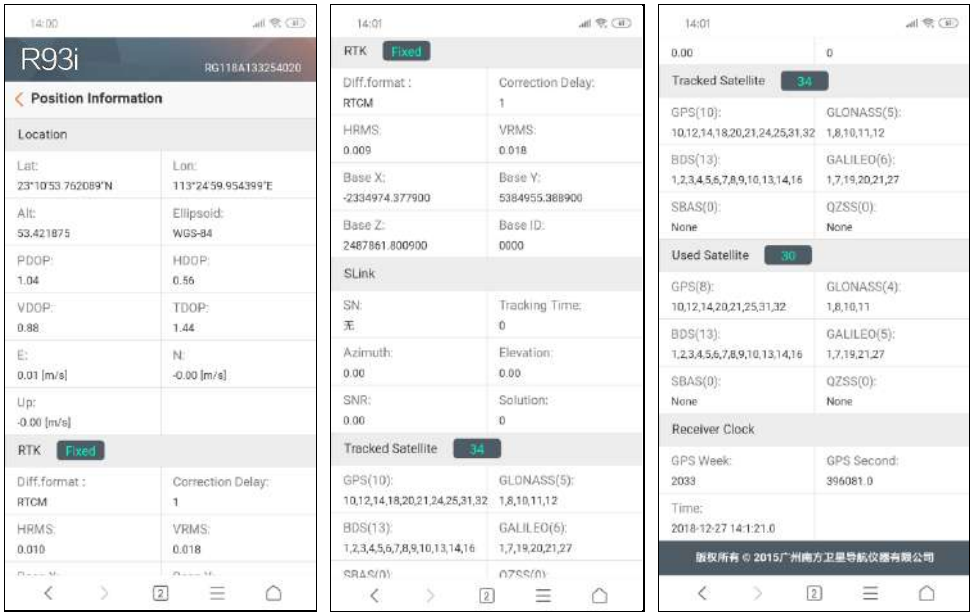
Work Status

The physical state of R93i such as working mode, datalink, host temperature, remaining power and the free memory is listed here.



Position Information

Check and view the current position information and satellite information.

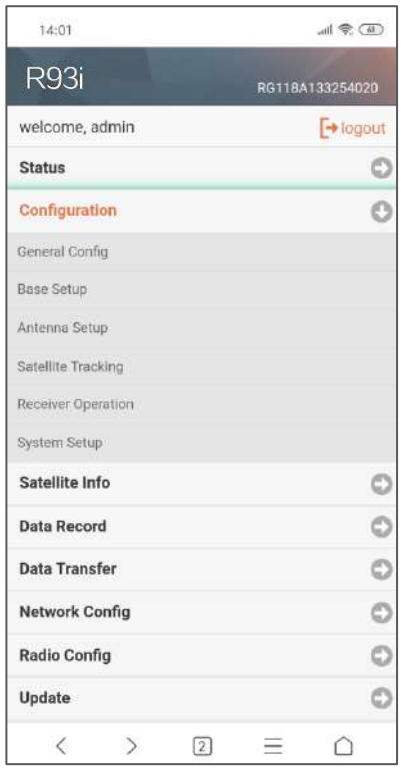


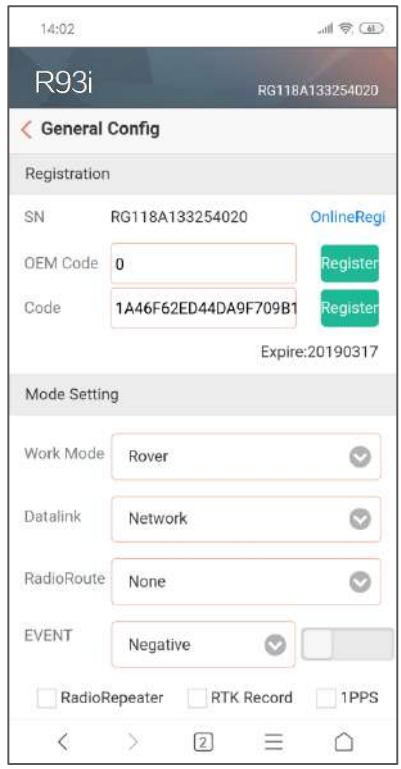
3.3.2 Configuration

Users can configure all kinds of parameters through this menu.

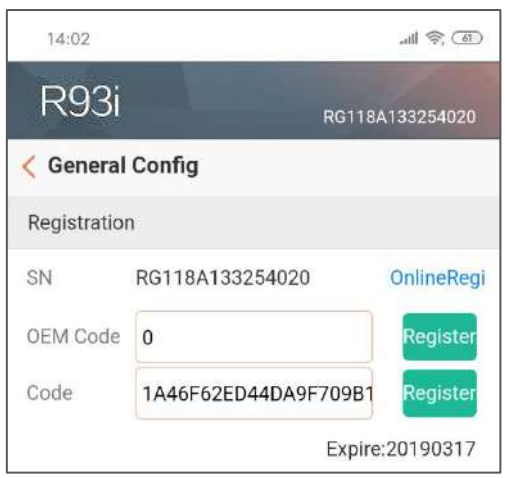
General Config

The registration for the receiver and working mode setting can be accomplished here.

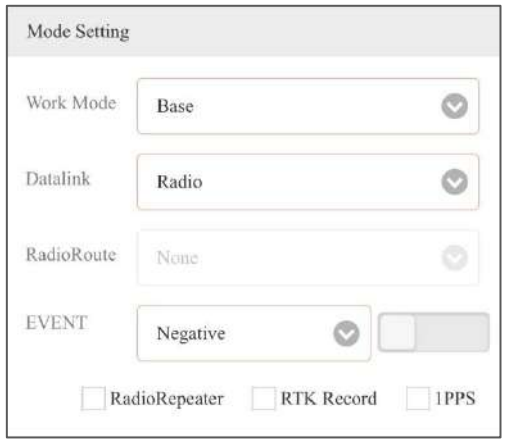




Directly input the code and click “Register” to register the receiver online.

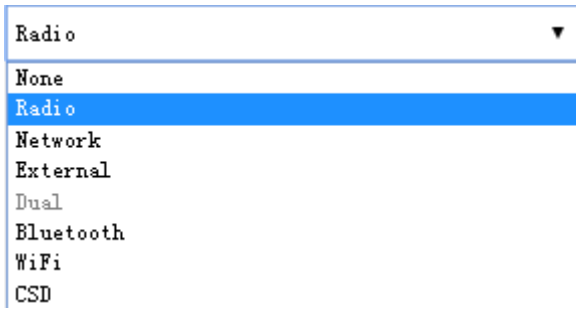


Mode setting provides setting the work mode, datalink of the receiver as well as some other new functions equipped on R93i.



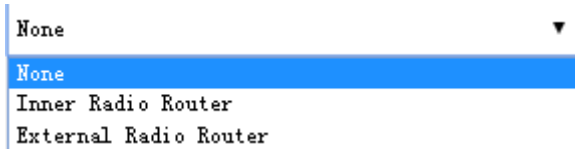
Work Mode: Rover, Base and Static.

Datalink: Radio, Network, External, Bluetooth, WIFI and CSD.



Radio Route: This function refers to transferring the correction from the reference station to other rovers by radio, the rovers can acquire the same reference coordinates. Such function is for the case of working in some places where there is poor signal from the reference station or there is only one SIM card for a few rovers.

Either internal radio or an external radio can be applied to transfer the correction.



Such function can only be activated when the receiver is in Rover mode. Please refer to section 5.1, Radio Route for more details.

RadioTransfer: This is the function that R93i transfers the correction from Base station to the other rovers with the internal UHF, i.e. R93i can work as a radio repeater. Please refer to section 5.2, Radio Transfer for more details.

RTK Record: Check to enable the raw data recording function in base mode or rover mode for post-processing

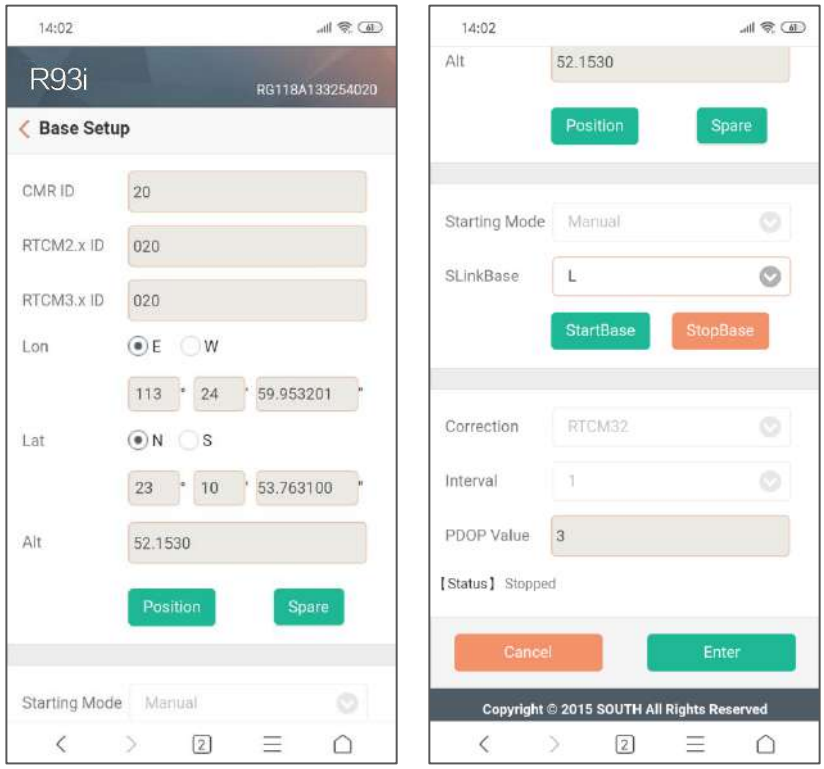
1 PPS: 1 pulse per second output

EVENT: EVENT marker input

EVENT Polarity: EVENT input method.

Base Setup

The basic configuration for base is listed here. Users can input the correct coordinates or capture a current position for the base. Also users can define what kind of correction format to be transmitted.



CMR ID/RTCM2.X ID/RTCM3.X ID: ID for transmitting correction.

Position: Click this button to capture the coordinates for current position

Spare: Repeat station function.

Start Mode: There are 3 methods to start the Base, manually start base, automatically start base by fixed point, automatically start base by current point.

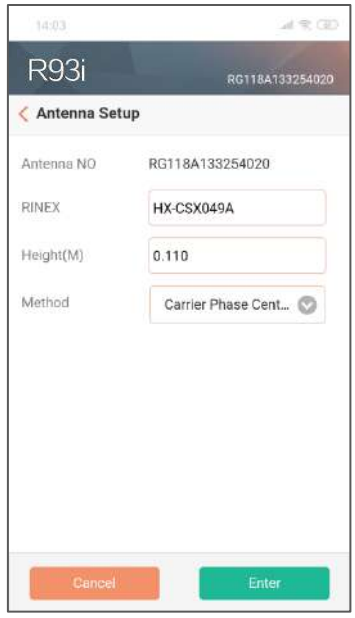
Correction: Correction formats, including RTD, RTCM23, RTCM30, RTCM32, CMR and SCMRx.

PDOP : Set the PDOP limitation.

Status: Display the status for base in real-time.

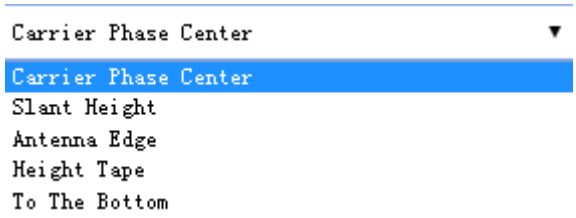
Antenna Setup

The antenna parameters can be configured in this page, including the antenna height, measuring method.



Antenna Height: Input the value of antenna height.

Measuring Method: Here are several methods for measuring the antenna height such as carrier phase center, slant height, antenna edge, height plate and to the bottom.



Satellite Tracking

From this page, users can set the mask angle for satellite tracking, view the tracked band from the constellation and set which corresponding band to use or not.

