SMA Survey App

User Manual

2024-4 | Software Version: V2.0.5

Copyright statement:

Revision record:

Version	Date	Revised content
1.0.0	2023.10	SMA Survey Software 1.0.0 Version Manual
2.0.5	2024.6	SMA Survey Software 2.0.5 Version Manual

Read before use:

Please use the software strictly according to this manual!
If you have any questions during use, please contact the service personnel in a timely manner.

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Contents

1 Introduction

1.1 Instructions for use

Welcome to the SMA Survey app (hereinafter referred to as SMA Survey or app) manual, which introduces how to set up and use SMA Survey.

1.2 Technical services

If you have any technical questions, please contact us and we will answer your questions in a timely manner.

E-mail: tech@smajayu.com; support@smajayu.com;

1.3 Comments and recommendations

If you have any comments or suggestions on this manual, please contact us. Your feedback information will greatly help improve the quality of our manual.

2 Software Overview

2.1 Software introduction

SMA Survey is an Android platform measurement software launched by SMAJAYU. It is combined with SMAJAYU GNSS receiver to provide users with high-precision measurement results. Users can use this app to control, query, or manage corresponding hardware products. This article takes SMAJAYU 20 series as examples to introduce users' operations such as setting and switching working modes, data measurement, and using commonly used tools on the device after connecting to the app.

2.2 Software features

- **Feature-rich and meticulous**

From project creation, coordinate system selection, coding management, to point measurement, point stakeout, CAD stakeout and editing, to rich and practical tool modules, we delve into the industry, refine settings, and approach user scenarios.

- **Fresh interface, intuitive icons**

Page interaction minimalist design, what you see is what you get, making it more convenient for field surveyors to use.

- **Coordinate system**

Powerful coordinate system function module, built-in EPSG predefined coordinate system, supports plane, elevation mesh model and geoid model correction, supports RTCM1021~ 1027 coordinate correction.

- **External data and layer management**

Support overlaying vector graphics on the map, including formats such as * .shp, * .xml, * .sjw, * .dxf, * .dwg, etc. You can also modify layer names, layer colors, and layer display/hide.

- **COGO calculation**

Support commonly used measurement and calculation functions, including: reverse calculation, point-line distance, eccentric point, deflection angle, intersection calculation, line segmentation, arc segmentation, triangle, etc.

- **Online tutorials**

The app provides online tutorials. You can watch operation videos while connected to the internet, or share links to watch on other browsers.

2.3 Software installation

SMA Survey can be obtained in the following ways:

1. The field handbook that comes with RTK products has been pre-installed with SMA Survey software. After a new version is available, the handbook will prompt for upgrade when it is connected to the Internet. Follow the upgrade wizard to operate:

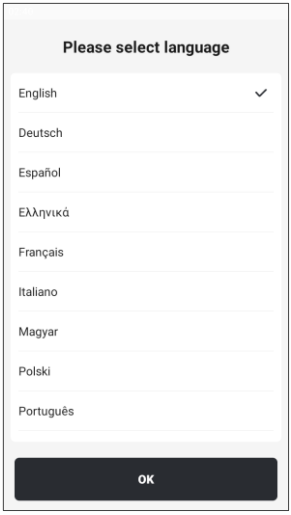
2. Copy the * .apk installation file to your Android device and click Program to install it.

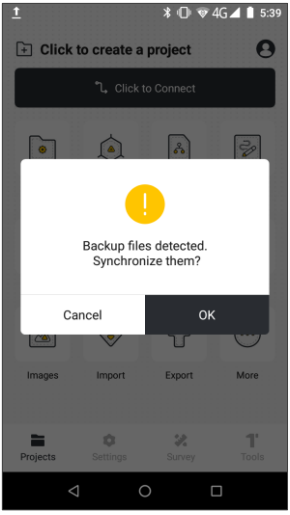
After successful installation, the icon of SMA Survey will appear on the device desktop.

2.4 Interface introduction

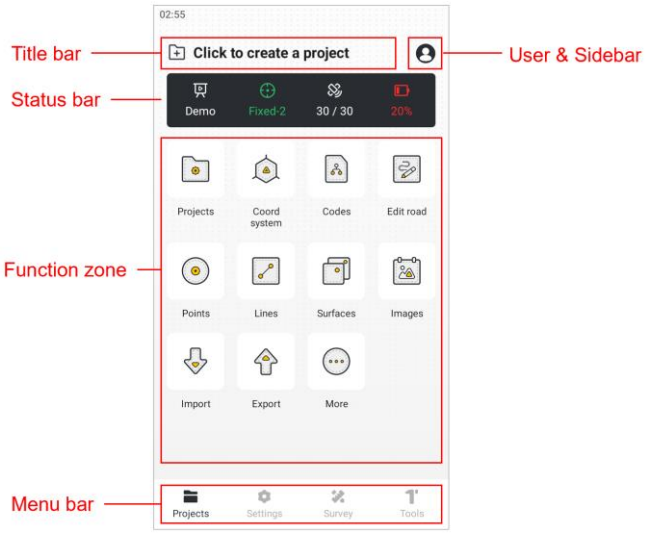
When running the software for the first time after installation or update, the system will select the language used by the app based on the Android device language. If there is no corresponding language, English will be selected by default. After clicking "OK", you need to grant the software file management and other permissions. It is recommended to allow such permissions, otherwise the app may run incorrectly.

After selecting [**OK**], enter the main page, where there are a total of four menus at the bottom: Projects, Settings, Survey and Tools. The function categories are clear.





When the SMA Survey connection receiver is working properly, the main page area is divided as follows:



2.4.1 Title bar

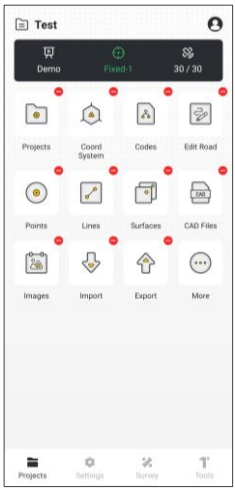
Display the current project name. If there is no project, display [**Click to create project**].

2.4.2 Status bar

Name	Icons and descriptions
Communication status	Null, In-Radio, Ex-Radio, Wi-Fi, Controller, Receiver, Demo
Positioning state	Initial, Single, RTD, Float, Fixed
Star search status	27 / 35
Power status	(0,30), [30,50), [50,70), [70,90), [90,100], Charging

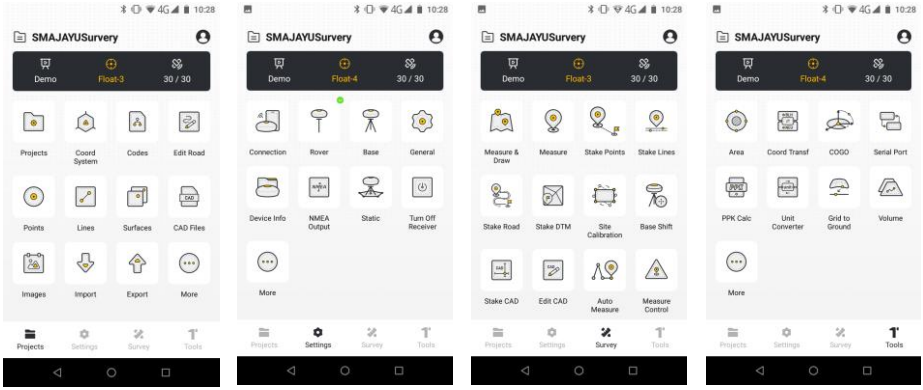
2.4.3 Function zone

Display the functions that can be used under each menu module. Long press the function icon to activate the editing status. Drag and drop to reorder. Click the red delete button in the upper right corner to hide the icon in the page [**More**].



2.4.4 Menu bar

It includes four functional modules: "Projects", "Settings", "Survey", and "Tools". Click on any module to switch to the corresponding page and display the corresponding function icon.



3 Quick Start

This chapter takes SMA20 built-in radio station 1 + 1 (base station + rover station) as an example to introduce the operation of quickly binding the receiver for data measurement.

The specific operation steps are as follows:

3.1 Preparation work

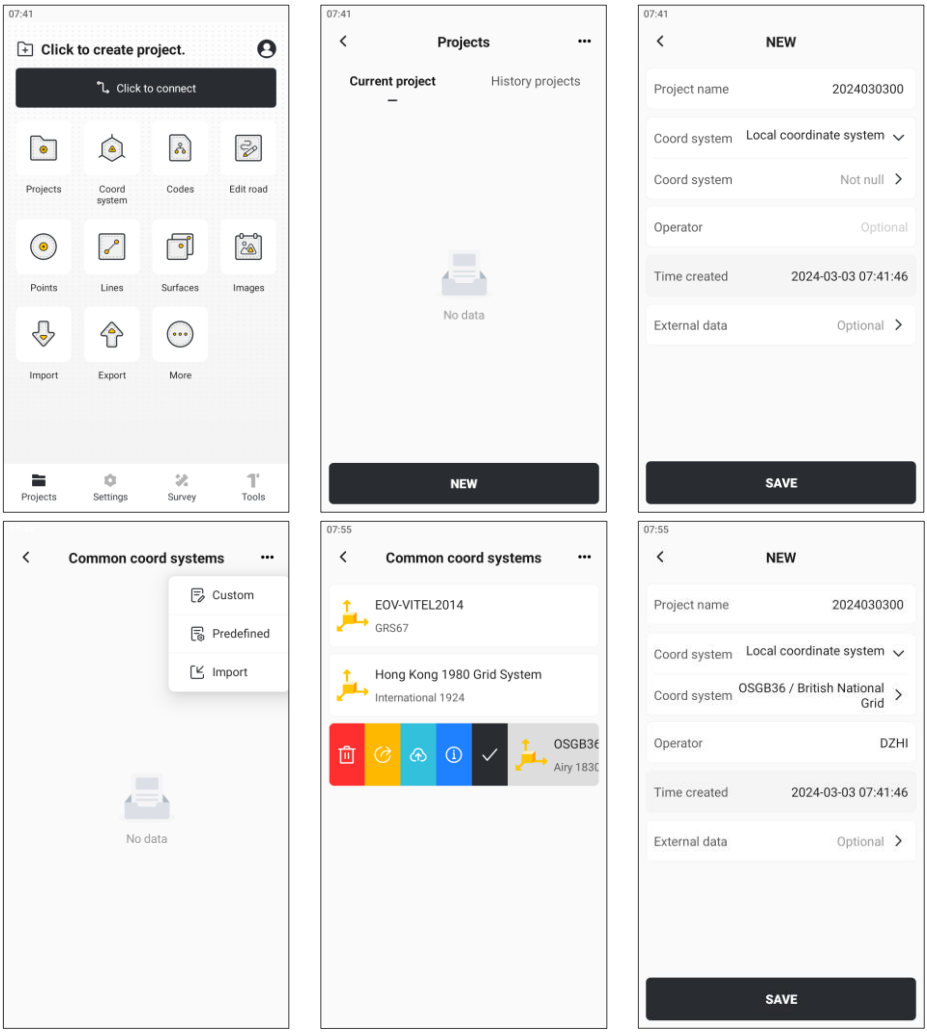
Prepare two sets of RTK equipment and a controller with SMA Survey installed.

RTK BASE

RTK ROVER

3.2 Create a new project

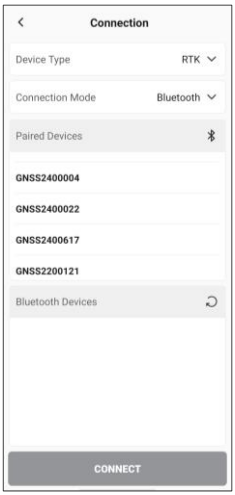
1. Open SMA Survey, select [**Projects**] → [**Projects**], click the bottom button [**NEW**], enter the project name, usually named after a date or other name. After editing the project name, select [**Coord System**] and select the coordinate system required for the project. You can select [**...**] in the upper right corner and add the required coordinate system to "Common Coordinate Systems" through [**Custom**], [**Predefined**] or [**Import**]. After adding, you can click on the corresponding coordinate system and click [✓] in the sidebar.
2. After all settings are set up, click [**Save**] to complete the project creation.

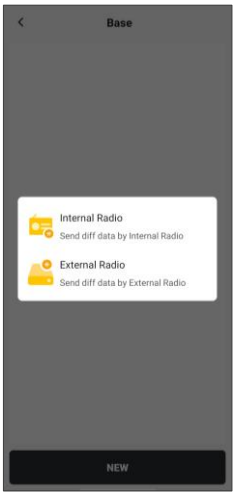


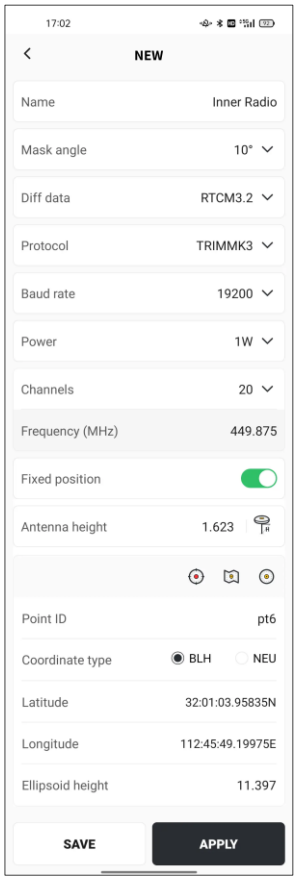
3.3 Set working mode

3.3.1 Base station setting

Click [**Settings**] → [**Connection**], select **RTK** as the Device Type and **Bluetooth** as the connection Mode, then select the Bluetooth number (SN number suffix) of the base station, and click [**CONNECT**]. After the connection is successful, select [**Base**], click the bottom button [**NEW**], select [**Internal Radio**], enter the name, and configure GNSS parameters. After the configuration is completed, click the bottom button [**APPLY**].

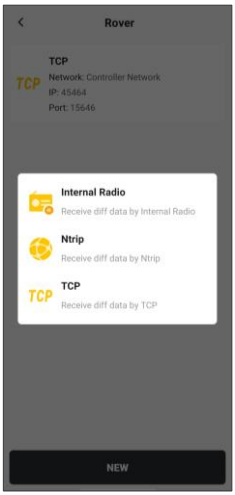


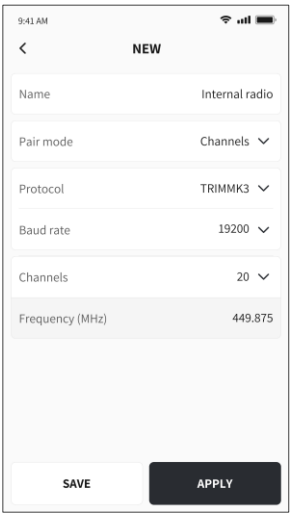


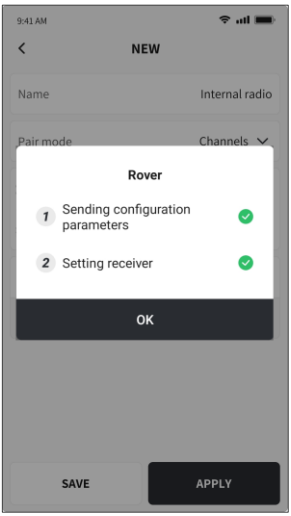


3.3.2 Rover station settings

After configuring the base station, disconnect and prepare to configure the rover station. Click [**Connection**], select the Bluetooth number (SN number suffix) of the rover station, and click [**CONNECT**]. After the connection is successful, select [**Rover**], click the bottom button [**NEW**], select [**Internal Radio**], and enter the radio parameter configuration interface, and pay attention to keeping them consistent with the base station. After completion, click [**APPLY**]. The controller prompts a fixed solution, and the instrument is successfully set up.

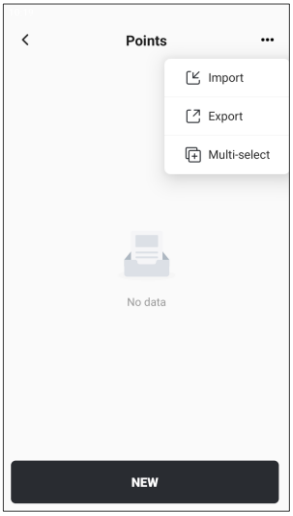


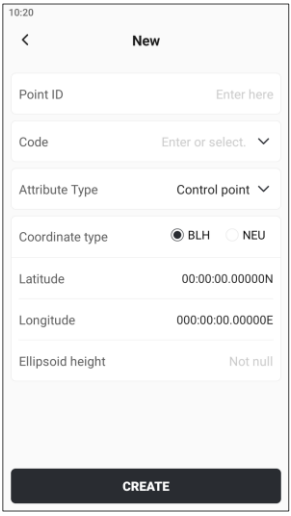


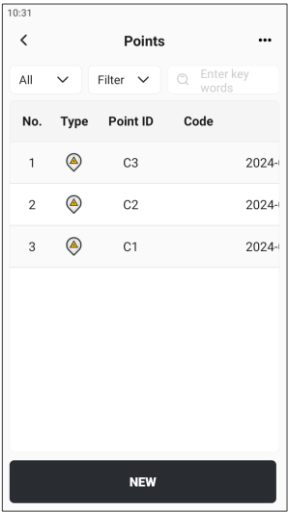


3.4 Site Calibration

1. After obtaining a fixed solution for the instrument, if there are no coordinate parameters, the parameters need to be converted. Click [**Projects**] → [**Points**], click [**NEW**] or select [**Import**] in the upper right corner, enter the point name, select the control point for the point type, enter the coordinates, and click [**CREATE**]. Generally, two or more points are needed for Site Calibration, which can be added here in order.

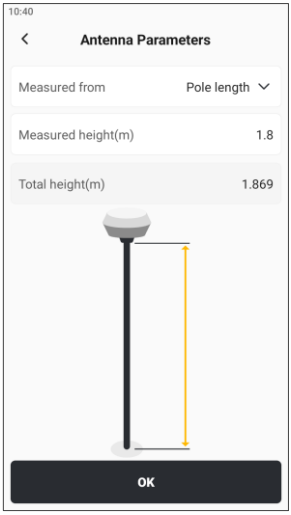


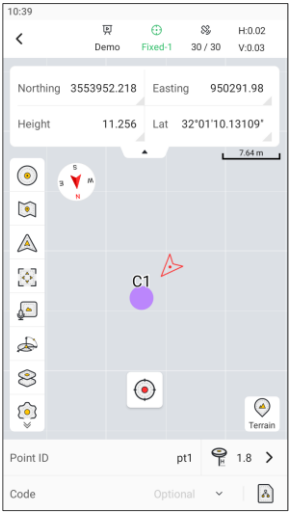


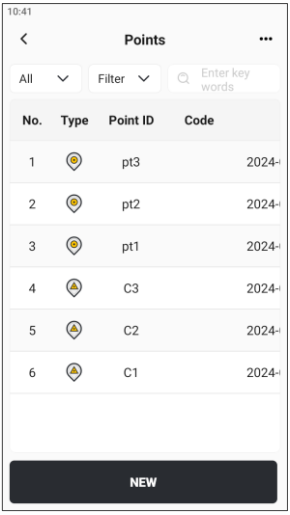


2. After adding, it is necessary to measure the control points on site. Click [**Survey**] → [**Measure**] and enter [**Antenna Height**]. Note that the antenna height should be

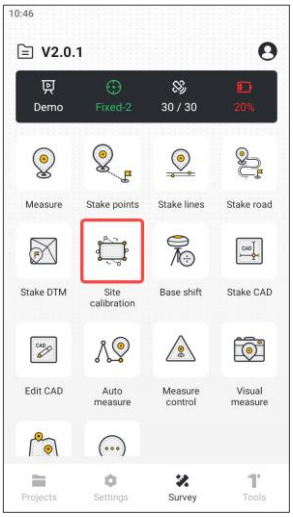
consistent with the height of the centering rod. Then, place the centering rod on the control point, strictly center the leveling bubble, and click the [**Measure**] button to measure the control point. After measuring at this point, you need to go to other control point locations and measure the control points one by one.

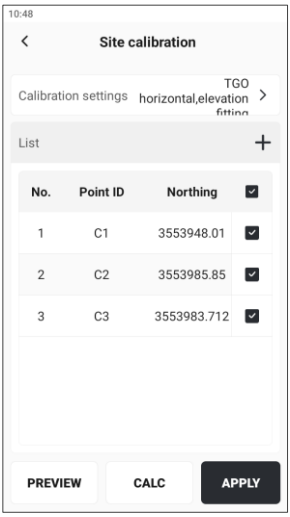


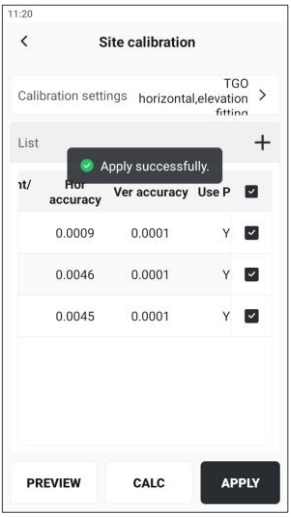




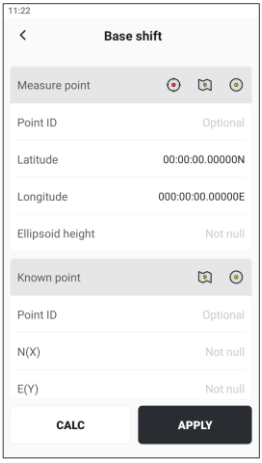
3. After the control point measurement is completed, return to [**Survey**], select [**Site Calibration**], click [**+**], and correspond the control points and measurement points one by one. Select two or more pairs of control points, select the point pair to be calculated, click [**CALC**] → [**APPLY**]. After completion, we can perform external operations such as **Measure**, Stake Points, or Stake Lines.





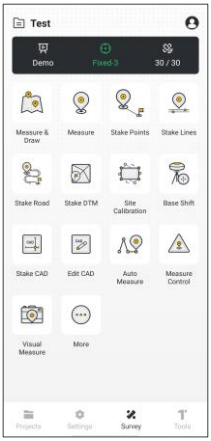


4. Note that when the base station shuts down or moves, the position of the base station changes and requires a base station translation operation. Click [**Base Shift**], the operation here is similar to **Site Calibration**, but only requires one pair of points. Select the corresponding [**Measure point**] and [**Known point**], and click [**CALC**] & [**APPLY**].



3.5 Data measurement

Only when the positioning state is fixed and the **Site Calibration** meets the requirements can the measurement work be carried out. SMA Survey supports conventional measurements, such as **Measure**, **Measure Control**, **Auto Measure**, **Stake Points/Line/DTM** as well as unconventional measurements such as **Measure & Draw**, **Stake Road**, **Stake CAD**, etc.



3.6 Data export

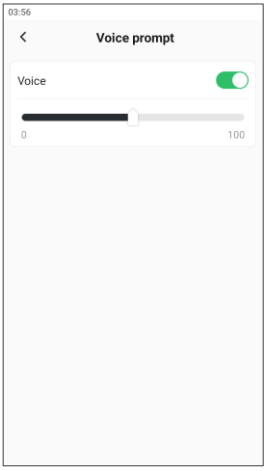
After the measurement is completed, click [**Projects**] → [**Export**]. Configuration information is as follows:

Name	Description
Format	Optional text format and other formats
Format name	Corresponding to different format types, different export formats can be selected, text format can be customized, other formats support * .dat/* .kml/* .dxf/* .shp/* .NCN/* .sim/* .html/* .xls
Type	Optional 5-point types
Time	Customizable time period, export data within that time period
Data Sort	In chronological order or reverse order
Code	It can be exported after filtering by code.

4 Personal center

4.1 Voice prompt

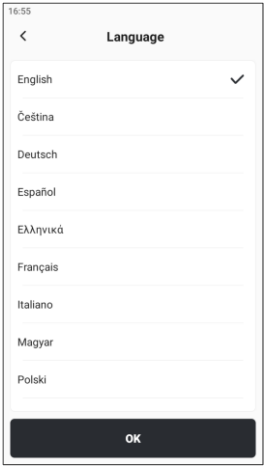
You can set whether to enable voice prompts, and drag the slider to increase or decrease the prompt volume.



4.2 Language

Currently, the software supports multiple simplified Chinese, English, German, Spanish, Greek, Portuguese, Russian, Japanese, etc.

When switching languages, in order to ensure the integrity of the app display and functions, the app will automatically restart.

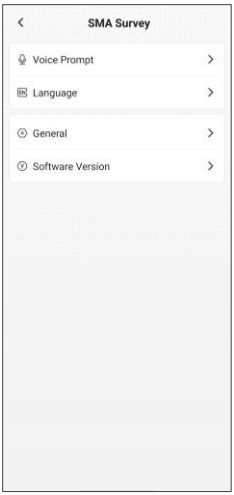


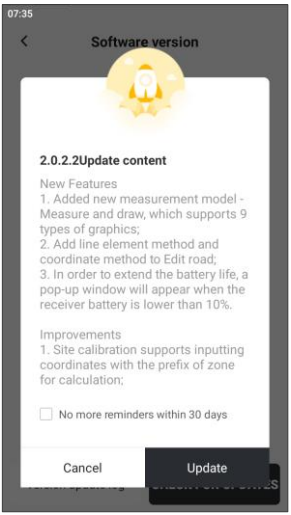
4.3 General

Click on [**General**] to open the software's general global configuration. For detailed information, please refer to **Chapter7.5.**

4.4 Software version

Click on 'Software Version' to view the current software version number. Click on 'Check for New Version', and if there is a new version, you can choose to update it immediately.



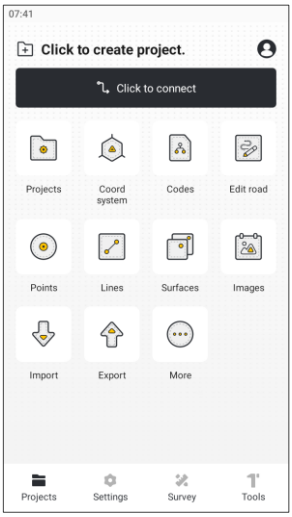


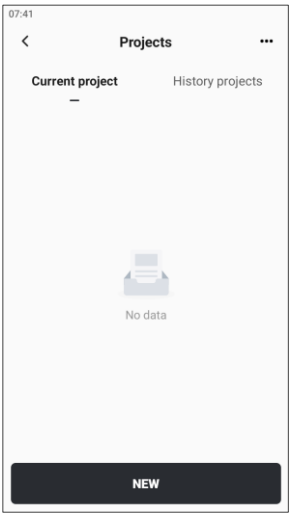
5 Projects

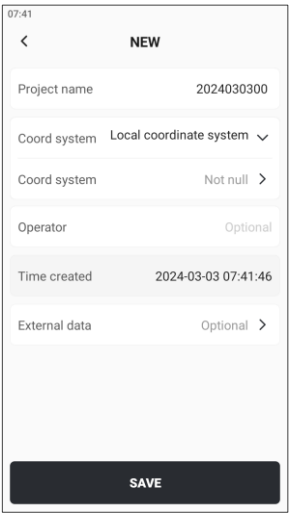
5.1 Projects

5.1.1 New

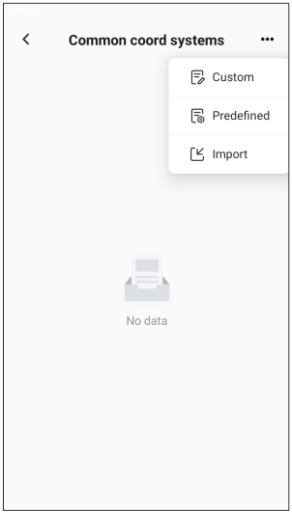
Before using a RTK job, you must create a new project to manage the data. Open SMA Survey, select [**Projects**] → [**Projects**], click the bottom button [**NEW**], enter the project name, usually named after a date or other name.

