
SATLAB
GEOSOLUTIONS

# Manual Revision

SATLAB GEOSOLUTIONS AB

| Revision Date | Revision Level | Description |
|---|---|---|
| Jan, 2019 | 1 | Satsurv User Manual B1 Version |

# Satsurv

## Introduction

Welcome to the Satlab Satsurv. This introduction describes how to use this product.

## Experience Requirement

In order to help you use Satlab series' products better, we suggest you carefully read the instructions. If you are unfamiliar with the products, please refer to http://www.Satlab.com.cn/

## Tips for Safe Uses

**Notice**: The contents here are special operations and need your special attention. Please read them carefully.

**Warning**: The contents here are very important. Wrong operation may damage the machine, lose data, break the system and endanger your safety.

## Exclusions

Before using the product, please read these operating instructions carefully: they will help you to use it better. Satlab Surveying Instrument Co., Ltd assumes no responsibility if you fail to operate the product according to the instructions, or operate it wrongly due to misunderstanding the instructions.

Satlab is committed to constantly perfecting product functions and performance, improving service quality and we reserve the right to change these operating instructions without notice.

We have checked the contents of the instructions the software and hardware, without eliminating the possibility of error. The pictures in the operating instructions are for reference only. In case of non-conformity with products, the products shall prevail.

## Technology and Service

If you have any technical issues, please call Satlab's technology department for help.

## Relevant Information

You can obtain this introduction by:

1. Purchasing Satlab products: you will find this manual in the instrument container to guide you on operating the instrument.
2. Logging onto the Satlab official website, downloading the electronic version introduction at "Download center" "Partners" "Partner center".

## Advice

If you have any comments and suggestions for this product, please email info@Satlab.com.se. Your feedback will help us to improve the product and service.

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**Device**

# Chapter 1

## Software Introduction

**This chapter contains:**

-Introduction
-Features
-Installation
-Quick Start
-General Collection

# 1.1 Introduction

Satsurv is measurement software with a high degree of accuracy on the Android system of Satlab.
Satsurv should be run on Android 2.3.3 or above, it can be run on a Satlab professional measure controller, a general phone, pad and other Android devices. Just copy the Satsurv APK to the Android device and install it or do it by third party assistance software.

## 1.1.1 Satsurv

Satsurv is designed for road measuring and staking with strong functions; it can be used for staking complex roads, combining road lines, and has three road algorithms (intersection, element, coordinate): cross sections can be defined easily. The linear element method adopts the unified curve element model with rigorous theory, and the numerical integration algorithm is used to avoid the higher order errors of traditional algorithms. Generally, the computing result can support all kinds of roads, common line and multi-type complex lines and connect receivers to measure online via Wi-Fi, Bluetooth and networks.

## 1.1.2 Road Function

- Support for horizontal-section, vertical-section, cross-section, road-staking, slope-staking and visual cross-section collection.
- Calculate line-staking point in real time, support for adding stake over any mileage, mileage-projecting in real time, and displaying the mileage of staking points.
- Direct and convenient guidance method of staking, with line-staking and mid-level measurements working at the same time.
- The horizontal section line supports the common method (intersection, element, coordinate) and can freely define the line of any form. For example: interchange ramp.
- The cross-section earthwork provides two methods: Mean Area method and Prism method to calculate the amount of excavation.
- Supports multiple cross-section grade-change point-setting, the left and right slope can be edited into asymmetric type; it can also edit over-elevation and widening of a slope.
- Supports DTM surface design, DTM surface-staking and DTM earthwork calculation.

# 1.2 Features

## 1.2.1. Easy to Use

-Text and Graphic measuring interface in Detail Survey can be chosen by user;

-Simple design to give a big mapping screen;

-Station option can be one-key set by configuration file;

-Defined coordinate system selected by region, convenient to set coordinate parameters;

-Supports many kinds of angle units, meets the operating habits and demands of business customers: good for globalization.

### 1.2.2. Supports Operating Big Data

-Supports big raster, vector data in .dxf, .td2, .shp format (geodetic coordinate and plan coordinate);

-Raw data and coordinate data saved independently to make sure the data primitiveness and realize post-processing kinematic, it is more flexible in data storing and processing, and the antenna type and height of raw data can be changed, to make sure the data can be recovered (by resetting the coordinate parameters, antenna type and height);

-More complete antenna parameters management.

### 1.2.3. Fashionable

-The software and receiver firmware check the updates online automatically;

- Satlab and profession news are real-time pushed;

-Beautiful and fashionable interface;

-Wonderful and rich visual and touch experience, help make users enjoy working.

## 1.3 Installation

### 1.3.1 Installation

Copy the Satsurv program (.apk) to an Android device, click it to start installing, a Satsurv icon will appear on the desktop if installation is successful. The software can be installed by third party assistance software.

*Figure 1-3-1 Satsurv*

### 1.3.2 Starting Interface

On first running, it will show the welcome pages listing the software features, slide them to the starting interface. The welcome pages will not be displayed after the first starting (view it in the About interface).

There are 4 pages on the main interface: Project, Device, Survey, COGO. (slide or press the Tab button to change the page)


*Figure 1-3-2 Welcome Page (1)*

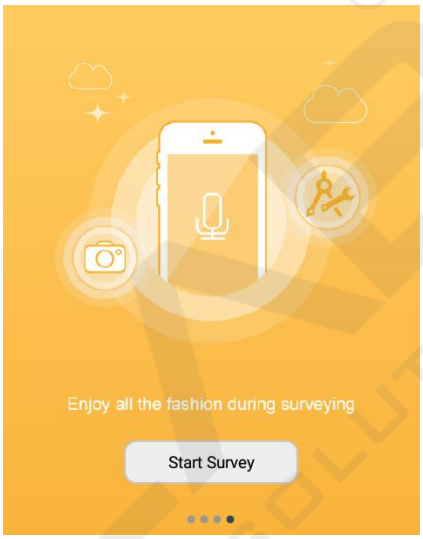



*Figure 1-3-3 Welcome Page (2)*

There are 3 main interface themes: List, GridView and Simple: the default setting is GridView.

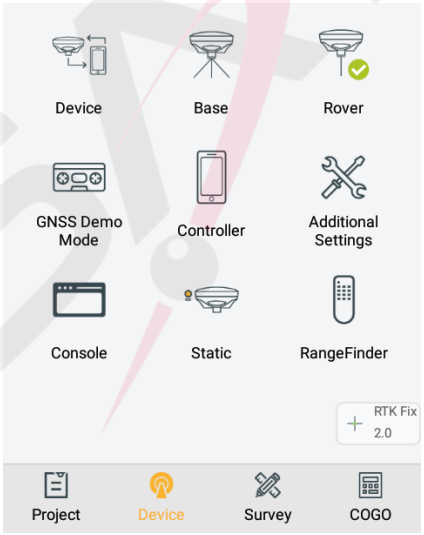



*Figure 1-3-4 Device-GridView*

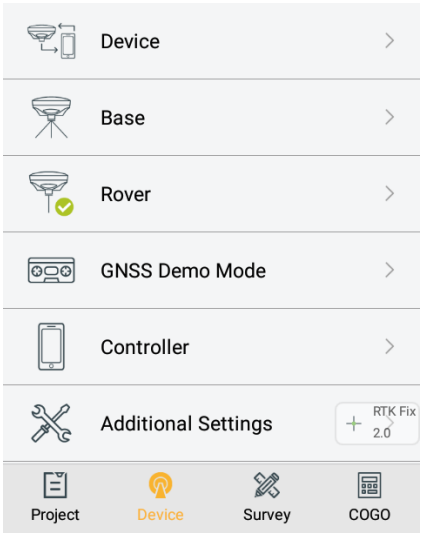



*Figure 1-3-5 Device-List*

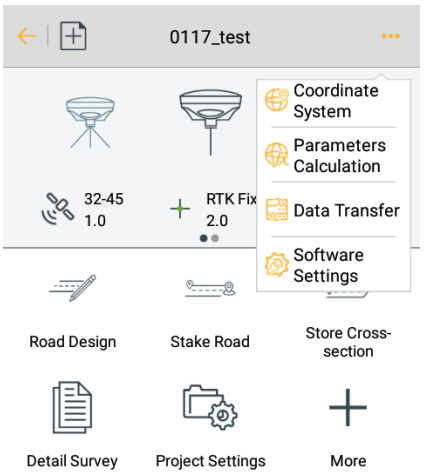



*Figure 1-3-6 Device-Simple*

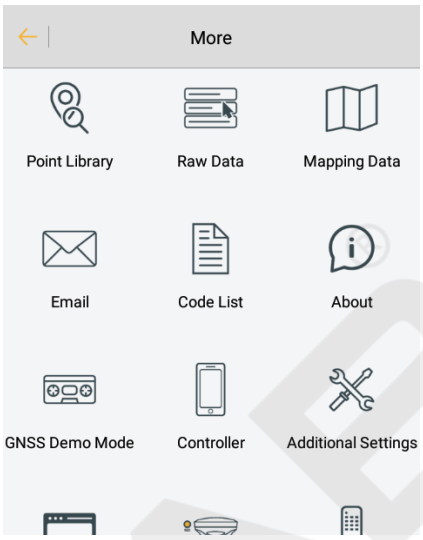



*Figure 1-3-7 Device-More*

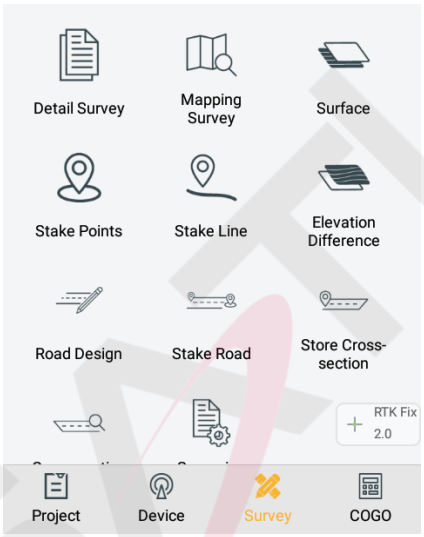



*Figure 1-3-8 Survey-GridView*

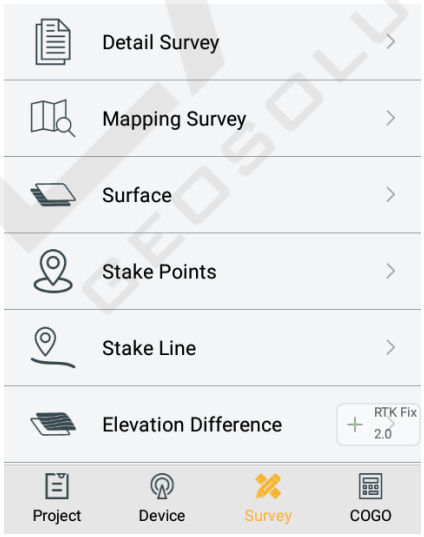



*Figure 1-3-9 Survey-List*

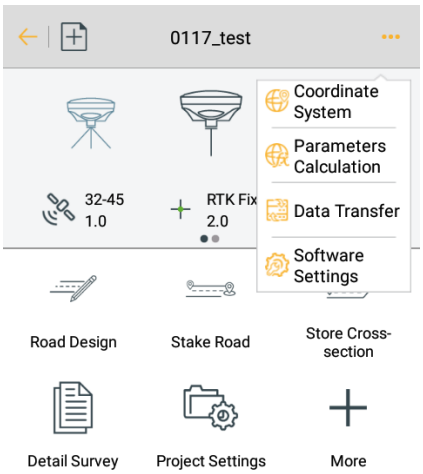



*Figure 1-3-10 Survey-Simple*

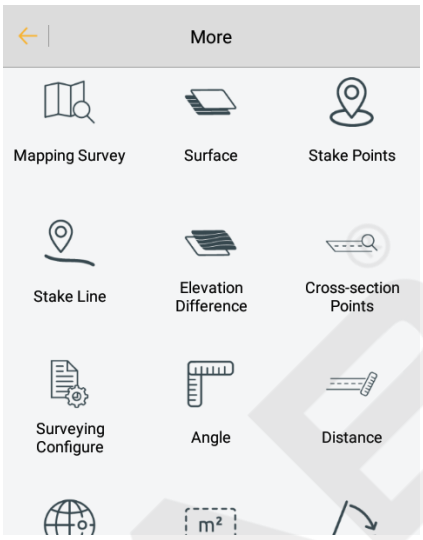
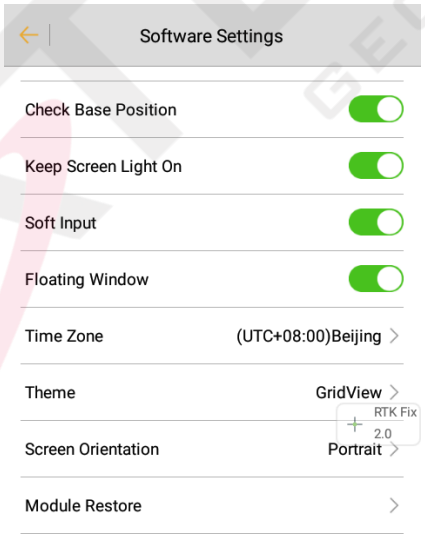



*Figure 1-3-11 Survey-More*

The module can be added and deleted in simple theme, and can be deleted and recovered in gridview and list theme. Long press the module to delete, the module can be recovered in Project→Configure→Module Recovery.


*Figure 1-3-12 Delete*




*1-3-13 Module Restore*

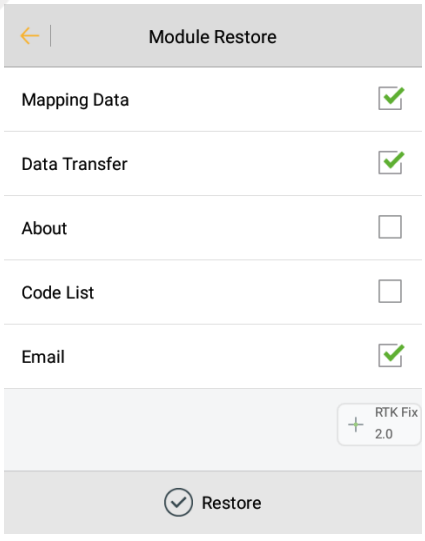



*Figure 1-3-14 Select*

Satsurv working on the folder SATLAB, and the project is saved in folder SATLAB/Project/Road.


*Figure 1-3-15 Project*

When doing measurements, first create a new project, set the parameters - they are saved in the *.prj file; meanwhile, there will be a *.dam file with the same name of the project; the coordinate points, stake points, control points will be saved in the map folder. Afterward, create a new project (project name is Unnamed), as in the picture follow.

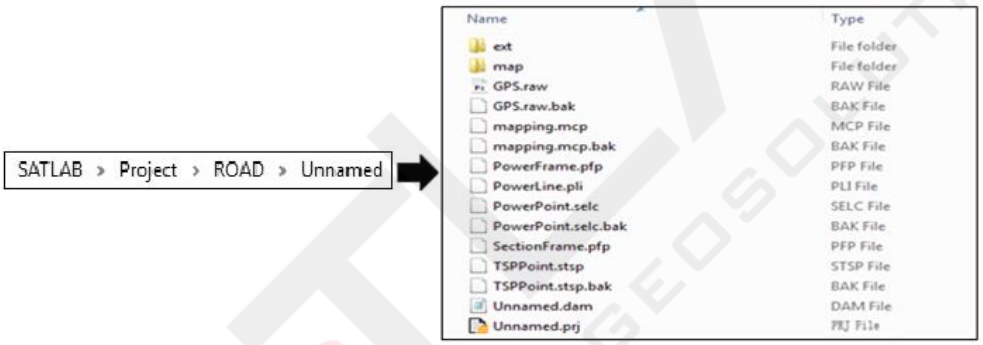



*Figure 1-3-16 Road Work File*

**Notice**:

1. If you create a new project when the hand-held does not have an external SD card, the project folder will automatically generate a * .bak backup file.
2. When the handbook has the external SD card, the backup data will be saved in the SATLAB-Bak folder. The specific project data is stored in the corresponding project folder, as in the picture follow.

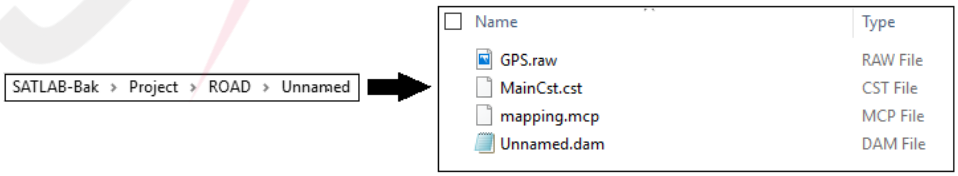



*Figure 1-3-17 Road Backup*

# 1.4 Quick Start

The following is the software quick start-operation process- refer to the detailed description of each chapter for the steps. This process is only a solution that we provide to users; skilled users do not need to follow this step.

## 1.4.1 Build a Project

1. Open the Satsurv software, the software main interface is as follows:

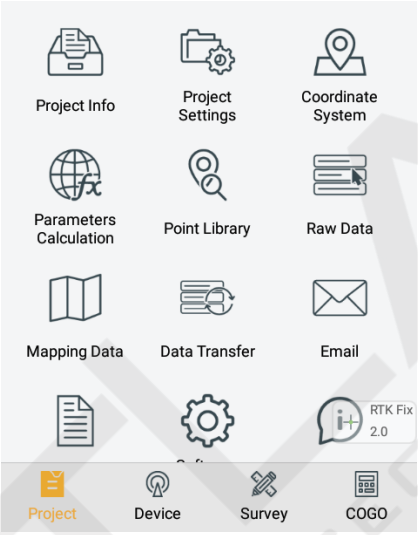
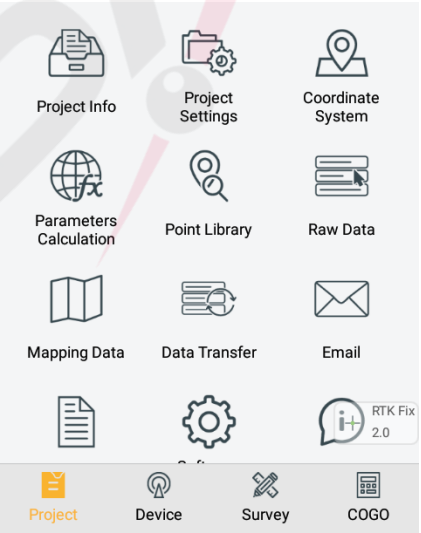



*Figure 1-4-1 Main Interface*

2. Create a new project, click Project→Project Info to enter the project name and click OK.



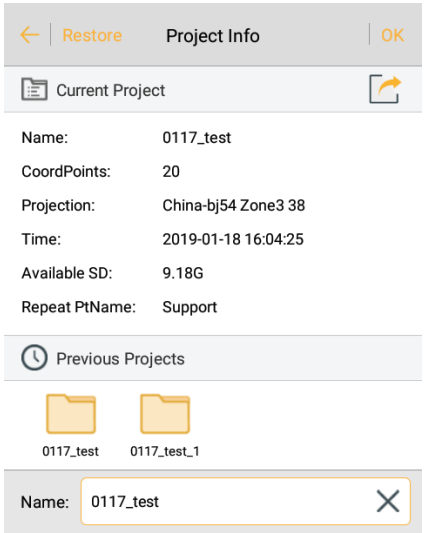
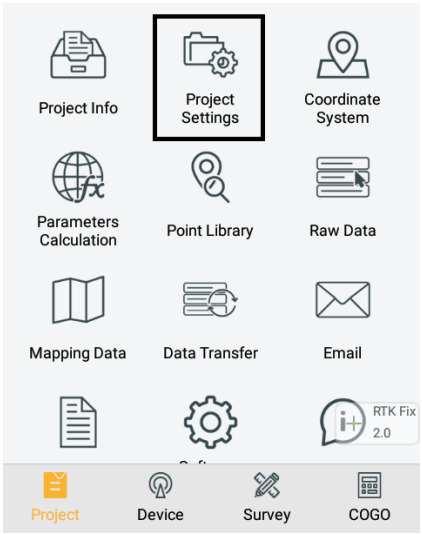



*Figure 1-4-2 Project Info*

*Figure 1-4-3 New Project*

3. Project Settings: select the projection, set the source ellipsoid and projection parameters.



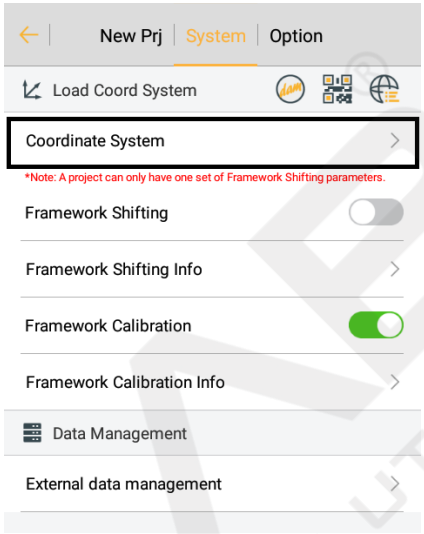
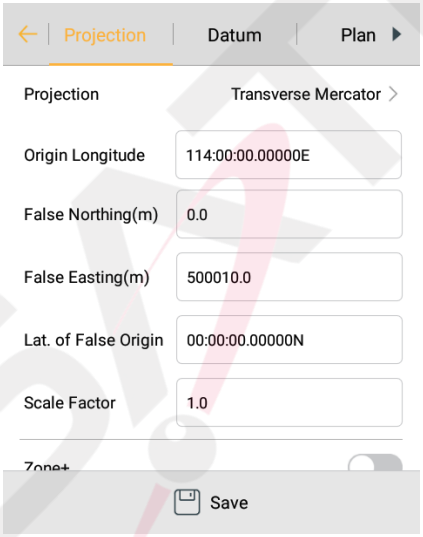




*Figure 1-4-4 Project Settings*

*Figure 1-4-5 Coordinate System*



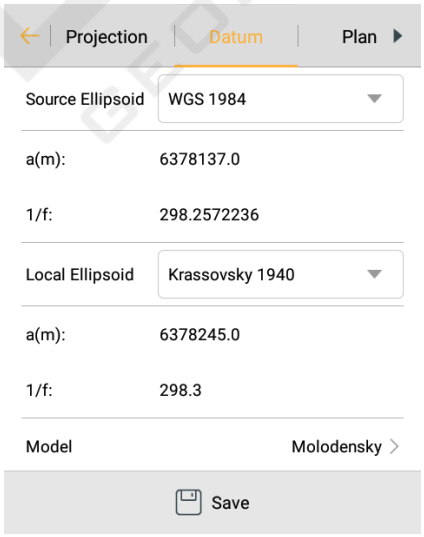




*Figure 1-4-6 Projection*

*Figure 1-4-7 Datum*

## 1.4.2 Set the Base

Connect the device, click Device→Device Connection→Connect to select the base station number for Bluetooth pair connection.

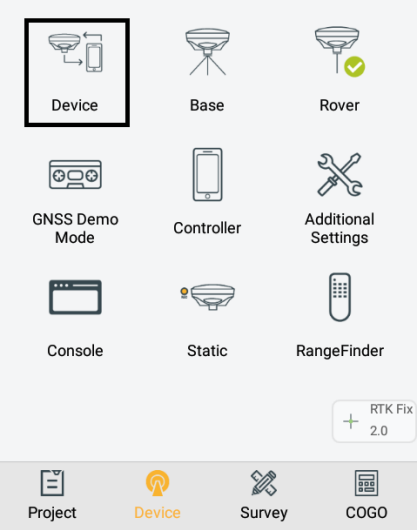



*Figure 1-4-8 Device*

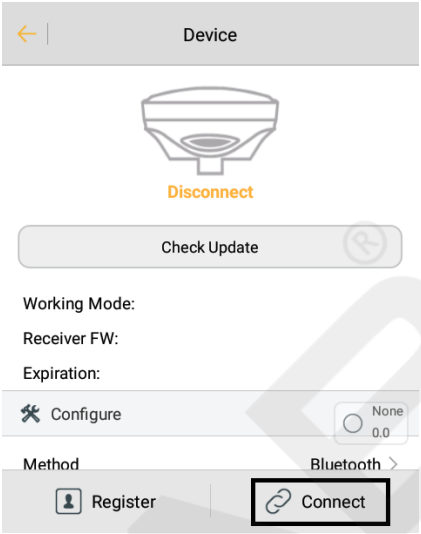



*Figure 1-4-9 Connect*

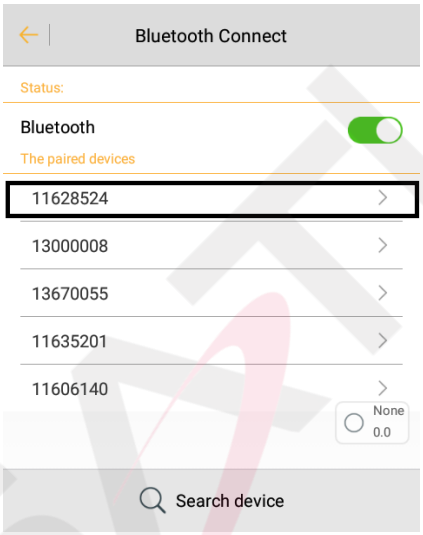



*Figure 1-4-10 Device Number*

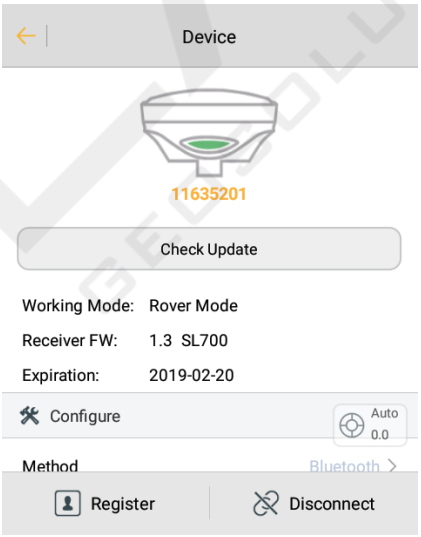



*Figure 1-4-11 Disconnect*

Set the base station and receiver position, then set the Datalink and Other.

1. Select antenna type to enter the height and type.

2. Set the base location. If the base station is located at a known point and know the conversion parameters, you may not select the smooth, direct input or select the point of the WGS-84 BLH coordinates from point library, or open the conversion parameters in advance, enter the local

NEZ coordinates, so that the base station puts the point of the WGS-84 BLH coordinates as a reference and does the transmission of differential data. If the base station is set as unknown, click Average , and click OK after smoothing to complete the coordinates of the base station.

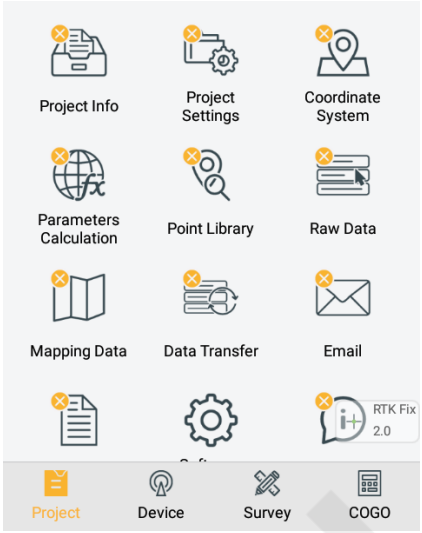



*Figure 1-4-12 Set Base*

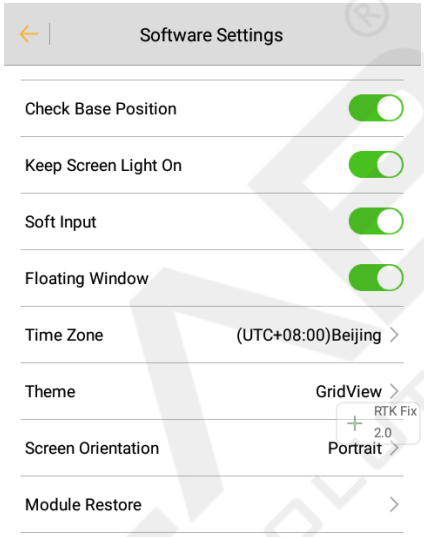



*Figure 1-4-13 Average*

3. Click Data Link, select the data link type and enter the relevant parameters.

(eg: when you use the Satlab server data to transfer operation, you need to set the parameters and select the built-in network; where the packet number and group number can be changed, the packet number is seven digits, the group number is three digits less than 255. When you use the radio station to work, you should select the Internal UHF as the data link, and then select the radio channel).

Radio mode is the traditional data link mode, and the built-in radio mode is taken as an example, to illustrate the introduction of radio station mode using simple steps.

- Internal UHF: built-in radio

- Channel: 0 ~ 115 any number, but the mobile station settings should be consistent with the base station.

- Airborne baud rate: 9600/19200 optional, the choice of mobile stations should be consistent with the base station

- Power: High / Middle/ Low

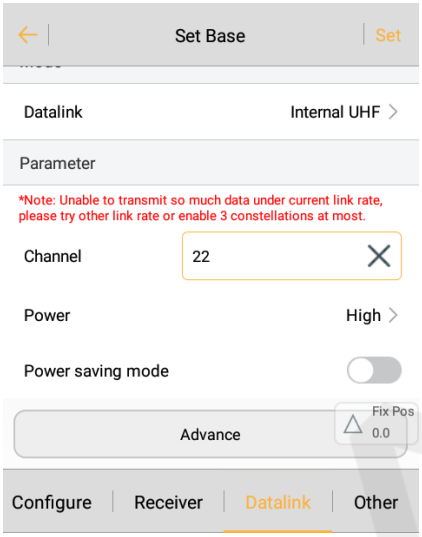



*Figure 1-4-14 Data Link*

4. Click Other, select the differential mode, the text format, click Set and it will promptly set up successfully. The parameters of the base station must be consistent with the rover station settings.


*Figure 1-4-15 Other*

5. Check whether the host differential light is flashing once every second (2/sec in power-saving mode). When using the external radio station, the radio will flash once every second, if it is normal, it will prompt Base station is ready, do you want to set Rover now?

After the parameter is set, click Set and the host will have a voice prompt, the host light will flash twice every second, indicating that the base station is set up successfully and sending the differential data.

Wait until the green light flashes once every second (2/sec in power-saving mode) and the radio red light flashes once every second, indicating that the base station is successfully operating, and is transmitting the signal. If the signal does not blink, you can restart the receiver host and re-operate once again.

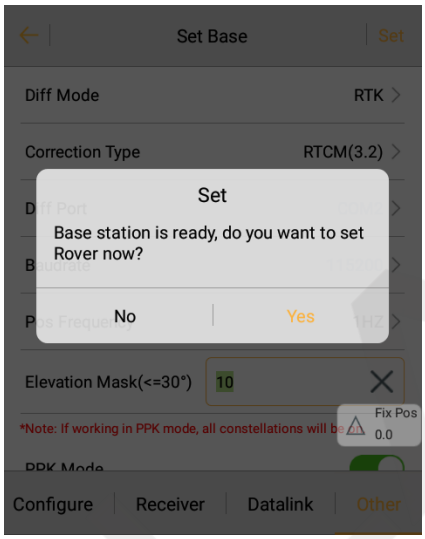



*Figure 1-4-16 Set Prompt*

### 1.4.3 Set the Rover

Connect to the rover by Bluetooth, and confirm that the rover data link and other parameters are consistent with the base station. The setting of the rover station is the same as that of the base station. The data link parameters of the rover station must be the same as the base station, to receive differential data. Then click Set and the host will do a voice prompt. Wait until it shows Fix Pos, and then start the measurement.

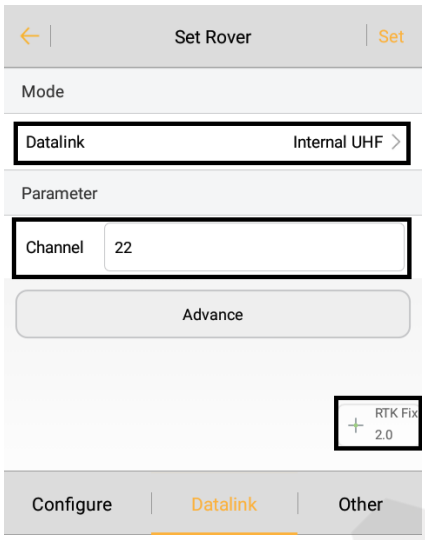



*Figure 1-4-17 Set Rover*

## 1.4.4 Parameter Calculation

First set the control point library in Point Library→Control Point to add control points, enter the name and the corresponding coordinates by manual input, real-time collecting, point library or map selection, and then click OK.

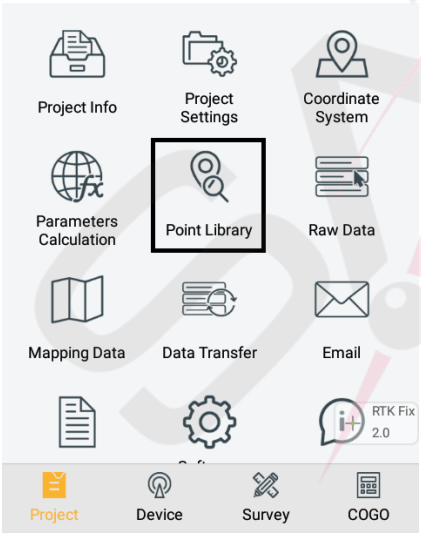



*Figure 1-4-18 Point Library*

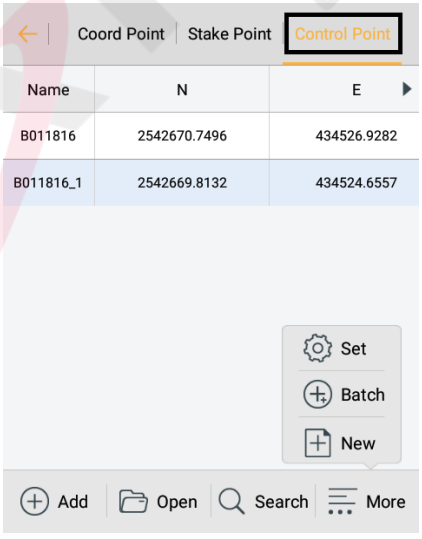



*Figure 1-4-19 Control Point*

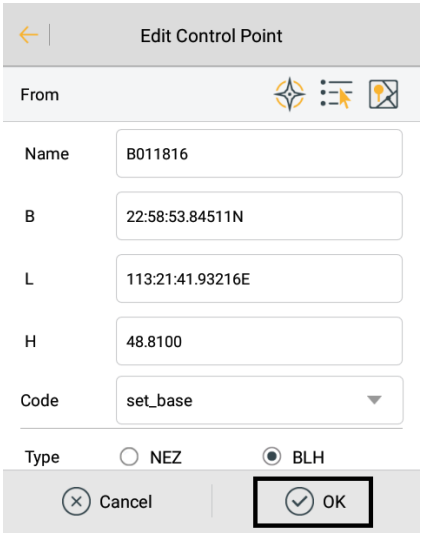



*Figure 1-4-20 Edit Point*

Click Parameter Calculation, select Plane + Height Fitting type and Constant Vertical Offset in Height (the Height can be selected as Plane Fitting when there are three points above), and then add point pairs, select the point as the source point, enter the corresponding control point coordinate in the target point, then click Save.

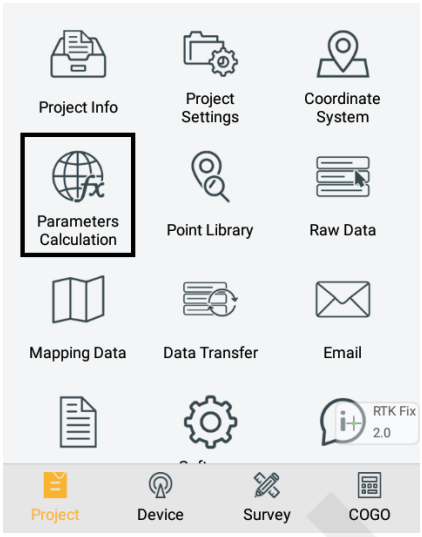



*Figure 1-4-21 Parameters Calculation*

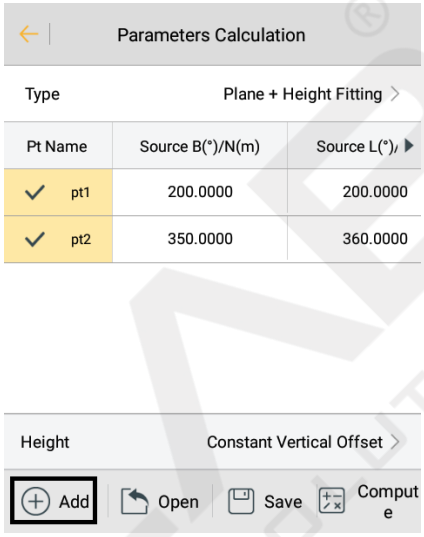



*Figure 1-4-22 Add Points*

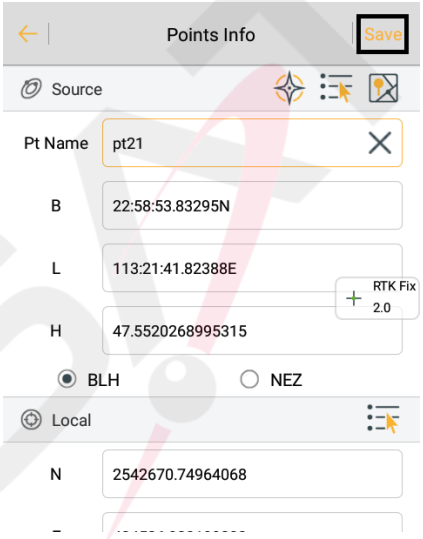



*Figure 1-4-23 Save Points*

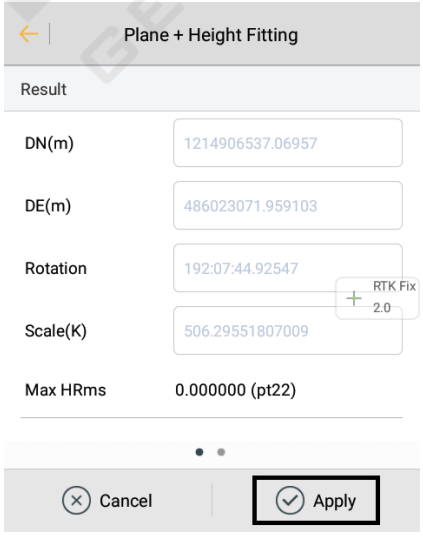



*Figure 1-4-24 Results*

After adding more than two points, click Calculate, it will show the calculated Plane + Height Fitting results, mainly to see the rotation and scale. The result of the plane translation is generally smaller in the north and east, the rotation is about zero, the scale is between 0.9999 and 1.0000 (in general, the closer to 1, the better the scale

is), the smaller the plane and elevation residual is, the better the result. Click Apply and the software will automatically use the new parameters to update the coordinate point library.

## 1.4.5 Detail Survey

In the Detail Survey interface, start the acquisition coordinates work when the display can be fixed. After the rover station on the unknown point is OK, you can press the acquisition key and enter the Name, Target H and Target-H type. Then press OK to record the point.


*Figure 1-4-25 Detail Survey*


*Figure 1-4-26 Save Points*

## 1.4.6 Stake Out

Click Stake Points to enter the point staking-out interface and click the button to select the staked-out point, then, according to the direction and distance, tips to find the staked-out points. There is a process to make the current point (triangle mark) close to the target point (round plus cross sign). When the staking-out circle turns red, it is finished and meets the precision parameters.

In the process of staking-out, you can also collect detail points, by the Store on the interface or store keying on the hand-held.

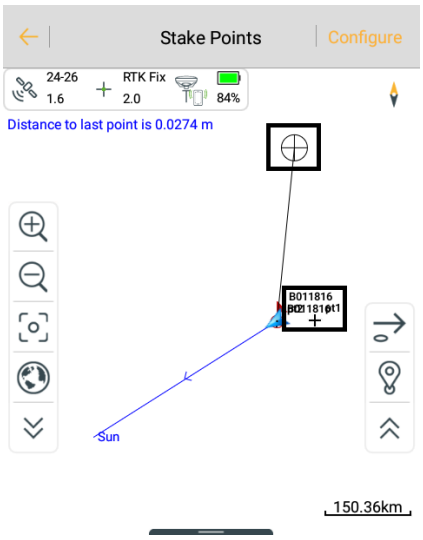



*Figure 1-4-27 Staking Point*

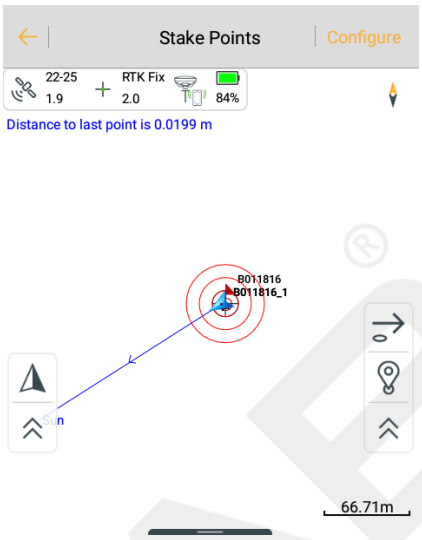



*Figure 1-4-28 Stake Success*

## 1.4.7 Data Transfer

In the Data Transfer interface, select Raw Data, and select the exchange type for export, select the corresponding format export or User-defined export, input the file name, select the file save the path, and then click OK to export data. If it's User-defined export, after clicking OK, you can enter the custom format settings to select export content, then click OK to export the data.

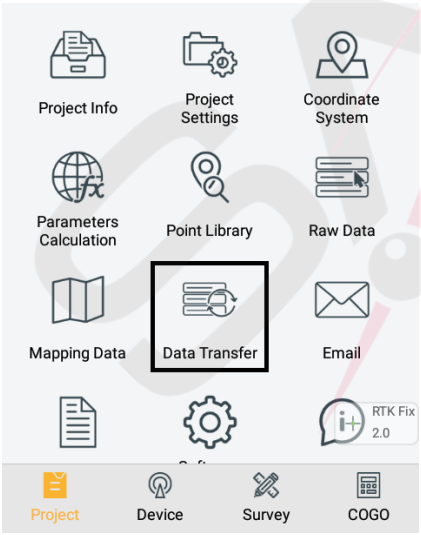



*Figure1-4-29 Data Transfer*

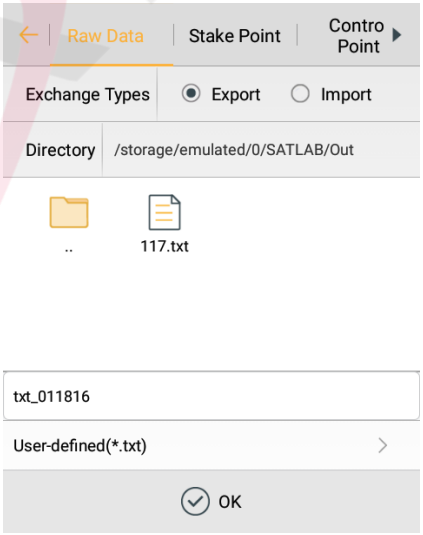



*Figure 1-4-30 Export*

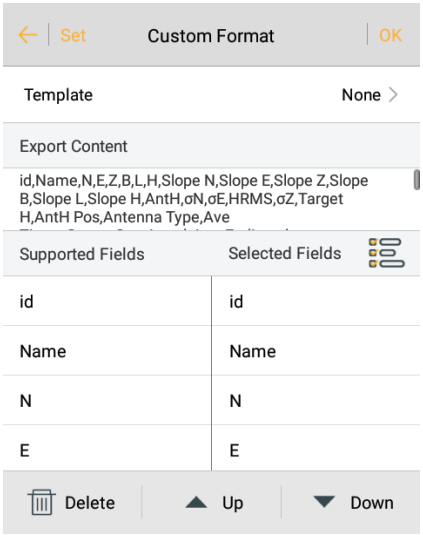



*Figure 1-4-31 Custom Format*

### 1.4.8 Connect the and-held to Download Data

Connect the hand-held to the computer with the USB data cable. Click USB Storage in the following dialogue box, then click OK in the dialog box when that appears.

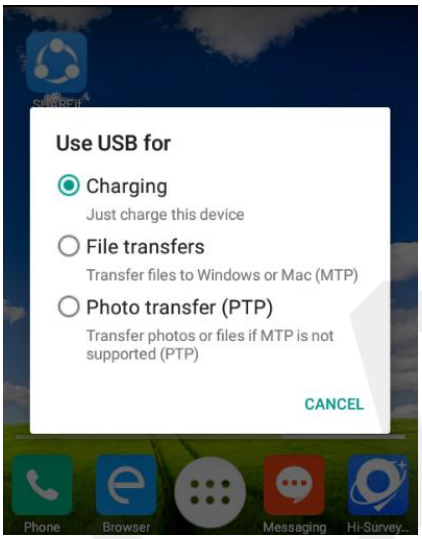



*Figure 1-4-32 Transfer by USB*

Find the path to export the data file on the hand-held (default: SATLAB\Out), copy it to the computer, and then the RTK measure is finished.

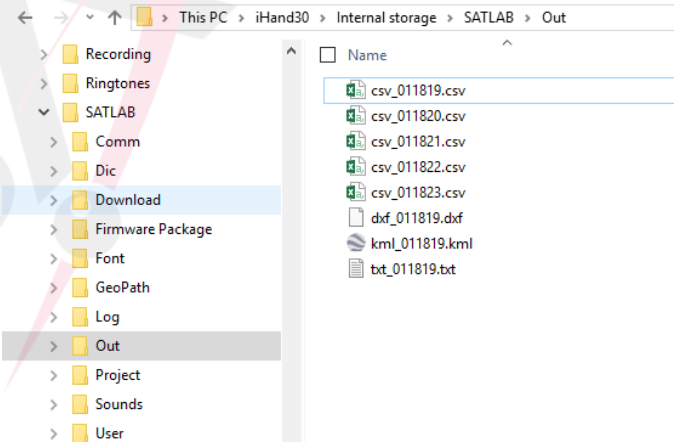



*Figure 1-4-33 Exported Data*

# 1.5 General Collection

There are four common ways to get coordinates: Average, Select Point, Select point on map, Real-time Collection.

## 1.5.1 Average

Get the coordinate in single status by average, 10 times default, including Average, Weighted average, Window average, Median filter.

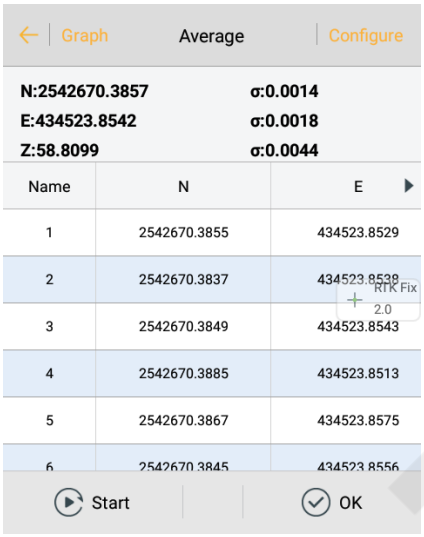



*Figure 1-5-1 Average*

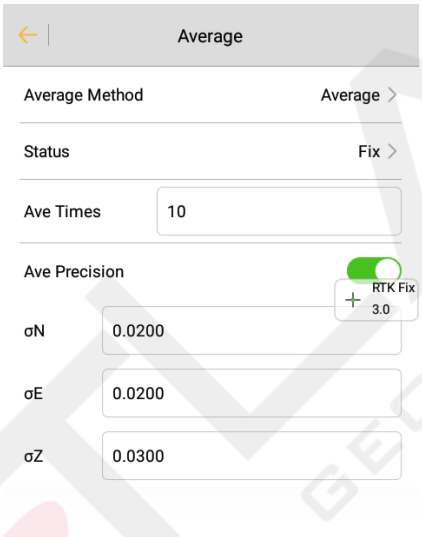



*Figure 1-5-2 Configure*

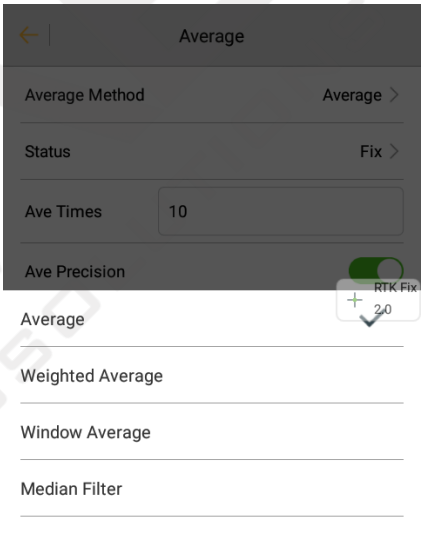



*Figure 1-5-3 Type*

**Notice**:

When using the hand-held for data collection, it supports shortcut key operation. The shortcut keys are only supported for detailed survey graphic collection. To avoid input conflict, the text interface has no shortcut keys.

Button 1： Zoom In  Button 2： Zoom Out

Button3： Zoom center  Button 4： Zoom All

Button5： Culture Create  Button 6： Auto Collection

Button7： Average Survey  Button 8： Indirect Survey

Button *：Open the configure　Button Shift：text-map

## 1.5.2 Select Point in Library

The NEZ point can be selected in Coord Point, Stake Point, Control Point library. The BLH points can be selected in Raw Data and Control Point library

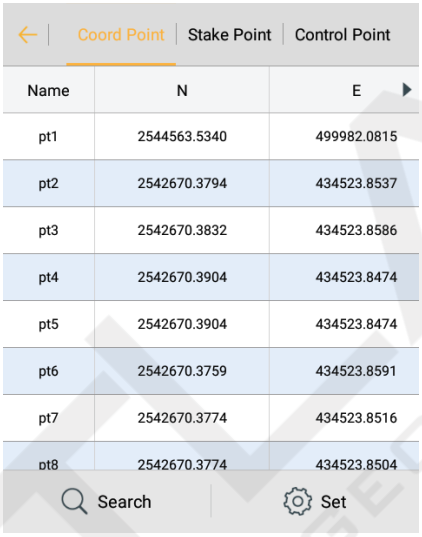



*Figure 1-5-4 Coord Point*

## 1.5.3 Select Point on Map

Click or to enter the select point on map mode, click to select the points in the box. Select a number of points with the icon. Click again to exit the map selection, When the icon is on status, it can select points on screen, click again to exit choose node on line mode, then click OK to complete.

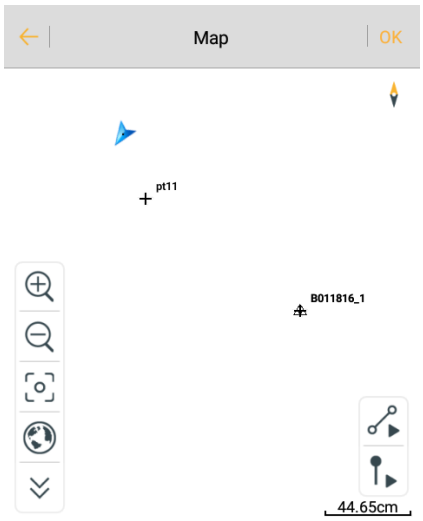



*Figure 1-5-5 Select Point*

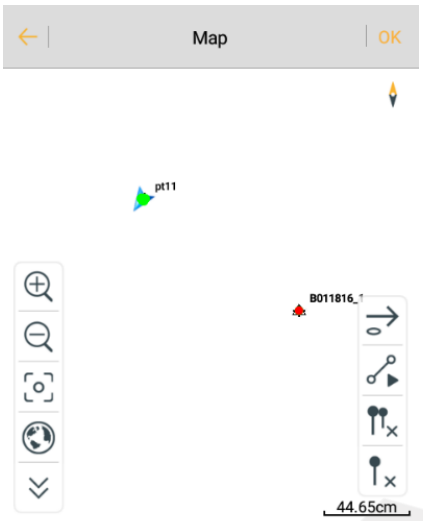



*Figure 1-5-6 Map Selected*


*Figure 1-5-7 Line Selected*

## 1.5.4 Real-Time Collecting

Real-time collecting refers to real-time data acquisition through the receiver equipment.

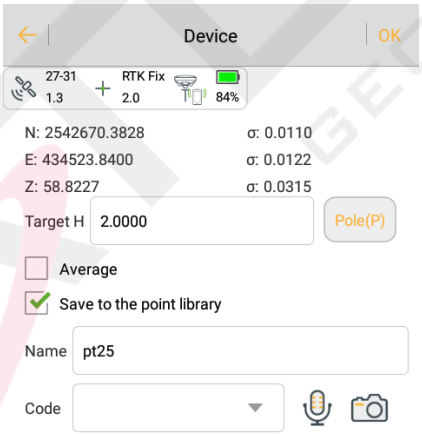



*Figure 1-5-8 Real-time Collecting*

**Notice**:

1. To carry out real-time collection and support data storage, select Save to point library (save to Point Library and Raw Data library), then click OK to collect.

2. Connect to devices supporting electronic bubble, they will display the electronic bubble view in the Device Collection interface, devices that do not support the electronic bubble will not display.

# Chapter 2

## Project

**This chapter contains:**

-Project Info
-Project Settings
-Coordinate System
-Parameters Calculation
-Point Library
-Raw Data
-Mapping Data
-Data Transfer
-Email
-Code List
-Software Settings
-About

## 2.1 Project Info

Click *Project Info* in the main interface to manage the *Project*. Check the project information, including name, points, projection, time, available space and whether to support the collection of the same name point and history point. You can make some operations with the project, including create, open, delete, recover, export, view, edit, and add attributes.

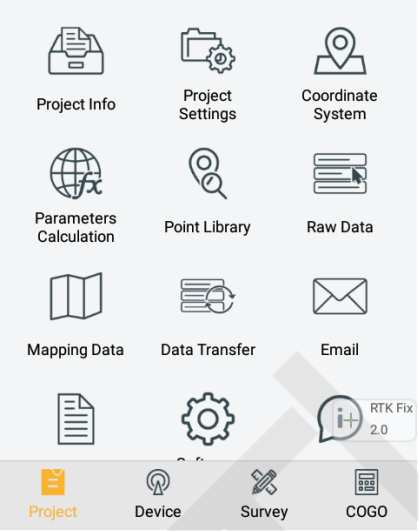



*Figure 2-1-1 Main Interface*

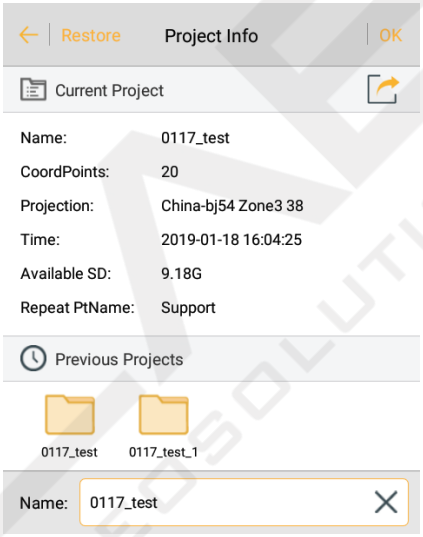



*Figure 2-1-2 New Project*

- *OK*: After you input the project name, click *OK* to get a new project and automatically open it for the current project. If there is already a project with the same name, click *OK* to open it; or create a new project as the current project. The old project can be opened or deleted by long pressing.

- *Attribute*: Save the title and content of the current project. Long press a project to select *Properties* in the toolbar. The attribute length is not limited, nor supported for writing and deleting in batches; attribute titles can be the same, when adding attribute names you can enter different values; the attribute name cannot be null, it need to be digits.

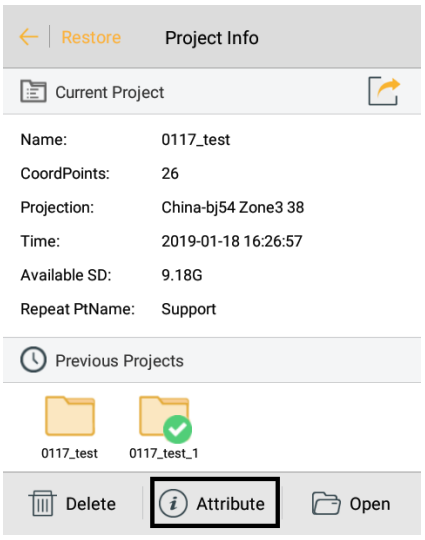



*Figure 2-1-3 Enter Attribute*

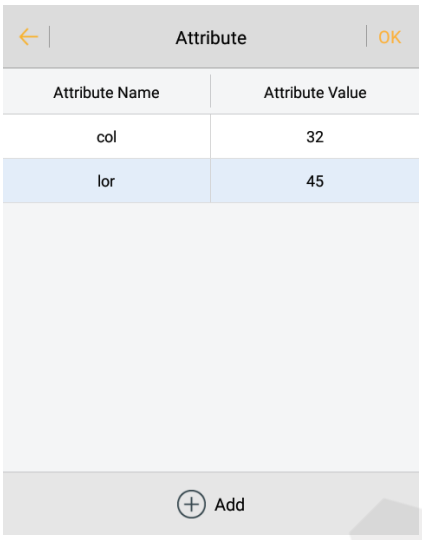



*Figure 2-1-4 Edit*

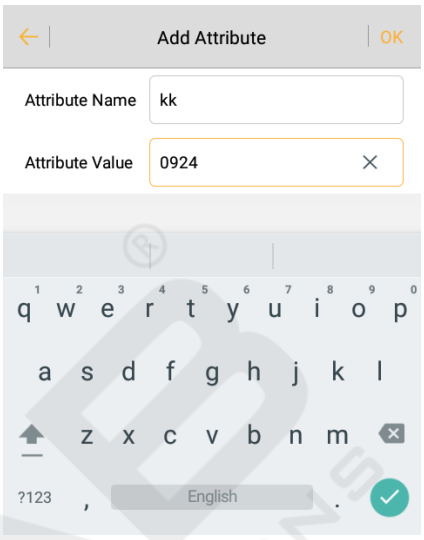



*Figure 2-1-5 Add Attribute*

- *Delete*: Delete the selected project. The project can be deleted directly or backup delete (similar to recycle bin), providing the user with a remedial measure after mis-operation. (backup delete compresses and then deletes the project). The compressed version is stored at *SATLAB / Project / ROAD* directory).

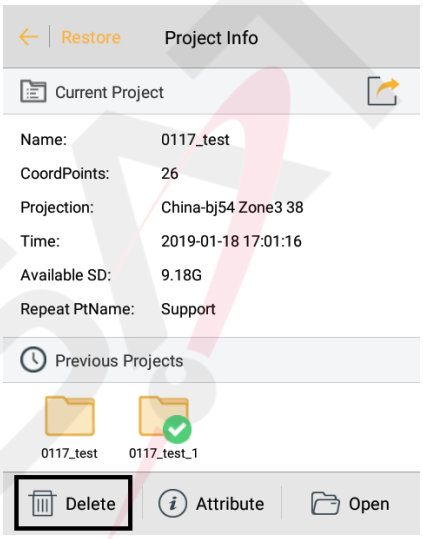



*Figure 2-1-6 Delete*

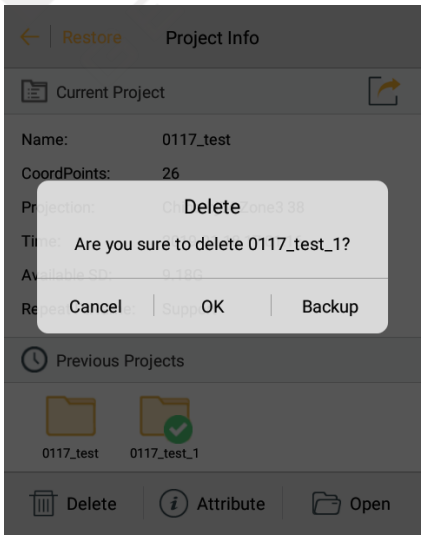



*Figure 2-1-7 Prompt to Delete*

- *Restore*: The *Raw Data*, *Coordinate Parameters* and *Project Info* can be restored from the *SATLAB-Bak* folder of the external SD card of the work folder. When creating a project or collecting the points, the raw data file, dam or QR code coordinate parameters file, project information file and cross-section points library in the same

project name folder will be backed up on the external SD card *SATLAB-Bak* folder. The *Restore* function can only be used when installing an external SD card.

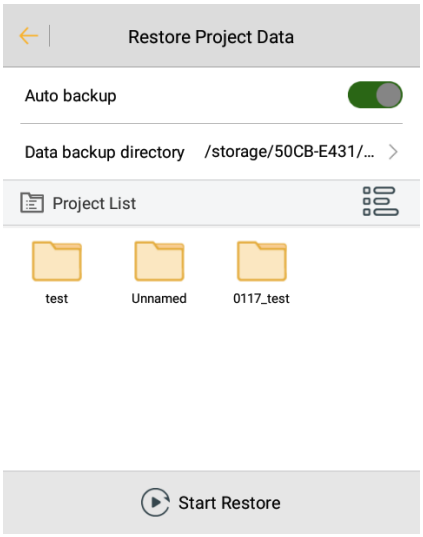



*Figure 2-1-8 Restore List*


*Figure 2-1-9 Backup Folder*

**Notice**:

1. If there is no external SD card, it will prompt every time you start the Satsurv.
2. The backup function requires that the hand-held version must be in V1.0.2 and above.

When you restore data, long press the project to select, press the selected project again to cancel. Click *Select All / Cancel All* to select all projects or cancel. After selecting, click *Start Restore* to recover.

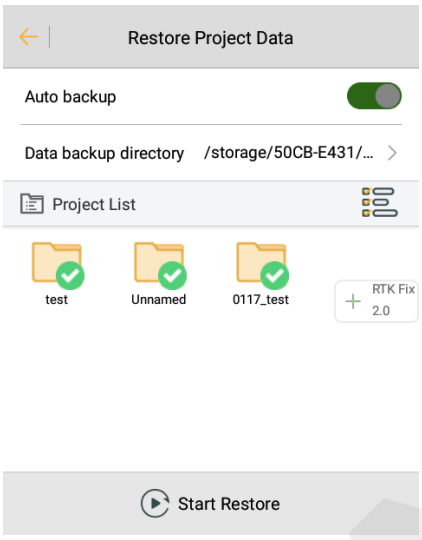



*Figure 2-1-10 Select All or Cancel All*

The recovered project will be saved at *Project Info→Previous Projects*. If there is a previous project with the same name as the restored project, it will add _1 at the end of the recovered project name.

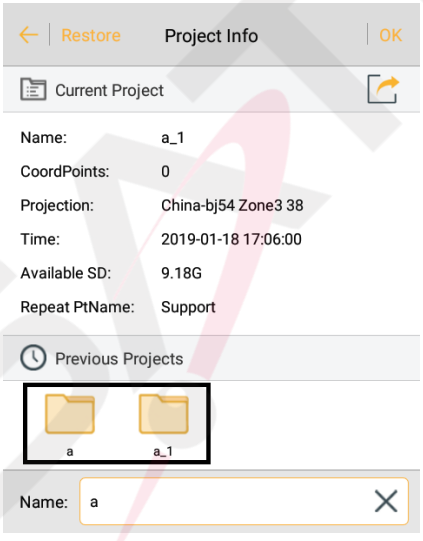



*Figure 2-1-11 Same Name*

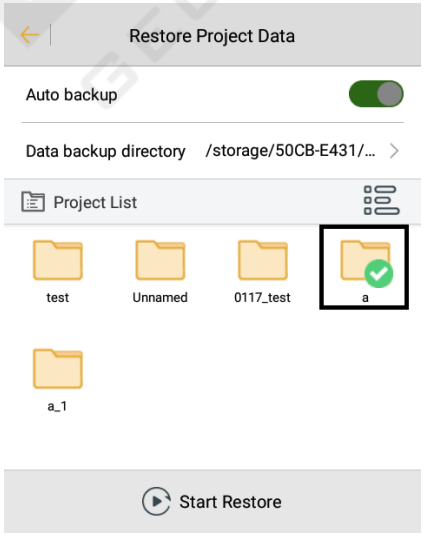



*Figure 2-1-12 the Recovered File*

-*Export*: Export the current project reports in **.txt* format, **.html* format of Project Report or *MappingPoint Report* in **.html* format.

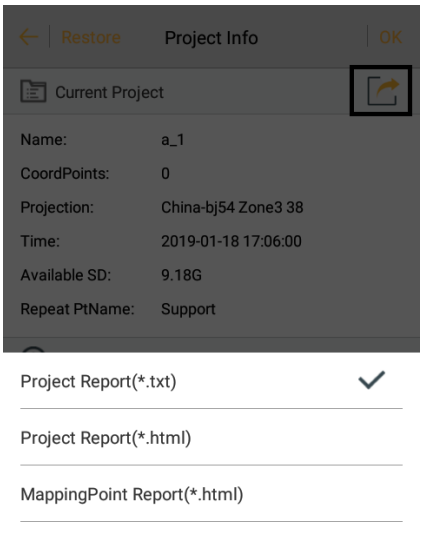



*Figure 2-1-13 Export Format*

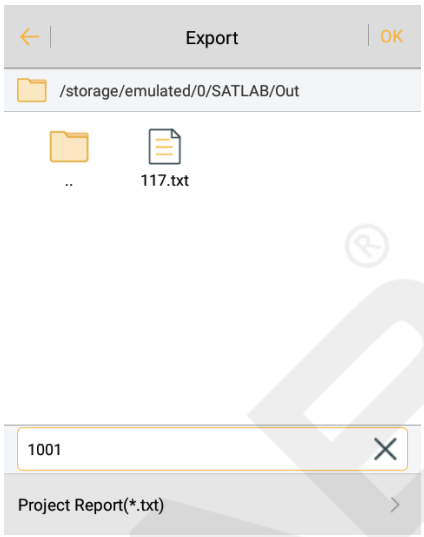



*Figure 2-1-14 Export*

# 2.2 Project Settings

## 2.2.1 New Project

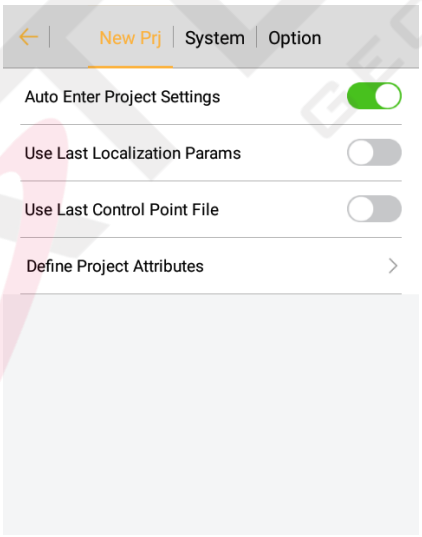



*Figure 2-2-1 New Project*

- *Auto Enter Project Settings*: On opening, it will automatically go to *Project Settings*, and show the *System* interface to set coordinates.