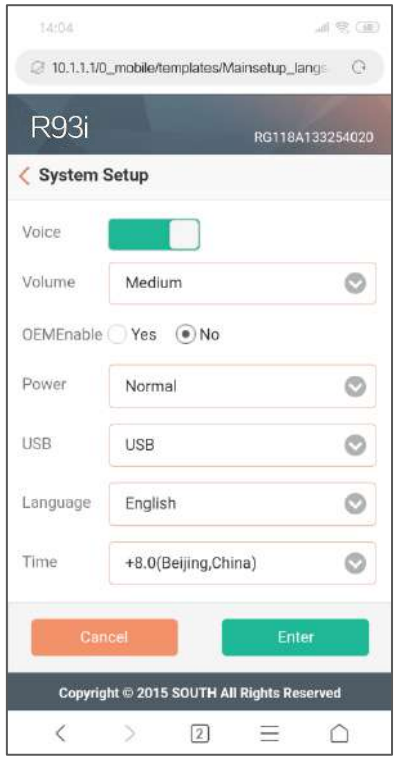
Receiver Operation

The page provides all kinds of operations to control the receiver such as self-check operation, clean epochs, factory reset, reboot and power off.

Module Self-check: Self-check can be also accomplished here. Click the Check all button to check all the modems or click the check button after each modem to self-check separately.
Clean EPH: Click this button to clear the remaining epochs, making the receiver track the satellites better.
Factory Default: Click this button to reset the receiver to default.
Reboot: Click this button to restart the receiver.
Power Off: Click this button to power off the receiver.

System Setup

Users can control Voice prompt, volume of voice, power saving, USB mode and the default language for receiver through this page.

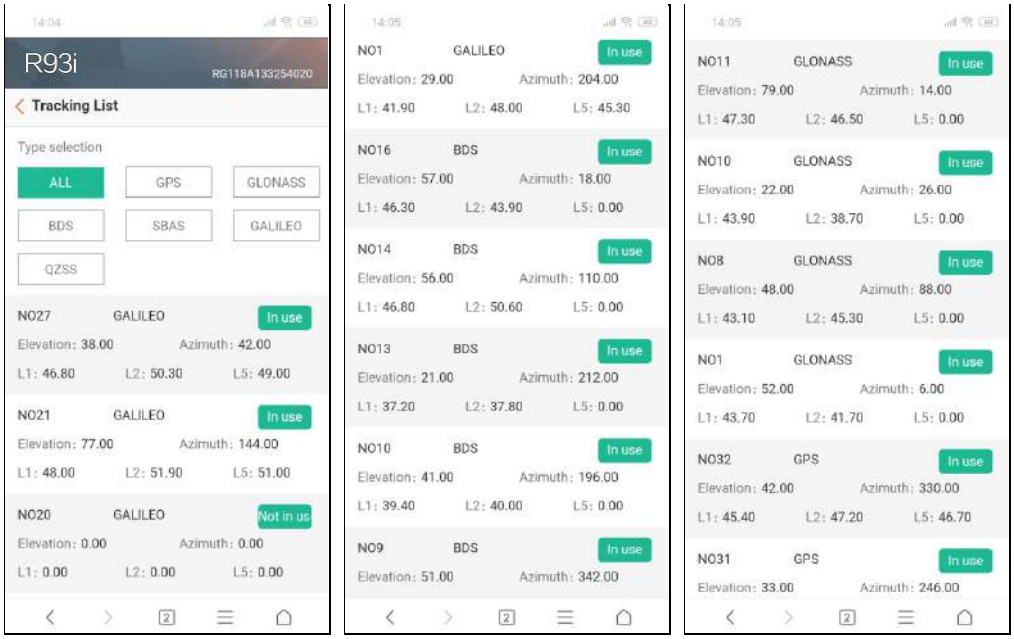


Voice: Set to turn on/off the voice guide for R93i.
Volume: Set the voice volume for R93i's speaker.
Power: Configure the receiver to use the power saving mode or not.
USB: Configure the output mode of the 7-pin port of R93i when connecting the receiver with computer via USB cable, including USB and network port.
Language: Set the language for voice guide.
Time(h): Set the corresponding time zone of your area.

3.3.3 Satellite Information

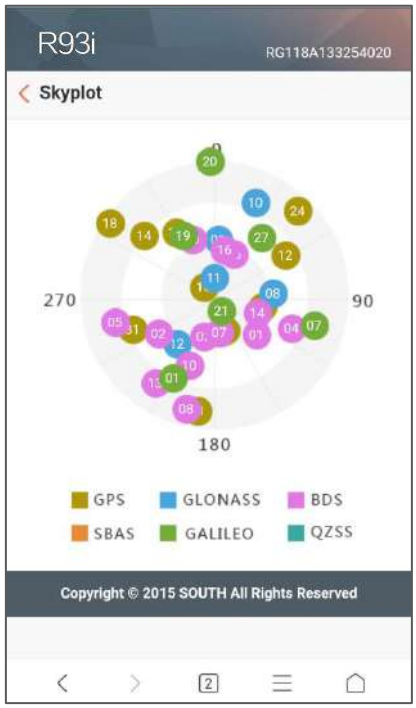
The "Satellite Information" provides all kinds of tables, graphics and the skyplot to view the information of tracking satellites. And it is allowed to configure which satellite in constellation to be used.

Tracking Table
It lists all current used satellites and the other information for these satellites.



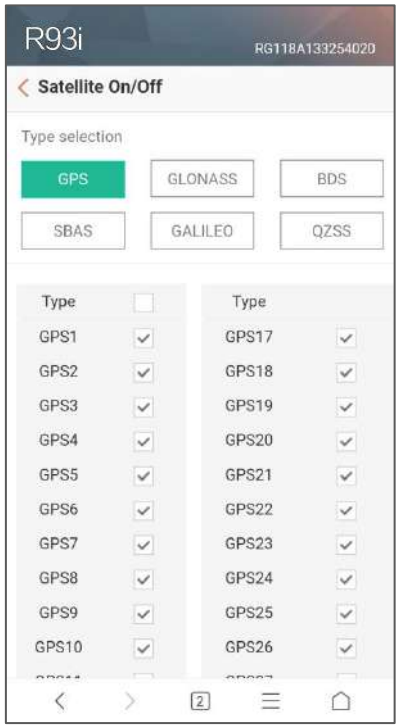
Skyplot

All the tracking satellites are shown on the skyplot. Let users intuitively view and know where the current position of satellite is.



Satellite ON/OFF

For all the running GNSS constellations or the augmentation system, R93i allows to configure which satellite to use.

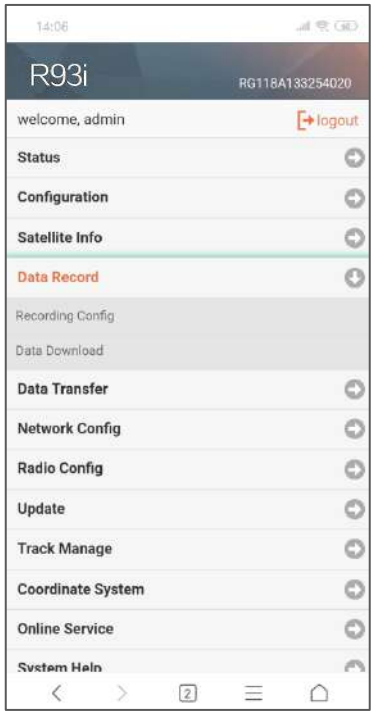


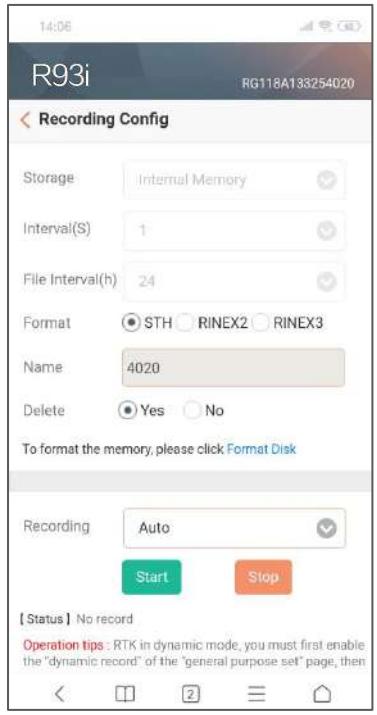
3.3.4 Data Record

It is mainly used to configure all the parameters for receiver in static mode.

Recording Config

The page provides more practical operations for raw data storage.





Storage Option: Select where the raw data will be stored, internal memory or external memory.
Interval: This is the sampling interval for data storage, 50Hz(0.02s) sampling interval now is available for R93i.
File Interval: This is used to define the data storage time for the static file.
Data Format: Here are 3 options of the static data format, STH, Rinex2.0 and Rinex3.0.
Point Name: A point name is required, the last 4 digits of SN is the default point name.
Auto Delete: This is used to configure R93i to delete the previous data files automatically if the memory is full.
Format: Click this button to format the internal memory for R93i.
Recording Mode: Here are 2 options to configure R93i to record raw data automatically or manually.
Start/Stop: Click these buttons to start recording or strop recording the raw data.
Recording Status: Here shows the status of static data storage.

Data Download

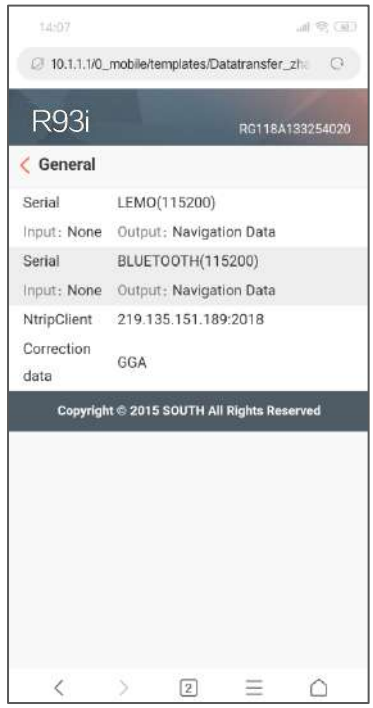
This page provides the options for downloading the data.
Choose the storage where the static data is recorded, and file type, click on the blank of "Select Date" to choose the date when the data was recorded. Then click "Get Data" button, all the files recorded in the date you choose will be shown in the table, tap download button to download the data files.

3.3.5 Data Transfer

This part contains General, Serial Port Config, TCP/IP Config, NTRIP Config and Data Flow Config. The "Data Transfer" allows configuring the output mode for raw observation data and differential data, as well as to the NTRIP performance configuration.

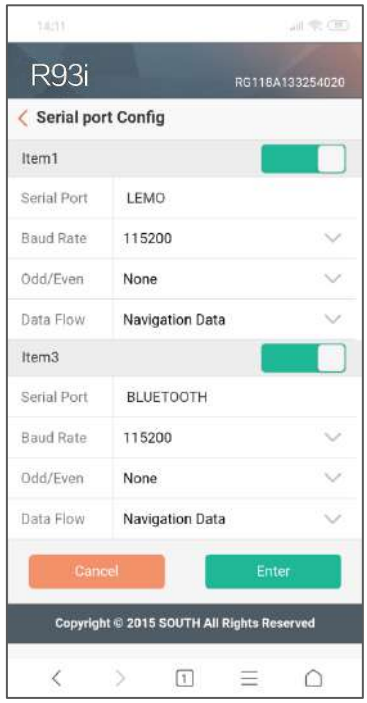
General

It shows the service condition and the output contents of the ports. If the port item is displayed in green, that means the port is being used, and the port is not used while the item is displayed in red.



Serial port Config

Configure the baud rate, odd-even check and the data flow for serial port (5-pin port) and Bluetooth.



NOTE: Do not modify the default value in this page for each item without permission.

In the dropdown list of data flow, there are 4 items for selection.

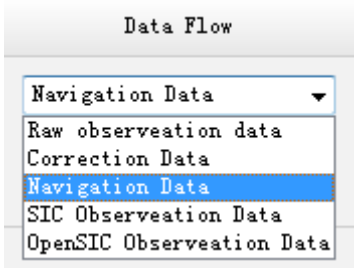
Raw observation data: Raw observation data straight from OEM board.

Correction Data: Correction data straight from OEM board.

Navigation Data: Navigation data output from receiver such as NMEA-0183, GSV, AVR, RMC and so on. It is configured in the menu of Data Flow Config.

SIC Observation Data: This is the user-defined format observation data from RUIDE.

OpenSIC Observation Data: This is the open version of user-defined format observation data for secondary development.

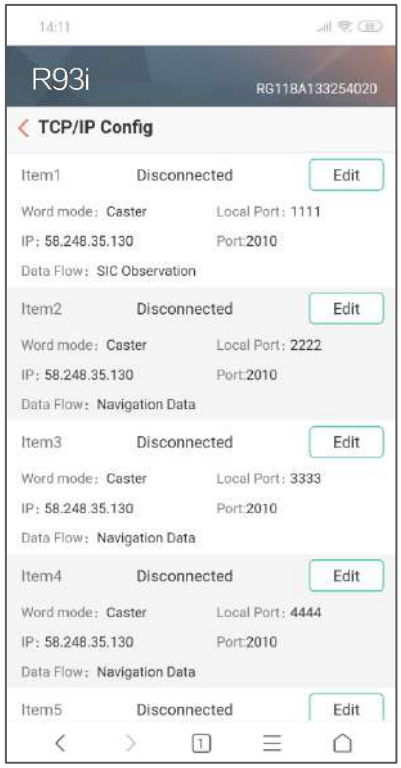


TCP/IP Config

This menu is to configure the raw data or navigation data to be uploaded or transferred to a server. And there are Caster and Server working mode for this part.