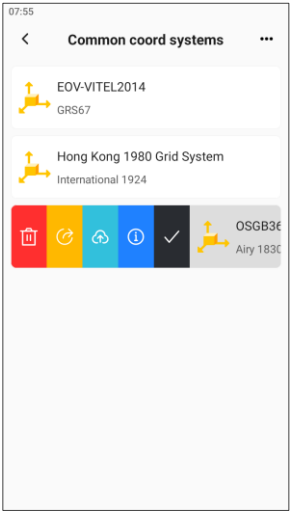


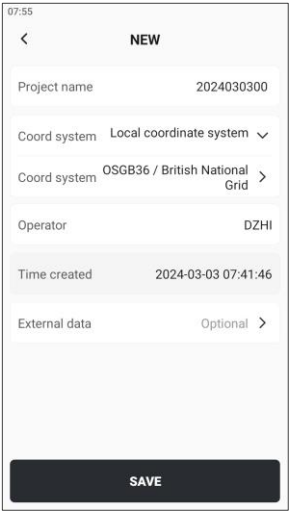




After editing the project name, select [**Coord System**] and select the required coordinate system for the project. You can select [**...**] in the upper right corner and add the required coordinate system to [**Common Coord Systems**] through [**Custom**], [**Predefined**] or [**Import**]. After adding, click the corresponding coordinate system and click [✓] in the sidebar.

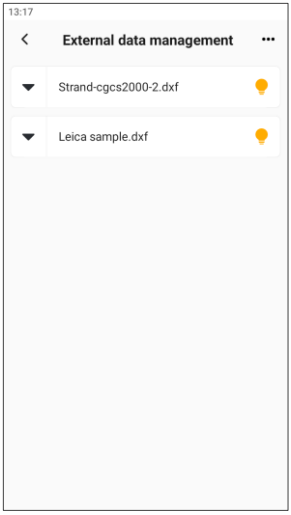


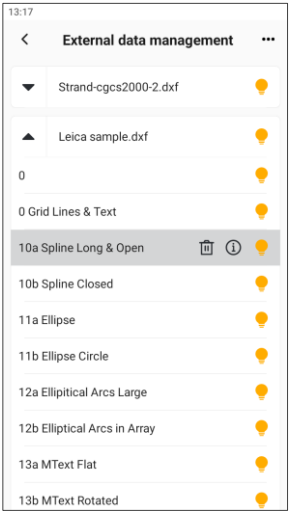


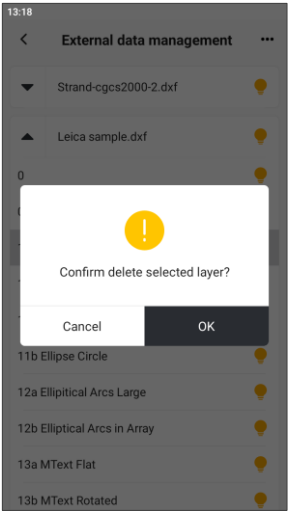


External data is optional and supports adding base maps to measurement maps. Currently, four formats are supported: * .dxf, * .shp, * .xml, and * .kml. Selecting a layer allows you to choose to show/hide, delete, or edit.

Note: To ensure the smoothness of map operation, it is recommended to add a file size of no more than 10 MB.





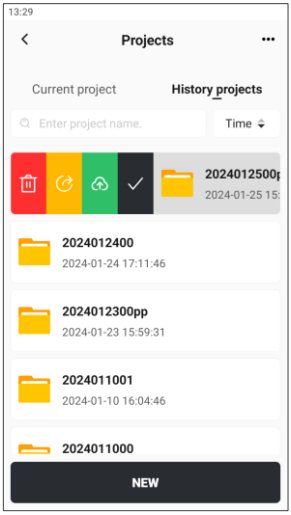


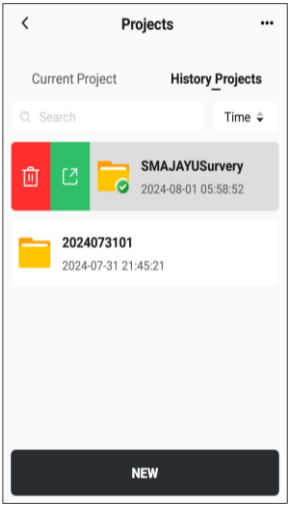
After all settings are set up, click [**SAVE**] to complete the project creation.

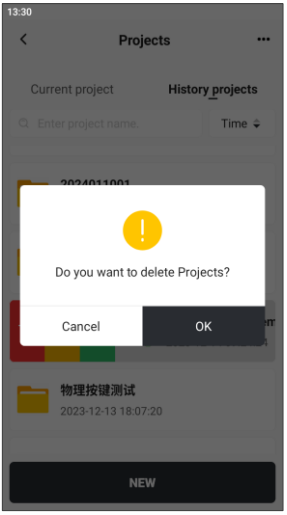
5.1.2 Delete

Click on [**History Projects**], click on a project (open or unopened) in the project list, side-swipe buttons will be displayed, click the red delete icon, and a deletion confirmation dialog box will pop up. Click [**OK**] to delete the project file; select [**Cancel**] to cancel the box.

Note: It cannot be restored after deletion, please operate with caution.







5.1.3 Open

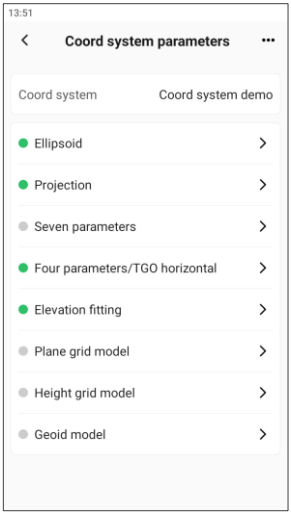
If you need to continue a previous project, you can open it. Select the project and click [✓]. When you need to open another project, also select the project you want to open in the [**History Projects**] interface and click [✓].

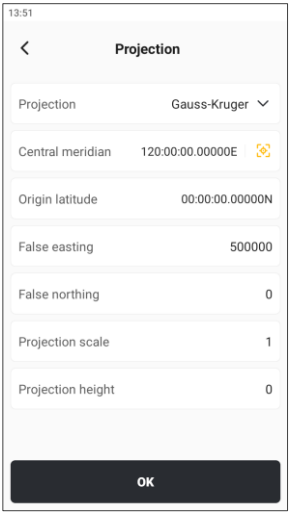
5.1.4 Upload and download

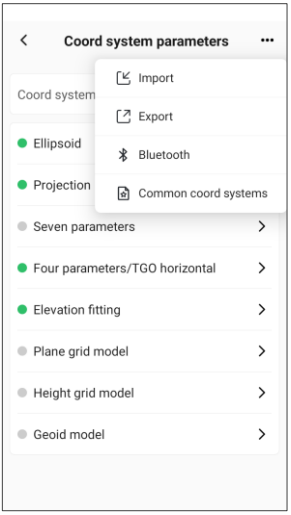
Project files can be uploaded to My Cloud Drive and downloaded locally from it, and the project can also be shared with other SMA Survey users. For details, please see **Chapter 5**.

5.2 Coord system

The coordinate system parameters include: ellipsoid, projection, seven parameters, four parameters/TGO horizontal, elevation fitting, plane grid model, elevation grid model and geoid model.







[**Ellipsoid**]: Including ellipsoid name, major axis, reciprocal of flatness, etc. Semi-major axis and reciprocal of flatness do not need to be set, they can be set to default values, also the parameters here can be edited.

[**Projection**]: Built-in commonly used projection methods, including Gauss-Kruger, Transverse Mercator, UTM projection, etc., and display the parameters of each projection model. Usually, only the central meridian needs to be changed. If you customize the coordinate system, you can input the average longitude of the measurement area, and the longitude error is generally required to be less than 0.5 degrees.

- **Central Meridian**: After opening the software and connecting to the instrument, click the Get icon to obtain the central meridian of the measurement area; or when the input central meridian longitude does not match the actual longitude of the measurement area, it will prompt "Detected that the central meridian deviates too much from the current coordinates, please correct it" during measurement, click [**OK**] to jump to the coordinate system parameter interface, and click the Auto Get icon to obtain the central meridian of the current position.
- **False Easting**: In order to ensure that the converted coordinates are positive, the east-facing add constant is generally defaulted to 500,000 meters, which can be filled in as needed.

[**Conversion Parameters**]: Represents the mathematical model used for the conversion of two coordinate systems. The benchmark conversion model (including three parameters, seven parameters, and ten parameters). If the user has local seven parameters, they can directly input them without Site Calibration.

- **Seven-parameter**: At least three known points are required (known points can be coordinates in the national coordinate system or coordinates with a small rotation between the WGS84 coordinate system, preferably with three or more known points to check the correctness of the known points). This method solves the model rigorously, so it requires high coordinate accuracy of the known points and is generally used in large-scale operations. When the accuracy of the known points is not high, it is not recommended to use seven parameters.
- **Three-parameter**: At least one known point (the known point can be a coordinate in the national coordinate system, or a coordinate with a small rotation between the WGS84 coordinate system, preferably two or more known points, which can check the correctness of the known points), used in a small range, the accuracy is determined by the operating range, and decreases with the increase of the operating distance.

[**Four parameters/TGO Horizontal**]: After finishing Site Calibration and application, the correction parameters will be displayed on the coordinate system parameter interface.

[**Elevation Fitting**]: Currently, four algorithms are supported for elevation fitting: single benchmark, plane Fitting, surface fitting and TGO vertical. Plane fitting is selected by default.

- Plane fitting: refers to generating an optimal fitting plane corresponding to elevation anomalies at multiple horizontal points. When this plane is parallel to the horizontal

plane, plane fitting is equivalent to fixed error correction. This fitting method requires at least three starting points.

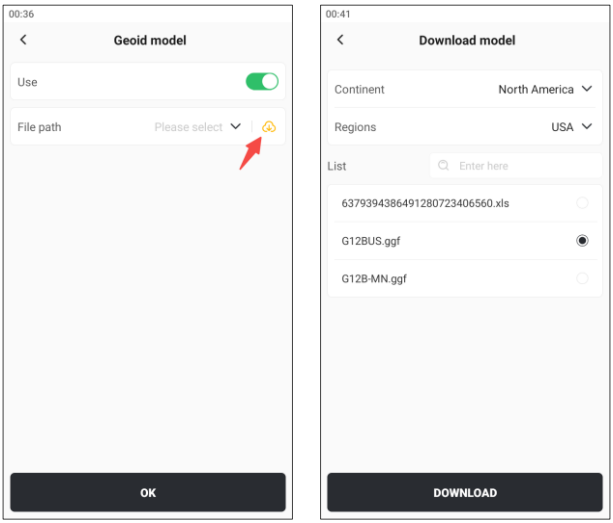
- Surface fitting: refers to generating the best fitting parabola corresponding to elevation anomalies at multiple leveling points. Surface fitting requires relatively high starting data. If the fitting degree is too poor, it may cause the elevation correction number in the work area to diverge, and the fitting requires at least five starting points.

[**Plane Grid Model**]: The representation of a plane is usually achieved through a two-dimensional array or list. Each element of this array represents a point on the plane, and the coordinates of that point can be determined by its x and y values. To better describe this plane, we usually use a grid model, which consists of a series of rectangular grids with equal side lengths and known positions and directions in the coordinate system. In this way, we can more conveniently manipulate and study the plane, such as measuring distances and determining whether a point is on the plane.

[**Elevation Grid Model**]: A way to represent height information in three-dimensional space. In this model, we divide three-dimensional space into several equal small blocks, each of which is called a "unit", and each unit has an "elevation value" representing its height.

[**Geoid Model**]: After clicking to enter, turn on the [**Use**] switch and select the geoid model file. Currently, the software supports geoid model files in formats such as * .tif/*. gtx/* .asc/*. grd/*. ggf.

The plane grid model, elevation grid model and geoid model all support online downloads. Currently, the software platform has built-in commonly used correction models worldwide and supports filtering by continent and regions.



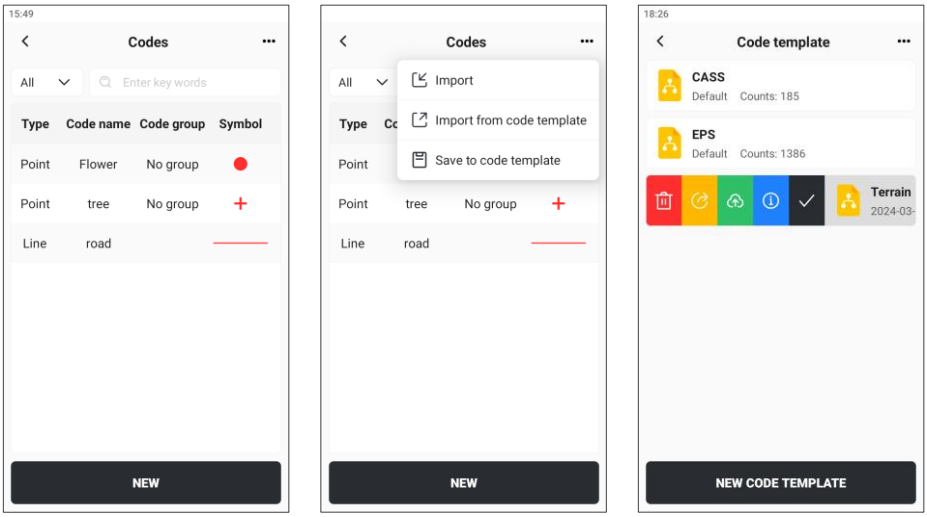
Establish the relationship between geoid model correction and RTCM1021-RTCM1027 receiving correction information, with priority given to RTCM1021-RTCM1027 correction information. When using RTCM1021-RTCM1027 correction information, if there is a message of 1023 or 1024, the geoid model cannot be selected. If RTCM1021-RTCM1027 correction information is not used, or if RTCM1021-RTCM1027 correction information is used but there is no message of 1023 or 1024, the geoid model can be selected.

Note: When switching from a single base station to multiple base stations, if you want to use the original Site Calibration parameters to cause a fixed difference between coordinates, you can create a new project using this correction parameter to eliminate this fixed difference.

5.3 Codes

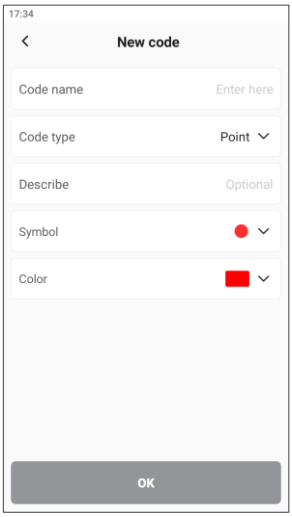
The main function of codes is to finely manage the codes of different work environments, such as water conservancy measurement and road measurement, which require different codes. Establish multiple code sets, store them separately, and choose different code sets for different projects.

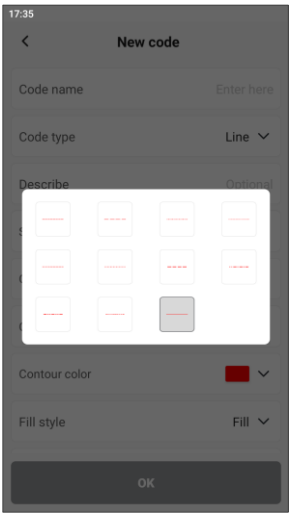
Go to [**Codes**] and click the [**...**] button in the upper right corner. You can import codes from the outside or from the code template, or save the current codes to the code list.

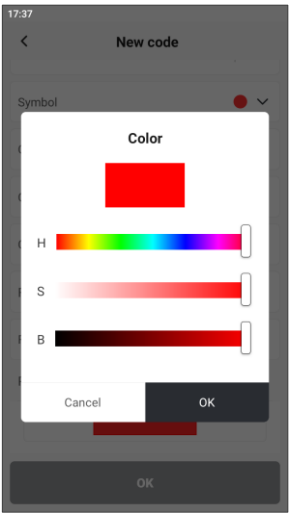


Click [**NEW**] button at the bottom to create a code. It supports three types: point, line and polygon. You can set rich properties for the code.

Name	Description
Code name	Enter code name
Code type	Optional types include: point, line, surface
Code ID	Optional, supports letters and numbers, some industry software supports recognition
Code group	Group management can be performed on encoding
Description	Not required
Symbol	Node symbols, optional circle, cross, diamond, square, triangle, etc
Color	Set the color of the node symbol
Contour	The contour line type of line/polygon elements can choose different dotted lines, solid lines, etc.
Contour color	Set the color of the contour line
Fill style	When the target is a polygon element that is closed by a line or directly created, optional filling
Fill color	When the fill style is Fill, you can set the color of the fill.
Preview	Preview able contour and fill styles





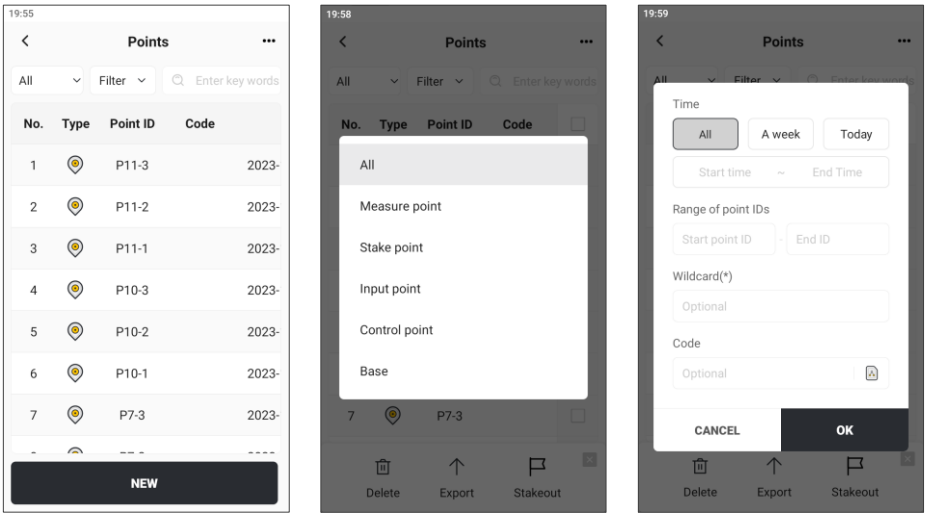


5.4 Points

Points is used to unify the management of various types of coordinate points, including **Measure Point**, **Stake Point**, **Input point**, **Control point** and **Base point**.

Enter [**Points**], all points are in the point list, and can be filtered through the first line button.

1. [**Point Type**]: All points are displayed by default. Click to pop up the point type selection dialog box, which can quickly filter by type.
2. [**Point Filter**]: Provide 4 filtering methods, optional time, range of point IDs, wildcard (*) and code.
3. **Search box**: Can perform fuzzy search on point name and code.



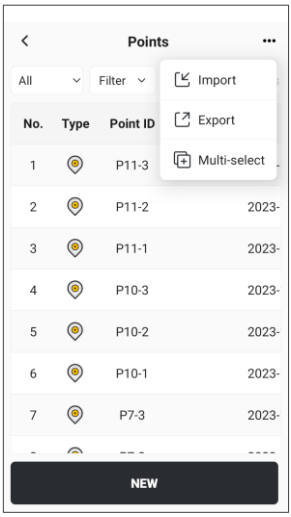
The point list displays the attributes of points in the form of a table, including:

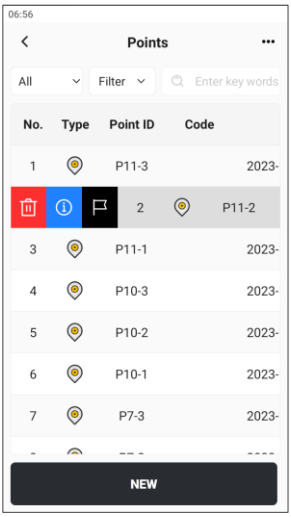
No.	Time	Latitude (B)	Diff age
Type	Northing (N)	Longitude (L)	HRMS
Point ID	Easting (E)	Ellipsoid height (H)	VRMS
Code	Elevation (U)	Status	Counts (refer to stake)

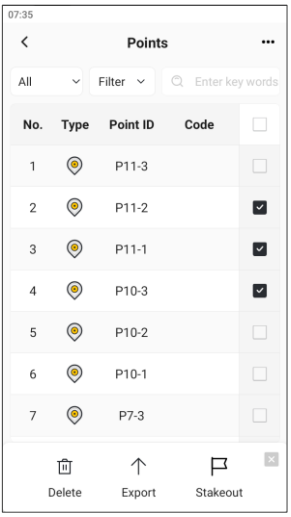
Click on the top right corner [**...**], a pop-up menu will appear, and you can choose [**Import**], [**Export**], or [**Multi-Select**].

Click on a point, the line slides sideways, and three operation buttons appear: **Delete**, **Details** and **Stake**. Click [**Details**] to view and modify the detailed properties of the point, including **General**, **Quality** and **Media** information.

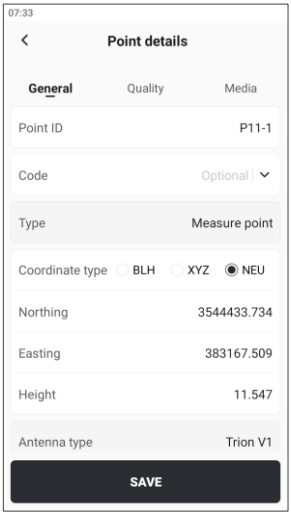
Click [**Multi-Select**] or long press a certain point to enter the multi-select interface. Select multiple points to achieve batch deletion, export or stake.

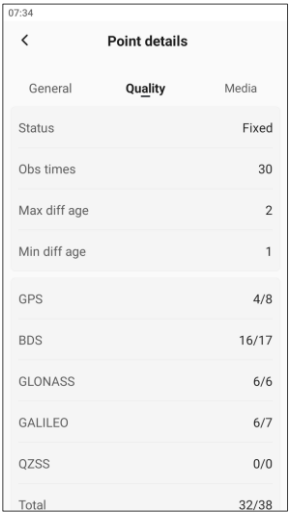


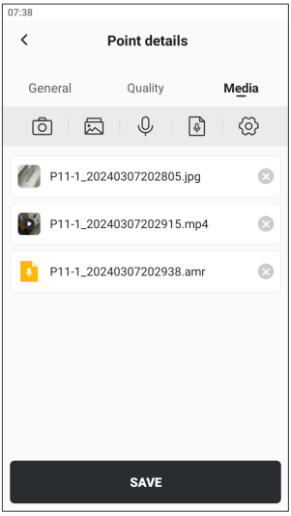




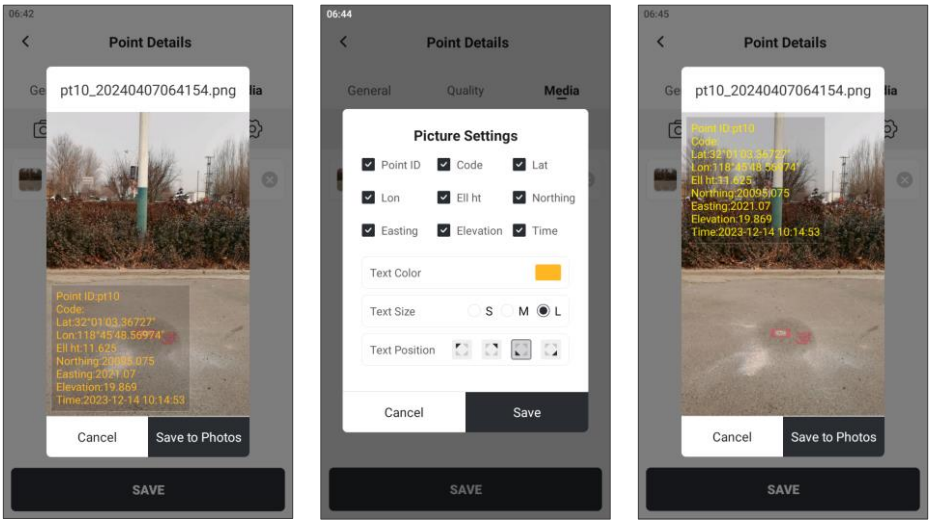
View [**Point details**], the general information has different editable attributes depending on the type of point. Quality information cannot be edited. Media information displays photos, videos and audio files at the same time.





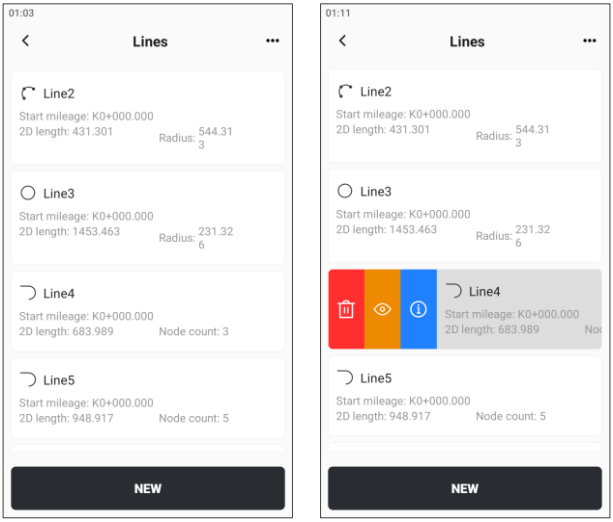


Media information supports adding photos, videos and audio files to the point. Click the list thumbnail to preview. Click the setting button to set the basic information displayed when previewing the photo. Click the bottom button [**Save to Photos**] to save the photos with watermark information to the system photos.



5.5 Lines

Lines is used to store the position of line elements. When staking lines, you can directly select the target line from Lines. In the line list, click on the card to display executable operations: delete, preview and details.

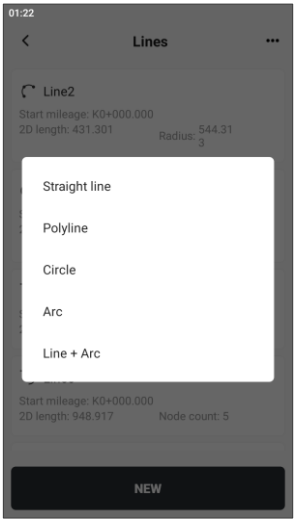


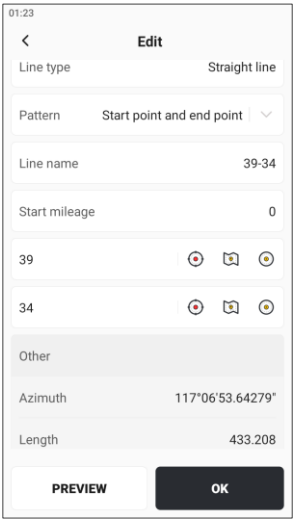
5.5.1 Line introduction

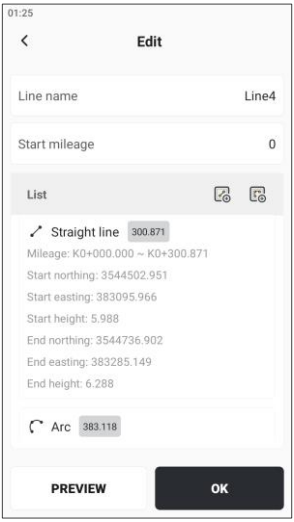
Click the bottom button [**NEW**] to create lines. Straight line, polyline, Circle, Arc and Line &Arc are optional:

Line type	Creation method
Straight line	• Start point + end point • Starting point + azimuth + length
Polyline	Measurement point selection/map selection/library selection
Circle	• Three points • Center + radius
Arc	• Three points • Two points + radius • Start point + azimuth + length + radius
Line & Arc	Add straight line/add arc

Once created, click the card in the line list and select Details to edit and preview.