- *Use Last Localisation Params*: After opening, the current project will use the same coordinate parameters as the last project (including the transformation model and parameters of plane conversion and elevation fitting).

- *Use Last Control Point File*: After opening, the control point of the last project will be copied to the current project.

- *Define Project Attributes*: Set the note of a new project. It will automatically go to the attribute-inputting interface to edit the corresponding attribute, after defining the project's attribute.

### 2.2.2 System

In *System* interface, coordinate system parameters can be set with the *dam* file, *QR code* or in *Coord Sys Management*. If coordinate parameters are changed, the coordinate point library will be updated too.

Project coordinate parameters include *Coordinate System, Framework Shifting, Framework Shifting Info, Framework Calibration* and *Framework Calibration Info*. Data Management is used for external data management.

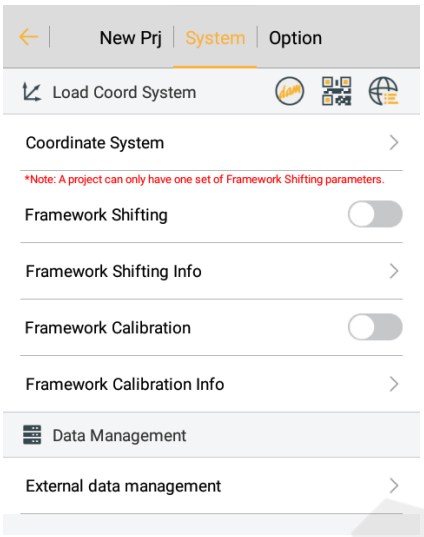



*Figure 2-2-2 Load Coord System*

1. Coordinate Parameters - *Dam File Loading*

Each software project corresponds to a separate **.dam* file, there will be a new *Dam* file (the same name as the project) when you create a project. In *Project Settings*→*System* interface, the user clicks to load a dam file, getting the coordinate parameter of the existing project applied to the current project: the coordinate point library will be updated at the same time.

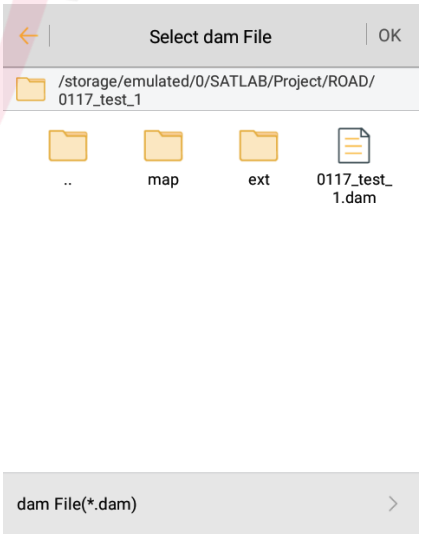



*Figure 2-2-3 Add Dam File*

2. Coordinate Parameters - *QR Code*

In *Project Settings*→*System* interface, click to enter the QR code scanning interface, to get coordinate parameters from the QR code, and then create, *Encrypt*, *share* and *Save* the QR code.


*Figure 2-2-4 Scan QR Code*

Click *My QR Code* and it will create a QR code of the current project coordinate parameters; the user can encrypt, share and save it. The scanned encrypted QR code only can be used, it cannot be viewed and edited.

- *Encrypt*: The user can choose to encrypt the coordinate parameters first, and then re-generate the QR code; the encrypted QR code can be shared and saved; encrypted parameters are not visible and cannot be edited, only called.

- *Share*: The QR code can be shared by third party software to other customers;

- *Save*: The QR code can be saved as a picture in the controller. If there is a file with the same name under the save path, you can tick the coverage or enter a new filename.


*Figure 2-2-5 QR Code*


*Figure 2-2-6 Encrypt*


*Figure 2-2-7 Share*

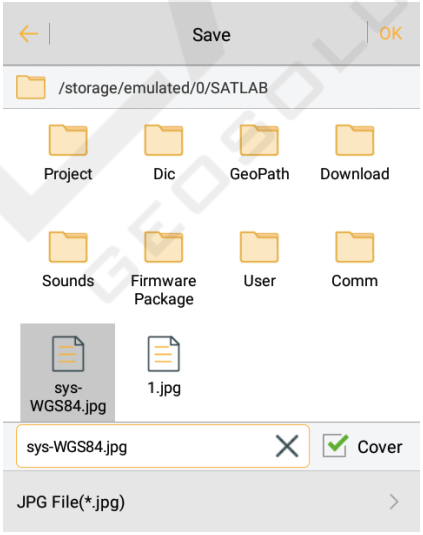



*Figure 2-2-8 Save*

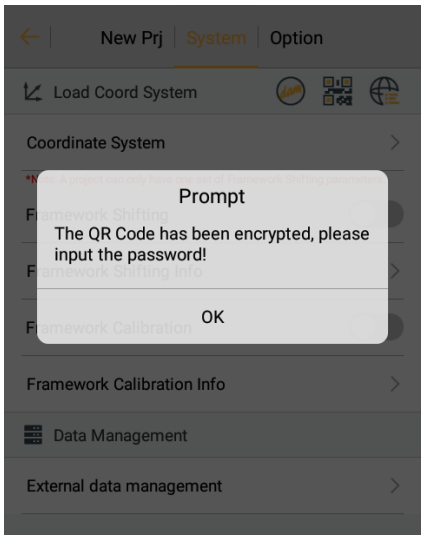



*Figure 2-2-9 Prompt*

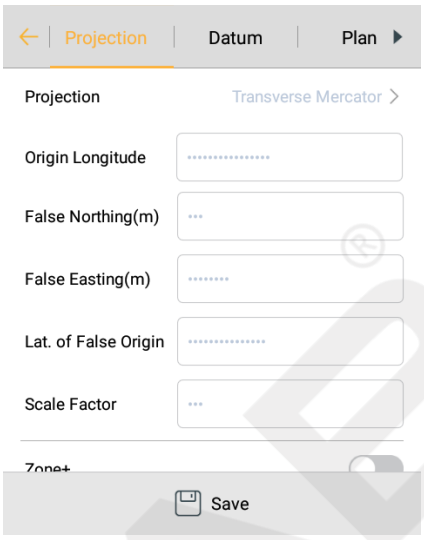



*Figure 2-2-10 Projection*

3. Coordinate Parameters - *Coord Sys Management*

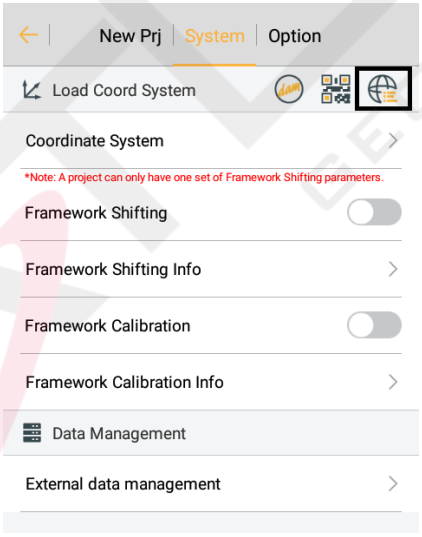



*Figure 2-2-11 Coord Sys Management*

The software coordinate transformation module is CoordLib module, which has been verified for many years and provides practical and full coordinate calculation ability. In *Projection*, it includes *Gaussian*, *Mercator*, *Lambert* projection, etc. In *Datum* conversion, it provides *Bursa-Wolf Transformation, Molodensky, Ten Params* and others. In *Plane* conversion, it provides *2D Helbert, TGO, Planar Transformation Grid, FreeSurvey and*

*Polynomial Fitting* and other conversion methods. In *Height Fitting* conversion, it provides *Mathematical Models*, *TGO*, *FreeSurvey* and *Geoid-Ellipsoid Separation Grid*.

In the *Project Settings*→*System* interface, users can click to enter the *Coord Sys Management* interface. Common coordinate systems can be added to system lists for easy use.

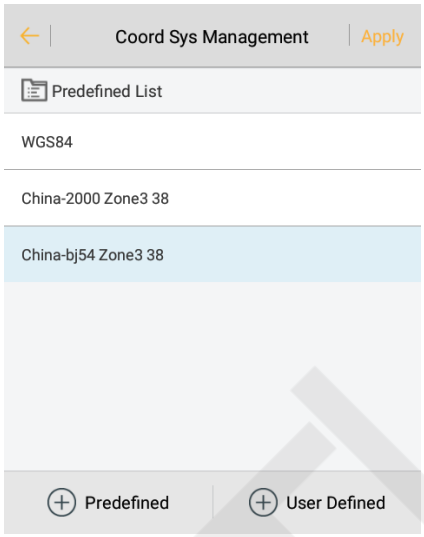



*Figure 2-2-12 Pre-defined List*


*Figure 2-2-13 Pre-defined Coord*

- *Pre-defined*: Support for loading the Pre-defined coordinate systems, which are classified by continent and country, for convenient selection.

- *User Defined*: Add user defined coordinate system according to local situation.

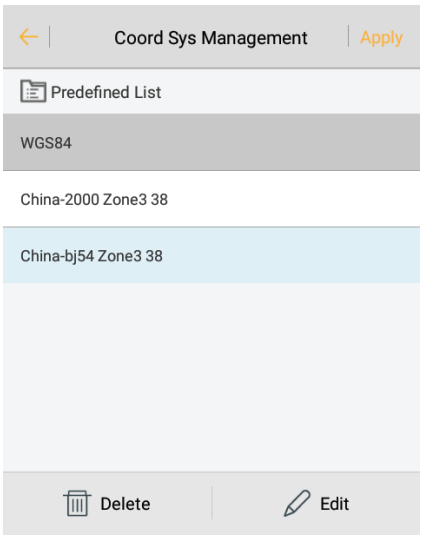



*Figure 2-2-14 Select Coord*

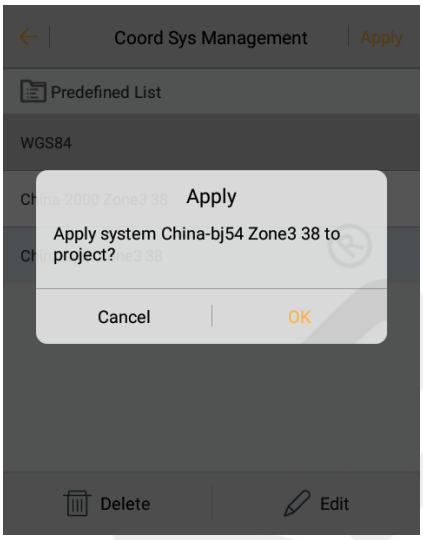



*Figure 2-2-15 Apply Coord*

- *Delete/Edit*: Long press the coordinate system on *Pre-defined List* to delete and edit. Editing coordinate system parameters in the system list do not affect the coordinate system parameters in the project, unless you click the *Apply* button after editing the coordinate system.

- *Apply*: Update the projection parameters used by the project. There will pop up a dialog to prompt whether the selected coordinate system should be applied to the current project. Click *OK* and the parameters are used successfully. The software converts the *WGS84* geodetic coordinate *BLH*, measured by the receiver, to the plane coordinate *NEZ* of the selected coordinate system parameters.

4. Coordinate System

Click *Coordinate System* to go to the *Coord Sys Management* edit interface; you can edit the current project coordinate parameters and the created coordinate system is just used for the current project. Whether to update the parameters to the corresponding projection list can be chosen when saving. If *OK*, coordinate system parameters will be applied to the project according to current settings; if you select *Cancel*, coordinate system parameters will not be updated.

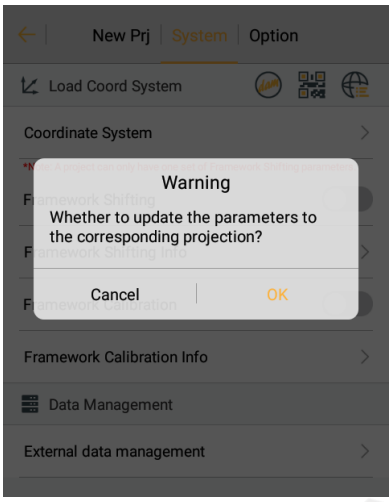



*Figure 2-2-16 Warning*

5. Framework Shifting

This is for computing the horizontal and vertical translation between two coordinate systems.

The user can transfer the collected GNSS coordinates to local *NEZ* by one point. For example, give the top left point as (0, 0, 0), then other points are translated to an independent coordinate system, according to the point.

Generally, the translation value is too large, if you translate BLH and NEZ, there will be a big projection error, so after framework-shifting, the saved BLH is still the original BLH, while the NEZ is the local one.

- *Compute*: Compute the *dN*, *dE*, *dZ* from the current point and known point. Users need to obtain the source point (the current point) coordinates and the coordinates of the known point first. The known point can be input directly or selected from the library. The source point can be got from average collection, real-time collection , library and map.

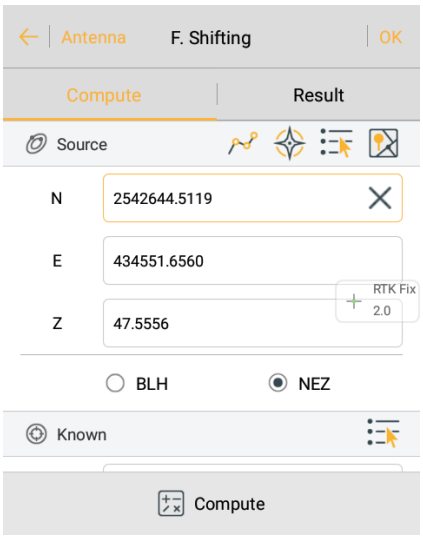



*Figure 2-2-17 Compute*

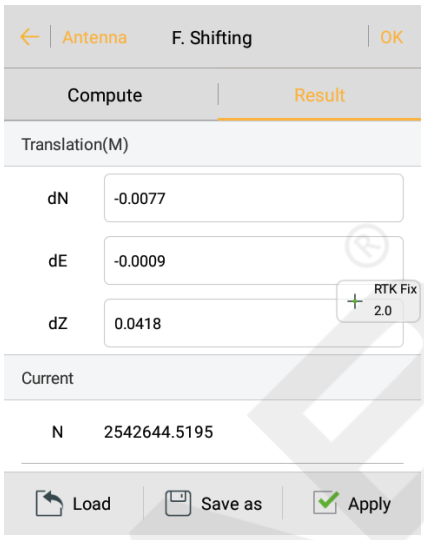



*Figure 2-2-18 Result*

- *Apply*: Check it to apply the correct value to the project.

- *Load*: Load the existing translation file.

- *Save as*: Save the translation parameters as a .txt file, so it can be used by other projects.

- *OK*: Save the translation parameters and update the project.

The calculated point translation parameter can be selected in the *Project Settings*→*System* interface.

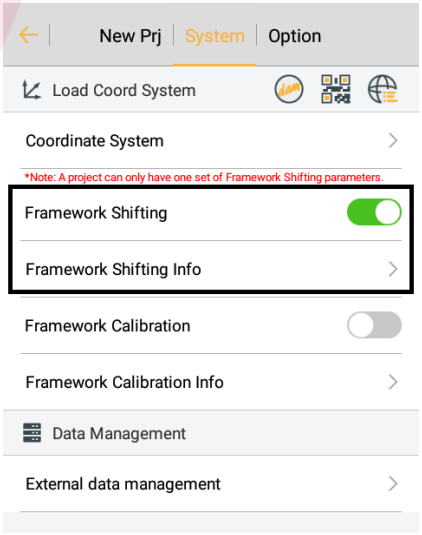


*Figure 2-2-19 Framework Shifting*

6. Framework Calibration

This is for computing the horizontal and vertical translation between two coordinate systems, generally used for situations as below:

Only one BJ-54, XIAN-80 point or only one point of a coordinate system which is a little rotated from WGS-84. Set the Base, then take the Rover to a known point, click *Framework Calibration* → *Compute*, collect the *NEZ* coordinate, input the known point, click *Compute* to get the *Correction dN, dE, dZ* of the known point and source point, press *Apply* to apply the parameters and the collected points will be corrected to the coordinate system of the known point.

You created a project, it worked, but you don't want to set the base at the same place, so now you can set the base at any place, by using the *Framework Calibration* function Open the first-used project to a known point to correct the coordinates. The correction method is the same as the first situation.

- *Compute*: Calculate the coordinate correction *dN, dE, dZ* according to the current point and the known point. Users need to obtain the source point (the current point) coordinates and the coordinates of the known point first. The known points can be entered in three ways: select from the point library, select from the map, or enter the coordinates directly. Select NEZ / BLH : the resulting known point coordinates will correspond to the *NEZ/BLH* format.

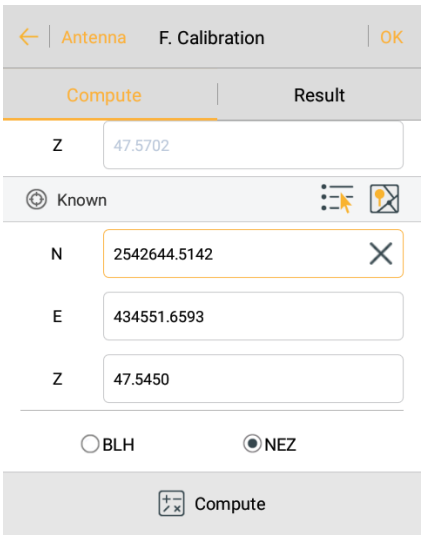



*Figure 2-2-20 Compute*

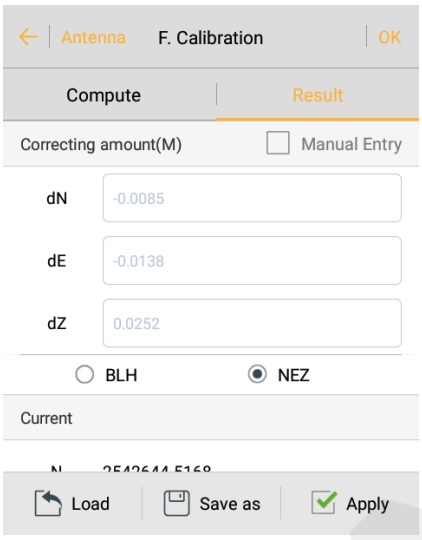



*Figure 2-2-21 Correcting Amount*

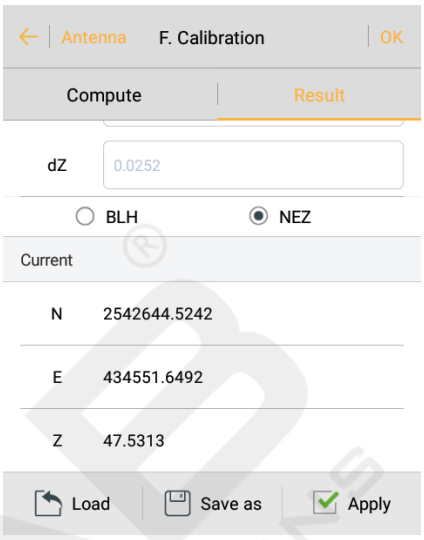



*Figure 2-2-22 Current*

- *Apply*: Apply the calculated correction to the project.

- *OK*: Select *Apply* after computing, and click *OK* to apply the framework calculation parameters (notice: it is different from the *OK* that appears after pressing the return key).

- *Cancel/OK*: Select *Apply*, and click the return key to pop up the prompt dialog, click *Cancel* to return the framework calculation parameters; click *OK* to give up modifying the parameters.

- *Load*: Load the stored parameters.

- *Save as*: Store the calculated calibration parameters.

The calculated calibration parameters can be selected in the *Project Settings→System* interface.

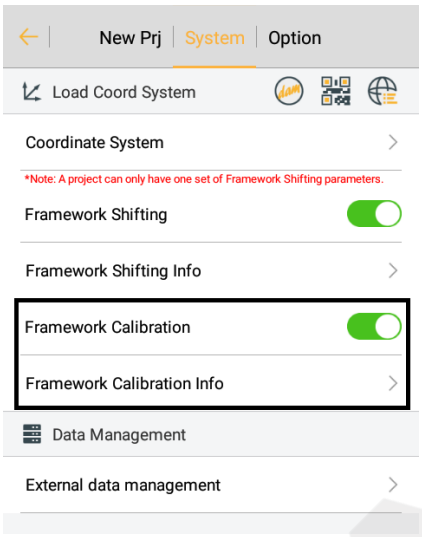



*Figure 2-2-23 Framework Calibration*

After using the framework calculation parameter to collect points, the parameters are automatically recorded in the raw data of each point, so that the geodetic coordinates of WGS-84 coordinates are restored when errors occur. In the Raw *Data→Edit RawData* interface, the framework calculation parameters of the original data can be viewed.

7. External Data Management

Enter *External data management*, click *Add* to load layer file **.td2*, **.dxf* and **.shp* (when the external data format is incorrect, the file can't be imported) as the map background. Support

for arc, circle and spiral curve. The imported dxf can be viewed in map in colours. The colour can be switched in *Configuration→Display→Display colour*. Switch on to display all kinds of colours in **.dxf*; switch off to display the default black. After loading point, line, polygon in **.td2* format, the raster layer is always at the bottom, followed by polygon, line and point.

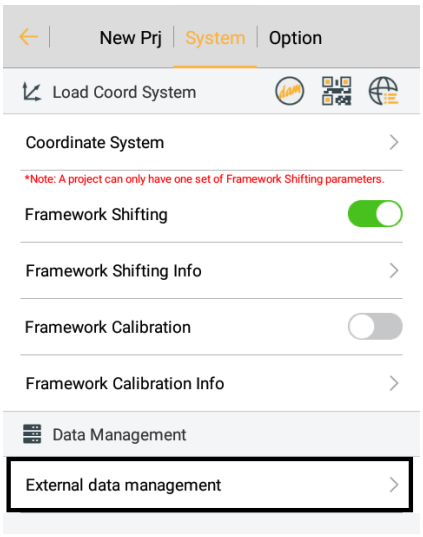



*Figure 2-2-24 External Data Management*

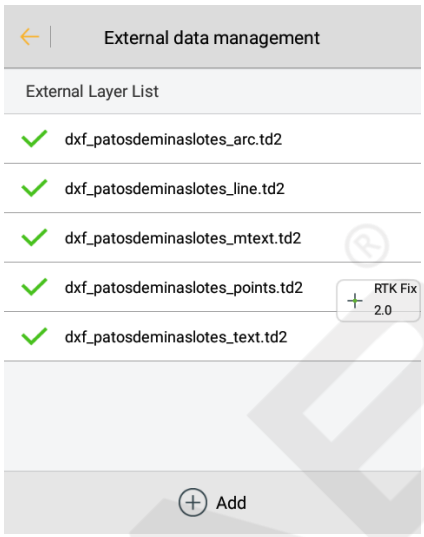



*Figure 2-2-25 External data*

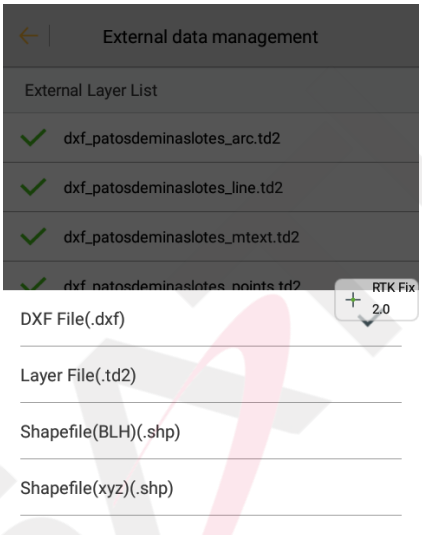



*Figure 2-2-26 Add External Data*

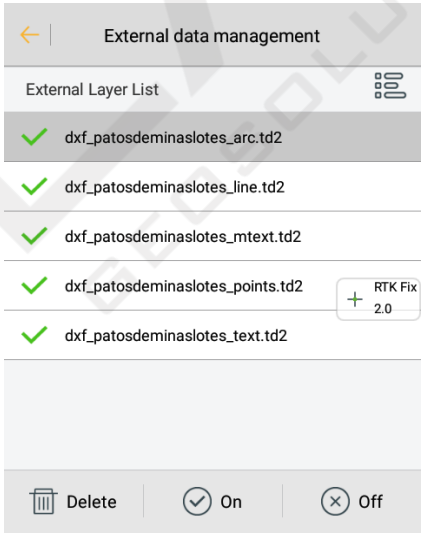



*Figure 2-2-27 Edit External Data*

**Notice**:

*External data management*: opens all layers by default when adding the base map. Click the icon in front of the list, to switch layer visibility (on or off), which corresponds to that the base map of measurement interface display or not. Long press the added layer to open/close/delete the operation.

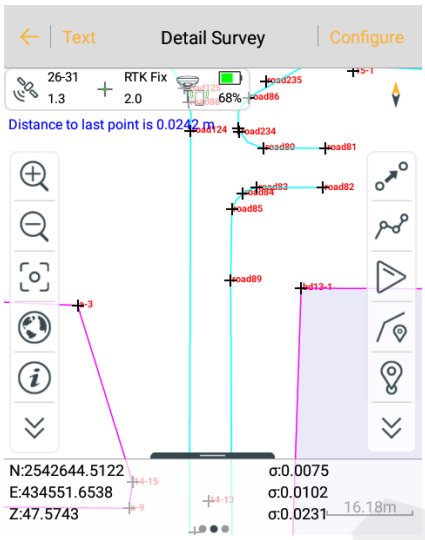



*Figure 2-2-28 Display External Data*

## 2.2.3 Option

Do some other configurations, including *Angle*, *Distance*, *Apply Unit to Data Output*, *Time Stamp*, *Store GNSS Precision* and *Auto Load Last Road File*.

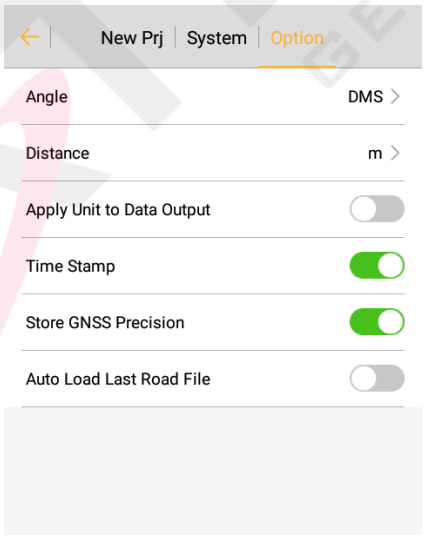



*Figure 2-2-29 Option*

- *Angle*: Confirm the angle unit, including *DMS*, *Gons* and *mil*.

- *Distance*: Confirm the distance unit, including *m*, *Foot* and *U.S.Foot*.

- *Apply Unit to Data Output*: Export data according to the set angle and distance format.

- *Time Stamp*: Record the real-time of each collecting point.

- *Store GNSS Precision*: Record the precision of each point collection.

- *Auto Load Last Road File*: Load the road file used when last opening the project.

## 2.3 Coordinate System

There are 3 methods to get into the coordinate system setting interface:

1. Main Interface *Project*→*Coordinate System*;

2. Main Interface *Project*→*Project Settings*→*System*→*Coordinate System*;

3. Main Interface *Project*→*Project Settings*→*System*→*Coord Sys Management*, long press the Coordinate system on the list to edit and enter the interface. Click *Save* after setting all the parameters, the system will prompt whether to update the parameters to the corresponding projection list, click *OK* to finish setting parameters.

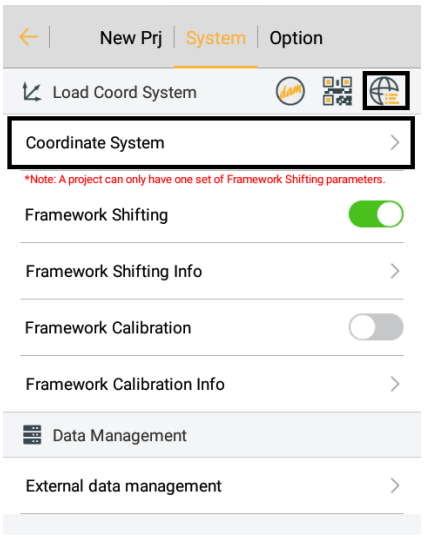



*Figure 2-3-1 System*

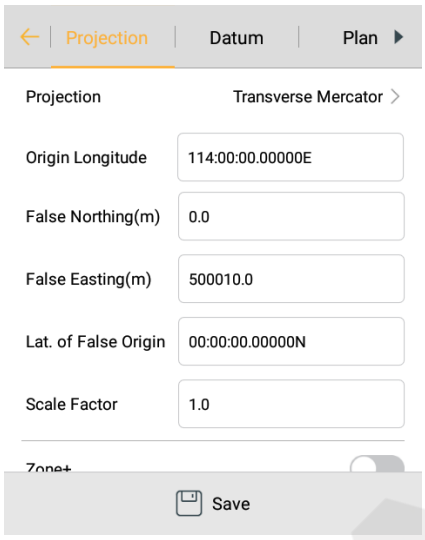



*Figure 2-3-2 Projection*

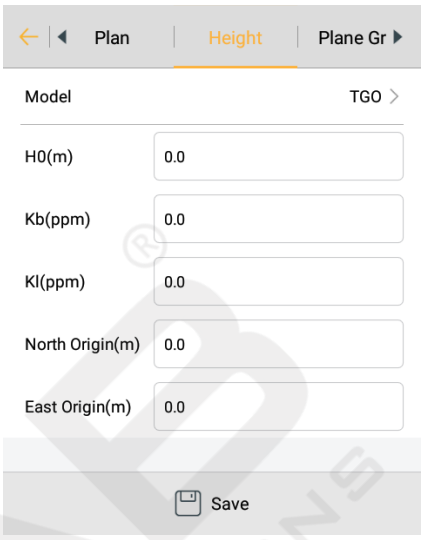



*Figure 2-3-3 Height*

**Notice**:
All the tabs in the software can be swiped by gestures, or click the tab page title bar to switch the page and make the tab page title bar automatically centred.

## 2.3.1 Projection

Frequently-used projections built-in: *Gauss*, *Mercator*, *Lambert*, etc. (notice: when using Gauss-3 or Gauss-6, the device can automatically compute the origin longitude after connecting, other custom projections are not supported).

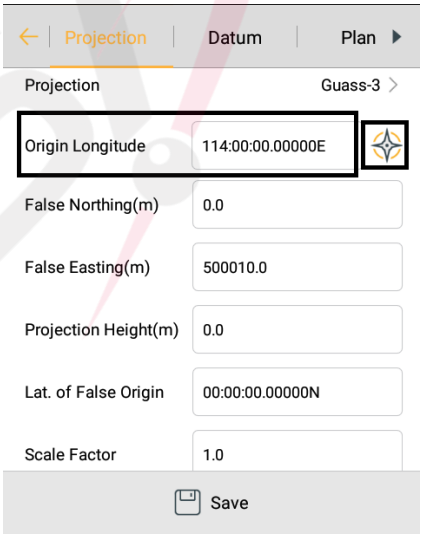



*Figure 2-3-4 Obtain Origin Longitude*

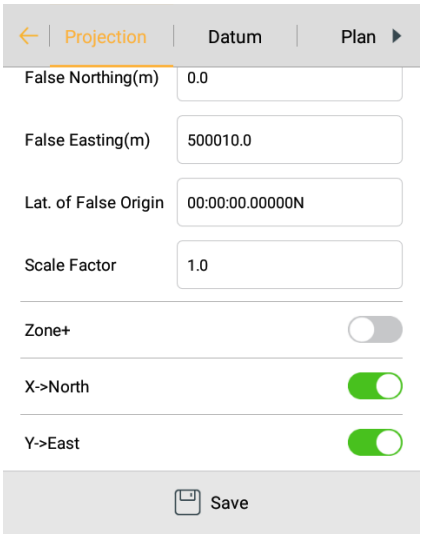



*Figure 2-3-5 Other Parameters*

**Notice**:

1. Coordinate system-Projection-Zone+ to set whether to add the number.

2. After opening Zone+, all coordinate E input box will be carried out with the number detection, if the number does not match, the input box will display the red font indicating that the number does not match the data confirmation.

## 2.3.2 Datum

Users can set source ellipsoid, local ellipsoid and datum transfer model (including: *Bursa-Wolf Transformation, Molodensky, One-touch, Polynomial Regression* and *Ten Params*).

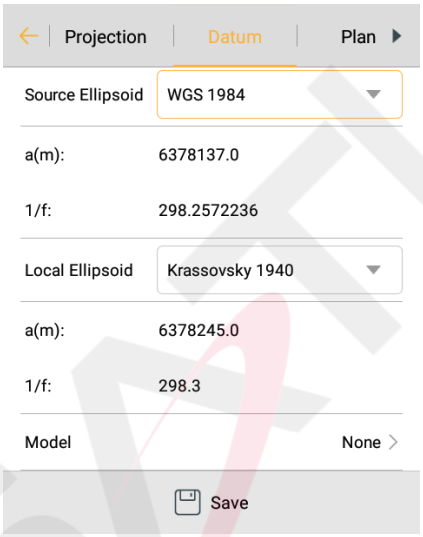



*Figure 2-3-6 Datum Settings*

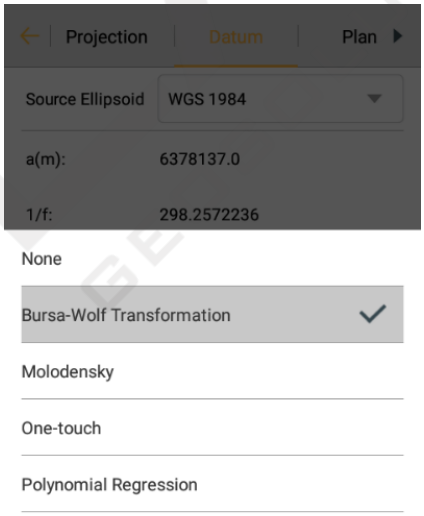



*Figure 2-3-7 Datum Model*

- *Save*: Click *Save* to save the parameters in a *.dam* file after settings, the set parameters are invalid without clicking *Save*.

- *Source Ellipsoid*: Generally using *WGS-84*, *a* means semi-major axis, *1/f* means the inverse of flattening, and there are many frequently-used ellipsoids built-in.

- *Local Ellipsoid*: Local used ellipsoid.

**Notice**:
Customize the ellipsoid:

Edit the name of the source ellipsoid or target ellipsoid, long axis a (m) and the inverse of flattening (1/f) into the two lines to be input, the user input, the corresponding parameters and save it. Then the custom ellipsoid parameters will be saved in the file SATLAB / Ellipse.csv

.

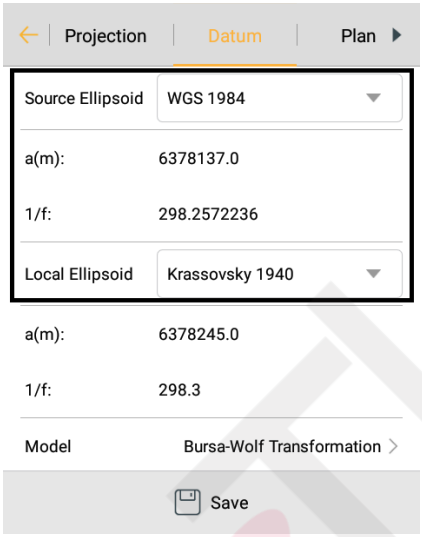



*Figure 2-3-8 Datum-Source Ellipsoid*

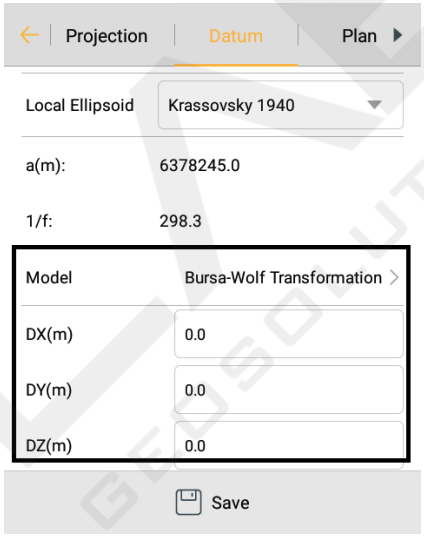



*Figure 2-3-9 Datum-Local Ellipsoid*

1. *Bursa-Wolf*

Including translation, rotation, scale parameters between two ellipsoids, the rotating angle should be very small. Bursa-Wolf needs at least three points to compute, it's suitable for conversion between different ellipsoidal coordinates.

2. *Molodensky*

A simplified mode of Bursa-Wolf, only space translation parameters, it is a low accuracy mode and just needs one point to compute: suitable for the transformation of WGS-84 to a national coordinate system.

3. *Polynomial Regression*

Express the transfer relations of each space vector between two ellipsoids by a polynomial.

### 2.3.3 Plan

Include *2D Helmert*, *TGO*, *Planar Transformation Grid*, *FreeSurvey* and *Polynomial Fitting*.

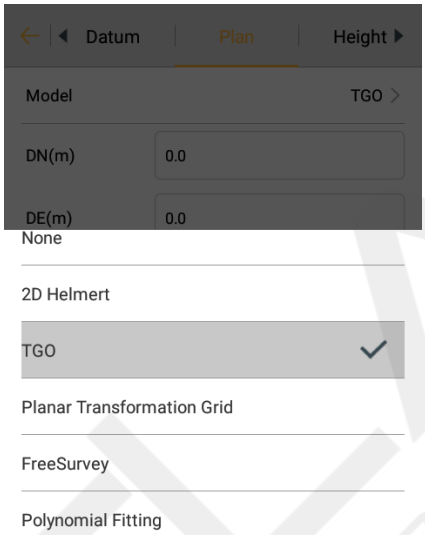



*Figure 2-3-10 Plan Method*

1. 2D Helmert

Includes translation, rotation, scale parameters between two plane coordinate systems, it just needs two points in any coordinate system to compute.

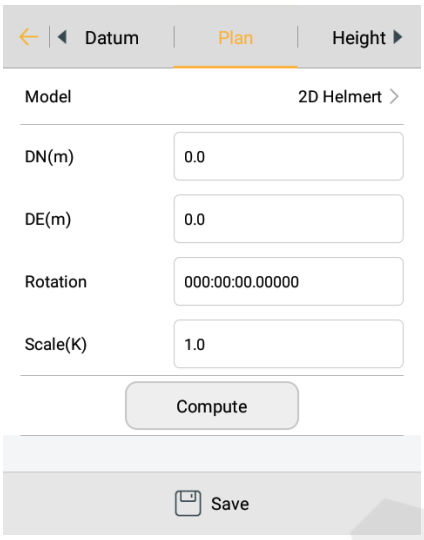



*Figure 2-3-11 Plan Configure*

2. *TGO*

A plane coordinate system transfer method of *TGO* software, more *North Origin, East Origin* than *2D Helmert*.

3. *Planar Transformation Grid*

Select existing grid file to transfer *WGS-84* to grid coordinate. The grid file (*.*grd*) needs to be copied to the *GeoPath* folder in *SATLAB*.

4. *FreeSurvey*

A transfer method of THALES company, more *North Origin, East Origin* than *2D Helmert*.

5. *Polynomial Fitting*

Transfer the place by a polynomial model. In some projects, when the known points involved in calculating plane transformation and elevation fitting parameters are different points, use *2D Helmert* and *Height Fitting* to individually calculate parameters.

The *2D Helmert* is used in the calculation part of the plane, and the method is similar to the datum conversion model.

- When using four-parameters, the scale parameter is generally very close to 1, about 1.0000x or 0.9999x.

- When using three-parameters, the parameters generally need to be less than 120.

- When using seven-parameters, the parameters are required to be smaller, preferably less than 1000.

### 2.3.4 Height

Include *Mathematical Models*, *TGO*, *Geoid-Ellipsoid Separation Grid* and *FreeSurvey*.

1. Mathematical Models

- *Constant Vertical Offset*: Translation needs one starting point at least.

- *Planar Fitting*: Needs three starting points at least.

- *Quadratic Surface*: Needs six starting points at least.

- *Zonal*: Needs three starting points at least.

2. *TGO*

A height transfer model includes five parameters: *H0 (constant adjustment), Kb (north slope), Kl (east slope), North Origin* and *East Origin*.

3. *Geoid-Ellipsoid Separation Grid*

Select existing grid file to fit height. The grid file (**.grd*) needs to be copied to the *GeoPath* folder in *SATLAB* path.

4. *FreeSurvey*

A transfer method includes five parameters: *H0 (constant), Kb (north slope), Kl (east slope), B0 (origin latitude)* and *L0 (origin longitude)*.

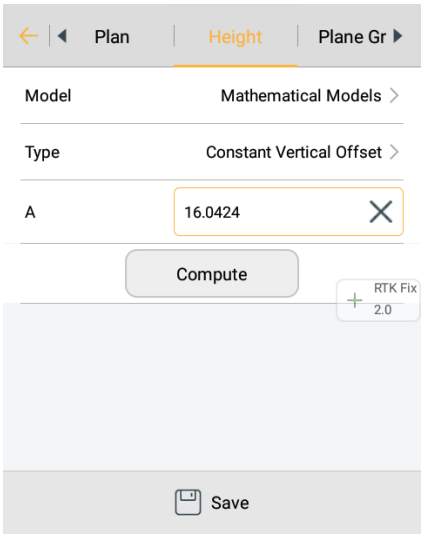



*Figure 2-3-12 Height*

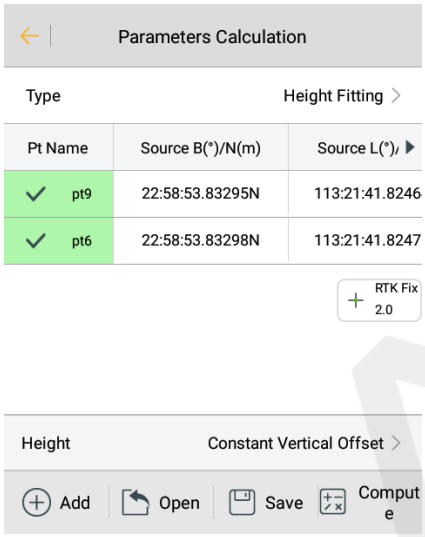



*Figure 2-3-13 Parameters*


*Figure 2-3-14 Result*

The calculation of the individual height-fitting parameters includes *Constant Vertical Offset*, *Planar Fitting*, *Quadratic Surface*, and *Zonal*, which correspondingly require one, three, six and three starting points, at least, to be used. Enter the *Name*, *N*, *E*, the original *H* and the target *H* of the point involved in the height fitting parameters calculation, then click *Add*. After adding all points, click *Compute* to see the residual values, the maximum residual value is generally required to be less than 3 cm. If the value meets the requirements, click *Apply*. If not, click *Cancel*, remove the points with a big error and have a re-solution.

Set the height fitting mode:

- *Constant Vertical Offset* refers to the receiver measured height plus a fixed constant as the use of elevation: the constant can be negative.

- *Planar Fitting* refers to the height anomaly corresponding to multiple levelling points to produce an optimal fitting plane. When the plane is parallel to the horizontal plane, the planar fitting is equal to the constant vertical offset.

- *Quadratic Surface* refers to the height anomaly corresponding to multiple levelling points to produce an optimal fitting paraboloid. *Quadratic Surface* is relatively high for the starting data, and if the fitting is too poor, it may cause a height correction value divergence in the work area.

- *Zonal*: two known benchmarks to create a virtual mark, used to make the planar fitting.

- *Grid Fitting* needs to select the grid fitting file, it supports *Trimble (ggf), Satlab (zgf), Geoid99 (bin)* formats, compatible with *egm-96* model. Grid fitting files are often large, the reading may take some time, please be patient. *Grid Fitting* is rarely used. If *Grid Fitting* and the other four kinds of elevation method are selected at the same time, *Grid Fitting* will be taken first, and then the hother fittings.

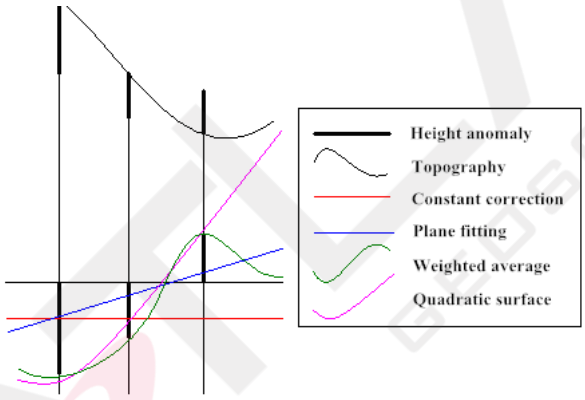



*Figure 2-3-15 Height Fitting Plane Simulation*

Notice: When importing parameters from the computer, the parameters can be edited into * .txt, parameter formats are as follows:

*Table 2-3-1 Built-in Network Parameter Settings*

| Four-parameters | Seven -parameters |
|---|---|
| // The first line is skipped and just written | // The first line is skipped and just written |
| DX:9847.12172733449 | DX:511.755584317388 |
| DY:-200265.017483647 | DY:-674.430387295999 |
| R:0.0162640727776042 | DZ:-656.294939762613 |
| m:0.000162436743812444 | RX:-0.000126577363609681 |
| | RY:-1.44916763174951E-05 |
| | RZ:0.0261524898234588 |

| | |
|---|---|
| | m:0.000168070284370492 |

## 2.3.5 Plane Grid

Open the *Grid* needed and select the grid file. The grid file (**.grd*) needs to be copied to the *GeoPath* folder in *SATLAB*.

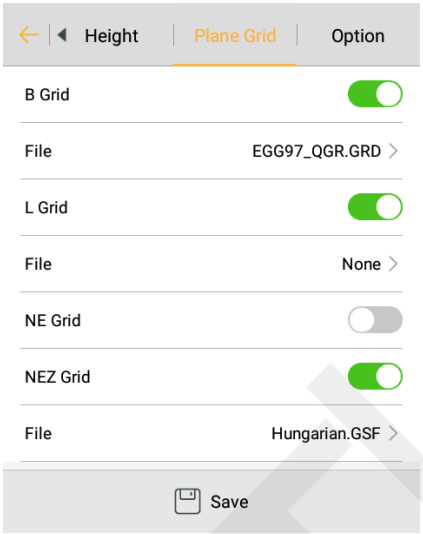



*Figure 2-3-16 Plane Grid*

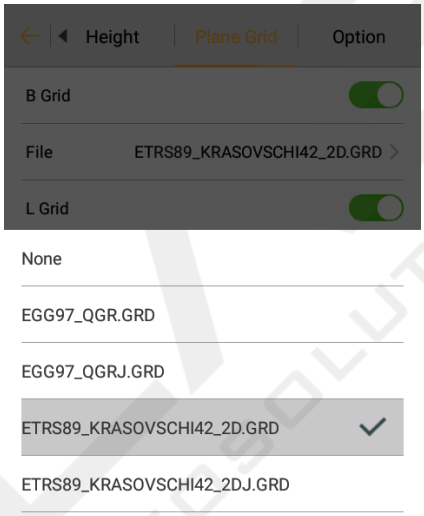



*Figure 2-3-17 Grid-Grid File*

## 2.3.6 Option

To apply the parameters computed by *HD-Power* to Satsurv, just input the parameters, select Simplified in *Helmert Formula* and the first in *2nd Eccentricity Formula*.

- *ncrypt*: To display the file encryption, the settings cannot be changed; if the *dam* parameter file is encrypted, you can see if the coordinate system date is expired.

- *Plane Correction Grid*: *Bilinear Interpolation/Dual-quadratic Spline Interpolation*. The default is dual-quadratic spline interpolation.

- *Plane Correction Grid*: It is hidden by default, and it can be seen only if the model in the *Plane* interface is either *Planar Transformation Grid*, or the *NE Grid* or *NEZ Grid* in *Plane Grid* interface is opened.

After modifying the values above, click *Save*, the software will modify the *dam* file under the current project, with the same name as the project; if the reference ellipsoid has been transformed, the coordinates will change.

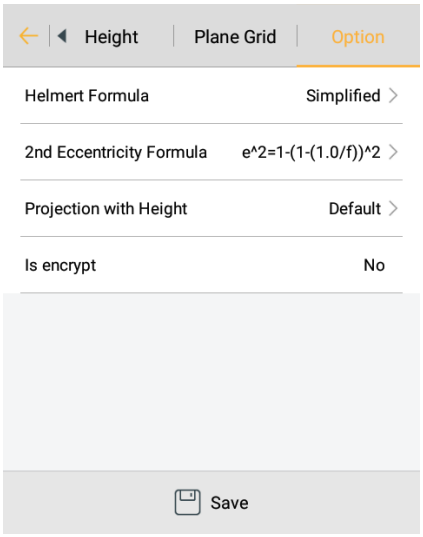



*Figure 2-3-18 Option*

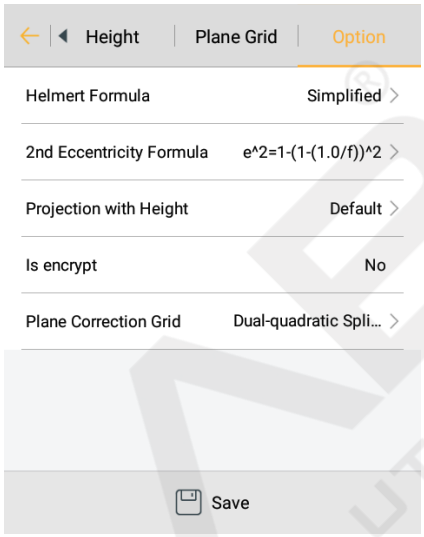



*Figure 2-3-19 Plane Correction Grid*

## 2.4 Parameters Calculation

This function is for computing the transfer relation between two coordinate systems, including *Bursa-wolf Transformation*, *Modensky*, *Plane + Height Fitting*, *2D Helmert Transformation*, *Height Fitting* and *One Touch*.

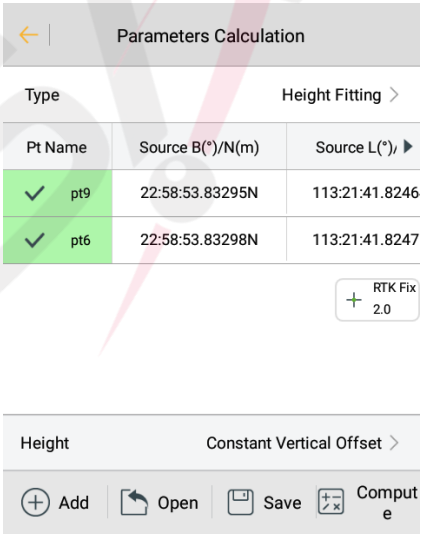



*Figure 2-4-1 Parameters Calculation*

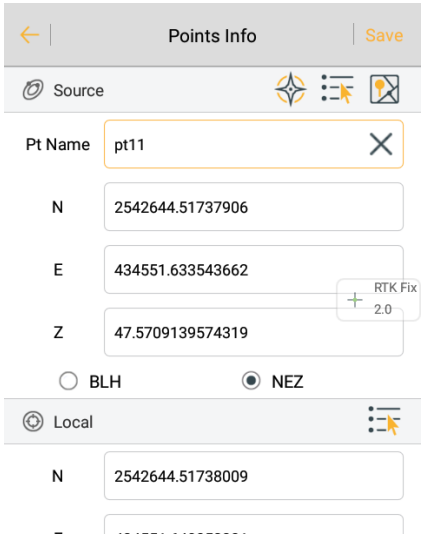



*Figure 2-4-2 Add Point*

- *Add*: Add the source point and local point; the source point can be input from manual, real-time collecting, library and selecting on map (*BLH* by default), the local point can be input from manual and library. Single or average collection is used for parameter calculation and data storage is supported (save to the *Coord Point* & *Raw Data*). After input, click *Save*. If you need to manipulate the existing point information, long press it to edit or delete.

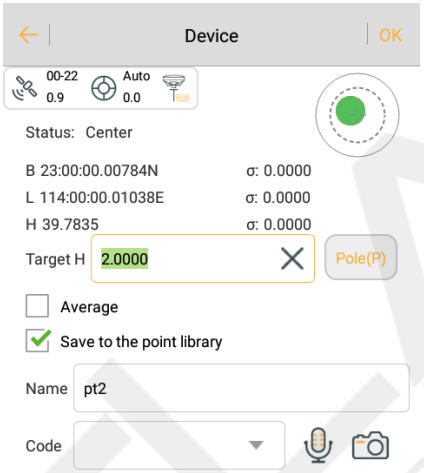



*Figure 2-4-3 Save to the Point Library*

- *Open*: Support for *Point pairs* (**.txt*), *Carlson Loc File* (**.loc*), *User-defined* (**.txt*).

- *Save*: Save the point pairs coordinate information, support for *Point pairs* (**.txt*) and *User-defined* (**.txt*). The angle format and exported file can be set in *User-defined* (**.txt*)

- *Compute*: Compute the transfer parameters from source point to local point, it will compute the parameters and *HRMS*, *VRMS* of each point (*HRMS*: the horizontal *RMS* of the current point; *VRMS*: the vertical *RMS* of the current point).


*Figure 2-4-4 HRMS and VRMS*

- *Apply*: Apply to corresponding coordinate parameters, and the result will be updated to *Coord point* library.

- *Cancel*: Cancel the parameters computing result and go back to calculation interface.

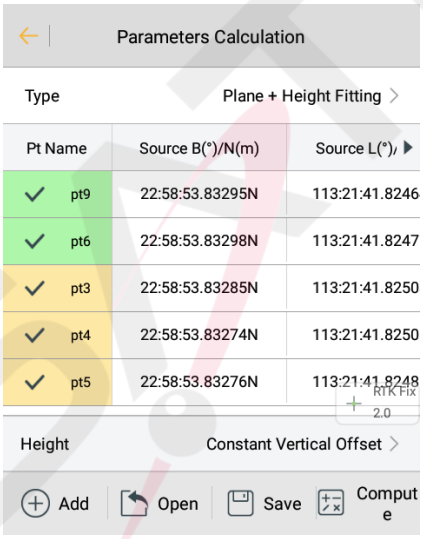



*Figure 2-4-5 Edit Point*

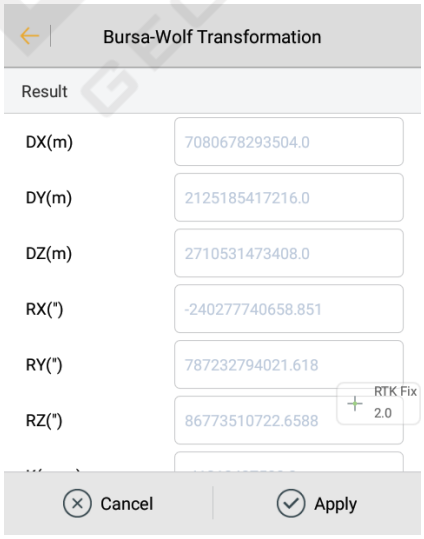



*Figure 2-4-6 Result*

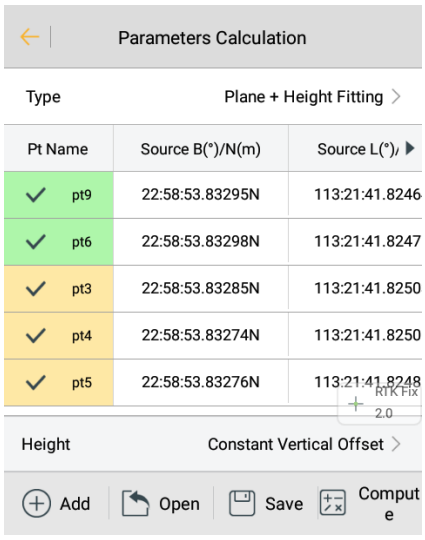



*Figure 2-4-7 Plan + Height Fitting*

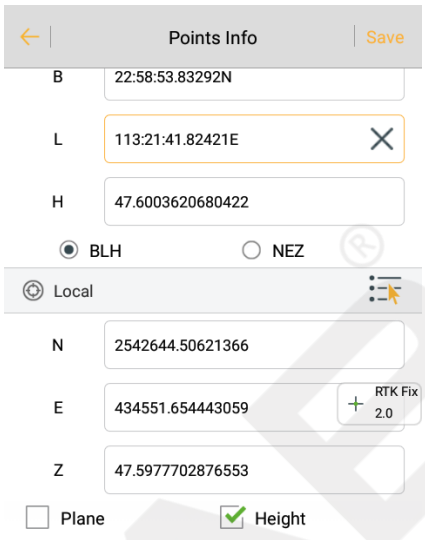



*Figure 2-4-8 Add Point*

The coordinate information input of point pairs by *Plane + Height Fitting* calculation can be set with specific types:

- Tick *Plane*: Use the plane coordinate NE of the point.

- Tick *Height*: Use the elevation coordinate Z of the point.

- Tick *Plane* & *Height*: Use the plane coordinate NE and elevation coordinate Z of the point, to compute plane and height fitting.

The colour description of point pairs in *Plane + Height Fitting*:

- Blue: Use plane coordinate information of point pairs only.

- Yellow: Use elevation coordinate information of point pairs only.

- Green: Use plane and elevation coordinate information of point pairs.

**Notice**:

1. From the Project Settings→System→Coord Sys Management, enter the Edit or Define Project Attributes coordinate parameter interface to do the parameter calculation, which is the calculation for parameters' conversion corresponding to current custom or edited coordinate system type (you can't change the parameter calculation type);

2. From the Project→Parameter calculation or Project→Coordinate system →Parameter calculation or Project→Project Setting→System→Parameter calculation - to calculate the current project coordinate conversion parameters. The parameters' calculation type can be selected independently, and the default is the Plane + Height Fitting. Height-fitting type is the current selected type for parameter fitting by default.

## 2.5 Point Library

All coordinate point, stake point, control point data will be saved here, including *Name, N, E, Z,* and *Description*. The list can be viewed by left and right slipping. You can search and add points, or change the display settings. Long press to enter select mode, tick to select all/ cancel all; the selected points can be deleted or edited, you can delete many points, but only edit one point.

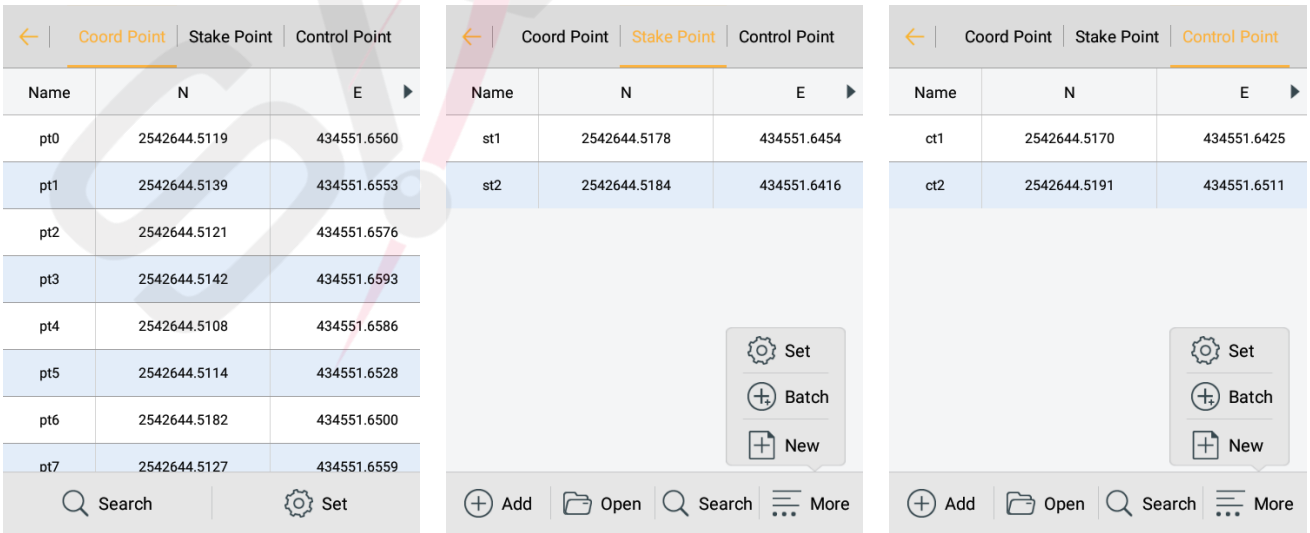


*Figure 2-5-1 Coord Point* *Figure 2-5-2 Stake Point* *Figure 2-5-3 Control Point*

**Notice**:

1. In the Coord Point and Raw Data, the coordinate point list is a positive sequence display, the latest collection points shown in the last.

2. Coord Point - only for viewing, showing and editing the description, it does not allow add or delete.

- *Search*: Search the corresponding point by name and description.

- *Set*: Set the *NEZ* display order of the coordinate points, the decimal number of the coordinates, and the number of coordinate points.

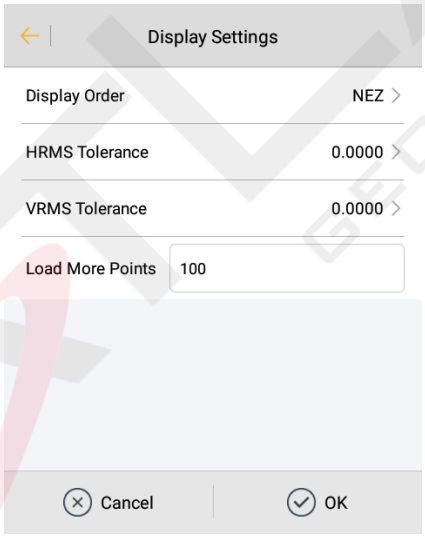



*Figure 2-5-4 Display Settings*

- *New*: Create the new stakeout document at the same project. Click *Stake Point*, the current list will be cleared, at the same time, the file system will be in a fixed file directory (*map* folder under project) new a blank *Stake Point* as the current staking points file.

- *Open*: Open other stakeout documents at the same project; if you need to open the A project stakeout point, you must first copy the **.td2* and **.tdb* file of A to the same project directory.

- *Batch*: Support to add numerous stake and control points from the point library.

- *Add*: Add coord point information, including name, coordinate and description; the coordinate can be from real-time collection, select point and select on map.

- *Edit*: Only edits description of coord points. All data of stake point and control point can be edited.

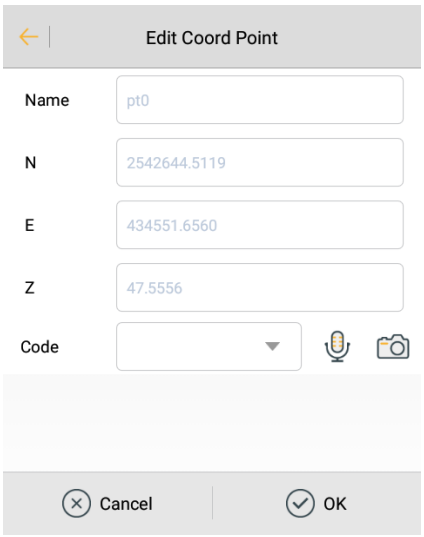



*Figure 2-5-5 Coord Point*

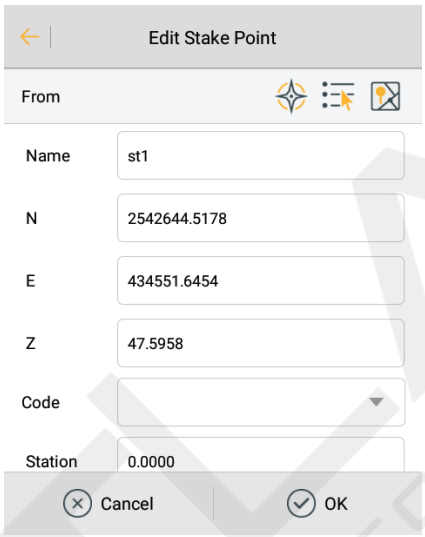



*Figure 2-5-6 Stake Point*

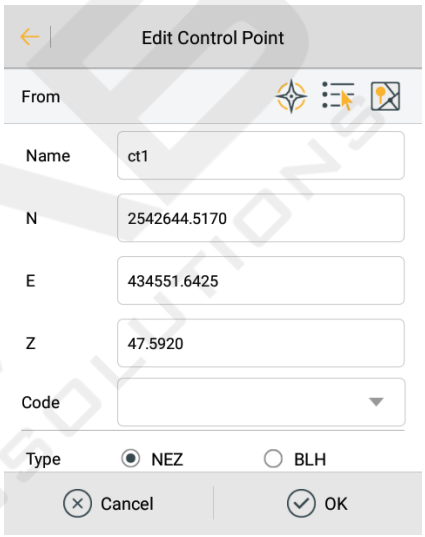



*Figure 2-5-7 Control Point*

**Notice**:
1. *Point Library* of *Edit* operation does not allow editing the name and coordinates, it can only edit *description*.
2. *Edit* operation can only choose one edit at a time.

- *Delete*: Delete the selected stake point and control point; points can be deleted en asse, or tick in front of a name to select all to delete. *Point Library* cannot be deleted. If you need to delete the coordinates, go to *Raw Data* interface for deletion.

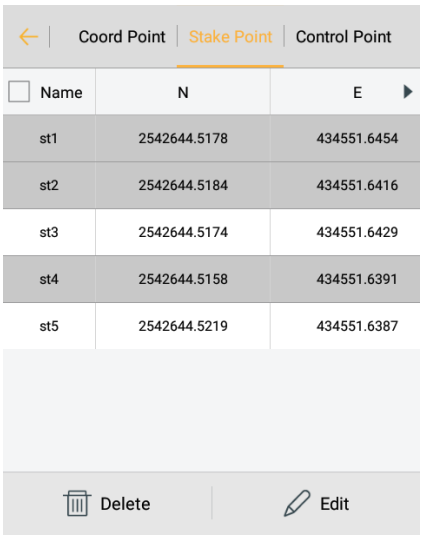



*Figure 2-5-8 Delete*

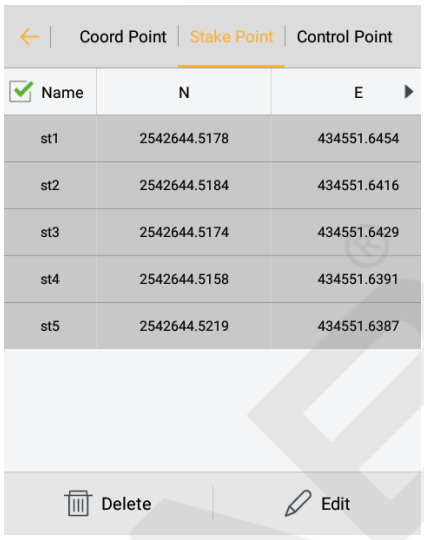



*Figure 2-5-9 Delete All*

**Notice**:

1. The *Stake Point* and control point support *full / full cancel*. The *Point Library* does not support this operation.
2. Long press to enter the selection mode, click to select multiple points, check the button to select the *all / cancel all* operation; you can delete one or more selected points, but each time only one point to edit.