Caster: In Caster mode, R93i will be a client to upload the data to a specific server if it connects to the internet by WIFI or GPRS connection with SIM card inserted. Input the specified IP and port for server, and the data format to be uploaded. Users are able to see the uploaded data on server.

Server: In Server mode, R93i will upload the data onto internet by the static WIFI. Then users are able to obtain its dynamic data by accessing to R93i through the IP from receiver.

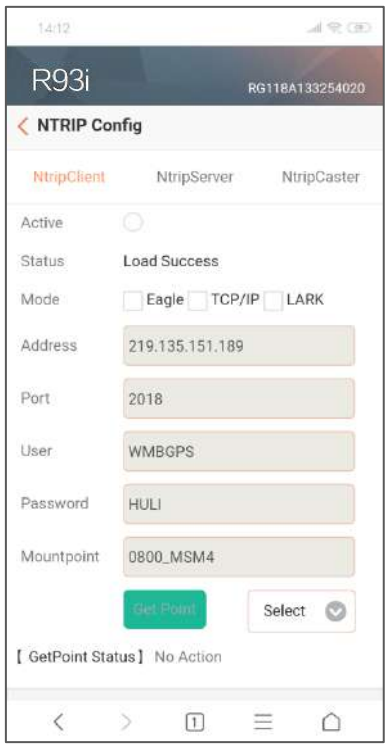


NTRIP Config

This menu is for configuring the NTRIP performance while receiver is going to connect to internet. R93i supports complete NTRIP performance including NTRIP Client, NTRIP Server and NTRIP Caster.

NtripClient

This is a commonly used function for rover set in GPRS mode. At the field of NtripClient, the specified IP address, access port of reference station, as well as the assigned username and password need to be input for the NTRIP connection.



Status: Display the current status of NTRIP connection.

Active: Check to activate this function.

Authentication Mode: It includes Eagle Mode, TCP/IP Mode and LARK Mode.

① Eagle Mode is RUIDE standard mode, usually, this mode is selected when both Base and Rover are using GPRS mode.

② TCP/IP Mode is for private network use.

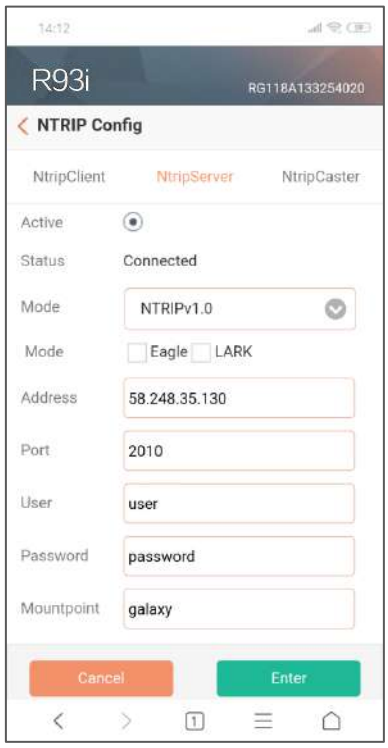
③ LARK Mode is a new technology, which is similar to GSM dial. By this mode, it no longer needs a CORS server, the corrections are transmitted by GPRS network. Besides, it is different from the feature of Caster.

NtripServer

This configuration is used in Base+GPRS mode. Base station will transfer its correction onto the server as long as it connects to internet, then Rover downloads the base's correction from server for use. Or use the LARK mode.

Ntrip Version: It provides options of NTRIPv1.0 and NTRIPv2.0.

Access Point: Users can customize the correction format transferred to the server from the base, such as HHHH_RTCM30

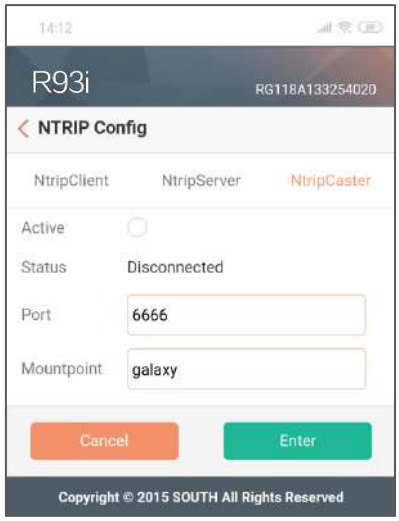


NtripCaster

With this feature, the receiver become equivalent to a CORS system, it can generate and broadcast the user-defined correction for rover if R93i connects a static IP address.

Port: This is the specified port for the access.

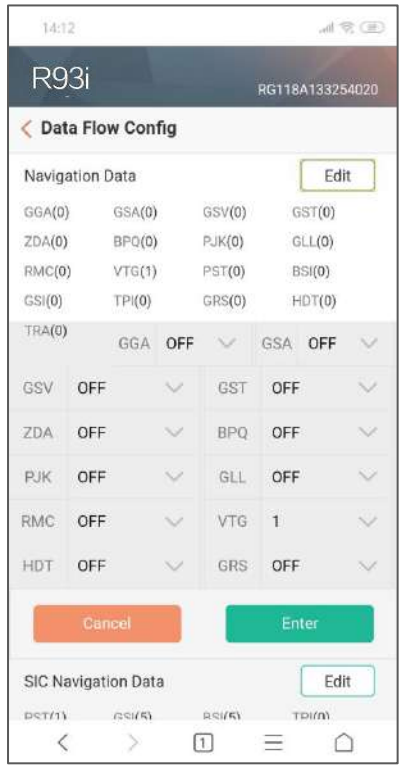
Access Point: This is mountpoint which can be defined by users themselves.



Data Flow Config

Users can configure the content and the update rate of data flow, and choose to shut down

the output of a specific data format from this menu.
Click on the dropdown list for each data format to define the update rate



3.3.6 Network Config

Network Config provides configuration of the methods and the corresponding contents for internet access of R93i, including GSM/GPRS Config, CSD Config, WIFI Config, Bluetooth Config, Port Forwarding, Router and Network Testing.

GSM/GPRS Config

In this page, all the information of receiver under GPRS mode will be displayed including the hardware information and dialing status.

Status: The dialing status and hardware information are displayed in this field. Users can intuitively view the signal of network, module model and the IMEI number of the module.

Parameter Config: The parameters of SIM card are needed to be input here including APN, assigned username and password, dial mode.

SMS Config

Input a phone number in "SMSNumber", R93i will send text messages to this phone number.

CSD Config

CSD is the function of direct dialing between Base and Rover with SIM card inserted (the CSD function should be activated on local SIM card), this function is mainly used in the area where there is very poor internet signal coverage.

Status: This field displays the dialing status.

Parameter Config: To enable the CSD function with checking the box of Enable option in this

field, then input the phone number for Rover and Base in CallNumber and LocalNumber.
NOTE *: Please choose CSD as datalink for receiver in General Config.*

WIFI Config

There are AP mode and Client mode for WiFi config.

AP:

In AP mode, R93i acts as a WiFi hotspot for mobile devices such as smartphone or tablet to connect and access the WEB SERVER.

Select AP in Work Mode to enable the WIFI hotspot for R93i, and define the SSID, password, encryption method and broadcasting channel for WIFI connection.

DHCP IP Range: It provides user-defined IP address for WEB SERVER login.

Client:

This mode enables R93i to search and connect the other WIFI hotspot which connects to the internet, the receiver is able to download and use the mountpoint from reference station.

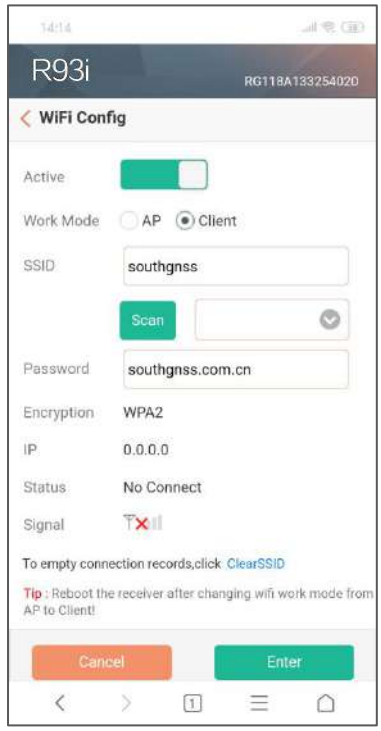
SSID: This is the WIFI hotspot which R93i is going to connect

Scan: Click this button to search the surrounding available WIFI hotspot.

Password: Password of the connecting WIFI hotspot.

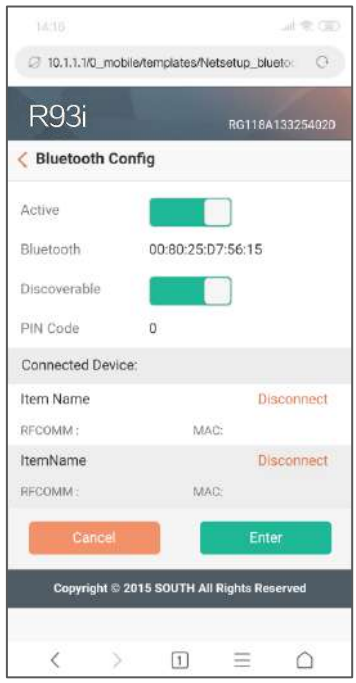
IP : If R93i successfully connects to the WIFI, there will be an LAN IP address generated here.

ClearSSID: Click this button to clear the SSID list.



Bluetooth Config

Here users can view the information and connection status of Bluetooth, such the MAC of Bluetooth, discoverable or not, the PIN code, and the connection devices in following table.



Port Forwarding

It is mainly used to view and configure the internet transmission port for R93i, customize and debug receiver.

NOTE: Please do not modify the parameters without permission.

Router

It is mainly used to view and configure the parameters for router, only under the condition of customizing and debugging receiver.

NOTE*: Please do not modify the parameters without permission.*

Network Testing

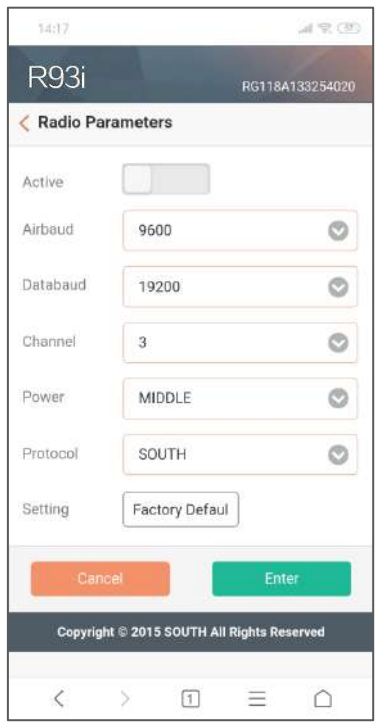
This function is for testing the network status for R93i after connecting to the internet.

Input the IP address to which R93i has already been connected, then click PING button, the testing information will be displayed in Result.

3.3.7 Radio Config

Radio configuration is divided into two parts, Radio Parameter and Radio Frequency.

Radio Parameter



Air Baud Rate: The default value is 9600.

Data Baud Rate: The default value is 19200.

Channel: This is the communication channels for internal UHF, the value of the channel must be the same both in Base and Rover.

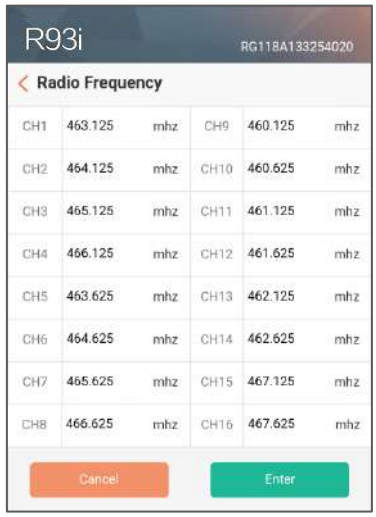
Power: The radio transmitting power. R93i provides three options, High, Middle or Low power. And it is only available in Base mode.

Protocol: Radio communication protocol for data transmission, SOUTH and TRIMTALK are

optional. Base and Rover must use the same protocol for communication.
Factory Default: Reset the internal UHF module to default setting.