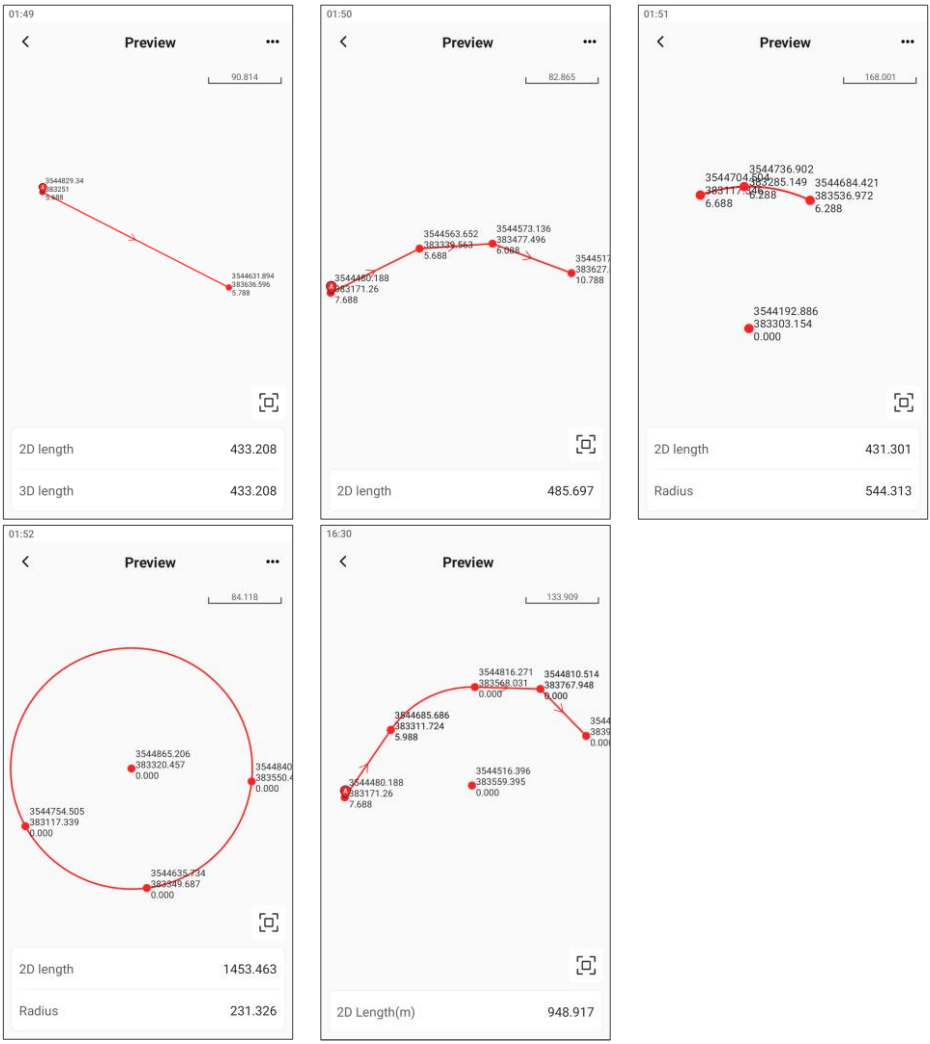






5.5.2 Line preview

Each created line can be previewed to assist in checking the correctness.



5.5.3 Import and export

Click the [**...**] button in the upper right corner to select **Import**, **Export** or **Multi-Select** operations. Among them, **Export** exports all line types by default, while **Multi-Select** operation is only effective for deletion.

When selecting Import or Export, click the cloud icon in the upper right corner, which supports uploading to or downloading from the cloud.

1) Import

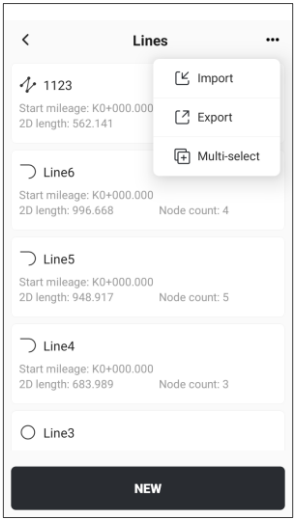
Support importing custom *.lne format file, which can fully restore the parameters

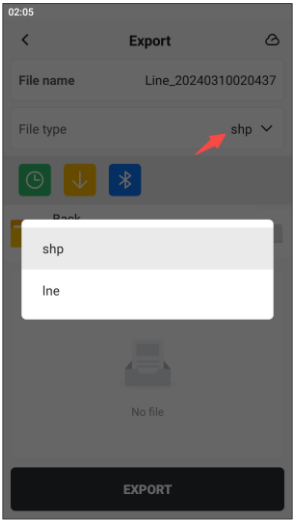
created during line creation.

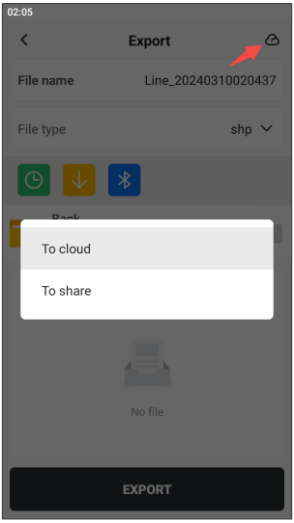
Note: This format is currently incompatible with third-party software.

2) Export

Support exporting custom *. lne or * .shp format file.

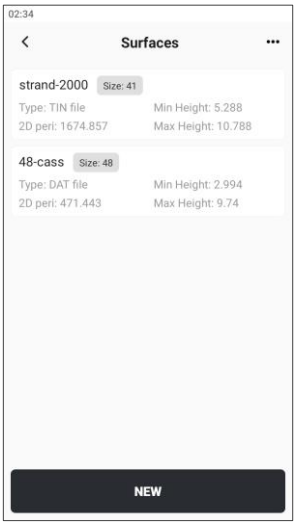


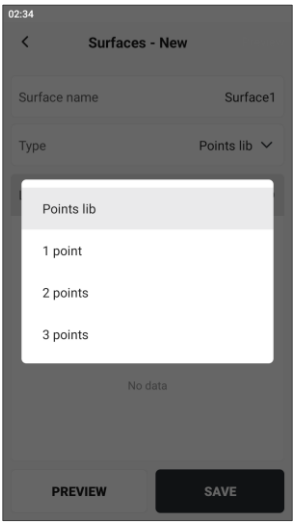


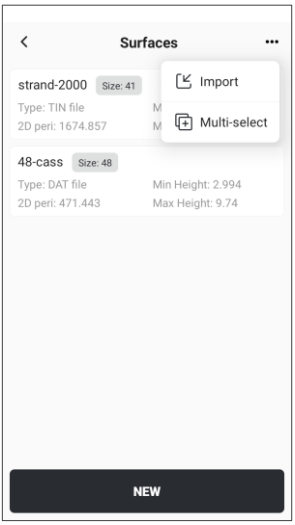


5.6 Surfaces

Surfaces is a location for storing surface type files. It can be called by the programs of Stake DTM and Volume. Click [**NEW**] button at the bottom of the main page to create a surface file; click [**...**] → [**Import**] button in the upper right corner to create a surface by loading the file.

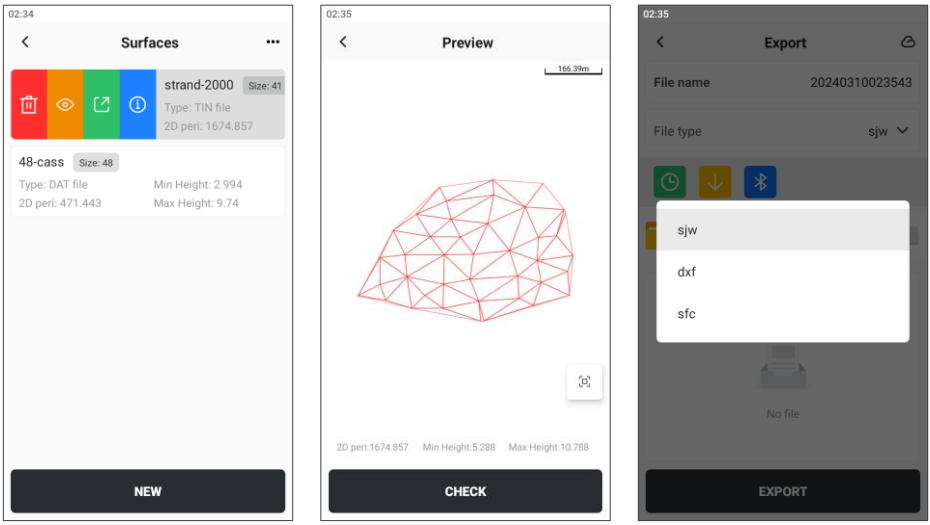






Creation method	Type of surface	Description
New	Points	Select several points from Points to create a triangular mesh surface
	1 point	Create a surface with one point and a slope of N/E, which extends infinitely and has no preview function
	2 points	Create a surface with two points and a slope perpendicular to the forward direction, which extends infinitely and has no preview function
	3 points	Create a surface with three points, which extends infinitely and has no preview function
Import	*.dat text file	Create a triangular mesh from points in a *.dat text file (format: point name, code, easting, northing, elevation)
	* .sjw/*.dxf/*.xml format file	Load existing triangle mesh files

Click on the surface file card to choose from **Delete**, **Preview**, **Export** and **Details**. Except for the three types of surfaces that cannot be previewed, other surface files can be previewed. Click the **Export** button to export the surface file as *.sjw, * .dxf file, or as SMA Survey custom surface file format *.sfc.



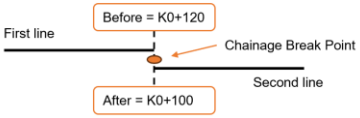
5.7 Edit Road

During road engineering construction, in order to ensure that the structures of each part of the line meet the design and specification requirements, and to better grasp and control the construction quality of the project, technical personnel need to constantly inspect and monitor the centerline and excavation (filling) edge of the line. The main work of **Stake Road** is to calibrate the plane position and excavation height of each pile point on the line.

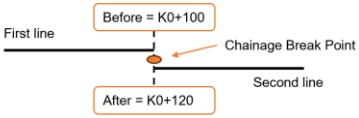
Before performing road field survey, the road must first be edited or imported.

5.7.1 Glossary

Glossary	Explanation
Intersection	Currently, the commonly used road design method only requires users to input the coordinates of the intersection points of the line curves and the corresponding information such as the length, radius, and mileage of the line to obtain the coordinates of the element points, pile points, and line points, as well as intuitive graphic display, making it easy to carry out measurement work such as line stakeout.
Element	The line element method, also known as the element method or building block method, divides the road according to the properties of straight lines, gentle curves, and circular curves. With each section of input, the shape of the line can be arbitrarily combined. For complex curves such as oval lines, multi-intersection curves, and virtual intersection points, the line element method can be used to define them.
Coordinate	Coordinate method is a new road input method developed on the basis of traditional element method and intersection method, which is simpler and easier to popularize. Due to the fact that some roads are composed of straight lines and circular curves, and the connection between these straight lines and circular curves is not absolutely tangent, in simple terms, the azimuth angle of the straight line is 130 °, and the starting azimuth angle of the circular curve it connects to is 140 °. This kind of road is more troublesome to handle with the element method and the intersection method, so a special and relatively simple flat curve design method - coordinate method has been extended.
Broken chain	The phenomenon of discontinuous pile numbers caused by local line changes or segmented measurements. There are mainly two situations: 1. Long chain: Front mileage > Back mileage, the connection time is longer. 2. Short URL: Front mileage < Back mileage, the connection is shorter. Breaking pointThe point where the new and old pile numbers are not continuous. Generally set at: 1. The position where the new line meets the old line exactly. 2. On a straight line or at points HZ/YZ, it is basically not set on a curve.



K0+120 = K0+100, Overlap = 20.000

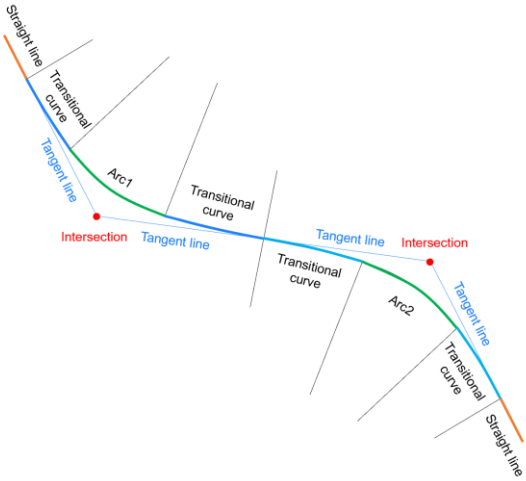


K0+100 = K0+120, Gap = 20.000

Horizontal Alignment

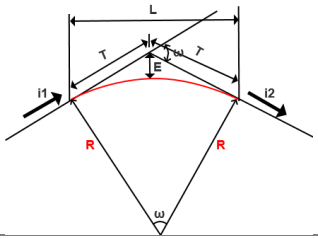
During road construction alignment, due to the influence of terrain factors, the direction of the route on the plane inevitably needs to be changed. Therefore, the route determined by directional measurement is generally composed of broken lines. In order to meet the requirements of driving, curves must be used to connect adjacent straight line segments.

A flat curve consists of straight lines, gentle curves, and arcs.

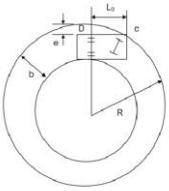
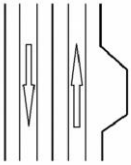
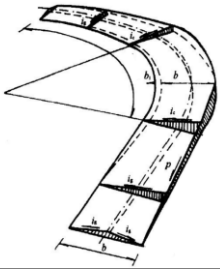


Vertical Alignment	The intersection of two adjacent longitudinal slope lines on the longitudinal section of the road is called the slope change point. In order to ensure driving safety, comfort, and visual distance, a vertical curve is set at the slope change point. The main function of the vertical curve is to alleviate the impact caused by the change in driving momentum at the longitudinal slope change point, ensuring the longitudinal driving visual distance of the road; appropriately combining the vertical curve with the flat curve is conducive to road drainage and improving the visual guidance and comfort of driving.

R: Vertical curve radius; L: Vertical curve length; T: Vertical curve tangent length; E: Vertical curve outer distance

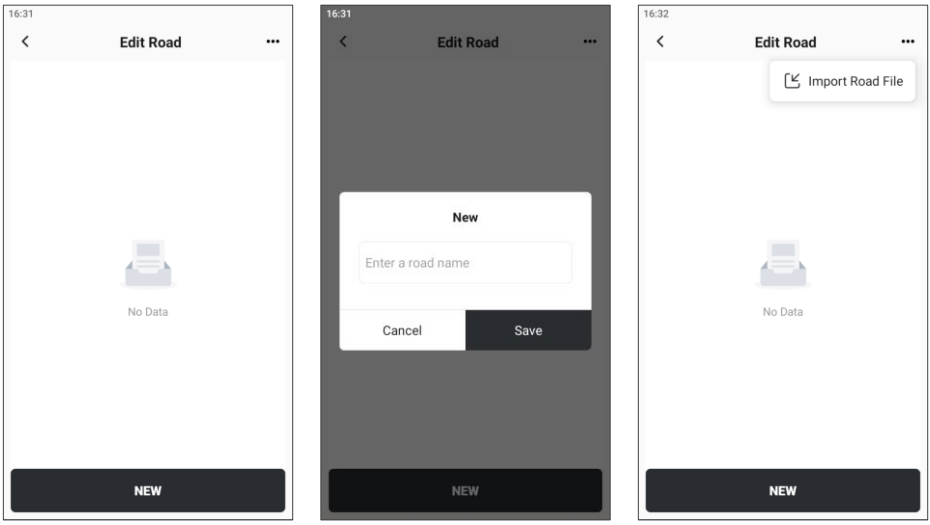


Cross section	Section perpendicular to the centerline of the road. The main components of the highway cross-section include: roadway (road surface), shoulder, ditch, slope, greenbelt, partition, retaining wall, etc.

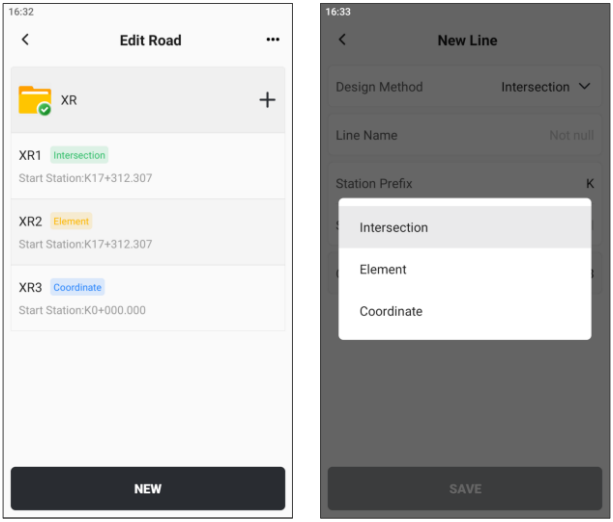
Widths	When a car is driving on a bend, the driving trajectories of each wheel are different. The radius of the driving trajectory of the rear wheel on the inside of the bend is the smallest, while the radius of the driving trajectory of the front wheel near the outside of the bend is the largest. In order to ensure that the car does not occupy adjacent lanes when turning, all curve sections with a radius of less than 250 meters need to be widened. Widening includes the following types: turning widening, emergency parking strip widening, and line separation widening.  Widening at the location of the turn  Emergency parking strip widening
Superelevations	When driving on a circular curve, sliding will occur due to lateral or centrifugal forces. In order to counteract the centrifugal force generated by the vehicle when driving on a circular curve section and ensure that the vehicle can pass through the circular curve safely, stably, meet the design speed, economically, and comfortably, a one-way horizontal slope with the outer side higher than the inner side is set on the cross section of the section. Simply put, when the line turns, one side is raised or the other side is lowered to overcome the centrifugal force. This is reflected in the software as changes in the plate slope. On curved sections of roads, to counteract the centrifugal force generated by vehicles, the road surface is designed as a one-way cross slope with the outer side higher than the inner side. This is called superelevation on curves. 

5.7.2 New roads

A project can only display one road file. Go to [**Edit Road**], click [**NEW**] to create a new road file, or click [**Import Road File**] in the upper right corner to open one directly.



A road usually consists of many lines. Click [+] icon to the right of the road file name to add a new line. The newly added line will be displayed in the list.



The information to be filled in for adding a new line is as follows:

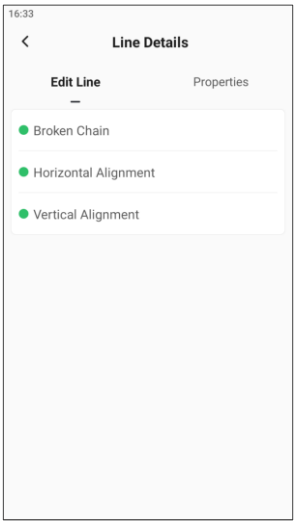
Name	Description
Design method	Optional **Intersection**, **Element** and **Coordinate** method
Line name	Enter the name of the line
Station prefix	Fill in up to two letters

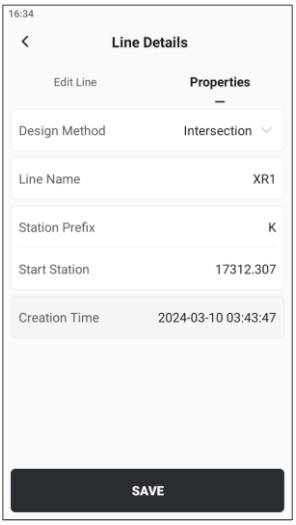
Start station	Input line start station
Creation time	The time when the line is added cannot be modified.

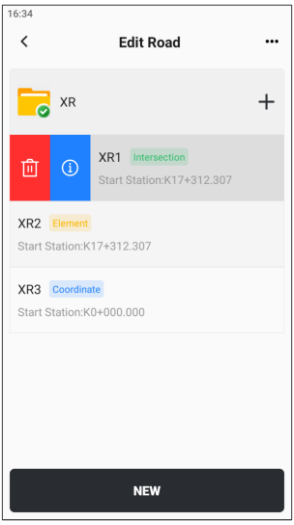
5.7.3 New line - intersection

Select [**Intersection**] for the design method. After entering the information, click [**SAVE**] to enter the page **Line Details**, where you can edit the line or modify the line properties. Click on a line on the main page, select the details button, and you can also open the line details.

Note: once the line is newly built, the design method cannot be changed.







Currently supports editing broken chain, horizontal alignment and vertical alignment.

1) Broken chain

Click [**Broken Chain**] on the page **Edit Line** to enter the broken chain editing page.

1. Broken chain list

Display the overlap and gap, indicating the length, before and after station.

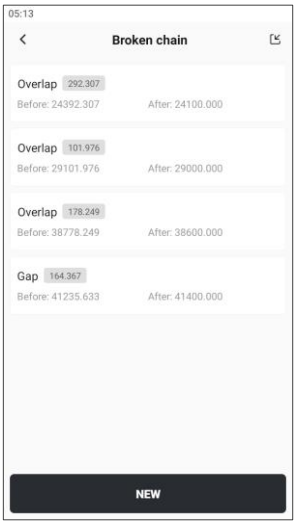
2. Create a new broken chain.

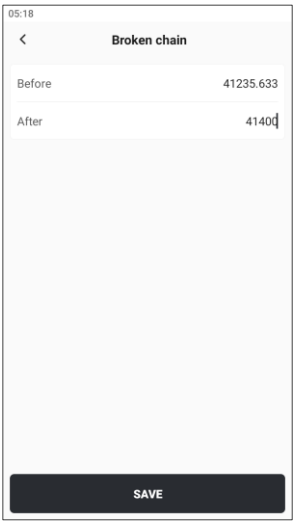
Click [**NEW**] to directly enter the before and after station values. The software will automatically determine whether it is a overlap or a gap based on the input values.

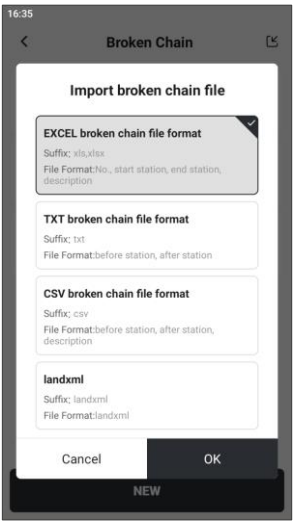
3. Import

You can export broken chain from some industry software, and then import it directly by clicking the import button in the upper right corner.

Note: If there is already broken data in the list, it will prompt that the original data will be cleared.







2) Horizontal alignment

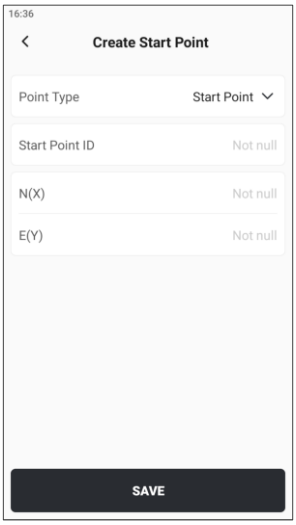
The horizontal alignment is the most important design line in road design, and the three design methods are also distinguished. The advantage of the intersection method is that the input conditions are simple, generally centered on the intersection point, and the intersection method is the most convenient for defining symmetrical lines.

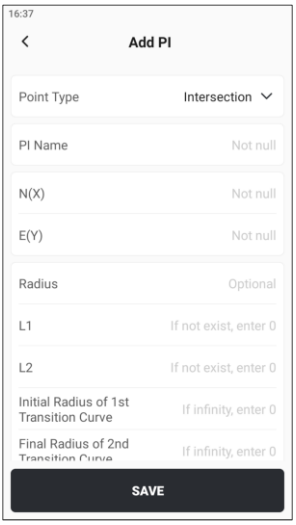
If the line is relatively complex, such as including C-shaped curves, oval curves, convex curves, composite curves, etc., it is recommended to use the element method for definition. In addition, the intersection method is generally used for highway mainlines, and the element method is generally used for interchange ramps.

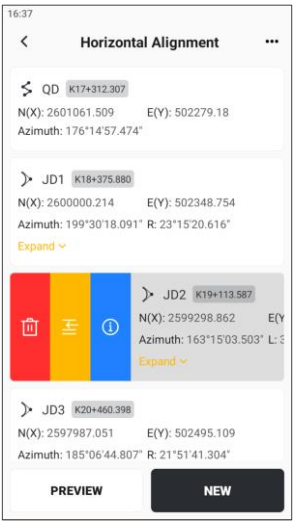
Click on [**Horizontal Alignment**] on the page **Edit Line** to enter the editing page.

1. Create

Click [**NEW**] to choose from three-point types: start point, intersection and end point. Different point types correspond to different input elements, and intersection points have the most input information. During the adding process, you can also click the card and select the Insert Row button to insert a new row before the current element.

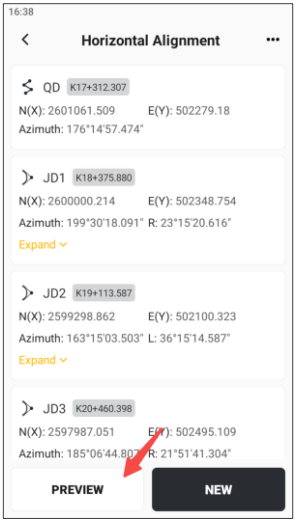


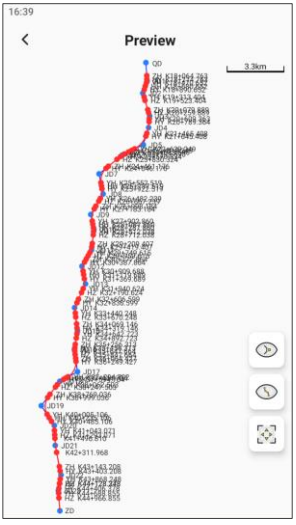


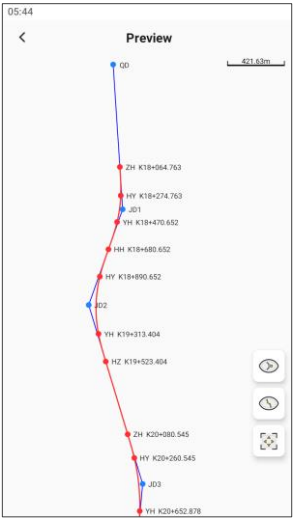


2. Preview

During the input process, you can preview the line and check its direction at any time. During the preview, both the intersection and the main point information can be displayed / hidden.





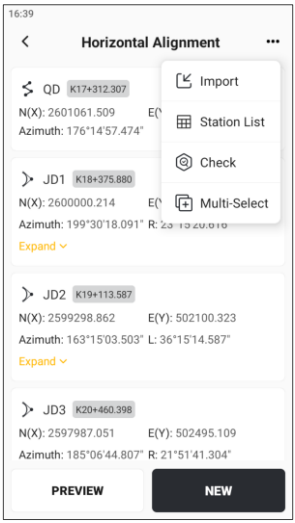


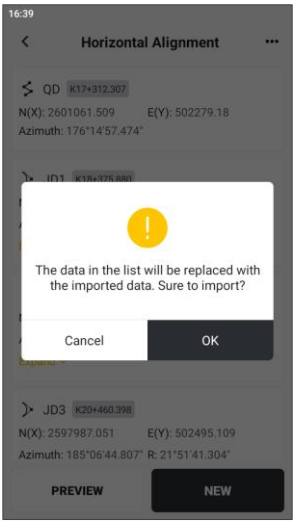
3. Import

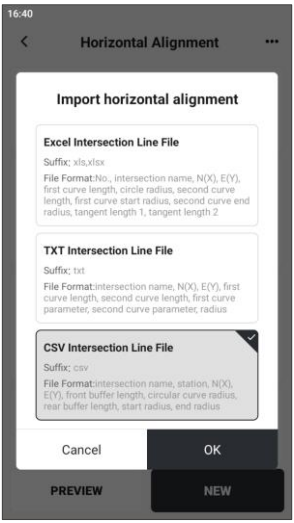
Click on the top right corner [**...**] → [**Import**], you can import the horizontal alignment directly. The app has already adapted some formats.

Note: If there is already horizontal alignment data in the list, it will prompt that the

original data will be cleared.





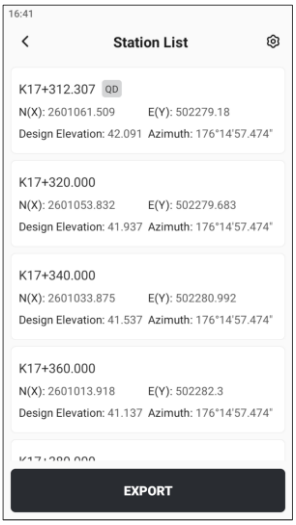


4. Station list

The station list is an indispensable part of the design and construction of roads, railways, or other linear projects. This list details the precise coordinate information of each station position, which is used to guide the construction team to accurately calibrate the station position and ensure that the project is carried out according to the design requirements.