## 2.6 Raw Data

*Raw Data* is to record *BLH*, *Target H RMSE* and *description* under *WGS-84* ellipsoid collection, it can be transferred to get plane coordinates by using the coordinate transfer system.

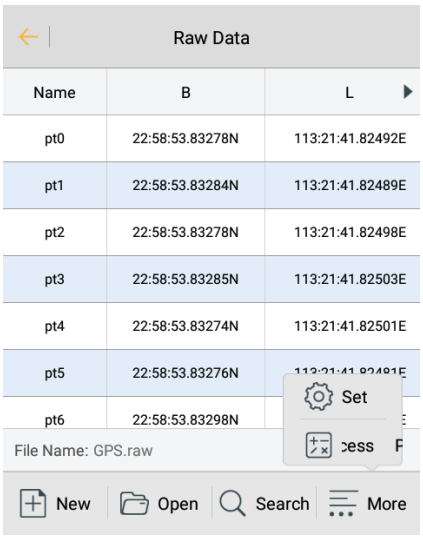



*Figure 2-6-1 Raw Data*

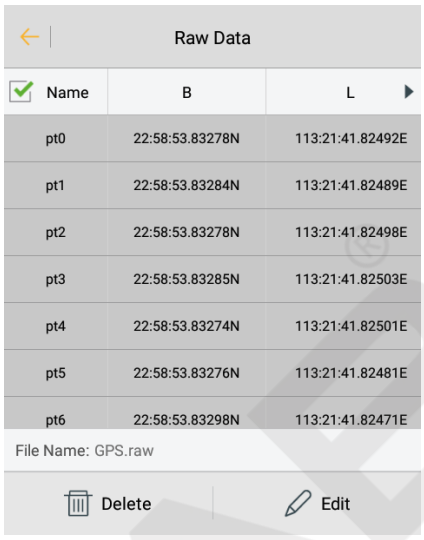



*Figure 2-6-2 Select Raw Data*

- *New*: Create a raw data file (*.raw).

- *Open*: Open an existing raw data file.

- *Search*: Search the coordinate point by name or description.

- *Edit*: Edit the raw data point name, code, station, target height, height type and antenna type; it supports batch edit; the corresponding coordinate point name will be changed after editing raw data.

View other information of point, including solution type, coordinate information, number of average, difference ages, PDOP, satellite, the recording time, station coordinates, the vertical Angle, azimuth of tilt vector and points calibration information, etc.

**Notice**:

1. Raw Data list shows the ground point of the earth coordinates B, L, H (consider Framework Calibration, the Antenna high), slide to right to view the original data list.

2. All the geodetic coordinates shown in measurement interfaces are geodetic coordinates of ground points.

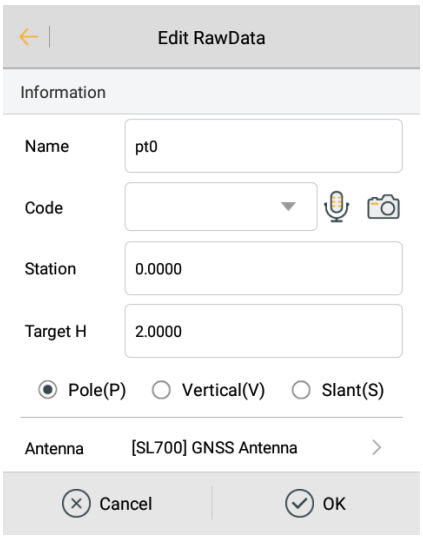



*Figure 2-6-3 Edit RawData*

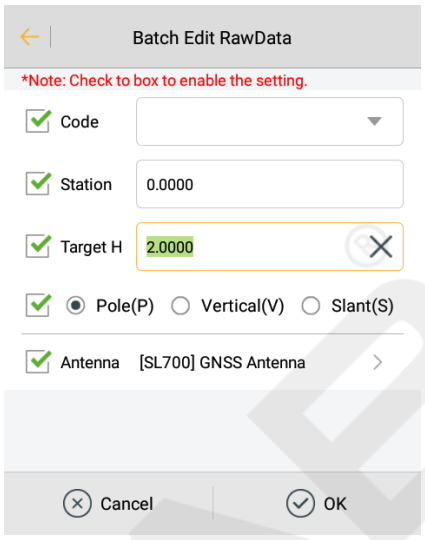



*Figure 2-6-4 Batch*

**Notice**:

1. Turn on Surveying Configure → Data → Allow Same PtName function, raw data supports the same name point collection. If you close it, the name of the re-entry will be prompted to repeat that Duplicate name: please enter it again.

2. In the Edit RawData→Other Info can check Framework Calibration information. If the project does not open using the Framework Calibration, the Framework Calibration value is 0.

- *Upload*: Upload raw data to the private cloud.

- *Set*: Set the loading sequence and display.

- *Process*: Apply the current parameters to point library and get the result. Tick *Use coordinate system* of current project, the project coord system is used by default, do not tick *Use coordinate system* of current project if you need to update the coordinate system, just go to *Coord Sys Management* to set it.

**Notice**:

Data after the handle will update the coordinate point library by default, the measurement interface will display the new point coordinates after opening the new coordinates system.

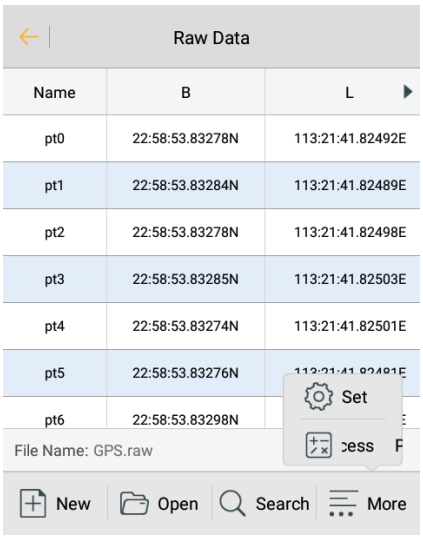



*Figure 2-6-5 Raw Data*

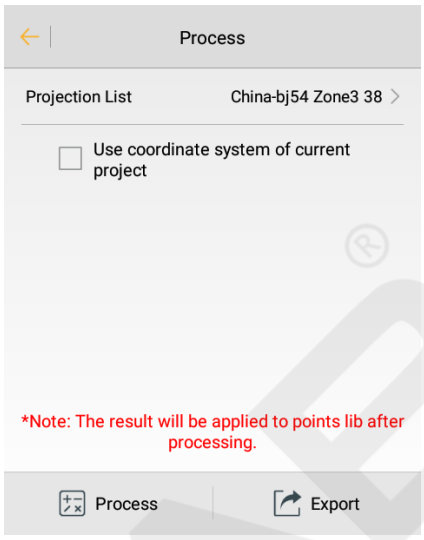



*Figure 2-6-6 Process*

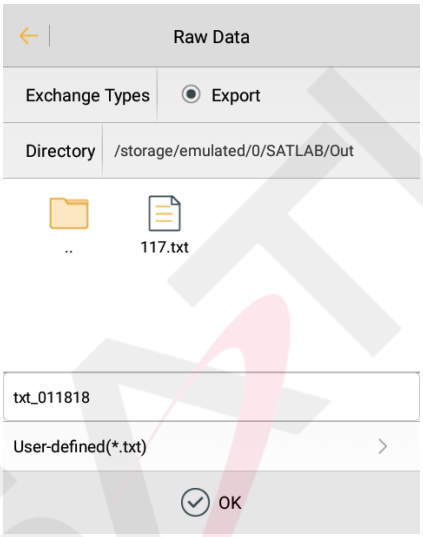



*Figure 2-6-7 Export*

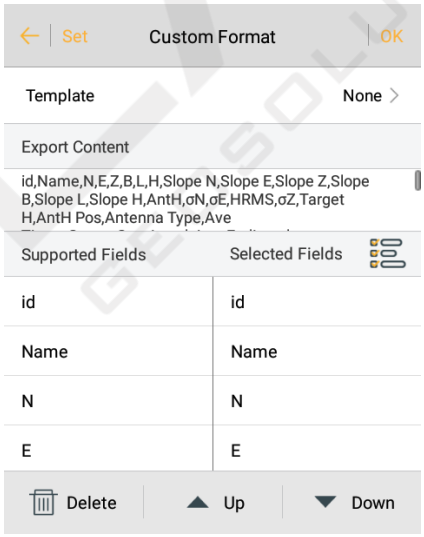



*Figure 2-6-8 Custom Format*

Processed data can be exported and export content can be selected in the optional field of the custom format setting. If there is the same file name, then it will prompt “the same file name already exists’, you can check to *Cover* the original data or enter a new file name, then click *OK* to export.

Optional fields include: *id, Name, N, E, Z, B, L, H, Tilt N, Tilt E, Tilt Z, Tilt B, Tilt L, Tilt H,*

*Antenna H, σN, σE, Plane HRMS, σZ, Target H, Ave Times, Status, StartLocal time, EndLocal time, StartUTC time, EndUTC time, Desc, Latency, Sats, Shared Sats, PDOP, Elevation(°), VRS Name, Base B, Base L, Base H,*

*Station, Tilt Angel, Tilt Azi, Tilt X, Tilt Y, TiltX Azi, Local B, Local L, Local H, Baseline Length, Azimuth, Offset, Audios, Images and Null.*

## 2.7 Mapping Data

*Mapping Data* can show all mapping survey points and supports *New, Open, search,* and long pressing to delete and edit.

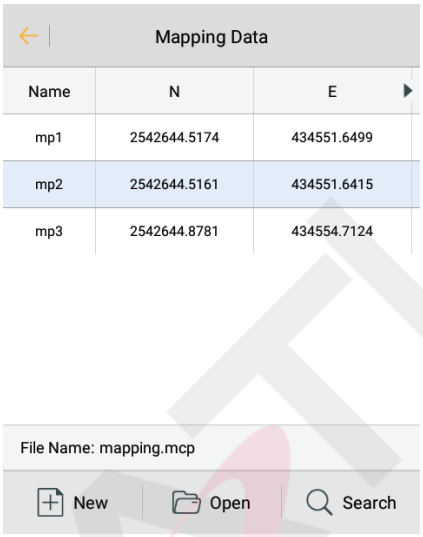



*Figure 2-7-1 Mapping Data*

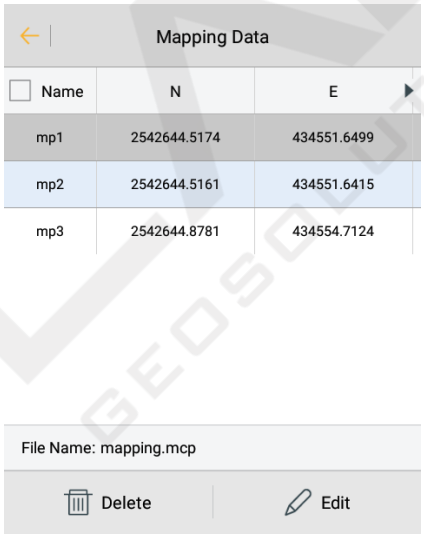



*Figure 2-7-2 Edit Mapping Data*

## 2.8 Data Transfer

Export or import *Raw Data, Stake Point, Control Point* and *Mapping Data* of the current project, for convenient searching and using. If there is a file with the same name as the exporting one, it will show *A file with the same name already exists*, tick *Cover* to export it - this does not delete the old one.

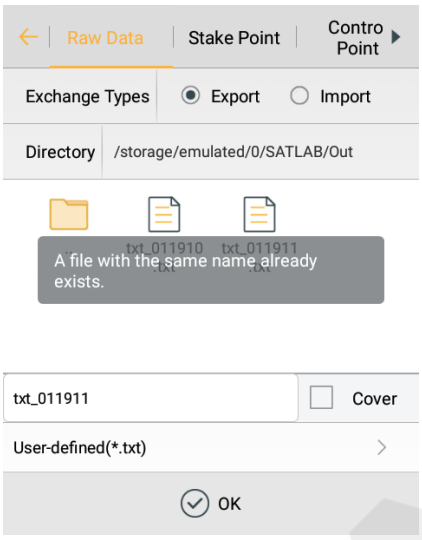



*Figure 2-8-1 Export*

Raw data export format includes:

*User-defined(*.txt), User-defined(*.csv), dxf File(*.dxf), shp File(*.shp), Excel File(*.csv), South cass7.0(*.dat),*

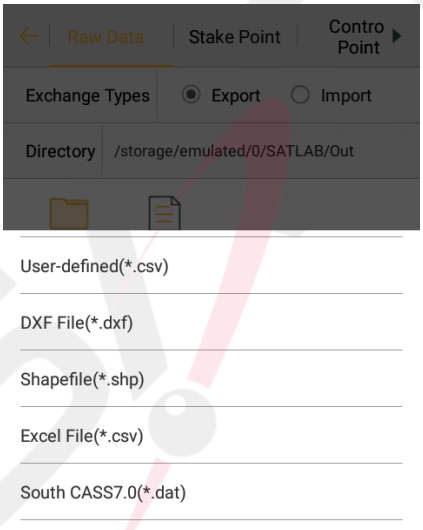



*Figure 2-8-2 Format-CSV*

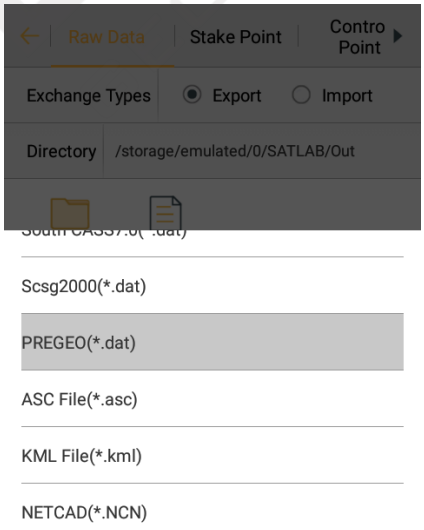



*Figure 2-8-3 Format-List*

Coordinate point, stake point and control point are saved as *Survey.td2*, *Stake.td2*, *Control.td2* in the *Map* folder.

The import and export operation of custom format file method is:

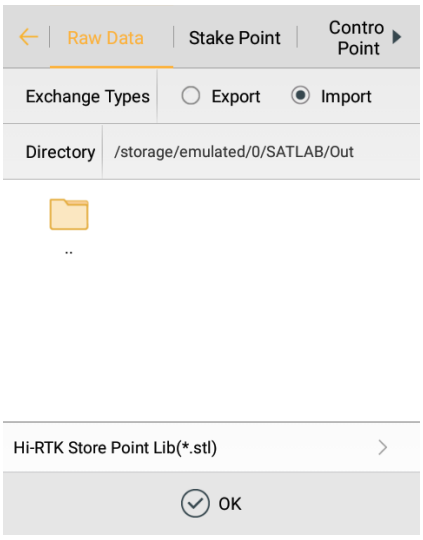



*Figure 2-8-4 Import*

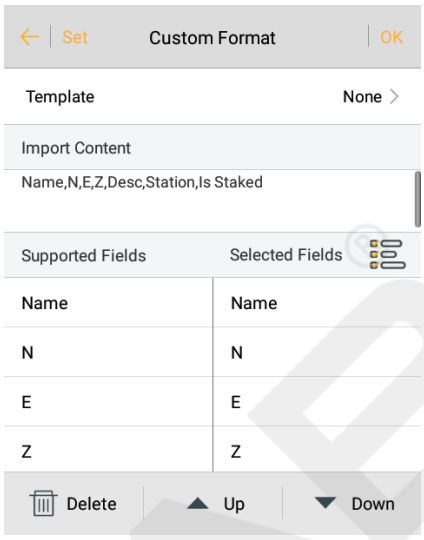



*Figure 2-8-5 Fields*

1. In the *Supported Fields* list, select the fields that need to be exported. The *Selected Fields* are automatically filled in the *Selected Fields* list click the button to select the full or full cancellation fields. The *Export Contents* will show the heads of the parts in proper order;

2. Select one item of *Selected Field*, clicking *Delete* will not export the field. If you move *Up* or *Down* to adjust the export order, the *Export Contents* field order will change all together;

3. Click the *Set* button to set the *Angle* format, *Precision*, *Splitter* and whether to include the *Format Header* and *Template Management*, etc;

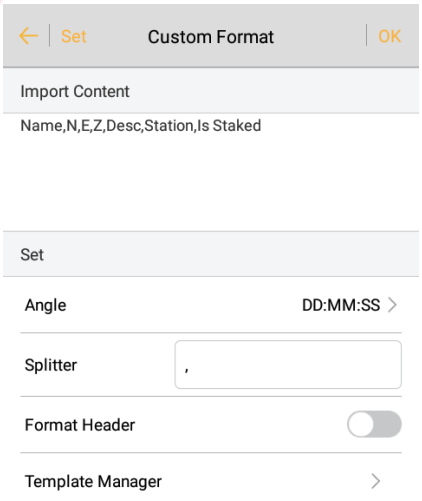


*Figure 2-8-6 Custom Format*

4. After setting, click *OK* to import or export the file; when the software is reintroduced into the staking point interface, the import format will default to be the data format of the last import, as long as the user does not do data cleaning or uninstall the software.

5. Project tilt measurement, *Data Transfer→Raw Data* custom export, supports the export of non-tilt correction of the plane coordinates.

6. If the item *PPK* function is ticked, when the mobile station is set, the *PPK* correction prompt box will pop up when the original data is exported in *Raw Data→Data Processing or Data Exchange*. Click *Yes* to enter the *PPK* correction file selection box, then select the file to correct the processing or exported point.

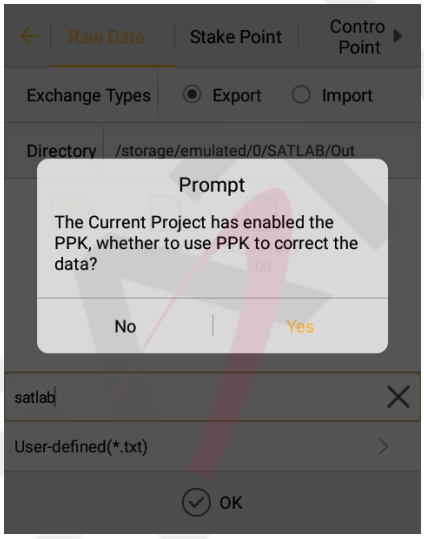



*Figure 2-8-7 Prompt PPK*

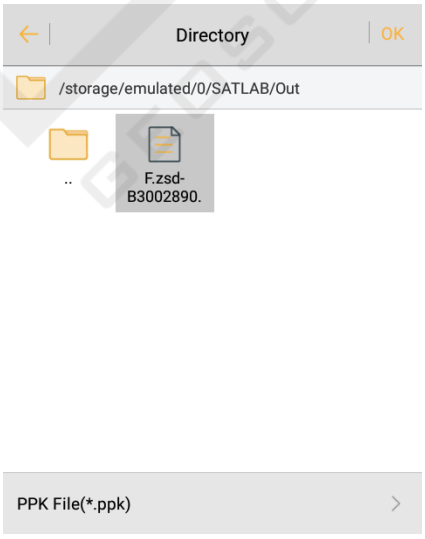



*Figure 2-8-8 Select PPK File*

**Notice**:

1. All the import and export methods involved in the file custom format are the same with this step.

2. The file import data needs to do the number and coordinate range detection (including parameter Calculation Loading, Data Exchange - Stake Point / Control Point import, Stake Line→Stake Line Library loading, Road Stake/Cross-section Collection→Road Design File the choice of loading, Road Design →Plane-Section Design Line intersection, line element, coordinate method of loading. If the test data is not within the range of the value, or the E coordinate band number does not match, the Input import error prompt box is displayed.

## 2.9 Email

As an Android email client, the user can send project files by email to realize for remote uploading of data.

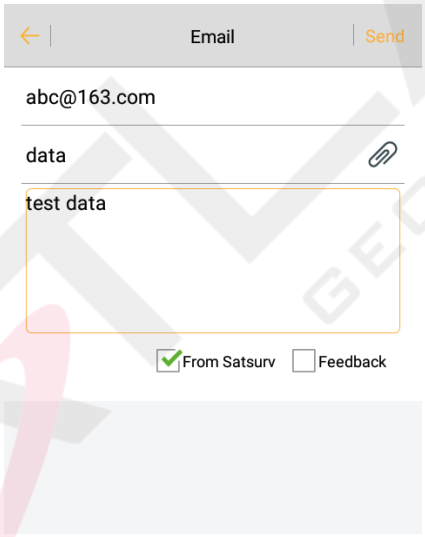



*Figure 2-9-1 Email- From Satsurv*

Tick *From Satsurv* to let Satlab send mail as the sender.

Otherwise, users can switch to the mail type and enter the address, it supports most email systems.

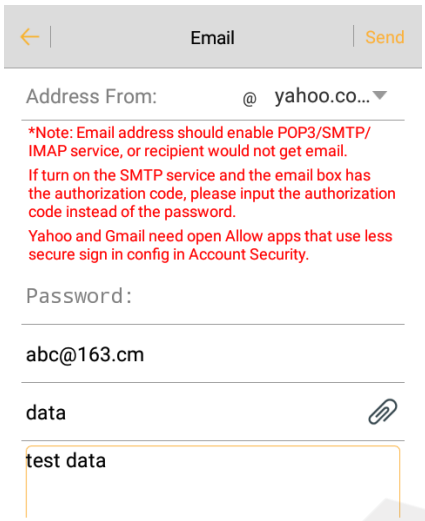



*Figure 2-9-2 Email-Enter Address*

Tick *Feedback* to give the feedback to Satlab - the default address is Satlab enterprise mail.

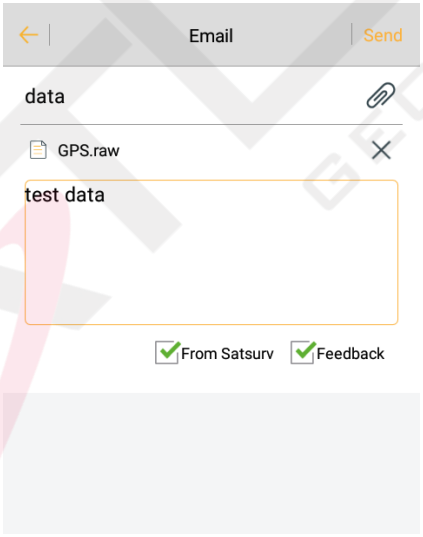



*Figure 2-9-3 Feedback*

File browser operation method (all operations involved in the file browsing options are applicable to this method in this software):

1. Press and hold an item; when the bottom right corner of the current item ☑ appears, put all items into selection mode, press the *BACK* button to exit the selection mode;

2. In the selection mode, you can select or deselect, or select multiple options;

3. In non-selection mode, click on each page, to return to the upper directory, until you reach the root directory of *sdcard*;

4. Click *OK* to complete the file selection;

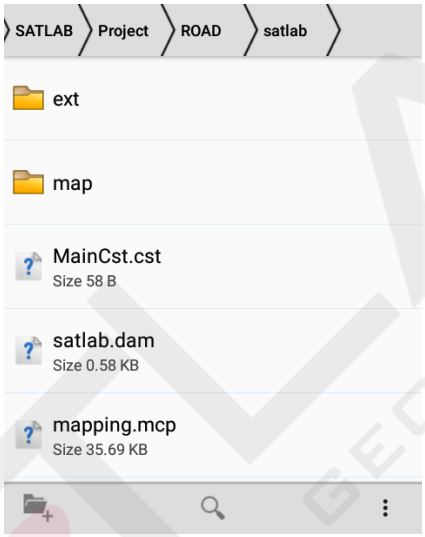



*Figure 2-9-4 File Manager*

File transfer network status test; enter the file transfer interface initially, without displaying the network status test button. When clicking *Send* and the message fails to send, it will show the *Test Network* button; click it to *Test Network* status, and display the test results.

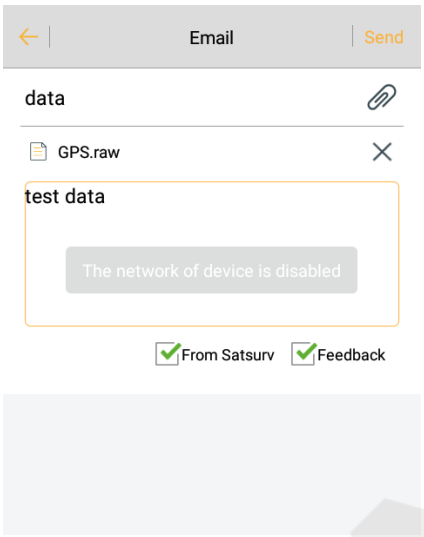



*Figure 2-9-5 Check the Network*

## 2.10 Code List

*Code List* is to replace the long description with a short code. The user can enter *Code List* from the main interface, to *Add*, *Search*, *Edit* and *Delete* the code, and the code is synchronised with the *property.txt* or *property_zh.txt*.

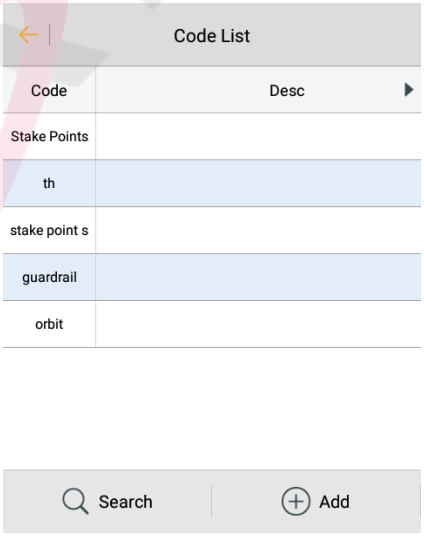



*Figure 2-10-1 Code List*

- *Add*: Users click *Add* to switch to the add page, user input code and descriptions; click *OK* to store the code, the software will update the *Code List*.

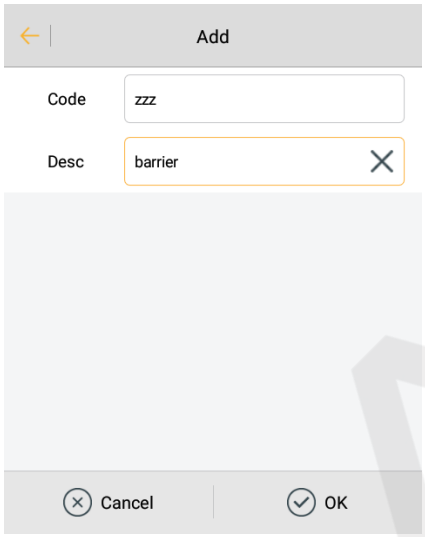



*Figure 2-10-2 Add Code*

- *Search*: Users can click *Search* to switch to the search page, or the user input code; click *OK*, and the software will retrieve a match, switch to *Code List* showing the matched code. If no results appear, the search page is stopped.

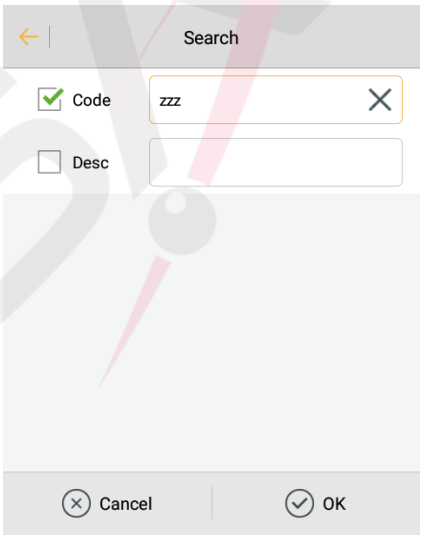



*Figure 2-10-3 Search*

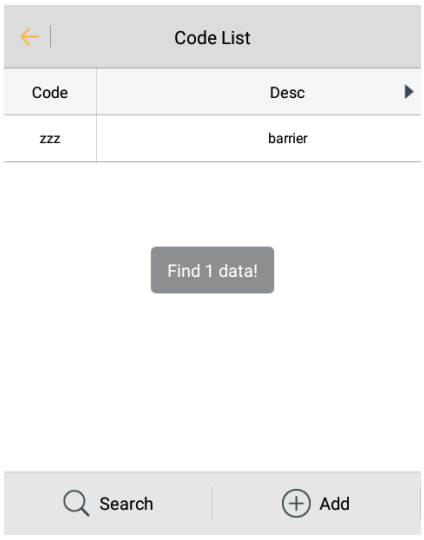



*Figure 2-10-4 Search Result*

- *Edit*: Long press the specific code, click *Edit* to switch to the edit page, click *OK* to store the code; the software will switch to *Code List* to update the list (NB no support for batch editing).

- *Delete*: Long press the specific code, click *Delete* to delete the selected code (batch editing supported).

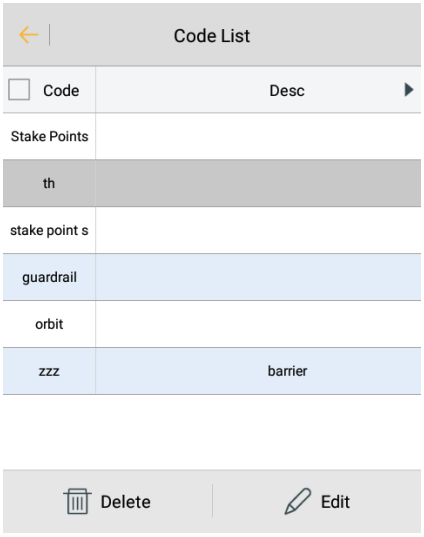



*Figure 2-10-5 Select Code*

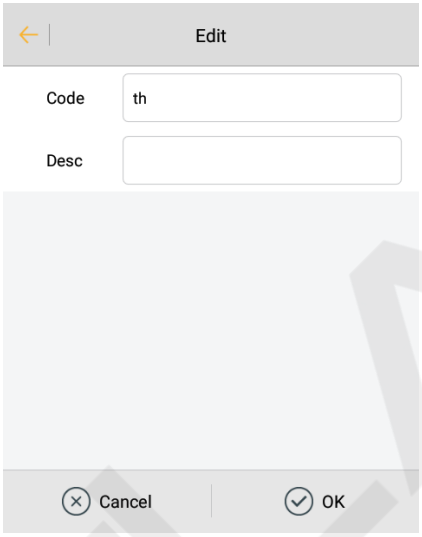



*Figure 2-10-6 Edit Code*

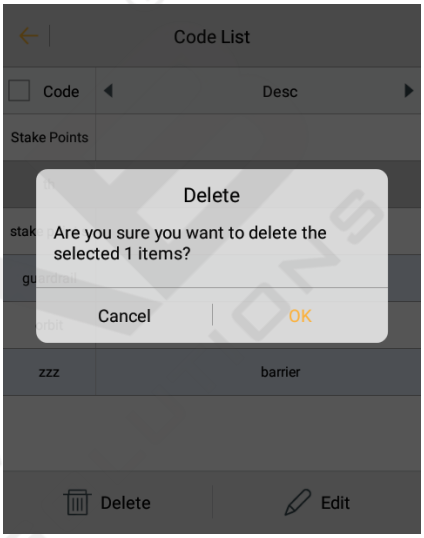



*Figure 2-10-7 Delete Code*

## 2.11 Software Settings

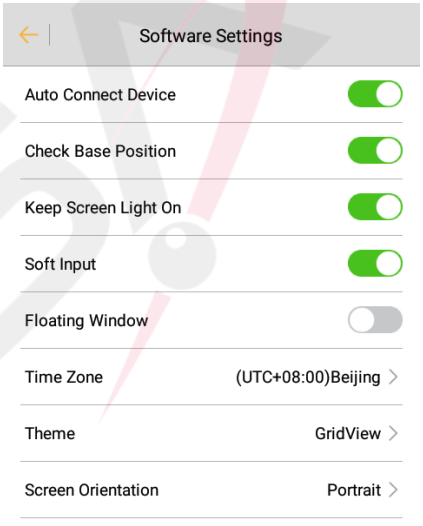



*Figure 2-11-1 Software Settings (1)*

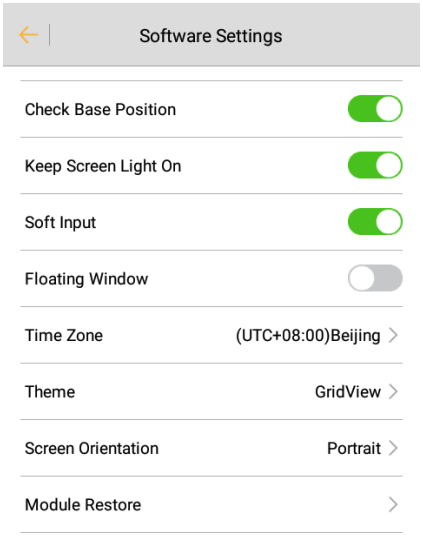



*Figure 2-11-2 Software Settings (2)*

- *Auto Connect Device*: Once opened, it will auto prompt whether to connect to last device automatically when in the connecting, station setting and survey interface.

- *Check Correction Transmitting*: Once opened, it will check difference sending status in Base model and check difference receiving status in Rover model, and will show it in a floating window. : close check correction transmitting; : send no difference message; : sending difference message. When in the handle difference mode, there is difference detection function, so there is no Check Correction Transmitting option.

- *Check Network Status*: Once opened, it can detect the network status of the host, or support iRTK5 series host. In the built-in network mode, open the software *Settings* → *Check Network Status* switch and open the floating window to view the current network signal strength directly.

- *Check Base Position*: Once opened, when rover is first getting the difference, if the Base position is different from before, it will prompt whether to calculate a point. During operation, if a base station change is detected, it will prompt the user base station location to change, and the user can judge the problem according to the actual situation.

- *Keep Screen Light On*: The shutdown status indicates that the power-saving mode is selected and the screen is not in light status.

- *Soft Input*: You can use soft input (screen input method) if opened; if closed, only via the keyboard.

- *Floating Window*: The floating window is set to display in the non-survey interface. The fixed position of floating window in the survey interface shows no shrinkage; when in non-survey interface, you can hold the floating window and drag it to any position in the screen, after 5 seconds, it automatically shrinks

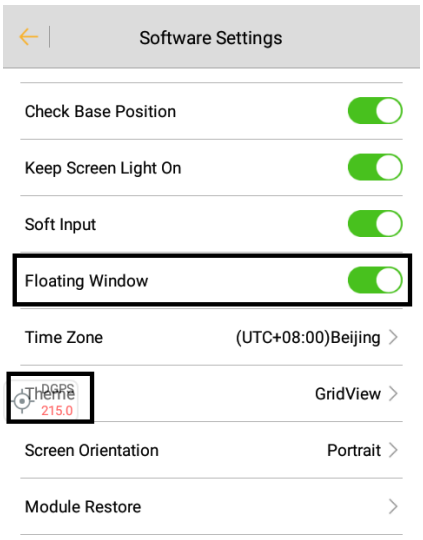
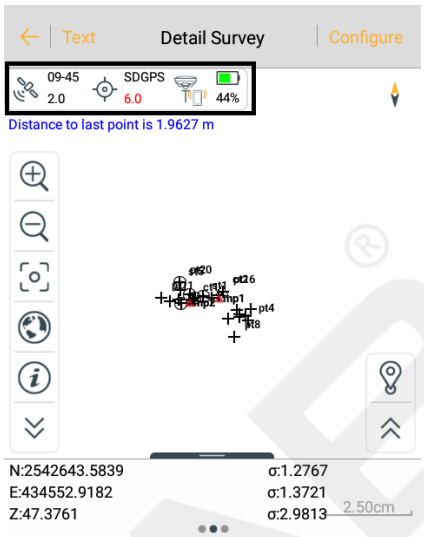



*Figure 2-11-3 Floating Window*




*2-11-4 Floating Window Display*

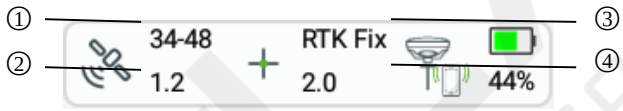



*Figure 2-11-5 Floating Window*

① Public satellites & Visible satellites ② PDOP
③ Solution state ④ Differential age

- *Public satellites*: There is no public satellite in Base station, only when rover station receives the difference data. Public satellites refer to the calculated used satellites, when the base and rover station participate in whole cycles and search at the same time, generally it needs more than 5 to work properly.

- *Visible satellites*: The number of satellites received by the receiver, and 5 at least in RTK works.

- *PDOP*: The spatial geometrical intensity factor of satellite distribution; the better the satellite distribution, the smaller the *PDOP* value; generally less than 3 is the ideal state.

- *Solution state*: mainly includes the following modes (except for the fixed coordinates, the precision ranges from high to low): the known points refer to the fixed (base station) △→ *Fix Pos* → *RTK Fix* → *Float* → *DGPS* → *SDGPS* → *Auto* ○→*None* (no GNSS Data).

- *Differential Age*: Refers to the time when a rover station receives a base station signal for solution.

Description of working mode mark of the *Floating Window*:

Rover Station (close *Check Correction Transmitting*)

Rover Station (send no difference) Rover Station (sending difference)

Base Station (close check correction transmitting) Base Station (send no difference) Base Station (sending difference) *Built-in GPS* *Demo Mode*

No Connection Unknown Device Static Mode

Description of *Floating Window* data link:

No data link With data link Built-in network

External network (3G) Built-in radio External radio

Handle difference (sending difference) Handle difference (no difference)

Handle difference (non-normal difference) WIFI data link

When the data link is handle difference, click on the floating window to enter the *Data Collector Internet Status* interface and check the network status. Click *Connect server* to achieve the handle difference forwarding; if the user has connected to the receiver for the rover station difference, click *Disconnect server* to stop forwarding difference.

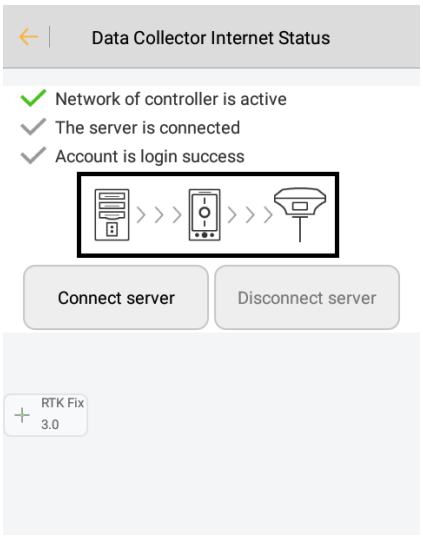



*Figure 2-11-6 Connect*

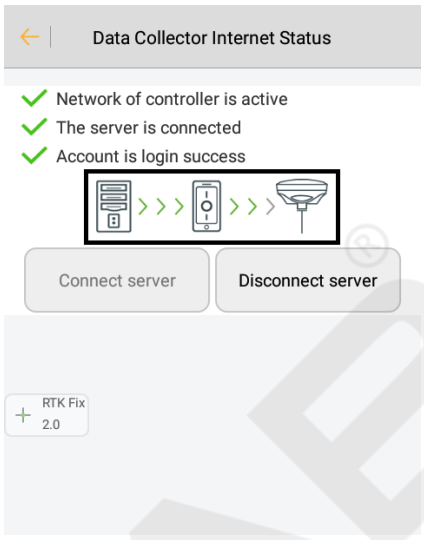



*Figure 2-11-7 Disconnect*

- *Time Zone*: Select work time zone, correct the UTC time input by GNSS receiver to the local time in the user's area.

**Notice**:
For the iRTK5 host, after the time zone is selected, the handle is connected to the receiver, and the software pops up the waiting box to set the receiver time zone. The handle sets the time zone of the receiver each time the device is connected. After the software has set the time zone, the host needs to be restarted, which can be verified by static file creation time.

- *Theme*: Three themes, including *List*, *Style Box* and *Simple*.

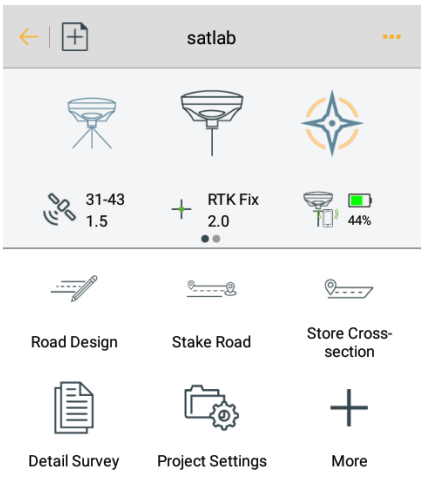



*Figure 2-11-8 Simple*

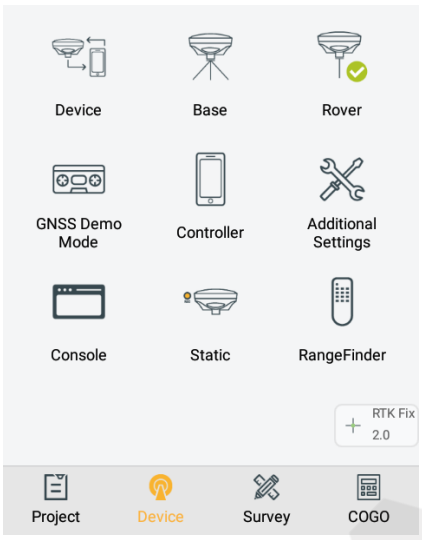



*Figure 2-11-9 Gridview*

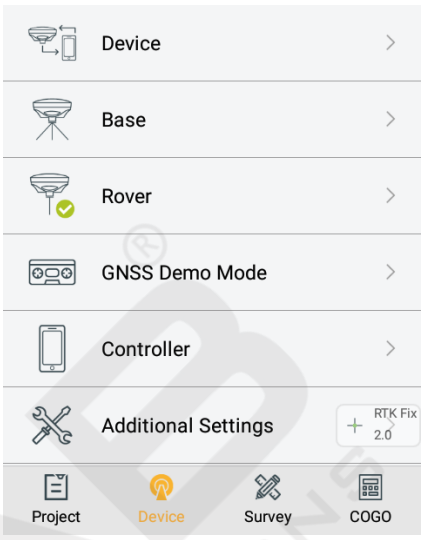



*Figure 2-11-10 List*

- *Screen Orientation*: Can be either landscape or portrait.

- *Module Restore*: Long press to delete module, press return key to exit delete mode, software settings module cannot be deleted. After deletion, module recovery can restore the deleted module to its original location.

- *User Guide*: The user guide can be viewed through a third-party PDF reader. When viewing the user guide, you need to have a PDF document in the SATLAB directory, or the handle on the Internet, and a PDF reader installed.

## 2.11.1 Location Information

Click position icon on the floating window to quickly view the location details.


*Figure 2-11-11 Floating Window - Location Information*

Display the location information of the current point, including *NEZ*, *Velocity*, solution state, *Local time*, and so on.

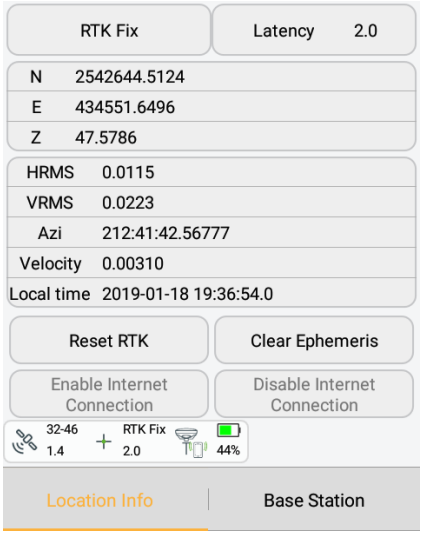



*Figure 2-11-12 Location Info*

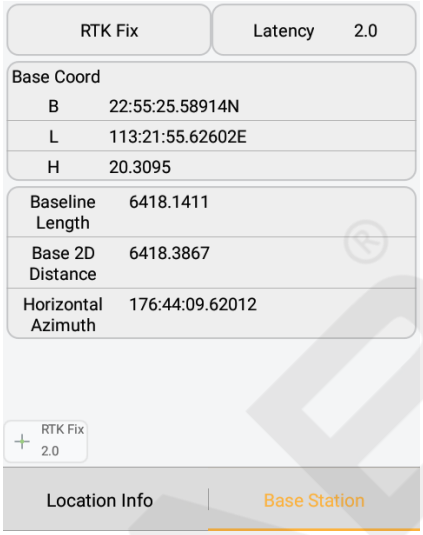



*Figure 2-11-13 Base Station*

- *Reset RTK*: Rover station will calculate the received difference from base station again, usually under the condition of poor satellite status, you can calculate it many times, save the coordinates, to rule out an incorrect solution with multipath interference.

- *Enable internet connection*: Check whether the network is disconnected; after connecting, it is convenient to direct reconnect.

- *Disable internet connection*: Disconnect the network after connecting.

- *Clear Ephemeris*: When the rover station is out of lock, floating and unable to achieve the fixed location, and cannot find Beidou or GLONASS, then click the Clear the ephemeris button. Reset the main board after clearing.

- *Base Station Information*: Display base station coordinates, distance, horizontal distance and azimuth。

## 2.11.2 Satellite Information

Click satellite icon on the floating window to quickly view the satellite details.

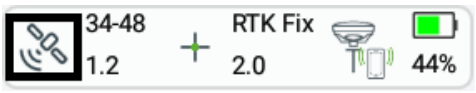



*Figure 2-11-14 Floating Window-Satellite Information*

1. SATView

View the projected location of the satellite, the national flags represent their satellites, and the corresponding number below each satellite is the number of the locked satellites.

- *GPS*: The Prn range is 1-33

- *GLONASS*: The Prn range is 65-96

- *SBAS*: The Prn range is 120-151(EGNOS: Prm values: 120,124,126; SDCM: Prm values: 125,140,141; GAGAN: Prm values: 127,128; MSAS: Prm values: 129,137; WAAS: Prm values: 133,135,138)

- *BDS*: The Prn range is 161-195

- *GALILEO*: The Prn range is E1-E52

- *QZSS*: The Prn range is J191-J195

View and set GNSS satellite elevation mask, click *Set* to set the elevation mask.

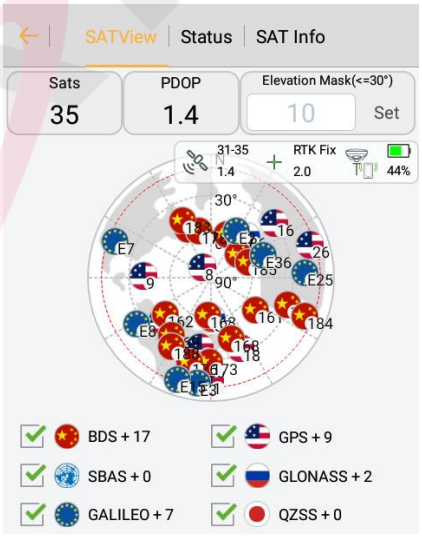



*Figure 2-11-15 SATView*

Set the colour according to the L1 carrier signal-to-noise ratio of satellite, colour: red <= 31, 31 < orange <=41, green >41.

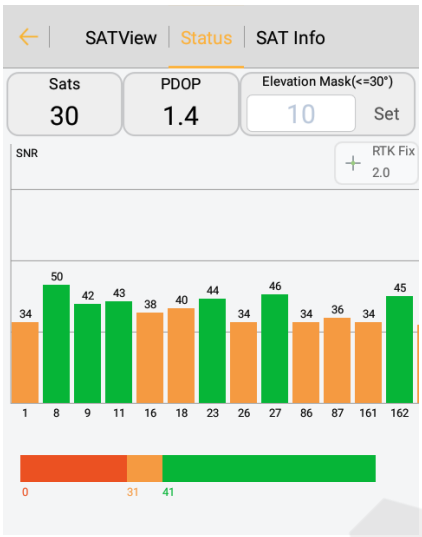
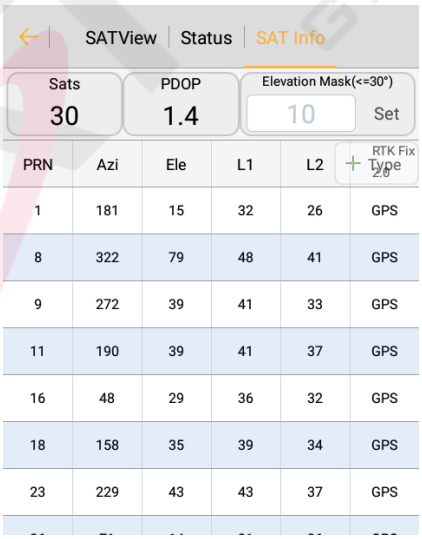



*Figure 2-11-16 Status*

2. Satellite Signal-To-Noise Ratio Map

*PRN* is satellite number, *Azi* is the azimuth of satellite, *Ele* is the elevation mask, *L1* is the signal-to-noise ratio of L1 band, *L2* is the signal-to-noise ratio of L2 band, and *Type* is the satellite type.




| PRN | Azi | Ele | L1 | L2 | Type |
|---|---|---|---|---|---|
| 1 | 181 | 15 | 32 | 26 | GPS |
| 8 | 322 | 79 | 48 | 41 | GPS |
| 9 | 272 | 39 | 41 | 33 | GPS |
| 11 | 190 | 39 | 41 | 37 | GPS |
| 16 | 48 | 29 | 36 | 32 | GPS |
| 18 | 158 | 35 | 39 | 34 | GPS |
| 23 | 229 | 43 | 43 | 37 | GPS |

*Figure 2-11-17 SAT Info*

## 2.12 About

Here are the related instructions for the software version and upgrade.

Open the application in the networked state, and when a new version of the software is detected, the system will display the popup, according to the configuration information on the server. If the current link is a non-WIFI data link, the user will be prompted whether to download.

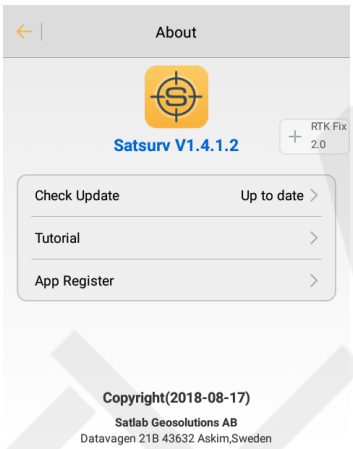



*Figure 2-12-1 Update*

**Notice**:
The information above is virtual information, the factual operations are based on actual information.

# Chapter 3

## Device

**This chapter contains:**

-Device
-Base
-Rover
-GNSS Demo Mode
-Controller
-Additional Settings
-Console
-Static
-RangeFinder

# 3.1 Device

## 3.1.1 Device Connection

To connect the hand-held controller to GNSS receivers set the device connection method and antenna type (can be modified after connection), and then click Connect.

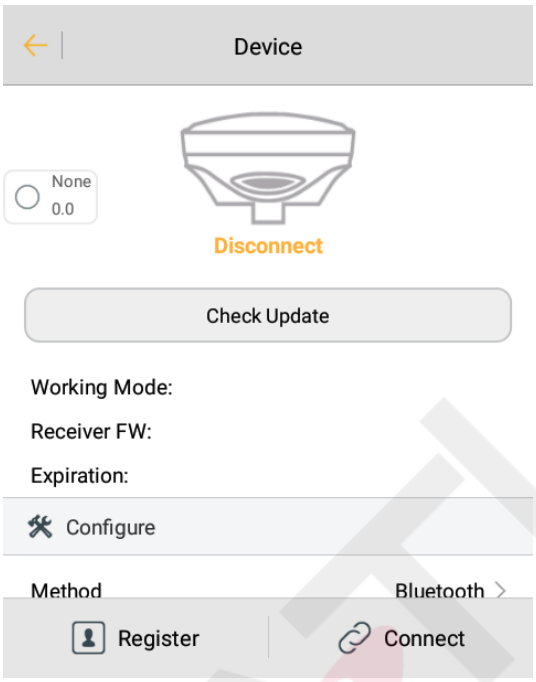



*Figure 3-1-1 Device*

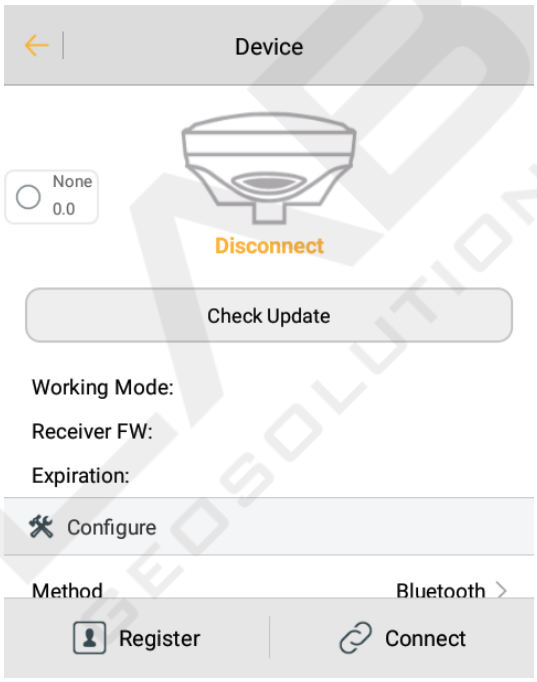



*Figure 3-1-2 Bluetooth Connect*

There are three methods of connection, Bluetooth, network and Wi-Fi. In addition, the built-in GPS and demo modes can be set independently with the hand-held controller.

1. In Bluetooth connection mode, it's necessary to turn on the Bluetooth function of the receiver and hand-held controller at the same time, and click Connect to enter the Bluetooth connection interface. Click Search device to search for the device that needs to be connected, choose it in the list by the S/N and there will be a Bluetooth pairing prompt. Enter the pairing password (default password is 1234) to connect the device, and paired devices do not need to enter the pairing password again. If no device is found, please click Search device to search again.
2. In Wi-Fi connection mode, if there is no Wi-Fi connected to the current hand-held controller, it will

automatically enter the system Wi-Fi connection interface. Please choose the Wi-Fi that is needed, then click Connect. If there is already Wi-Fi connected, users can choose *Cancel*, *Other* or *OK*, according to the situation.

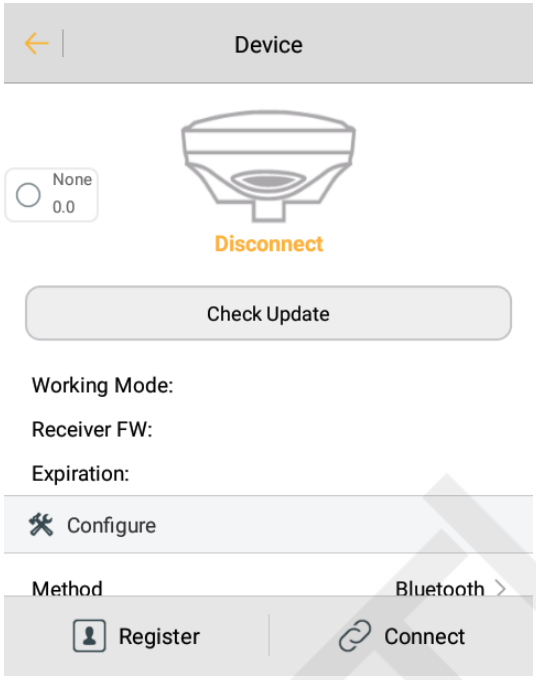



*Figure 3-1-3 Wi-Fi*

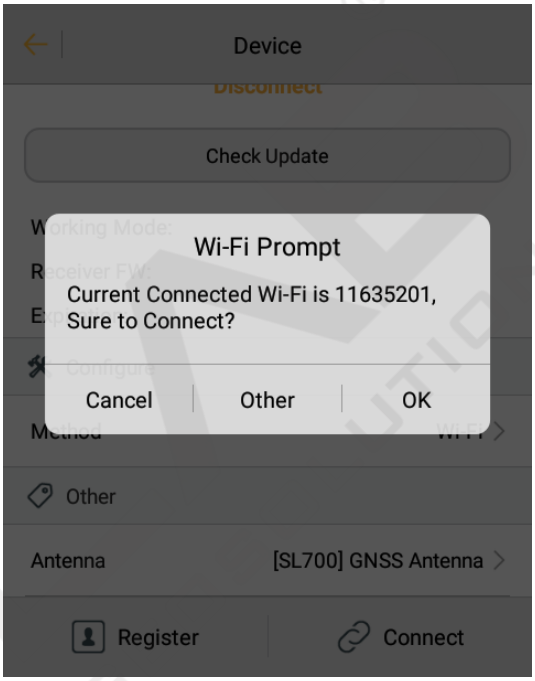



*Figure 3-1-4 Wi-Fi Prompt*

3. In Built-in GPS connection mode, it will display the S/N of the hand-held controller, when using the Satlab hand-held controller, otherwise it will be blank. In working mode, receiver FW and expiration will be blank too.

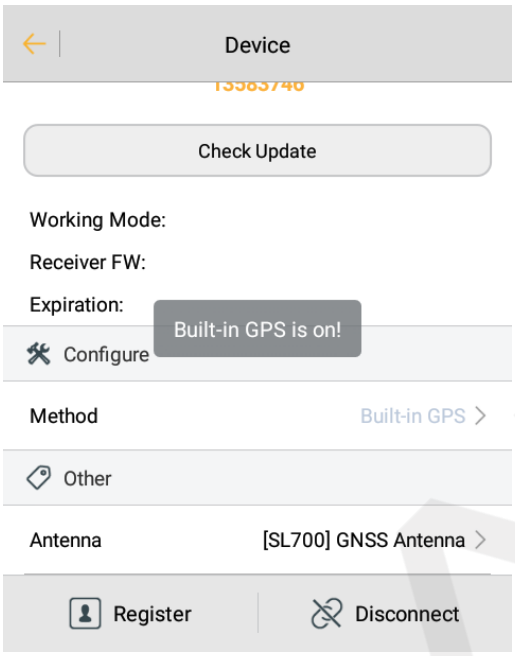



*Figure 3-1-5 Built-in GPS*

4. In Demo connection mode, the working mode, receiver FW and expiration will be blank too. S/N will display as demo mode.

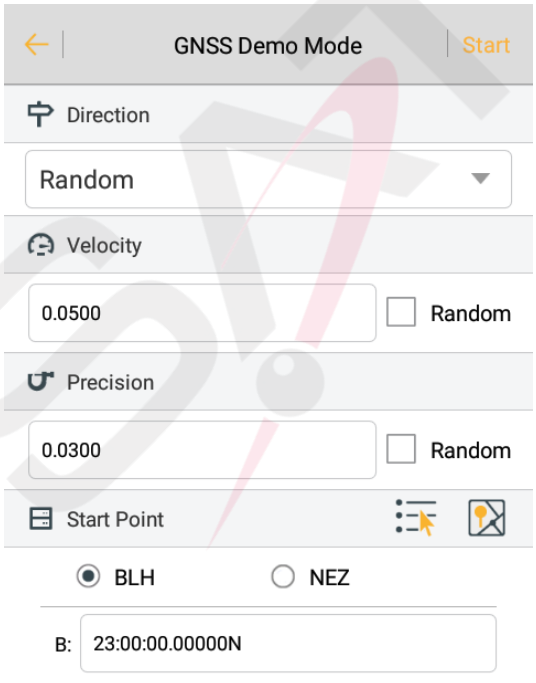



*Figure 3-1-6 Demo Mode*

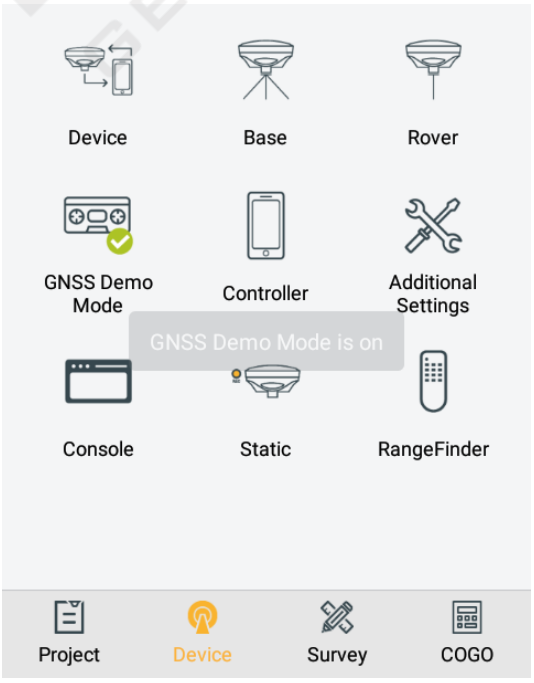



*Figure 3-1-7 Mode Prompt*

The current receiver's connection status will be displayed after the device is connected successfully, including the S/N, Check Update, Working Mode, Receiver FW, Expiration, Method and Antenna.

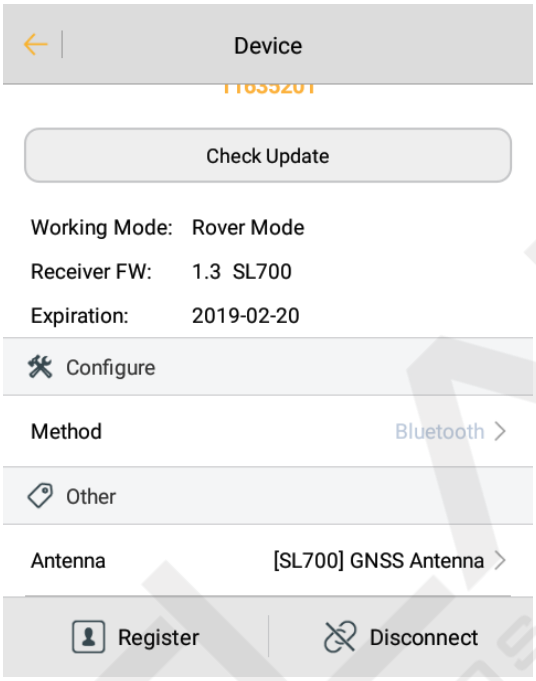



*Figure 3-1-8 Device Info*

- *Check Update*: Check and upgrade the connected host and motherboard firmware. After connecting the receiver by Bluetooth or Wi-Fi, click *Check Update* to enter the firmware update interface. If there is new firmware, there will be a prompt, and users can click Update button to upgrade.

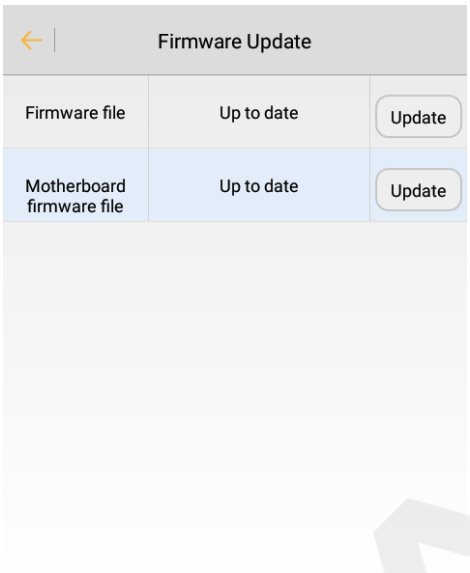



*Figure 3-1-9 Firmware Update*

- *Working Mode*: Display the current receiver's operating status, generally base mode, rover mode or static mode.

- *Receiver FW*: Receiver firmware version number and receiver type.

- *Expiration*: Deadline for registration code use.

- *Antenna*: Set the antenna type. Enter the antenna manage interface to choose it, according to the model; if there is no matching antenna type, you can click *Add* to add the custom antenna type by inputting the Model, Desc, Radius, L1 Phase Offset, L2 Phase Offset and SHMP Offset in the Add Antenna interface.

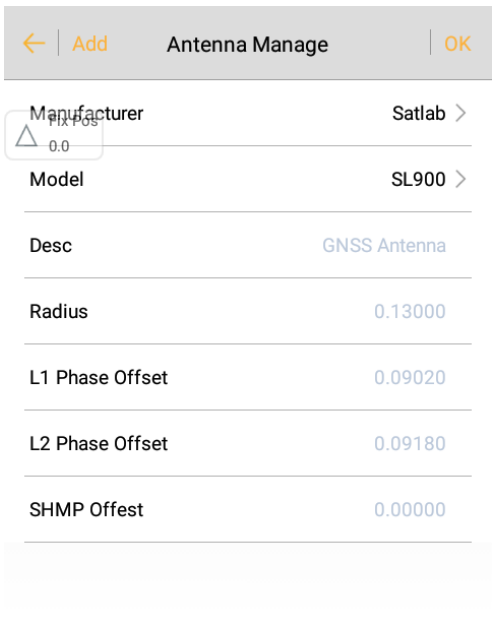



*Figure 3-1-10 Antenna Manage*

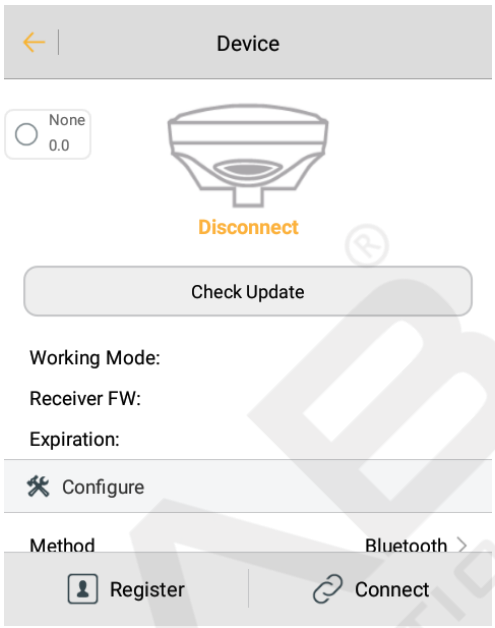



*Figure 3-1-11 Add Antenna*

## 3.1.2 Register

Registering the receiver. Connect the GNSS receiver, input the receiver registration code, or scan the receiver QR code to register (please ask the Satlab service person for the registration code or QR code). The code for the 7-digit S/N receiver is 21-digits, with a 24-digit code for the 8-digit S/N receiver.