Radio Frequency

There are 16 radio channels listed here. Users can change the frequency freely to their own needs.
Click Restore button to reset all the frequency to be default value.

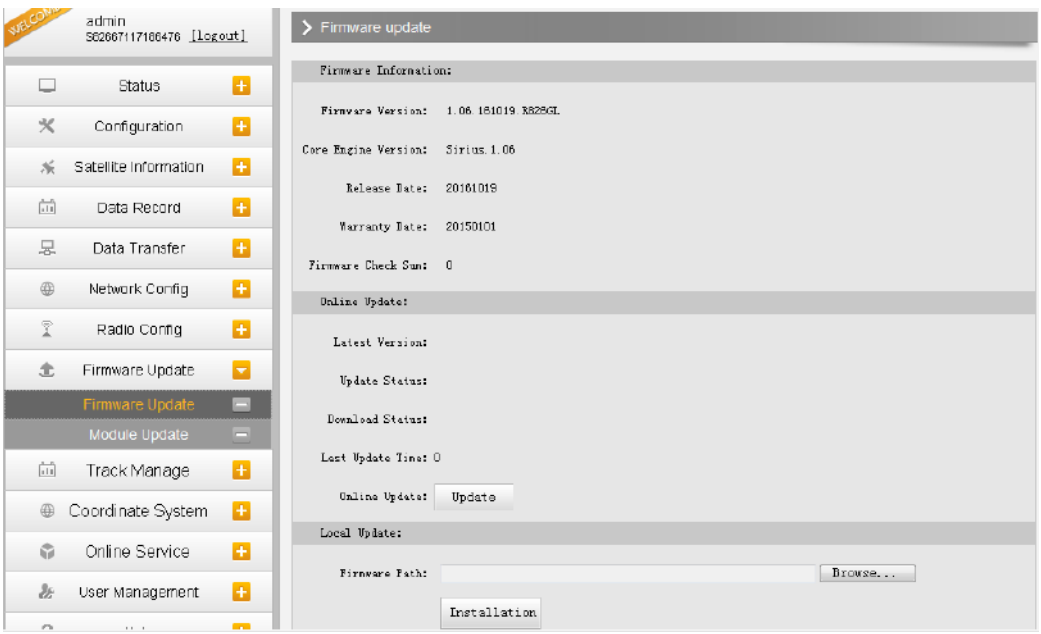


3.3.8 Firmware Update

Update the latest firmware for receiver or separately update the corresponding modems.

Firmware Update

It displays all the information of the firmware currently installed on R93i, and allows to update the latest version firmware for receiver.



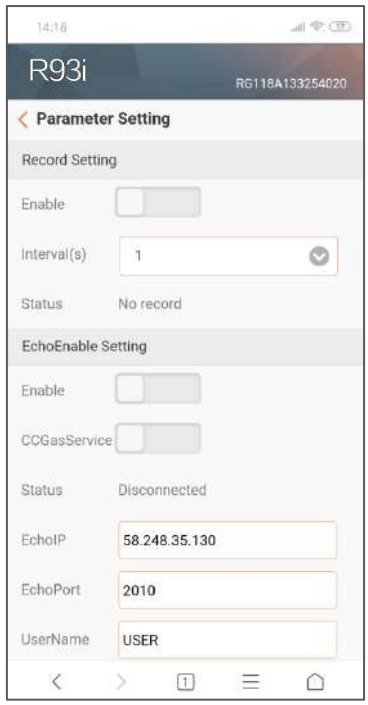
NOTE: *It is recommended to upgrade via connecting R93i with computer.*

Online Update: R93i supports to update the firmware online anytime.

Local Update: Update the latest firmware after loading the firmware file in your computer. Please refer to section 7 Firmware Update for more details.

3.3.9 Track Manage

R93i supports recording the track while doing measurement, and uploading the data onto the server.



3.3.10 Coordinate System (reserve)

Users can set the local coordinate system through WEB SERVER. The instrument will output the local coordinates according to the input coordinate system.

3.3.11 Online Service (reserve)

This function enables R93i to upload data to a server in real-time, including Navigation data, raw observation data, correction data, SIC observation data and open SIC observation data.

3.3.13 Help

Users can get help and check the log book of receiver (the log book can help to backtrack the working status of receiver).

4. OPERATIONS

GNSS measurement modes refer to the operating modes used to determine the relative position between the stations with the help of GNSS technology. Point coordinates precision obtained is not the same. Its operating methods and observation time are also different, thus having different range of applications. GNSS receiver operating program is divided into two types: static measurement and RTK dynamic measurement (including the base station and rover station).

Environmental Requirements

a. Observation stations (i.e., the receiving antenna settlements) should be away from high-power radio transmitters and high voltage transmission lines in order to avoid the magnetic field interfering the GNSS satellite signal. Receiver antenna and its distance shall not be less than 200m.

b. Observation station should not be near to large waters or objects which can strongly affect (or absorb) electromagnetic wave to weaken the effects of multi-path.

c. Observation station should be located in places where the receiving device can be installed easily with good vision. Elevation angle of obstacles in view should generally be greater than 10° - 15°, in order to weaken the effects of troposphere refraction.

d. Observation station should be put in a convenient place, and easy to use other means of measuring, joint measurement and expansion.

e. For the long baseline GPS network, you should also consider the good communication facilities nearby (telephone and telegraph, post and telecommunications) and power supply.

4.1 STATIC MODE

4.1.1 About Static Measurement

Definition

GNSS positioning measurement is realized by installing three (or more) GNSS receivers to perform simultaneous observation and determine the relative position between the stations.

Applications

a. The establishment of a national geodetic control network.
b. The establishment of precise engineering control network, such as bridge measurement, tunnel measurement, etc.
c. The establishment of a variety of encryption control networks, such as city measurement, Drawing Point measurement, road survey, demarcation measurement.

d. For the GNSS measurement of small and medium-sized city, town, as well as mapping, cadastral, land information, real estate, geophysical exploration, surveying, construction and other control measurements.

4.1.2 GPS Net Design

a. GPS net generally constitutes a closed figure by independent observation edge, such as a triangle, polygon or annexed line, to optimize the checking conditions, and improve the reliability of the network.
b. The points of the GPS network should coincide as close as possible with that of the original ground control network. Coincidence point generally should not be less than 3 (performs leveling conjunction when not enough) and should be evenly distributed in the network in order to reliably determine the transformation parameters between the GPS and ground networks.
c. The points of the GPS network coinciding with the leveling points should be considered. Non-coincidence point should generally perform leveling conjunction method (or methods of equivalent accuracy), or set a certain density leveling conjunction point in the network, to provide information for the study of the geoid.
d. In order to facilitate the observation and perform leveling conjunction, GPS outlets should generally be located in unobscured and easy-to-reach places.
e. In order to facilitate the classical leveling conjunction or extension, emplace near the outlet a good view orientation point, to establish leveling conjunction direction. The distance between the point and the station should generally be greater than 300 meters.
f. According to the different purpose of GPS measurements, the independent observations edge of GPS network should be certain geometry. The basic forms of the graph are as follows: triangular network, ring network, stellate network.

4.1.3 Operation

Step 1: Setting Up

Mount the receiver on the tripod.

Step 2: Setting Working Mode

Power on the receiver. Wait until hearing the voice broadcasting the current working mode. Hold the Power button until hearing the voice saying “Rover, Base, Static” with the LED indicator shifting. After the word “Static”, release the button. At this moment the receiver will be turned off. Turn it on again and you will hear the voice confirming the mode of Static.

Step 3: Data Collecting

NOTE*: Static Mode does not require a controller to work with.*

4.2 BASE + ROVER MODE (RTK MODE)

4.2.1 Definition

Real-time Dynamic Measurements, referred to as RTK.

RTK technology is the real-time dynamic differential carrier phase positioning technology, combining global satellite navigation and positioning technology with data communication technology which includes base station and rover station. Base station transmits the data by radio or network to the rover station, which will perform differential analysis, thus providing real-time coordinates of the measurement point in the specified coordinate system. Depending on the modes of transmission of the differential signal, RTK is divided into the radio mode and network mode. Here we introduce radio mode first.

4.2.2 Operation

4.2.2.1 Base Setup

Step 1

Mount the base on the tripod.

Step 2 (please refer to 2 different data link modes you will use.)

<Using External radio>

Set the high gain antenna *(e.g. QC450A-T(B))* on a tripod, and connect it to the external radio *(e.g. HX-U202) on another tripod*, which should have been connected with the external power supply via the multi-functional cable *(e.g. LE52X-00-01)*.

Note: Place the 2 tripods at least 2m away from each other to avoid signal interference.

<Using internal UHF radio>

Install the transmitting antenna *(e.g. QT450AS-1)* on the UHF interface under the receiver. The 30cm pole support *(e.g. CFFMG)* is recommended in order to realize a higher position.

Step 3

Make sure all connections are correct, then power on the base receiver and the external radio.

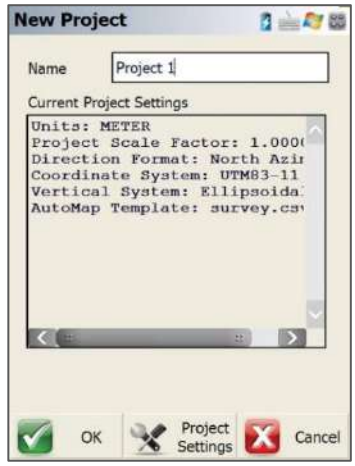
4.2.2.2 Setting the Base

Step 1: Selecting Project

Run FieldGenius.

Select an existed project, or create a project. Edit the Project Settings if

necessary.

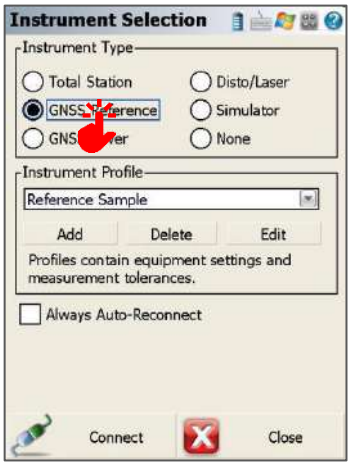


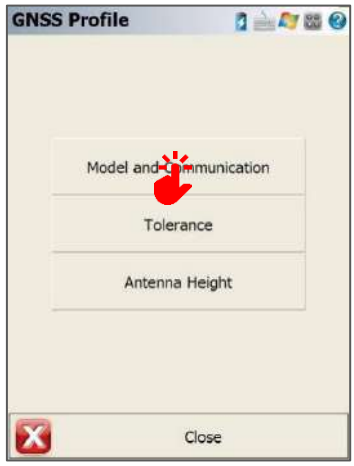
Step 2: Selecting Model and Connecting Bluetooth

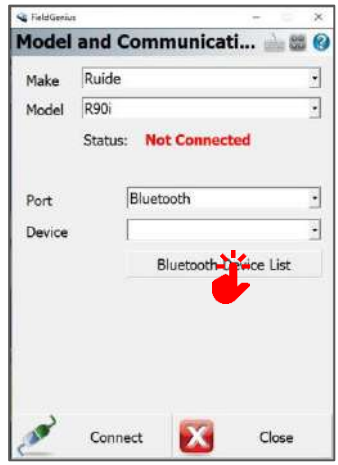
Click Select Instrument... .

Choose *GNSS Reference* as the *Instrument Type*, which means this receiver will be defined as Base.

Press Edit → Model and Communication. Select the brand, model name, and select *Bluetooth* as the *Port*. Then press Bluetooth Device List to browse the list.

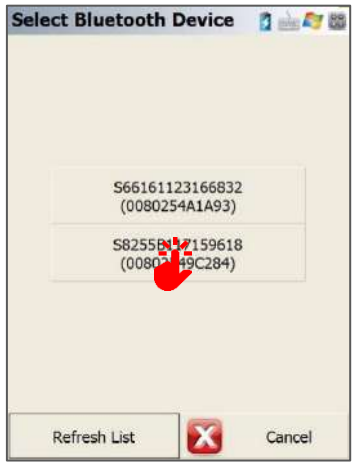


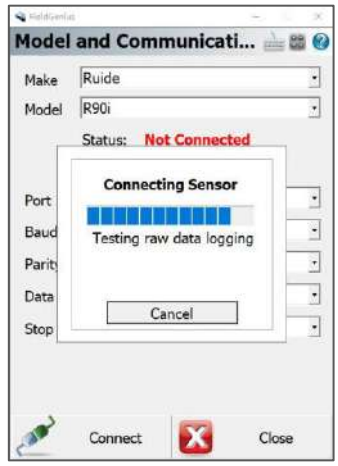




Press Search and choose select the correct serial number on the list.