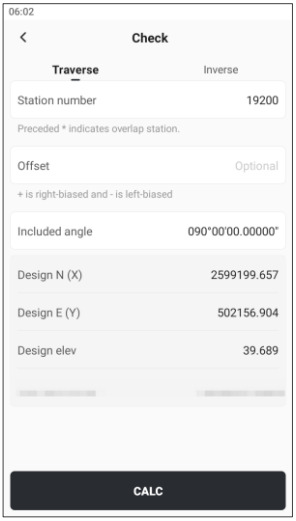
After entering the station list page, click the configuration button in the upper right corner to set the station interval. There are two incremental methods to choose from: whole station and start point increment, and the station interval is set to 20 meters by default.

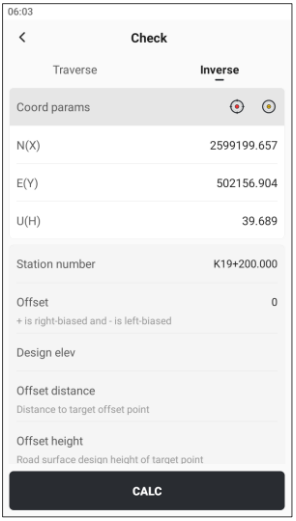
If the vertical alignment has been defined, the corresponding station design elevation will be displayed. If it has not been defined, the design elevation will be displayed as N/A.



5. Check

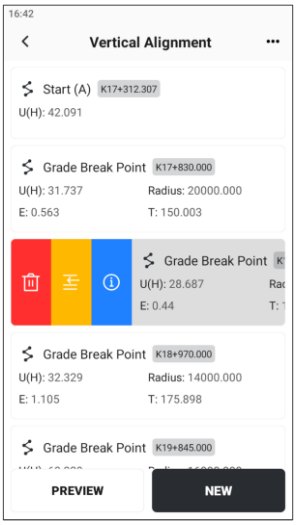
The design coordinates can be calculated by the station, offset, and angle, or the relative relationship between the position and the line can be calculated by backtracking the coordinates.

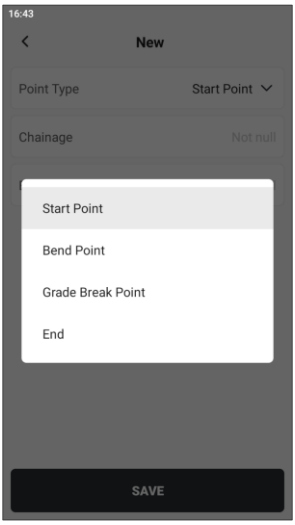


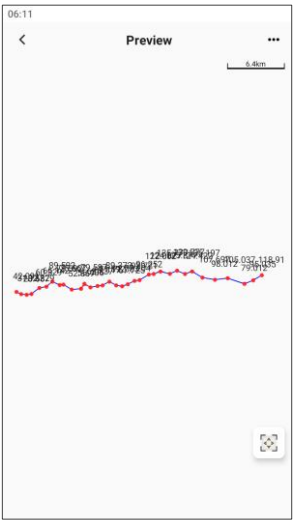


3) Vertical alignment

The definition of a vertical alignment is much simpler than that of a horizontal alignment. When adding a vertical alignment, the point type can be selected from the start point, bend point, grade break point and end point.



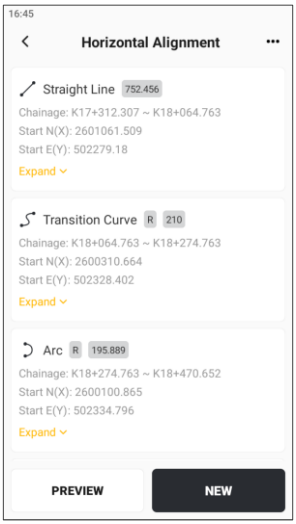


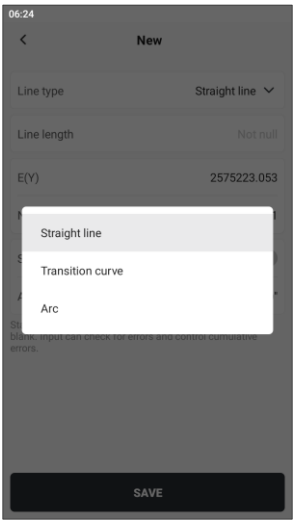


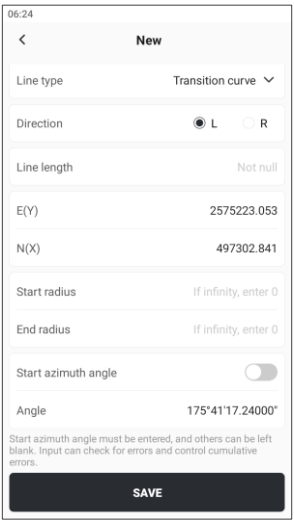
Vertical alignment can also be loaded from files exported by some industry software. The station list function is consistent with the horizontal alignment.

5.7.4 New line - element

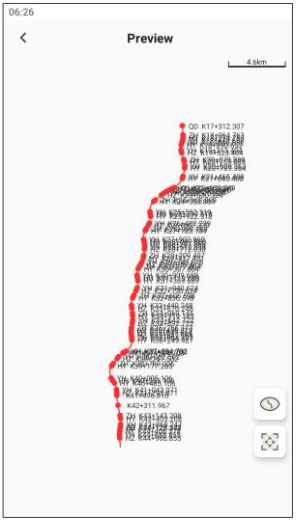
The element method is the most commonly used way to define complex circuits. When using the element method to define circuits, the definition of broken chain and vertical alignment is consistent with the intersection method, which will not be repeated here. The only difference is the definition of horizontal alignment. When clicking [**NEW**], the line types can be selected as straight line, transition curve and arc.

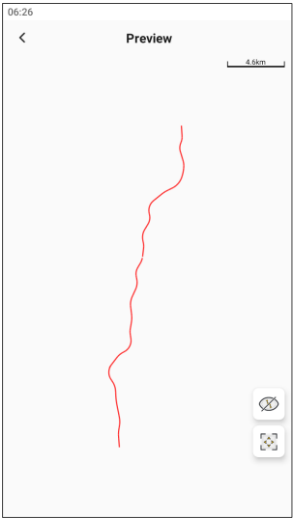






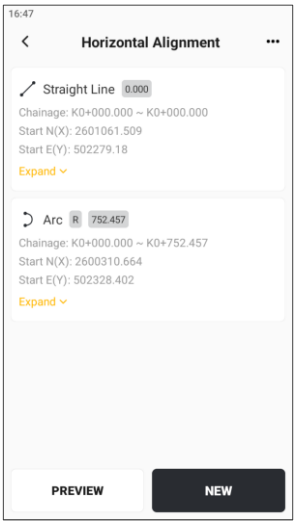
During the input process, you can click [**PREVIEW**] to view the graphics, and the main point station information can be displayed / hidden.

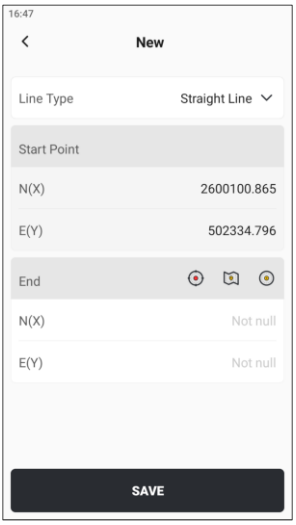


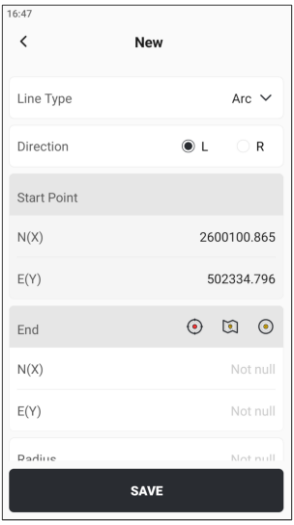


5.7.5 New line - coordinate

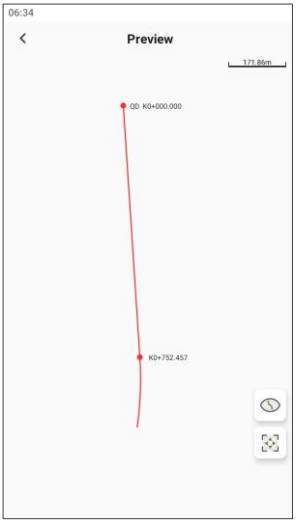
When only straight line and arc are defined, the coordinate method is the fastest way to create them. Among them, the arc is defined by two points + radius.

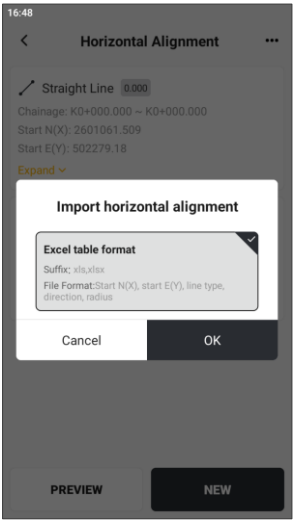






The main point station information during preview can be set to show/hide. Click [**...**] → [**Import**] in the upper right corner of the page to organize the table according to the prompt format and import it quickly.





5.8 Images

Click on [**Projects**] → [**Images**] on the main page, open all visual measure tasks, there are a total of 3 states:

1. Modeling success

Display the photos used for actual modeling, click to start point measurement

immediately, see **Chapter 8.13** for details.

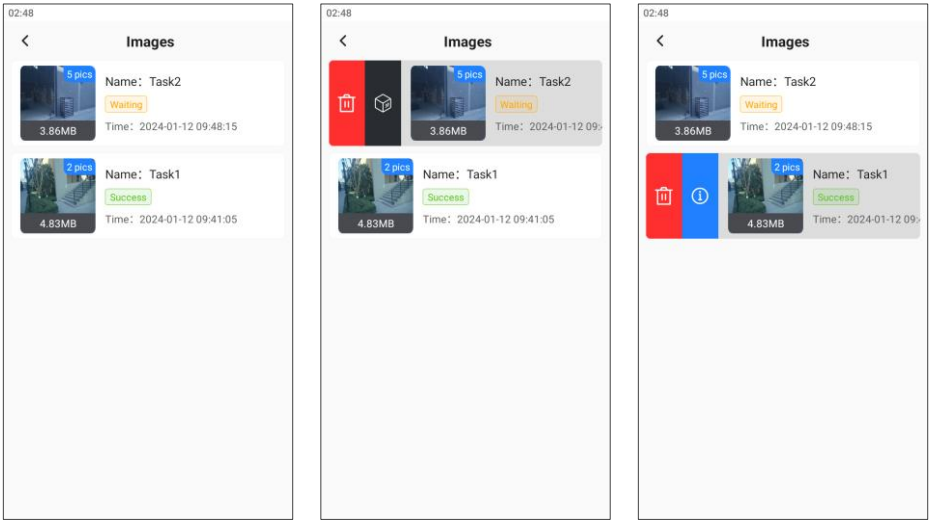
2. Modeling failure

You can browse the photos taken, but cannot start point measurement.

3. Not modeled

Click to execute modeling immediately.

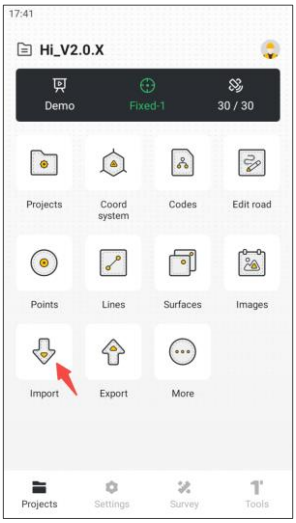
The number of photos is displayed in the upper right corner of the thumbnail for each task. If the modeling is successful, the actual number used is displayed, otherwise the number taken is displayed.

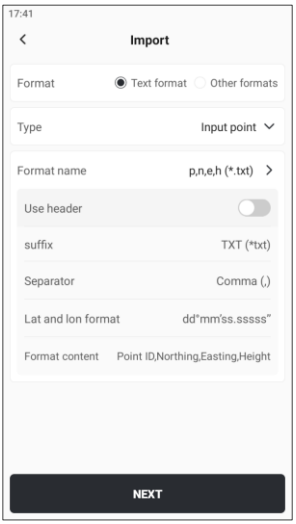


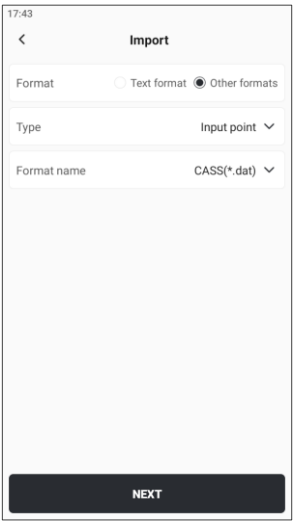
Select the task that has not been modeled to perform modeling. Select the task that has been modeled and start point measurement. Please refer to **Chapter 8.13** for details.

5.9 Import

The data in Points can be exchanged with external data through import and export modules. Click [**Projects**] → [**Import**] to open the page **Import**.

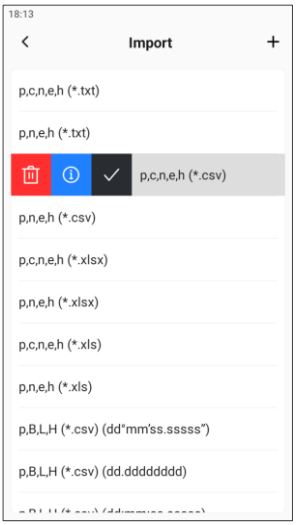


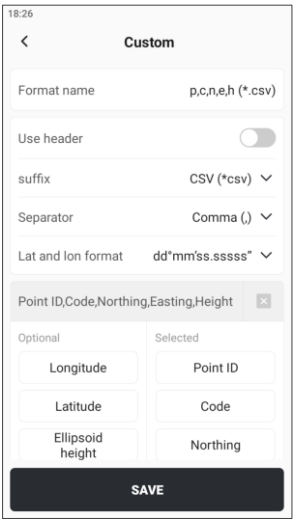




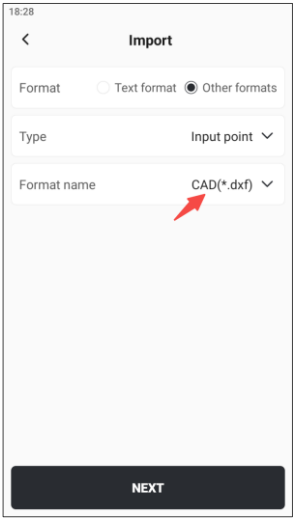
Name	Description
Format	1. Text format: Custom fields, editable format; 2. Other formats: industry standard formats, which cannot be edited.
Type	What type of point is assigned to the imported point. Optional input point, stake point and control point.
Format name	Click to open the Format Management dropdown page or select the corresponding standard format.
Format content	Display content details in text format.

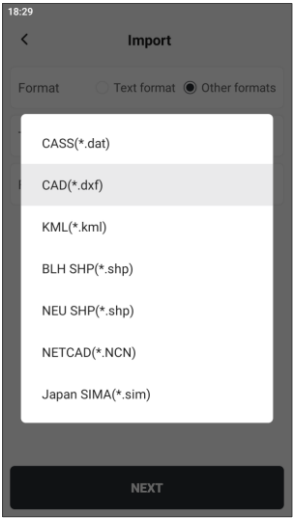
Select [**Text Format**], click [**Format Name**], and open the format management page. The App predefines some formats with suffixes including * .txt, * .csv, * .xlsx, * .xls, etc. Click a format to choose Delete, Details and Apply. Click the Details button to view and modify the detailed information of the format.





Select [**Other Format**], click [**Format Name**], and directly select the corresponding format from the list.





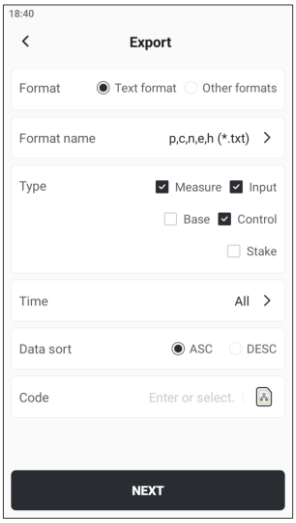
When selecting the file path, you can also click the cloud icon in the upper right corner, select the file from "My Cloud Drive" or enter the sharing code to get the file.

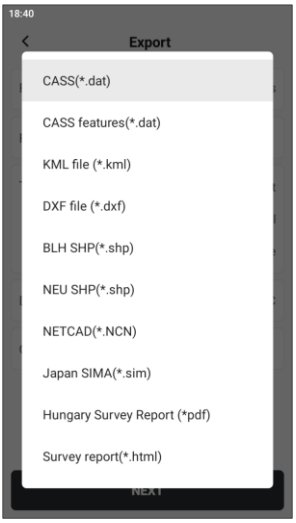
5.10 Export

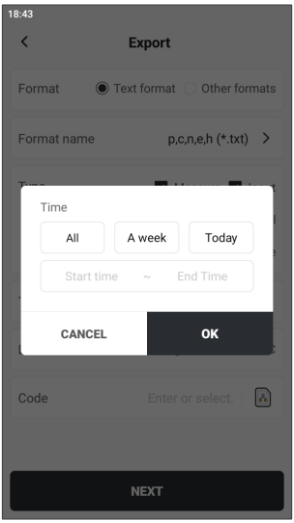
By using the export module, point coordinates can be exported to the desired format. The coordinate types support two types: BLH and NEU. Select [**Projects**] → [**Export**] to customize the export format and export path, or store it to the cloud or create a sharing

code.

Export format selection is the same as importing module. Filtering and sorting parameters are added when exporting.







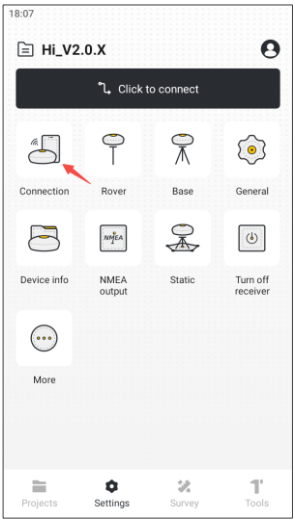
6 Settings

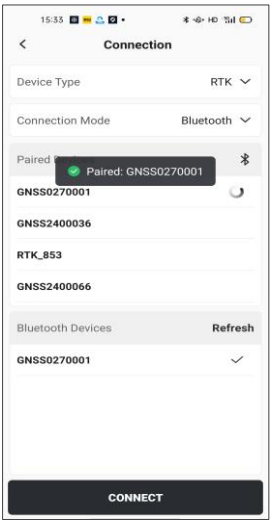
6.1 Connection

6.1.1 Bluetooth

1. Select [**Settings**] → [**Connection**], select the device type as **RTK**, select the connection mode as **Bluetooth**, select the receiver's Bluetooth number (i.e. the receiver's SN number) in the Bluetooth device list, and click [**CONNECT**].
2. If the corresponding Bluetooth number is not displayed, please check the device status or click the refresh button.
3. After the connection is successful, the instrument can be set to the next working mode.

Note: The SN number of the receiver can be viewed at the bottom of the device. If the Bluetooth connection is not available, you can restart the receiver and search again to pair and connect again.





6.1.2 Internal Android Device

The app can obtain the location information of internal Android device, and can measure and stakeout with meter-level accuracy. Select the device type as **Internal Android Device**, and simply click to connect.

6.1.3 Simulation

The simulation mode provides rich configuration parameters that can simulate realistic RTK device positions, including motion direction, speed, solution status, diff age and start point coordinate.

6.2 Rover

When the receiver is a rover station, a fixed solution is obtained by setting the differential mode.

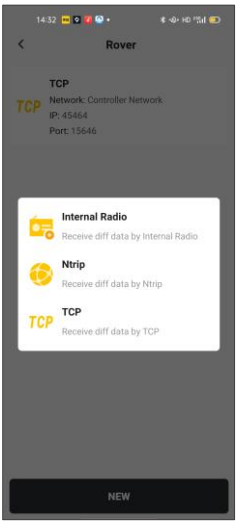
6.2.1 Internal Radio

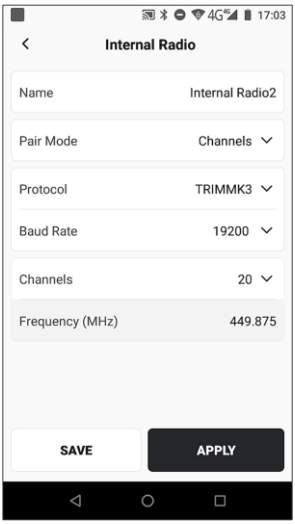
The receiver has two internal radios, 400M and 900M, which have different frequency ranges and configurations.

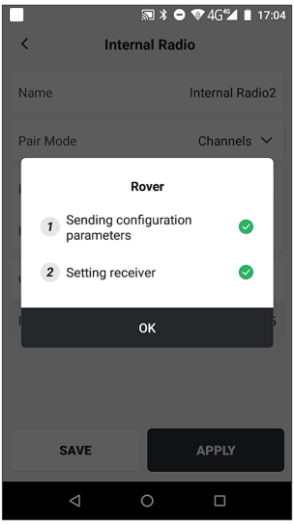
Name	Description
400M radio	410 MHz ~ 470 MHz
900M radio	840.5 MHz ~ 845MHz, 902 MHz ~ 928MHz

Click [**NEW**] button at the bottom, select [**Internal Radio**], and the configuration information of the 400M radio is as follows:

Name	Description
Name	Enter a configuration name
Pair Mode	Channel
Protocol	Default TRIMMK3, optional TRIMTALK, TT450S, TRANSEOT, SATEL
Baud Rate	Different protocols can choose different baud rates
Channels	There are 25 defined frequency channels by default, and you can also customize the frequency. Note that the frequency range is 410 MHz ~ 470 MHz
Frequency (MHz)	Display the frequency value of the corresponding channel.

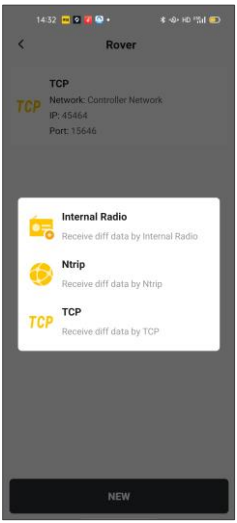


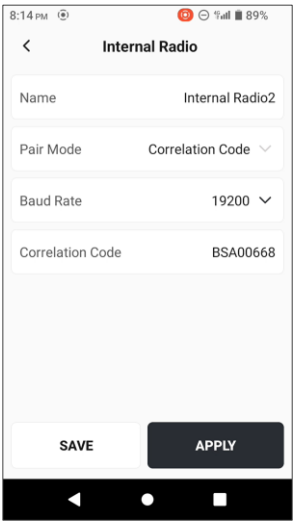


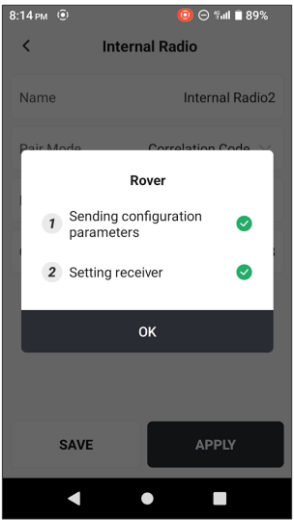


900M radio configuration information is as follows:

Name	Description
Name	Enter a configuration name
Pair Mode	900M radio can only select correlation code
Baud rate	Default 19200, optional 4800, 9600 and 19200
Correlation Code	The format is BSA + 5 bit serial number, consistent with the base station setting







After completing the configuration, return to the main page. When using radio communication, you can use the [**RSSI**] in the [**Tools**] to assist in checking the radio signal strength of the receiver.

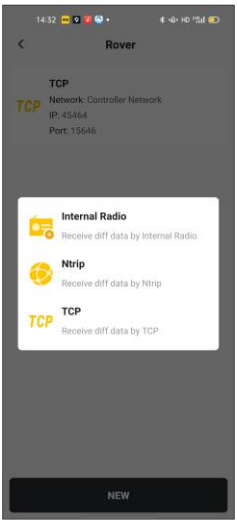
Note: When the communication method is radio, an external whip antenna is required, and the antennas of 400M and 900M are different.

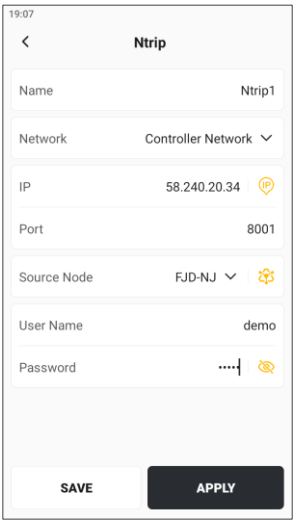
6.2.2 Ntrip

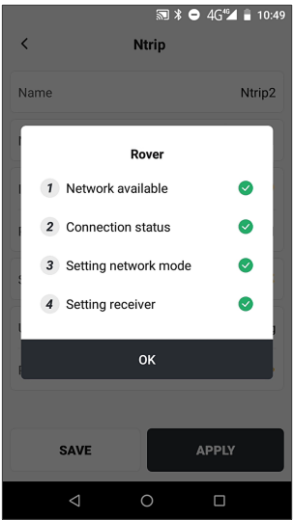
Click [**New**] button at the bottom, select [**Ntrip**], and the configuration information is as follows:

Name	Description
Name	Enter a configuration name
Network	Default controller network, if the receiver supports internet access, optional receiver network
IP	Enter the IP address or dynamic domain name of the Ntrip server
Port	Enter the corresponding differential source port
Source Node	When the correct IP and port are entered, click the icon on the right to automatically get the source node, and then select the correct one from the pop-up list
Username	Username verification
Password	Password verification

Click the bottom button [APPLY] and wait for the differential signal to be received.





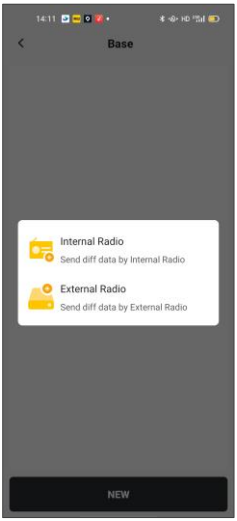


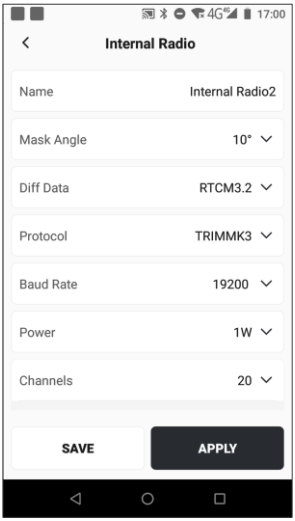
6.3 Base

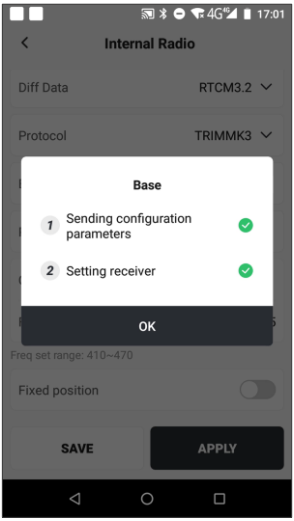
GNSS receivers can be used as both rover and base stations, and the receiver mode can be configured through the [**Base**].

6.3.1 Internal Radio

Click [**Base**] → [**NEW**], select [**Internal Radio**], enter relevant parameters, click [**APPLY**], and wait for the base station to be set successfully.