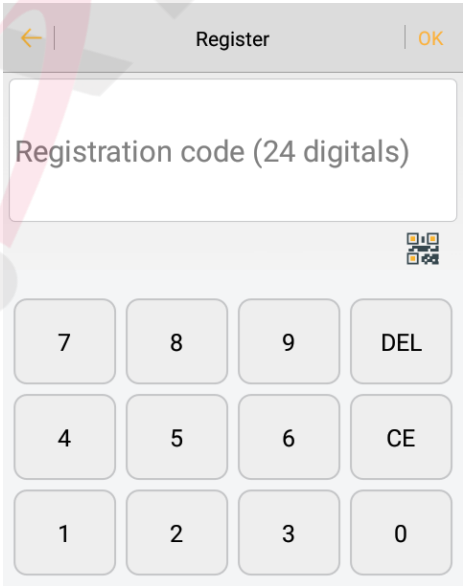



*Figure 3-1-12 Register*

### 3.1.3 NFC Connection

Users can scan the NFC-enabled receiver's NFC tag, with the NFC-enabled hand-held controller, to connect the device.

The current receiver's connection status will be displayed after the device is connected successfully, including Working Mode, Receiver FW, Expiration, Method, Antenna, etc.

## 3.2 Base

The base settings mainly set the working parameters of the base station, including the base coordinates, data link and other parameters.

### 3.2.1 Base Configuration

Users can save all the parameters, set in the base station, as a configuration file, or load the parameters directly from the configuration file.

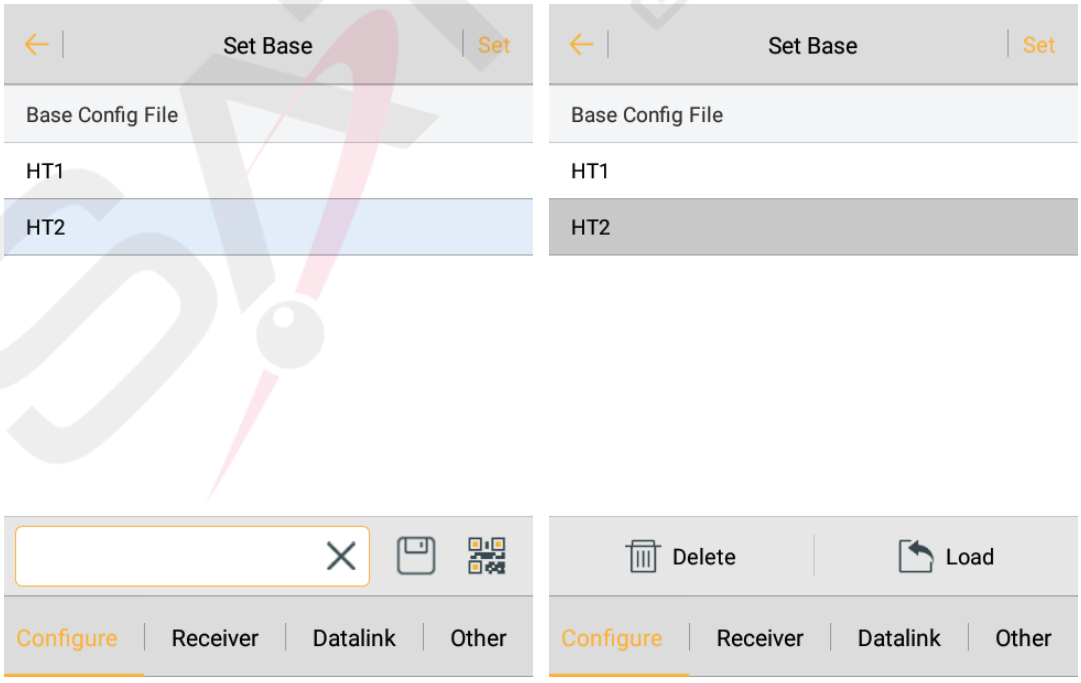



*Figure 3-2-1 Configure* *Figure 3-2-2 Delete or Load*

- *Save*: Input the configuration name and click to save the current set parameters.

- *Delete:* Delete the selected configuration file.

- *Load:* Load parameters of the selected configuration file.

- : Generate the parameters of the current settings as a QR code.

### 3.2.2 Receiver Position

Set the coordinates of the base station to the latitude and longitude coordinates in the WGS-84 coordinate system (requires the GNSS to be measurable to get the height anomalous value, because the H of the base position is the ellipsoid height and the motherboard needs the geoidal height of the internal model).

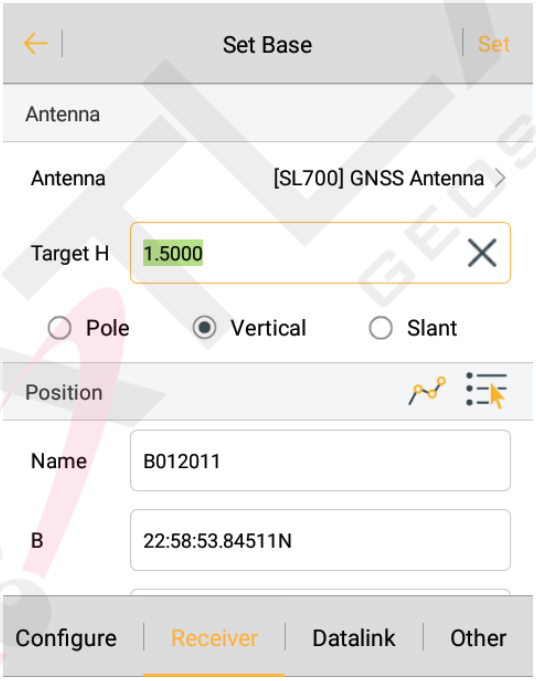



*Figure 3-2-3 Receiver*

When setting up the base station at an unknown point, point coordinates can be obtained by average collection. (the more coordinates in the average collection, the higher the reliability).

When setting up the base station on a known point, users can input the coordinates directly, or select data from the point library by clicking the point library icon.

- *Antenna*: To enter the antenna type management interface and select antenna type.

- *Target H:* Input the instrument height and height type of the base station.

- *Position:* The ground reference point of the base station, it can be manually-set or obtained by average collection, or from the point library.

- : Point library. It is used to get points in the coordinate library to the current interface.

- : Average collection. To enter the average collection interface, the default number of smoothing is 10 times.

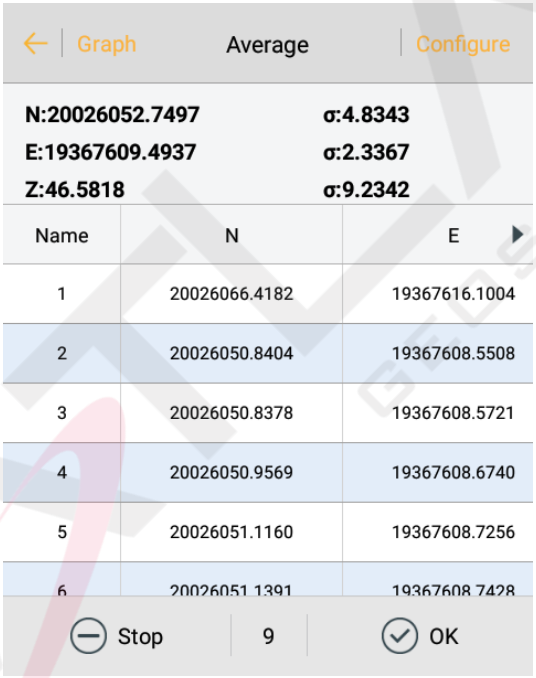



*Figure 3-2-4 Average*

In the Average interface, users can collect points manually

- *Stop:* Click the average collection icon and it will start smoothing automatically. Users can click Stop to stop it, or click Start to begin the collection.

- *OK:* Apply current average coordinate data.

- *Graph:* Enter the graphical interface of the average collection, and view the distribution of points.

- *Configure:* Set the Average Method, Status, Ave Times and Ave Precision.

- *Delete:* According to the accuracy of points, users can select the point to participate in the average calculation. Long press on an item, in the list of average points, to delete the point (it will be unrecoverable).

### 3.2.3 Data Link

Data link settings are used to set the communication mode and parameters between the base and rover, including the Internal UHF, Internal GSM, External Radio, Wi-Fi and Data Collector Internet (for specific models).

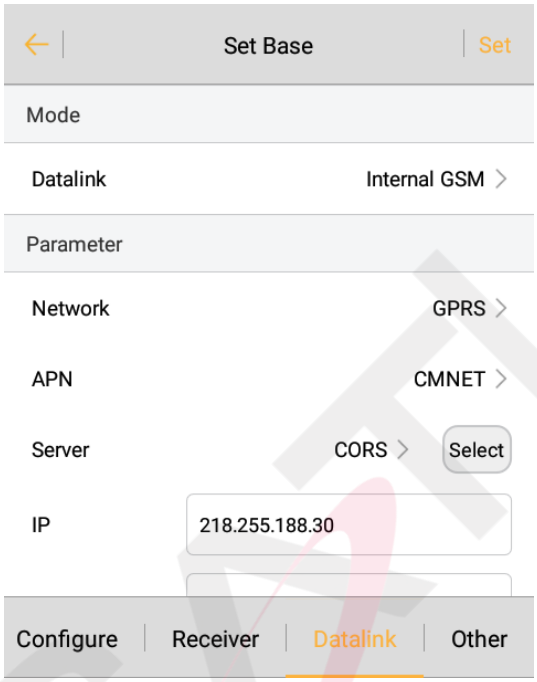



*Figure 3-2-5 Datalink*

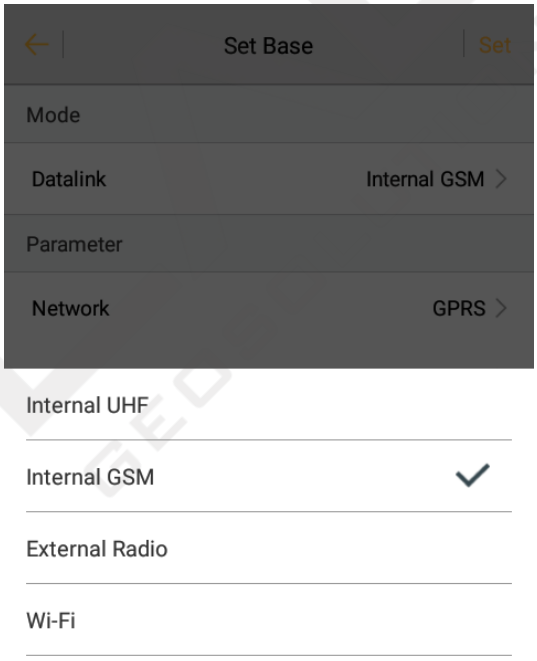



*Figure 3-2-6 Choose the Datalink*

1. In the Internal UHF mode, users can set the Channel, Power, Advance settings (for specific models), etc.

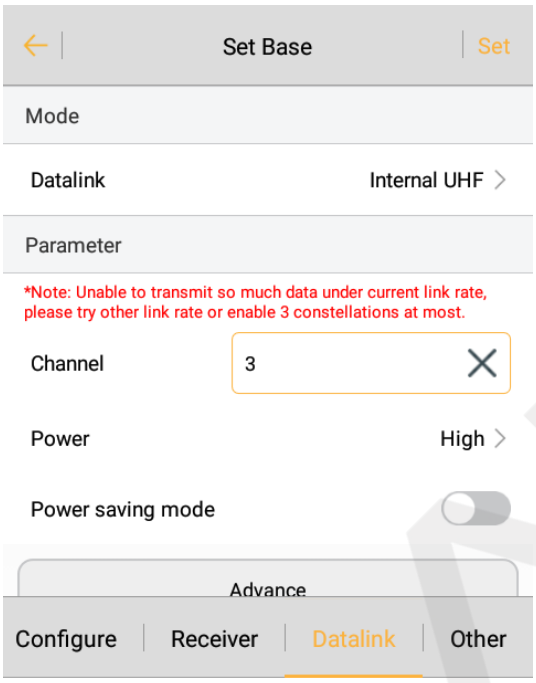



*Figure 3-2-7 Internal UHF*

- *Power*: There are three options, including high, middle and low options.

- *Advance*: Click to enter the interface to get the most suitable channel (for specific models).

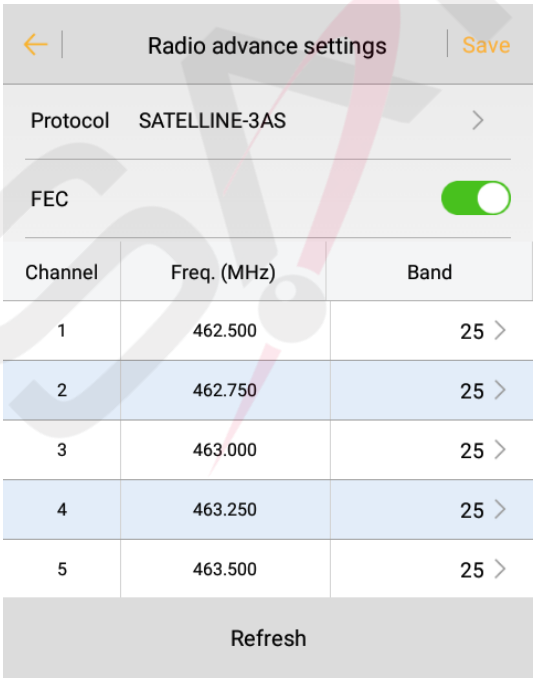



*Figure 3-2-8 Channel List*

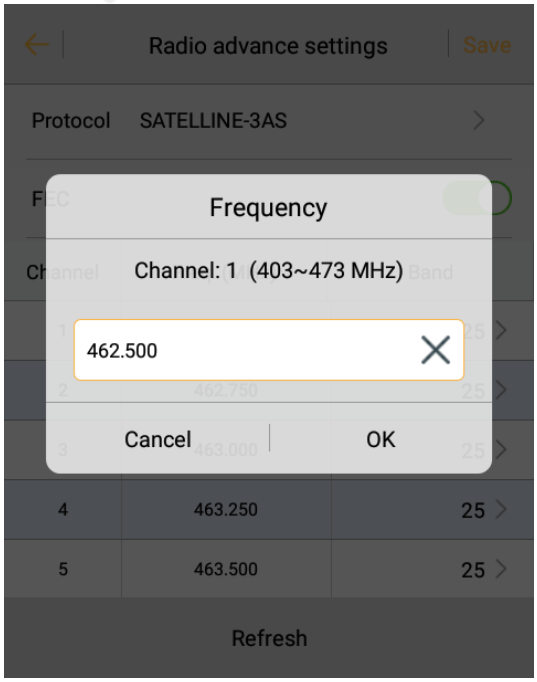



*Figure 3-2-9 Frequency*

Click the frequency of a channel to modify the frequency of the channel, within the frequency range specified by the channel.

- *Refresh*: If the result of the current search is not a suitable channel, users can change the starting channel to continue a new round of searches.

- *Reset:* Click to restore the list to default state.

- *Save:* After modifying the frequency table, please click to complete the modification.

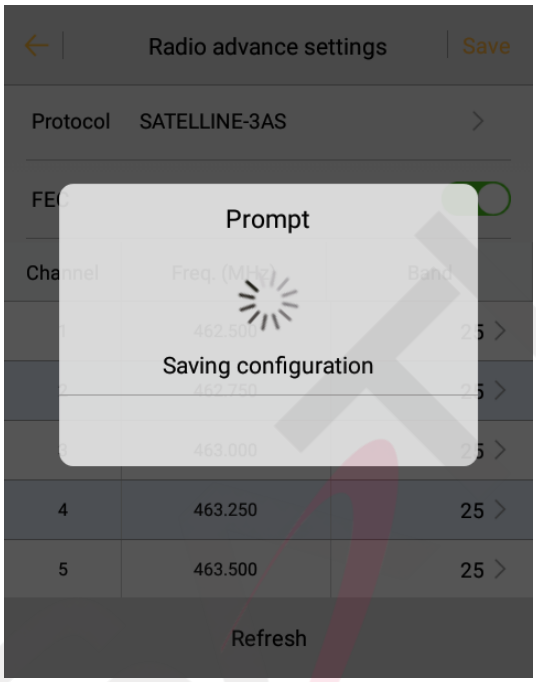



*Figure 3-2-10 Saving Prompt*

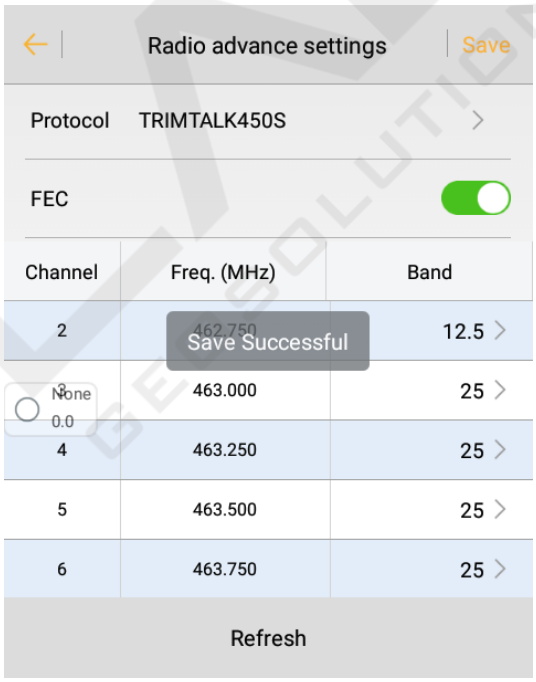



*Figure 3-2-11 Save Success*

2. In Internal GSM mode, users can click Network to choose the network type (GPRS, GSM, CDMA).

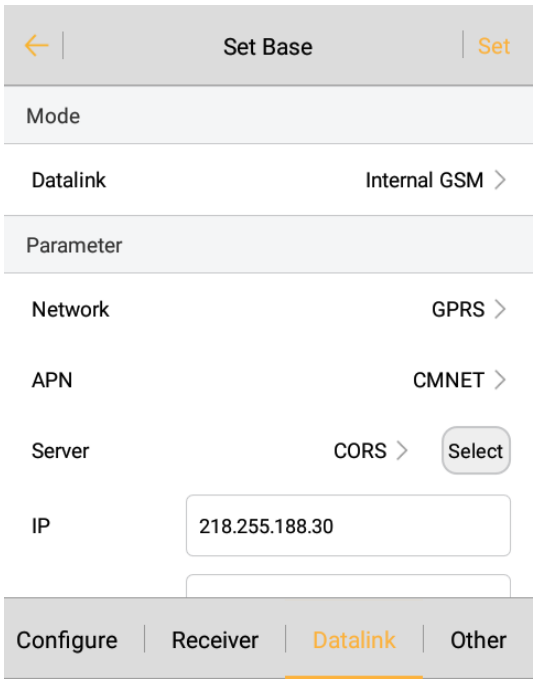



*Figure 3-2-12 Internal GSM*

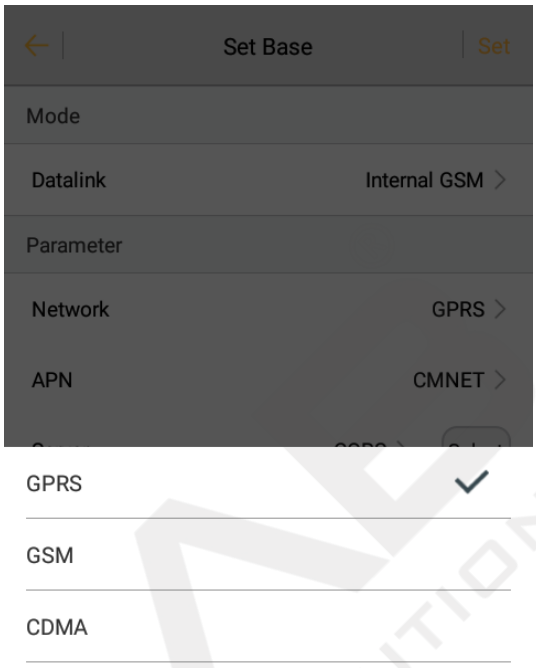



*Figure 3-2-13 Network*

- *APN*: Different networks will have different settings.

- *Server*: Choose the mode. Input the IP and port manually, or click *Select* to enter the server list and choose a suitable server.

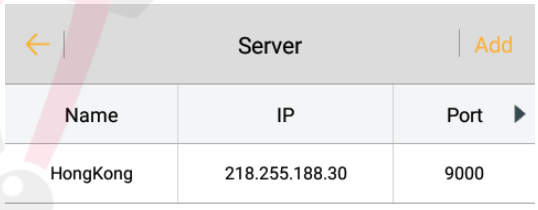



*Figure 3-2-14 Server*

When in SATLAB mode, there are two kinds of group types, including City Number and Base Station SN.

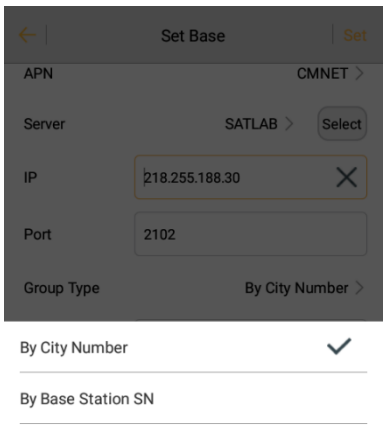



*Figure 3-2-15 Group Type*

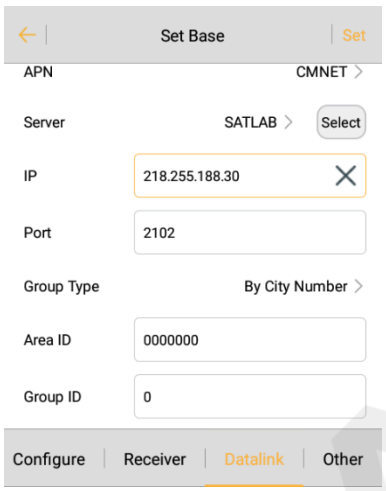



*Figure 3-2-16 City Number*

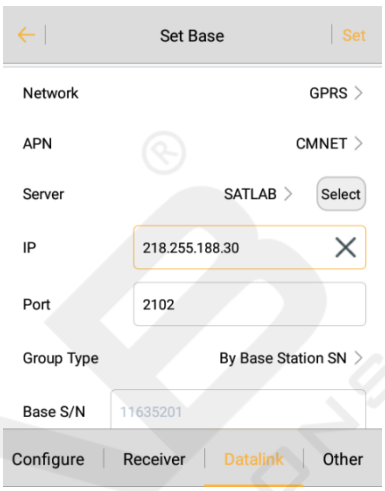



*Figure 3-2-17 Base S/N*

- *By City Number:* The Area ID and Group ID are 7 and 3 digits respectively. The group ID needs to be less than 255. The base and rover need the same parameter settings to work properly

- *By Base Station SN*: Input the base S/N, and set the same number in the same way with the rover.

When you use the CORS mode, please set the right IP, port, mountpoint, etc. Then click Set to save the settings.

3. In the External Radio mode, the device can connect to the external radio to transmit data.

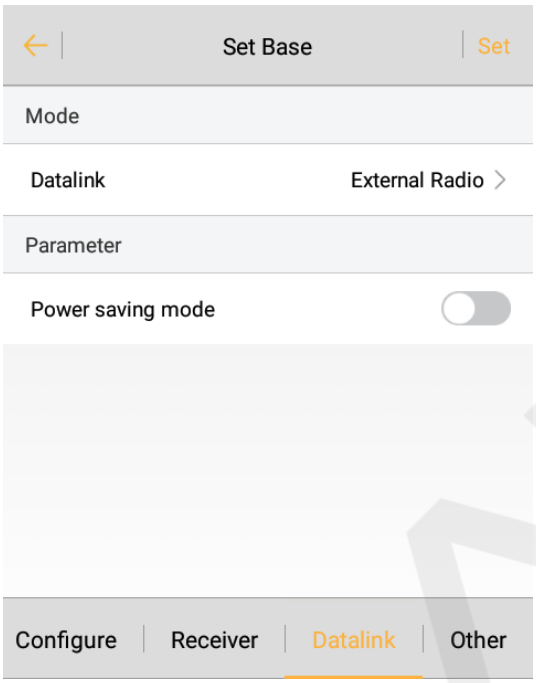



*Figure 3-2-18 External Radio*

4. For the *Wi-Fi* mode, after the hand-held controller is connected to a WiFi-enabled receiver, through a non-WiFi connection, the data link will add the Wi-Fi mode. In this mode, the receiver can be set to connect to a third-party Wi-Fi and send differential data.

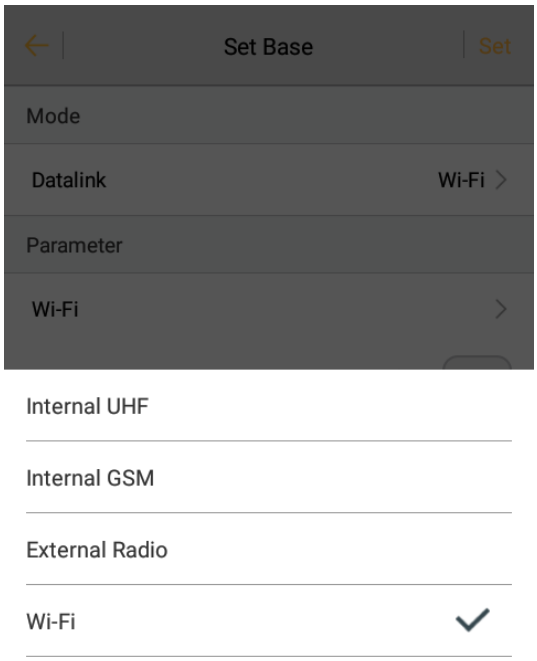



*Figure 3-2-19 Wi-Fi Mode*

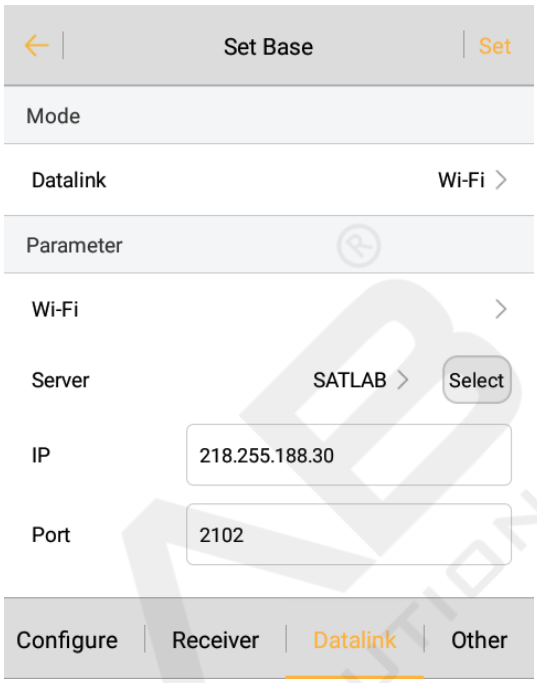



*Figure 3-2-20 Wi-Fi Mode Settings*

Click the Wi-Fi option to enter the *Wi-Fi Parameter* interface. When the Wi-Fi hotspot is turned on, the connection to the Wi-Fi of the hand-held controller is supported; otherwise, a third-party Wi-Fi hotspot will be connected.

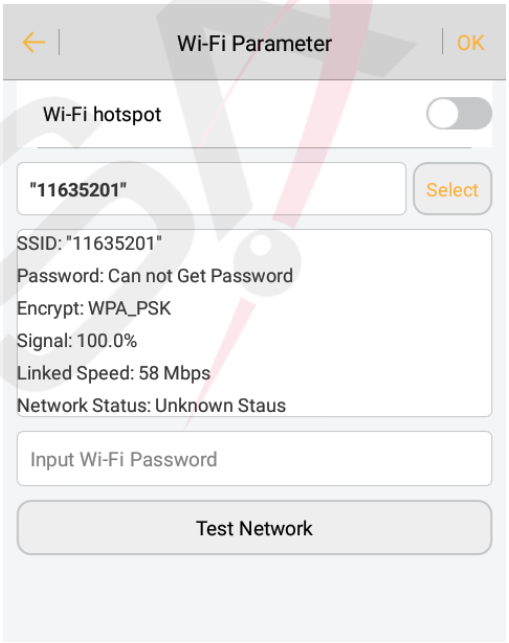



*Figure 3-2-21 Wi-Fi Parameter*

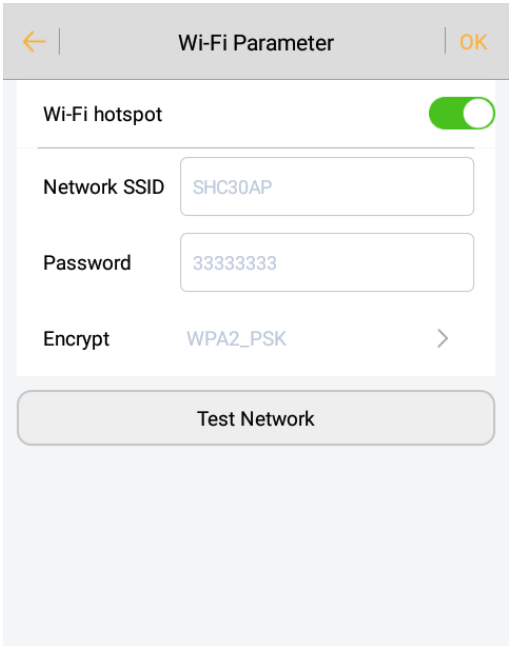



*Figure 3-2-22 Wi-Fi Hotspot*

5. In *Data Collector Internet* mode, it supports SATLAB and CORS mode to connect the server (for specific models).

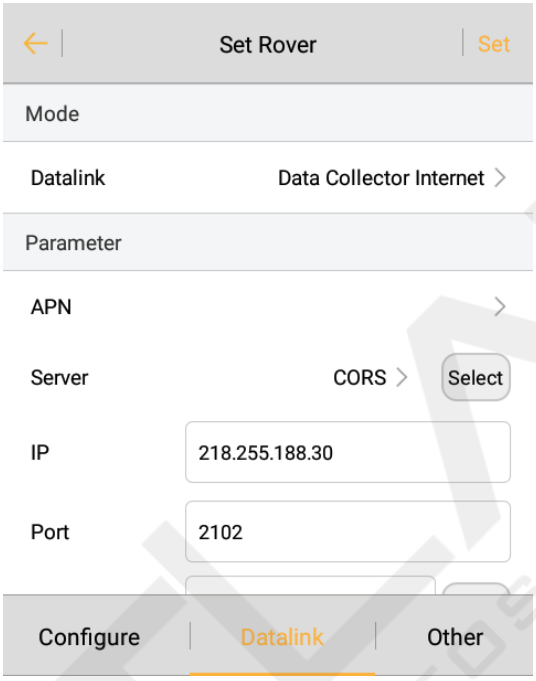



*Figure 3-2-23 Data Collector Internet*

It uses the hand-held network to connect the server as the RTK, dial-up internet access by the network module of the hand-held. Send the received differential data to the host by Bluetooth after connecting to the server, so that the host can do network RTK without the SIM card.

### 3.2.4 Other Options

Set the *Diff Mode, Correction Type, Elevation Mask* and other parameters.

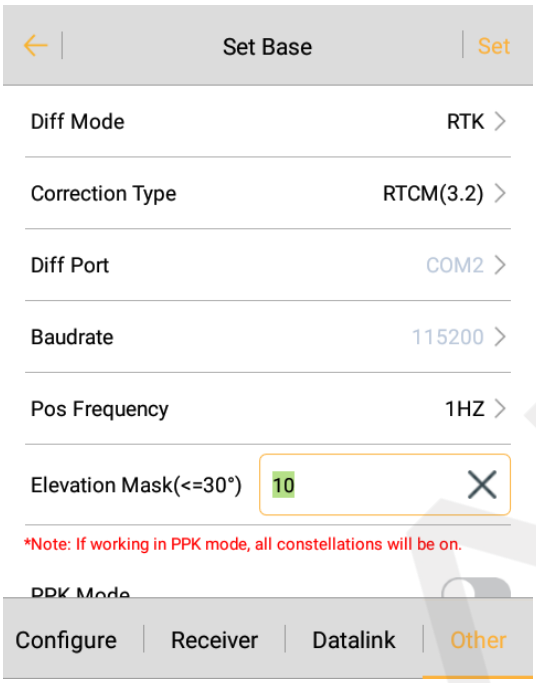



*Figure 3-2-24 Other*

- *Diff Mode*: Including RTK, RTD and RT20. The default is RTK, RTD is the code differential GNSS positioning, and RT20 is the single-frequency RTK.

- *Correction Type*: Including RTCM(3.2), RTCM(3.0), CMR and RTCM(2.x).

- *Diff Port and Baudrate*: The default is COM2 and 115200 (unchangeable).

- *Pos Frequency*: Software update positioning data frequency, supports 1Hz and 2Hz.

- *Elevation Mask*: Adjustable from 0 to 30 degrees.

- *PPK Mode*: Connect to a receiver that supports PPK function; the receiver will start a temporary static acquisition synchronously after the base turns on the PPK mode.

Click *Set* after all the base parameters are set, and there will be a prompt to indicate the success or failure of the settings.

# 3.3 Rover

The rover settings mainly set the working parameters of the rover, including Configure, Datalink, etc.

## 3.3.1 Rover Configuration

Users can save all the parameters set in the rover as a configuration file, or load the parameters directly from the configuration file.

In the configure interface, users can click the QR code icon to read the QR code shared by the base station, to obtain the configuration parameters quickly.

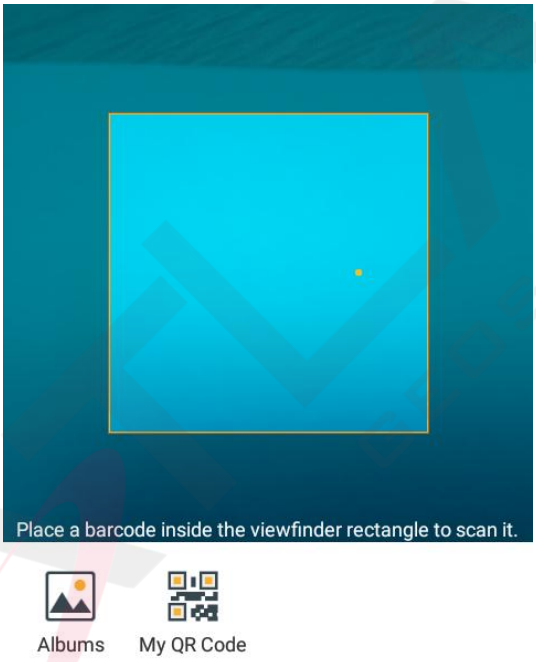



*Figure 3-3-1 QR Code*

## 3.3.2 Data link

Rover data link settings are used to set communication types and parameters between the base and rover, including the Internal UHF, Internal GSM, External Radio, Data Collector Internet, External Network (3G), PPP Service (for specific models), etc.

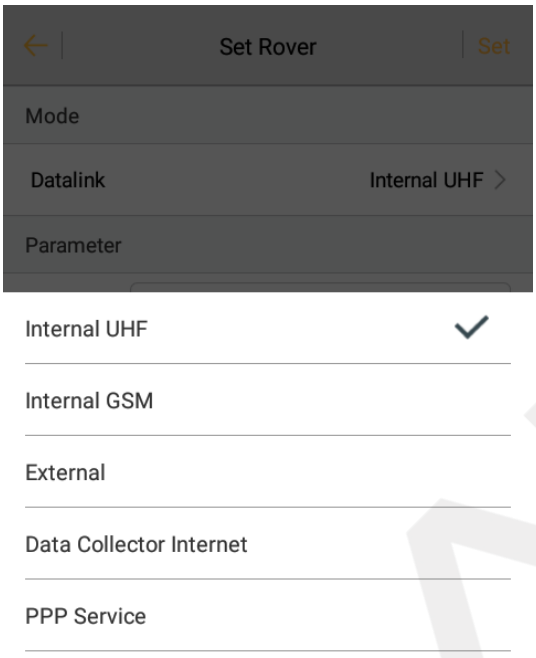



*Figure 3-3-2 Datalink*

1. In the Internal UHF mode, users can set the Channel, Protocol, etc. The channel must be consistent with the channel of the base.

2. In the Internal GSM mode, users can click Network to choose the network type (GPRS, GSM, CDMA).

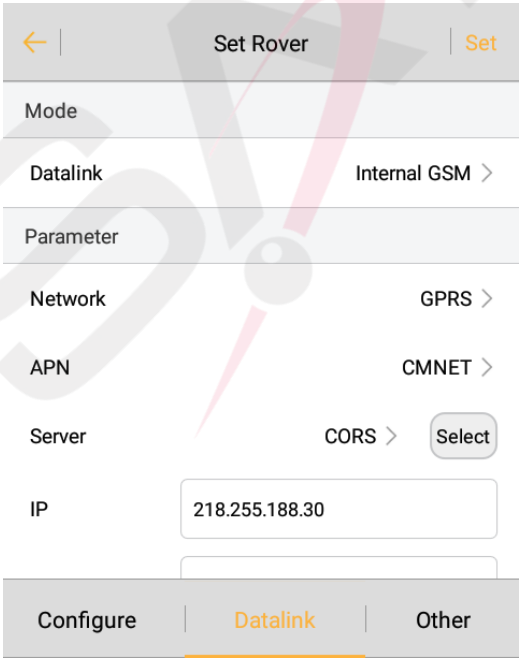



*Figure 3-3-3 Internal GSM*

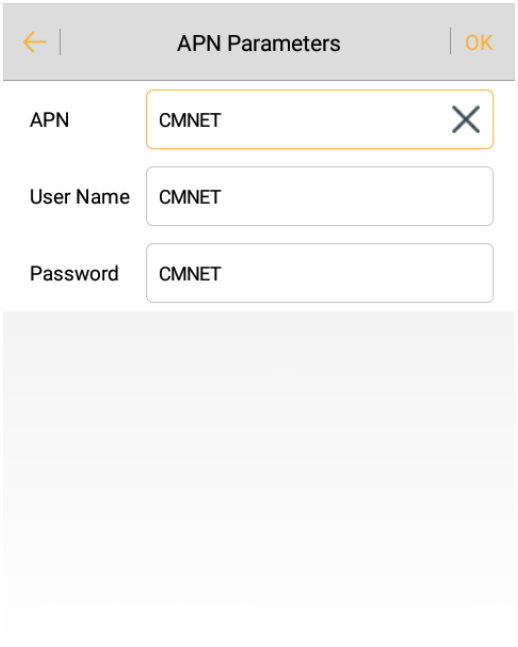



*Figure 3-3-4 APN Parameters*

- *APN:* Different networks will have different settings. It's parameters of the host SIM card.

- *Server:* Choose the mode, including SATLAB and CORS. Input the IP and port manually, or click Select to enter the server list and choose a suitable server.

When use SATLAB mode, the settings need to be same as the base settings. And when you use the CORS mode, please set the right IP, port, mountpoint, etc. Click Set to enter the CORS Parameters interface, and click Get Mountpoints to choose the suitable mountpoints and input the User Name and Password to finish the settings.

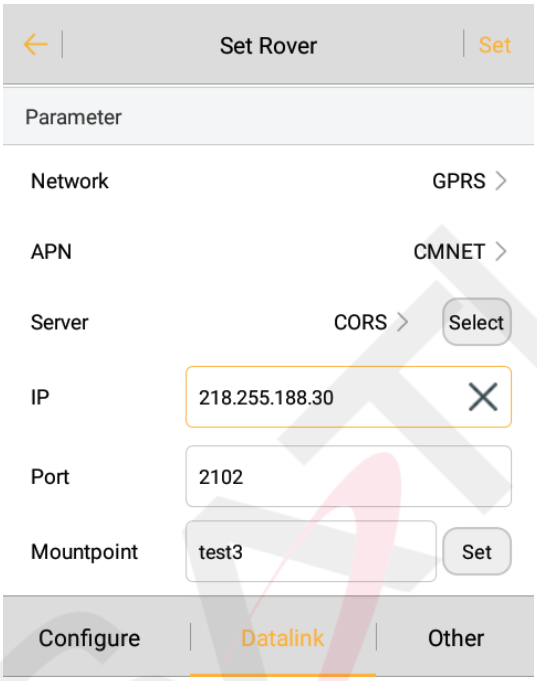



*Figure 3-3-6 Set Rover*

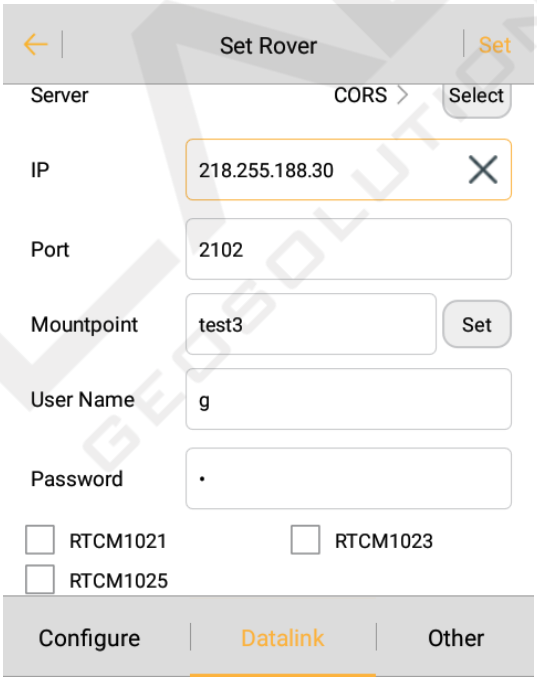



*Figure 3-3-7 CORS Parameters*

- *Open*: Load existing CORS parameters.

- *Save:* Save the current CORS parameters.

- *OK:* Complete the settings and return to the previous screen.

3. In the External Radio mode, the hand-held controller needs to be connected to a host that supports external radio.

4. In Data Collector Internet mode, users can choose SATLAB or CORS mode, and the correction data will transmit from the software to rover by Bluetooth. With server support, the differential format (including the coordinate system) can be set manually (RTCM 1021: reference ellipsoid, RTCM 1023: seven-parameters and RTCM 1025: elevation parameters).


*Figure 3-3-8 RTCM Formats*

The APN of the data collector internet mode are the parameters of the hand-held controller system. If the WiFi is not connected, the hand-held controller must be installed with the SIM card to do APN settings, otherwise there will be a prompt.

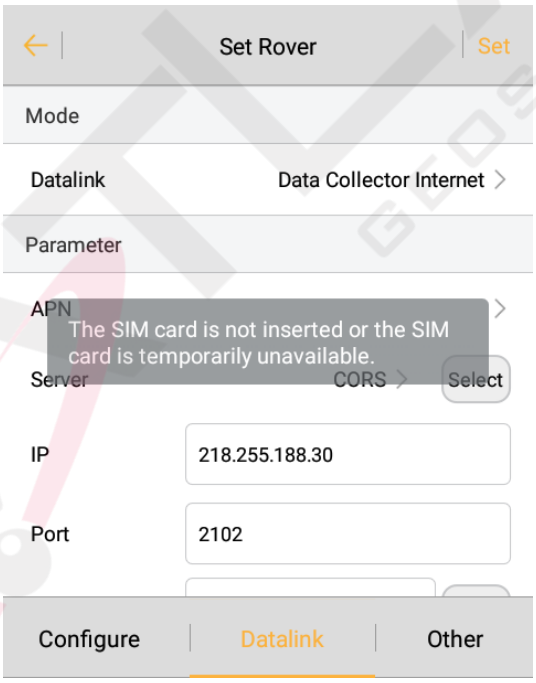



*Figure 3-3-9 APN of the Data Collector Internet Mode*

5. In the PPP Service mode, users can set the Diff Mode (satellite or network).

### 3.3.3 Other Options

Set the Diff Port, Pos Frequency, Elevation Mask and other parameters.

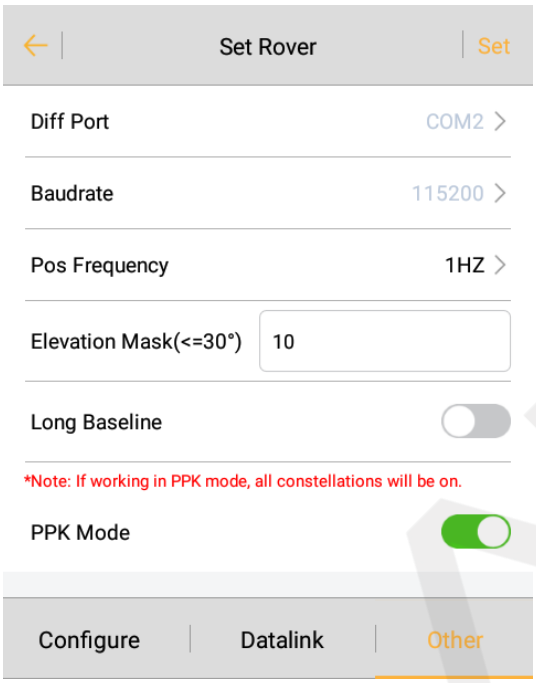



*Figure 3-3-10 Other*

- Diff Port and Baudrate: The default is COM2 and 115200 (unchangeable).

- Pos Frequency: Software update positioning data frequency, supports 1Hz and 2Hz.

- Elevation Mask: Adjustable from 0 to 30 degrees.

- PPK Mode: The receiver will start a temporary static acquisition synchronously after the rover turns on the PPK mode. It will record the RSP file in the Detail Survey, Stake Points, Stake Line when using the average collection. The file name will be consistent with the static collection file name.

**Notice**:
If the project was turned on in PPK Mode, when setting up the rover, there will be a PPK correction prompt when the original data is exported.

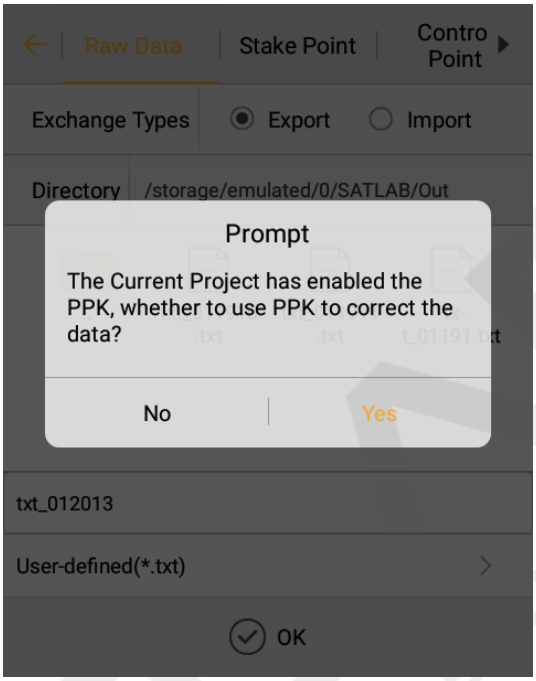



*Figure 3-3-11 Prompt*

Click Set after all the rover parameters are set, and there will be a prompt to indicate the success or failure of the settings.

## 3.4 GNSS Demo Mode

The receiver can simulate measurement data in the demo mode to make it easy to learn the software.

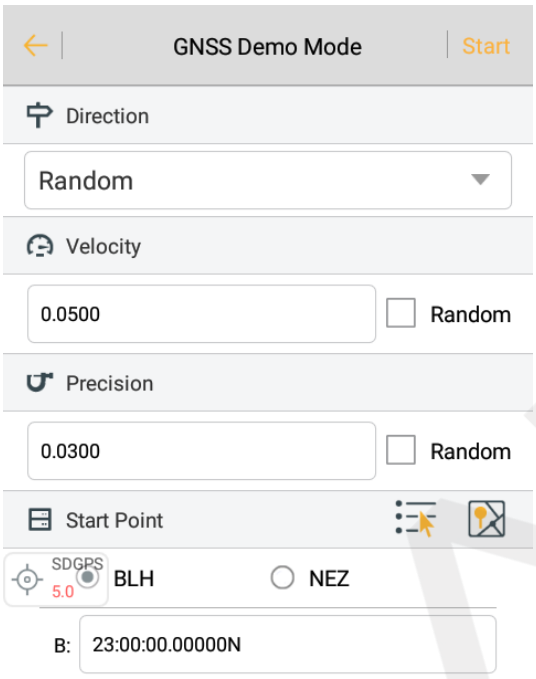



*Figure 3-4-1 Demo Mode*

Choose the Direction according to demand, including Random, Input, Map and Line.

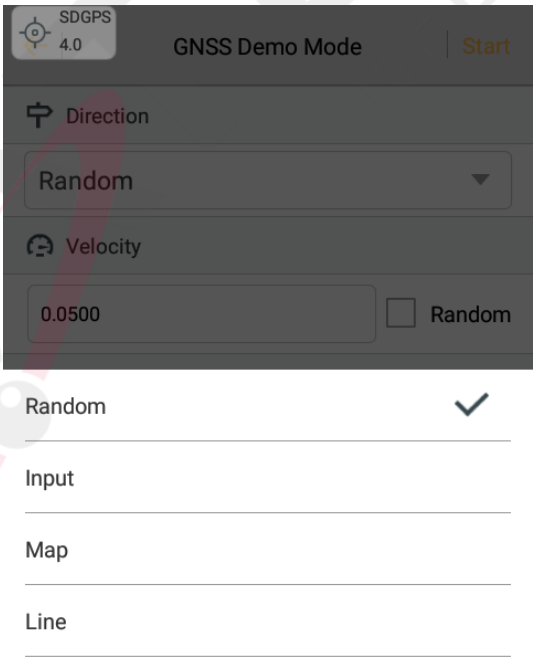



*Figure 3-4-2 Direction*

- *Random*: Current point direction is displayed randomly.

- *Input:* Specify the travel azimuth.

- *Map*: Specify the direction as the direction of the map. There are four options, East, South, West and North.

- *Line*: Specify the line in the Stake Line or Stake Road.

Velocity is the moving speed of the current point, it can be a specified speed or random. Precision is the precision limitation of the current point, it can be input or given randomly. Start Point can be specified with any coordinate. The coordinate can be input, or selected from the point library or map directly.

After completing the settings, click Start to start the demo mode. If the GNSS receiver or built-in GPS is connected, it will prompt whether to disconnect to start the demo mode. After the demo mode is started, the interface will automatically jump to the main software interface.

## 3.5 Controller

In this interface, users can check the current hand-held controller type, Bluetooth support status, network, serial port, etc. It will display the corresponding model with the Satlab hand-held controller, and display General for others (all non-Hi Target Android devices).

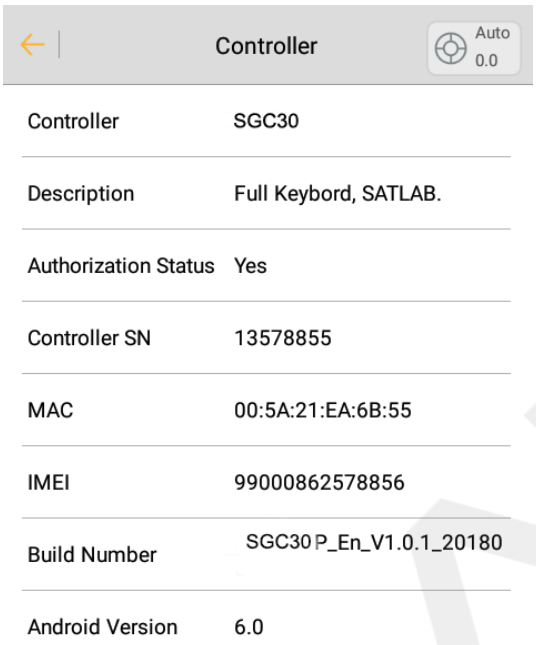



*Figure 3-5-1 Controller*

The additional settings include module info, registration info, 5-pin port data output, satellite tracking switch, receiver settings, service info, restore system, network diagnostics, electronic bubble calibration, orientation sensor calibration, magnetic calibration, Wi-Fi hotspot password set, update firmware, PPP service authority, etc. Different types of devices or connections support different functions.

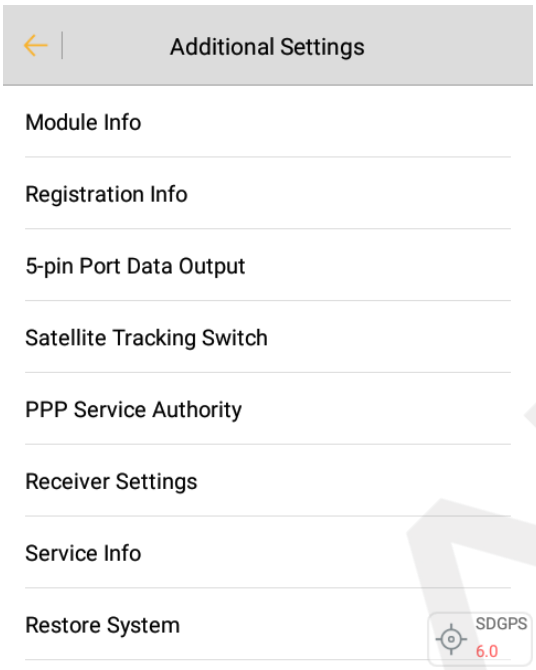



*Figure 3-6-1 Additional Settings*

### 3.6.1 Module Info

Check the radio module type and network module type. The viewing of module information only supports some models.

- *Radio Module Type*: Displays the type information of the host radio module.

- *Network Module Type:* Displays the type information of the current network module.

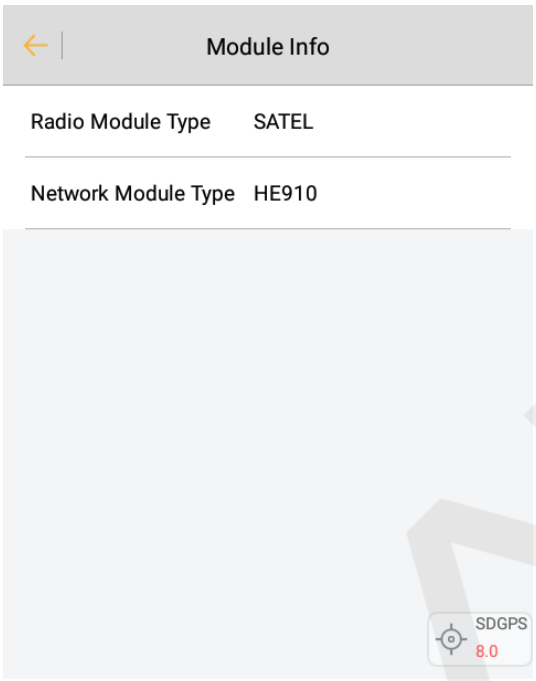



*Figure 3-6-2 Module Info*

## 3.6.2 Registration Info

In the registration info interface, check the device registration code and expiration time.

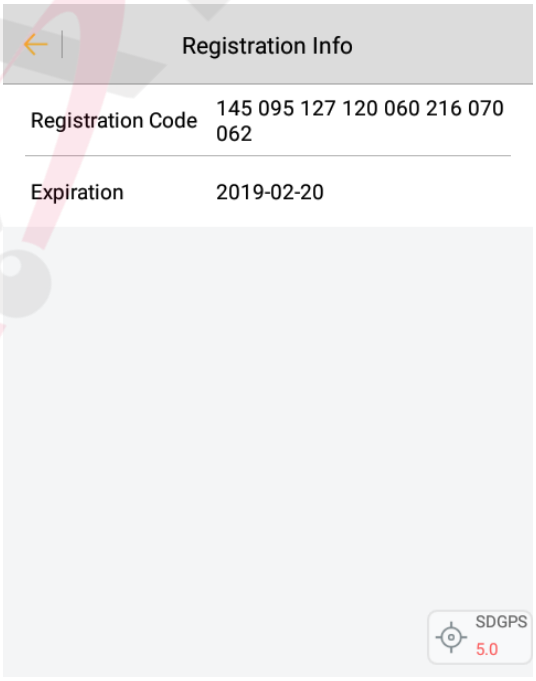



*Figure 3-6-3 Registration Info*

### 3.6.3 5-pin Port Data Output

Open the 5-pin port data output option; users can select the corresponding port's baudrate, commands that need to be sent and the corresponding frequency (1Hz, 2Hz and 5Hz).

After turning on the settings, static collection will be stopped and it will not be allowed to open. If users try to open this option, when using the static collection or the base mode, the software will prompt that the current mode does not support this operation.

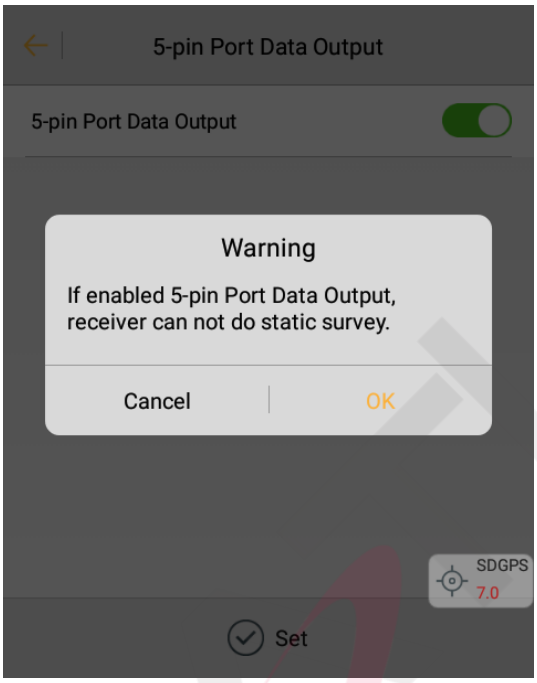



*Figure 3-6-4 Warning*

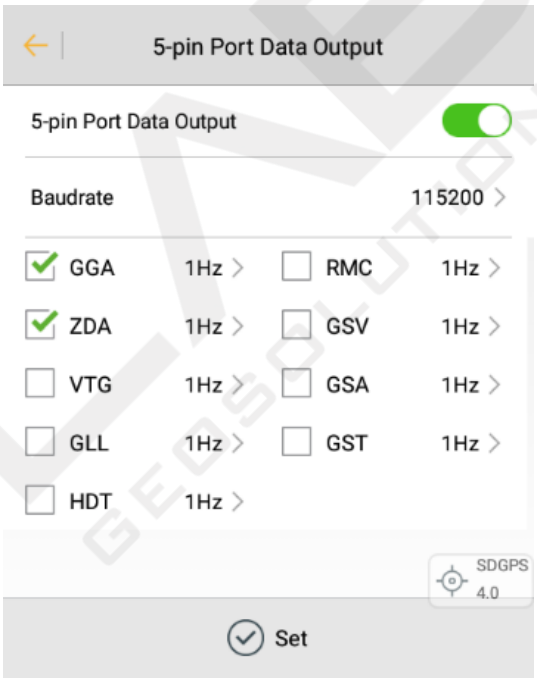



*Figure 3-6-5 5-pin Port Data Output*

### 3.6.4 Receiver Settings

Set the store RINEX data, stop and go, firmware upgrade prompt, remote connection, USB virtual serial port, store static data in receiver SD card, sound type, volume, one-step set station, quasi dynamic RTK, etc. Different hosts have different settings.

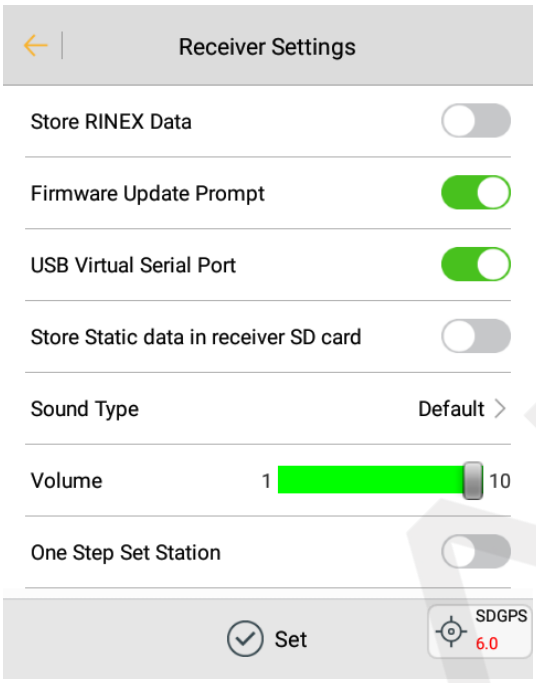



*Figure 3-6-6 Receiver Settings*

- Store RINEX Data: After turning on, the RINEX format data will be recorded synchronously with the static collection.

- Stop and Go: Support the function to collect temporary static data after turning on.

- Firmware Upgrade Prompt: After turning on, there will be a prompt when there is upgradeable firmware.

- Remote Connection: The host will automatically connect to the corresponding server after turning on. Remote connection IP and port do not need to be changed, the default value is OK.

- USB Virtual Serial Port: After turning on, users can connect the USB debugging virtual serial port.

- Store Static Data in Receiver SD Card: Set static files to save to SD card.

- Sound Type: Switch the voice announcement (None, default and user defined).

- Volume: Adjust the volume.

- One-step set station: After turning on, the base can be set automatically after power on.

- Quasi dynamic RTK: Users can do it in the detail survey after turning on.

### 3.6.5 Service Info

The service info interface will display the current receiver version type and its corresponding function rights.

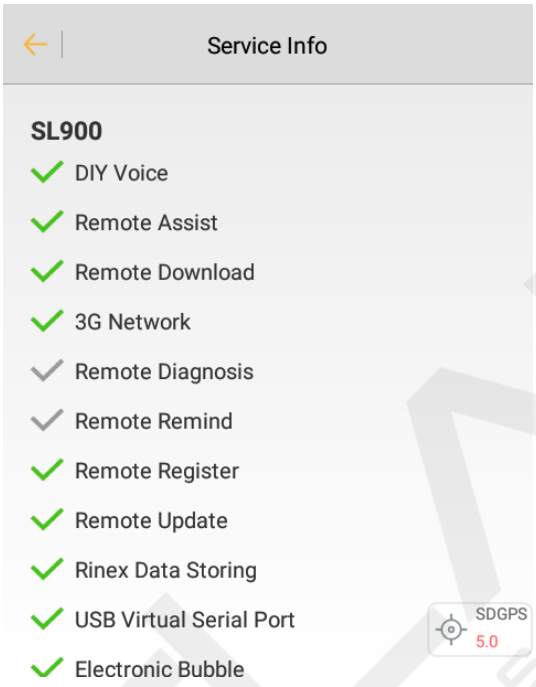



*Figure 3-6-7 Service Info*

### 3.6.6 Restore System

Restore the firmware to its original state.

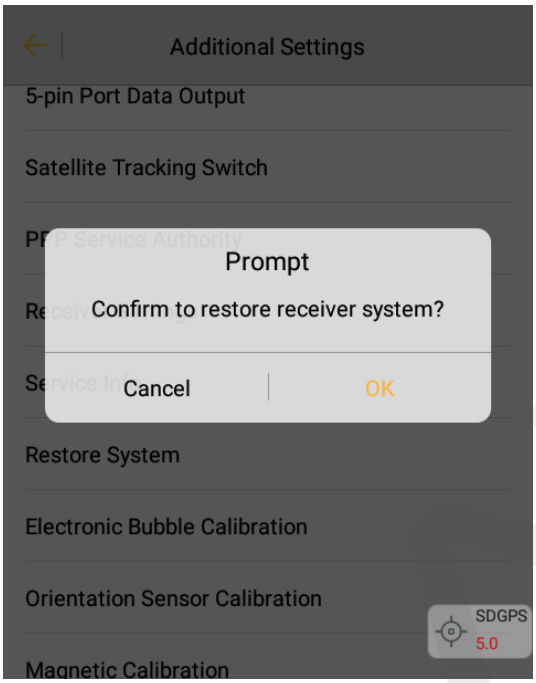



*Figure 3-6-8 Restore*

### 3.6.7 Wi-Fi Hotspot Password Set

To modify the connection password for the receiver's Wi-Fi hotspot, please connect the receiver by Bluetooth first. Then enter the old password and new password twice correctly, and click Set to complete the operation.

collection. The file name will be consistent with the static collection file name.

---

**Notice**:

1. The default Wi-Fi password is 12345678;
2.If you forgot the Wi-Fi password, you can use the GNSS Receiver Manager → Wi-Fi Password Settings to set a new password.

---

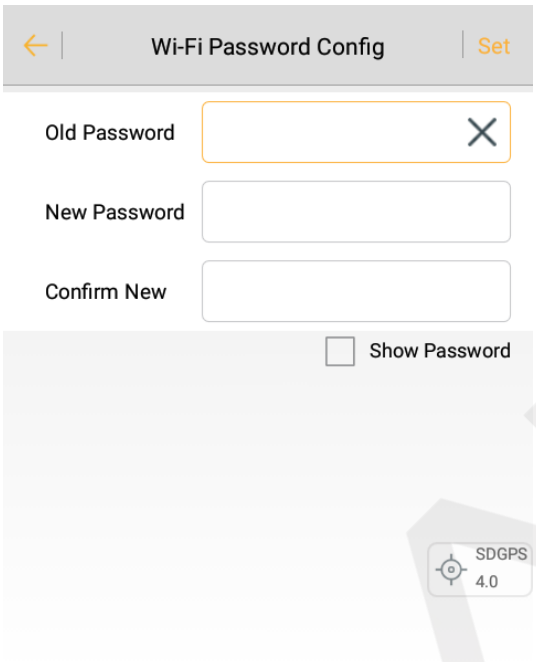



*Figure 3-6-9 Wi-Fi Password Config*

### 3.6.8 PPP Service Authority

View and register the PPP service authority information. If the PPP service authority has expired, it will be displayed in red. If it has not expired, it will be displayed in black (only supported on some models).

## 3.7 Console

It's mainly used to debug data and detect the GPRS signal strength. It can save the received debugging data as files.

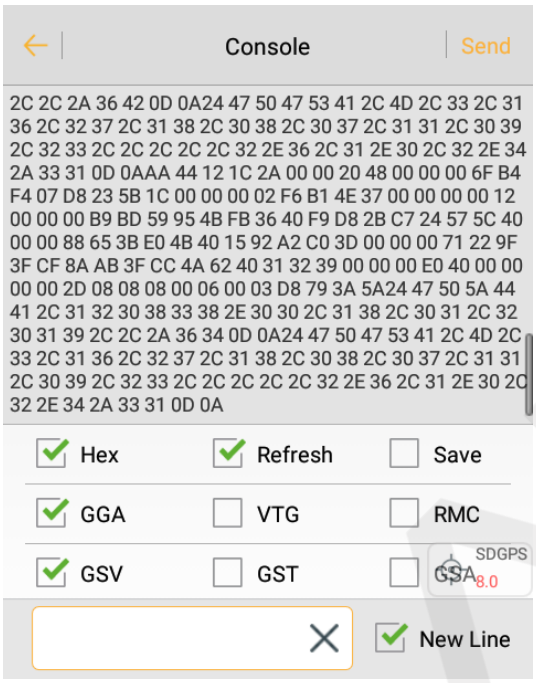



*Figure 3-7-1 Console*

- *Hex*: Select to display data in hexadecimal format.

- *Refresh*: Select to refresh the output.

- *Save*: Select to save the output data.

- *New Line*: Select to send the new line, select it when sending commands normally.