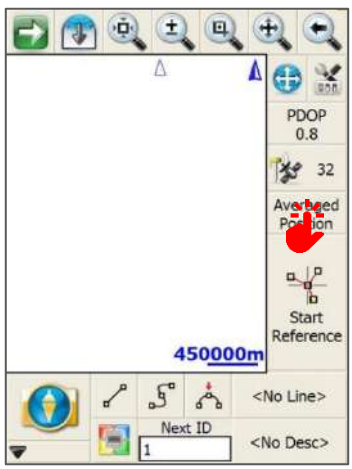
Press Connect.

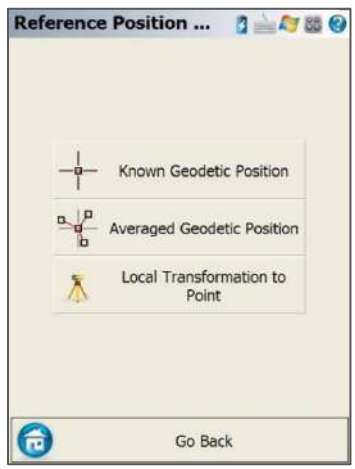




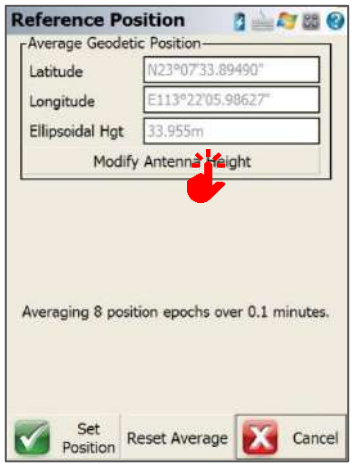
Step 3: Start Reference

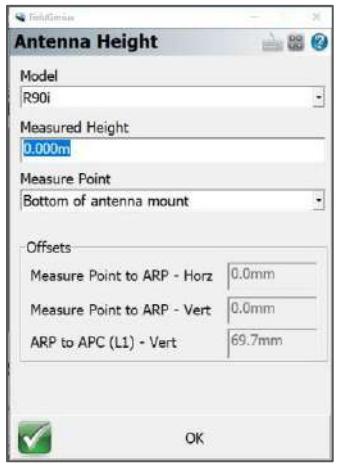
Click Averaged Position. Choose one way of getting reference position.





Click Start Reference after that. Enter to *Average Position* screen. Click Modify Antenna Height to input the height of antenna.



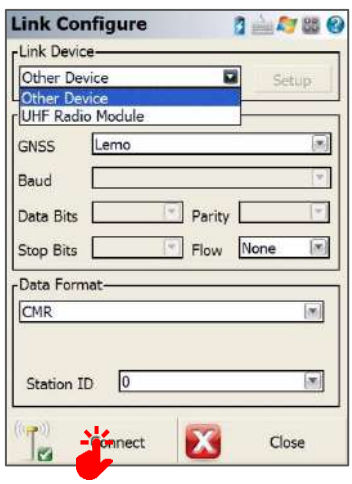


Click Set Position to finish the setting of reference position, and select whether to save the reference point to the point database according to your need. Then you will enter to the interface of *Link Configure*.

Step 4: Select data link.

<Using External radio>

Choose *Other Device* in *Link Device* and click Connect to start the base.



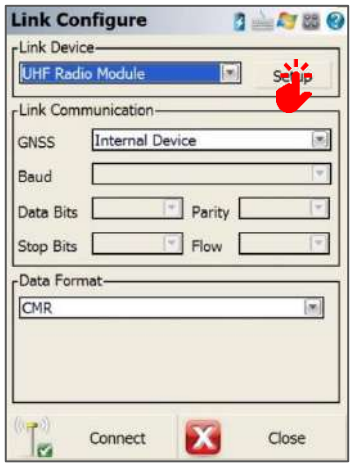
Make sure all connections are all right, then power on the radio by pressing . Press to define the channel. Keep in mind the channel number that is selected to match the settings in controller late.

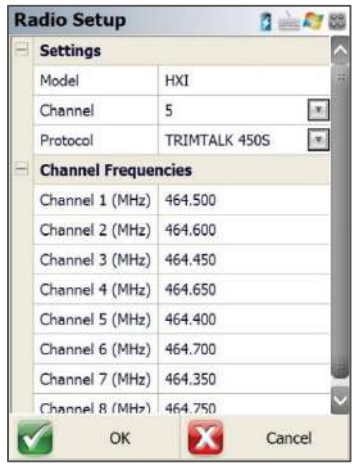
Note: Radio starts to transmit when TX light is flashing.

<Using Internal UHF radio>

Choose *UHF Radio Module* in *Link Device.*

Click Setup to set Channel and Protocol.
Click Connect to start the base.





4.2.2.3 Setting the Rover

Step 1 Rover Setup

Install the rover receiver and the bracket on pole, and fix the controller into the bracket.

Step 2

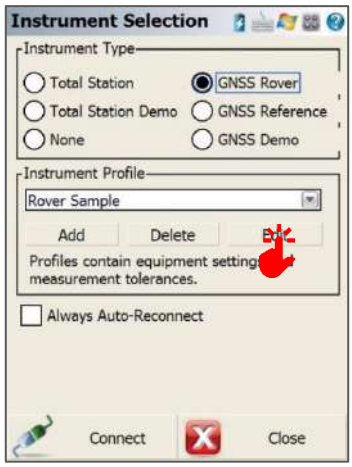
Install the UHF antenna *(e.g. QT450AS-1)* on the UHF interface under the rover. Power on the receiver.

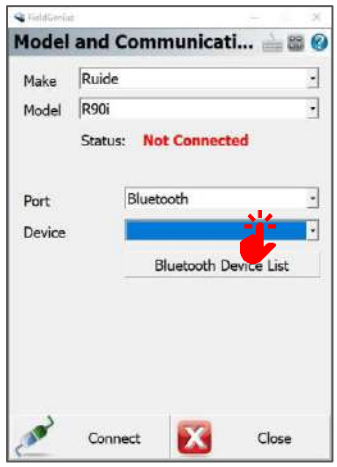
Step 3: Selecting working mode, model name and Bluetooth connection.

The procedure is similar to setting the Base, except the *Instrument Type*. Select *GNSS Rover* as *Instrument Type*.

From Edit, Select the correct brand and model.

Connect to the right serial number from the *Bluetooth Device List*.





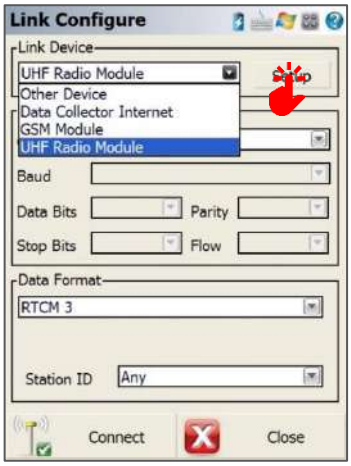
Step 4: Select the data link.

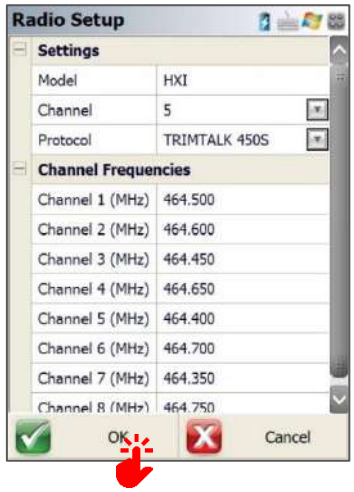
Select *UHF Radio Module* in the *Link Device*.

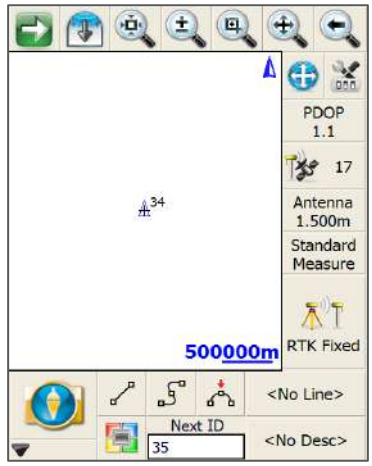
Click Setup to choose the Channel and Protocol same as the settings in Base (GNSS Reference).

Click OK to apply this channel setting in *Radio Setup* interface.

Finally, click Connect to go to the main interface.



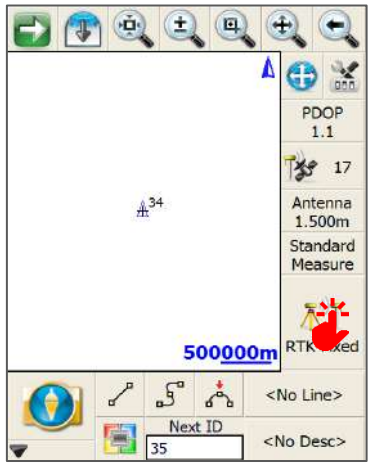




Step 5: Get fixed solution and start collecting.

After you get the status RTK Fixed, you can start to survey.

Collect any points by clicking RTK Fixed.



4.3 NETWORK MODE

4.3.1 Definition

The main difference between Base+Rover mode and Network mode is the network transmission of differential data. Therefore the erection is similar to the radio mode. As R93i

is without integrated GSM module, the data link should be set to Data collector internet.

4.3.2 Operation

4.3.2.1 Rover Setup

Step 1

Activate WiFi connection of the controller, making it online.

Step 2

Install the bracket onto the carbon fiber pole, and fix the controller onto the bracket, then power on the controller.

Step 3

Power on the receiver.

4.3.2.2 Setting the Rover

Step 1: Setting working mode and connect the Bluetooth.

Refer to chapter 4.2.2.3

Step 2: Select Data collector internet as data link.

Choose Data collector internet in Device Type.

Click Press to set up.

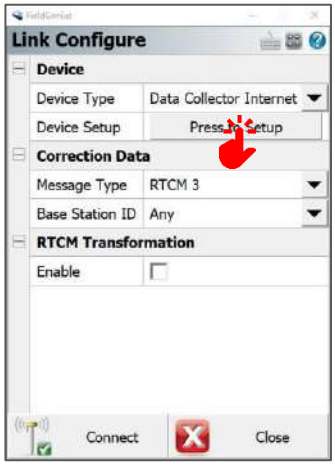
<Internet APN>: Check with your SIM card telecom provider.

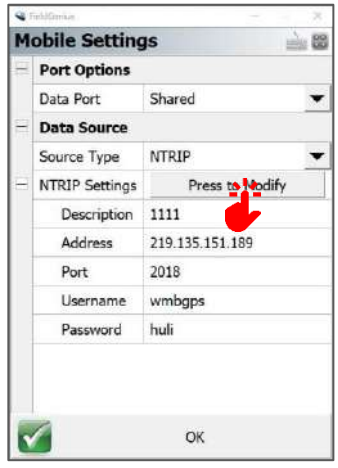
<Internet Username>: If necessary.

<Internet Password>: If necessary.

Press to Modify, Add to add a new CORS server information.

(Or select the existed CORS information to re-edit/use directly.)





Step 3: Add CORS information.

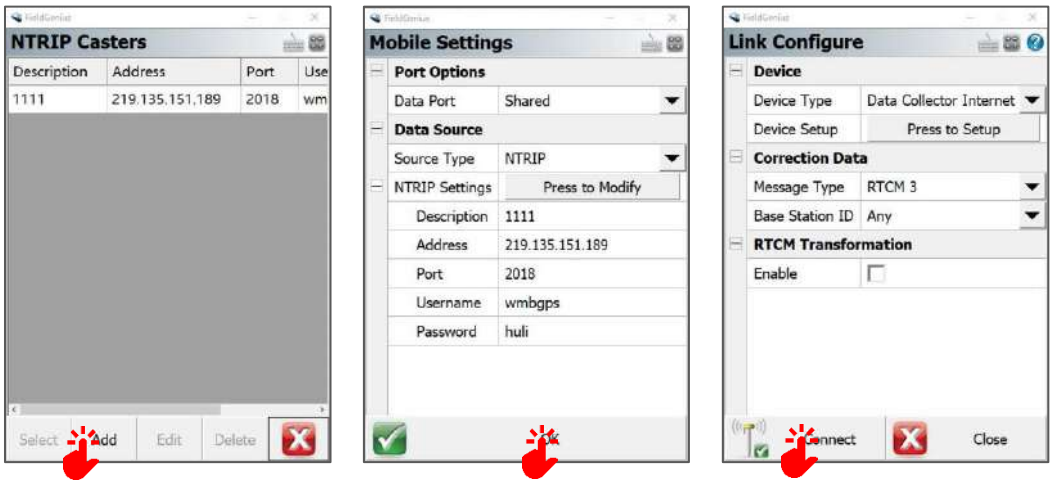
<Description >: Input a name for this CORS.