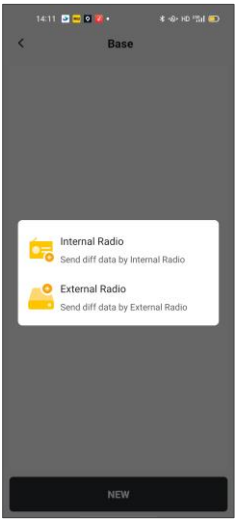
When setting up a base station, if it is a known point station, open the [**Fixed position**] switch and enter the antenna height and base station coordinate in turn; if it is not a known point station, keep the [**Fixed position**] switch closed, and the coordinate automatically obtained will be used as the base station coordinate when setting up the station.

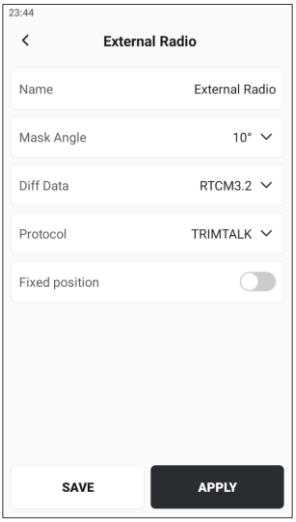
Both internal and external radios require external whip antennas, and the antenna parameters of 400M and 900M are different.

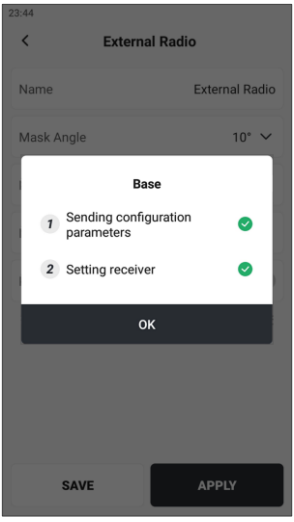
6.3.2 External Radio

When the operation range is large, the baseline distance is more than 5 km, and there are many obstacles blocking, the external radio should be considered.

Click [**Base**] → [**NEW**], select [**External Radio**], enter relevant parameters, click [**APPLY**], and wait for the base station to be set successfully.







Note:

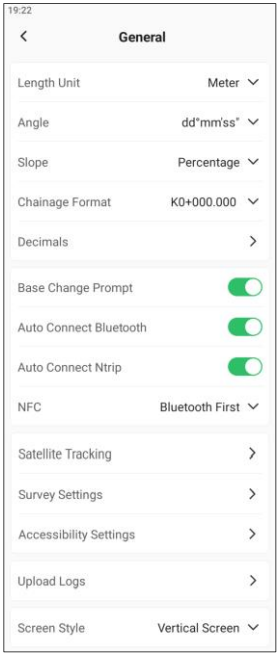
1. Considering the relatively large power of the external radio, the surveyor should not stay next to the external radio antenna for a long time.
2. In order to ensure the transmission distance, the antenna of the external radio station should be raised as high as possible.
3. Generally, external radio stations are powered by power banks, batteries or mains power.

6.4 General

6.4.1 General settings

Name	Description	Page

Length Unit	Optional: meters, feet, US feet. 1 feet = 0.3048 meters 1 US feet = 0.3048006 meters
Angle	5 common angle formats to choose from
Slope	4 commonly used slope formats are available
Chainage Format	Custom chainage prefix and format
Decimals	Set the displayed decimal places
Base Change Prompt	There is a pop-up prompt after the base station changes.
Auto Connect Bluetooth	The app automatically connects to the receiver after opening
Auto Connect Ntrip	App automatically surfs the internet to receive differential data
NFC	Optional: Bluetooth first, Wi-Fi first
Satellite Tracking	All satellite systems are turned on by default, and you can click to turn them off.
Survey Settings	See **Chapter 7.2.5**
Accessibility Settings	See **Chapter 7.3.5**
Upload Logs	Click to upload receiver logs and app logs
Screen Style	Default vertical screen, optional horizontal screen

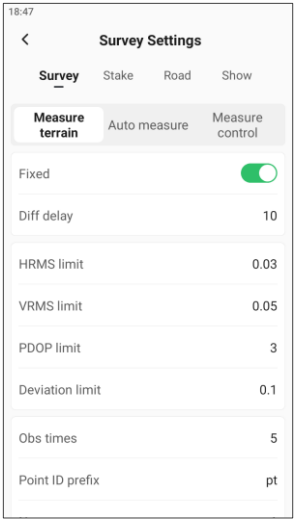


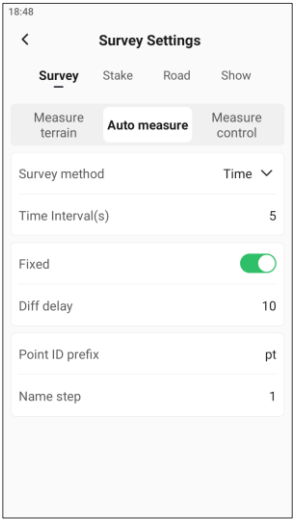
6.4.2 Survey Settings

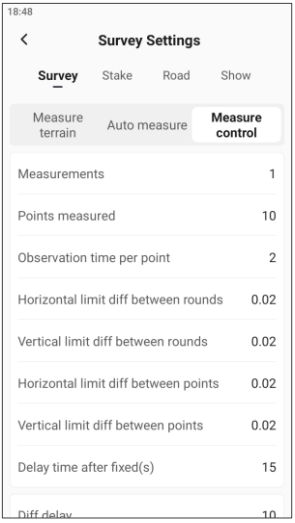
Survey Settings includes Survey, Stake, Road and Show settings, which can be accessed by clicking the toolbar setting button in the corresponding measurement module.

6.4.2.1 Survey

The Survey settings are divided into **Measure Terrain**, **Auto Measure** and **Measure Control**, each corresponding to different measurement functions.







Measure Terrain setting instructions are as follows:

Name	Description
Fixed	After the switch is turned off, the measurement result will no longer be used as a verification basis for whether it is a fixed solution.
Diff Age	Default 10s, fixed solution will be lost if exceeded 10s
HRMS Limit	Horizontal Root Mean Square
VRMS Limit	Vertical Root Mean Square, elevation accuracy
PDOP Limit	Position Dilution of Precision, the strength of satellite position accuracy, the better the satellite distribution, the smaller the PDOP value, generally less than 3 is a more ideal state
Deviation Limit	The mutual difference limit of any two values at the observation point
Time Interval(s)	Time to acquire coordinates for each measurement cycle
Point ID Prefix	Default measurement point prefix

Name step	The difference between two adjacent point numbers
Use Quick Code	After starting, add an code icon to the measurement toolbar, and click to open the quick code panel.
PPK Measure	After startup, a PPK icon will be added to the measurement toolbar. For more details, please refer to the section.**97**
E-Bubble	After starting the IMU, E-Bubble can be optionally displayed on the measurement page.

Auto Measure setting instructions are as follows:

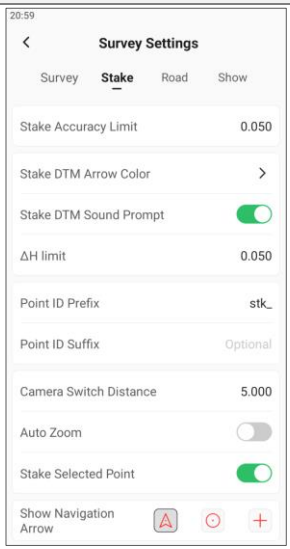
Name	**Description**
Measure Method	Optional Time interval, 2D distance, 3D distance, ▵H. Choose different measure methods and display different parameter settings accordingly.
Time Interval (s)	It varies with the choice of measure method.
Fixed	After the switch is turned off, the measurement result will no longer be used as a verification basis for whether it is a fixed solution.
Diff Age	Default 10s, fixed solution will be lost if exceeded 10s.
Point ID Prefix	Default point ID prefix
Name Step	The difference between two adjacent point IDs

Measure Control setting instructions are as follows:

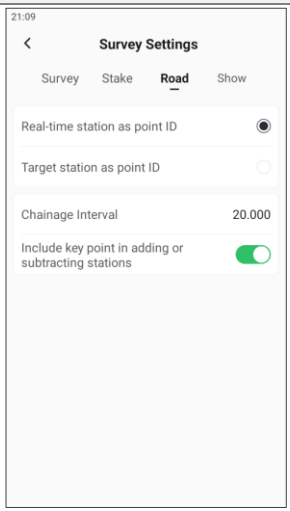
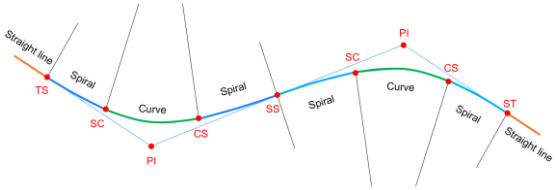
Name	**Description**
Measurements	Set measurement cycle
Points measured	Set the number of measurements per cycle point
Observation time per point	When the value is greater than 1, the measurement result is averaged over multiple epochs
2D dist limit between rounds	The current mean of all points measured back and the plane difference limit of other measurements
H dist limit between rounds	The elevation difference between the mean of all points currently measured and other measurements is limited
2D dist limit between points	The difference between the last measured point and the mean plane of all points in the current measurement is limited
H dist limit between points	The difference between the elevation of the last measured point and the mean of all points in the current measurement is limited
Waiting time after	After obtaining the fixed solution for the first time, wait for

fixed(s)	several seconds before starting the measurement
Diff Age	Default 10s, fixed solution will be lost if exceeded 10s
PDOP Limit	The strength of satellite position accuracy, the better the satellite distribution, the smaller the PDOP value
Point ID prefix	Default measurement point prefix
Name step	The difference between two adjacent point numbers

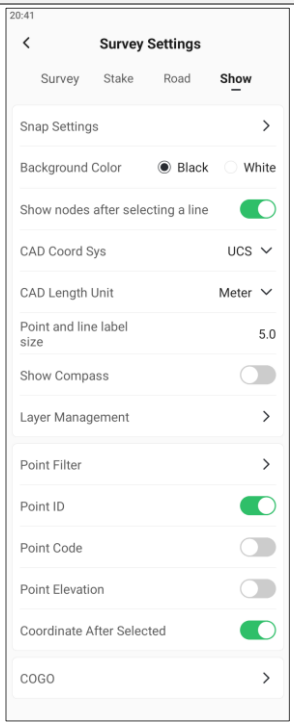
6.4.2.2 Stake

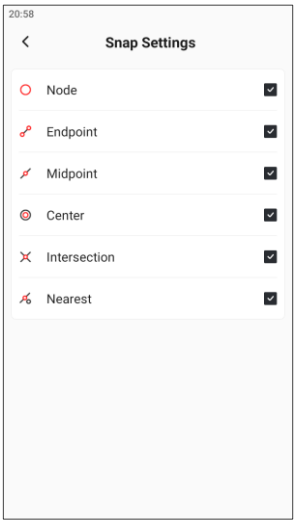
Name	Description	Page
Stake Accuracy Limit	The plane distance limit between the measurement point and the stakeout point	
Stake DTM Arrow Color	Set the arrow color for cut / fill in the Stake DTM	
Stake DTM Sound Prompt	After opening, you can set the limit difference. There is a prompt sound for the inner surface stakeout	
ΔH limit	Set elevation threshold	
Point ID prefix	Default point name prefix for measure points during stakeout	
Point ID suffix	Default suffix for measure points during stakeout	
Camera Switch Distance	Distance threshold for automatic switching between front and bottom camera views during AR Stakeout	
Auto Zoom	The view automatically scales to display the current and target positions	
Stake Selected Point	Support clicking the stake point on the map to start directly.	
Show Navigation Arrow	Stake arrow symbol setting	

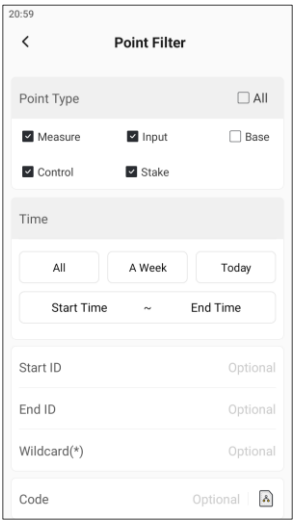
6.4.2.3 Road settings

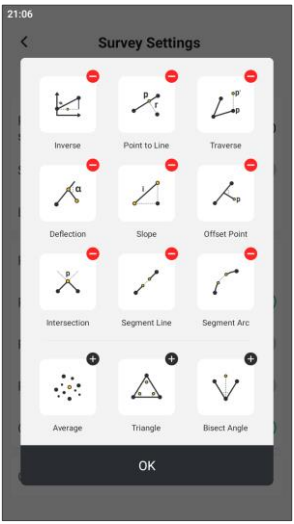
Name	Description	Page
Point ID style	Optional: Real-time station, target station	
Chainage Interval	The distance between adding and subtracting piles when setting road stakeout	
Include key point in adding or subtracting stations	Set whether to include the main point station number defined by the line	

6.4.2.4 Show settings

Name	Description	Page
Snap Settings	Set whether to capture node, endpoint, midpoint, center, intersection and nearest points in Stake CAD / Edit CAD	
Background Color	Set CAD view background color	
Show nodes after selecting a line	Can be set to turn on/off, turned on by default	
CAD Coord Sys	Default UCS, optional WCS	
CAD Length Unit	Default meter, optional millimeter, centimeter, feet, US feet	
Point and line label size	Set the display size of labels drawn in CAD	
Show Compass	Off by default	
Layer Management	Open layer for CAD files	
Point Filter	Set the display/hide of points on the map	
Point ID	Set whether to display point IDs on the map	
Point Code	Set whether to display point codes on the map	
Point Elevation	Set whether point elevation is displayed on the map	
Coordinate After Selected	Click on a point on the map to display coordinates	
COGO	Set the display and sorting of functions in the COGO shortcut window of the map toolbar	

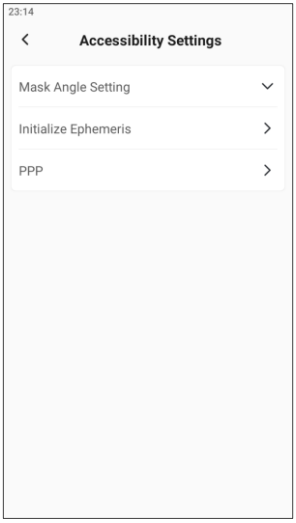


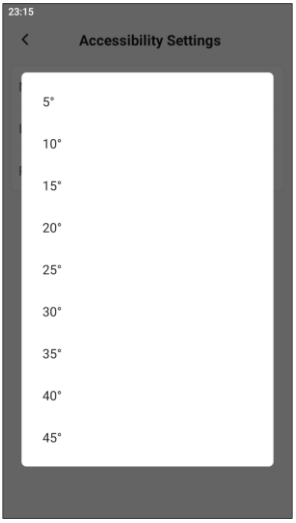


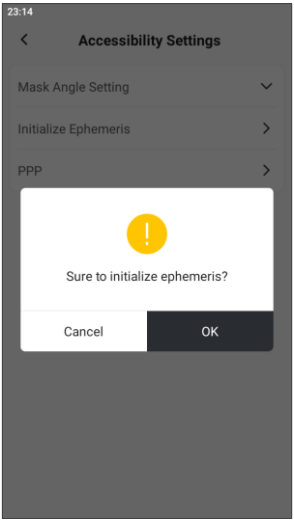


6.4.3 Accessibility settings

Mask angle setting, initialize Ephemeris, PPP, receiver restart and receiver network can be set by auxiliary features.







6.4.3.1 Mask angle setting

Set the height cutoff angle for rover station observation, optional: 5 °~ 45 °.

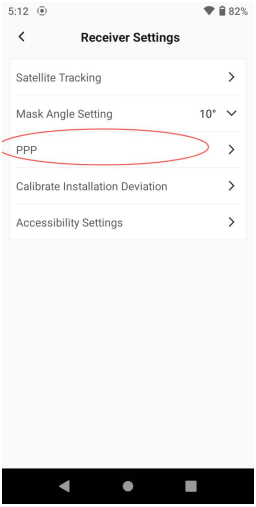
6.4.3.2 Initialize ephemeris

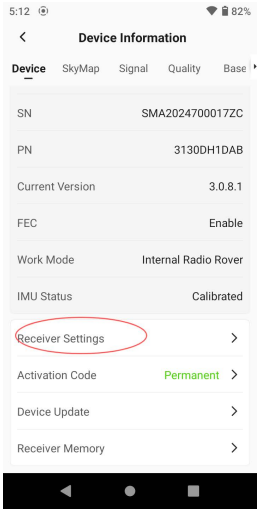
After connecting the receiver, click "Initialize Ephemeris", and the receiver will

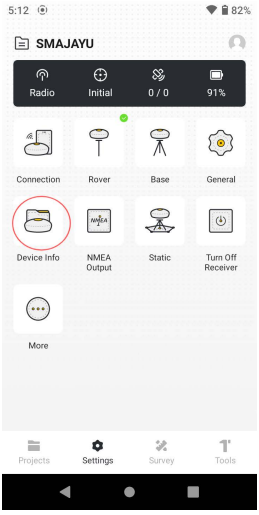
automatically clear the ephemeris and search for stars again.

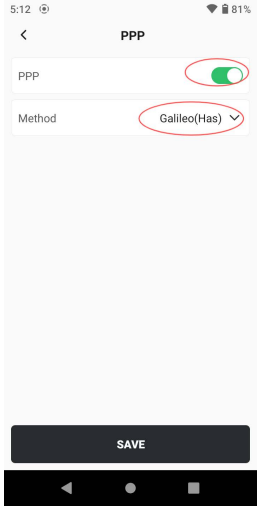
6.4.3.3 PPP

Click to open the PPP function, and the convergence time is about 15 minutes. Note, not all receivers support PPP functionality. Need to connect to the receiver setup









6.4.3.4 Receiver restart

After connecting the receiver, click "Receiver Restart" and the receiver will automatically restart.

6.5 Device information

6.5.1 Device

After connecting the receiver, click [Settings] → [Device Info] to view the detailed information of the current receiver.

Name	Description
Type	Display receiver model
SN	SN number of the display device
PN	PN number of the display device
Current Version	Display the firmware version number of the receiver
IMEI	Display the IMEI number of the receiver
FEC	Radio forward error correction code status
Work Mode	Display receiver configuration mode
IMU Status	Calibrated by default
Device volume	Modify the volume of the receiver
Device activation code	Display the activation status. When it is not permanent, click to enter a new activation code.
Firmware Upgrade	Click to check the current version, and choose local upgrade or OTA check and upgrade.
Module upgrade	Radio, GNSS and IMU modules can be upgraded separately, and only local upgrades are supported
Receiver memory	Display the total memory size and remaining memory size of the receiver, optional formatting
Calibration Installation Deviation	Click to recalibrate the IMU. Generally, it has been calibrated at the factory.
Factory Reset	Click to Restore Receiver Factory Configuration.

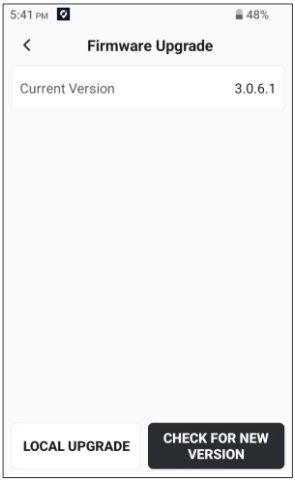
6.5.1.1 Firmware upgrade

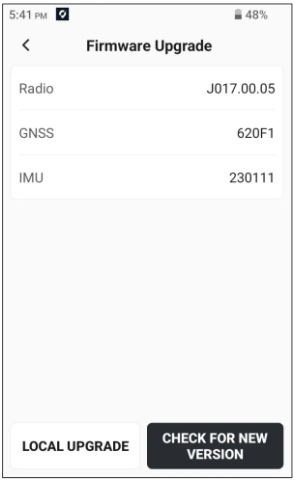
When a new firmware is released for the receiver, every time the receiver is connected to the Internet, a pop-up window will prompt that there is a new firmware. Click [Upgrade] to start downloading directly. If you do not upgrade temporarily, there will also be a red new version icon prompt on the page.

Note: it is recommended to always upgrade the receiver to the latest firmware.

6.5.1.2 Module upgrade

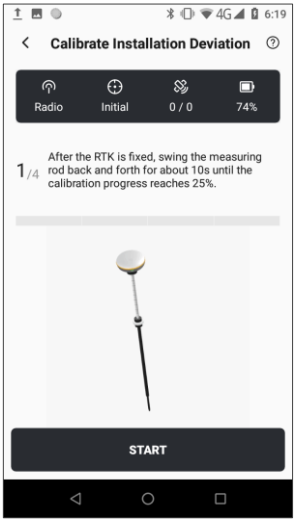
The receiver firmware can be upgraded as a whole package, or by module (radio, GNSS, IMU), and can be automatically upgraded in the cloud or locally loaded.





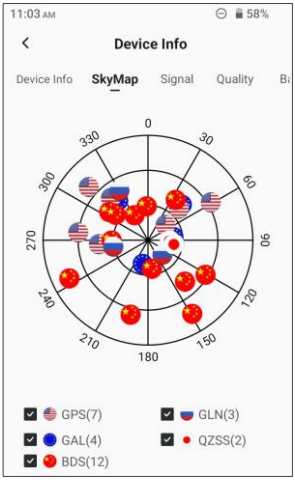
6.5.1.3 Calibration Installation Deviation

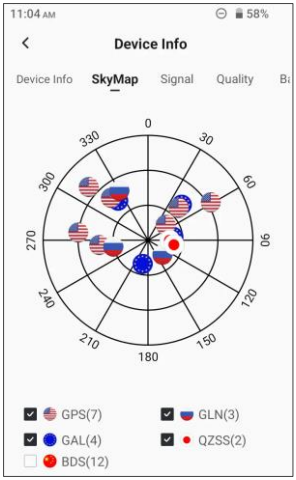
Receivers with IMUs are strictly calibrated for deviations when they leave the factory to ensure the availability of the IMU. Users can also manually perform repeated calibration. Calibration is very simple, check the height of the center rod according to the prompts, and then shake in four directions according to the animation.



6.5.2 SkyMap

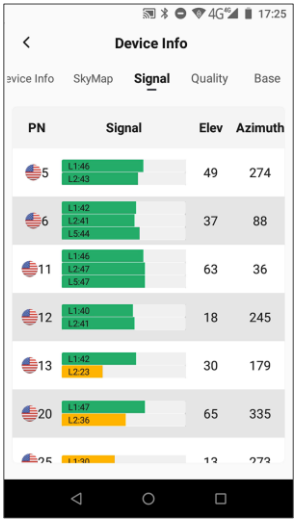
Click [SkyMap] to display the current distribution of satellites, check the satellite system at the bottom, and set the display and hide.





6.5.3 Signal

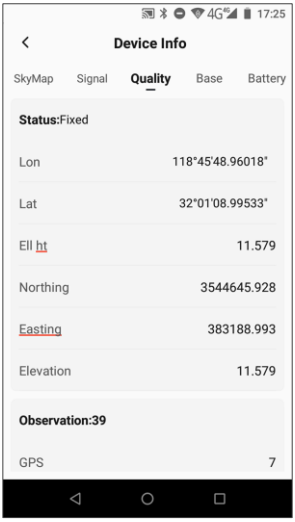
Displays the signal to noise ratio information for different frequency bands of the tracking satellite.



6.5.4 Quality

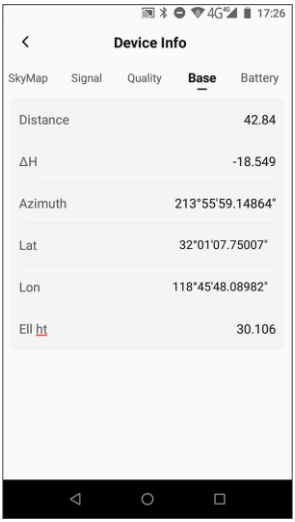
Display the current positioning status, including solution status, coordinates, number of

observation satellites, and positioning accuracy.



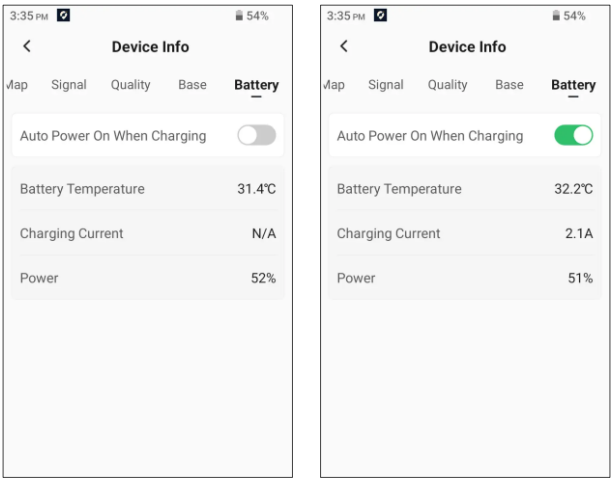
6.5.5 Base

Displays baseline distance, elevation, azimuth latitude and longitude coordinates.



6.5.6 Battery

Check the battery temperature, charging current and current power. You can also control whether the receiver needs to be turned on when connected to the power supply in the off state through the switch.

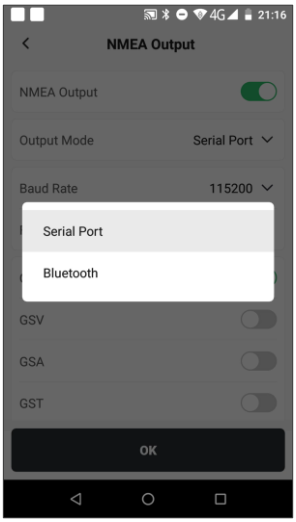


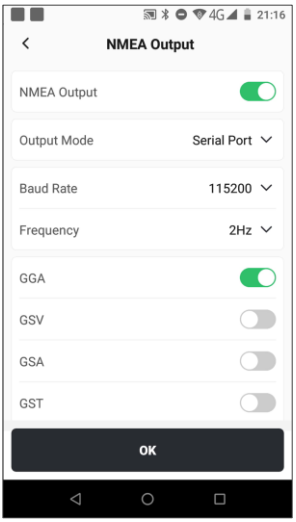
6.6 NMEA output

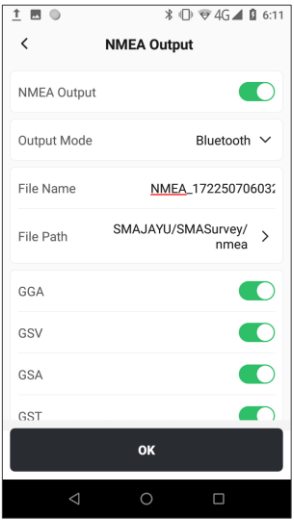
SMA Survey can output NMEA observation data, with optional output methods including Serial port, Bluetooth. The output content includes GGA/ GSV/ GSA/ GST/ RMC/ VTG/ ZDA.

Output Mode	Description
Serial port	The cable connects the receiver and the computer, and the NMEA data is output to the computer's serial port tool.
Bluetooth	The handbook connects to the receiver via Bluetooth and saves NMEA data on the handbook at a frequency of 2 Hz.

Output content	Description
GGA	Output latitude and longitude, solution status, number of satellites and other information
GSV	Output satellite quantity, satellite ID, signal ID and other information
GSA	Output receiver working mode, satellite and DOP information involved in positioning calculation
GST	Output pseudorange error information
RMC	Output information such as time, date, location, speed, etc
VTG	Output ground heading, speed and other information
ZDA	Output UTC time and date information



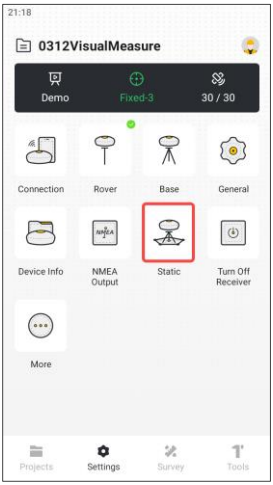


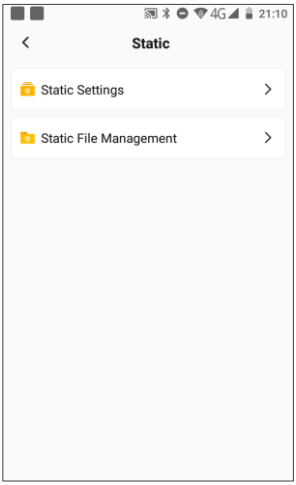


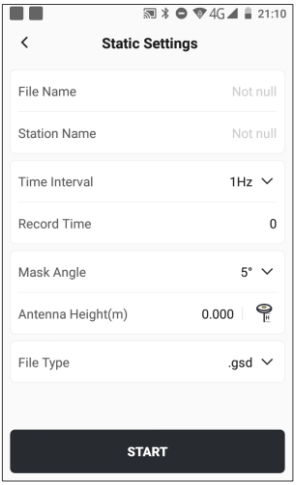
6.7 Static

6.7.1 Static settings

Connect the receiver with storage function, select [Settings] → [Static], choose [Static Settings] and [Static File Management]. Select [Static Settings] to open the setting page.