- *Send*: Click to send the command after entering the command.

- *GPRS Signal Test*: When using the internal GSM mode (for some specific models), select and click *OK* to enter the signal test. The current GPRS signal strength will be displayed in the text box in the pass-through mode. *+CSQ: 6,2* means that the signal strength is 6.

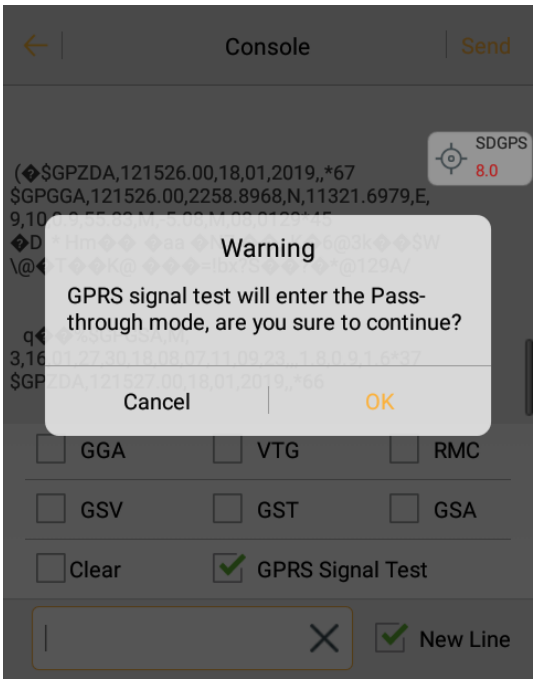



*Figure 3-7-2 Warning*

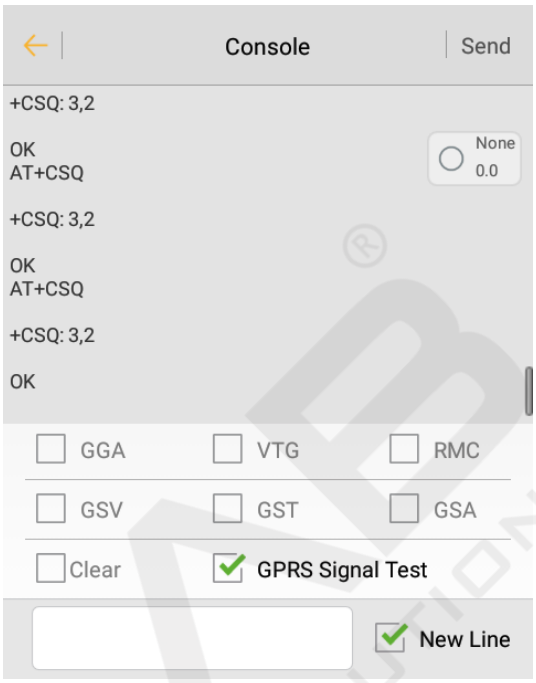



*Figure 3-7-3 Pass-through Mode*

**Notice**:
The two numbers behind the CSQ represent the GPRS signal strength value and the signal symbol error rate. The larger the previous value, the better the signal. The last value is 0 normally.

The software presets commonly-used data types and can receive data without selecting the command. Select data types, it supports multi-selection combination sending. Users can select *Clear* to clear the receiver's current data and request the selected data again and then click *Send* to send the data.

There will be sensor values output when using the demo mode or built-in GPS mode.

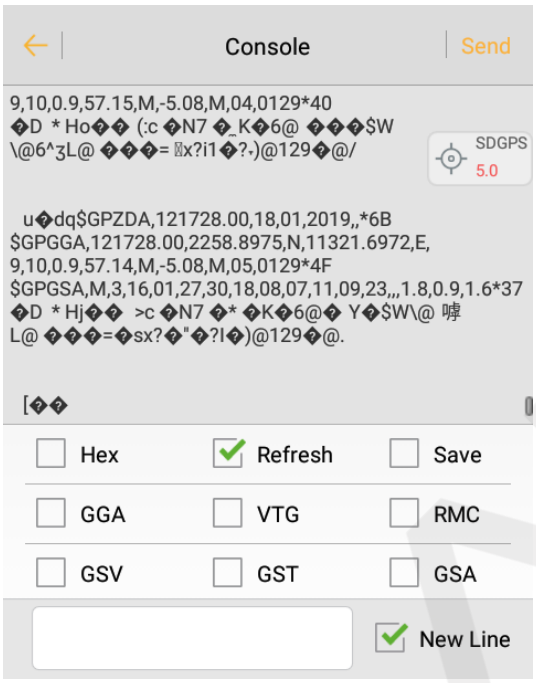



*Figure 3-7-4 Sensor Values*

# 3.8 Static

## 3.8.1 Static Settings

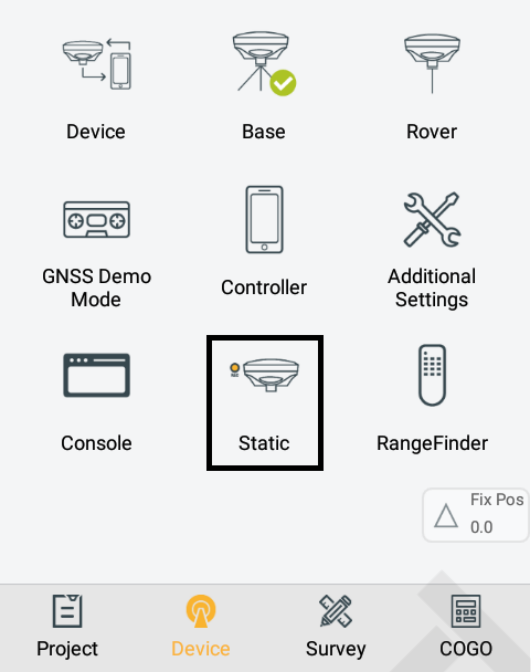



*Figure 3-8-1 Device Interface*

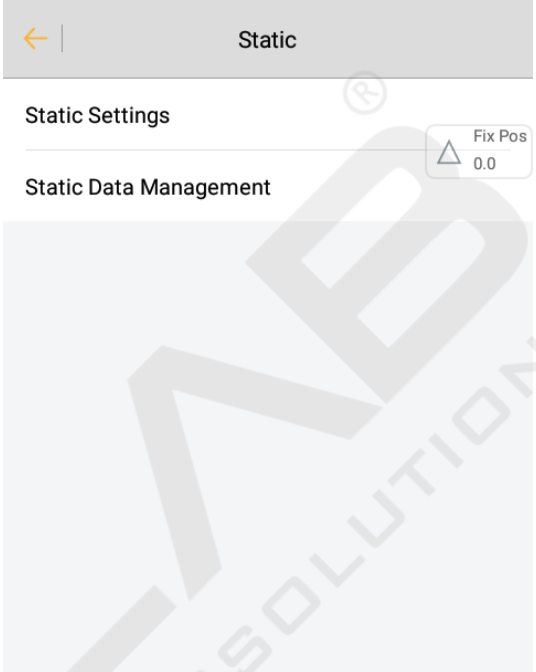



*Figure 3-8-2 Static*

In RTK mode, if users need to do static acquisition at the same time, please click to enter the static settings interface to input the interval, file name, pole and elevation mask. Users can view the GDOP, start time and recording time. Click *Start* to start recording.

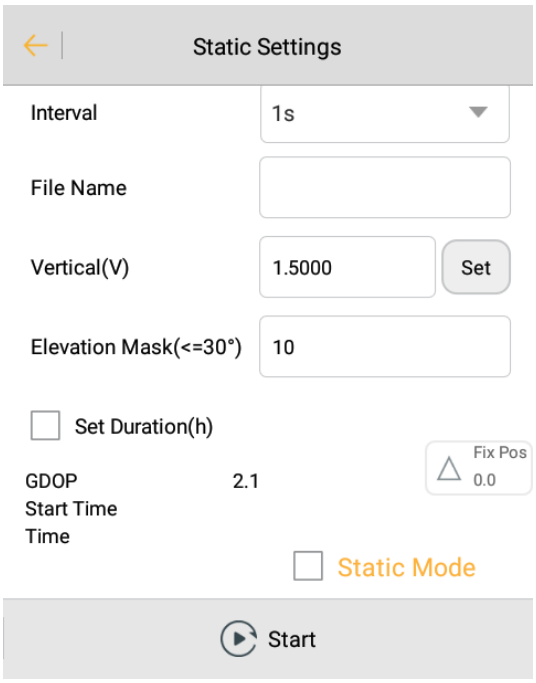



*Figure 3-8-3 Set Duration*

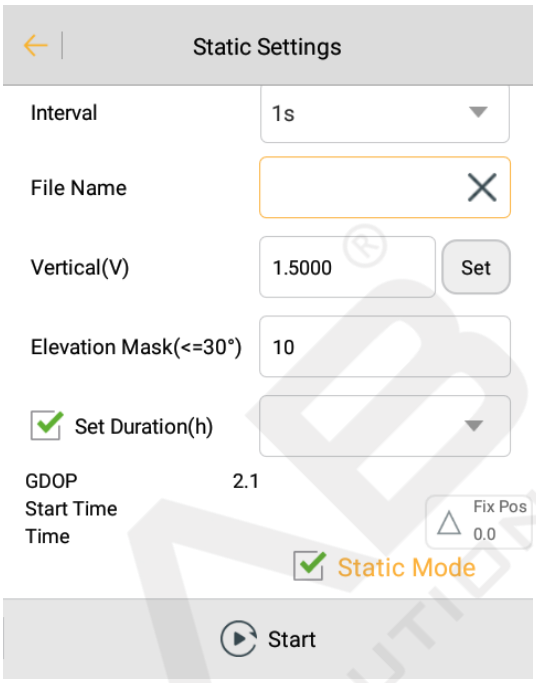



*Figure 3-8-4 Static Mode*

The *Set Duration* function can be enabled only when the *Static Mode* option is selected (for some specific models). After the specified acquisition time is enabled, the current acquisition will stop and the receiver will automatically shut down.

**Notice**:
The height limit (antenna height) cannot be greater than 65m. If the height exceeds 65m, the HGO display antenna will be inconsistent. The software will fail and prompt when users input a value that exceeds 65m. The elevation mask limit must also not exceed 30 degrees.

### 3.8.2 Static Data Management

View static files in the current receiver and do some related operations.

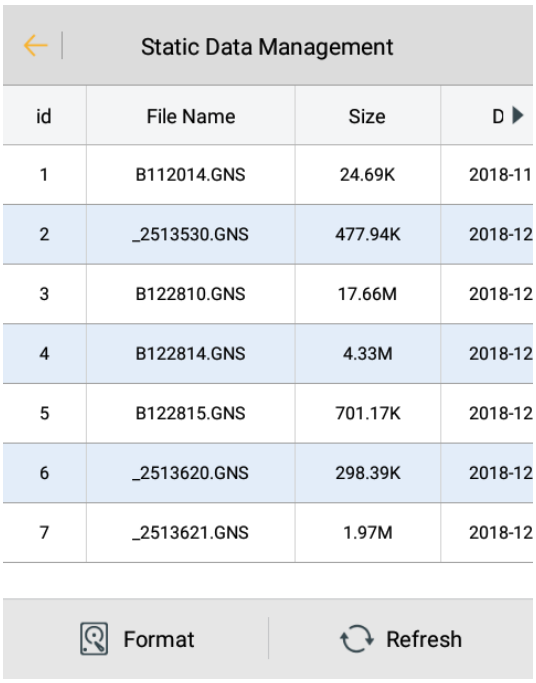



*Figure 3-8-5 Static Data Management*

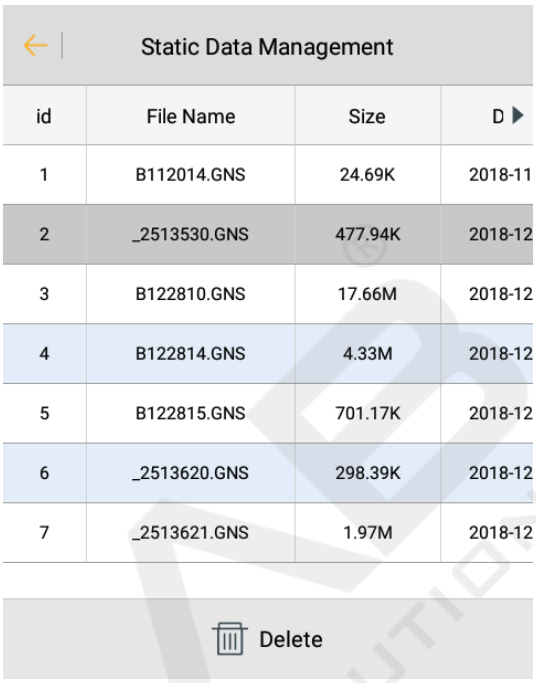



*Figure 3-8-6 Download or Delete*

- *Format*: Format static data, data is not recoverable.

- *Refresh*: Refresh the current file list interface.

- *Download*: Connect the receiver by Wi-Fi, it supports the FTP static files download to the local store. Long press to choose files, and it will prompt the save path after the download is successful.

- *Delete*: Long press a record to delete the selected static data, allowing multiple files to be selected and deleted.

# 3.9 RangeFinder

## 3.9.1 RangeFinder Connection

Select the type of the rangefinder to be connected, including the Leica Disto D8/D5/D3 and Trupulse 360B, and click Connect to connect. The rangefinder choice is not available if already connected.

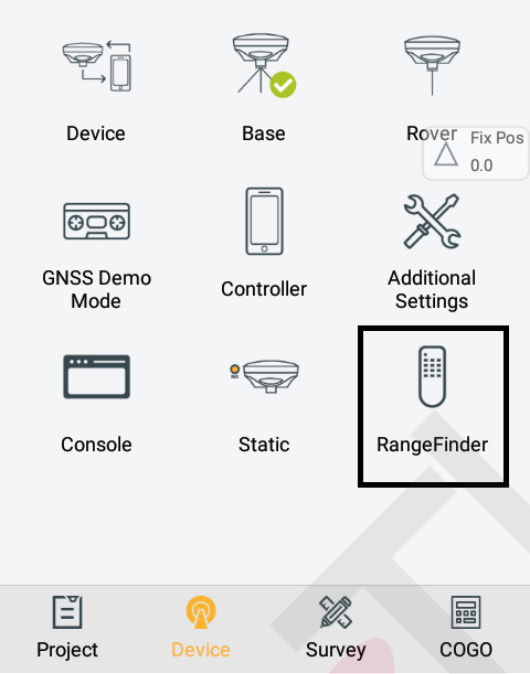



*Figure 3-9-1 Device Interface*

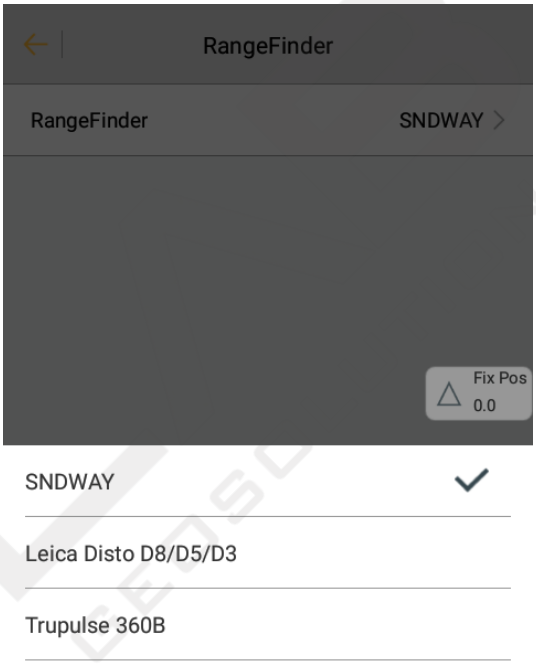



*Figure 3-9-2 Choose the RangeFinder*

## 3.9.2 RangeFinder Intersection

Click *COGO→Intersection* in the main interface to enter the intersection interface.

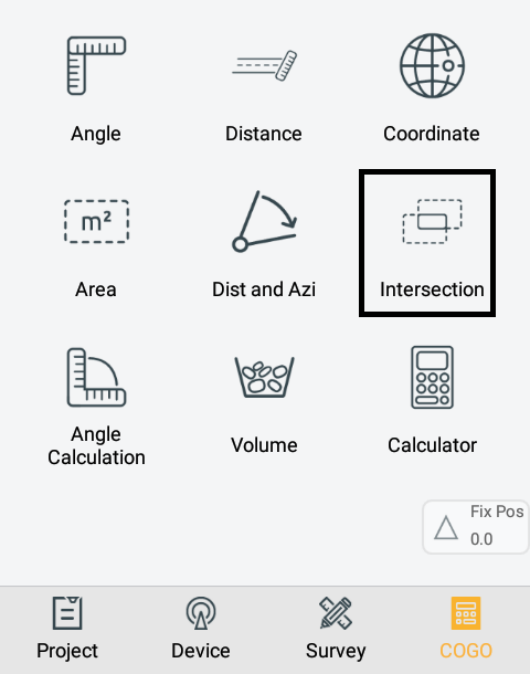



*Figure 3-9-3 COGO Interface*

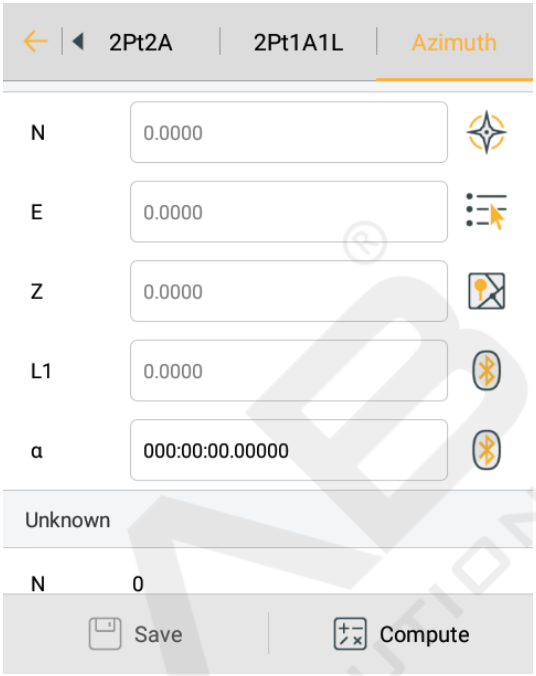



*Figure 3-9-4 Azimuth Interface*

When the rangefinder device is not connected, users can click the Bluetooth button in the *2Pt2L*, *2Pt1L*, *2Pt1A1L* and *Azimuth* interface to enter the rangefinder interface to connect the rangefinder.

After entering the rangefinder interface, click *Connect* to connect the rangefinder by Bluetooth and use the rangefinder to measure the corresponding value.

**Notice**:
When using the software to read the rangefinder ranging value, make sure that the rangefinder is in the initialized state and not in the waiting state.

# Chapter 4

## Survey

**This chapter contains:**

-Detail Survey
-Stake Points
-Stake Line
-Menu
-Mapping Survey

# 4.1 Detail Survey

Click the *Detail Survey* icon in the *Survey* interface to enter detail survey; text interface and graphical interface can be switched via the *Text* / *Graph* button.

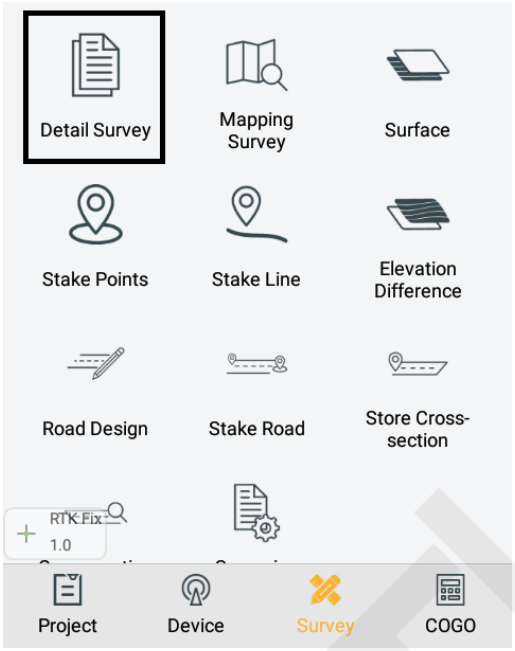



*Figure 4-1-1 Survey Interface*

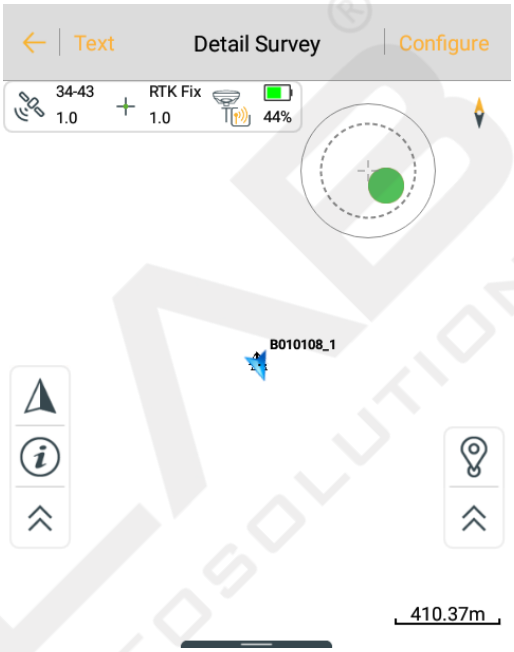



*Figure 4-1-2 Detail Survey*

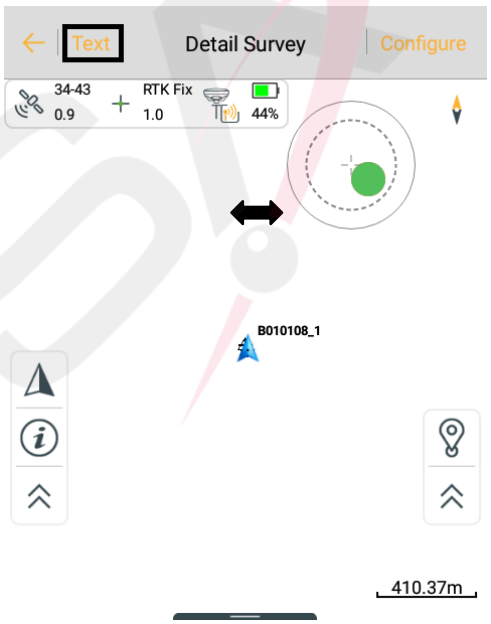



*Figure 4-1-3 Text Icon*

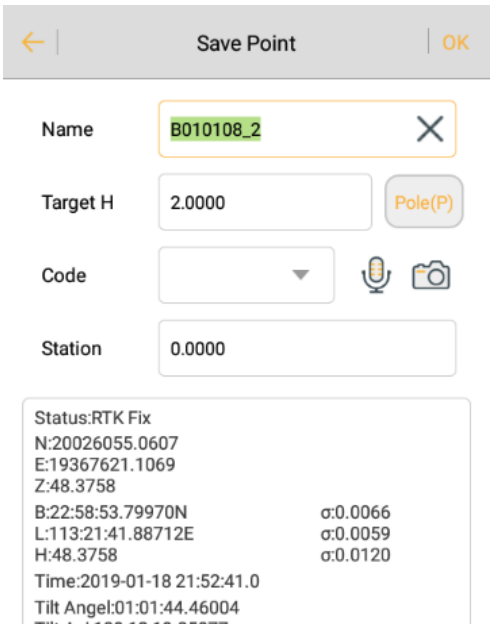



*Figure 4-1-4 Graph Icon*

Navigation Zoom in Zoom out Zoom center

Zoom All Attribute Info Select Point Intersection

Auto Survey Turn off Auto Survey Average Survey

Manual collection Expand Tools Hide Tools Culture Create

### 4.1.1 Map Navigation

Enter the *Survey* interface; the map navigation is shown when the left toolbar is hidden. It allows users to view the current position, or search for a point position more intuitively, and the navigation tool provides three types walk, driver and bus for route searching.


*Figure 4-1-5 Map Navigation Icon*

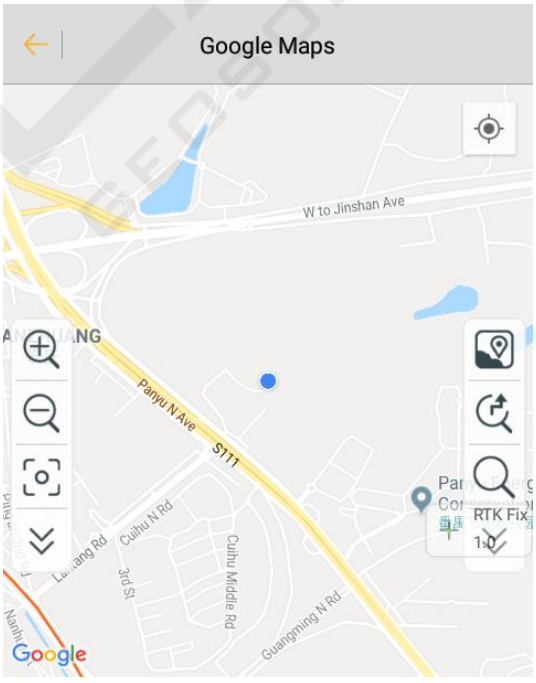



*Figure 4-1-6 Map Navigation*

**Notice**:

1. In *Survey* interface you can enter map interface by clicking the icon.

2. Map navigation function doesn't display the points collected during measurement; the third party map in the configuration can display the points of the measurement.

3. It not only supports domestic maps, but also offline maps (download offline maps in configuration).

After entering the *Map navigation* interface, the same tools as the survey interface will not repeat the introduction; add the following functions:

Satellite Imagery ：Layer General ：Route Search ：Point Search

Click and tools, loaded map can be switched between satellite image and layer general.

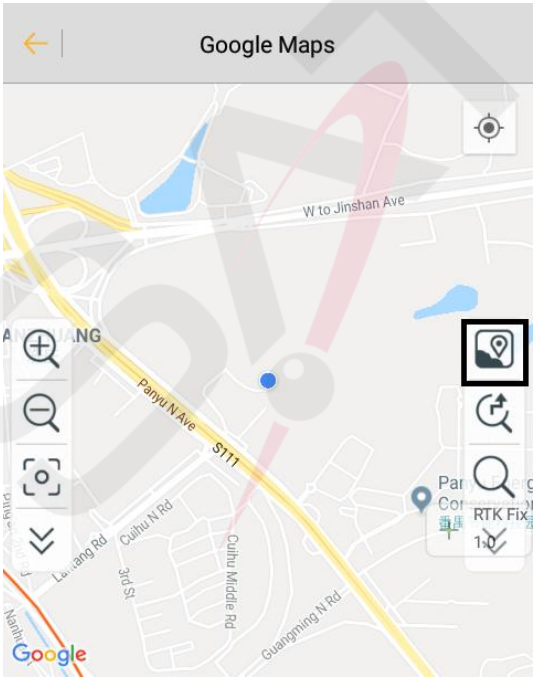



*Figure 4-1-7 Satellite Imagery*

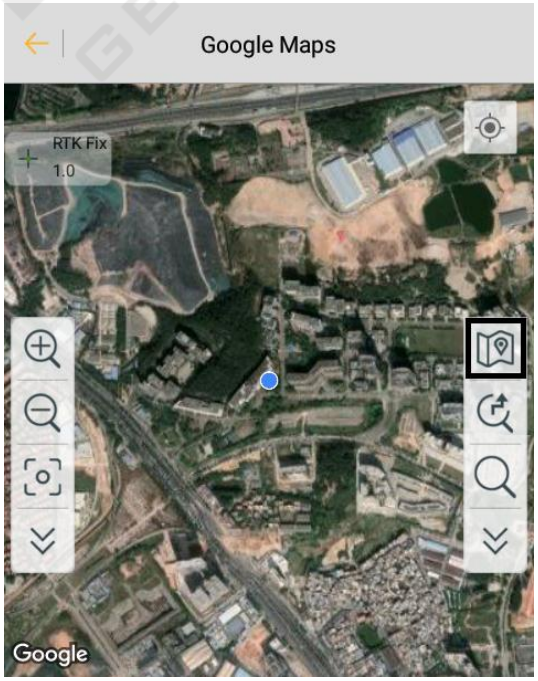



*Figure 4-1-8 Layer General*

During the survey, you can use the function point search if you search for the position of a point, use for route search. The coordinates of the search point can be obtained by real-time collection, point library, graphic selection and manual input, and then clicking *Search*. Back to the map interface, the red icon on the map is the position of the search point. If you want to search the route to the point, click *Go Here*, then it will display route mileage at the bottom of the screen; you can select three methods walking, driving and bus. Click *Details* to view the detailed route of start to end points.

If you know the start and end points, you can use the route search. After entering its interface, select the route type, input coordinates of start point and end point, and then click *Search*.

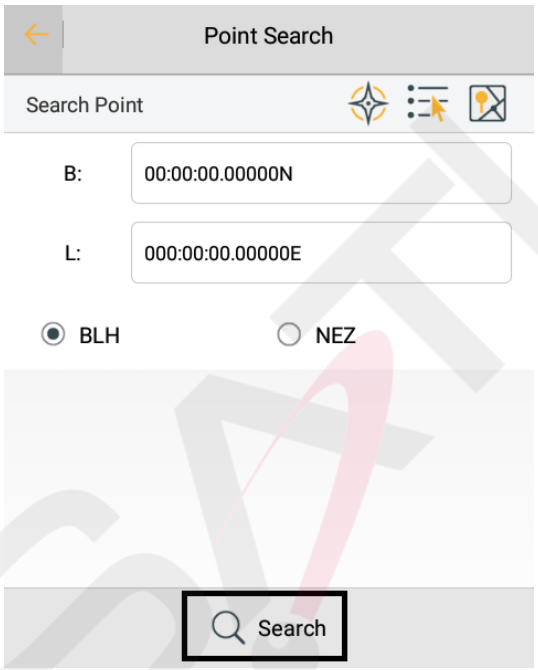



*Figure 4-1-9 Search*

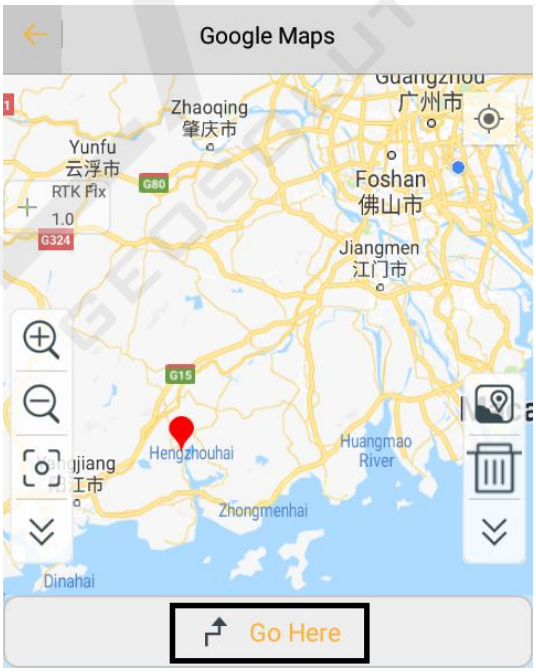



*Figure 4-1-10 Go Here*

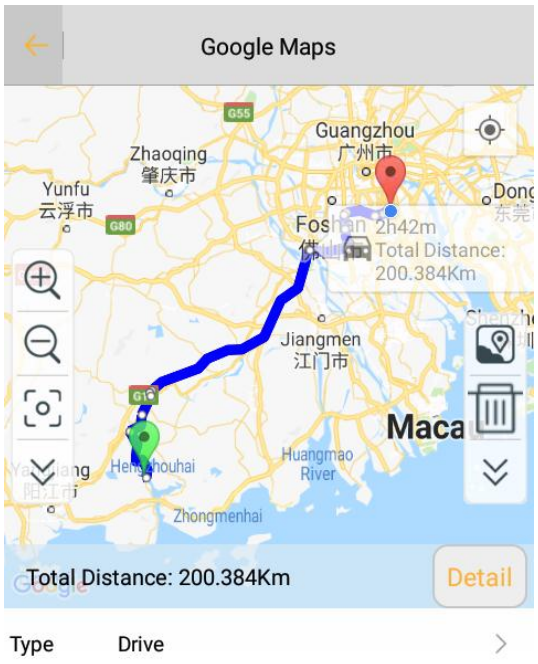



*Figure 4-1-11 Route*

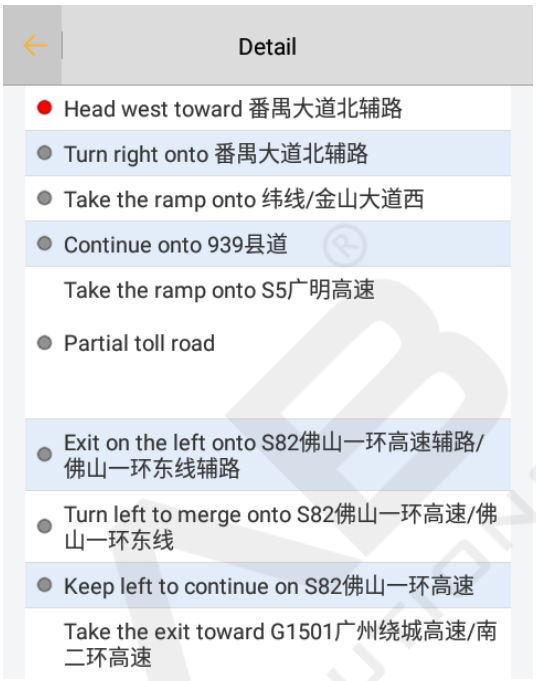



*Figure 4-1-12 Route Detail*

### 4.1.2 Manual Collection

In general, you reach the survey position, according to the survey coordinates, accuracy and solution state displayed on the interface, and then decide whether to collect points. General RTK Fix solution; click for manual collection, the software first checks the accuracy (accuracy settings in *Surveying Configure* → *Data* in detail). If accuracy is not required, the software will be prompted.

Before completion of the collection the interface of *Save Point* will pop up with the details, you can check the reliability of the point; at the same time, the software automatically records data cumulatively, according to the global point number and the prefix of point name from last use. You can directly input *Target H*, and also click *Pole* for detailed settings of target height configuration and antenna type. *Code* can input note information, and you can also select commonly used note types; Set *Station* in the collection confirmation frame.

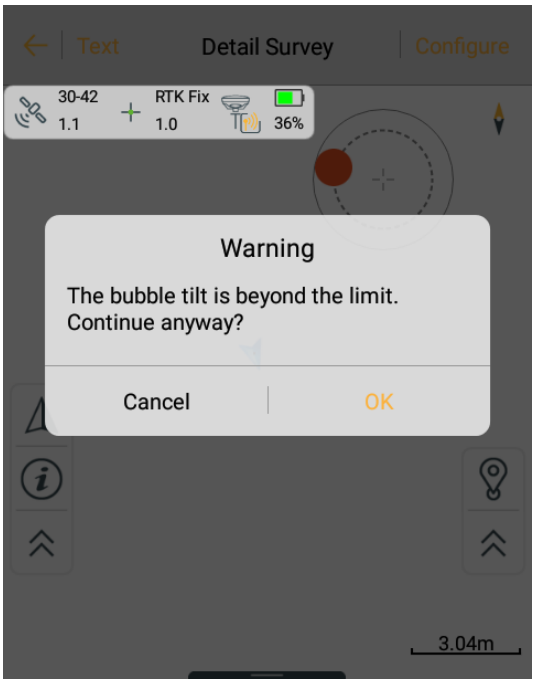



*Figure 4-1-13 Bubble Warning*

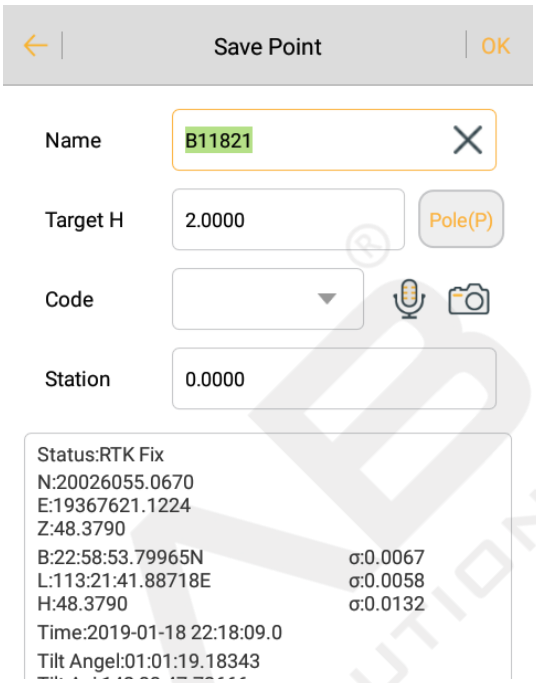



*Figure 4-1-14 Save Point*

### 4.1.3 Culture Create

Open the culture creation. After, you can take the point of real-time collection as the point of culture creation: collection point and detail point are synchronously connected. On finishing *Culture Create*, it will prompt line collection in a pop-up window, which displays whether to close the ticked culture; do not tick *Culture Close* to create a line, tick to create the surface, and mark on the map.

A hidden bar at the bottom displays WGS-84 BLH, local NEZ and BLH coordinates, with left-right sliding to select to display coordinate types.

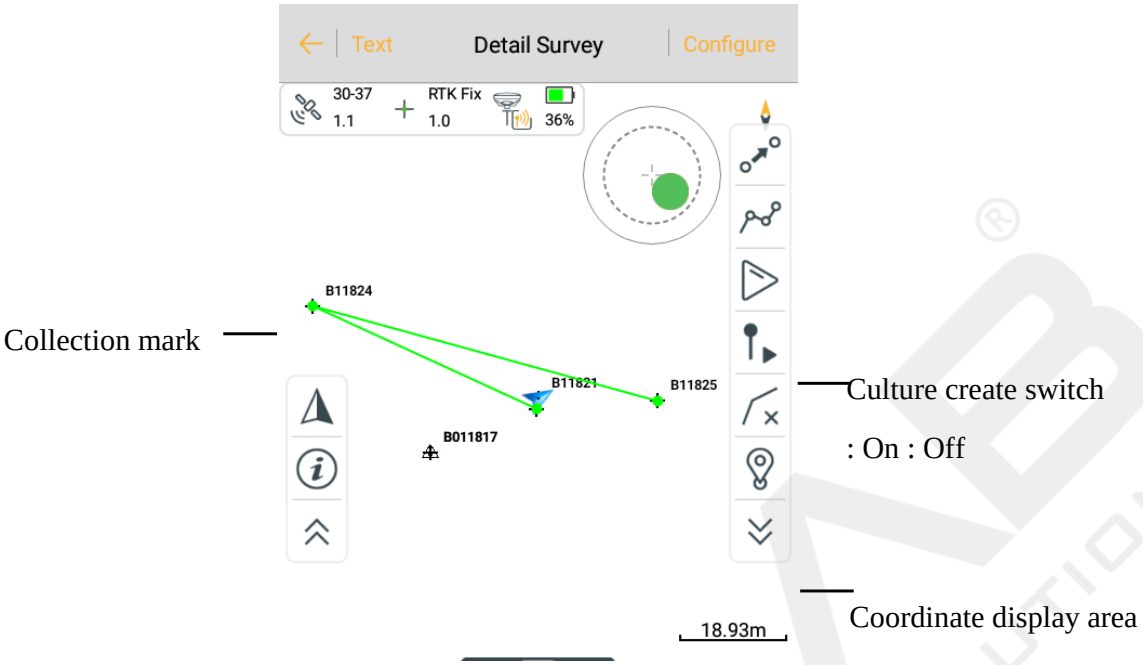



*Figure 4-1-15 Culture Create*

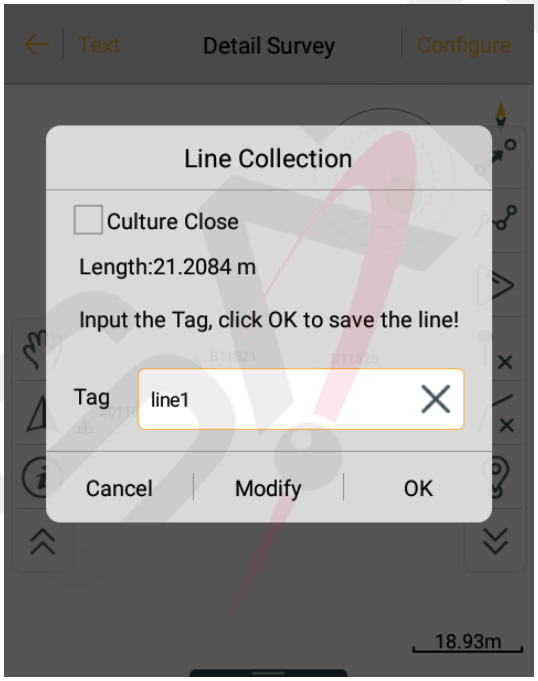



*Figure 4-1-16 Line Collection*

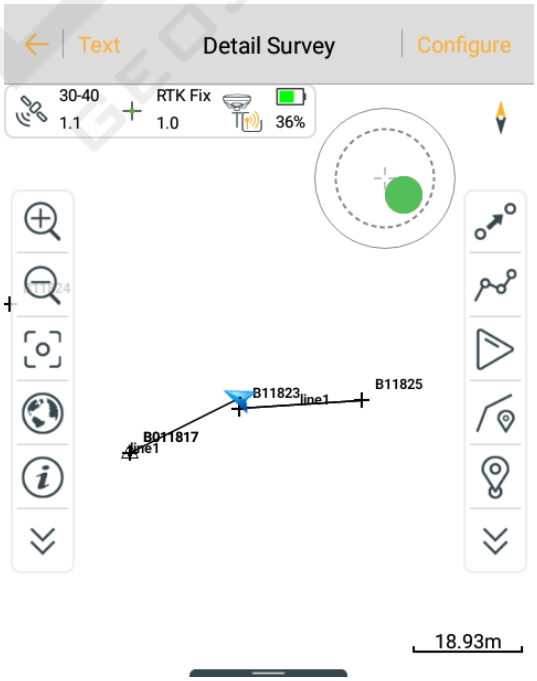



*Figure 4-1-17 Line*

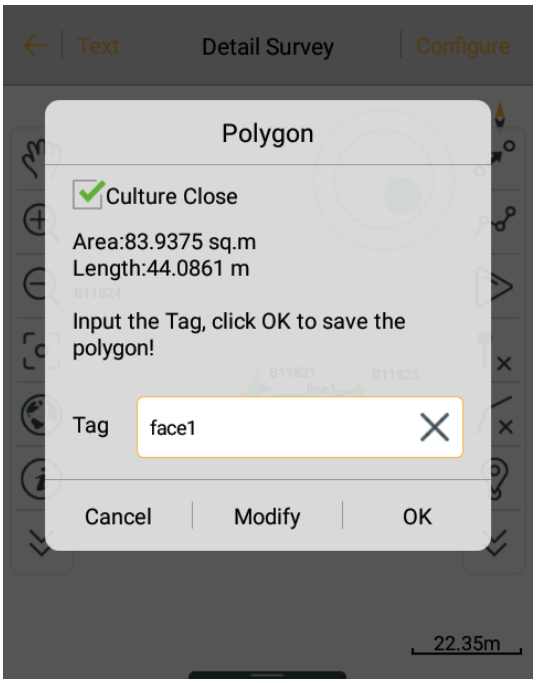



*Figure 4-1-18 Polygon*

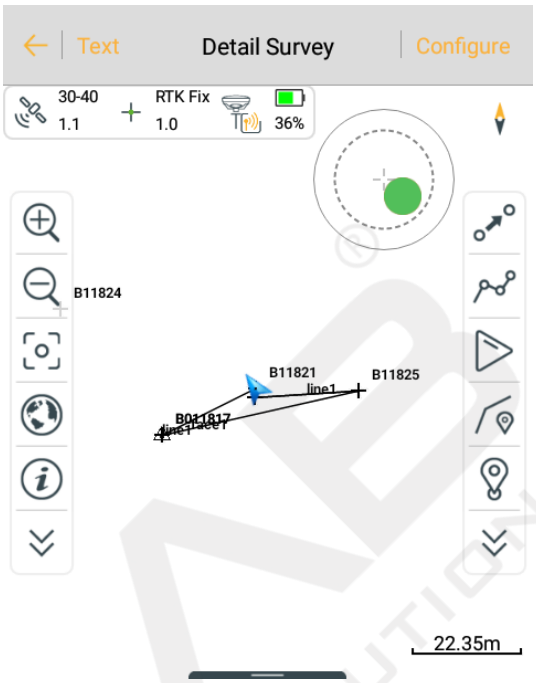



*Figure 4-1-19 Face*

### 4.1.4 Collect Input Method

After demo mode, built-in GPS or connecting device, it can support electronic bubble survey.

It will display the diagram of the electronic bubble position in the software interface, you can select electronic bubble automatic survey in *Auto* and automatic collect point according to the state of electronic bubble. Electronic bubble has the following states:

- *center*: Bubble is within the set limits, center good.

- *Wait center*: Waiting for user to adjust the pole to center the bubble.

- *Wait survey*: Waiting 2 seconds after center, enter the survey state, and collect points in this state.

- *Wait move*: After the last collection point is finished, it waits for you to move the pole; after moving a distance it will start the next survey.

- *Out of Range*: In the set limits, bubble deviates from the center position.

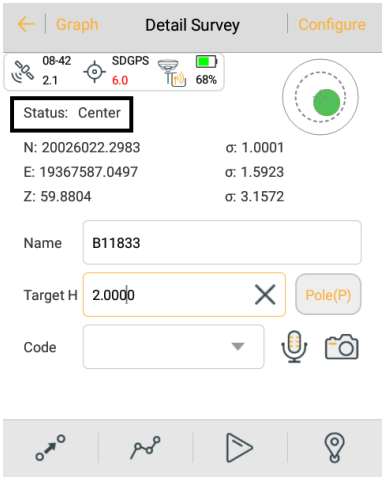



*Figure 4-1-20 center*

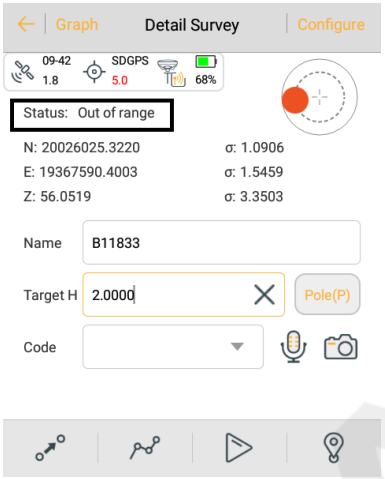



*Figure 4-1-21 Out of Range*

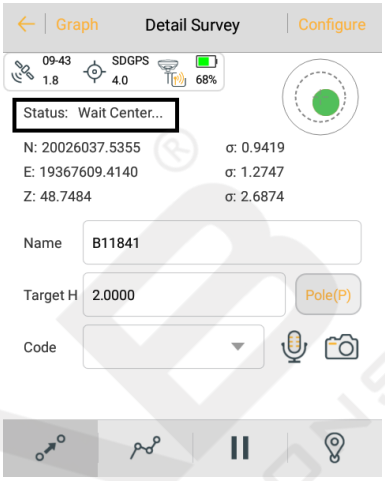



*Figure 4-1-22 Wait*

When collecting coordinate points, it supports input voice and photo attributes of coordinate points. In the prompt box or text interface, click  to enter *Audio* or *Image* information, and you can input and view voice and photo information; after point collection, the attribute is saved in the file. It supports voice and picture file addition; click *Add File*, audio file format can be *.amr, *.wav, *.mp3 and image file formats supported are *.jpg, *.png, *.bmp.

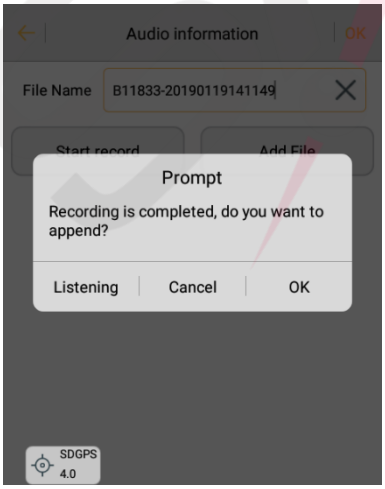



*Figure 4-1-23 Audio*

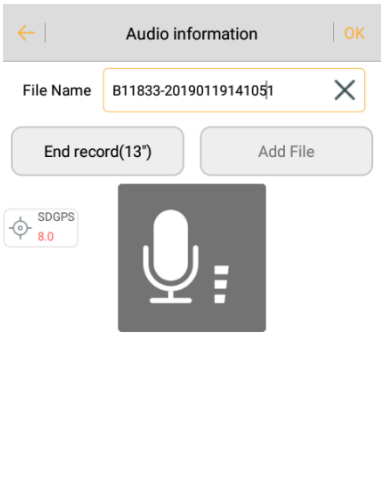



*Figure 4-1-24 Prompt*

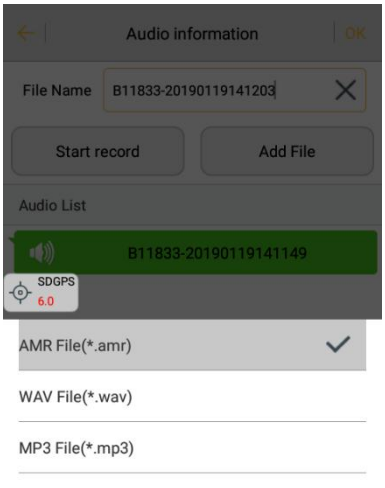



*Figure 4-1-25 Audio Format*

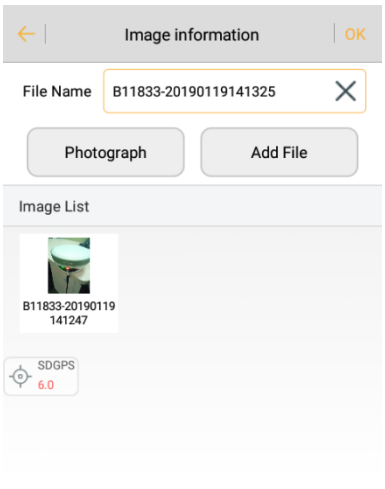



*Figure 4-1-26 Image*

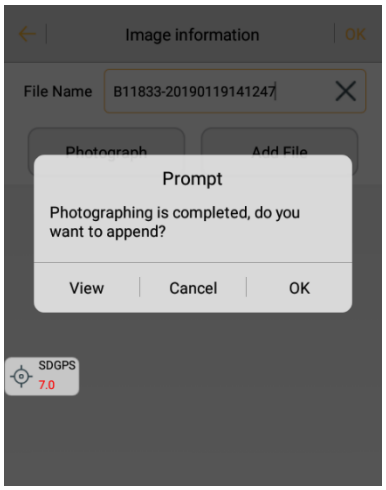



*Figure 4-1-27 Prompt*

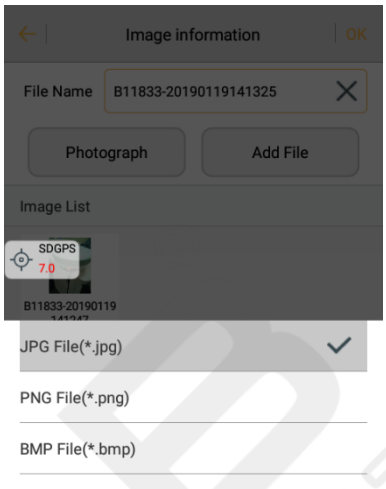



*Figure 4-1-28 Image Format*

After returning to the parent interface, once the user has input voice or photo information, the interface icon is changed to .

When you select point description information, you can directly select the common description information, or manually edit the *property.txt* file (*/sdcard/SATLAB* contents) according to the actual work situation. The edited description information will be displayed in the description list.

### 4.1.5 Automatic Collection

Click the *Auto* icon , enter automatic collection interface, select automatic collection mode (including *Time interval*, *Plane interval* (N or E direction change value), *Slant Interval*, *Electronic bubble center*), input the prefix, number, annotation and other information of the point name. Click *OK*; the software enters automatic collection mode. Accuracy will be checked during automatic collection (accuracy is set in *Surveying Configure* → *Data* has a detailed description. If it meets the accuracy requirements, it will automatically collect and prompt to save points; if it does not meet the accuracy requirements, there will be no prompts until the accuracy meets the requirements to continue to automatically collect and prompt points to save):click to finish automatic collection.

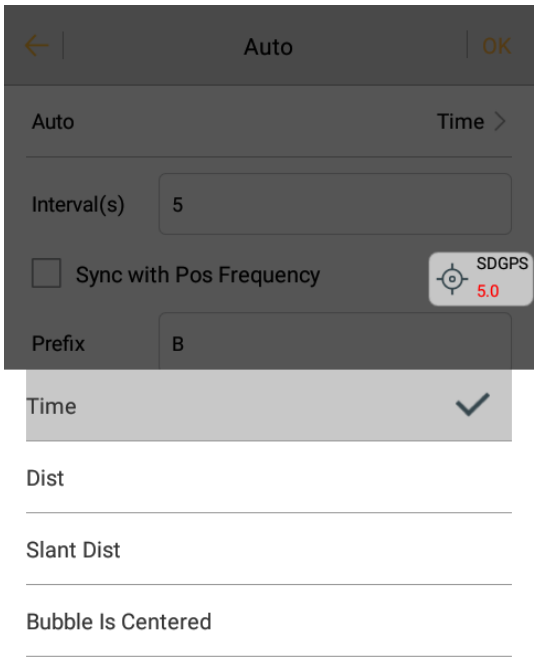



*Figure 4-1-29 Auto Method*

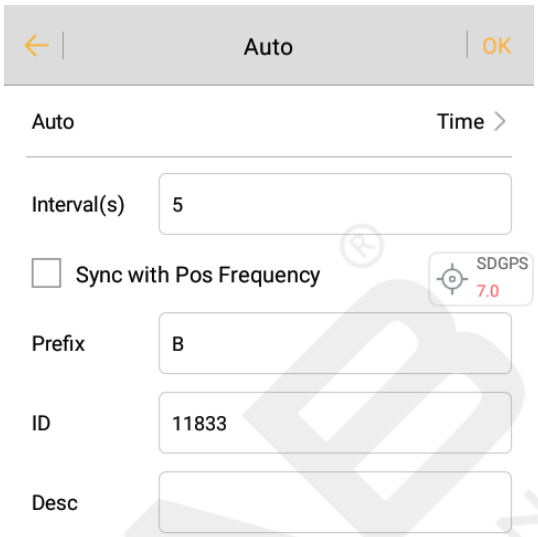



*Figure 4-1-30 Auto Interface*

When the automatic collection mode is *Time*, the interval(s) value can be set, and it will be in automatic collection mode, according to the set time interval.

When the automatic collection mode is *Distance*, the interval(s) value can be set, and it will be in automatic collection mode, according to the set plane interval.

When the automatic collection mode is *Slant Distance*, the interval(s) value can be set, and it will be in automatic collection mode, according to the set slant interval.

When the automatic collection mode is *Bubble is centered*, hold it straight for automatic collection, and take away immediately after collection, with no further human intervention. Clicking on the upper-right corner of the interface *Configure* → *Data* → *Bubble Precision* can set the bubble precision.

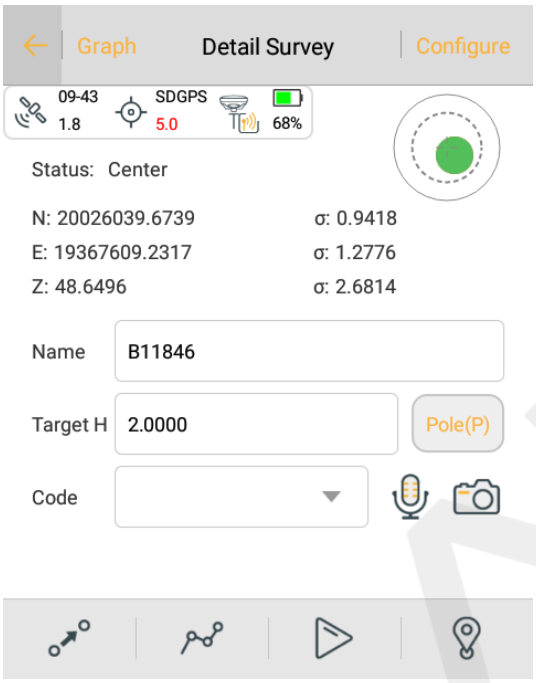



*Figure 4-1-31 Auto Collection Interface*

## 4.1.6 Average Collection

*Average Collection* is a simple way to improve measurement accuracy; according to the error theory, the error occurs in any direction, so if there are a large amount of observed quantities, accidental errors will be offset (but it's just theory, it doesn't mean that the more observed quantities, the higher the precision). In *Average Collection* interface, click *Start*, the software will collect points, and display the current point position at the same time. The software automatically analyzes the quality of the data, then calculates and displays standard deviation (root mean square error).

*Average Collection* supports text and graphic displays. After average collection reaches the set number and stops, in the *Text* interface, you can delete some scattered points in the average list to improve the collection accuracy (long press average list, display *Delete* toolbar), and then the software will automatically redo the average calculation. In the graphic display interface, click on the average collection point to display the point coordinates.

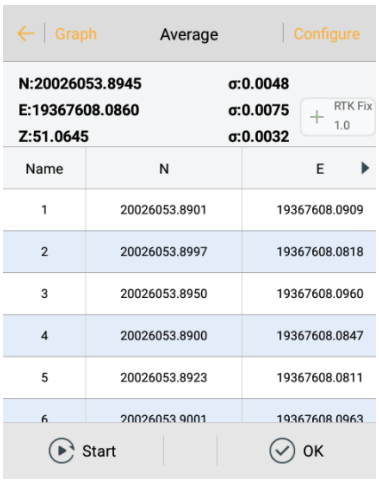



*Figure 4-1-32 Average*

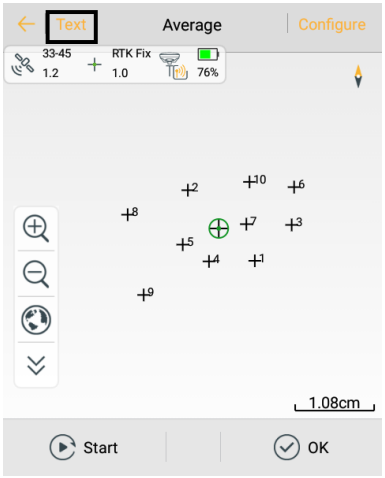



*Figure 4-1-33 Text*

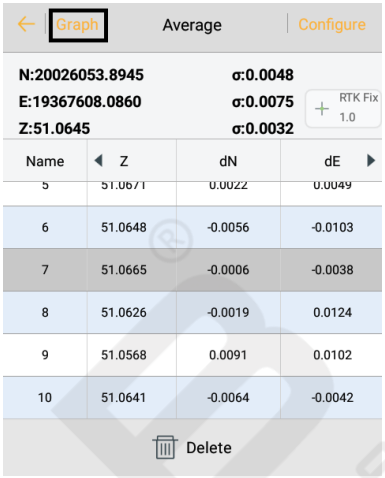



*Figure 4-1-34 Graph*

The calculated error is the same as the error of the measurement. However, because the average process is from a small collection of data, the estimated error may be less than the actual measurement error.

Configuration can be done before average collection; click *Configure* in the upper right of the collection interface. Set the average type, solution type, average times, average precision. Each time you exit the software, the solution type of the average collection configuration is set to the fixed solution. It cannot be configured during average collection. If it fails to achieve the average accuracy, as well as configuration over-limit, it will prompt *Unable to start average due to low precision.* Then you need to reconfigure the average precision.

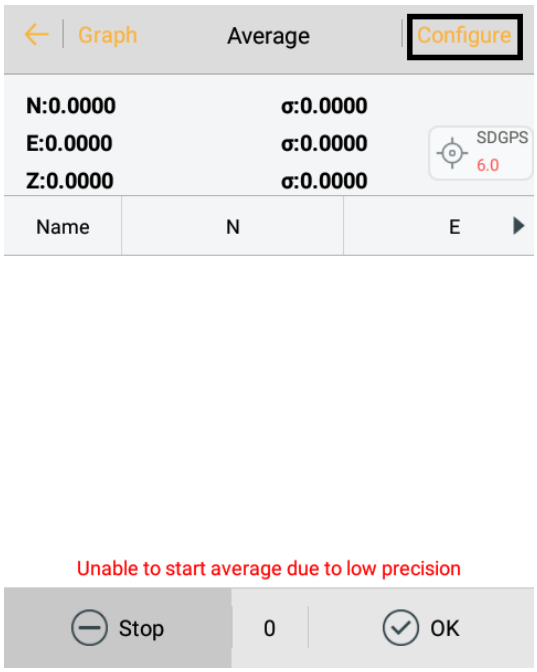



*Figure 4-1-35 Configure*

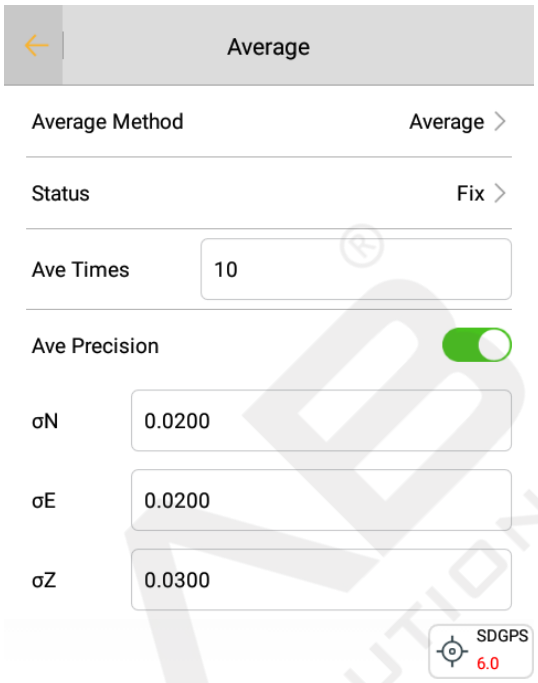



*Figure 4-1-36 Precision*

## 4.1.7 Indirect Survey

Intersection collection is designed for places where we cannot reach or there is no GNSS signal. Usually only plane coordinates can be obtained by intersection, and the elevation data should be obtained by other measurements. The principle of intersection is a simple graphical intersection calculation; there are many intersection ways, with different required quantity, you can choose according to your measurement tools (please refer to chapter 5 of this book for specific usage: *Tools→Intersection*).

---

**Notice**: The points calculated by intersection are saved in *Coordinate Data* and *Raw Data*.

---

## 4.1.8 Attribute Querying

Click ⓘ to open *Attribute Querying*, to go directly into the *Attribute Querying* state; it supports query line, face. Click and select line, face on the graphics, it will show the length of the line, the area, mu and length of face, and

can delete, modify operation; after the operation click *OK* or *Cancel*. Click again to exit the attribute querying.

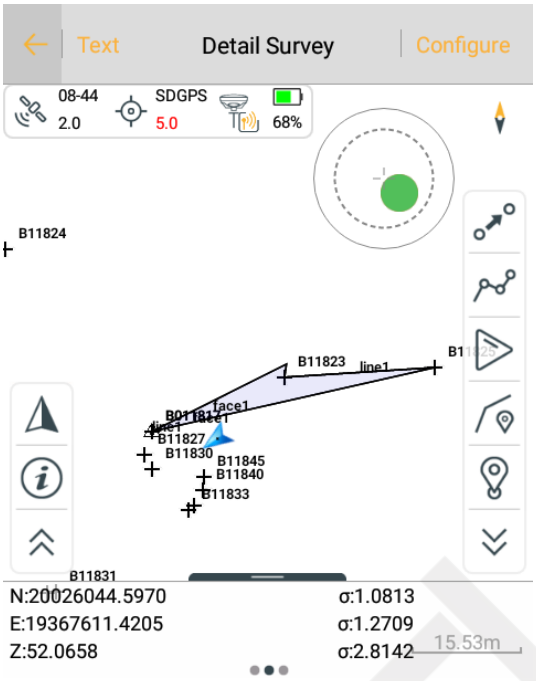
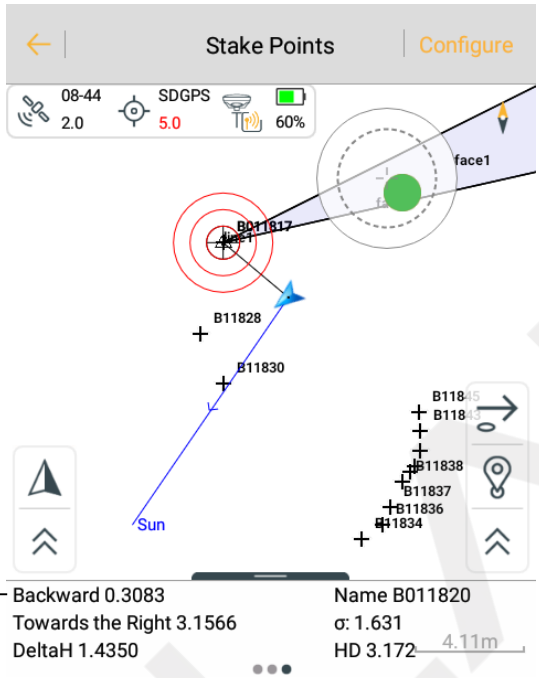



*Figure 4-1-37 Attribute*


*Figure 4-1-38 Line Info*

# 4.2 Stake Points




Stake instructions: Forward and Towards the Left to 0 means it has reached stake point. DeltaH represents the Verticals difference

*Figure 4-2-1 Stake Point*

Choose node on line  Select Point  Nearest Stake Point

Average Collection  Select Stake Point  Single Collection

- *Select Stake Point*: In the Stake Point interface cick , enter *Select Stake Point* interface; it provides three ways to define a point:

1. Manual input.

2. Select from the *Coordinate Library*.

Enter the name of the point to be searched at the point name, click the search button to search from the *Coordinate Point Library*, *Stake Point Library* and *Control Point Library*, *Mapping Data Point Library*, *Cross section Point Library*. The search results are displayed in the interface for user selection; if you do not find the coordinates of the specified point, a name will be prompted.