<Address>: Check with the CORS operator.

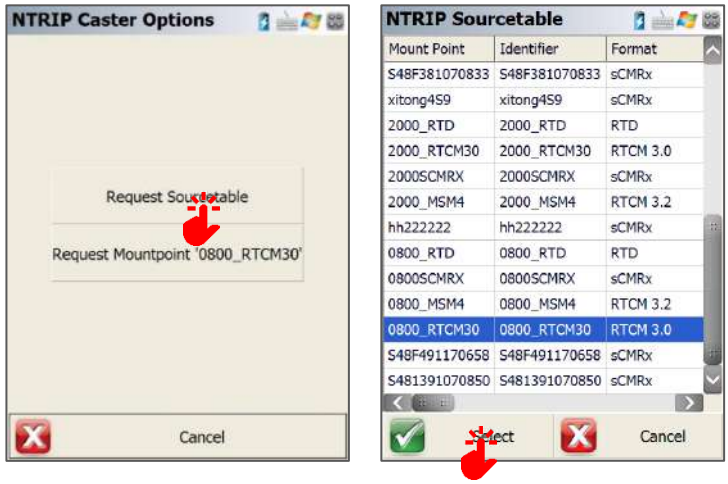
<Port>: Check with the CORS operator.

<Username>: Check with the CORS operator.
<Password>: Check with the CORS operator.

After adding new CORS information, return to *Link Configure* interface.
Click Connect again to start NTRIP connection.

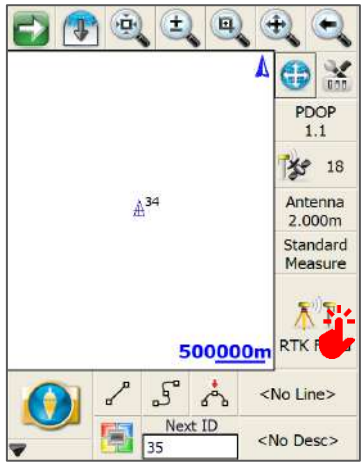


Step 4: Select mount point.
If the receiver has connected to a mount point before, reconnect directly this mount point which has been stored.
Or request the whole sourcetable if you connect this NTRIP broadcaster for the first time.
Click Request Sourcetable to select the available mount point from the NTRIP Sourcetable.
Click Select to confirm the mount point you choose.



Step 5: Get fixed solution.
The receiver will get a fixed status if it receives differential signals successfully from CORS station.

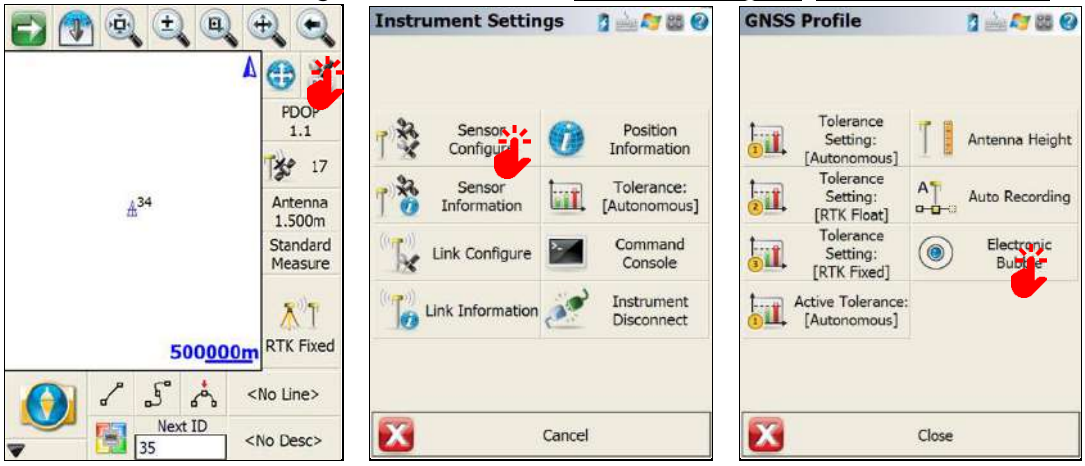
Click RTK Fixed to start to collect points.



4.4 E-BUBBLE

Step 1: Enter to Electronic Bubble.

After the receiver gets fixed, click , Sensor Configure, Electronic Bubble.



Step 2: Setting.

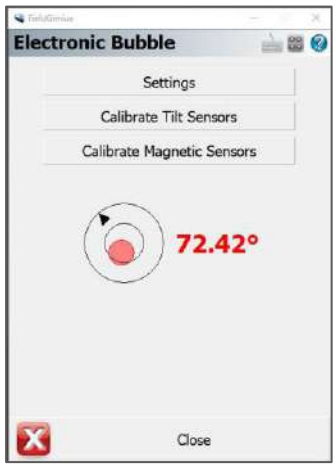
There are four options you can choose in *Setting* interface.

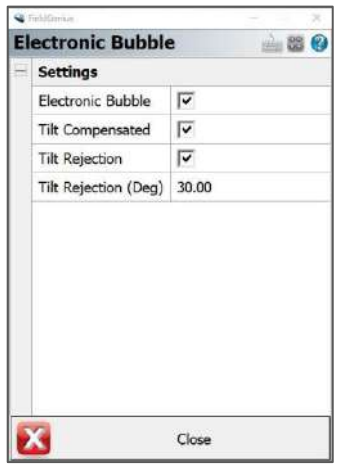
<Electronic Bubble>: to display the graphic of the electronic bubble on the screen of storing points.

<Tilt Compensated>: Eliminate error from pole inclination.

<Tilt Rejection>: Refuse storing a point if the tilt is over.

<Tilt Rejection (Deg)>: Set the maximum tolerance of tilt angle, usually less than 30°.



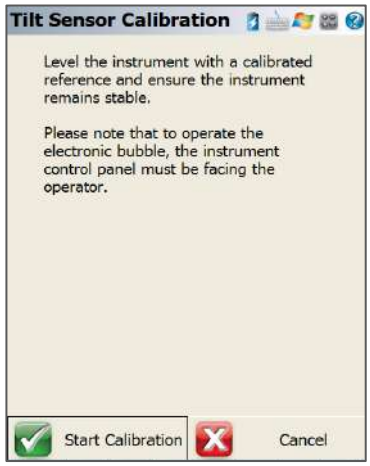


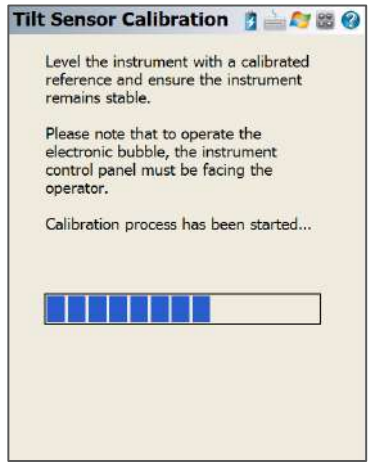
Step 3: Calibrate tilt sensor.

This process is to calibrate the internal tilt sensor, and reset the vertical angle to zero.

a. Click Calibrate Tilt Sensor to start.
b. Perfectly level the receiver with a calibrated reference such as a bipod or tripod.
c. Make sure the receiver is in a stable plumb position.
d. Click Start Calibration button to start the tilt sensor calibration.

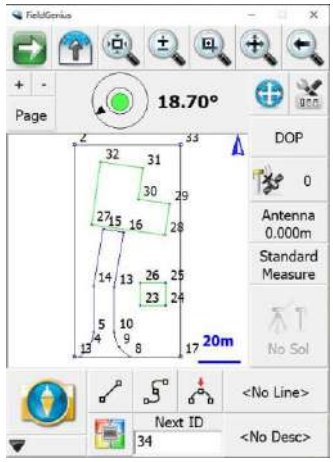
Note: the control panel of the receiver must be facing to the operator during calibration.





Step 4: Measuring with E-bubble.

Return to measuring interface, click page to see the E-bubble, which reflects the current leveling status of R8i.



4.5 Tilt Offset Measurement by FieldGenius

4.5.1 Definition

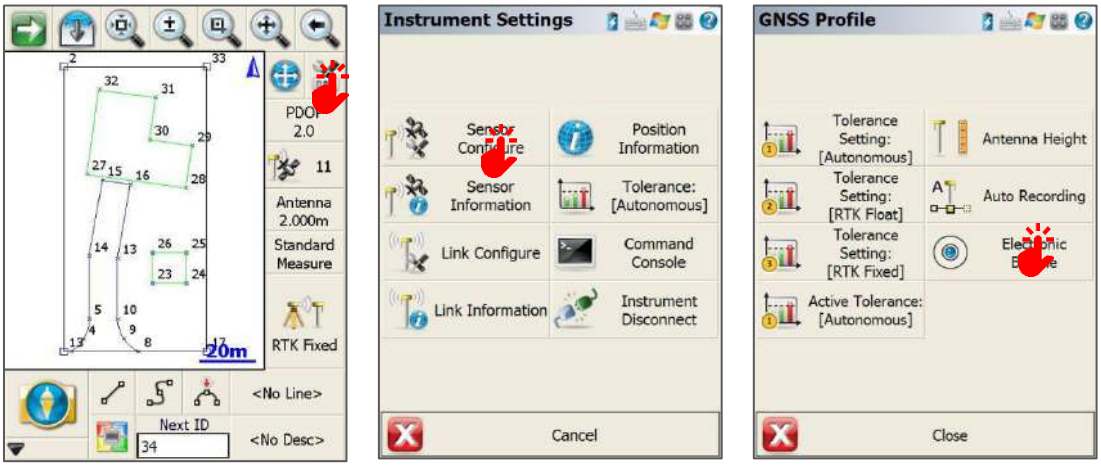
Microsurvey has launched a new function of Tilt Offset Measurement on FG9.0 version or above version.

Such function applies the Tilt Sensor to acquire the coordinate of the place which is difficult to survey without tilted pole measurement via the algorithm of trilateration. Before doing the measurement, we need to calibrate the tilt sensor of the receiver.

4.5.2 Operation

Step 1: Enter to Electronic Bubble.

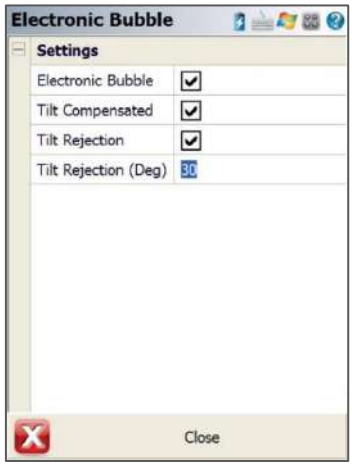
After the receiver gets Fixed solution, click , Sensor Configure, Electronic Bubble.



Step 2: Setting.

There are four options you can choose in *Setting* interface.

<Electronic Bubble>: to display the graphic of the electronic bubble on the screen of storing points.
<Tilt Compensated>: Eliminate error from pole inclination.
<Tilt Rejection>: Refuse storing a point if the tilt is over.
<Tilt Rejection (Deg)>: Set the maximum tolerance of tilt angle, usually less than 30°.

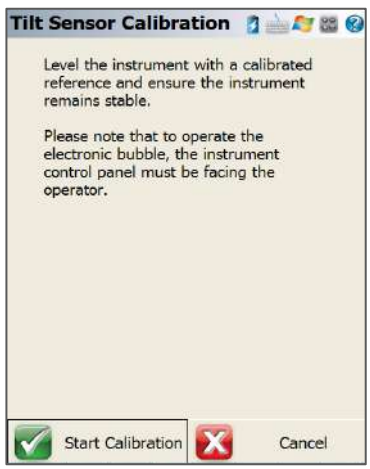


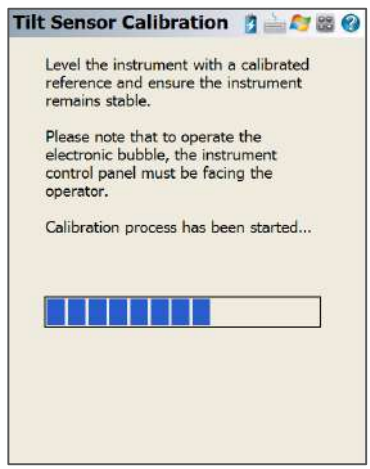
Step 3: Calibrate tilt sensor.