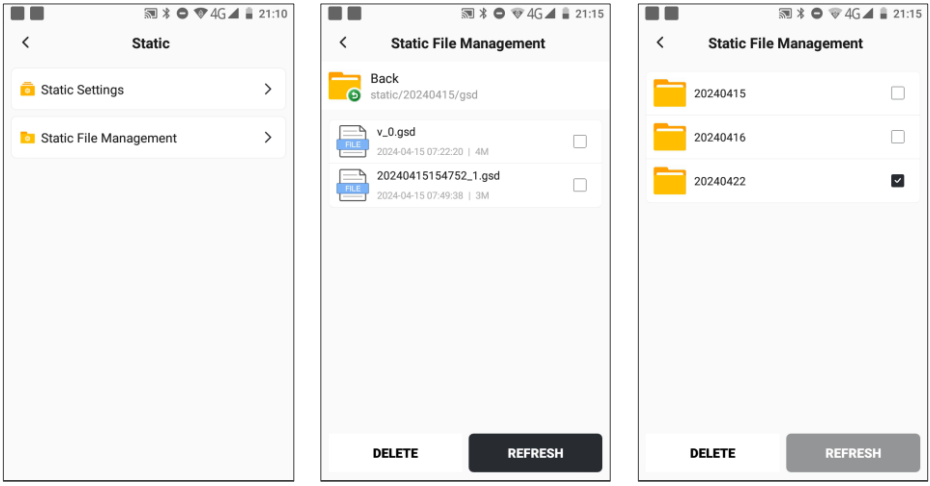
Name	Description
File Name	Enter the name of the saved static file
Station Name	Enter the name of the observation point

Time Interval	Sampling rate, optional 1Hz, 2s, 5s, 10s, 15s, 30s
Record Time	Unit minutes, input range is [10,1440].
Mask Angle	Default 5 °, optional 10 °, 15 °, 20 °, 25 °, 30 °
Antenna Height	Input antenna height, and there are four optional antenna measurement methods
File Type	List optional file formats, including: * .gsd, * .rtcm

Note: During the collection process, you can choose to hide the collection page, which does not conflict with other functions. When you enter the static collection page again, the collection time will be automatically restored.

6.7.2 Static File Management

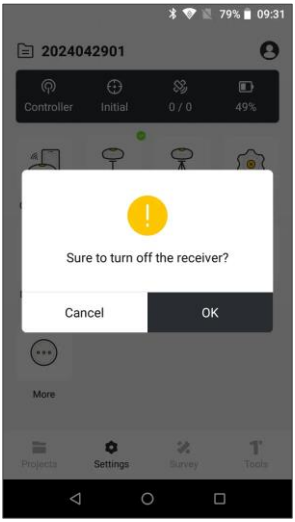
Select [Static File Management] to access static data in the receiver's memory. Optional [Delete] to release the receiver's memory.



6.8 Turn Off Receiver

When the app is connected to the receiver, you can quickly turn off the receiver.

1. After connecting the receiver, click [Turn Off Receiver].
2. The pop-up prompt asks "Sure to turn off the receiver?" Click [OK] and wait for the receiver to shut down.



7 Survey

7.1 Measure & Draw

RTK field work is gradually transitioning from simple point measurement work to measurement with graphics and attributes. Field work can draw line segments and graphics based on the collected points, add attribute information and save some time when processing data in the field.

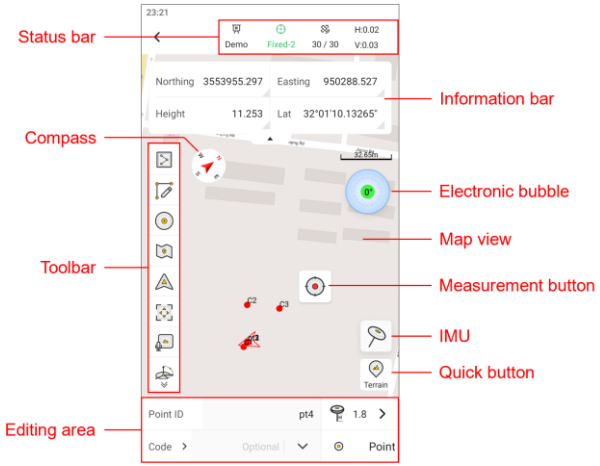
Common extended functional modules include surveying and mapping (also known as surveying & mapping) and GIS acquisition.

Name	Description
Measure & Draw	Draw line segments, closed graphics, etc. by measuring points. Common post-processing drawing tools include AutoCAD, CASS, EPS, etc.
GIS Survey	Based on point, line, and surface elements, pre-defined attribute fields are used to input information in real-time during the collection process, and finally exported in shape format. Common post-processing GIS drawing tools include ArcGIS, SuperMap, QGIS, etc.

Note:SMA Survey does not currently support GIS collection function.

7.1.1 Draw

Click on [Survey] → [Measure & Draw] to enter the main function page. The page preview and introduction are as follows.



Name	Description
Status bar	Display solution status, number of satellites, and RMS values
Information bar	1. Display real-time point information, including latitude, longitude, ellipsoidal height, north coordinates, east coordinates, elevation, HRMS, and VRMS. 2. Click the information bar box to switch the display. 3. When HRMS or VRMS exceeds the limit, the information box is highlighted in red.
Compass	Read the Compass information of the current handbook.
Toolbar	Display commonly used tools for operating this function.
E-Bubble	1. It can be used after starting IMU tilt measurement. It is turned off by default and can be enabled in Survey settings. 2. When the tilt angle is ≥30 °, the color of the bubble turns black.
Measurement button	After reaching the target location, click the button to record the point coordinates.
IMU icon	1.  IMU is not enabled. 2.  IMU is turned on but not available, need to shake for calibration. 3.  IMU is enabled and available.
Quick button	Quickly switch between measurement modes: Terrain, Quick and Control.
Editing area	1. Point ID: Click to enter, the default measurement point name is the corresponding stakeout point name with the prefix "stk_", or you can add a suffix in the settings; 2. Antenna height: Click to enter the antenna type selection and input page. 3. Code: Can be manually entered. When there is a user-entered code in the code library, you can directly click the drop-down button to select it. Click the code label on the left, or you can directly jump to the "Codes" for selection. 4. Code type: optional points and lines, quick classification of existing codes. When selecting a drawing operation, the coding type automatically switches to line.

The toolbar provides a wealth of tools that bring many conveniences to actual measurement work.

Icon	Name	Description

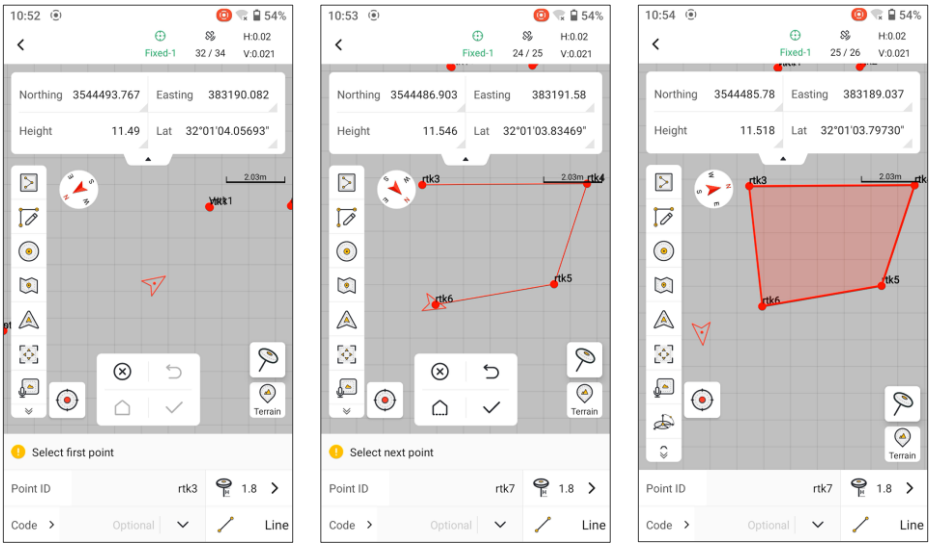
	Graphics library	Open the graphics library to display a list of drawn graphics.
	Drawing	Click to select the drawn line type, a total of 9 common line types are provided.
	Points	Click to open the point library.
	Map	Click optional street and satellite map, the default is to turn off map mode
	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a few seconds and it will automatically return to the centered mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click the rear view to zoom in and show all points.
	Media	Click to activate, and after completing the measurement, prompt to capture the Media information of the point.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Settings	Survey settings entrance, see **Chapter 7.5.2** for details.

Click the Drawing button on the left toolbar and select one of the 9 line types to enter the state of Measure & Draw at the same time. The parameters and optional operations of each shape are different. Please follow the prompts on the page to complete the drawing.

9 types of line types are introduced as follows:

Icon	Name	Description
	Multipoint polyline	Draw polylines with multiple points, optional reverse and closed
	Three-point arc	Draw an arc with three points, optional reverse and closed
	Fitting curve	Draw a fitting curve with multiple points, optional reverse and closed
	Two-point square	Draw a square with two diagonal points
	Center point square	Draw a square by the center point and a midpoint on one side
	Three-point rectangle	Draw a rectangle by two vertices of an edge and any point on the opposite edge
	One-point circle	Draw a circle by center + radius
	Two-point circle	Draw a circle by its center and a point on it
	Three-point circle	Draw a circle with three points

Taking drawing a multi-point line as an example, click on the multi-point line icon and measure the points in order according to the page prompts.

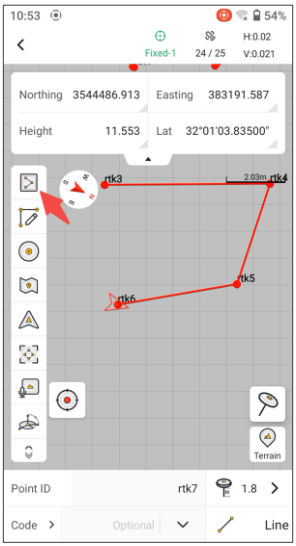


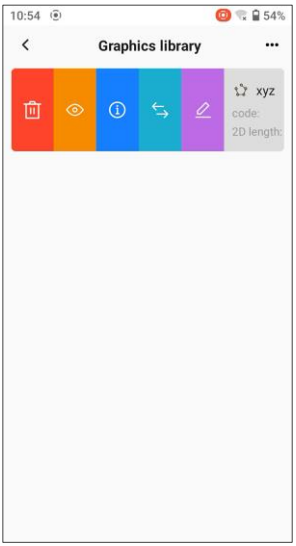
During the measurement process, the current position is connected to the previous node by a dotted line. Optional operations include: exit, return, close, and complete. When the node of the polyline is ≥ 2, the complete button is available; when the node is ≥ 3, the close button is available. After clicking the close button, enter the line name to complete the drawing directly.

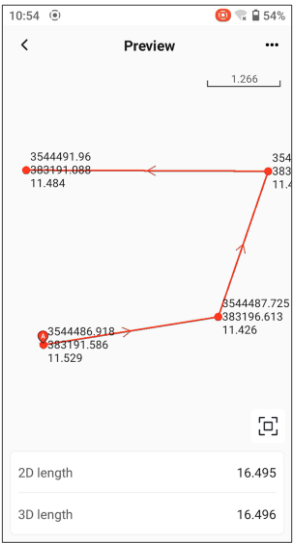
The system provides default dot, line, and surface styles that can be modified by defining codes.

7.1.2 View

After completing the drawing of the figure, click the Graph Library icon on the toolbar to open the drawing list. Click to view optional operations. Multi-point polyline, three-point arc, and fitted curve can be selected to reverse or continue drawing.



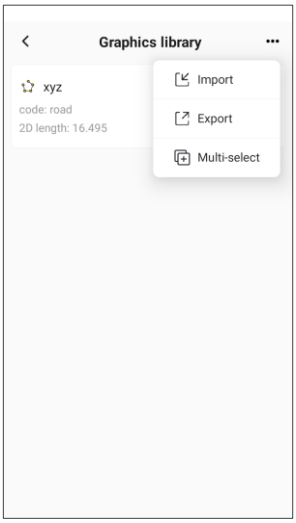


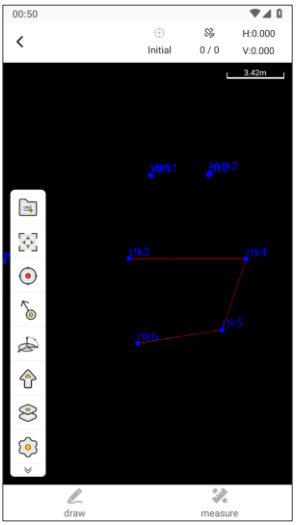


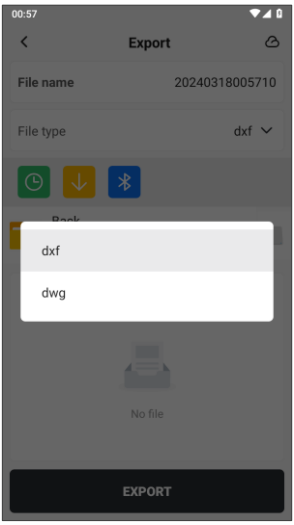
7.1.3 Export

It can be exported through the graphics library or in Edit CAD, see **Chapter 8.10** for details.

Location	Operation	Description
Graphics library	Import	Import custom * .dne files
	Export	Export custom * .dne or * .shp files
Edit CAD	Export	Export * .dwg/* .dxf files

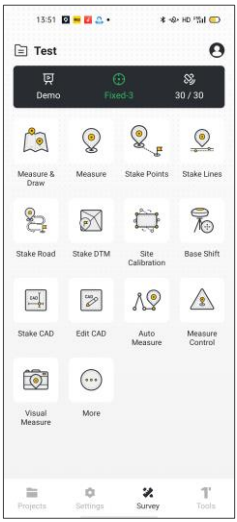


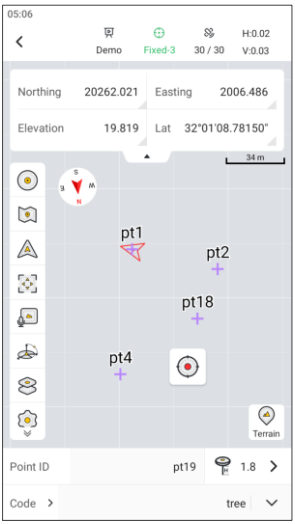




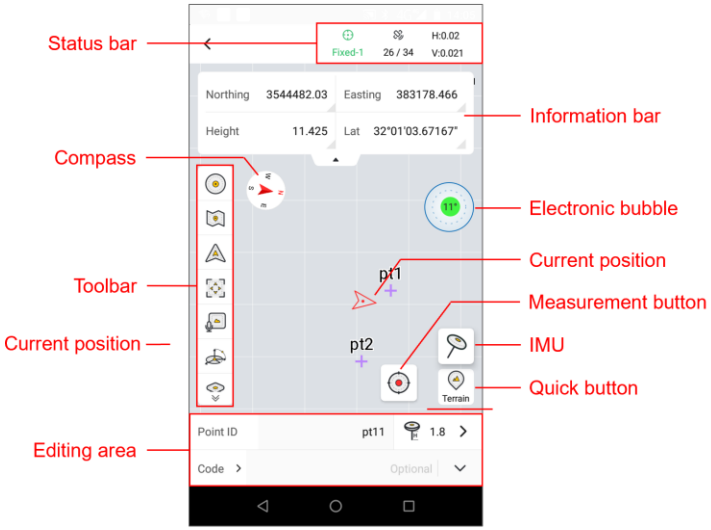
7.2 Measure

Measure is to obtain coordinates from a known position. Click [Survey] → [Measure] to open the main interface of point measurement.→





7.2.1 Measure interface



Name	Description
Status bar	Display solution status, number of satellites, and RMS values
Information bar	1. Display real-time point information, including latitude, longitude, ellipsoidal height, north coordinates, east coordinates, elevation, HRMS, and VRMS. 2. Click the information bar box to switch the display. 3. When HRMS or VRMS exceeds the limit, the information box is highlighted in red.
Compass	Real-time display of direction information obtained from the handbook.
Toolbar	Display the commonly used tools for operating this function, see **Chapter 8.2.2** for details.
E-Bubble	1. It can be used after starting IMU tilt measurement. It is turned off by default and can be enabled in measurement settings. 2. When the tilt angle is ≥30 °, the color of the bubble turns black.
Current position	The triangular arrow indicates the current position, which can be modified in the settings.
Measurement button	After reaching the target location, click the measurement button to record the coordinates of the measurement point.

IMU icon	1.  IMU is not enabled. 2.  IMU is turned on but not available, need to shake for calibration. 3.  IMU is enabled and available.
Quick button	Quick switch button for measurement mode: 1. **Terrain**: Default measurement mode 2. **Quick**: Set the observation time to 1s. 3. **Control**: Switch to the control point for measurement
Editing area	1. **Point ID**: Click to enter, the default measurement point name prefix can be customized. 2. **Antenna height**: Click to enter the antenna type selection and input page. 3. **Code**: Can be manually entered. When there is a user-entered code in the Codes, you can directly click the drop-down button to select it. Click the code label on the left, or you can directly jump to the [Codes] for selection.

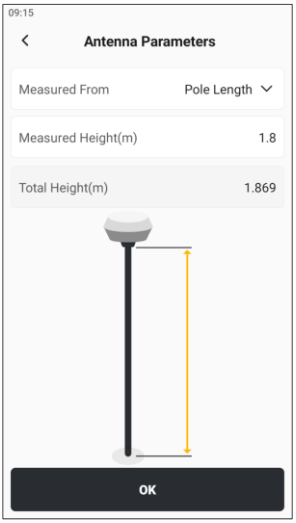
7.2.2 Measure toolbar

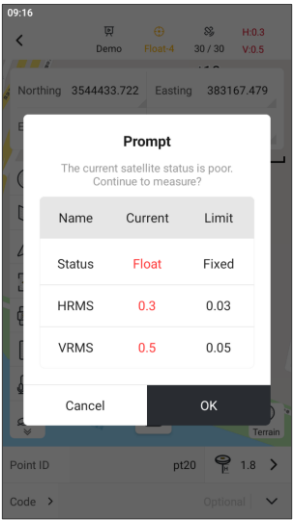
Icon	Name	Description
	Points	Click to open the point library, view the coordinates of the measured points, and optionally edit or delete the measured points by clicking on the measured points.
	Map	Click on the optional street and satellite map, the default is to turn off the map mode.
	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a few seconds and it will automatically return to the centered mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click the rear view to zoom in and show all points.
	PPK	PPK acquisition switch, see **Chapter 9.7.2** for details.
	Fast code	Quick encoding switch, see **Chapter 8.2.6** for details.

	Media	Add a Media information switch to obtain and save Media information after measurement is completed.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Layer	Click to open the Layer Management (External Data Management) page, where you can load vector layers on the map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

7.2.3 Centralized measure

1. Enter the point name, antenna height and code information in the editing area of the measurement page.
2. Use the bottom tip of the centering rod to press against the point, so that the centering rod bubble is centered.
3. Click the measurement button in the fixed solution state, save the measurement points to the Points, and view the measured point in the "Points" interface.
4. If the measurement exceeds the limit, a pop-up window will prompt whether to continue. Click the Settings button on the toolbar to set the specific limit in the measurement settings., See **Chapter 7.5.2.1** for details.



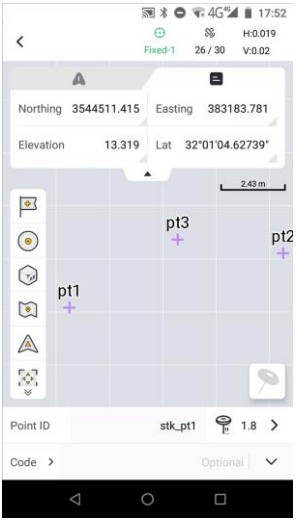


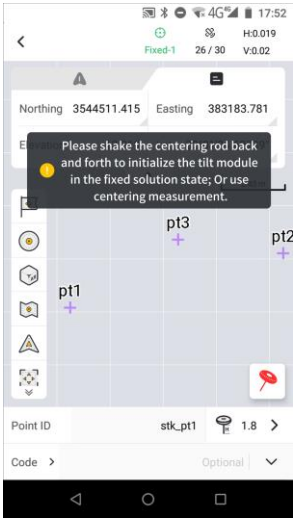
7.2.4 Tilt measure

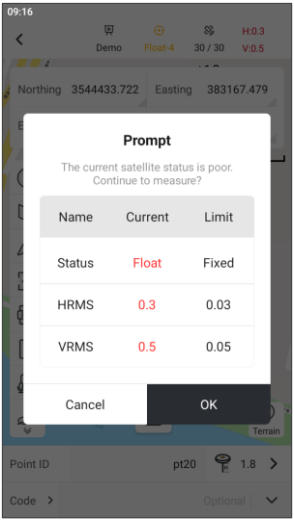
When the receiver supports tilt measurement, you can enable tilt measurement in SMA Survey by clicking the IMU icon on the right side of the measurement page. It should be

noted that:

1. For the first use, shake and calibrate according to the page prompts.
2. If you stay in place for a long time or the receiver rotates in place, the IMU accuracy will decrease. Please follow the page prompts to shake and recalibrate.
3. The best effect is to tilt within 30 °, and the maximum tilt angle is recommended not to exceed 60 °.
4. For high-precision measurements, it is recommended to turn off tilt measurement.







7.2.5 PPK measure

SMA Survey supports PPK collection and calculation, see **Chapter 8.6** for details.

7.2.6 Quick code

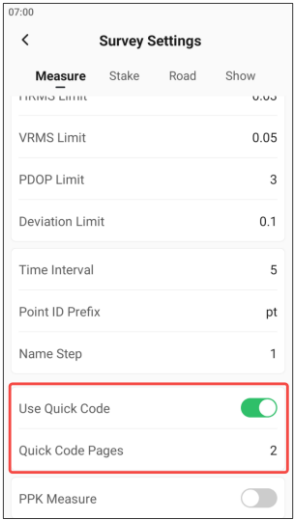
Some projects require adding codes to the points to mark different attributes. If there are too many codes and the targets are mixed, frequent switching of codes is required during measurement, which is very inconvenient. Based on this requirement, SMA Survey has supported **Quick Code** function.

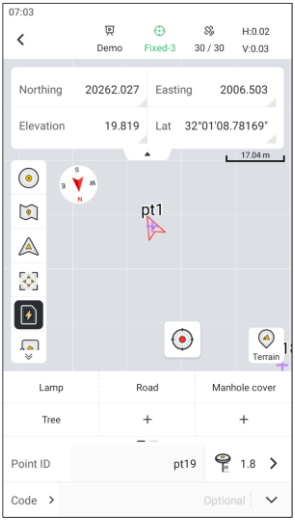
Click the Settings icon on the toolbar, turn on the Quick Code switch in Measurement Settings, and set the number of panels, the default is 2.

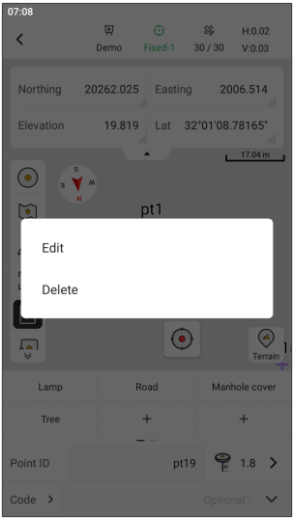
Note: Please add the code in Codes first before setting.

After setting up, there will be a Quick Code icon on the toolbar. Click on the icon to open the Quick Code panel. During the measurement process, you can click on the icon to show/hide the panel at any time.

The code panel is easy to operate. Click [+] to add a code, click the code to start measuring, and long press the code to modify or delete it.

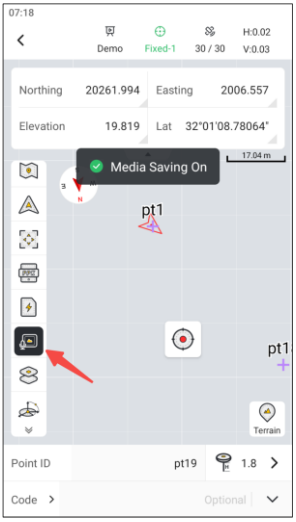


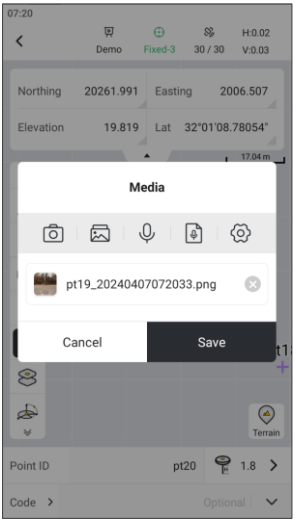




7.2.7 Media storage

Media information can be added to points in the point details, or added in real time during the measurement process.

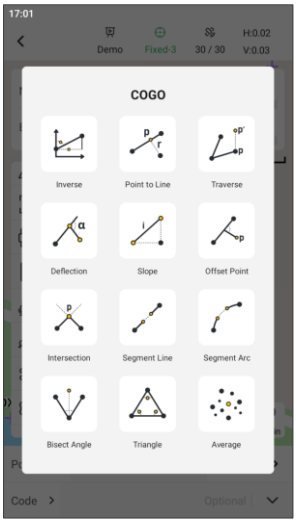




7.2.8 COGO quick tool

Click COGO on the toolbar to quickly call up the COGO tool. The tool supports sorting

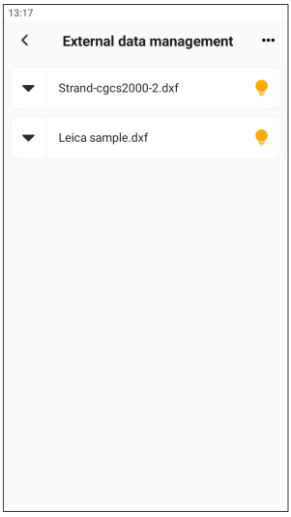
and show/hide, see **Chapter 7.5.2.4** for details.

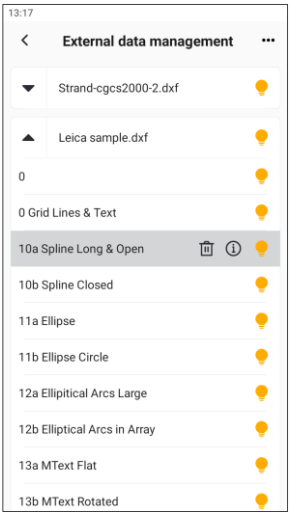


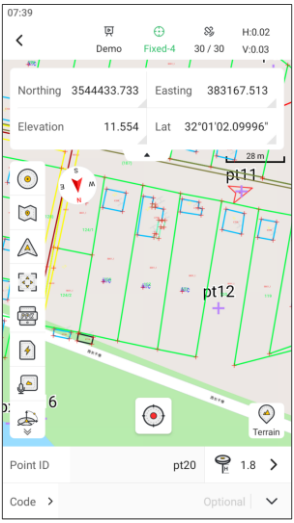
7.2.9 Layer

Support adding vector geospatial files to the map, currently supporting two formats: * .dxf and * .xml. Selecting a layer allows you to choose to show/hide, delete or edit.

Note: To ensure the smoothness of map operation, it is recommended to add a file size of no more than 10 MB.