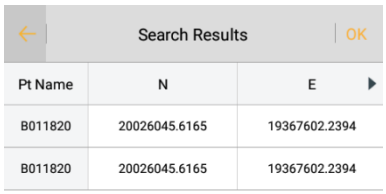



*Figure 4-2-2 Search Icon*

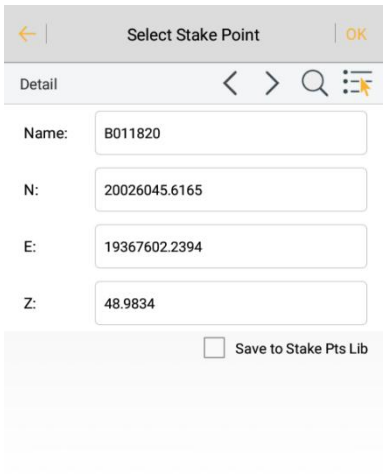



*Figure 4-2-3 Results*

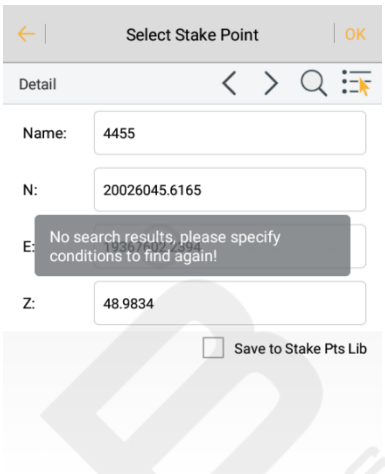



*Figure 4-2-4 Select Point*

3. Select from picture (select point on line and select point on the map ). When at stake point, click , it will automatically extract the coordinates of *Stake Point Library*, according to the positive sequence or reverse order to stake out. In *Select Stake Point* interface, check *Save to Stake Pts Lib*: corresponding points can be saved to the *Stake Point Library*.

- *Nea*rest Stake Point: End users click icon, you can set the nearest point as the current stake point; in the process of approaching the nearest stake point, if you configure options such as voice prompts, precision, and prompt on approaching point etc., the software will make a prompt, according to the distance, such as icons, voice and words.

## 4.3 Stake Line

Stake Line is a simple local staking tool. There are four basic lines: line, arc, spiral curve and circle. The line can be defined by two point coordinates, or one coordinate and the azimuth for plane or space; the arc can be defined by 2 points, or a unified curve metamodel with one point and the azimuth; the spiral curve can be defined by a unified curve metamodel with one point and the azimuth; the circle can be defined by the center and radius. (Note: in order to unify the concept, we think that stake of one line is the stake of a circuit, for each stake point, its position is only indexed by mileage).

Usually, stake line first needs to select line style.

Click to enter *Stake Line Library; it* defines line data, and includes four types of lines: *Line*, *Arc*, *Spiral Curve*, and *Circle*. You can add, edit, delete, create, load, save, save as, and open data for the *Stake Line Library*.

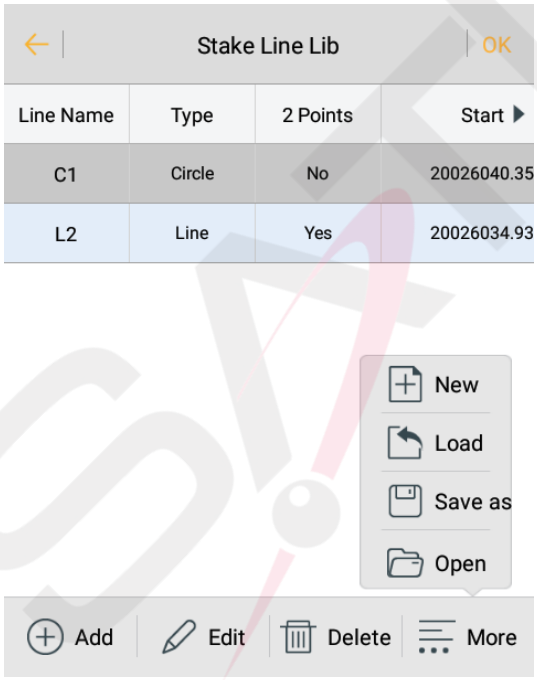



*Figure 4-3-1 Stake Line Library*

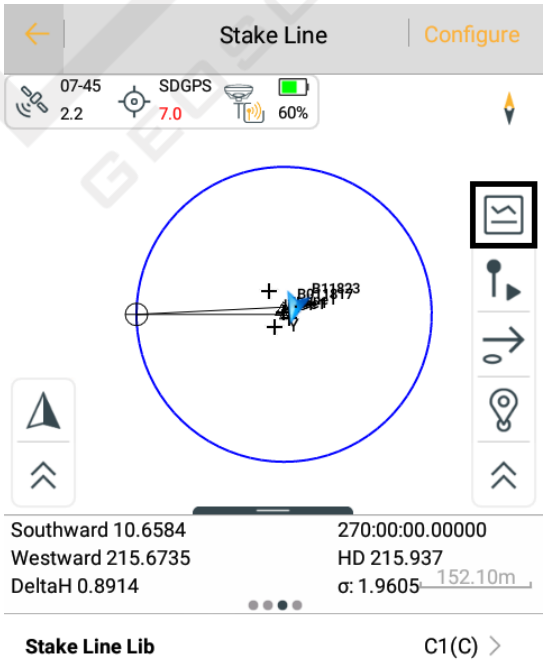



*Figure 4-3-2 Stake Line Interface*

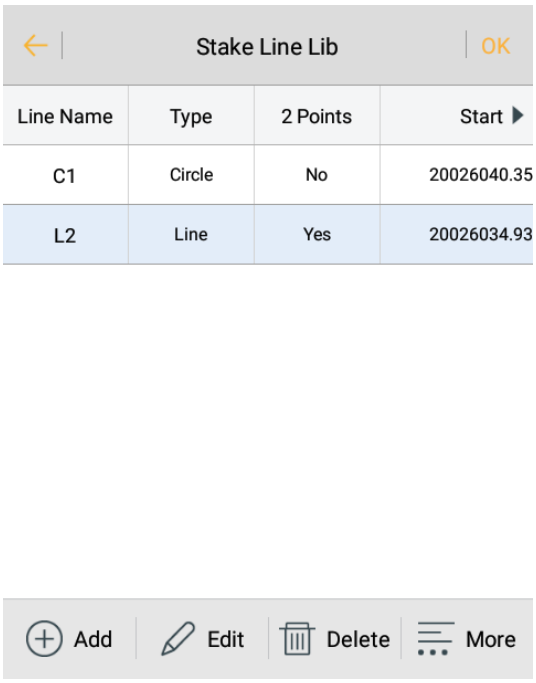



*Figure 4-3-3 Add Type*

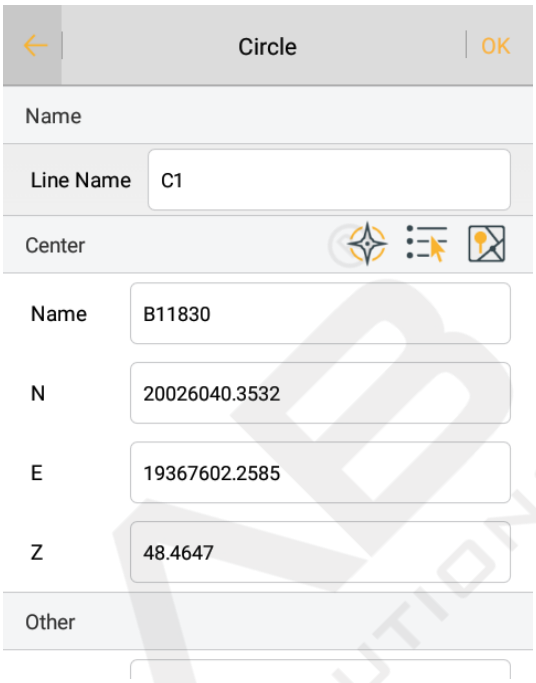



*Figure 4-3-4 Stake Circle*

- *Add*: Add the relevant parameter information of *Line*, *Arc*, *Spiral Curve*, and *Circle*, according to your requirement.

- *Edit*: Edit selected existing line elements.

- *Delete*: Delete the selected stake line.

- *Create*: New *.line file.

- *Load*: Accumulate line metafiles, the software will select the line element in the file and then switch to other projects and switch back. The loaded line element will be displayed in *Stake Line Library*.

Line library file (*.line) is the internal format of the software; add, edit, and save data by using software. *Two-point-line* file (*.2pt) is a public format, it can be edited by the user, choose to load *Two-point-line* to the *Stake Library* in the software.

- *Save* and *Save as*: Save current line element information.

- *Open*: Open the *.line file saved in */SATLAB/Project/ROAD/Unnamed*.

The following are the descriptions of each line type.

### 4.3.1 Define Line

Click *Line* button; enter line parameter definition menu - you can select to define a flat line or a three-dimensional line. The software provides two types, *Two-points to determine line* and *one point + azimuth*; if you select *Two-points to determine line*, extract two point coordinates from the *Point Library*, input the start mileage; If you select a *point + azimuth*, you only need to extract the coordinates of a point from the *Point Library*, then input the azimuth of the line and the start point mileage, and click *OK*.

Click sample point , input the mileage to be staked. Among them, the mileage and margins will automatically accumulate according to the increments. Click *OK* to enter the stake interface.

Calculate the position of the stake point and input mileage; (if necessary, calculate side stake), the *Up* and *Down* icons in the interface help to quickly adjust the mileage value, unit adjustments are the increments, the data is recorded in global variables. So each time you enter the interface, the software automatically calculates a mileage/offset as the default value to save time. For example, to stake a pile every 10 metres, set the increment to 10, the mileage of the starting stakeout point is 1850. After the end of the first point of thestakeout, enter this interface again. The software will automatically calculate the mileage as 1860, so click *OK* and continue to work.

- *Mileage*: Mileage of current stakeout points.

- *Offset*: In the direction of increasing mileage, the distance from the current point to the vertical line of the defined line (left is negative and right is positive).

- *Step*: Each time you enter a menu, the mileage increases.

- *Direction*: Taking defined line as the reference, set the direction to the left or to the right.

According to the prompt, the process of staking the specified milestone points is the process of the current point (triangle) closing to the target point (circle with cross).

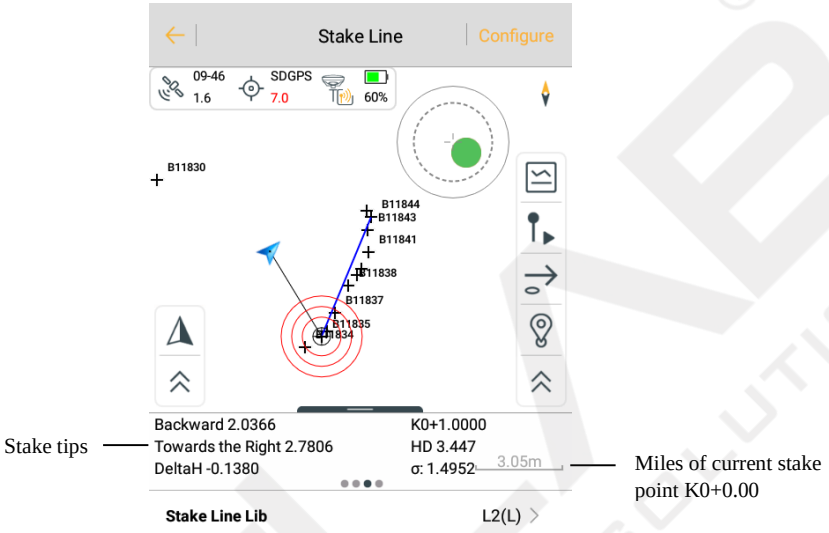



*Figure 4-3-5 Stake Line One*

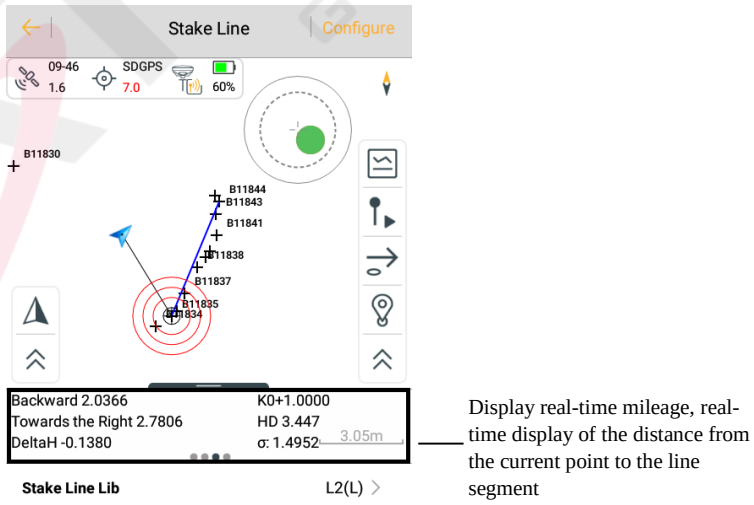



*Figure 4-3-6 Stake Line Two*

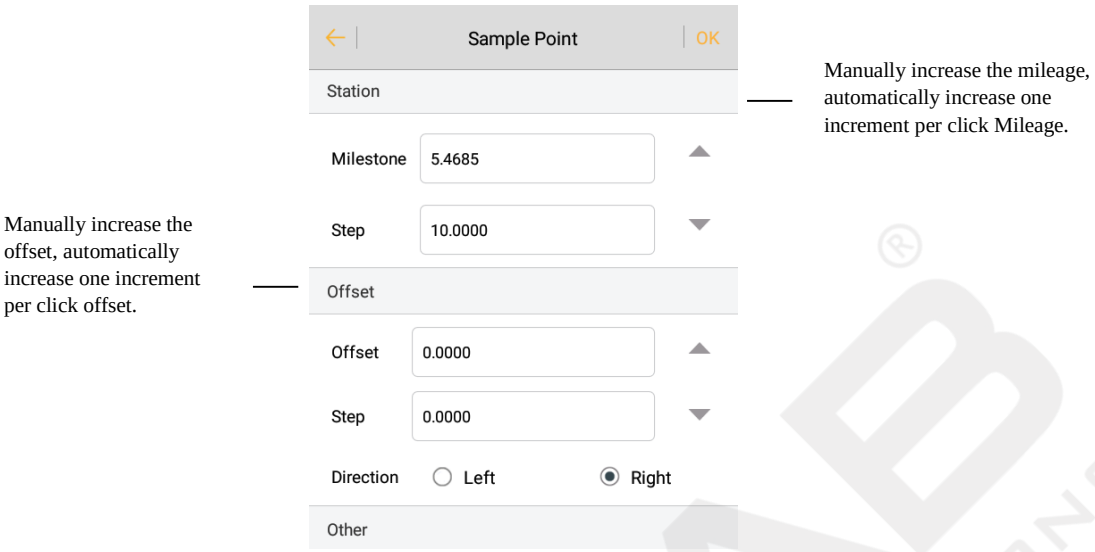



*Figure 4-3-7 Sample Point*

**Notice**: *Offset* is generally used when the road side pile; *Left* or *Right* in *Deflection* represents the left and right of the line, respectively; input distance from the center line to the edge line, in increments of zero, to stake a specific mileage. In addition, when opening the real-time mileage function, the software will project the current position point on the line and display the mileage of the projection point, which is helpful to determine the walking direction.

Select the *Three-dimensional line* to define a three-dimensional line. Three-dimensional lines are defined in two types: *Two-poin*t and *One point + Azimuth + Slope*.

When three-dimensional lines are staked, the defined stake miles are three-dimensional spaces long, and non-traditional two-dimensional projections are long.

In order to guide the destination, the software draws a connecting line, just make sure that the current walking direction coincides with the connecting line, to ensure that the walking direction is correct. At the same time, there are some guidelines below, for some strong sense of location, or point to clear areas, can be the software below the lofting instructions guide.

Stake instructions can be selected in two types: Front-Back, North-South. In the configuration item of the configuration interface, select the stake prompt types you want.

If you turn on *Real-time Mileage HT Diff*, the current mileage will be displayed on the interface, and its connection with the current point will be drawn. Draw a small dot on the line to indicate the position of the projection; *Real-time Mileage* is also used to determine whether the direction of walking is correct (compare real-time mileage with stake point mileage, and increase direction).

---

**Notice**: Triangle is the position and velocity direction of the current point, circular icon is the target point, the dotted line is the line connecting the current point and the target point. As long as the walking direction coincides with the connecting line, it is possible to ensure that the stake direction is correct, so that the target point can be easily found. The following information box is the staking information, indicating the difference between the walking direction and the vertical direction.

---

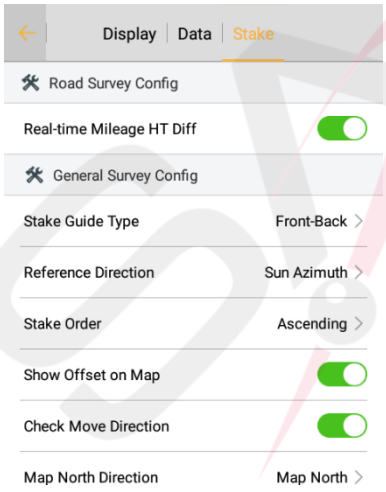



*Figure 4-3-8 Stake*


*Figure 4-3-9 Close*


*Figure 4-3-10 Success*

- *Green*: When close to the stake point it prompts *Reach the preset tip range*.

- *Red*: Stake success prompts *Reach the set stake precision*.

You can also turn on staking voice prompt in the configuration. When reaching the preset prompt range, and reaching the lofting accuracy, the hand-held will give different voice prompts.

### 4.3.2 Define Arcs and Spiral Curves

Click the *Arc* or *Spiral Curve* to define the line type; after defining the line style, the staking function is similar to *Line*. You only need the Stake Line interface; click the *Stake Point* , input the mileage to be the stake point. Among other data, the mileage and margins will automatically accumulate according to the step. Click *OK* to enter the stake interface.

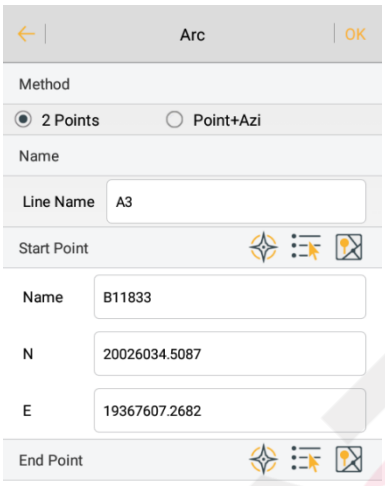



*Figure 4-3-11 Arc*

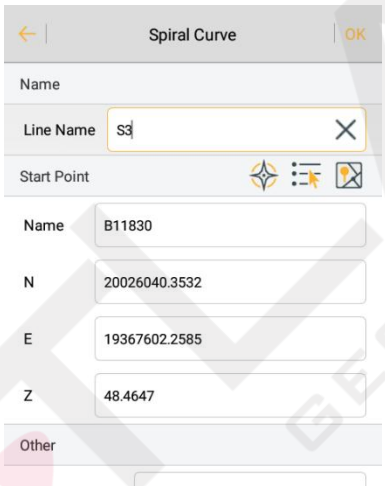



*Figure 4-3-12 Spiral Curve*

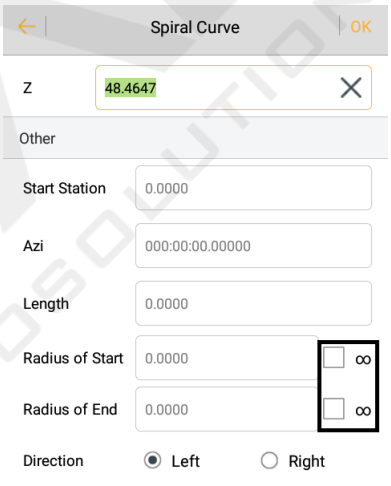



*Figure 4-3-13 Radius*

- *2 Points*: Input line name, start and end point coordinates, start point mileage, radius and deflection direction;

- *Point + Azi*: Input line name, start and end point coordinates, start point mileage, radius, azimuth, length and direction.

- *Radius of Start*: Spiral curve of radius of start, check ∞ to indicate a straight line.

- *Radius of End*: Spiral curve of radius of end, check ∞ to indicate a straight line.

## 4.4 Menu

Click the menu button of the hand-held in the *Detail Survey/Stake Point/Stake Line* interface; it will pop up a menu button for quick jumps or data viewing between associated interfaces.


*Figure 4-4-1 Menu Key One*

Click the menu button of the hand-held in the *Base/Rover* interface, to pop up the device connection button to quickly jump to the device connection interface.

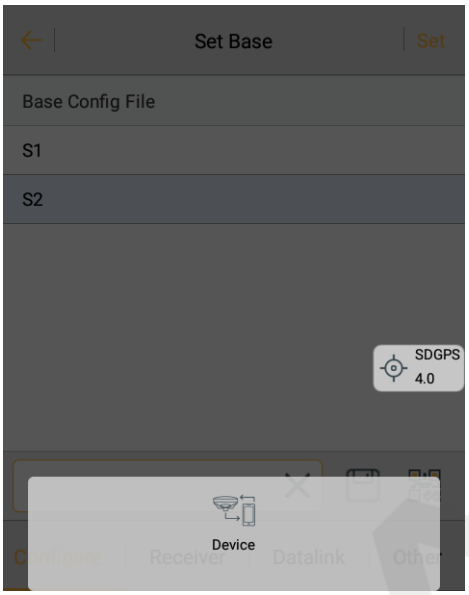



*Figure 4-4-2 Menu Key Two*

## 4.5 Mapping Survey

*Mapping Survey* is the work of measuring the plane coordinates and elevation of the control points needed for the mapping.

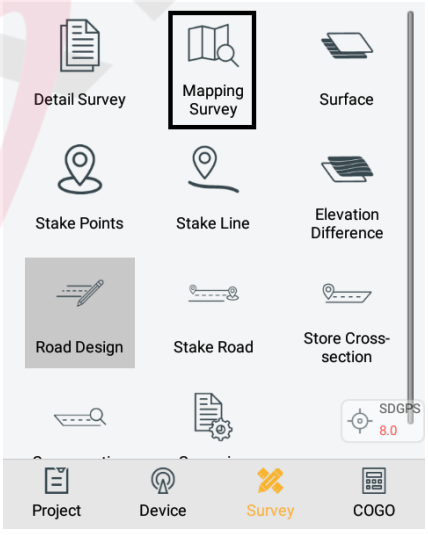



*Figure 4-5-1 Mapping Icon*

The accuracy of the map root point, RMS in point position relative to adjacent level control point, should not be greater than 0.1mm on the mapping; The error of elevation should not be greater than 1/10 on mapping.

Enter the *Map root measurement* interface; to see the map root acquisition progress, click *Configuration* setting parameters, the configuration page can automatically record the last input, and the name of point can be increased.

- *HRMS*: The horizontal RMS of the current point;

- *VRMS*: The vertical RMS of the current point.

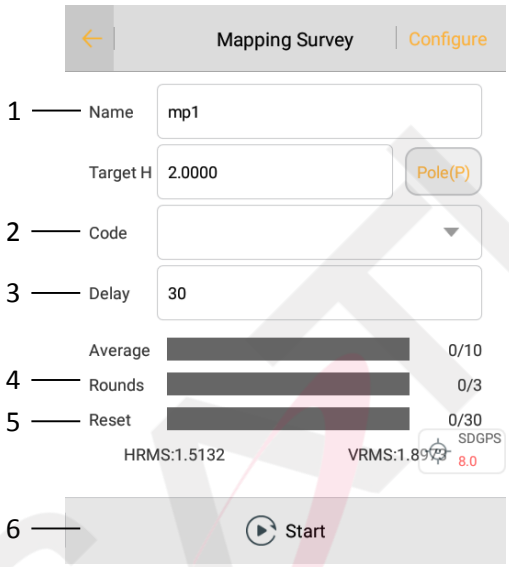



*Figure 4-5-2 Mapping Survey*

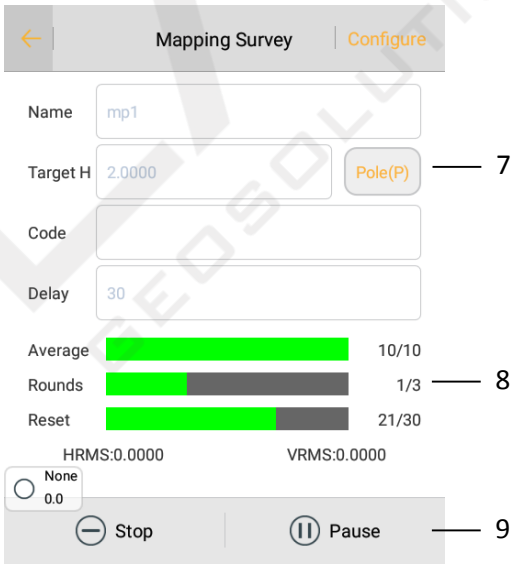



*Figure 4-5-3 Start Survey*

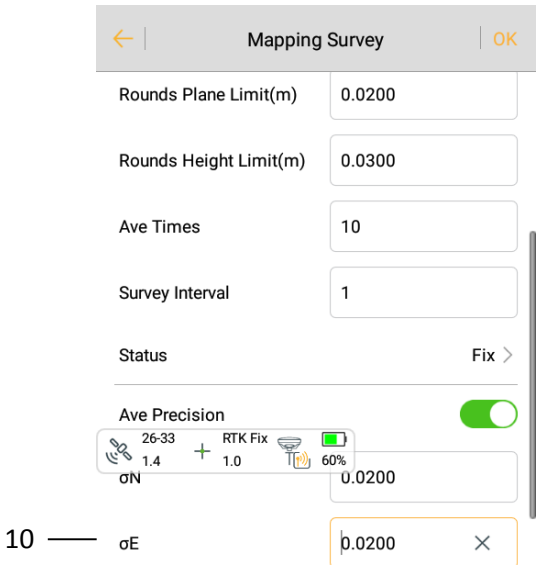



*Figure 4-5-4 Plane Limit Type*

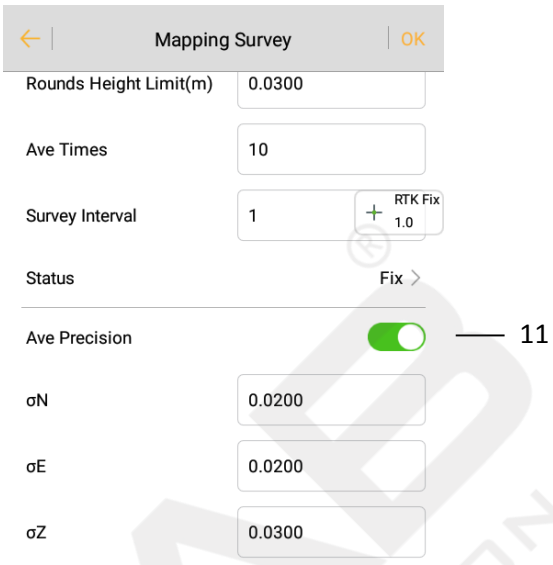



*Figure 4-5-5 Ave Precision*

-*1*: Edit point's name, or it will automatically add by default

-*2*: Input map root point of description

-*3*: Motherboard reset interval (s)

-*4*: Progress of smoothing times per return

-*5*: Motherboard reset progress

-*6*: After the parameters are set, click *Start*

-*7*: Click to select target high type, input target high

-*8*: Measured number and progress

-*9:* Can be stop or pause during mapping root collection

*-10*: When the plane limit typed is selected as the integrate, then the integrate is set here, conversely, it is each component

*-11*: Press to open, you need to set Σn, σe, Σz precision.

### 4.5.1 Mapping Data

*Project interface* → *Mapping Data*; you can view all map root measurement data, and you can also create, open, or search for data. Long press the map root point to delete and edit.

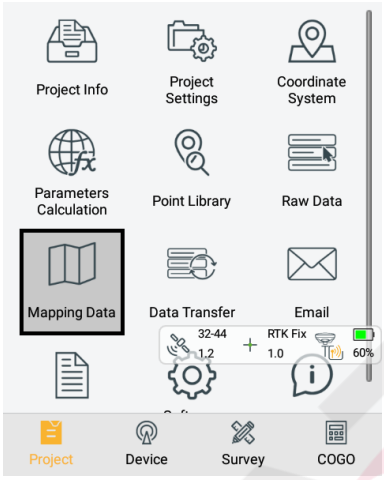



*Figure 4-5-6 Mapping Data*

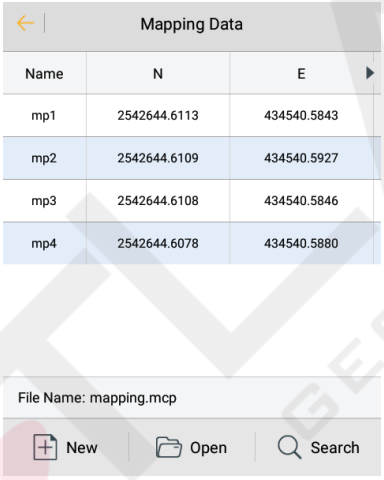



*Figure 4-5-7 List*

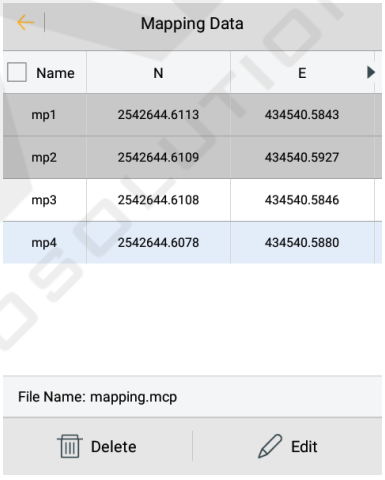



*Figure 4-5-8 Long Press*

### 4.5.2 Mapping Survey report export

*Project* interface→Project Information; click icon to export mapping reports in *.html format by default. The report can view the measured antenna height, observation time, and XYZ and BLH values of field observations at the map root point of the plot (the optimal value in 3 tests, the optimal value of 1 total data, and the average value of 4 data). Average collection of data for each point of DX, DY, DH, in the Statistical data table can also see the xyh point of Error (RMS), the point and maximum value of HRMS, according to the percent of pass, it can judge whether the point is available.

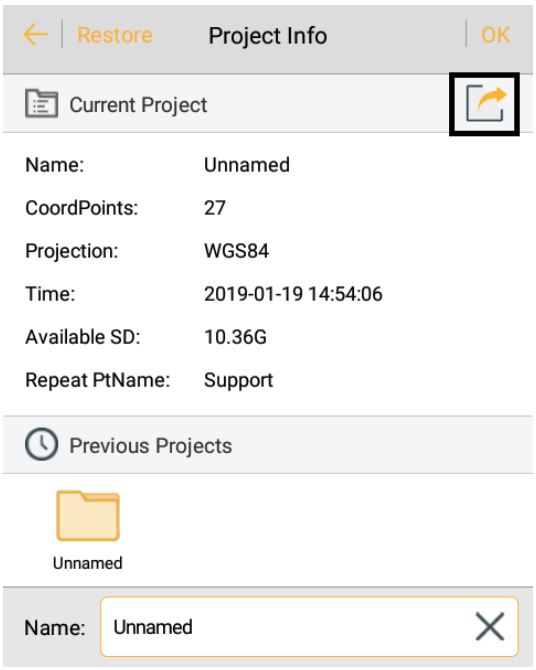



*Figure 4-5-9 Export*

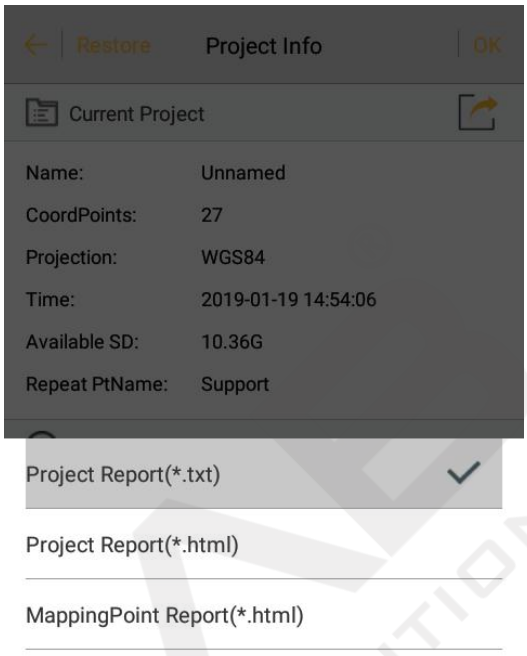



*Figure 4-5-10 Format*

# Chapter 5

## Road

**This chapter contains:**

-Operation Procedure
-Stake Road
-Road Design
-Store Cross-section
-Cross-section Points
-Surface
-Elevation Difference
-Surveying Configure

## 5.1 Operation Procedure

The road engineering survey contains the route reconnaissance and design survey and road construction survey.

1. Route reconnaissance and design survey

Preliminary measurement: Control measurement. Measure the strip topographic map and profile diagram, collect geological hydrological data along the line, do the paper location or site location and make comparison plans to provide a basis for the preliminary design.

Decided measurement: Route center line survey on the route of the selected design. Measure the profile diagram, cross-sectional profile, bridges and culverts, route crossing and facilities along the route to provide information for the construction design.

2. Road construction survey

Follow the design drawings to restore the road, measure the subgrade sidepiles and vertical curve, and do the project completion acceptance measurement.

## 5.2 Stake Road

Stake road is the key function of the SATSURV. The excellent working mode will make the surveying more efficient and systematic.

Stake road and stake line operations are mostly the same. The definition of the road is more complicated than the definition of the line, it will use the profile diagram and cross-sectional profile to design the line, so the calculation is more complicated. But, relatively speaking, the difference between the process of the stake road and stake line is only based on the operation of defining the line; point collection and staking-out operation are the same.

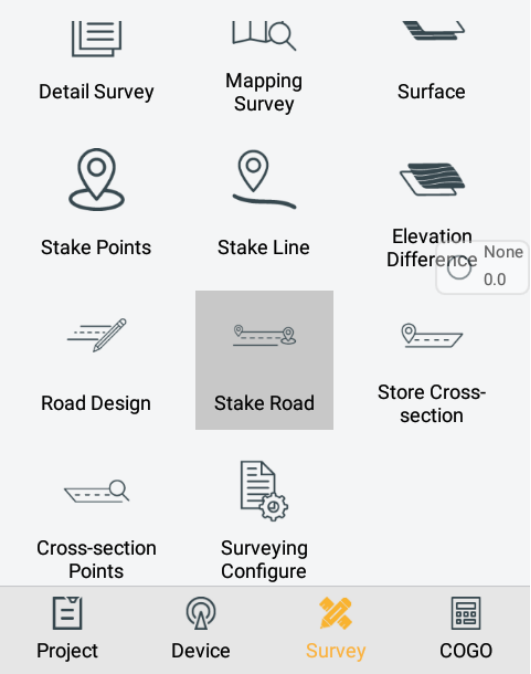



*Figure 5-2-1 Survey Interface*

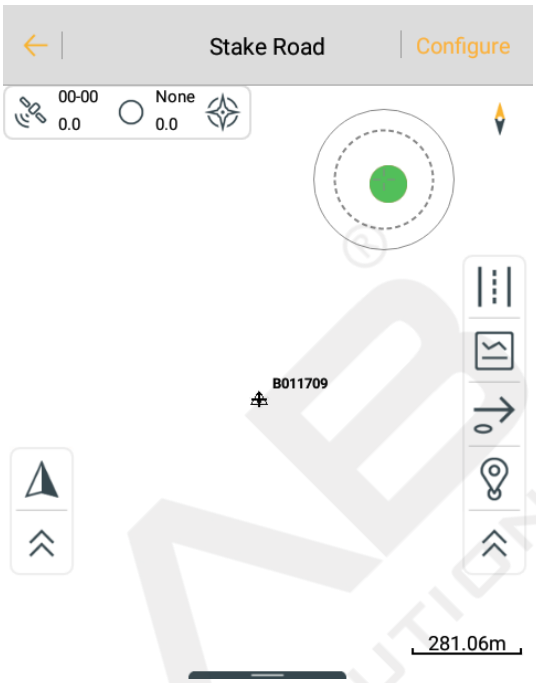
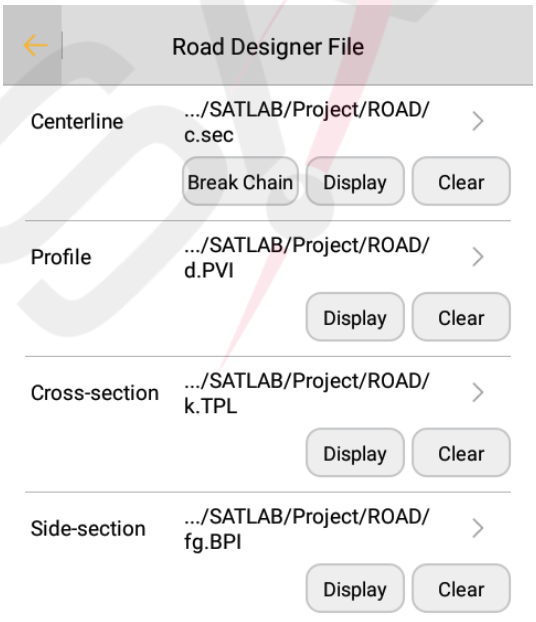



*Figure 5-2-2 Stake Road*

1. Load the road line

Click to enter the road designer file interface, load the centerline, profile, cross-section and side-section. Check the file path, and click *Display* to view the graphic and check the data.



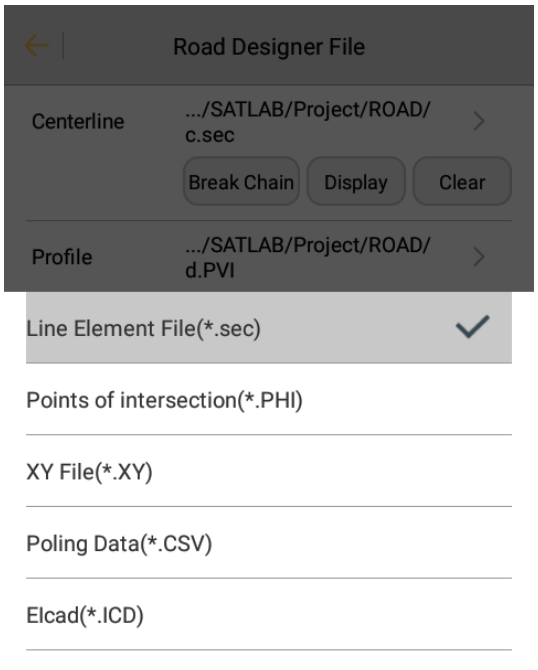



*Figure 5-2-3 Road Designer File* *Figure 5-2-4 Formats*

Click to switch the perspective (top view of the road or cross-section), and there will be the *Side-section* for users to choose if the side-section and cross-section are enabled.

If there is no profile elevation, cross-section elevation collection and side-section staking-out can't be done. Because the elevation is not known, it's impossible to get the height of filling and cutting.

In the cross-section view, the red dot indicates the corresponding position of the current position in the cross-section. In the upper left of the interface, the current real-time mileage and the offset from the center line are displayed. At the bottom left of the interface, the height of filling and cutting is displayed.

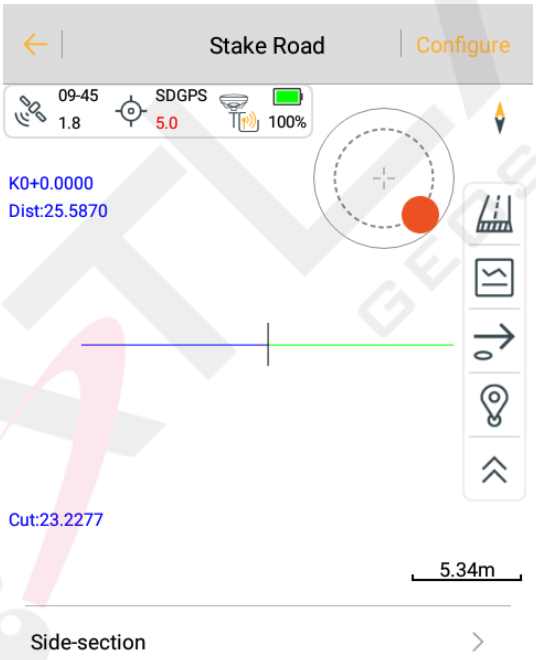



*Figure 5-2-5 Cross-section View*

2. Confirm the location of stakeout points.

Click to input and adjust the milestone and offset manually, or by ▼ and ▲ buttons. Click *OK* and the coordinate of this position will be calculated as the coordinate of the stakeout point automatically.

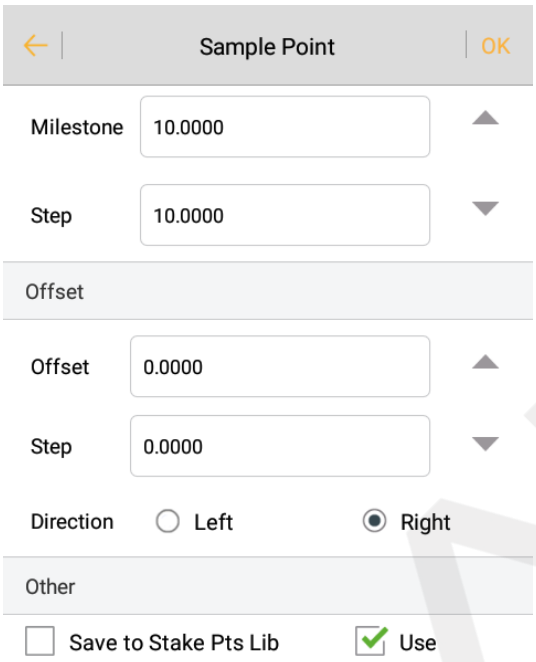



*Figure 5-2-6 Sample Point*

- *Use*: Stake out the stakeout point; the graphic interface will display the dashed line connection between the current point and the stakeout point, as well as the stakeout indication.

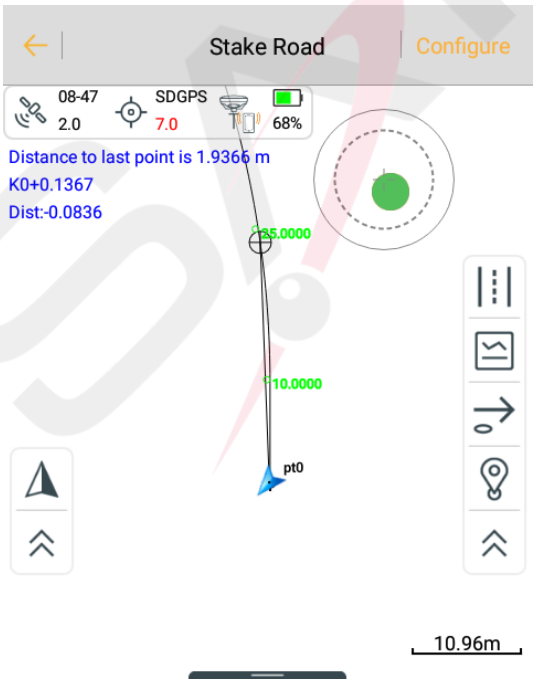



*Figure 5-2-7 Stake Road*

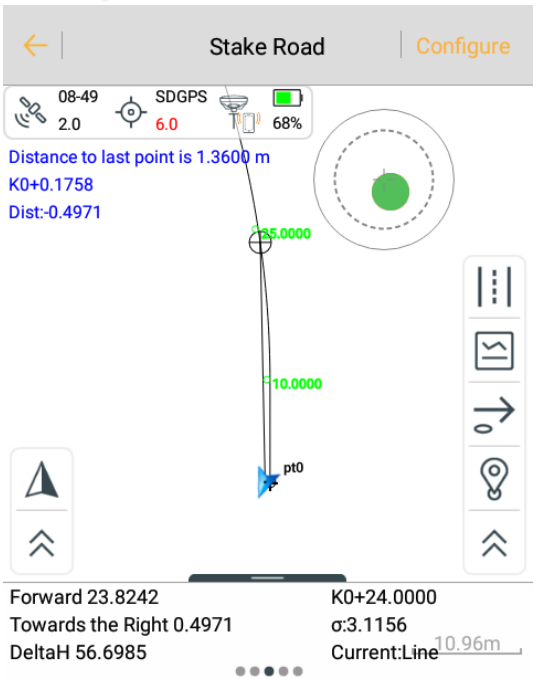



*Figure 5-2-8 Menu Key*

- : Menu key. Click to display and check the data status.

3. Stake out

This process is the same with the stake line operation.

## 5.3 Road Design

In the *Stake Road* interface, click  to enter the road designer file interface. For the centerline, users can load the Line Element File(*.sec), Points of intersection(*.PHI), XY File(*.XY), Poling Data(*.CSV), Elcad(*.ICD), Coord File(*.Zline), HDPM(*.pm), WDPM(*.pm) and LandXml File(*.xml), and click *Break Chain* to edit. For the *Profile*, users can load the PVI file(*.PVI) and LandXml File(*.xml). For the *Cross-section*, users can load the Template File(*.TPL) and LandXml File(*.xml). For the *Side-section*, users can only load the BPI File(*.BPI). After loading, please click *Display* or *Clear* to preview or delete data.

**Notice**: It's not possible to do the next mileage collection and stakeout without the centerline; and the slope cannot be staked out without the cross-section design line.

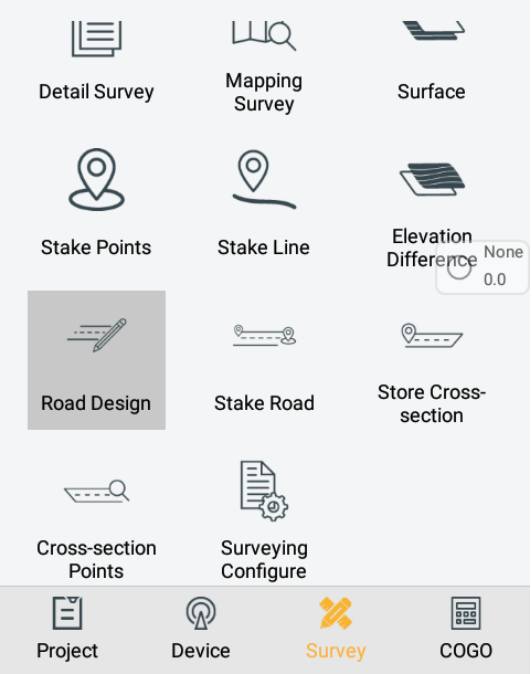



*Figure 5-3-1 Survey Interface*

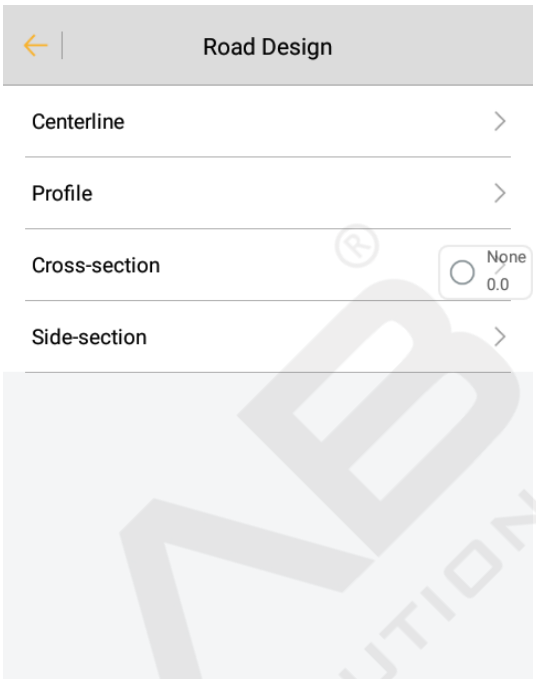



*Figure 5-3-2 Road Design*

## 5.3.1 centerline

There are many methods for centerline alignment, including the *Intersection*, *Element* and *Coordinate* methods. The intersection method is based on certain conventions; there are certain restrictions on the type of lines. The element method can combine line shapes arbitrarily, it supports polylines and is suitable for complex curves, including oval lines, multi-intersection curves and imaginary intersection points. The coordinate method is similar to the element method, but the definition of each line element is determined by defining coordinates of the start and en point. The line element format (*.sec) files won't contain the polyline corner information, so if the polyline corner information is needed, please save the file as the Coord File (*.Zline) format.

The SATSURV supports the *Intersection*, *Element* and *Coordinate* methods and the default line element combination within the intersection is the straight line - the first transition curve - circular curve - the second transition curve. It supports the smooth transition curve, and the non-smooth transition curve supports the transverse import.

**Notice**:

1. Two transition curves can be asymmetrical.

2. The reverse loop needs to be treated as a non-reverse loop, such as adding an intersection.

3. It supports the imaginary intersection point.

4. It supports the local curve, and the transition curve length can be zero.

1. Intersection method

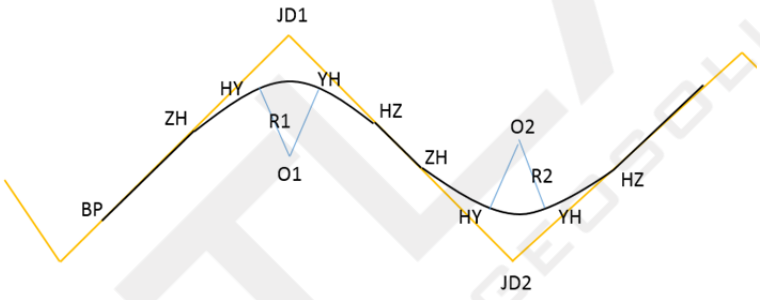



*Figure 5-3-3 Intersection*

- *Intersection JD1/JD2*: The intersection of two adjacent lines.

- *ZH*: The point where the straight line intersects with the first transition curve, that is, the start point of the first transition curve.

- *HY*: The point where the first transition curve intersects with the circular curve, that is, the end point of the first transition curve.

- *YH*: The point where the circular curve intersects with the second transition curve, that is, the start point of the second transition curve.

- *HZ*: The point where the second transition curve intersects with the straight line, that is, the end point of the second transition curve.

- *ZH-HY*: The first transition curve.

- *YH-HZ*: The second transition curve.

- *HZ-ZH*: The straight line.

- *HY-YH*: The circular curve.

Click *Intersection* to enter the intersection table data-editing interface. Click *Add* to add the intersection information, input the information manually or select the point from the point list.

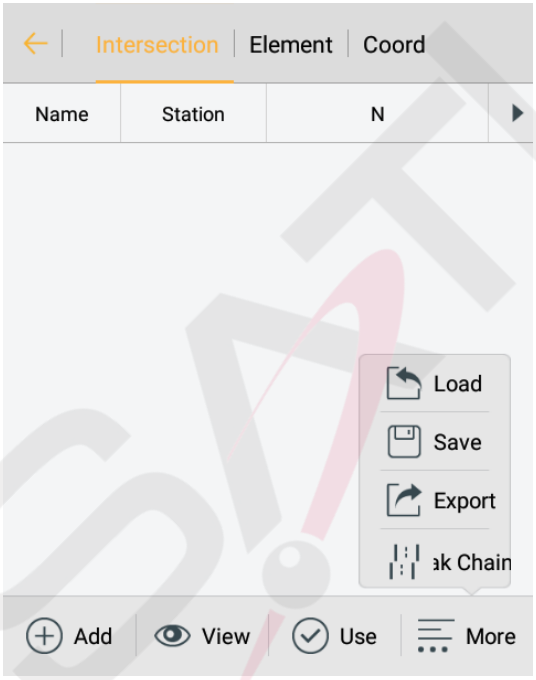



*Figure 5-3-4 Intersection Interface*

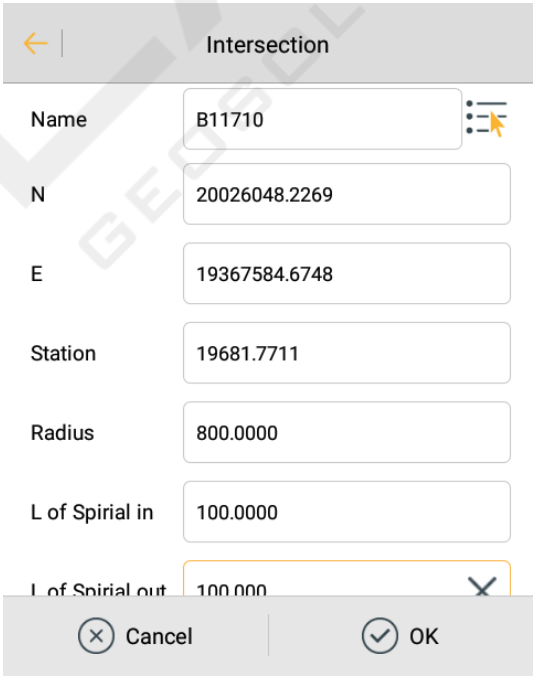



*Figure 5-3-5 Add Intersection*

- *Load*: Open the existing Points of intersection (*.PHI) or Poling Data (*.CSV) file.

- *Save*: Save the file in the *.PHI format. The default save path is the *SATLAB* /ROAD folder.

- *Export*: Export the file in the Poling Data (*.CSV) or Line Element File (*.sec) format. The default save path is the *SATLAB* /Out folder.

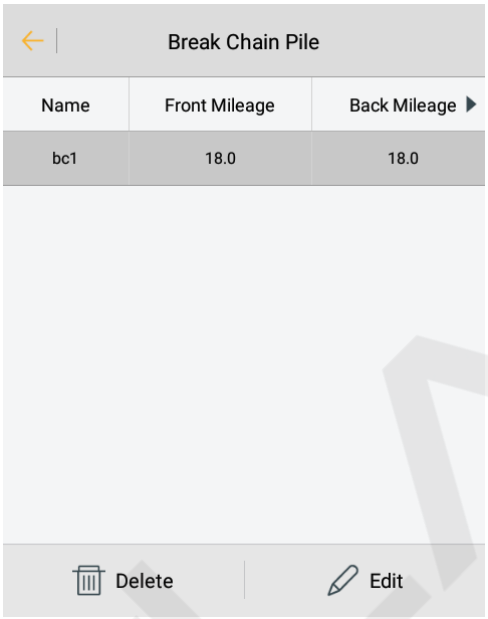



*Figure 5-3-6 Break Chain Pile*

- *Break Chain*: Long press the break chain pile record to delete or edit the break chain data.

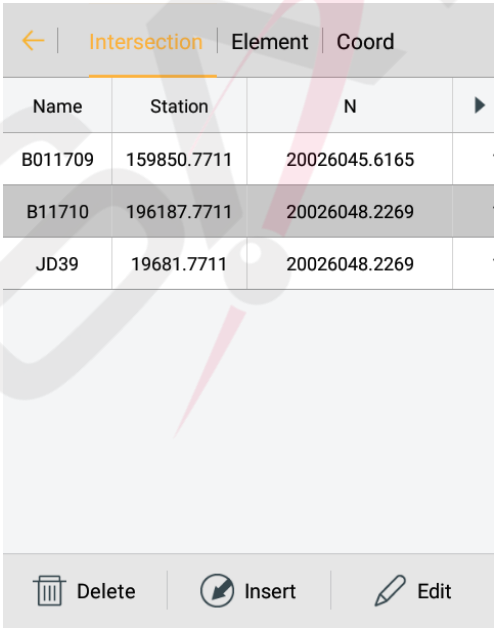



*Figure 5-3-7 Record Operation*

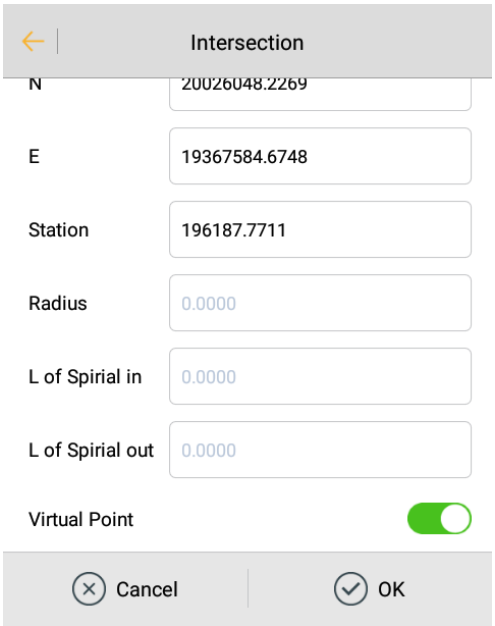



*Figure 5-3-8 Virtual Point*

Long press to select and operate the intersection record.

- *Delete*: Delete the existing point record.

- *Insert*: Insert an intersection data above the selected point record.

- *Edit*: Edit existing intersection data.

When adding the intersection data, the software will identify the suspected oval curve and users can change the data manually, according to the prompt.

It supports the virtual point option with the imaginary intersection point and reverse loop. Input the first point of the virtual point combination normally, and open the virtual point option after the second point is entered.

Click *View* to check if the centerline graphic is correct.

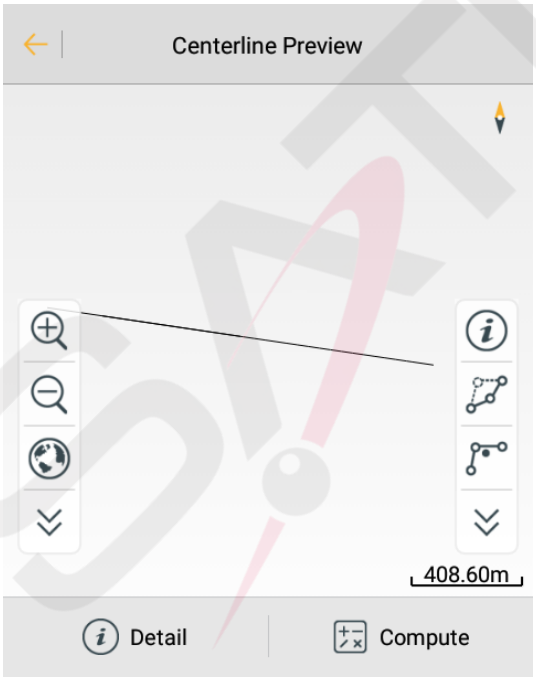



*Figure 5-3-9 centerline Preview*

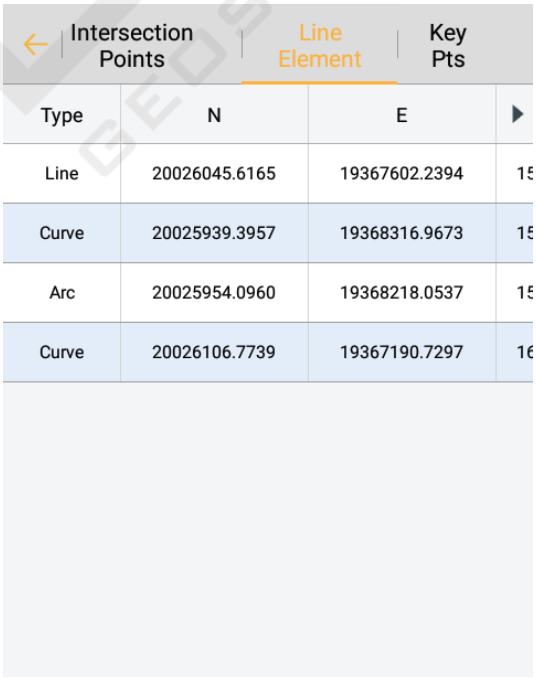



*Figure 5-3-10 Detail*

- *Detail*: Click to enter the interface to check the detail parameters, including the *Intersection Points*, *Line Element* and *Key Pts*.

- *Compute*: Input the station and offset; it can check the coordinates; input the coordinates, calculate the station and offset.

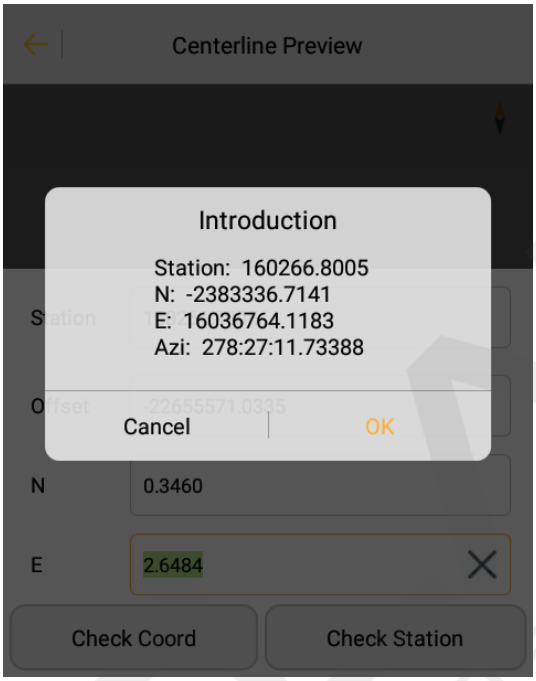



*Figure 5-3-11 Compute*

- : Click to input the limit point manually. Users can also select it from the point list or do real-time collection to get the point.


*Figure 5-3-12 Limit Point*

- : Change the line. Click to choose the point to be changed (start and end points are not selectable), and change it by *Manual input* or *Select from map*.

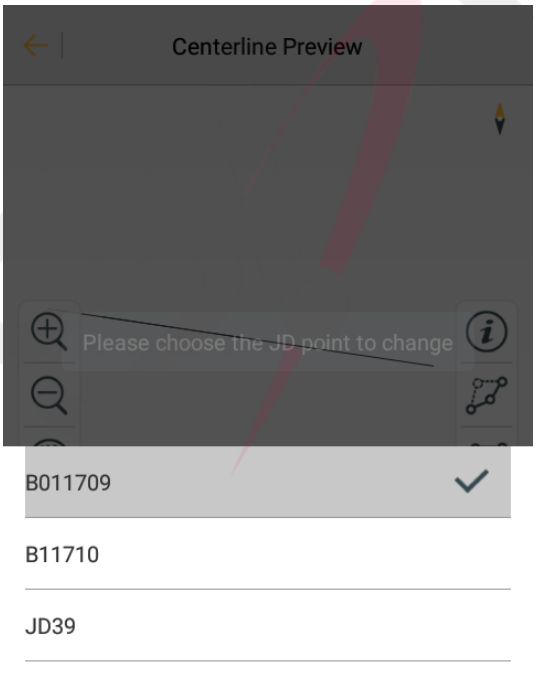



*Figure 5-3-13 Change the Point*

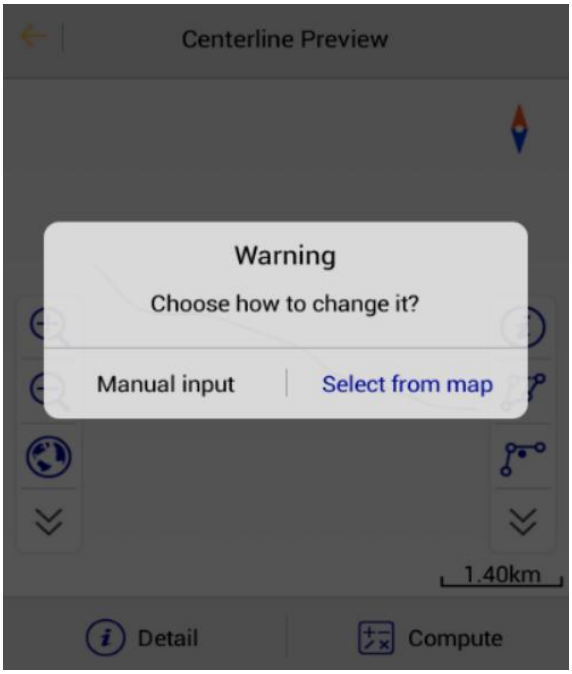



*Figure 5-3-14 Change Methods*

- ⓘ: Line auxiliary points. Click to view corresponding auxiliary points and auxiliary dashes in the figure.

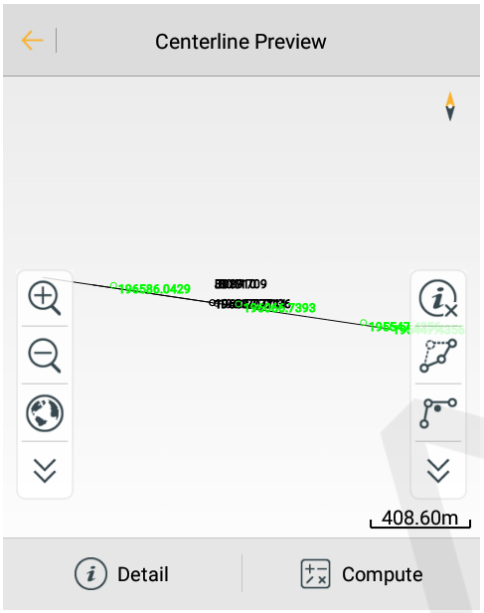



*Figure 5-3-15 Line Auxiliary Points*

Click *Use* to load the currently edited line data into the project, and users can select whether to save the defined or modified line data.

2. Element method

Element alignment decomposes the combination of complex route lines into several linear units. If there is information (coordinates, tangential direction, radius of curvature, etc) about the starting point of the route plane curve, the unit that extends in any direction can be set from the start point, and the end point information of the unit can be calculated. Then the end of this unit can be used as the starting point for the next unit.

Common lines contain the straight line, arc and spiral curve. Users can input the line manually or load files directly, including the Line Element File (*.sec), HDPM (*.pm), WDPM (*.pm), LandXml File (*.xml) and Poling Data (*.CSV) formats.

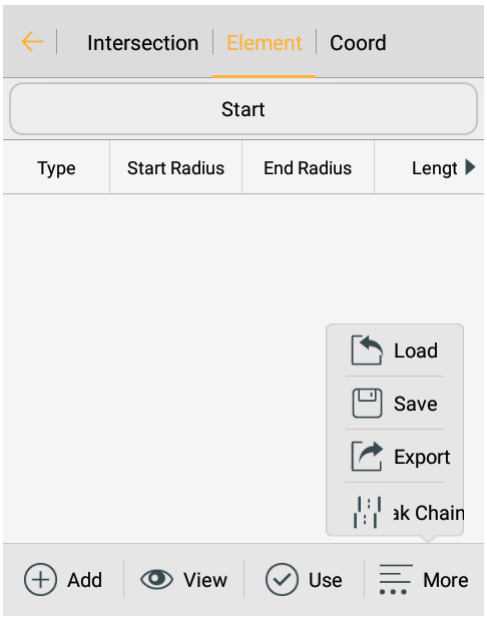



*Figure 5-3-16 Element*

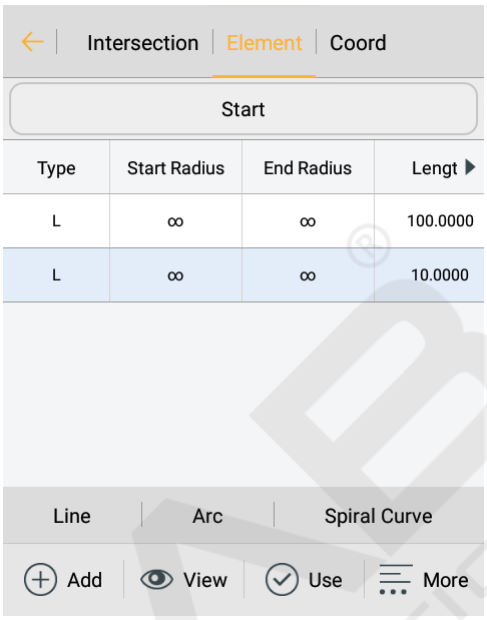



*Figure 5-3-17 Add*

In the general working process, users need to input the coordinate of the starting point, mileage and azimuth. Click *Add* to choose the line type and input the information.