This process is to calibrate the internal tilt sensor, and reset the vertical angle to zero.

e. Click Calibrate Tilt Sensor to start.
f. Perfectly level the receiver with a calibrated reference such as a bipod or tripod.
g. Make sure the receiver is in a stable plumb position.
h. Click Start Calibration button to start the tilt sensor calibration.

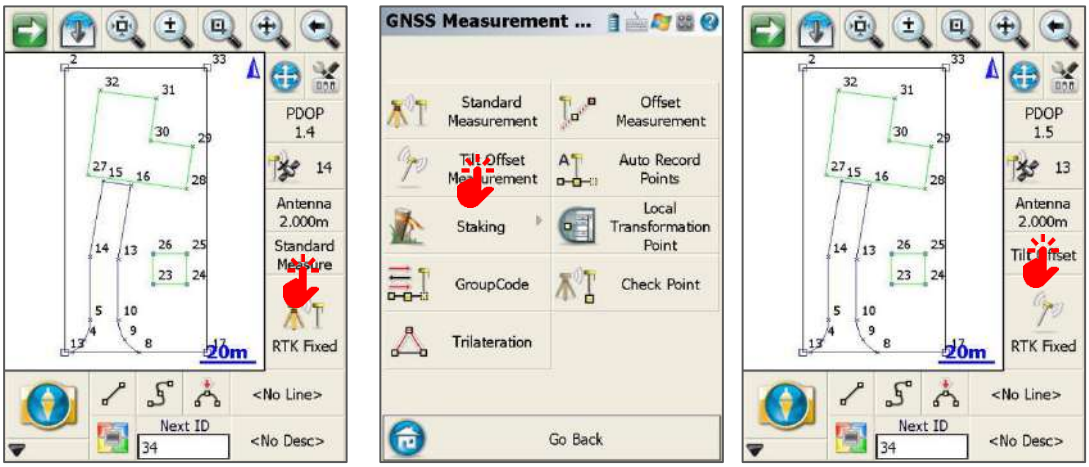
Note: the control panel of the receiver must be facing to the operator during calibration.





Step 4: Tilt Offset Measurement.

When you need to measure some corners by Tilt offset, click on Standard Measure, Tilt Offset Measurement to activate Tilt offset function.



There are two methods of Tilt Offset, two pole tilt intersection and three pole tilt intersection.

Two pole tilt intersection

Make sure the bottom of the pole is at the same point.

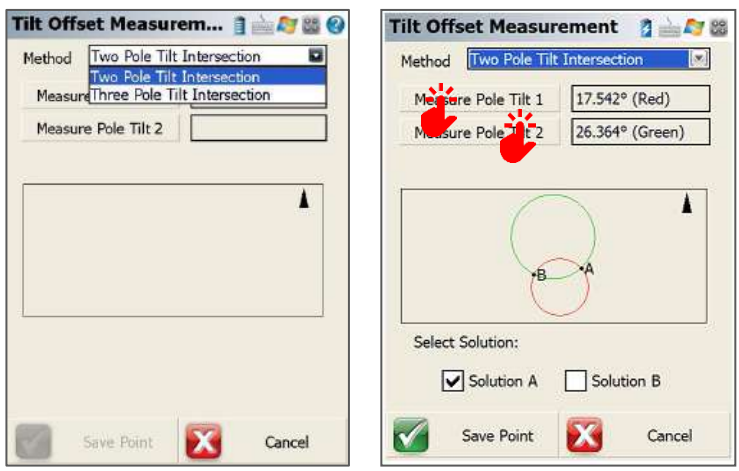
Measure Pole Tilt 1:

Tilt the pole in one direction and click this button to store the first tilt angle (Red Circle)

Measure Pole Tilt 2:

Tilt the pole in the other direction and click this button to store the second tilt angle (Green Circle)

There will be two intersecting points, choose Solution A or Solution B for the desired intersecting point, and click Save Point to Store it.



About the selection of A or B, we can draw an intersection draft according to the real tilt movement of the pole and decide which point is the real intersection point.

Three pole tilt intersection

Make sure the bottom of the pole is at the same point.

Measure Pole Tilt 1:

Tilt the pole in one direction and click this button to store the first tilt angle (Red Circle)

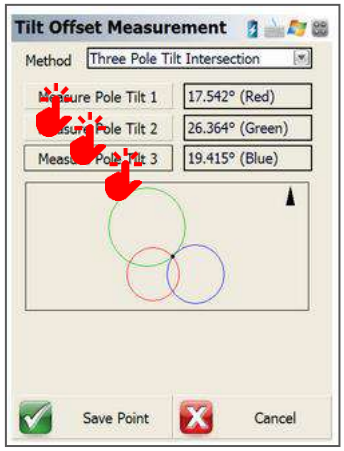
Measure Pole Tilt 2:

Tilt the pole in another direction and click this button to store the second tilt angle (Green Circle)

Measure Pole Tilt 3:

Tilt the pole in the last direction and click this bottom to store the third tilt angle (BlueCircle)

There will be only one intersecting point, click Save Point to Store it



In this case, three circles are intersected in one point, which is the point we need to survey.

4.6 MEASURING ANTENNA HEIGHT

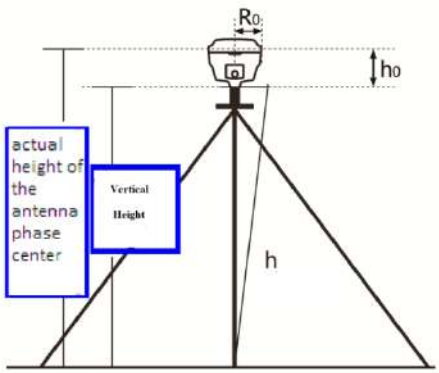
The antenna height is related to static operations and RTK operations.

Antenna height is actually the vertical height of the phase center to ground measurement point, measurement methods of antenna height in dynamic mode includes pole height, vertical height and slant height.

- Pole Height: the height of the centering pole, which can be read from the pole scale;
- Vertical Height: the vertical height from the ground to the bottom of the main mainframe + antenna phase center to the bottom of the mainframe.
- Slant Height: measure to the middle of the rubber ring. In the hand-held software, select the antenna height mode to the slant height, then input the value.

Antenna Height Measurement in Static Mode

Measures from the ground to the middle of the receiver rubber ring. Select the appropriate type of antenna in the post-processing software.



5. Advance Application

5.1 Radio Route

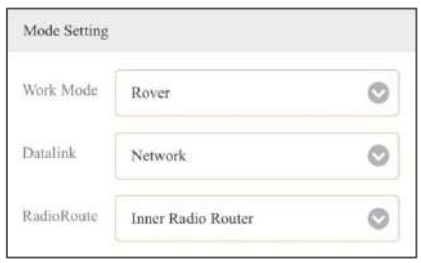
This function refers to transferring the correction from the reference station to other rovers by radio, the rovers can acquire the same reference coordinates. Such function is for the case of working in some places where there is poor signal from the reference station or there is only one SIM card for a few rovers.

Either internal radio or an external radio can be applied to transfer the correction.

Such function can only be activated when the receiver is in Rover mode.

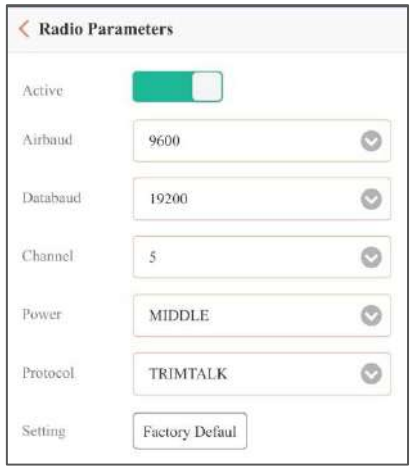
Steps:

1. Configuration-General Config, Choose “Inner Radio Route” and click “Enter” button to confirm the settings.



2. Go to “Radio Config” page, check the channel, communication protocol and the

frequency point of each channel.



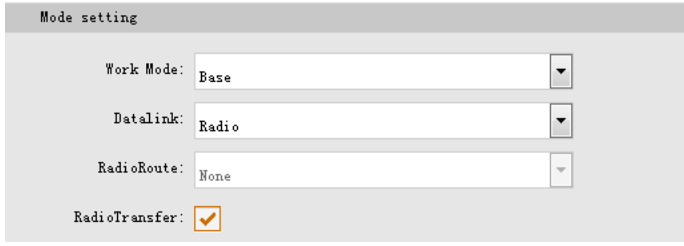
3. Configure the datalink of the other rovers into internal UHF mode, and make sure the channel, protocol and frequency point are same as “Route” rover.

5.2 Radio Transfer

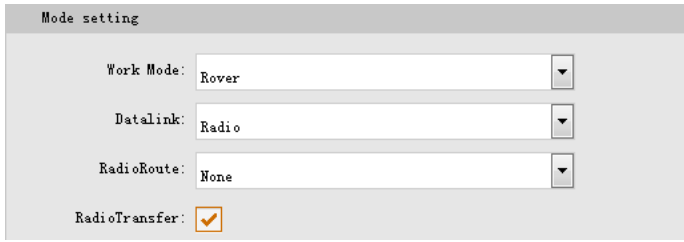
This is the function that R93i transfers the correction from Base station to the other rovers with the internal UHF, i.e. R93i can work as a radio repeater.

Steps:

1. Configuration-General Config, activate “RadioTransfer” for Base station.



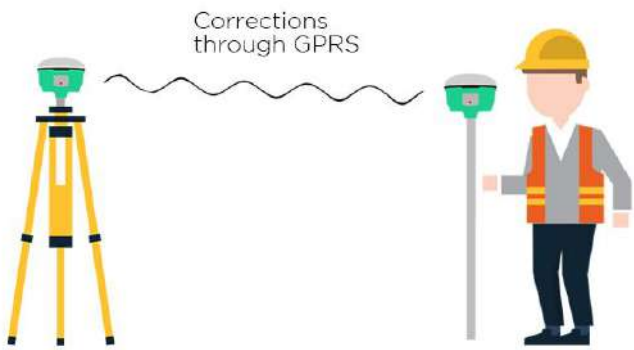
2. Activate the function for rover. Please make sure the rover is within the working range of the internal UHF of the base station.



3. Configure the datalink of the other rovers to internal UHF mode. Make sure the channel, protocol and frequency point are same as “Repeater” rover.

5.3 LARK Mode

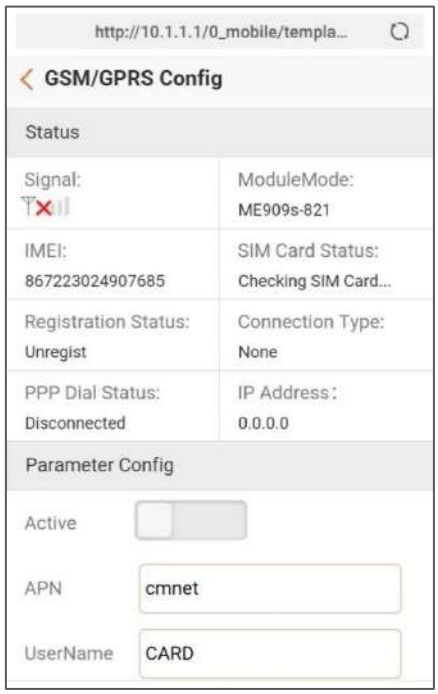
LARK Mode is a new technology, which is similar to GSM dial. By this mode, it no longer needs a CORS server, the corrections are transmitted by GPRS network. Besides, it is different from the feature of Caster.



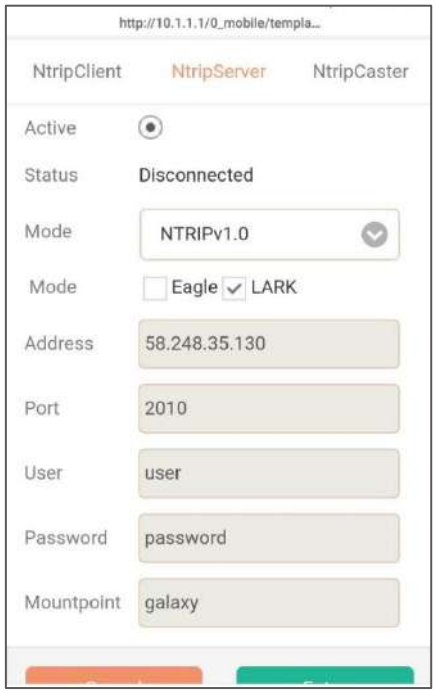
.