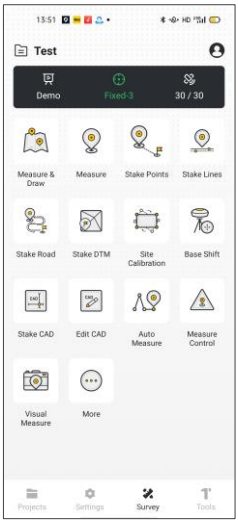


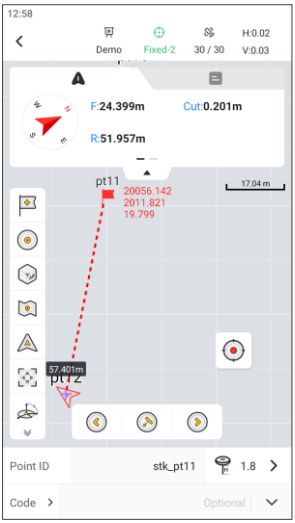




7.3 Stake Points

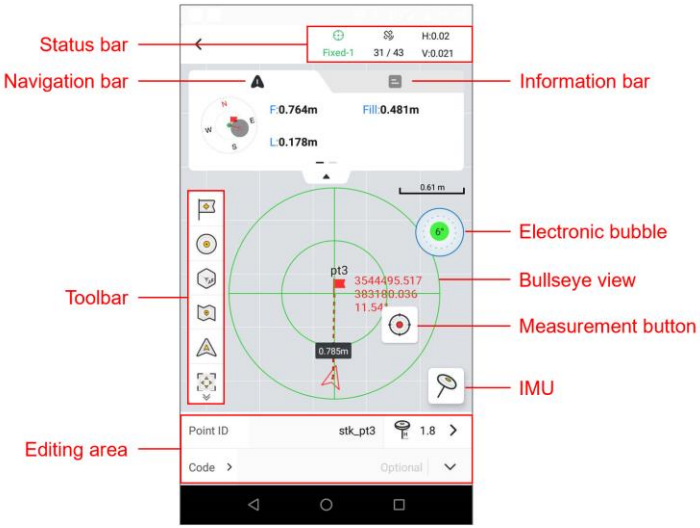
Stake Points is the process of finding the actual geographical location through coordinates. Click [Survey] → [Stake Points] on the main page, select the point to be staked, and enter the point stakeout interface.





7.3.1 Stake Points interface

Compared with the measurement interface, the interface mainly has a navigation panel and a bullseye view.



Name	Description
Status bar	Display solution status, number of satellites and RMS values
Navigation bar	1. After selecting the staked point, the real-time display shows the relative relationship between the current position and the target point, including the relative relationship (front, back, left, right) and the absolute relationship (east, south, west, north), and switches the display by sliding horizontally. 2. When the distance is less than 1 meter, the compass state will change to assist in stakeout.
Information bar	1. Display real-time point information, including latitude, longitude, ellipsoidal height, northing, easting, elevation, HRMS and VRMS. 2. Click the information bar box to switch the display. 3. When HRMS or VRMS exceeds the limit, the information box is highlighted in red.
Toolbar	Display the commonly used tools for operating this function, see **Chapter 8.3.2** for details.
E-Bubble	1. It can be used after starting IMU. It is turned off by default and can be enabled in measurement settings. 2. When the tilt angle is ≥30 °, the color of the bubble turns black.
Bullseye view	1. When the stakeout distance is ≤1 meter, a bullseye view appears, with a total of two circles, the radius of the large circle is 1 meter, and the radius of the inner circle is 0.5 meters. 2. When the stakeout distance is ≤0.5 meters, the bullseye view is enlarged, with a total of two circles, the radius of the large circle is 0.5 meters, and the radius of the inner circle is 0.05 meters.
Measurement button	After reaching the target location, click the measurement button to record the coordinates.
IMU icon	1.  IMU is not enabled. 2.  IMU is turned on but not available, need to shake for calibration. 3.  IMU is enabled and available.
Editing area	1. Point ID: Click to enter, the default measurement point name is the corresponding stake point name with the prefix "stk_", or you can add a suffix in the settings; 2. Antenna height: Click to enter the antenna type selection and input

page.

3. Code: Can be manually entered. When there is a user-entered code in the codes, you can directly click the drop-down button to select it. Click the code label on the left, or you can directly jump to the "Codes" for selection.

7.3.2 Stake Points toolbar

Icon	Name	Description
	Input point	Stake according to the manually entered point coordinates.
	Points	Click to open the points and select the stake point by single or multiple selection.
	AR stakeout	Click to enter the AR stakeout page, present the position of the target point through the camera of the receiver, and find the target point according to the real navigation.
	Map	Click on the optional street and satellite map, the default is to turn off the map mode.
  	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a few seconds and it will automatically return to the centered mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click the rear view to zoom in and show all points.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Layer	Click to open the layer management page, where you can load vector layers on the default map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

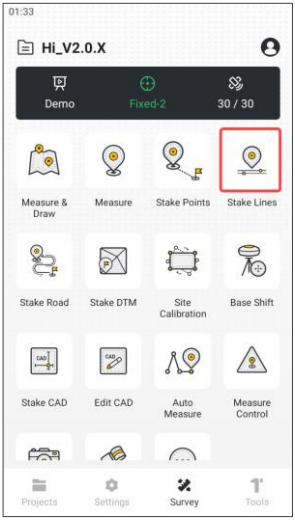
After entering the [Stake Points] and selecting the stake point from [Points], the target point will be marked with a red flag. The current position is connected to the target point with a dotted line, and the 2D distance to the target point will be displayed in real time above the arrow at the current position. When the stakeout distance is ≤ 1 meter, the target point becomes a bullseye view, and the controller will emit a buzzing sound and vibrate. As the stakeout distance shortens, the buzzing sound will become faster and the vibration

frequency will increase. When the distance is ≤ 0.05 meters, you will hear the correct sound reminder.

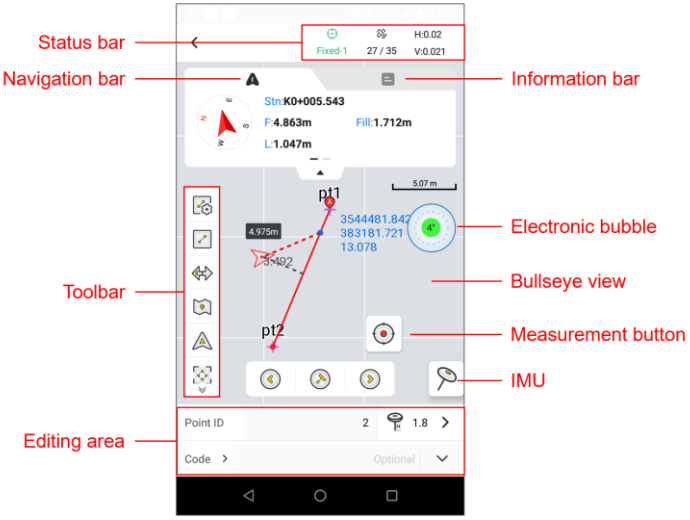
It should be noted that multiple selections are supported when selecting points. Three icons will appear at the bottom of the view: previous point, nearest point, and next point. You can switch between them conveniently by clicking or by pressing the left and right keys on the keyboard.

7.4 Stake Lines

Stake Lines is a simple tool for local line stakeout. The software provides five types of line stakeout. Click [Survey] → [Stake Lines], select a line or create a line for stakeout.



7.4.1 Stake Lines interface

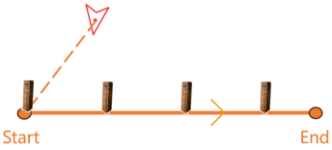
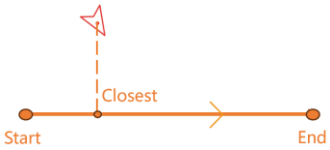


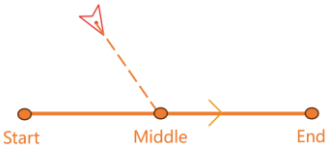
7.4.2 Line stakeout toolbar

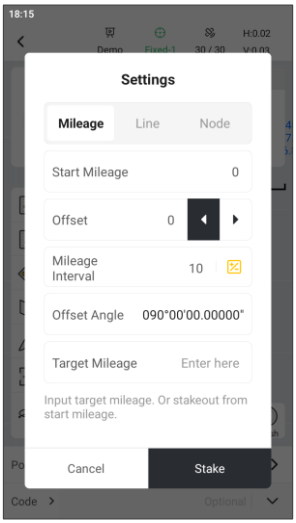
Icon	Name	Description
	Line setting	Optional three ways of selecting line stakeout: 1. Chainage: Customize the distance between adjacent stations and achieve continuous stakeout by adding or subtracting chainage; 2. Line: Find the position closest to the stakeout line segment at the current position; 3. Node: including start point, midpoint, node and end point.
	Lines	Click to jump to line selection in the lines.
	Inversion	Exchange starting and ending points, and when adding chainage, follow the new forward direction.
	Map	Click on the optional street and satellite map, the default is to turn off the map mode.
	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a few seconds and it will automatically return to the centered

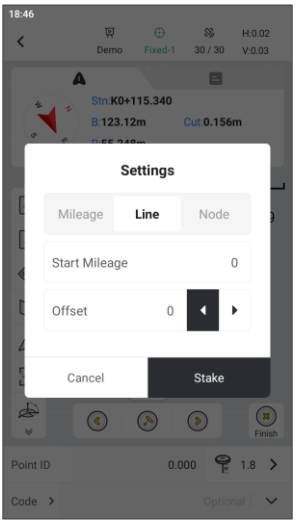
		mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click to zoom the map to show all points and the current stakeout line.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Layer	Click to open the layer management page, where you can load vector layers on the default map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

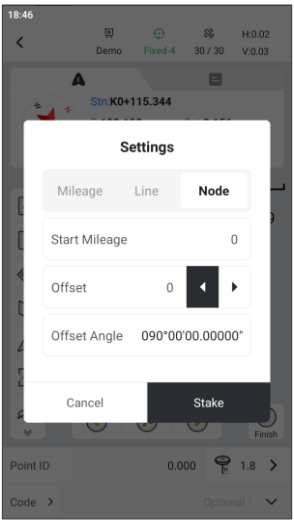
Enter [Stake Lines], select the line for stakeout from [Lines], open the line setting page, and choose to place chainage, line and node.

Line setting	Description	Illustration
Chainage	Customize the distance between adjacent chainage and achieve continuous stakeout by adding or subtracting stations. Custom content includes: 1. Start Chainage: Set the chainage value from the start point; 2. Offset: Set the offset value, left or right ; 3. Mileage Interval: Set the distance between adjacent stations; 4. Offset Angle: Angle of turning left/right in the forward direction. 5. Target Chainage: Set the chainage value of the target point.	
Line	Find the position closest to the stakeout line segment from the current position. The custom content includes: start Chainage and Offset.	

Node	The stakeout targets include: start point, midpoint, node and endpoint. **Note:** If it is a multi-segment line, then the targets are nodes; if it is a straight line, then the targets are start point, midpoint and end point.	







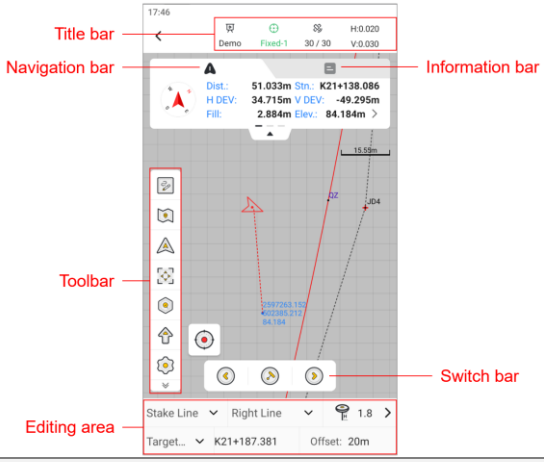
If there are multiple stakeout targets, three icons will appear at the bottom of the view: previous point, nearest point and next point. They can be easily switched by clicking or by pressing the left and right keys on the keyboard. During the stakeout process, you can click the Finish button on the right to end the stakeout immediately.

7.5 Stake Road

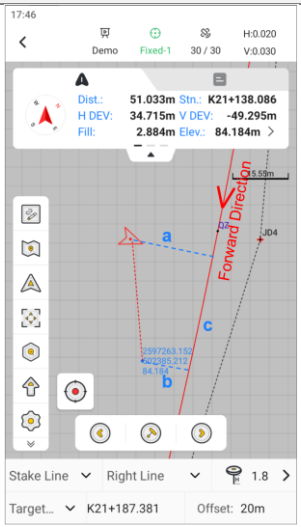
Click on the main page [Survey] → [Stake Road], open the main page, select the correct road file, and the road graph will be displayed on the main page map.

7.5.1 Stake Road interface

The navigation bar provides more stakeout information for reference.



Navigation bar	Description
Dist	The distance from the current position to the target.
Stn	Display the Chainage of the current position.
H DEV (a)	The distance from the current position to the line, left negative and right positive.
V DEV (c)	The delta chainage between the vertical point of current position to the line and the vertical point of the target to the line, positive before and negative after.
Cut/Fill	If the current elevation is higher than the target, it is Cut, otherwise it is Fill.
Elev	1. Enter new design elevation: cover the elevation of the target station; 2. Enter vertical offset: add or subtract the vertical offset value from the design height of the target station to obtain the target elevation; 3. Use original elevation: Default value, use the original design elevation of the target station.



The editing area consists of four parts:

1. Stake Line: optional (more options will be added in the future).
2. Center Line: After selecting the Stake Line, you can also select the left or right line here. Use the forward direction as a reference to input the offset, with negative left and positive right. The map view will be updated after confirmation.
3. Antenna height: the height of the center rod.
4. Target Station: optional, the real-time station always displays the nearest station from the current position to the line, and the target station can also be selected. When the target station is selected, a pop-up window will appear to input the target station. Click [OK] to go directly to the target station. The station can be directly added or subtracted according to the station interval, and the configuration is described in **Chapter 7.5.2.3**.

Note: When measuring in Stake Road, there is no need to enter the point ID. The target station is automatically used as the point ID. If the point ID needs to be modified, it can be manually modified in the point library.

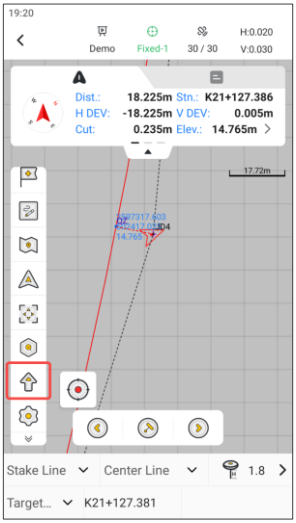
7.5.2 Stake Road toolbar

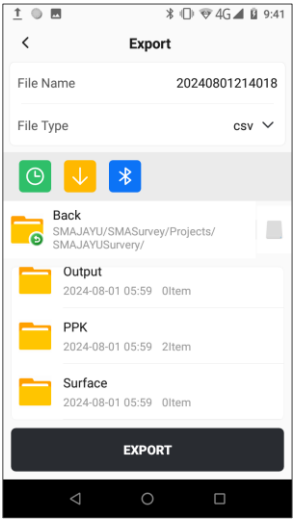
Icon	Name	Description
	Points	Click to open the point library and view or modify the measured points.
	Edit Road	Click to open Edit Road, select a line to start the stakeout.
	Map	Click Optional Street and Satellite Map, the default is to turn off map mode.
	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a few seconds and it will automatically return to the centered mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click Rear View to zoom in and display the entire line.
	Check	Provide forward and reverse calculation functions.
	Input	Manually add station, optionally input coordinate or chainage offset.
	Export	Support exporting road stakeout results.

	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Layer	Click to open the layer management page, where you can load vector layers on the default map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

Export

Click [Export] on the map toolbar to export road stakeout results. The content is as follows.



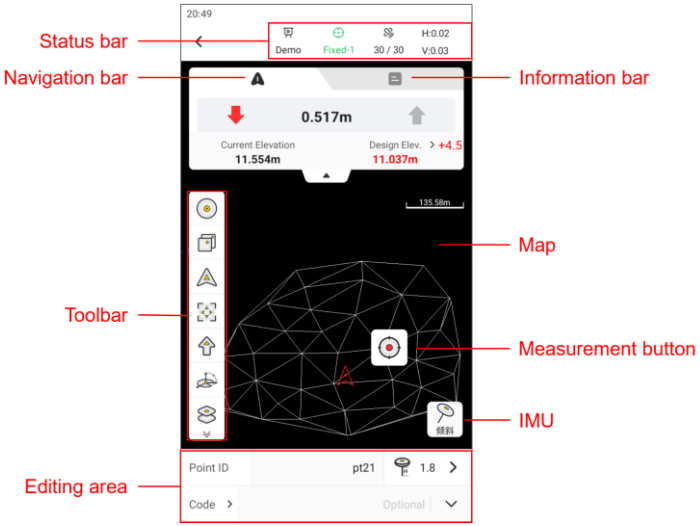


Point ID
Target N
Target E
Target Elev
Target Station
Target Cross Deviation
Measured N
Measured E
Measured Elev
Measured Station
Measured Cross Deviation
Delta Station
Delta Cross Deviation
Delta Elevation
Longitudinal Deviation
Time

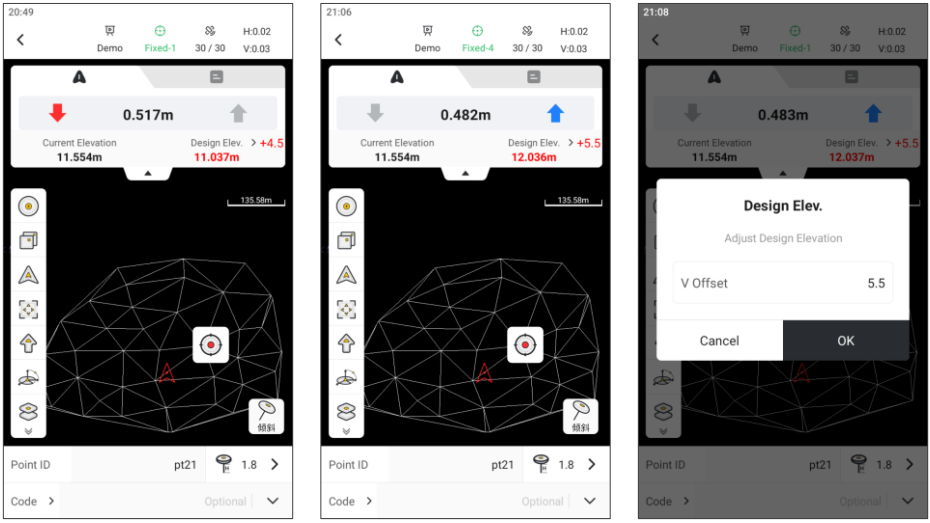
7.6 Stake DTM

In the measurement process, sometimes it is necessary to flatten an irregular field into a surface, and accurately and quickly lay out the elevation of any point on this surface. This situation is called RTK Stake DTM.

The main page of Stake DTM is as follows:



The navigation panel allows you to intuitively see the current elevation and the design elevation, which can be modified.



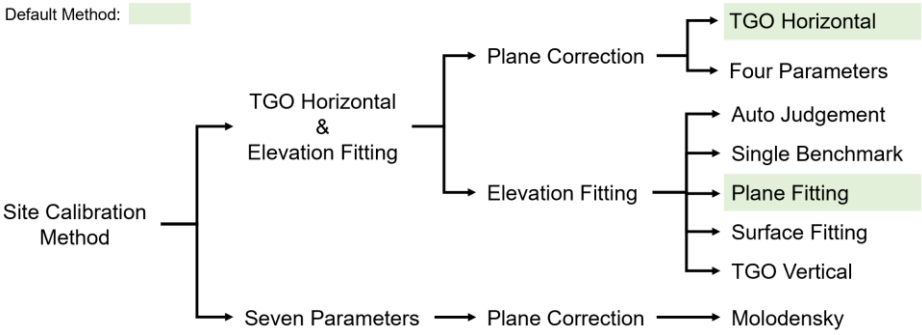
Click [**Export**] button on the toolbar to export the stakeout results to local or cloud, and the exported file records the value of Cut/Fill.

7.7 Site Calibration

Site Calibration is to convert the measured latitude and longitude coordinates into plane Cartesian coordinates used in engineering, and the calculation results of Site Calibration will be saved in the coordinate system.

7.7.1 Calibration method

The default calibration method is TGO Horizontal & Plane Fitting, with the following options.

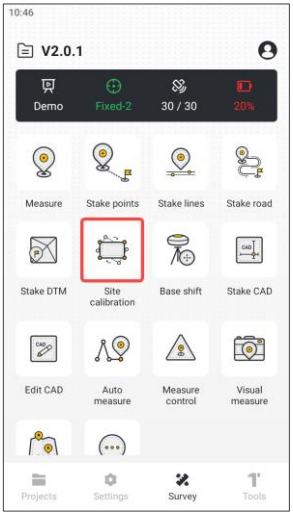


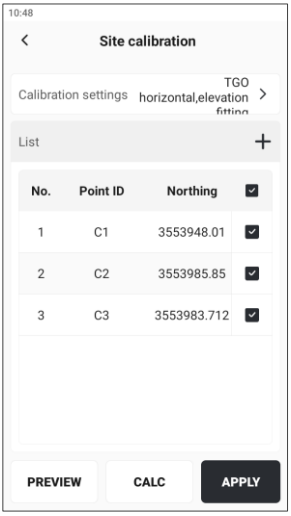
No.	Method	Description
1	Plane Correction Model	This is to correct the curvature of the earth's surface and other factors that affect the measurement results. The plane correction mode can use different parameters, such as four parameters, seven parameters, etc.
1.1	TGO Horizontal	By considering observation errors, random errors, and other uncertainties, more reliable coordinates are obtained.
1.2	Four Parameters	Four parameters are a plane correction mode used to convert local coordinate systems (such as UTM coordinate systems) to global coordinate systems (such as WGS84 coordinate systems). These four parameters usually include translation, rotation, and scale factors.
2	Elevation Fitting method	Used to convert the actual measured elevation value to the elevation value on the ellipsoid.
2.1	Automatic judgment	Automatically determine parameters or conditions.
2.2	Single Benchmark	It is used to weight the observed values according to their accuracy, so as to obtain more accurate results.
2.3	Plane Fitting	A method of estimating plane equations to fit a set of points. Plane fitting can use least squares or other mathematical techniques to find the best fit plane.

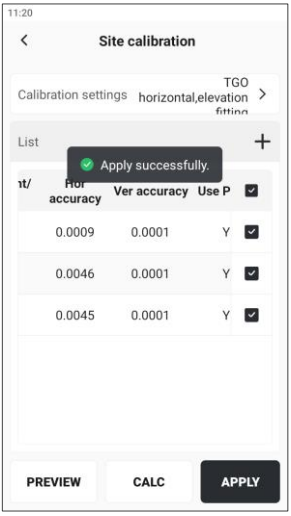
2.4	Surface Fitting	Similar to plane fitting, but considering more complex surfaces, such as quadratic surfaces or other nonlinear shapes.
2.5	TGO Vertical	A method for processing elevation data. It takes into account the curvature of the earth to obtain more accurate elevation measurements.

7.7.2 Operation process

After measuring the control points (known points), select [**Site Calibration**], click [**+**] in the upper right corner, and match the measurement points with the control points one by one. Add two or more pairs of control points, check them, and click [**CALC**] → [**APPLY**]. After completion, you can perform field operations such as point measurement, point stakeout, or line stakeout.







7.7.3 Notes

1. The known points should be distributed as far as possible at the edge of the work area, which can control the entire measurement area and avoid short sides controlling long sides. For example, if four points are used for correction, the work area should preferably be within the polygon connecting the four points.
2. Avoid linear distribution of known points, otherwise it will seriously affect the correction accuracy, especially in the elevation direction.
3. If only plane coordinates are needed and elevation coordinates are not, it is recommended to use at least 2 known points for correction; if horizontal residuals of

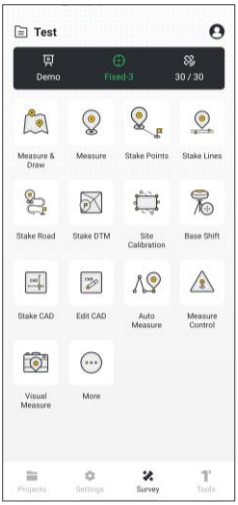
known points need to be checked, then at least 3 points are needed; if horizontal residuals and vertical residuals of known points need to be checked, then at least 4 points are needed.

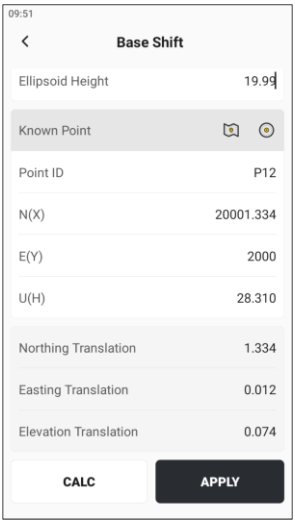
4. Before Site Calibration, please check the ellipsoid parameters and projection parameters.
5. Do not mix the levels of known points, for example, known points measured by GNSS and national high-level known points. If used together, the error of verification should be very large.
6. If an area is relatively large and has many control points, it needs to be calibrated by partition. It is not recommended to have more than ten or more points in one area participate in the calibration.
7. One area only needs to be corrected once.

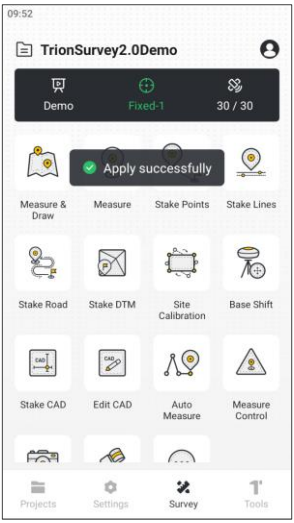
7.8 Base Shift

If the RTK base station set up moves for some reason, the measurement result of the rover station will be biased. At this time, either re-establish the coordinate system or use Base Shift to correct it. Among them, Base Shift is a method often used by surveyors.

Click on the main menu [**Survey**] → [**Base Shift**], select the measurement point and the corresponding known point coordinates, click [**CALC**] at the bottom to calculate the deviation of the base station. Click [**APPLY**] to complete the base shift operation.







Note:

1. The base shift function is a temporary solution after the base station changes. It is not recommended to use it for a long time or rely too much on it. Each project

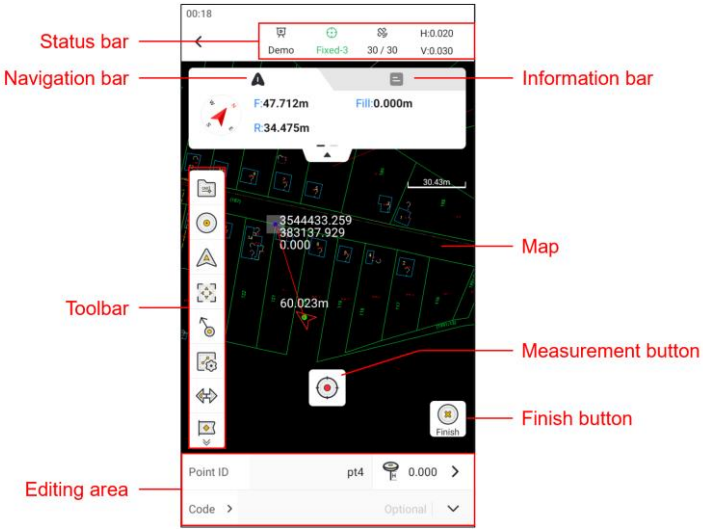
should ensure the stability and reliability of the base station location as much as possible.

2. If the base shift is redone after application, the result will be overwritten and will not be accumulated based on the original result.
3. If the base shift is applied and the Site Calibration is redone, the base shift result will be cleared and will not affect the correct calculation of the Site Calibration.

7.9 Stake CAD

Based on existing CAD files (* .dwg, * .dxf), select points or lines on the drawing and start the stakeout work directly.