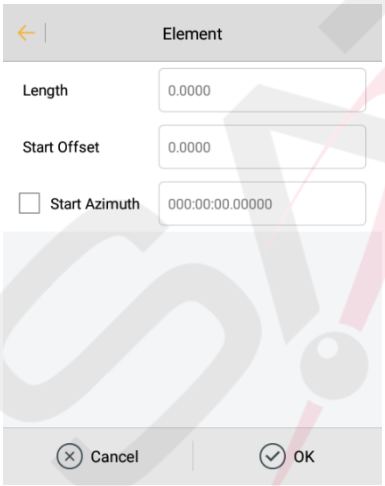



*Figure 5-3-18 Line*

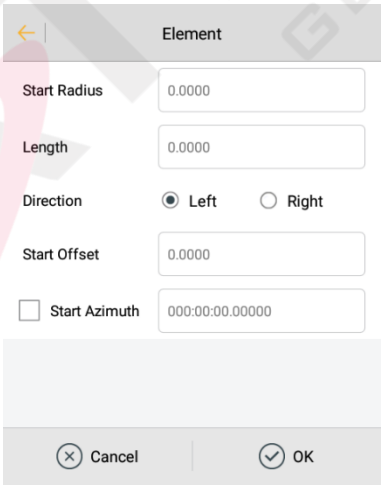



*Figure 5-3-19 Arc*

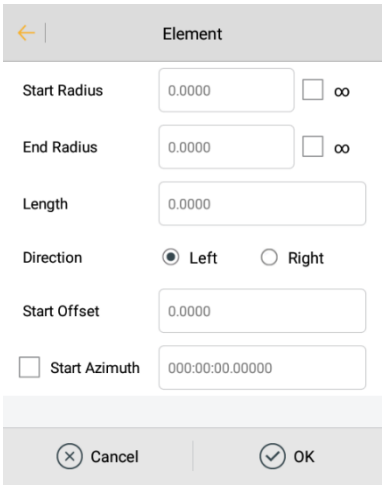



*Figure 5-3-20 Spiral Curve*

- *Line*: Input the *Length*, *Start Offset* and *Start Azimuth*.

- *Arc*: Input the *Start Radius*, *Length*, *Direction*, *Start Offset* and *Start Azimuth*.

- *Spiral Curve*: Input the *Start Radius*, *End Radius*, *Length*, *Direction*, etc.

Click *Start* to enter the element interface to edit the start point.

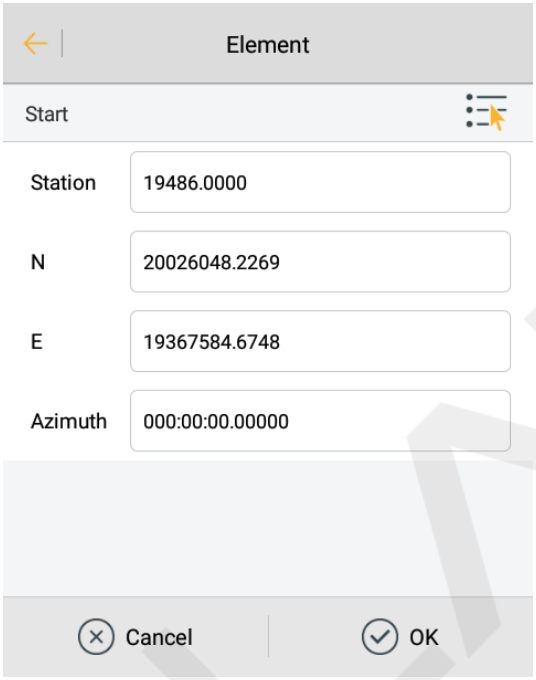



*Figure 5-3-21 Start Point*

Click *View* to preview and edit the centerline.

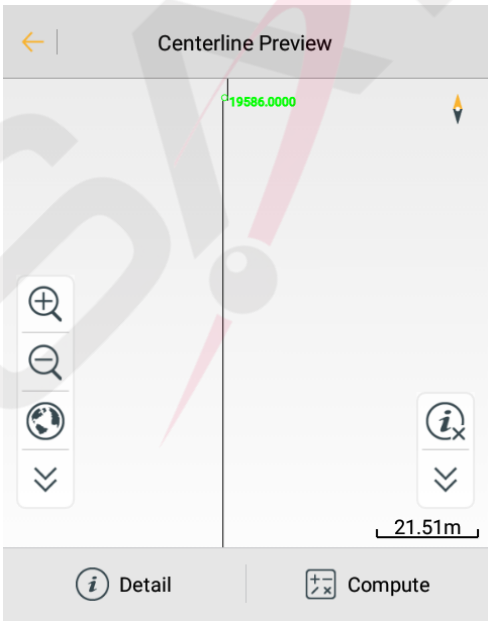



*Figure 5-3-22 Preview*

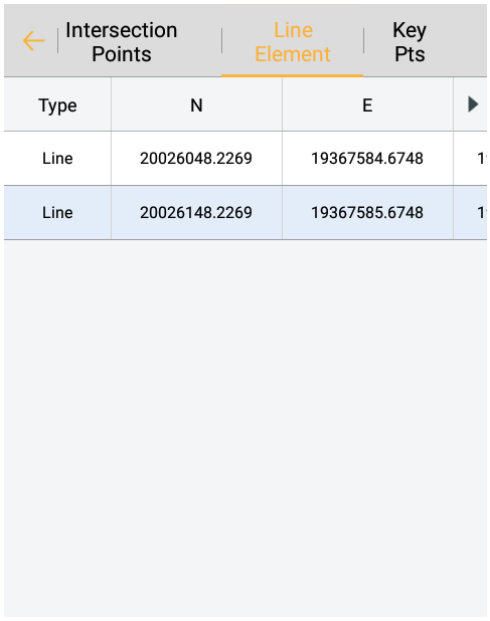



*Figure 5-3-23 Detail*

- *Detail*: Click to check the detail parameters, including *Line*, *Curve* and *Arc*.

- *Compute*: Input the station and offset, it can check the coordinates; input the coordinate, calculate the station and offset.

1. Coordinate method

The coordinate method is similar to the element method, but the definition of each line element is determined by defining coordinates of the start and end point. It can only load the Coord File (*.Zline) format.

In the general working process, users need to input coordinates of the start and end point. Click *Start* to input the station and coordinate manually, or select points from the point list. Click *Add* to choose the line type to input the line information.

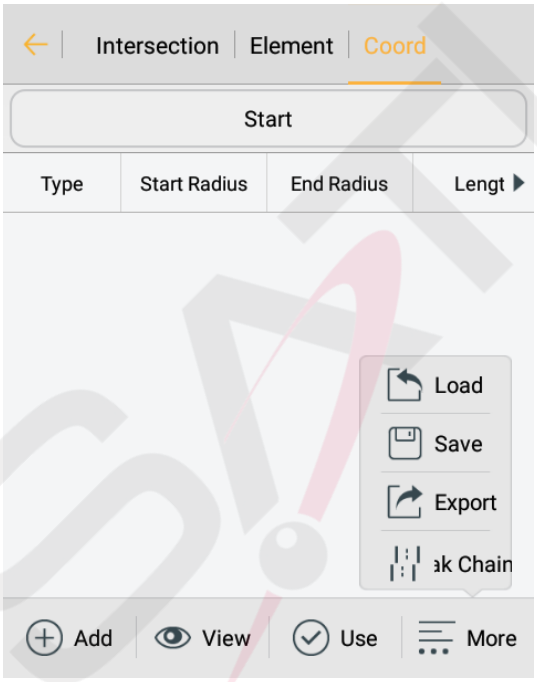



*Figure 5-3-24 Coord Interface*

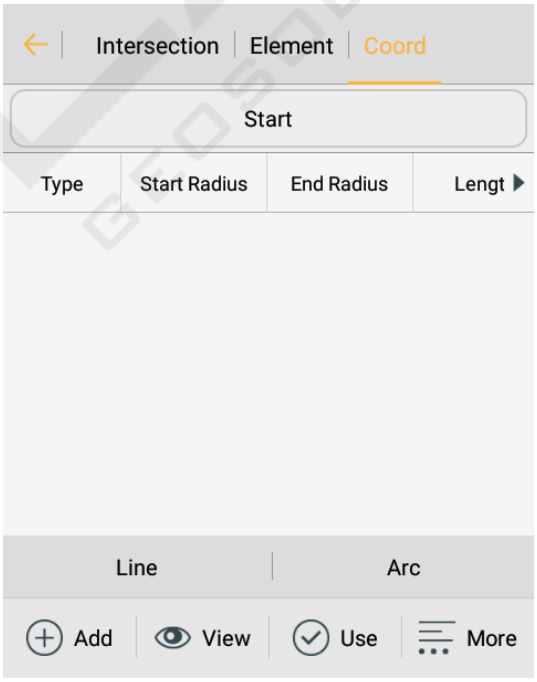



*Figure 5-3-25 Add Lines*

- *Line*: Click to input the coordinates of the start and end point.

- *Arc*: Click to input the coordinates and arc information.

### 5.3.2 Profile

The profile is an expression of the vertical movement of the road (the line fluctuates). It can be added manually, and users also can load the file in the PVI file (*.PVI) or LandXml File (*.xml) format.

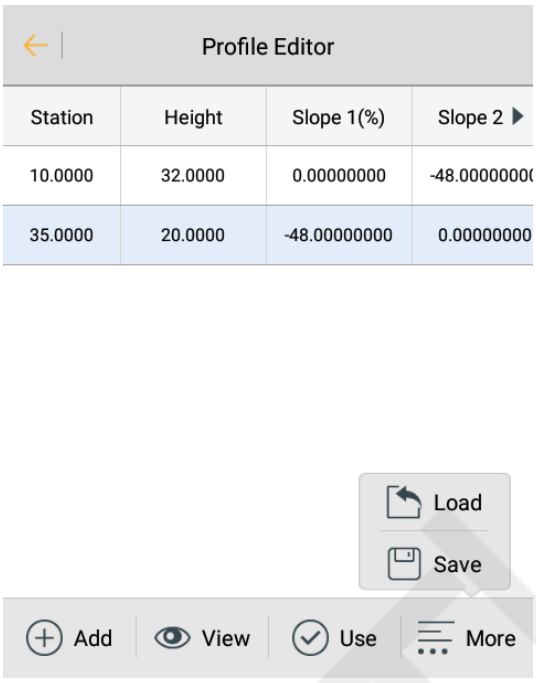



*Figure 5-3-26 Profile Editor*

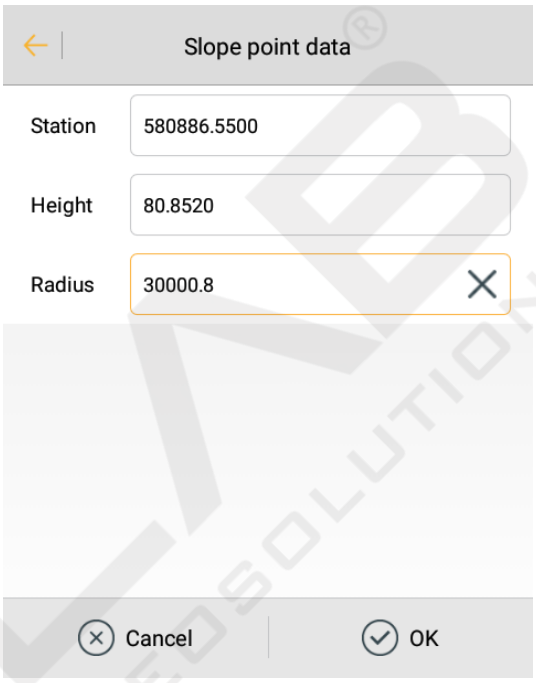



*Figure 5-3-27 Slope Point Data*

Click *Add* to add the slope point data, and long press the record to delete, insert or edit it. Click *View* to check the profile preview, and input the station value to check the height of the station.

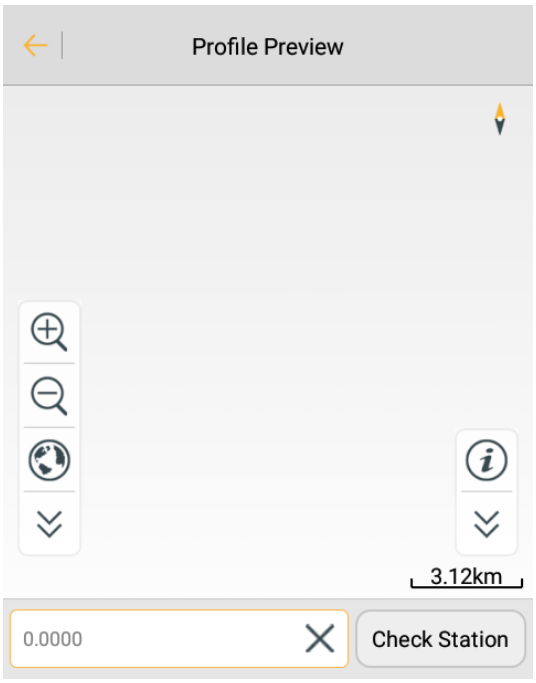



*Figure 5-3-28 Profile Preview*

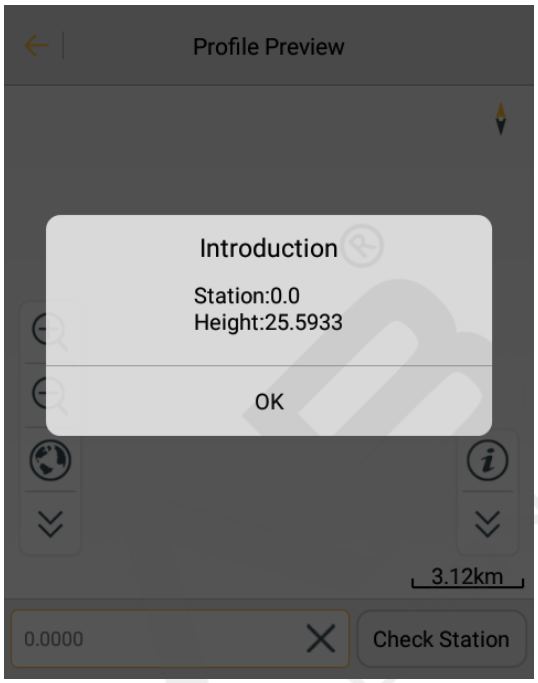



*Figure 5-3-29 Check Station*

### 5.3.3 Cross-section

The cross-section interface contains three options, including *Standard, SuperEle* and *WidePlus*.

Users can add, edit and delete the cross-section data.

1. Standard

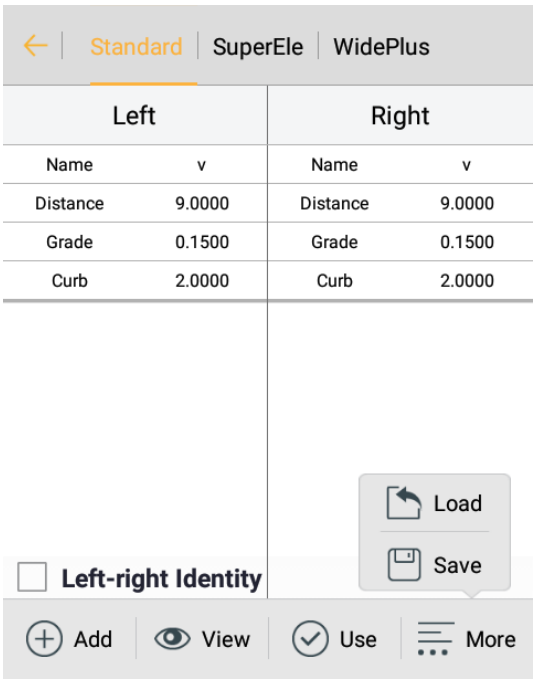



*Figure 5-3-30 Standard*

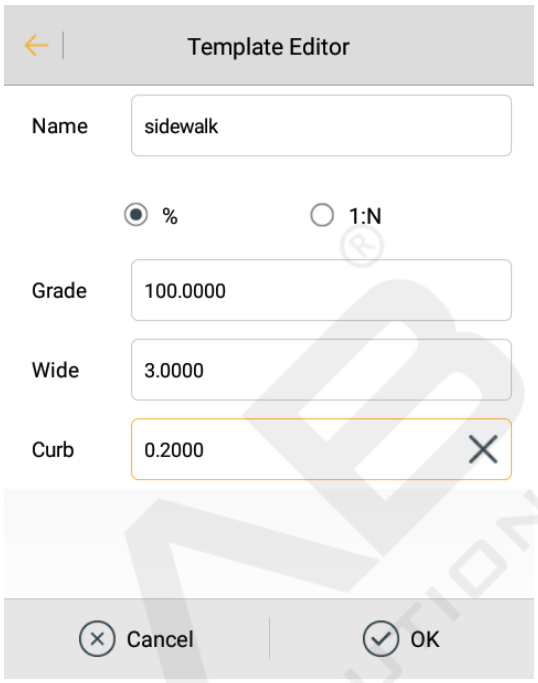



*Figure 5-3-31 Template Editor*

- *Left-right Identity*: The selection indicates that the left and right slopes are consistent, and the right slope data will be covered with data symmetrical to the left slope (the original right slope data will be covered and cannot be recovered).

- *Name*: The name of the current plate.

- *Grade*: From the middle of the road, uphill is positive and downhill is negative. The slope value is the ratio of the height difference between the two ends of the plate and the width of the plate.

- *Wide*: The width of the current plate.

- *Curb*: Click to input the height difference of the curb.

Click *View* to check the template preview, and input the station value to check it.

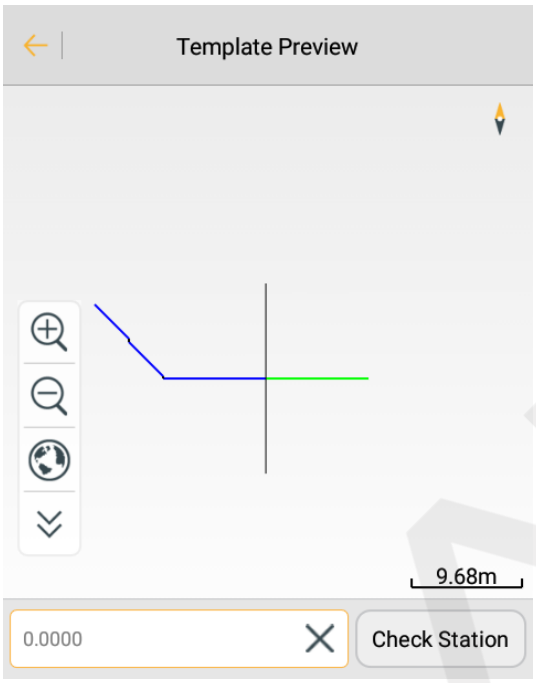



*Figure 5-3-32 Template Preview*

**Notice**:

There is only one cross section in memory. A road has different cross-sections at different road sections. Users can predefine several typical cross-sections according to their needs, and then transfer the cross-sections suitable for the terrain in different sections to stake out.

2. SuperEle

It's a way to make the road a lateral high-internal one-way cross slope to reduce the centrifugal force generated by a vehicle driving on the curve road.

In the *SuperEle* interface, users can choose the corresponding cross-section and input the super elevation information.

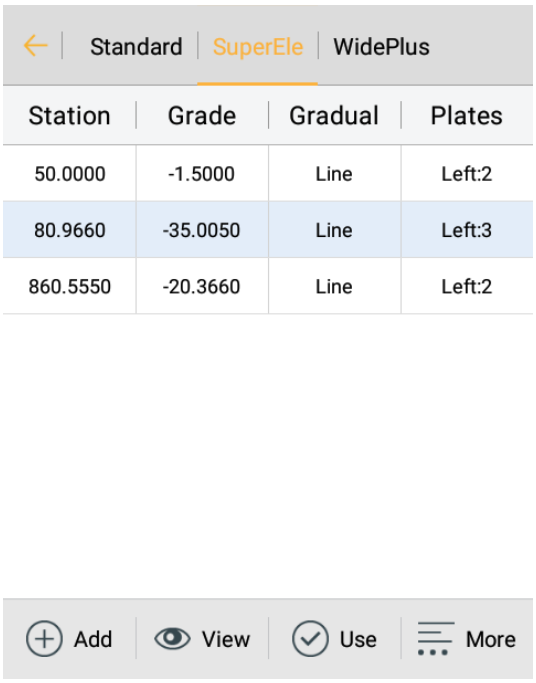



*Figure 5-3-33 SuperEle*

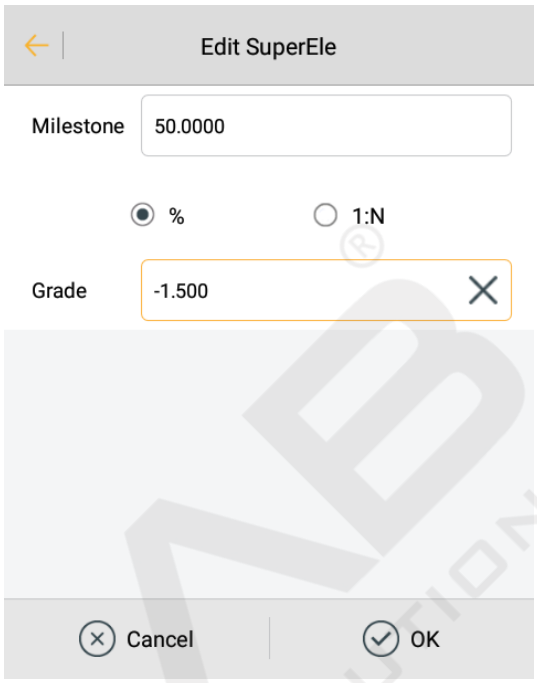



*Figure 5-3-34 Edit SuperEle*

Click *View* to check the template preview, and input the station value to check it.


*Figure 5-3-35 Preview*

3. WidePlus

In order to make the road surface transition from the normal width to the curve, a widened width is set so that a transition zone of curve widening needs to be set. In the transition zone of curve widening, the road surface has a gradually varying width. There are different settings methods of different road properties and levels.

In the *WidePlus* interface, users can input widening change point information according to design drawings.

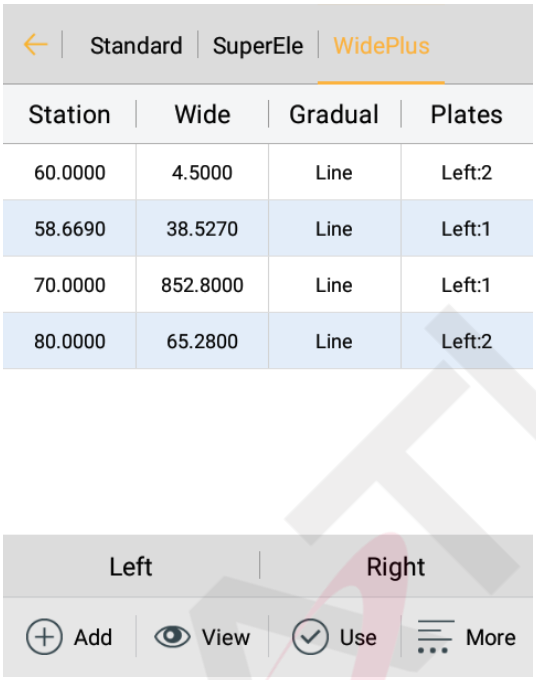



*Figure 5-3-36 WidePlus*

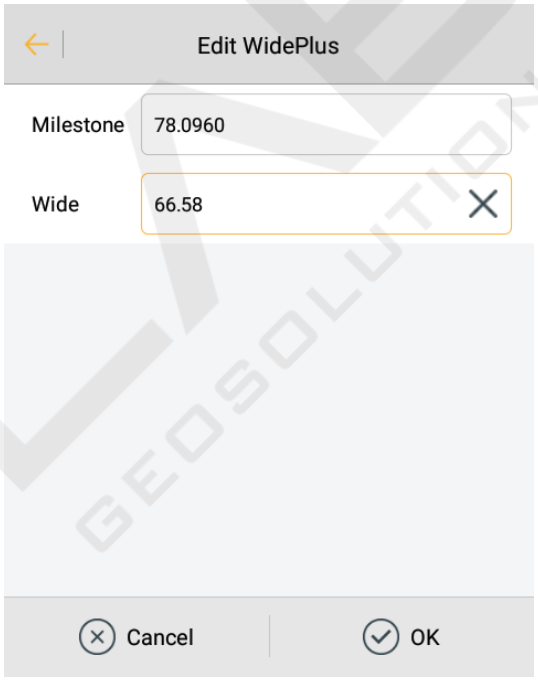



*Figure 5-3-37 Edit WidePlus*

Click *View* to check the template preview, and input the station value to check it.

---

**Notice**:

Users can switch *Standard*, *SuperEle* and *WidePlus* interfaces to view road data, and click *Use* on any of the three interfaces to apply the current cross-section to the road after confirmation. Users can also click *More*→*Save* to save it as the Template File (*.TPL) for subsequent loading and reuse.

---

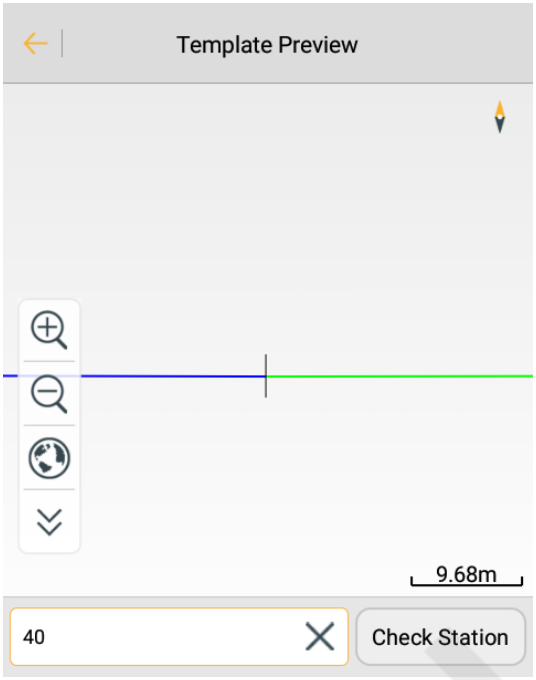



*Figure 5-3-38 Check Station*

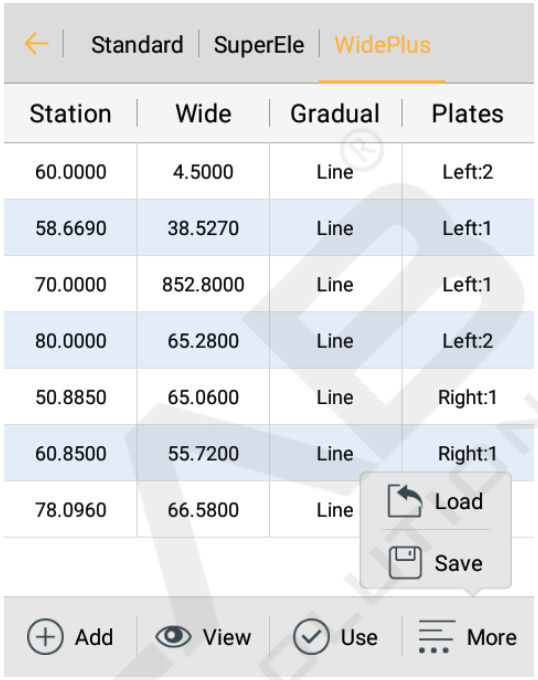



*Figure 5-3-39 Load or Save*

## 5.3.4 Side-section

In the *Side-section* interface, users can add, load, apply, and save the side-section.

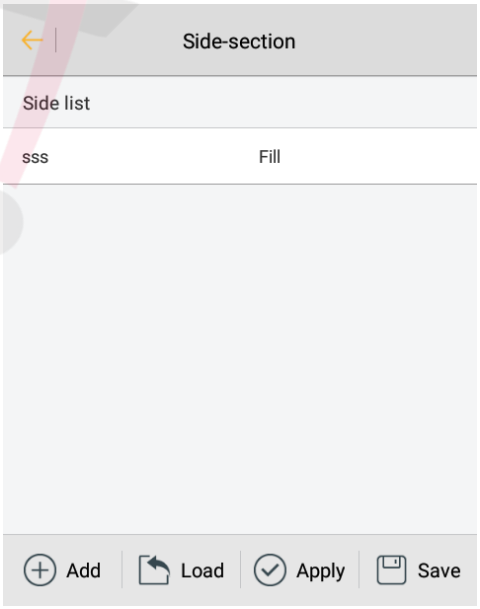



*Figure 5-3-40 Side-section*

- *Add*: Click to choose and add the *Fill* or *Cut*. Input the side-section name, and edit the side-section features.

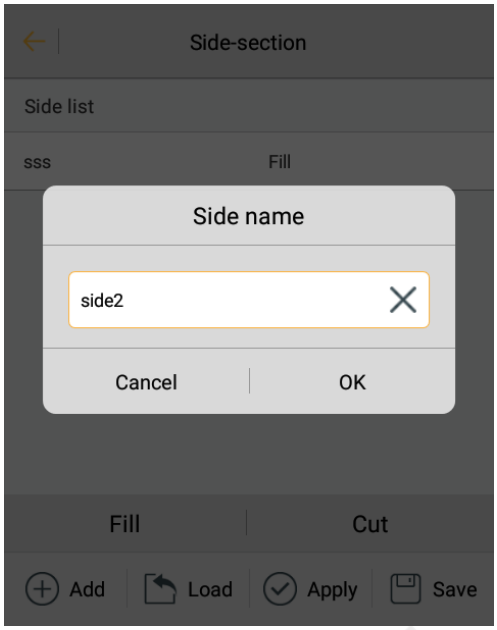



*Figure 5-3-41 Side Name*

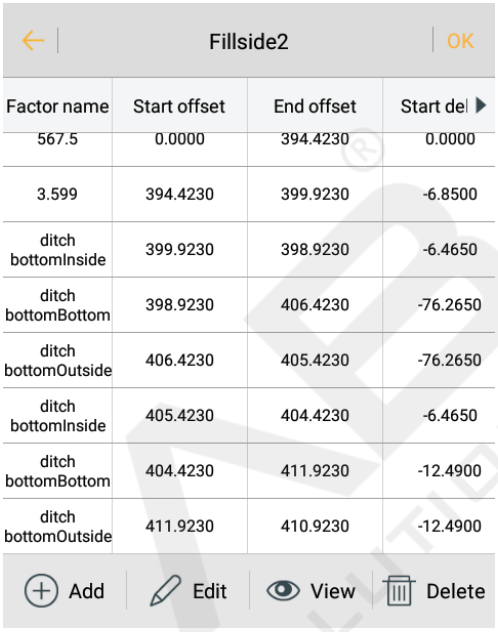



*Figure 5-3-42 Features*

- *Load*: Click to load the BPI File (*.BPI), and the side-section list will show all the section information in the current file.

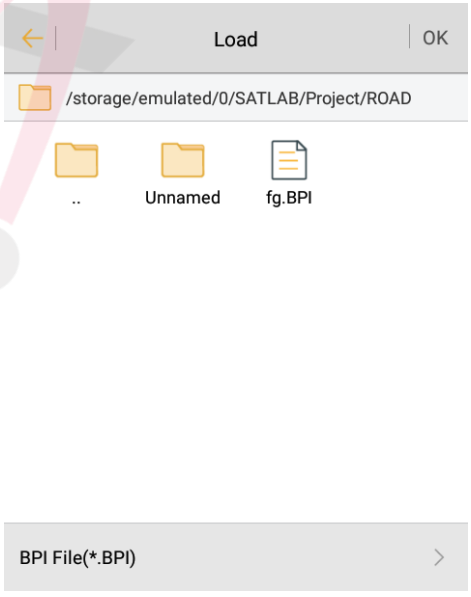



*Figure 5-3-43 Load*

- *Apply*: Click to apply the slope in the current side-section list to the current project road, and it will prompt *Use data successfully*.

- *Save*: Click to save the file in the BPI File (*.BPI) format.

Long press the record to delete or edit the side-section information.

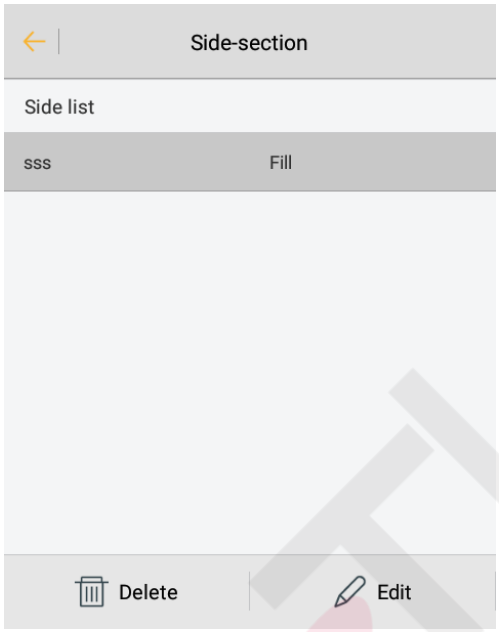



*Figure 5-3-44 Delete or Edit*


*Figure 5-3-45 Side Preview*

- *Delete*: Click to delete the side-section record.

- *Edit*: Click to edit the hillslope, platform and ditch; click *View* to check the side preview.

# 5.4 Store Cross-section

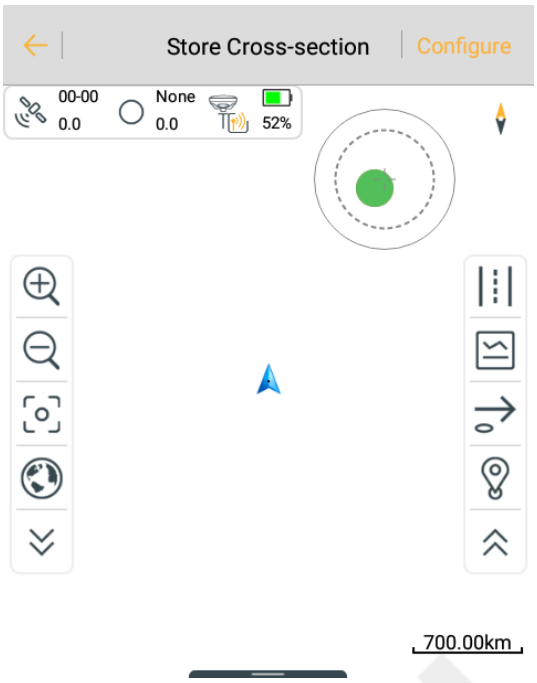



*Figure 5-4-1 Store Cross-section*

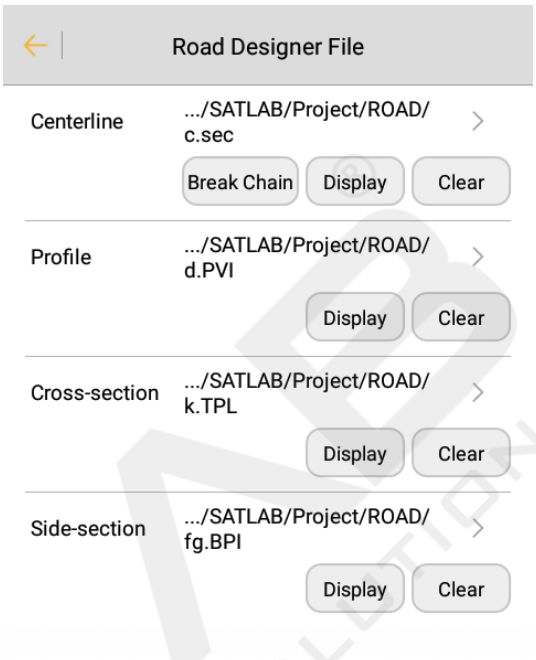



*Figure 5-4-2 Road Designer File*

Click to load existing road designer files, then click to define a specified mileage of the cross-section and input other settings. It will automatically calculate the cross-sectional position, at that distance, and display a dashed line as a reference line on the graph.

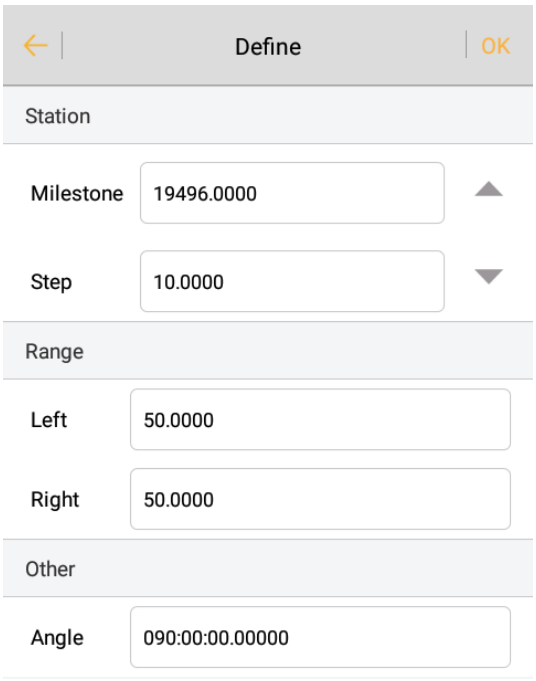



*Figure 5-4-3 Define*

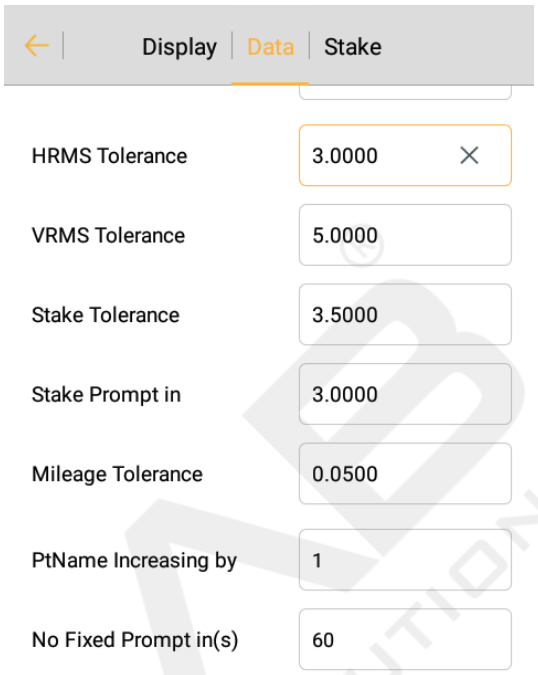



*Figure 5-4-4 Data Settings*

When approaching this reference line, the software will calculate the distance between the current position and the reference line. If the distance is less than the setting value of the cross-sectional tolerance (the value can be set in *Configure→Data*), users can do a cross-section point acquisition.

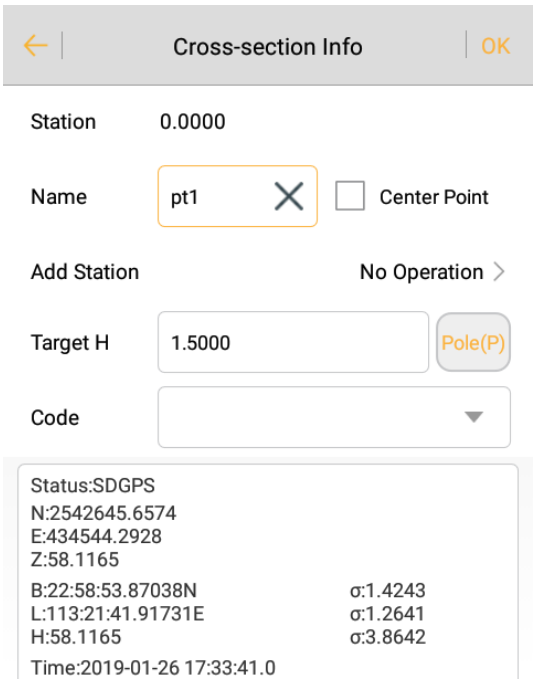



*Figure 5-4-5 Cross-section Info*

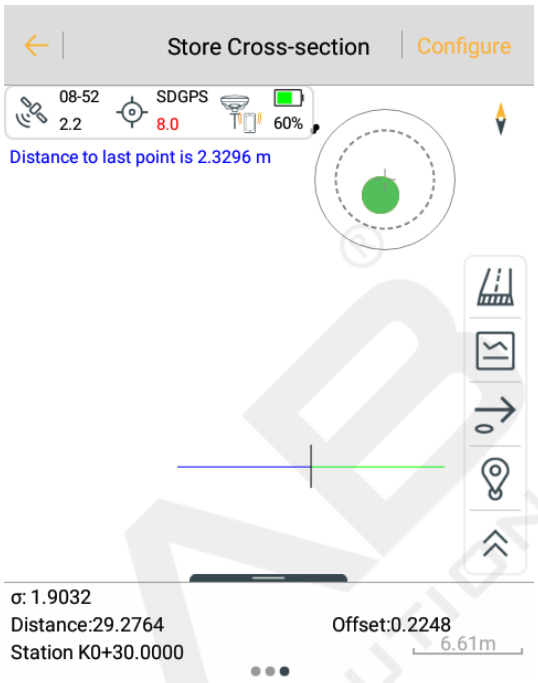



*Figure 5-4-6 Cross-sectional View*

- : Click to collect points and input the cross-section information. If the *Center Point* is selected, the point will be used as the reference point of the cross-section. The cross-section point library will store the horizontal elevation of other points on the cross-section relative to the center point (each section must define a section mileage and collect the center point, otherwise the section points collected in this section will be invalid, or users need to add the center point manually afterwards).

- : Click to switch to the cross-sectional view and check it.

## 5.5 Cross-section Points

Cross-section data can be edited and managed in the cross-section points library.

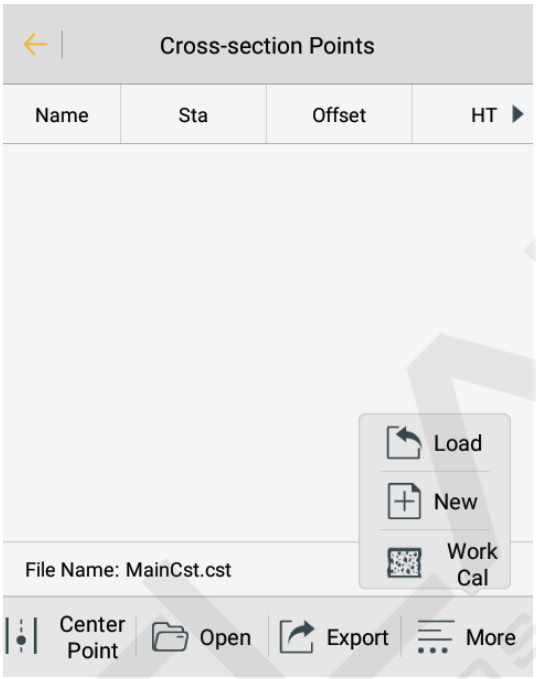



*Figure 5-5-1 Cross-section Points*

- *Center Point*: Click to add the center point.

- *Open*: Open other files in the project.

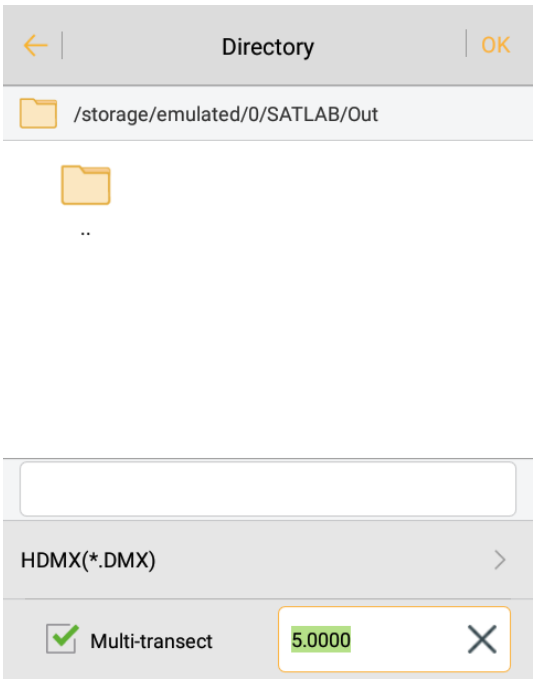



*Figure 5-5-2 Export*

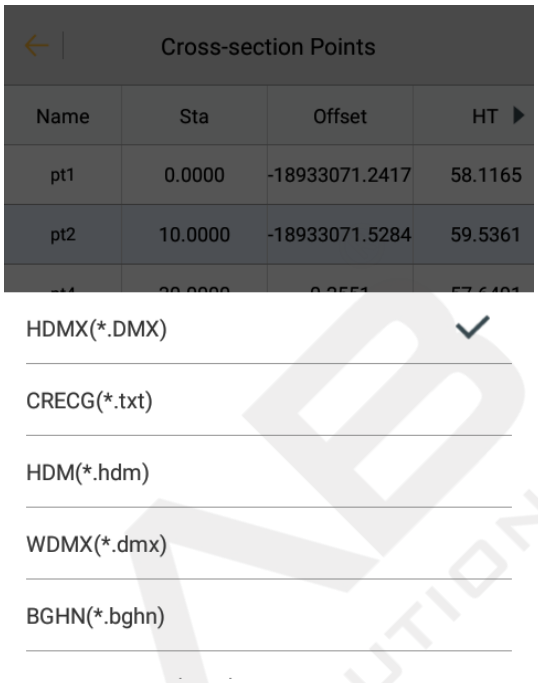



*Figure 5-5-3 Export Formats*

- *Export*: Export files to other data formats, including HDMX (*.DMX), CRECG (*.txt), HDM (*.hdm), WDMX (*.dmx ), BGHN (*.bghn), HDMG (*.DMG), South CASS7.0 (*.dat), South CASS7.0 (*.hdm), Defined (*.txt) and EICAD (*.HDX).

- *Load*: Load and merge cross-section data in current or other projects.

- *New*: Create a new cross-section points file in the project.

- *Work Cal*: Click to enter the *Earthwork Calculation* interface.

In the *Earthwork Calculation* interface, it will load all the cross-section points by default to the calculation list. Click the point name to choose whether to participate in the calculation.

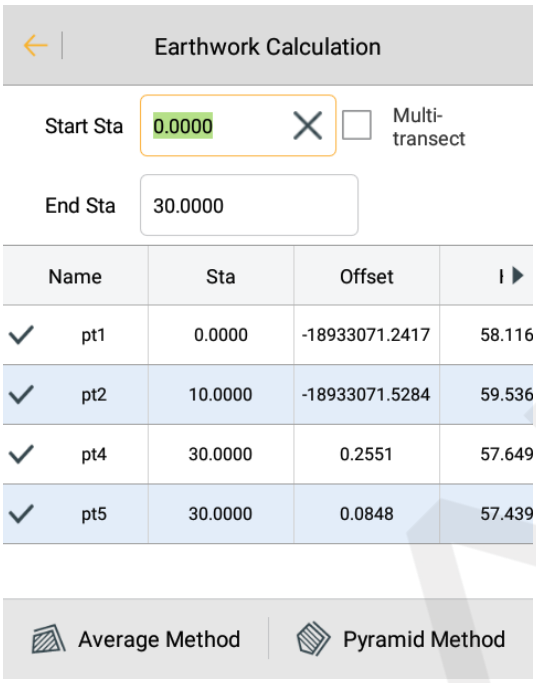



*Figure 5-5-4 Earthwork Calculation*

The earthwork calculation requires at least two cross-section points and corresponding center points within the range of start and end mileage. If the *Multi-transect* mode is selected, please input the projection distance limit in the input box. The result of the calculation is the amount of earthwork between the two cross-sections that are closest to the start and end mileage.

The earthwork calculation provides two methods, the *Average Method* and *Pyramid Method*.

The average method is simple and practical, but accuracy is not good. When the adjacent cross-sectional areas have a large difference, the pyramid method is more accurate.

## 5.6 Surface

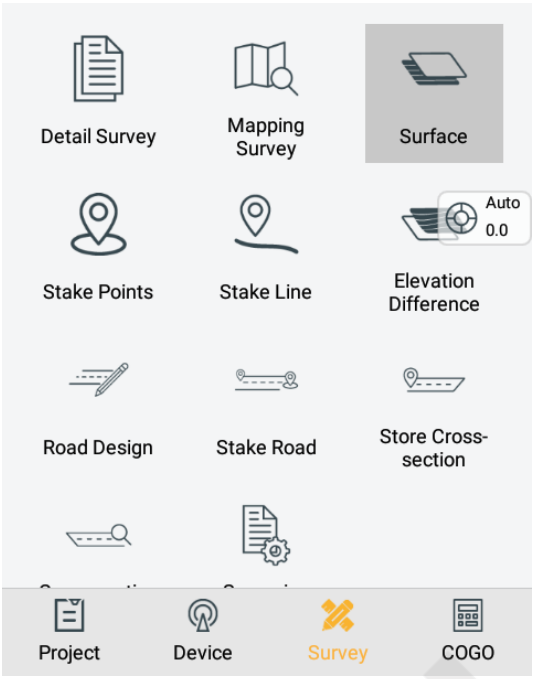



*Figure 5-6-1 Surface Function*

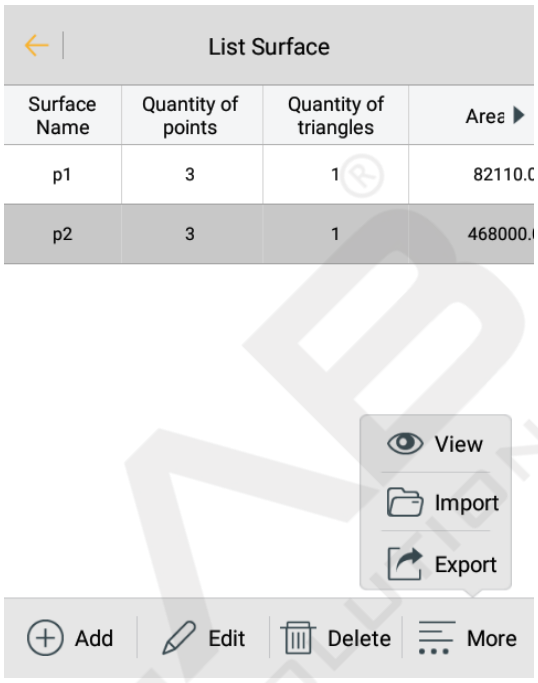



*Figure 5-6-2 Surface List*

This function is to design the DTM surface. Users can manage, add, delete, edit, import and preview the DTM surface.

- *Add*: Click to add the surface. Set the surface name, point name and coordinate. The point information can be obtained from real-time acquisition, point library or map selection. A DTM surface should contain no less than three points.

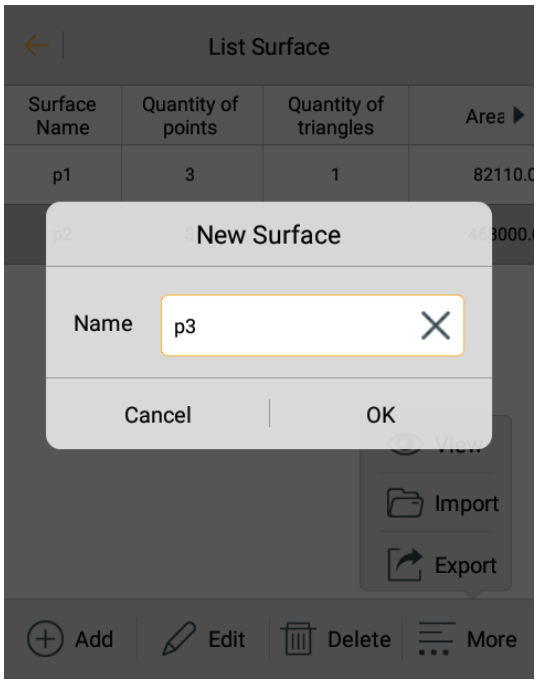



*Figure 5-6-3 Add New Surface*

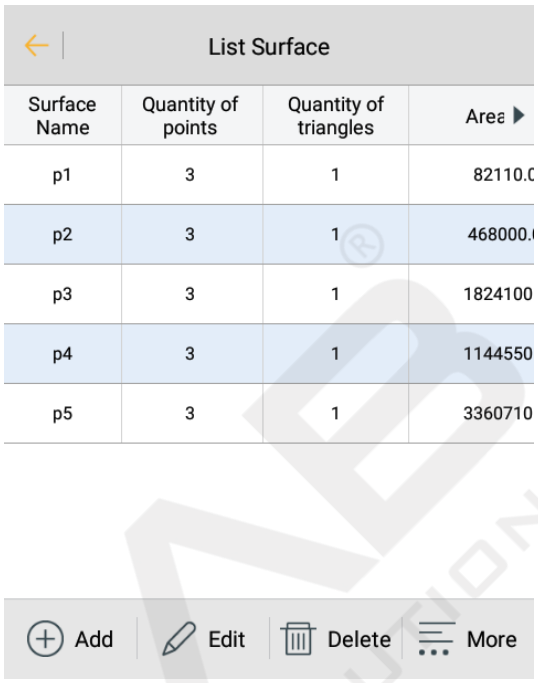



*Figure 5-6-4 Surface Points List*

- *Batch*: Add points in the point library in batches, select the check box before the point name to select all the points.


*Figure 5-6-5 Add Surface Point*

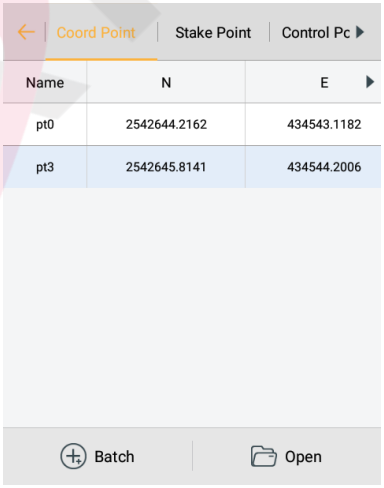



*Figure 5-6-6 Batch*

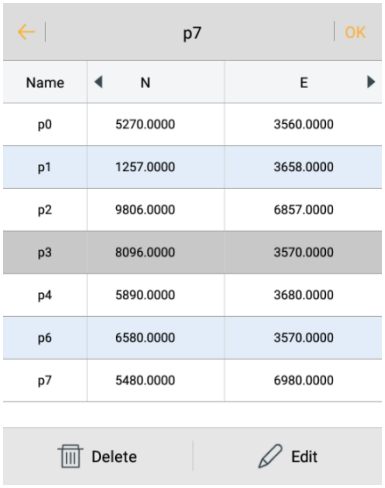



*Figure 5-6-7 Delete or Edit*

- *Edit*: Edit existing surfaces. Long press the selected surface point to delete or edit it.

- *Delete*: Click to delete existing surfaces.

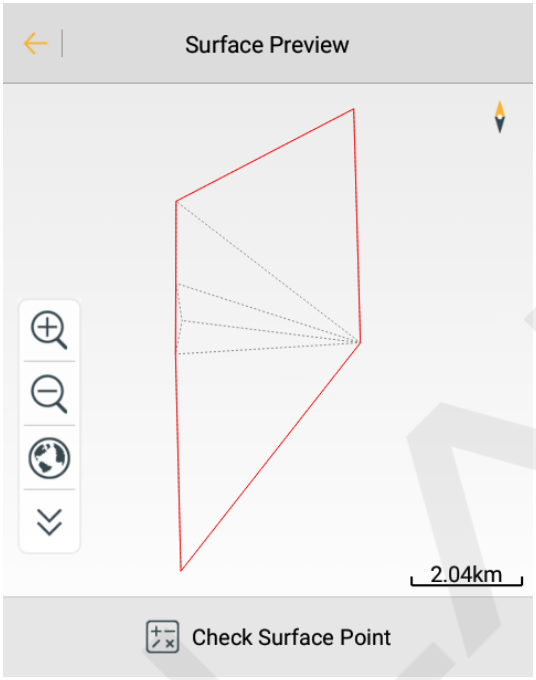



*Figure 5-6-8 Surface Preview*

- *View*: Select or create a new surface, and then click to view the surface preview.

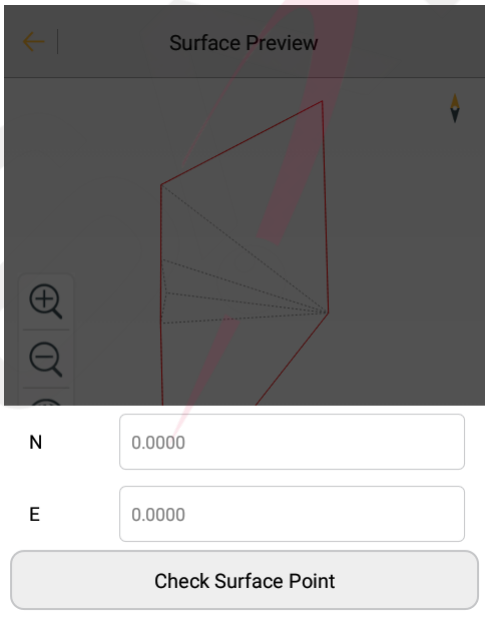



*Figure 5-6-9 Check Surface Point*

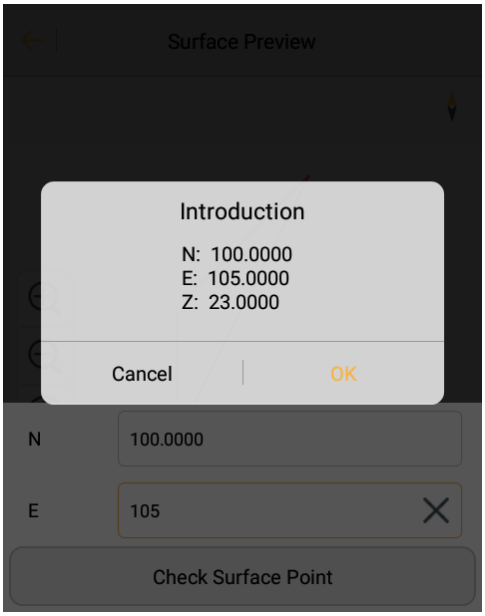



*Figure 5-6-10 Calculation*

- *Check Surface Point*: Calculate the elevation of the input point. If the point is not in the plane, it can't be calculated. If the point is in the plane, click *OK* after the check, the point will be saved in the stakeout point library and the description will be the checkpoint.

- *Import*: Click to import the surface file in the Surface File( *.ttin) format.

- *Export*: Click to export the surface file in the CASS Format (*.sjw) format.

## 5.7 Elevation Difference

This function is to do the DTM surface stakeout, and calculate the elevation difference between the current point and the fitted point of the selected surface.

Click *Stake Surface Lib* to choose the surface to stake out, then it will display the TIN grid information in real-time. The *Fill* value will be displayed on the top left, and the coordinates and detailed height will be displayed on the bottom slide bar.

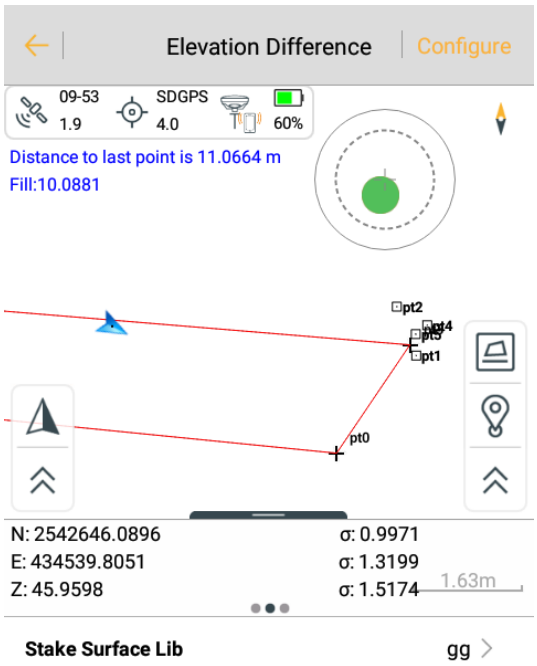



*Figure 5-7-1 Elevation Difference*


*Figure 5-7-2 Select the Surface*

- : Click to enter the surface library interface to add or load the surface, and edit the surface information.

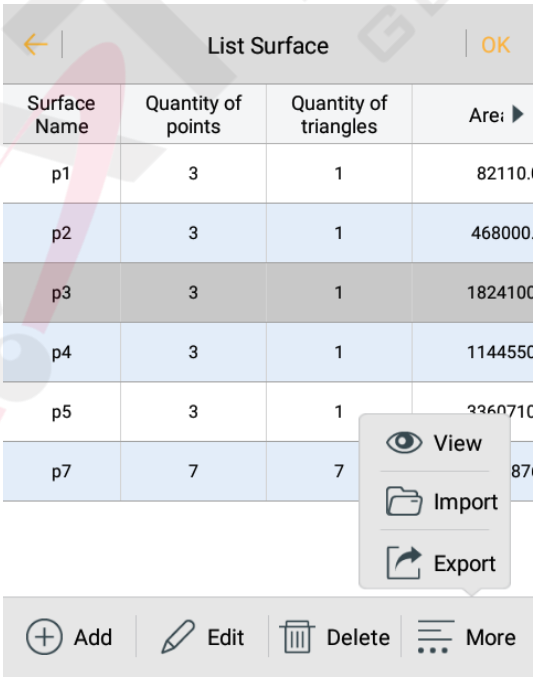



*Figure 5-7-3 Surface Library*

# 5.8 Surveying Configure

The surveying configuration is a common menu that is used to configure the graphical display of the work interface, including the road and general survey configuration of the *Detail Survey*, *Stake Points*, *Stake Line*, *Stake Road*, *Store Cross-section* and *Road Design*.

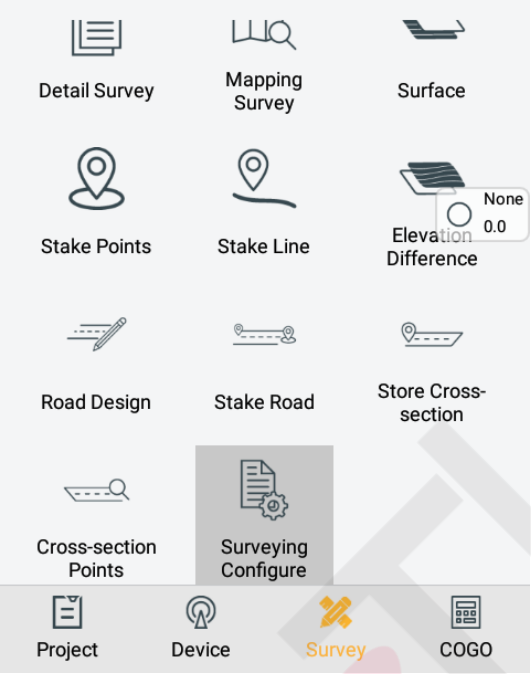



*Figure 5-8-1 Surveying Configure*

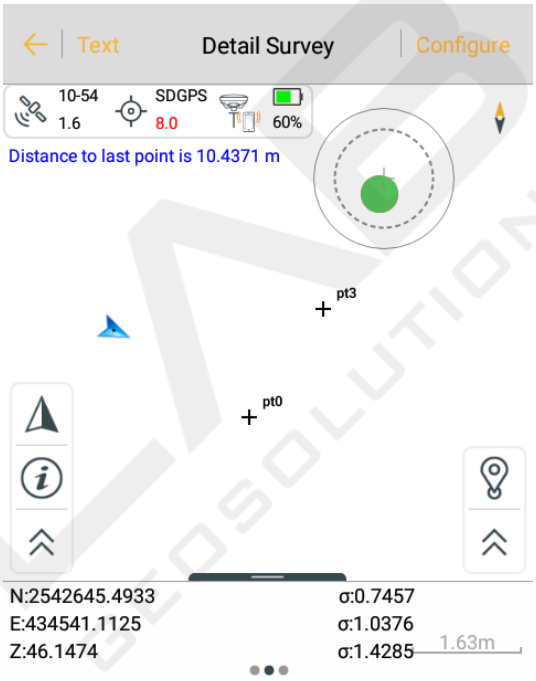



*Figure 5-8-2 Configure*

## 5.8.1 Display

The display configuration contains the *Road Survey Config* and *General Survey Config*.

*Road Survey Config*: *Cross-section Point* and *Roadline Transition Point*.

*General Survey Config*: *Coord Poinft, Stake Point, Control Point, Stake Line Lib, Voice Prompts, Optimize Scale, Centered Display GPS, Keep GPS Centering, Display Name, Electronic Bubble, Real-time Mileage, Dis to last Coord Pt, Fix Direction, Controller Dir, Display Color*and *Online Map*.

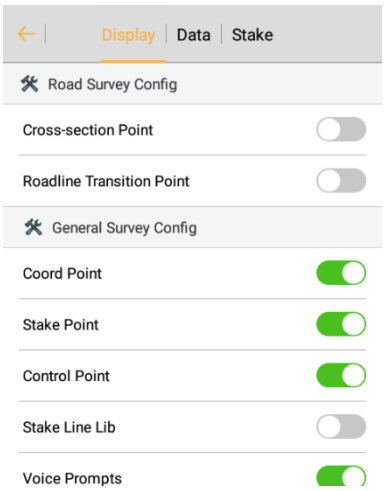
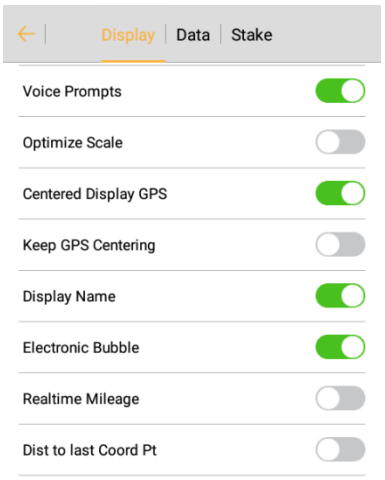
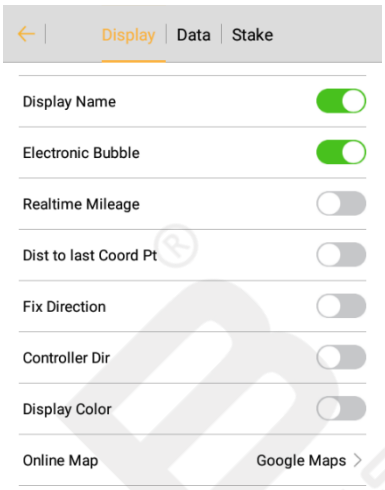



*Figure 5-8-3 Display(1)*




*5-8-4 Display(2)*




*5-8-5 Display(3)*

- *Cross-section Point*: Select whether to display the point name of the cross-section point during the road collection.