Steps:

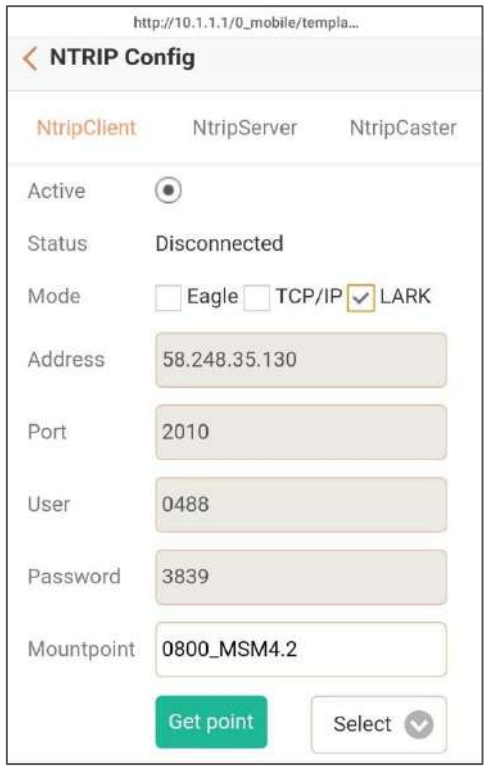
1. Insert SIM cards into both Base and Rover receiver.
2. Input the correct APN and the assigned username and password on Network Config page. Make sure both of them have been connected to internet.



3. Log in the WEB SERVER for base station. Data transfer-Ntrip Config-NtripServer. Check the box of LARK for Base. Then the following items will turn grey and cannot be edited.

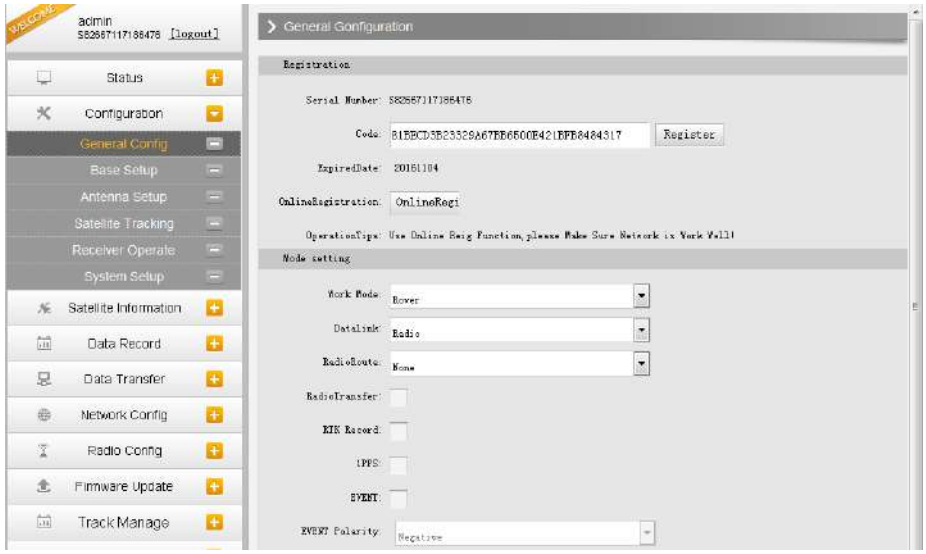


4. Log in the WEB SERVER for rover. Data transfer-Ntrip Config-NtripClient. Check the LARK Mode for rover. The key step is inputting the Serial Number of Base into Mountpoint field, then click “Enter” button to confirm all the settings.



6. Registration

Log in the WEB SERVER with WiFi or USB network connection.
Choose “Config—General Config”, the registration section is located at the top.



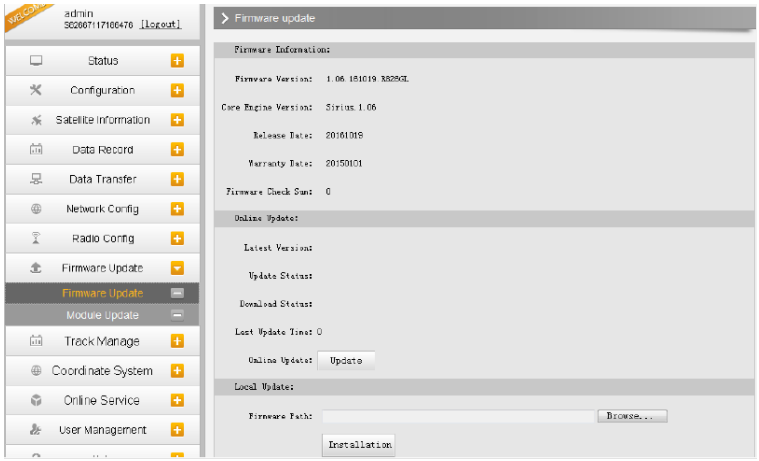
Input the registration code and click “Register” button, a pop-up window will show the status of the registration.

7. Firmware Update

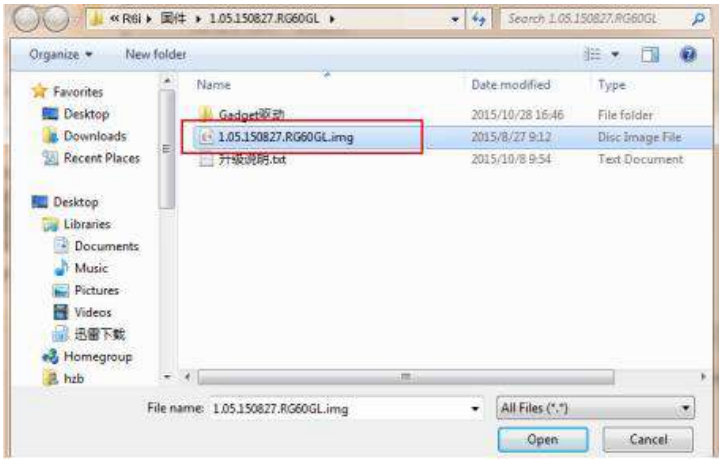
Note: The software of Instar does not support upgrading for R93i now.

Log in the WEB SERVER with WiFi or USB network connection on PC.

Choose “Firmware Update—Firmware Update”

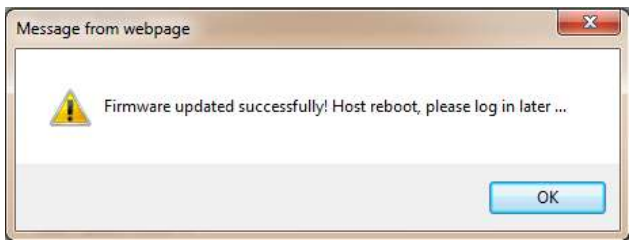


At the bottom page, Click on “Browse” button to load firmware file.



Click “Installation” button to start upgrading.

After the firmware upgrading is completed, the pop-up window will indicate “Firmware updated successfully! Host reboot, please log in later…”, then the receiver will restart automatically.



APPENDIX A: TECHNICAL SPECIFICATION

Performance No. of Channel		1598
Configuration		All constellation
Single Tracked	GPS	L1, L2, L5
	GLONASS	L1, L2
	BEIDOU	B1I, B1C, B2I, B2a
	SBAS	L1, L1C, L2C, L5
	Galileo	E1, E5a, E5b, AltBOC
		QZSS, WAAS, MSAS, EGNOS, GAGAN, SBAS
	Positioning rate	1-20Hz
Position Accuracy Code Differential	Horizontal	25cm+1ppm RMS
	Vertical	50cm+1ppm RMS
Real-time Kinematic	Horizontal	8.0mm+1.0ppm RMS
	Vertical	15.0mm+1.0ppm RMS
Static & Fast Static	Horizontal	2.5mm+0.5ppm RMS
	Vertical	5.0mm+0.5ppm RMS
Network RTK	Horizontal	8.0mm+0.5ppm RMS
	Vertical	15.0mm+0.5ppm RMS
L-Band	Horizontal	2.5cm(RMS)
	Vertical	5cm(RMS)
Communication	I/O	Radio data link antenna port
		Type C
		5-pin LEMO external radio power port +RS232
Wireless Modem		Integrated internal radio receiver & transmitter
	Frequency	410-470MHz
	Protocol	TrimTalk450s, TrimMark3, PCC EOT, SOUTH
	Output Power	2W
Double Module Bluetooth		BLEBluetooth 4.0 standard, supports connection with Android & iOS
		Bluetooth 2.1 + EDR standard
WiFi		802.11b/g
NFC		Close range (<10cm) automatic pair between R93i & controller (equipped with NFC wireless module)
Data Storage/Transmission		4GB SSD internal memory external USB pen drive
Data Format	Differential	CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM

		3.1, RTCM 3.2
	GPS Output	NMEA 0183, PJK plane coordinates, binary code, Trimble GSOF
	Network Model	VRS, FKP, MAC, fully support NTRIP protocol
Internal Sensor	Tilt Survey	IMU optional
	E-Bubble	Controller software displays electronic bubble, checking leveling status of the centering rod real time.
User interaction	Operating system	Linux
	Button	One
	WEB SERVER	Online management platform for monitoring and configuring
	Voice guide	Status and operation voice guide, multi-language
Physical	Dimension	135mmX135mmX85mm
	Weight	970g (including battery)
	Material	Magnesium aluminum alloy shell
Environmental	Operating Temp.	-45°C to 60°C
	Storage Temp.	-55°C to 85°C
	Humidity	Non-condensing
	Water Proof	IP68 standard, protecting from long time immersion of depth of 1m
	Dust Proof	IP68 standard, fully protecting against blowing dust
	Shock	OFF status: Withstands 2m pole drop onto cement ground naturally.
	Vibration	ON status: Withstands 40G 10 milliseconds sawtooth wave impact.
Electrical	Power Consumption	2W
	Battery	Internal Lithium-ion battery, 6800mAh 3.7V
	Additional Battery	PowerCase
	Battery Life	7h (static mode) 5h (internal UHF base mode) 6h (rover mode)

APPENDIX B: TECHNICAL TERMS

Ambiguity: unknown quantity is the integer number of cycles of the carrier phase measured from the satellite to the receiver.

Baseline: The connection line of the two measurement points, on which to receive GPS signals and collect observation data simultaneously.

Broadcast ephemeris: message released by the satellite demodulator satellite orbit parameters.

SNR (Signal-to-noise ratio): an endpoint signal power to noise power ratio.

Cycle skipping: interfere loop skips a few cycles from a balanced point, and stabilize in the new equilibrium point, this make the phase integer number of cycles to generate an error.

Carrier: As the carrier, Frequency, amplitude or phase modulation of the modulated wave by a known reference value.

C / A code: GPS coarse / acquisition code, modulate the pseudo-random binary code for the 1023 bit duplex, the bit rate of which is 023MHz, and code repetition period of 1ms.

Difference measurement: GPS measurements employ cross-satellite cross-receiver and cross-epoch.

Difference Positioning: the method of determining the relative coordinates between two or more receiver by tracking the same GPS signal.

Geometric dilution of precision: Describe the contribution of satellite geometry errors factor in dynamic positioning.

Eccentricity: $e = \sqrt{\frac{a^2-b^2}{b^2}}$ where a, b of the semi-major axis and semi-minor axis.

Ellipsoid: mathematical graphics formed when an ellipse moves around the minor axis of rotation in Geodetic Survey.

Ephemeris: the position of celestial bodies over time parameters.

Flattening: $f = \frac{1}{a}(a-b) = 1 - \sqrt{(1-e^2)}$

a is the semi-major axis, b is the semi-minor axis, e is the eccentricity.

Geoid: similar to the mean sea level and extends to the mainland special planes. Geoid everywhere perpendicular to the direction of gravity.

Ionosphere delay: delay of radio waves through the ionosphere (non-uniform dispersion medium)

L-band: The radio frequency range of 390-1550MHz.

Multipath error: the positioning error caused by the interference between two or more radio signal propagation path.

Observing session: the use of two or more receivers at the same time to collect GPS data period.

Pseudo Range: GPS receiver in the time required to copy the code aligned with the received GPS code offset and multiplied by the speed of light to calculate the distance. This time offset is the difference between the signal reception time (time series of the receiver) and the signal emission time (satellite time series).

Receiver channel: GPS receiver RF mixer and IF channel, can receive and track satellites two carrier signals.

Satellite configuration: the configuration status of the satellite with respect to a specific user or a group of users within a specific time.

Static position: do not consider the point of measurement of the movement of the receiver.

FCC STATEMENT

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

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

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Use the GNSS RECEIVER in the environment with the temperature between -45°C and 60°C.

CAUTION: RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.

The device complies with RF specifications when the device used at 0cm from the user's body

CE0700