- *Roadline Transition Point*: Choose whether to display line feature points in the measurement interface during the road collection.

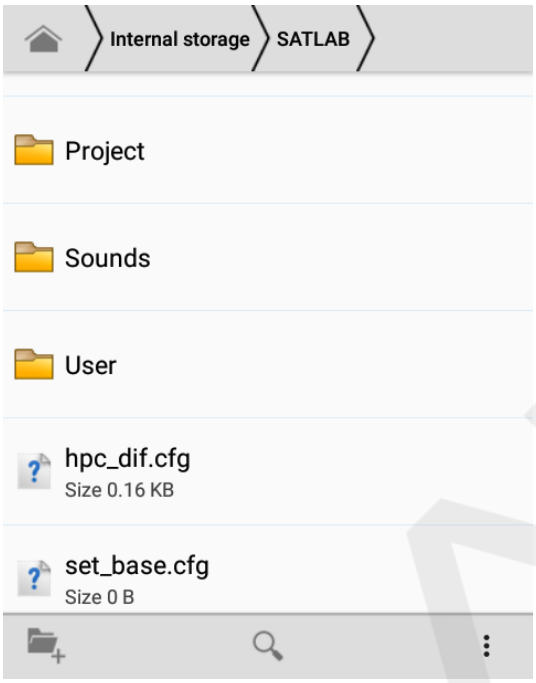
- *Coord Point*: Choose whether to display the coordinate point name.

- *Stake Point*: Choose whether to display the stake point name.

- *Control Point*: Choose whether to display the control point name.

- *Stake Line Lib*: Choose whether to display the stake line library.

- *Voice Prompts*: Choose whether to open the voice prompts. Users can record user-defined voice prompts in the *.wav format: the file storage path is *SATLAB /Sounds*. Customized file names have prescribed formats, including fixed.wav, losefix.wav, savedone.wav, stakereminder.wav and stakedone.wav.




*5-8-6 Voice Files Path*

- *Optimize Scale*: Choose whether to automatically adjust the scale to the right size. When enabled, it will automatically adjust the screen display based on the coordinate range in the coordinate data, and the *Centered Display GPS* and *Keep GPS Centering* will be invalid.

- *Centered Display GPS*: When the current point is not in the screen display range, the current point will be automatically centered.

- *Keep GPS Centering*: The current point is always in the middle of the screen.

- *Display Name*: Choose whether to display the point name.

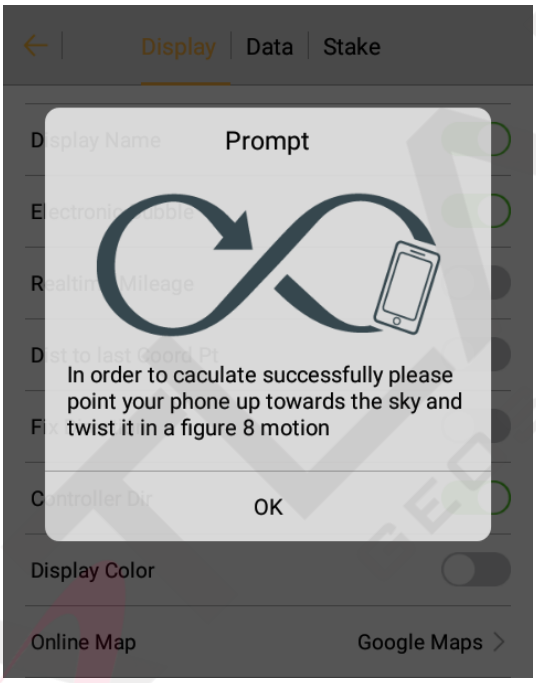
- *Electronic Bubble*: Choose whether to display the electronic bubble. When it's not displayed, the inclination won't participate in the acquisition accuracy judgment.

- *Real-time Mileage*: Select whether to display the current real-time mileage value in the *Stake Line* and *Stake Road* interface.

- *Dis to last Coord Pt*: Select whether to display the distance to the last point.

- *Fix Direction*: Smooth the sample over a period of time, and the calculated direction value will be relatively stable to reduce the irregular beats in direction.

- *Controller Dir*: After selecting, click *OK* as prompted to keep the hand-held controller screen upward, and move the hand-held controller according to the prompt to complete the calibration. Then return to the survey interface; the direction of the current point will be the direction of the hand-held controller.




*5-8-7 Controller Dir Prompt*

- *Display Color*: Select whether the map is displayed in the feature color.

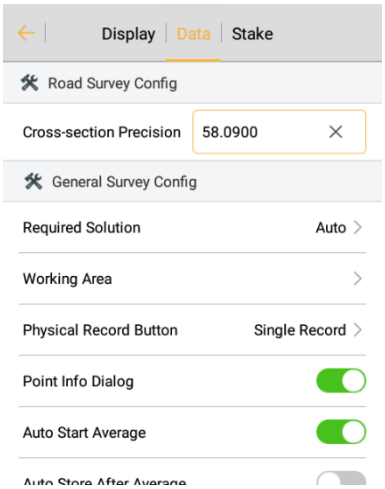
- *Online Map*: Select Google maps as the basemap to survey or stake out. Make sure the network is connected and it has updated to the latest Google service.

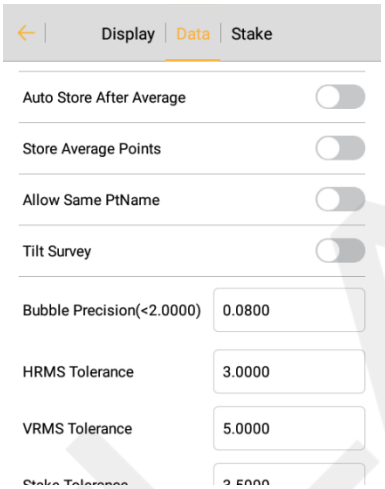
## 5.8.2 Data

The data configuration contains the *Road Survey Config* and *General Survey Config*.

*Road Survey Config*: *Cross-section Precision*, the default value is 0.0500m.

*General Survey Config*: *Required Solution, Working Area, Physical Record Button, Point Info Dialog, Auto Start Average, Auto Store After Average, Store Average Points, Allow Same PtName, Tilt Survey, Bubble Precision (<2.0000), HRMS Tolerance, VRMS Tolerance, Stake Tolerance, Stake Prompt in, Mileage Tolerance, PtName Increasing by* and *No Fixed Prompt in(s)*.



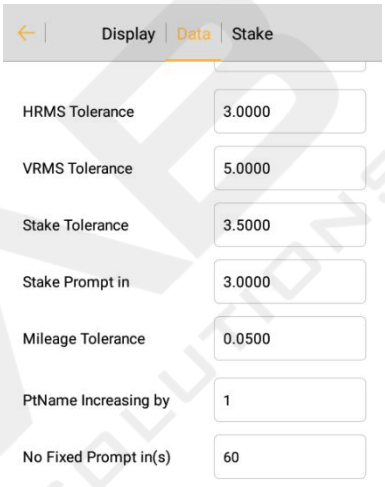
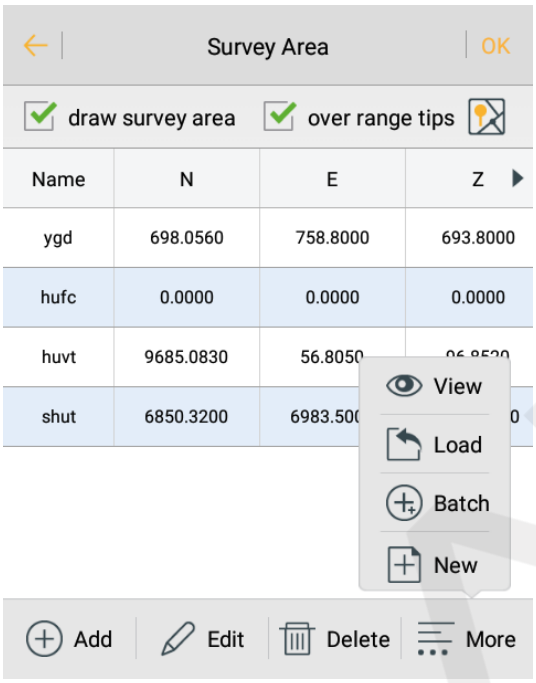




*Figure 5-8-8 Data(1)* *5-8-9 Data(2)* *5-8-10 Data(3)*

- *Required Solution*: Limit the solution type, including the *Auto*, *SDGPS*, *DGPS*, *Float* and *Fix*. When the solution type is limited to the *Fix*, the accuracy prompt box will not pop up if the solution is acquired in the fixed solution state.

- *Working Area*: Users can draw the range of the survey area and select over range tips.




*5-8-11 Survey Area*

- *Physical Record Button*: Set the acquisition key on the physical keyboard as the *Single Record* or *Average Record* shortcut key.

- *Point Info Dialog*: Choose whether to display the point information confirmation box after collection.

- *Auto Start Average*: Check this option and click the average button, to enter the average collection interface, to automatically start smoothing. If this option is not checked, the smoothing won't start automatically, users need to click the start button in the average collection interface to start.

- *Auto Store After Average*: After it's turned on, click *OK* to do the average collection. When the number of smoothing reaches the set number, it will automatically exit the average interface and save points. User can also click *OK* to end average collection in advance.

- *Store Average Points*: Choose whether to save average data automatically.

- *Allow Same PtName*: Choose whether users can collect points with the same name.

- *Tilt Survey*: Tilt survey can be done after turning on, and there will be tilt correction during data processing to get coordinates of points to be measured (only for specific models, and users can only start the tilt correction after completing calibration steps).

- *Bubble Precision (<2.0000)*: Set the electronic bubble acquisition accuracy. The acceptable range of tilt distance when acquiring coordinates is recommended to be within 30 degrees.

- *HRMS Tolerance*: The horizontal RMSE of points, users can enter the maximum RMSE limit. When collecting points, there will be a prompt if it exceeds the limit value.

- *VRMS Tolerance*: The vertical RMSE of points; users can enter the maximum RMSE limit. When collecting points, there will be a prompt if it exceeds the limit value.

- *Stake Tolerance*: The precision limitation of stakeout points. Within the limit, the software will indicate that it has reached the accuracy range of the stakeout. If the sound prompt is enabled, an audio prompt will be given.

- *Stake Prompt in*: Set the prompt range of the stakeout. When the stakeout point is within the range, the range line will change colour. If the sound prompt is enabled, an audio prompt will be given.

- *Mileage Tolerance*: Set the maximum error limit for real-time mileage.

- *PtName Increasing by*: The accumulation number value of the point name suffix. The default value is 1.

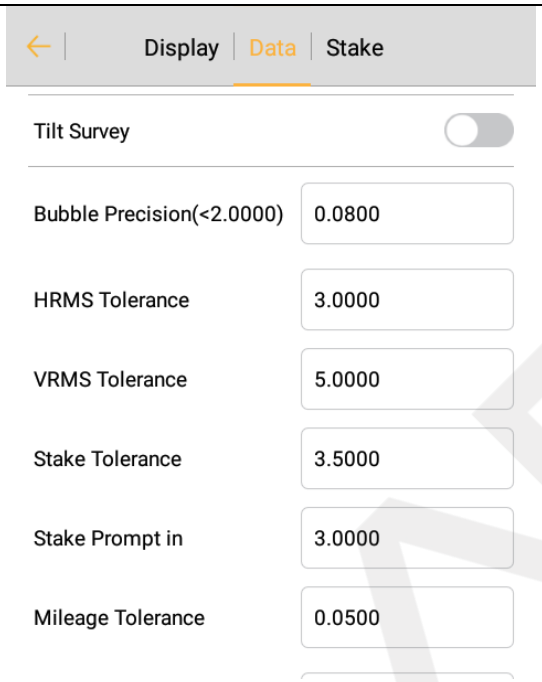
- *No Fixed Prompt in (s)*: Voice prompt interval when the fixed solution is reached. The default value is 60s.

---

**Notice**:

The default value of data acquisition accuracy of the fixed solution in the software is the value (m) shown in the figure below:

---




*5-8-12 Default Values*

### 5.8.3 Stake

The stake configuration contains the *Road Survey Config* and *General Survey Config*.

*Road Survey Config*: *Real-time Mileage HT Diff.*

*General Survey Config*: *Stake Guide Type, Reference Direction, Stake Order, Show Offset on Map, Check Move Direction, Map North Direction, Repeat Stake, StkName as PtName, Named by Station, Named by Real-time Station, Save Mileage* and *Save Real-time Mileage.*

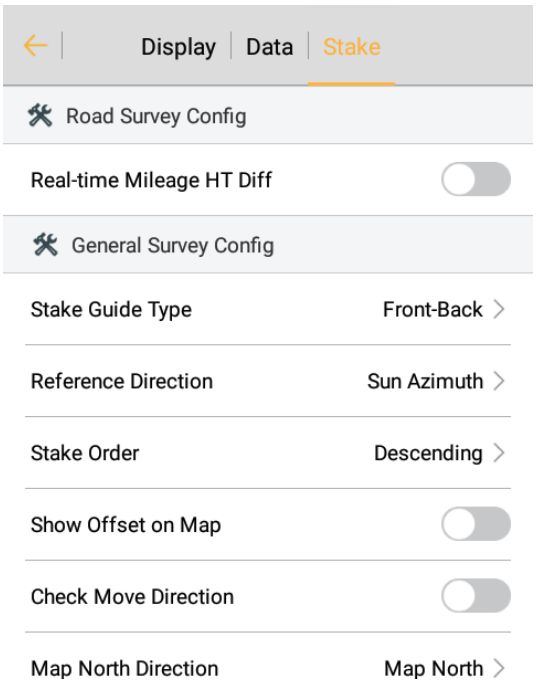



*Figure 5-8-13 Stake(1)*

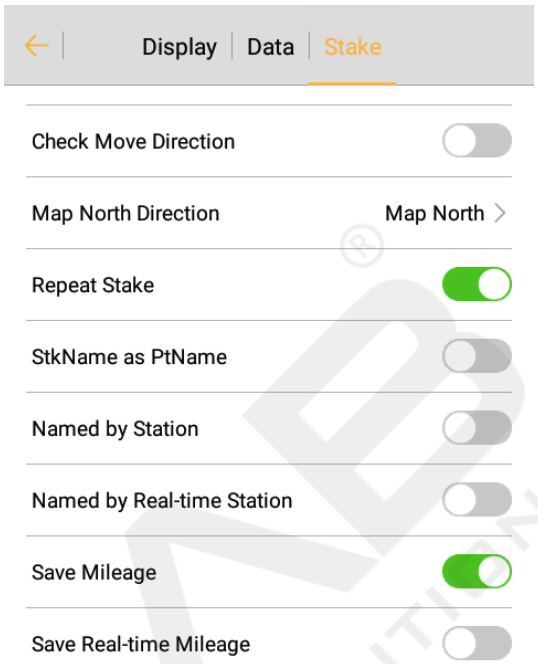



*Figure 5-8-14 Stake(2)*

- *Real-time Mileage HT Diff*: After turning on, the height difference in the information bar of the *Stake Road* interface is the height difference between the current point projection on the line and the current point (make sure there is a road profile).

- *Stake Guide Type*: Select the stake guide type, including *Front-Back* and *North-South*.

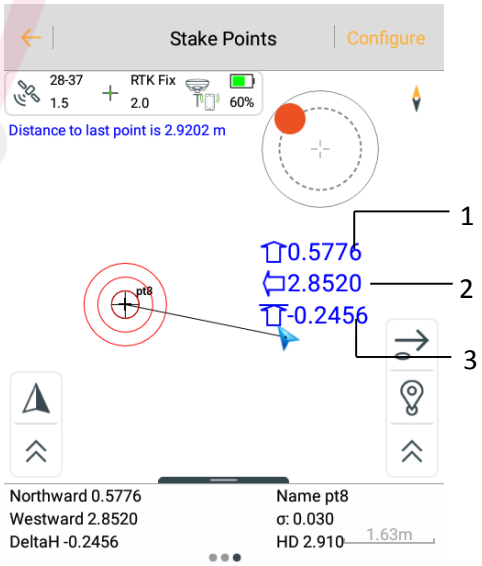



*Figure 5-8-15 Stakeout Prompts*

*-1:* In the Front-Back mode, the upward arrow indicates forward, and the downward arrow indicates backward. In the North-South mode, the upward arrow indicates the north, and the downward arrow indicates the south.

*-2:* In the Front-Back mode, the left arrow indicates left, and the right arrow indicates right. In the North-South mode, the left arrow indicates the west, and the right arrow indicates the east.

*-3:* In both modes, it indicates the height difference.

- *Reference Direction*: Select the reference direction, including the *Sun Azimuth, Base Azimuth* and *Custom Azimuth*.

- *Stake Order*: Select stakeout points with ascending or descending order.

- *Show Offset on Map*: When turned on, the stakeout prompt will be displayed on the map during the point stakeout process. If the *Check Move Direction* is turned on at the same time, and the distance from the current point to the stakeout point is greater than the stakeout distance, the horizontal distance from the current point to the stakeout point will be displayed; otherwise, the front-back or south-north prompt will be displayed.

- *Check Move Direction*: After turning on, when the distance from the current point to the stakeout point is not within the range of the stakeout distance, a large arrow will be displayed to indicate the deflection angle between the moving direction and the direction from current point to the stakeout point. If it's approaching the stakeout point, it will be displayed in green. If it's moving away from the stakeout point, it will be displayed in red. If the moving direction is almost perpendicular to the direction from current point to the stakeout point, it will be displayed in yellow.

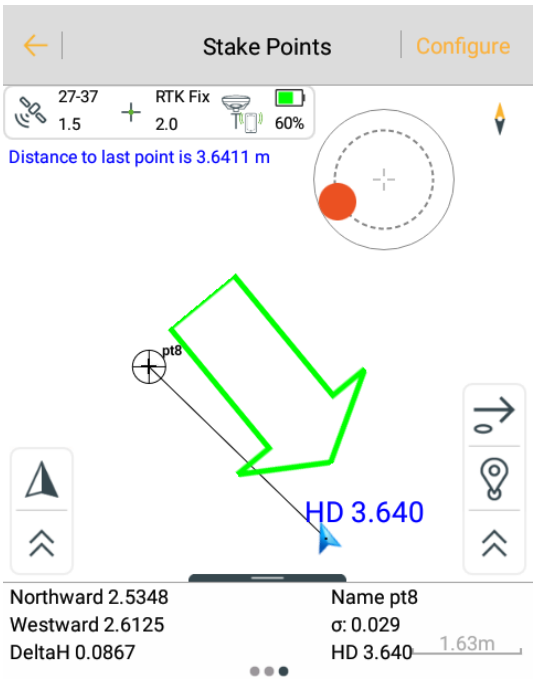



*Figure 5-8-16 Approaching*

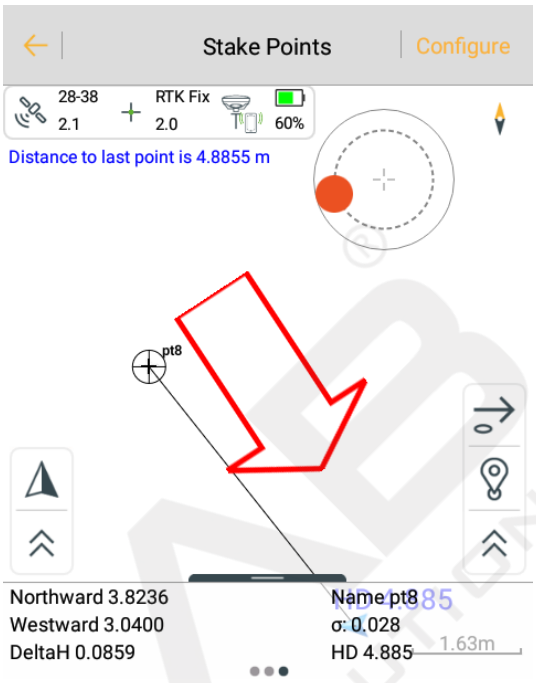



*Figure 5-8-17 Moving Away*

- *Map North Direction*: Select the map direction, including the *Map North* or *Forward*.

- *Repeat Stake*: When turned on, it supports the repeat stake. Users can choose whether to skip the collected stakeout points automatically.

- *StkName as PtName*: Select whether to set the stakeout point name as the default point name.

- *Named by Station*: Select whether to set the station as the default point name.

- *Named by Real-time Station*: Select whether to set the real-time station as the default point name. This option can't be opened simultaneously with the *Named by Station.*

---

**Notice**:

When turning on the *Named by Station* or *Named by Real*-time Station option, users need to select the Allow Same PtName option in the *Configure→Data interface*.

---

- *Save Mileage*: When collecting points, the mileage will be automatically filled as the

stakeout point mileage.

- *Save Real-time Mileage*: When collecting points, the mileage will be automatically filled as the real-time projection mileage (the *Save Mileage* and *Save Real-time Mileage* must and can only be selected one at a time).

# Chapter 6

## COGO

**This chapter contains:**

-Angle Conversion
-Distance Conversion
-Coordinate Conversion
-Area Calculation
-Distance and Azimuth
-Intersection Measurement
-Angle Calculation
-DTM Volume Calculation
-Calculator

# 6.1 Angle Conversion

Support *Radian, Degree, DMS, Gon, Mil* angle units transforming mutually. After you input a value to any item, click *Compute*: another several values will be calculated.

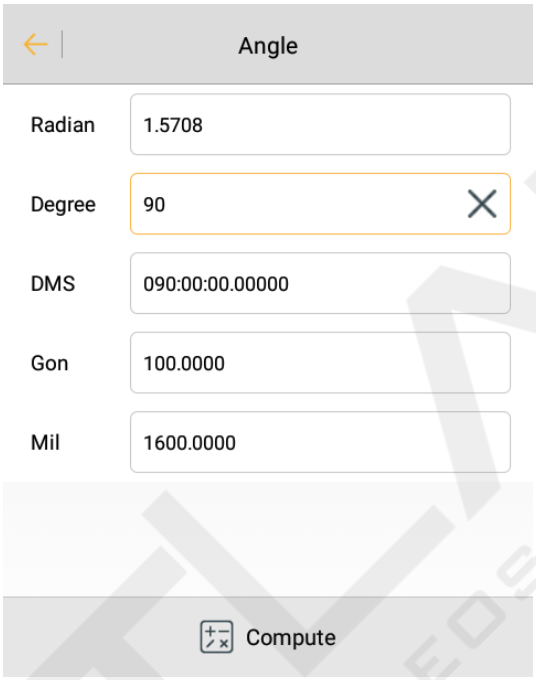



*Figure 6-1-1 Angle Conversion*

## 6.2 Distance Conversion

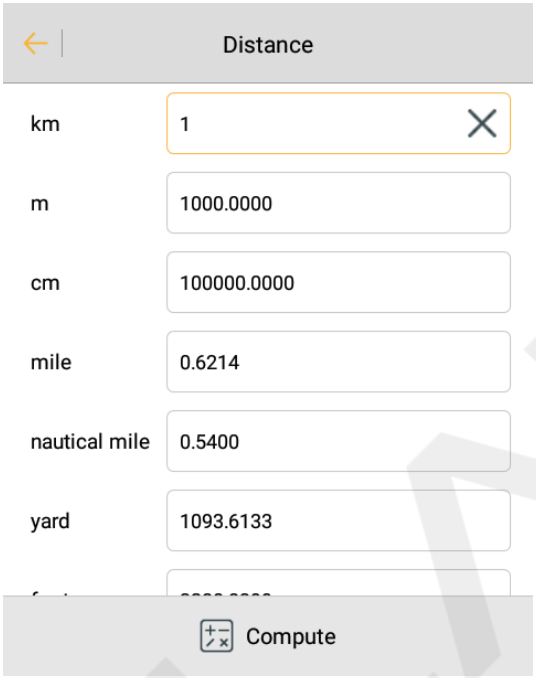



*Figure 6-2-1 Distance Conversion*

Support *km, m, cm, mile, nautical mile, yard, foot, inch* distance units transforming mutually. After inputting a value to any item, click *Compute*: another several values will be calculated.

## 6.3 Coordinate Conversion

The data includes source ellipsoid and local ellipsoid. After inputting point information, you can switch between BLH, XYZ or NEZ. Click *To Local* or *To Source* to complete conversion between source ellipsoid and local ellipsoid. The coordinate of point can be selected from real-time collection, coordinate library or map.

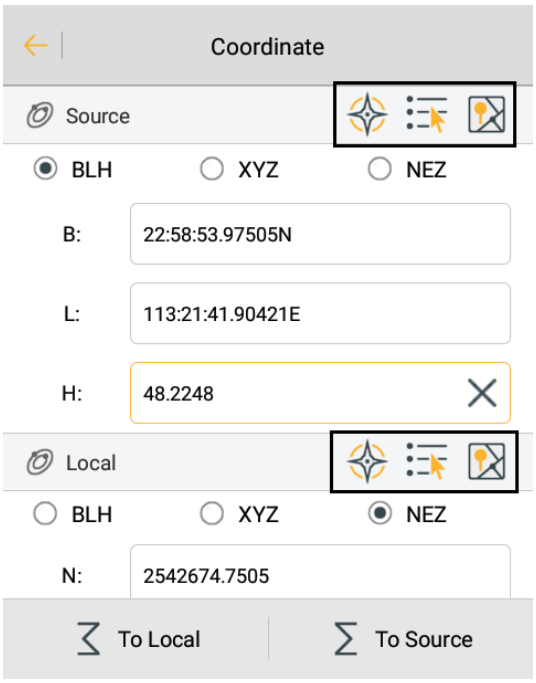



*Figure 6-3-1 Coordinate Conversion*

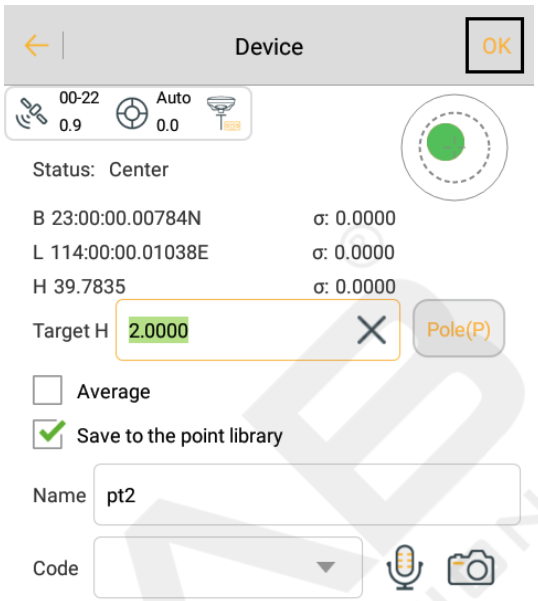



*Figure 6-3-2 Receiver Collection*

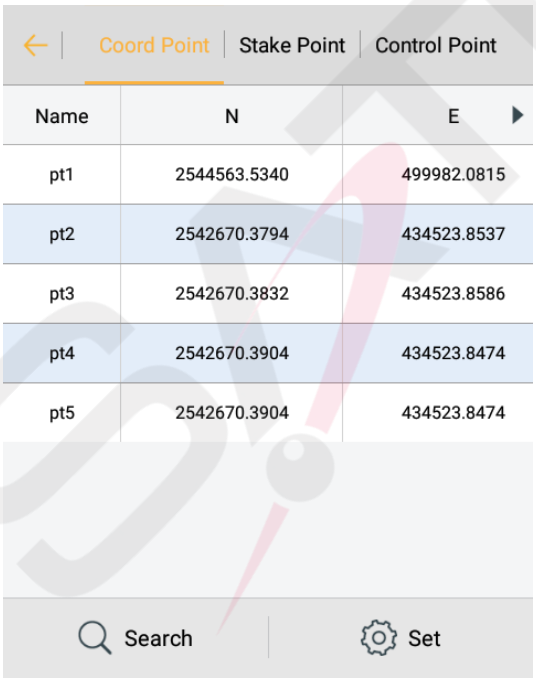



*Figure 6-3-3 Point Library Selection*


*Figure 6-3-4 Select Point from Map*

## 6.4 Area Calculation

Used for calculating area, circumference and some other parameters of graph. Area is indicated by *sq.m* or *mu* and circumference is indicated by *m*. The coordinate of point participated in calculation can be added manually, or real-time collected from the receiver, or selected from a coordinate library or map.

**Notice**:

*In the Map* interface of *Area, the Select Point* is not the same as the Map selection in the *List interface of Area.* In the former, the points on the map are selected by clicking on the point, and the latter by the way of selecting points in the circle and selecting the node on line.

The difference of map selection between *Area* and the other interface is: click to enter map selection mode. Frame select point on the map when the icon is in the state , when frame select multiple points, press but only one point in the box can be selected, click again to exit the map selection mode; Among them, when the icon is in the status , you can select multiple points in the box, click or again to exit the map selection mode, click *OK* to complete. Return to the list to view the selected points.

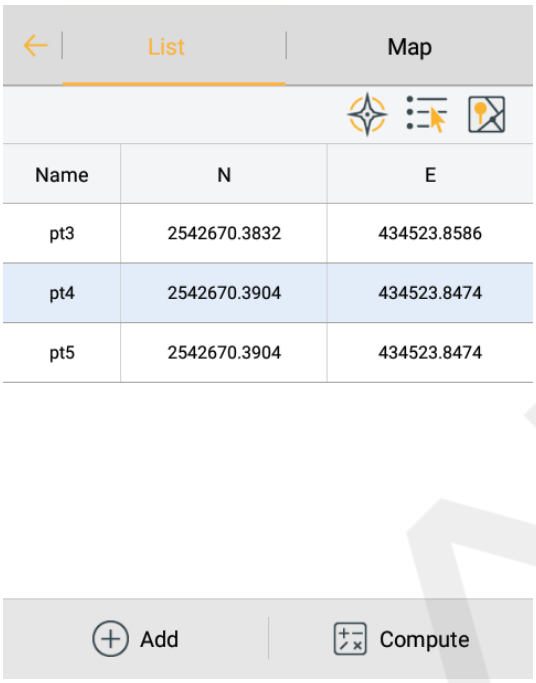



*Figure 6-4-1 Area Calculation*

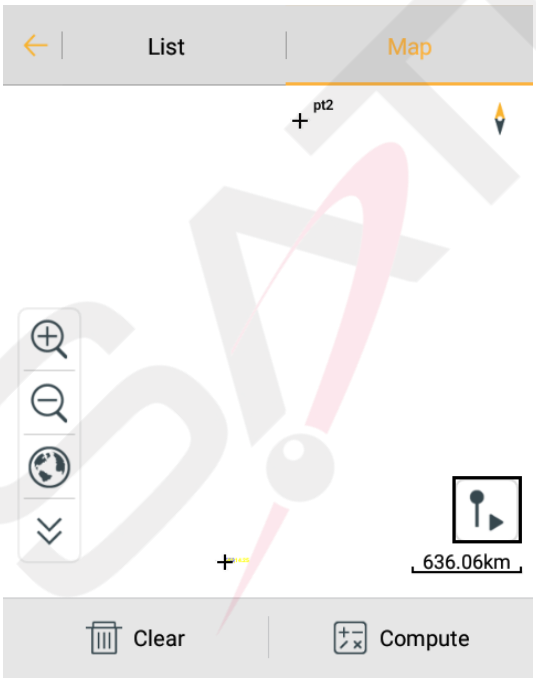



*Figure 6-4-2 Select Point*

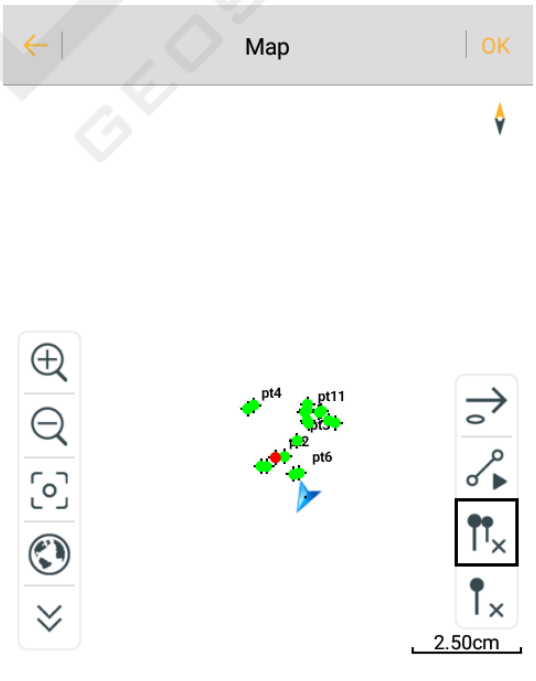



*Figure 6-4-3 Multiple Select*

- *Add*: The points can be added to list by the way of real time collection, point library and graph selection.

- *Compute*: Calculates the area, mu, and length of the current point in order, and can view graphics and calculations in the result interface.

## 6.5 Distance and Azimuth

Used for calculating distance and azimuth between two points. The coordinate of A and B points can be manually input, or read from receiver, coordinate library or map. After reading successfully, click *Compute* to calculate *Azimuth, Bank Angle, 2D-Distance, 3D-Distance and H-Distance*.

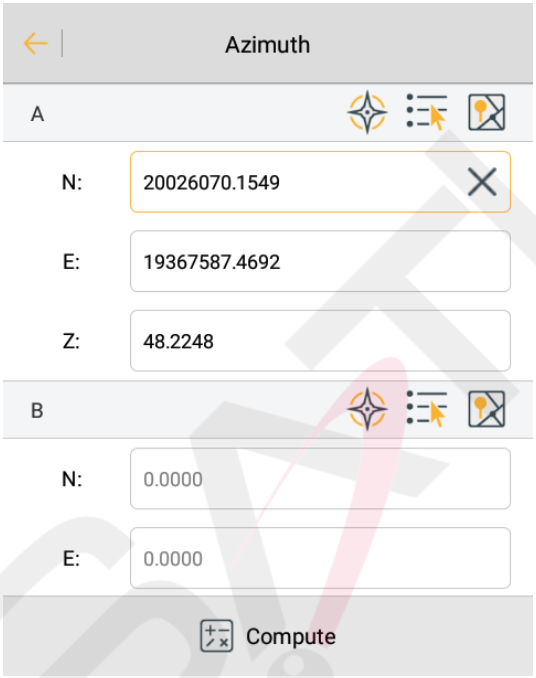



*Figure 6-5-1 Distance and Azimuth*

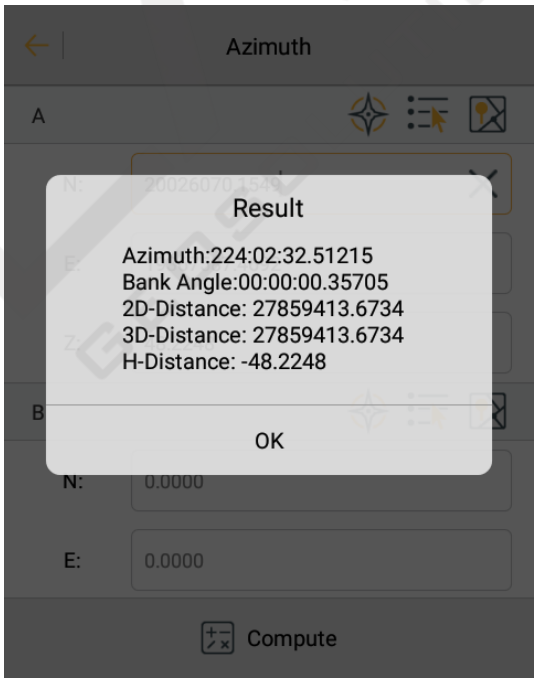



*Figure 6-5-2 Result*

## 6.6 Intersection Measurement

In the case of a point needing measurement, but observation conditions are not ideal, calculate the needed point coordinate by measuring a nearby point. Click every icon to enter the corresponding measurement mode. The software supports six measurement modes (*4Pt, 2Pt2L, 2Pt1L, 2Pt2A, 2Pt1A1L, Azimuth*).

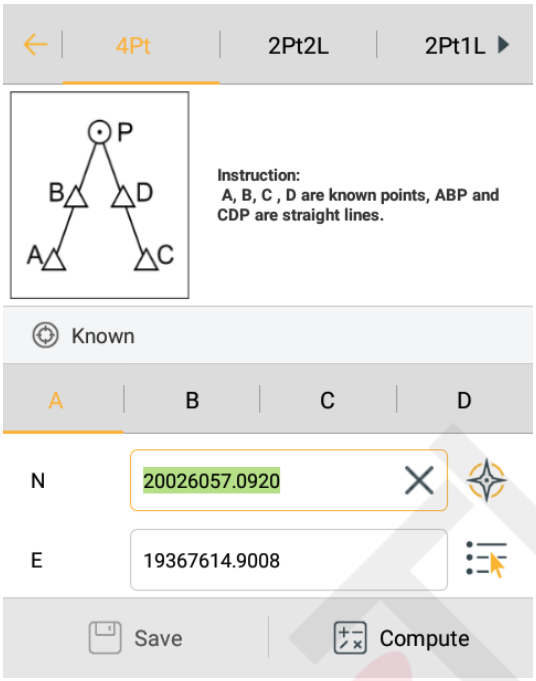



*Figure 6-6-1 4Pt Interface*

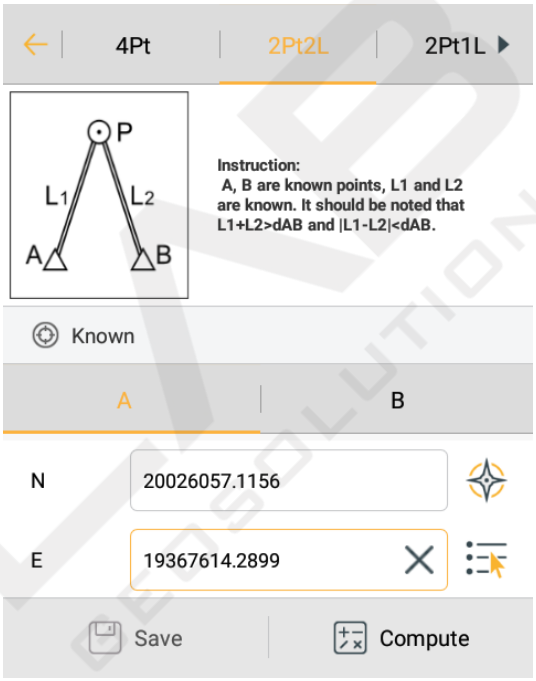



*Figure 6-6-2 2Pt2L Interface*

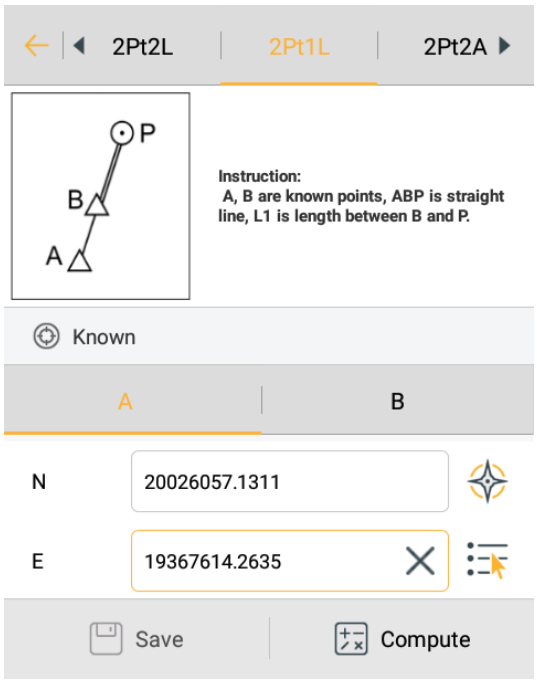



*Figure 6-6-3 2Pt1L Interface*

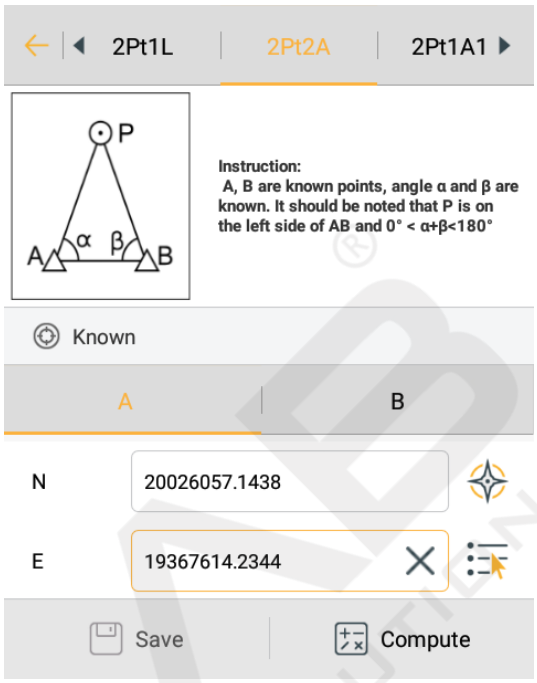



*Figure 6-6-4 2Pt2A Interface*

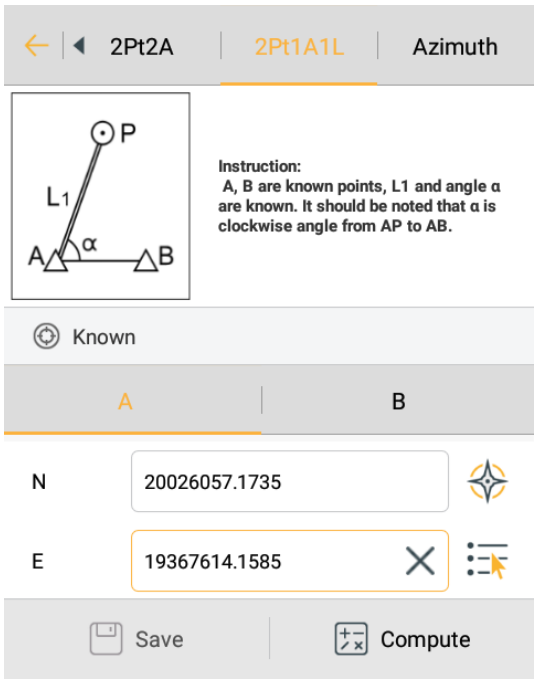



*Figure 6-6-5 2Pt1A1L Interface*

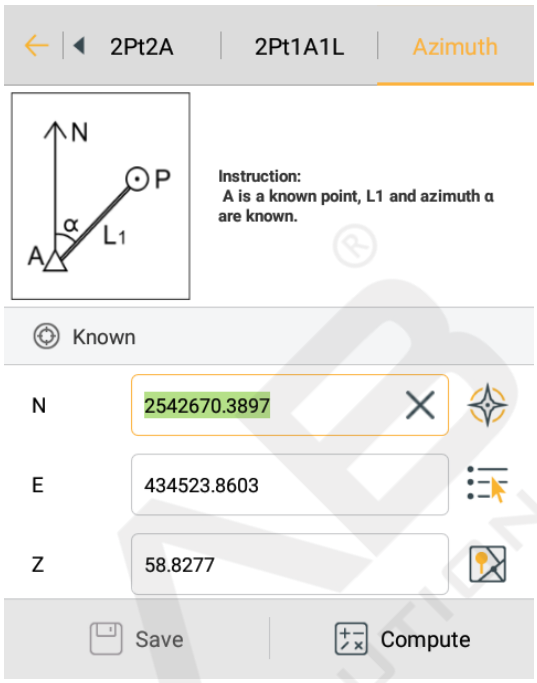



*Figure 6-6-6 Azimuth Interface*

There are two positions of *P* according to the theory of *2Pt2L; 2Pt2A, 2Pt1A1L*. If you input the coordinate of *A* first and then the coordinates of *B*, the position of *P* will be located above the *AB* line. Conversely, if you input the coordinate of *B* first, the position of *P* will be located under the *AB* line.

In the above intersection measurement methods, select known point *ID*, input the coordinate of the intersection measurement point (manual input, or read from receiver, coordinate library, map), input other known keys (such as: *L1*, *L2*, etc.), click *Compute*, calculate the coordinate of unknown point *P*, click *Save*, input name, description and so on to save into the coordinate library.

In the *Intersection*, when you click GPS collection, prompting precision information (accuracy setting is performed in the *Configuration*) is easy for understanding of real-time accuracy.

## 6.7 Angle Calculation

Used for calculating the angle of the three-point line.

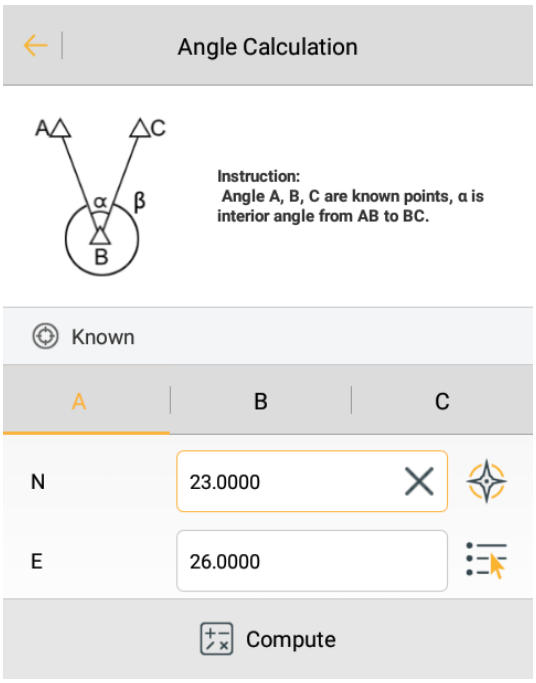



*Figure 6-7-1 Angle Calculation*

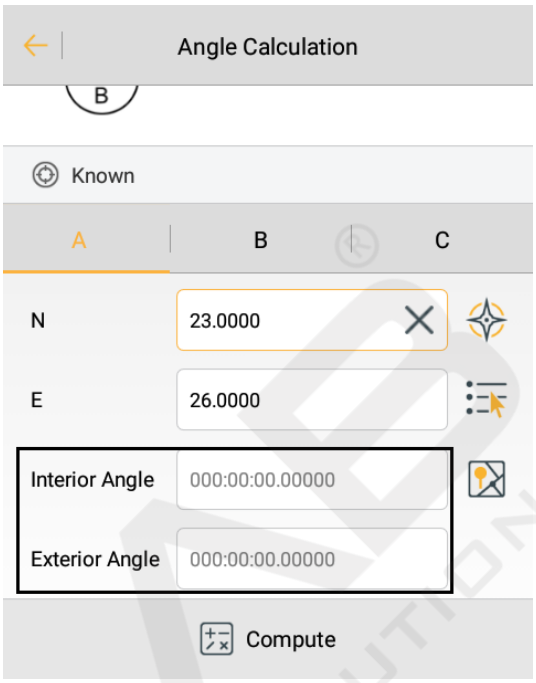



*Figure 6-7-2 Interior and Exterior*

## 6.8 DTM Volume Calculation

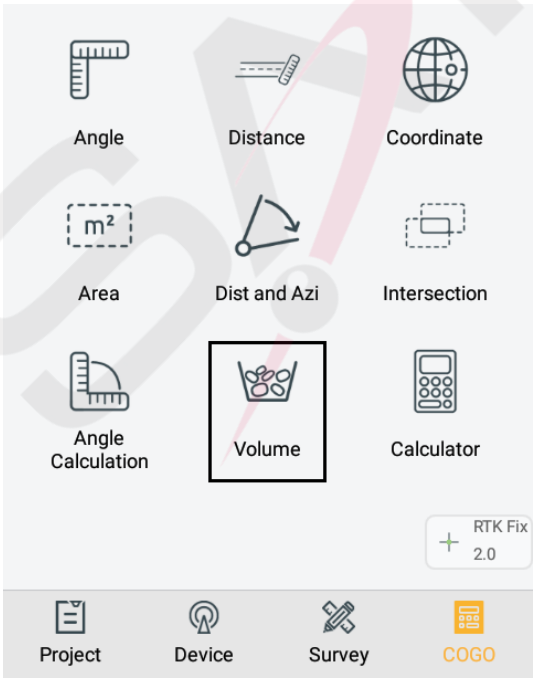



*Figure 6-8-1 COGO interface*

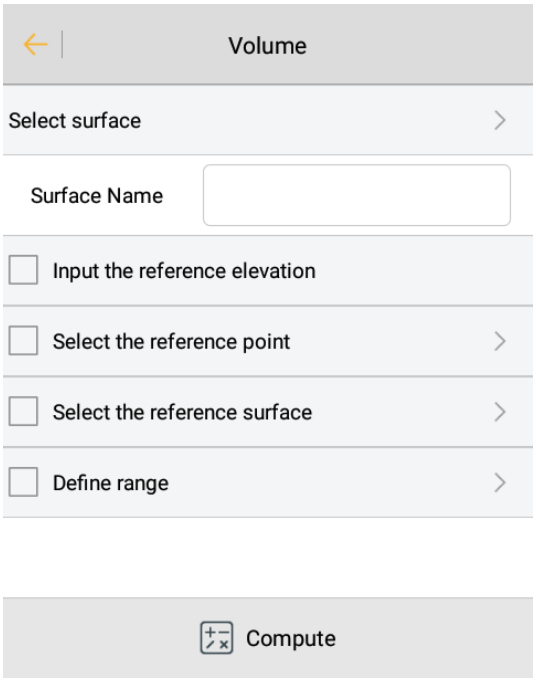



*Figure 6-8-2 Volume interface*

Calculate the volume, 2D perimeter, 3D perimeter, and DTM area of two DTM surfaces, or between a DTM surface and a predetermined elevation.

- *Select surface*: Click extend icon , Select an actual surface from the *List Surface*.

- *Input the reference elevation*: Check it, the reference elevation and the surface are used for volume calculation. Click extend icon , input the target height needed to fill/dig.

- *Select the reference point*: Check it, the reference point and the surface are used for volume calculation. Click extend icon , Select a point as a reference point from the *Point Library*.

- *Define range*: Check it, calculate the volume inside boundary; conversely, without checking it, it will calculate the volume in the public area. Click extend icon , you can select the range points on the *Define range* interface, and add, edit, delete, load, and save the range points.

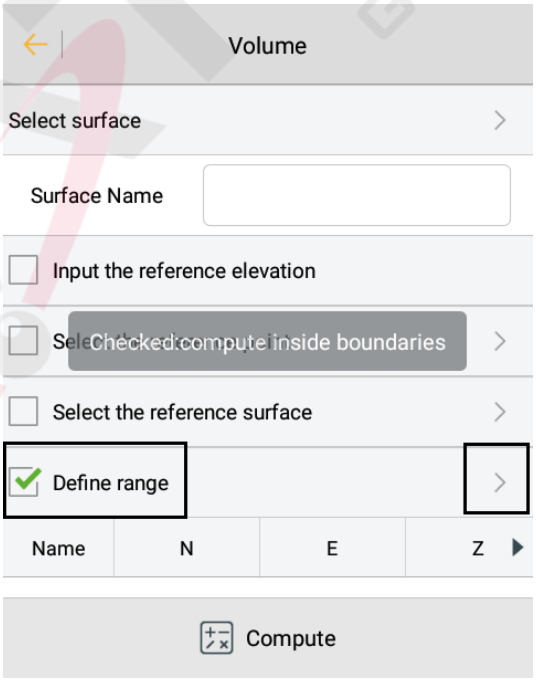



*Figure 6-8-3 Checked Boundaries*

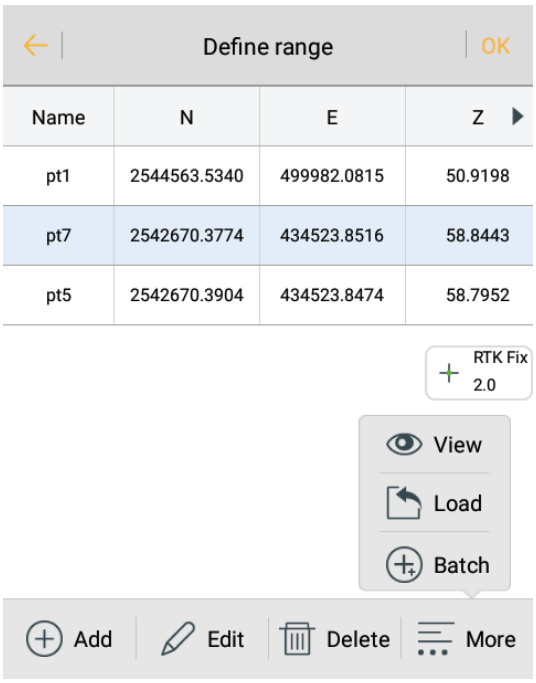



*Figure 6-8-4 Define Range*

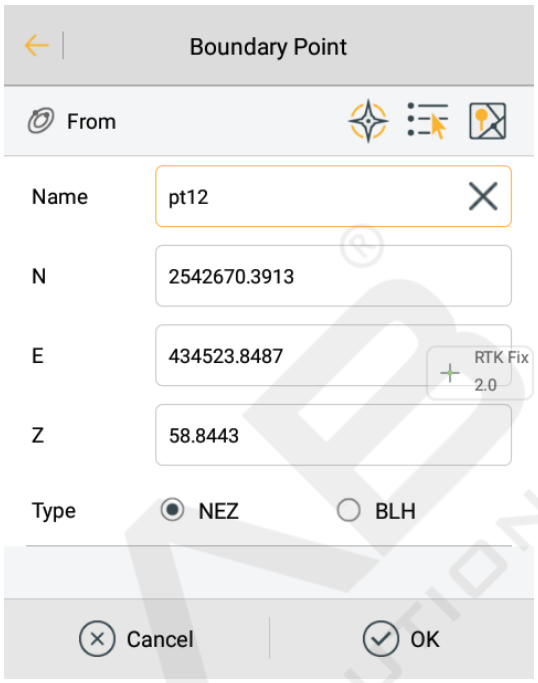



*Figure 6-8-5 Boundary Point*

- *Add*: Add a range point by manual input, real-time collection, point library selection or map selection, *Define Range* requires at least three points.

- *Edit*: Select the range point you want to edit: you can edit the coordinates of the point.

- *Delete*: Select a range point, click Delete to delete directly, no prompt.

- *Load*: Load an existing boundary file (*.waa), the load path is: *SATLAB\ Project\ ROAD\ Project Name\ dtm* folder.

- *Save*: Save the re-add/edit volume boundary file: the save path and file format is consistent with that in *Load*. When the saved file name already exists, it cannot be saved, but check *Cover* to save modified file. Also, click *OK* will also save re-add / edit volume boundary file.

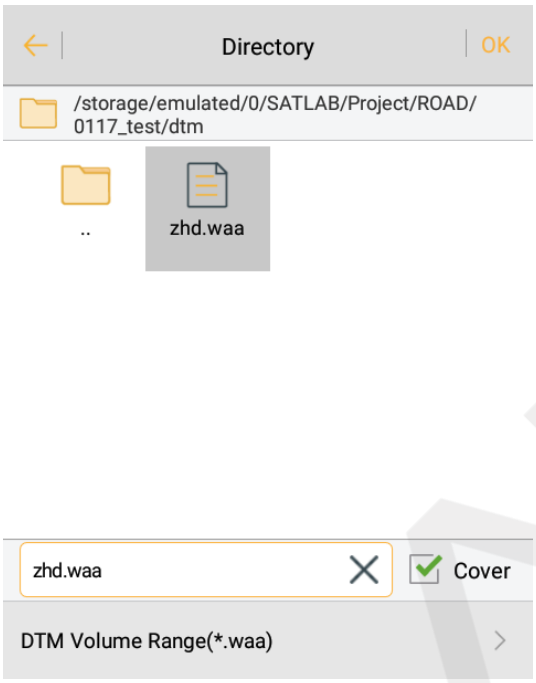



*Figure 6-8-6 Save Directory*

After selecting different calculation methods, click *Compute* and view the volume calculation, measurement surface, digging area, and fill area product information on the *Results* interface.

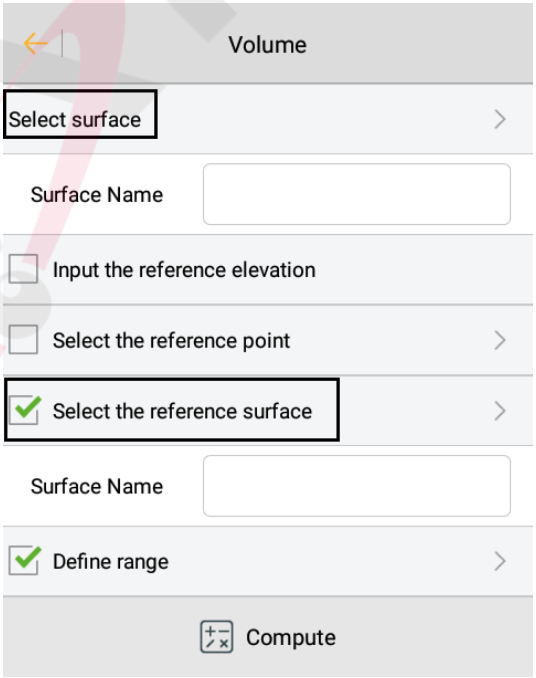



*Figure 6-8-7 Two Surfaces*

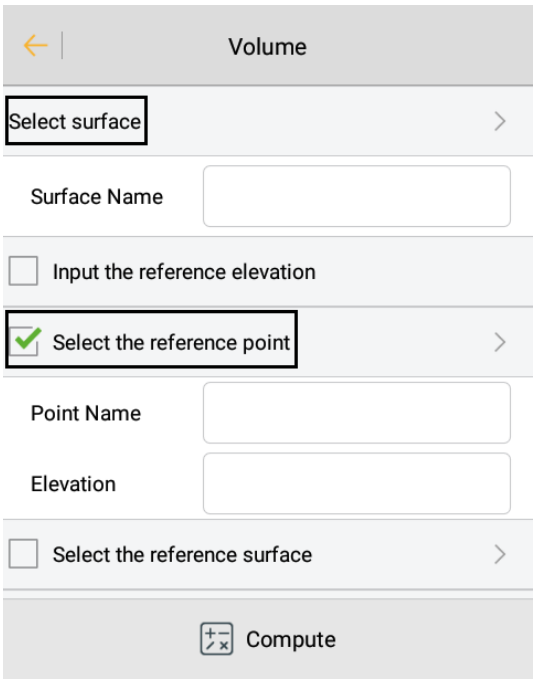



*Figure 6-8-8 Surface and Point*

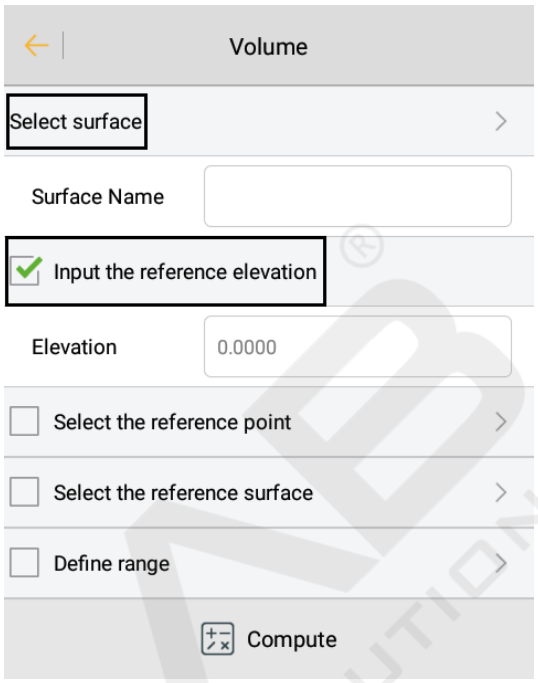



*Figure 6-8-9 Surface and Elevation*

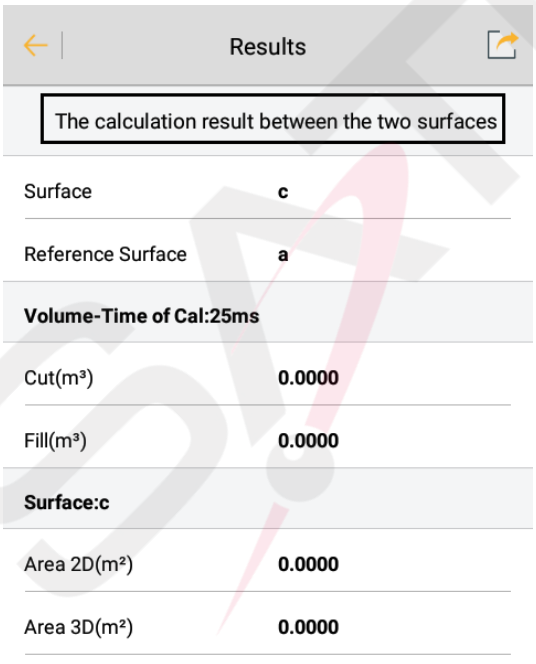



*Figure 6-8-10 Result Above*

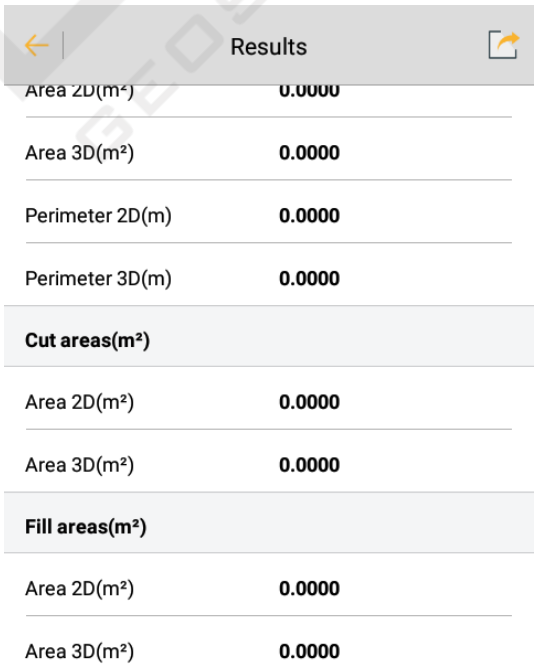



*Figure 6-8-11 Result Below*

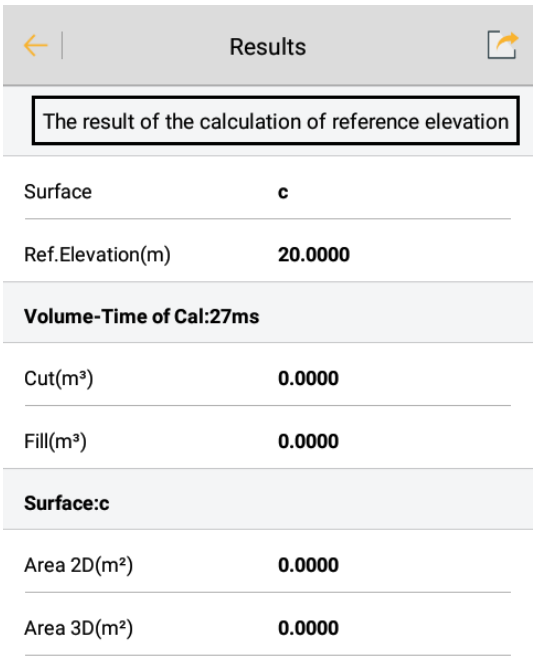



*Figure 6-8-12 Elevation Result*

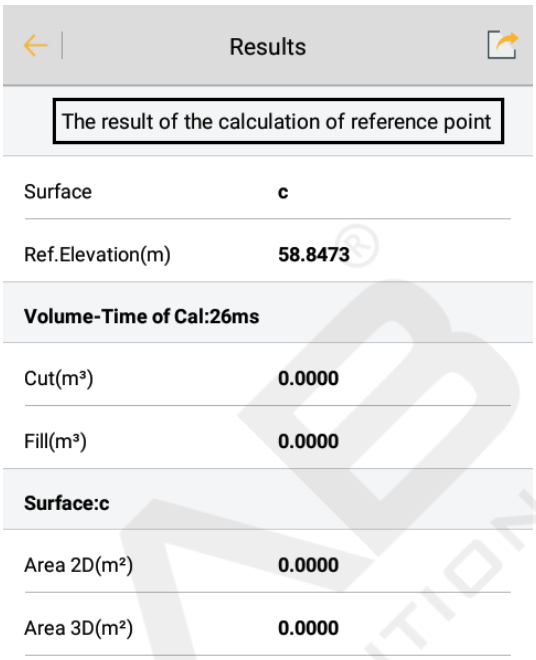



*Figure 6-8-13 Point Result*

- *Area (2D: $m^2$)*: The area projected onto the horizontal plane.

- *Area (3D: $m^2$)*: The area projected onto the slanted reference plane.

- *Perimeter (2D: m)*: The length of the polygon from the start point to the current measurement point in surface (2D).

- *Perimeter (3D: m)*: The length of the polygon from the start point to the current measurement point in surface (3D).

## 6.9 Calculator

Used for simple mathematical calculations.

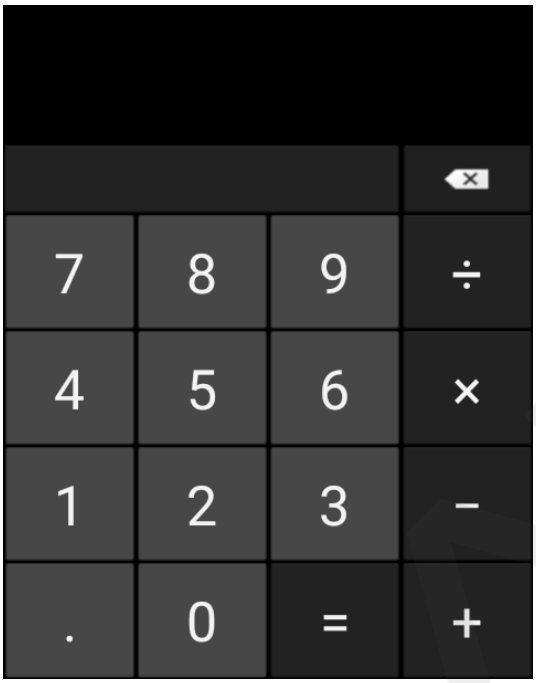



*Figure 6-9-1 Calculator*

**Headquarter:**
Datav ägen 21B
SE-436 32 Askim,Sweden
info@satlabgps.com

**Regional Offices:**
Warsaw, Poland
Jičín, Czech Republic
Ankara, Turkey
Scottsdale, USA
Singapore
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