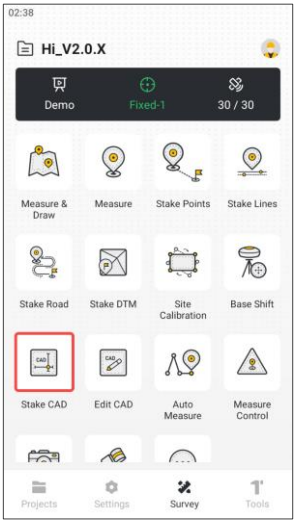
7.9.1 Stake CAD interface

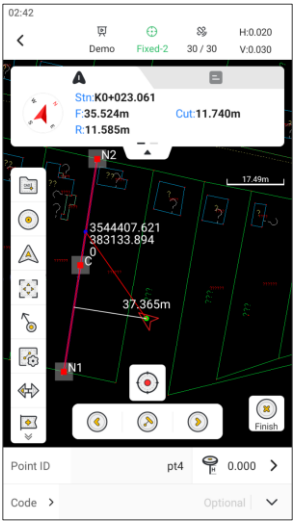


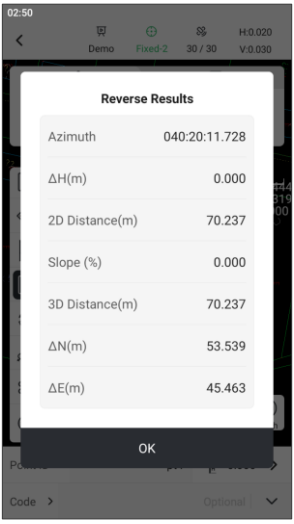
7.9.2 Stake CAD toolbar

Icon	Name	Description
	Open CAD	Click to load CAD files from the controller or Cloud Drive.
	Point library	Click to open the point library and quickly browse the historical measured points.
	Default Centered Follow	**Default**: The map will not automatically zoom during measurement and stakeout, and manual operation is required. The interface will not update when the position changes. **Centered**: The current position and target point are always displayed in the interface. If you manually drag the map, wait a

		few seconds and it will automatically return to the centered mode. **Follow**: The map rotates as the stakeout direction changes, and the current position is always in the middle of the interface.
	Full screen	Click to zoom in and show all points or lines.
	Capture	Precise selection of points.
	Line setting	Optional three ways of selecting line stakeout: 1. Chainage: Customize the distance between adjacent stations and achieve continuous stakeout by adding or subtracting chainage; 2. Line: Find the position closest to the stakeout line segment at the current position; 3. Node: including start point, midpoint, node and end point.
	Inverse	Exchange starting and ending points, and when adding the chainage, follow the new forward direction.
	Input point	Stakeout according to the manually entered point coordinates.
	Reverse calculation	Select two points and calculate azimuth, coordinate difference, slope distance, etc.
	Redraw	Reload the CAD drawing.
	Blast	Separate the selected blocks by reference or polyline.
	Save	Save the selected point and modify the basic information before saving.
	Delete	Delete the selected point or line.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Layer	Click to open the layer management page, where you can load vector layers on the default map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

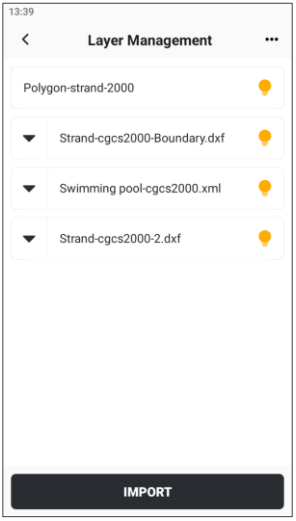






7.9.3 Layer

SMA Survey supports importing dxf/LandXML/shape files and overlaying them with CAD files to assist with Stake CAD. Click the layer icon in the toolbar to add the files that need to be loaded.



Note:

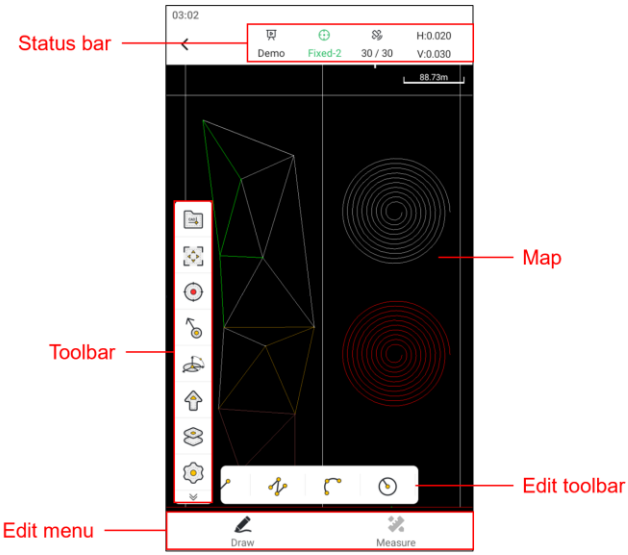
1. The size of a single file should not exceed 20 MB as much as possible. If the file is too large or too complex, there may be parsing failures or errors.
2. Import no more than 5 files.

3. If there is a situation where the drawing file cannot be parsed, please contact us for parsing and optimization.

7.10 Edit CAD

SMA Survey supports editing CAD drawings.

7.10.1 Edit CAD interface



7.10.2 Edit CAD toolbar

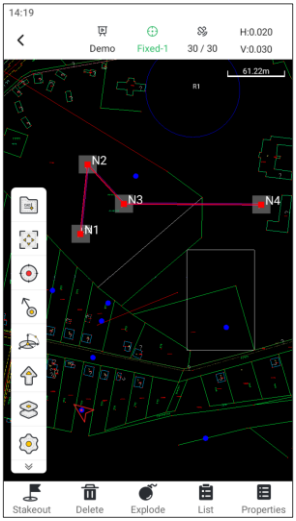
Icon	Name	Description
	Open CAD	Click to load CAD files from the controller or Cloud Drive.
	Full screen	Click the rear view to zoom in and show all points.
	Measure	Draw graphics by collecting coordinates.
	Capture	Precise selection of points.
	COGO	COGO tool shortcut entrance, can configure display/hide and sort in display settings.
	Export	Export the CAD file
	Layer	Click to open the layer management page, where you can load vector layers on the default map.
	Settings	Measurement settings entrance, see **Chapter 7.5.2** for details.

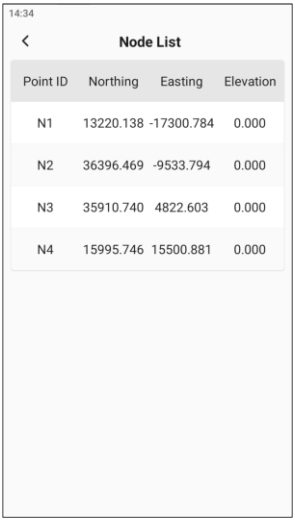
7.10.3 View

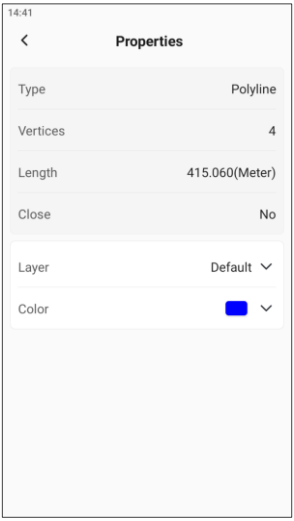
Click on a CAD element to view its relevant information. The selected target type will

display different information. Select a target Afterwards, the description of the bottom menu is as follows:

Icon	Name	Description
	Stake	Jump to Stack CAD and directly execute point/line stakeout.
	Delete	Delete the selected target.
	Blast	Displayed and available when a polyline or block reference is selected.
	List	Display a list of nodes when selecting a line. Click on a node to save it to the point library.
	Property	View the properties of the target. The properties of points, lines, arcs, circles, etc. are all different. The layer and color can be modified.





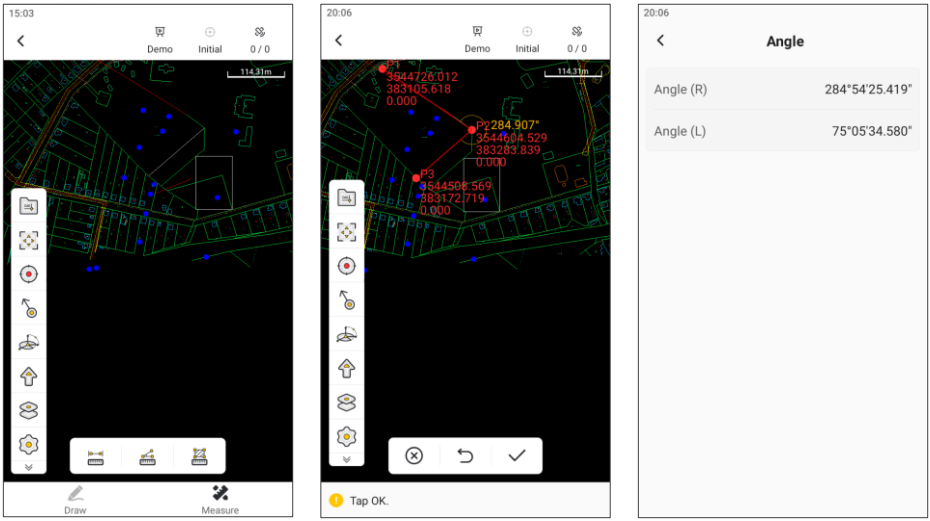


7.10.4 Draw

Edit CAD can draw common point and line graphics, including: point, line, polyline, three-point arc, one-point circle and three-point circle. When drawing, you can select existing points from the drawing by using the capture button, and you can also open the button through the toolbar [**Measure**] to use the collected coordinates as nodes.

7.10.5 Measure

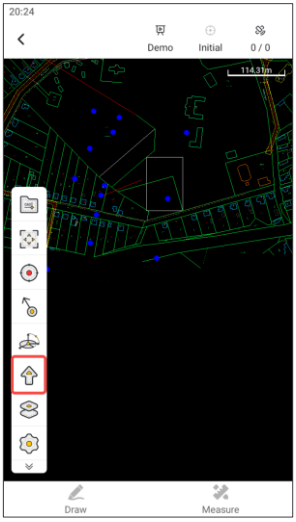
Edit CAD supports measuring on the drawing: two-point distance, three-point angle, and multi-point area. Among them, the angle measurement results show the left and right corners, and the area measurement results show the perimeter and area.

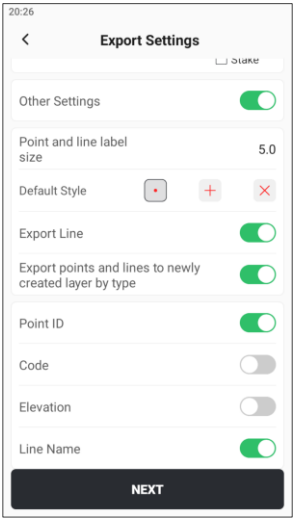


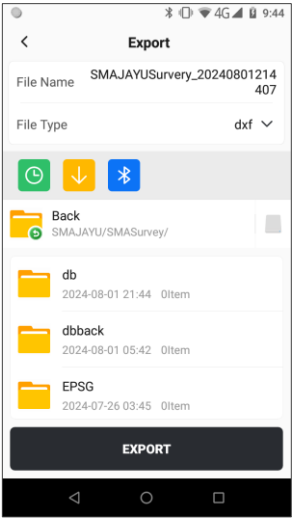
7.10.6 Export

After editing the CAD drawing, it can be exported to the local or cloud. Click the Export button on the toolbar to open the export settings page.

Name	Description
Point Type	The exported content includes points from the point library, which can be exported by point type.
Other Settings	Switch item, closed by default, does not display the following content.
Point and line label size	Sets the absolute size of the exported point and line target labels.
Default style	The style of the optional exported points can also be modified in the PC software later.
Export line	Export the newly created line
Export points and lines to newly created layer by type	Export newly created points and lines to separate layers.
Label	Optional export point name, code, elevation and line name.





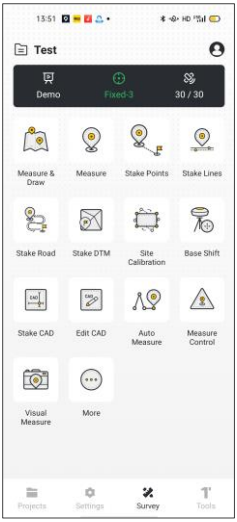


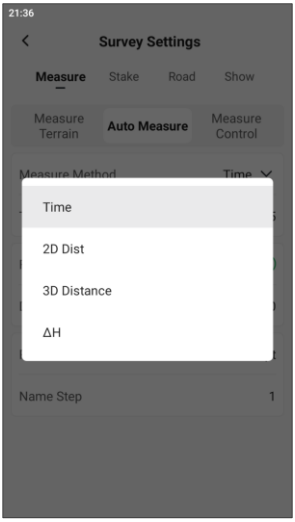
7.11 Auto Measure

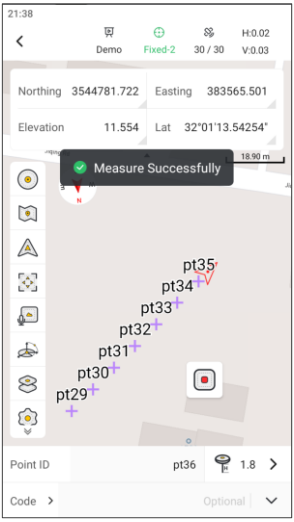
Setting up SMA Survey to automatically save measurement points according to certain rules during terrain measurement can greatly reduce user operations.

Click on [**Survey**] → [**Auto Measure**] to enter the continuous point measurement. The measurement methods can be selected: time interval, 2D distance, 3D distance, and height

difference.





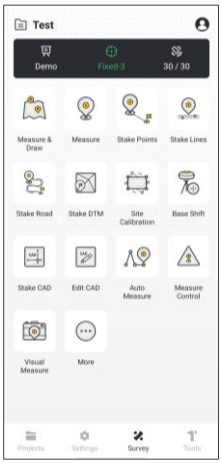


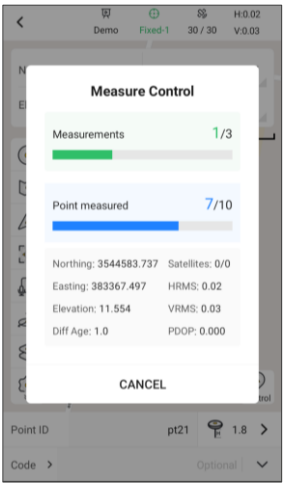
7.12 Measure Control

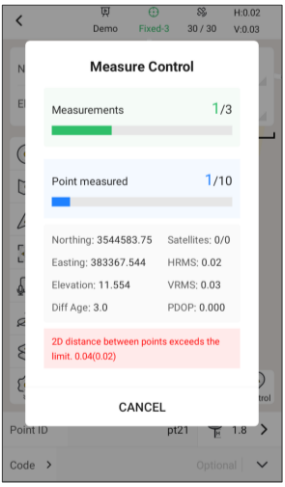
In order to establish the basis of measurement in topographic mapping, a series of points with high plane and elevation accuracy need to be determined to form a measurement control network, which are called control points.

Generally, mm-level precision control points are obtained using total stations or GNSS static methods. However, if the accuracy requirement is in the cm level, RTK can be considered for acquisition. By increasing the number of measurements and some error limiting methods, the measurement accuracy of RTK can be further improved.

The measurement page of **Measure Control** is the same as **Measure**. Before starting the measurement, it is necessary to check the relevant limits in the settings. See **Chapter 7.5.2.1** for details.







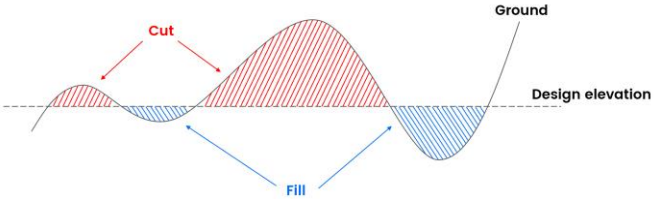
During the measurement process, if the error exceeds the limit, it will be highlighted in red at the bottom of the page.

8 Tools

8.1 Volume

Earthwork calculation is an important step in engineering construction. During the engineering design stage, the amount of earthwork must be budgeted, which directly affects the cost estimate and scheme selection of the project. SMA Survey supports TIN method to calculate earthwork, and can set four parameters: reference elevation, reference point, reference slope, and two phases of earthwork.

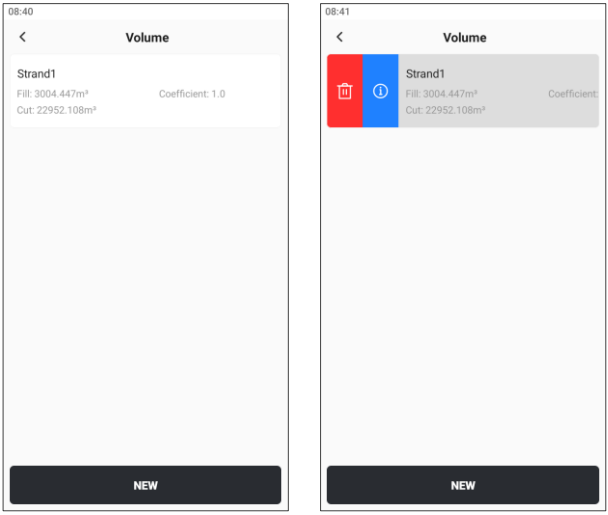
8.1.1 Glossary

Name	Explanation
Cut / Fill	**Cut**: When the surface of the roadbed is lower than the original ground, part of the soil and rock volume is excavated from the original ground to the surface of the roadbed. Fill: The volume of soil and rock filled from the original ground to the surface of the roadbed when the surface of the roadbed is higher than the original ground. 
Site leveling	By digging high and filling low, the original ground is transformed into a site plane that meets people's production and living needs. The design elevation of the site must be determined as the basis for calculating the amount of excavation and filling earthwork, balancing earthwork allocation, selecting construction machinery, and formulating construction plans.
Design elevation	The reference elevation for Cut is equal to Fill. The design elevation is the basis for calculating site leveling and earthwork volume, as well as for overall planning and vertical design. Reasonably determining the site design elevation is of great significance for reducing earthwork volume, accelerating project progress, and reducing project cost.

Sparsity coefficient	Set parameters for earthwork calculation, range: 0 < x ≤ 100, related to the compaction and looseness of the measurement target, and adjust the excavation and filling results proportionally.
TIN method	One of the earthwork calculation methods is to use the DTM model to calculate the earthwork volume based on the ground point coordinates (X, Y, Z) measured on site and the design elevation. By generating a triangular network, the earthwork volume of each triangular pyramid is calculated. Finally, the earthwork volume of filling and excavation within the specified range is accumulated, and the boundary line of filling and excavation is drawn.
Grid method	One of the methods of earthwork calculation, is to draw some small squares at a certain distance within the calculation range (establish an elevation triangle network based on the terrain elevation points, and then interpolate to calculate the elevation of grid corner points and boundary points). First, calculate the amount of soil filled and excavated in each square, and then accumulate and sum to obtain the total amount of earthwork measurement and calculation method.
Flat area	2D projection area of the surface file.

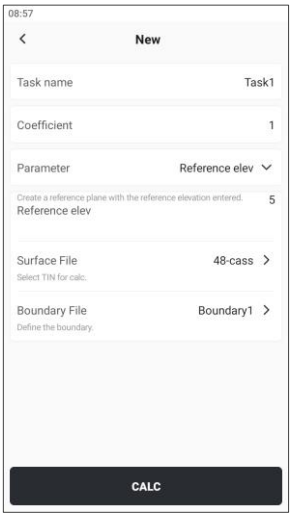
8.1.2 Add a task

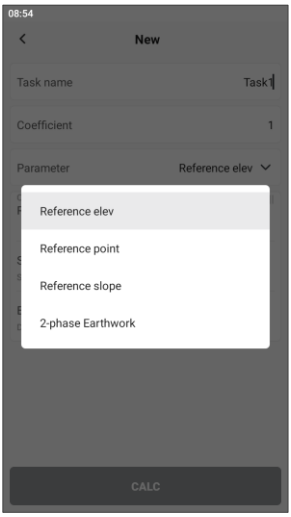
Click [**Tools**] → [**Volume**] from the main page to enter the earthwork calculation task list. In the task list, each task card displays: Fill value, Cut value and sparsity coefficient. Select a task to delete or click Details to view more information.



Click the button **[New**], open the new task page, enter the parameters listed, and click [**CALC**] to get the earthwork calculation results.

Name	Description
Task Name	Enter the name of the earthwork calculation task.
Coefficient	The soil quality is different, and the compaction or expansion of the earthwork is reflected by this coefficient.
Parameter	Different parameters will display different text boxes. 1 **Reference Elevation**: Build a reference plane based on the input reference elevation. 2 **Reference Point**: Build a reference plane based on the selected reference point elevation. 3 **Reference Slope**: Use three points as the reference plane. 4 2-phase Earthwork: Calculate the difference by selecting the surface triangle mesh before and after construction.
Surface File	When selecting the reference elevation, reference point, and reference slope, it usually appears as the surface triangulation mesh measured on site. Click to jump to the surface library for creation or selection.
Boundary File	Calculate the earthwork within the boundary, and calculate the earthwork in the public area if there is no boundary file. Click to enter the boundary management page to create or select.

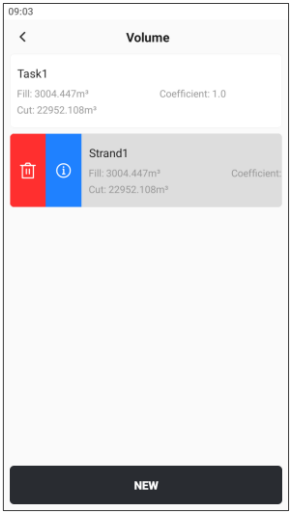


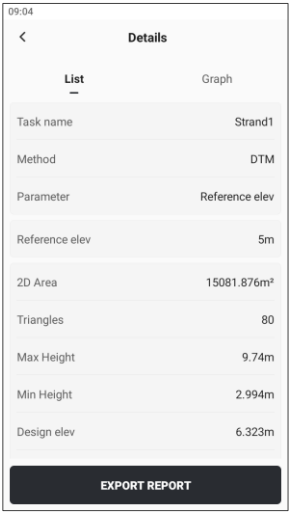


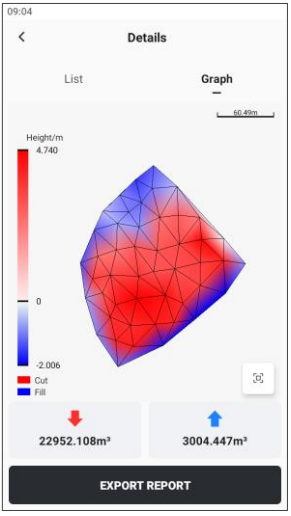
After inputting the necessary information, click the button [**CALC**] at the bottom. If the set parameters and surface file are correct, there will be a Toast Notification "Calculation Successful" and jump to the task list.

8.1.3 View details

Click the task card and select Detail button from the side slide menu to browse the task details.







Name	Description

Task name	Display task name
Method	Using the TIN method
Parameter	Display the parameter selected for calculation
Reference elev	Display the calculation parameter
2D area	Earthwork calculates the 2D area of the actual area, and if there is a boundary, it is the 2D area of the overlapping area
Triangles	Count the number of constructed triangles
Max elevation	Maximum elevation in display area
Min elevation	Minimum elevation in display area
Design elev	Display the elevation value when Cut = Fill, which has reference significance for engineering design
Fill Volume	The volume of space calculated below the reference elevation
Cut Volume	The volume of space calculated above the reference elevation

Click [**Graph**] to display the earthwork calculation results in the form of a color spectrum, reflecting the amount of Cut and Fill through different color differences, giving users an intuitive feeling.

1. ● Red is the Cut area, the darker the color, the higher the elevation value;
2. ● Blue is the Fill area, the darker the color, the lower the elevation value;
3. Color ribbon: 0 means elevation = design elevation, no need to fill/dig.

After the calculation is completed, click [**Export Report**] button at the bottom to export the calculated graphic and text results as * .pdf or * .html files. The content includes:

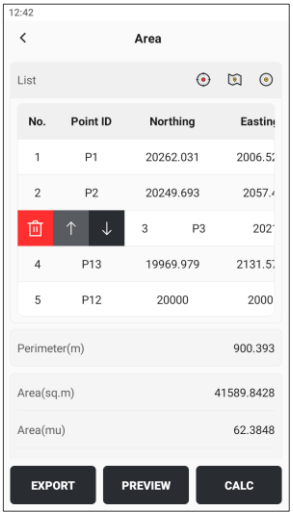
1. Task information
2. Surface information
3. Boundary information
4. Cut area
5. Fill area
6. Graphic

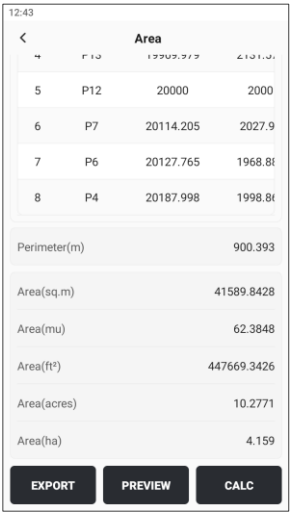
8.2 Area

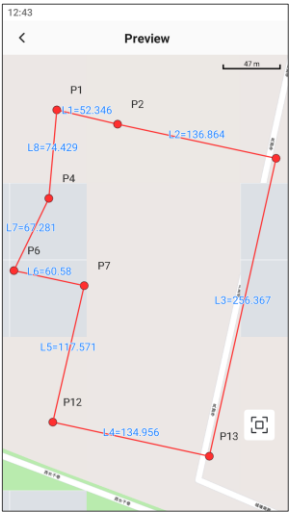
Click [**Tools**] → [**Area**] to calculate the perimeter and area of the figure. The coordinates involved in the calculation can be measured, selected from map or selected from point library. The perimeter unit switches globally with the system, and the area is displayed in five units simultaneously for easy user viewing.

Node list:

1. Point selection method: Support measurement, map selection and point selection.
2. List: Display the Point ID, northing, easting and elevation of the selected point.
3. After selecting a point in the list, it supports deletion and sorting up and down, because the points calculated by area have a connection order, and the calculation results are different with different orders.







Calculation results:

1. Perimeter: Display the perimeter of the calculated area.
2. Area: Five units are listed on one page, including: square meters, acres, square feet, acres and hectares.

Preview and export:

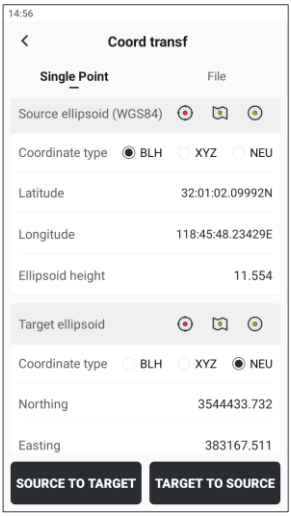
1. Preview: After the calculation results are out, you can click the [**Preview**] button to view the plane view of the area calculation, which also displays the length of each side.
2. Export: You can save the file in * .html/* .pdf format, including node information, graphic information and result information.

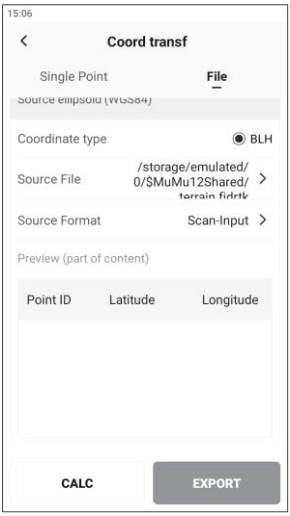
8.3 Coord Transf

Define the coordinate system of the project first, and then you can use the coordinate transformation tool to achieve the mutual conversion of coordinates between different coordinate types.

In addition to supporting single-point conversion, it also supports batch conversion of a file. After selecting the correct source file and file format, you can preview part of the file below. The file conversion function is currently only available for scanner encrypted files,

and will be generalized in the future.



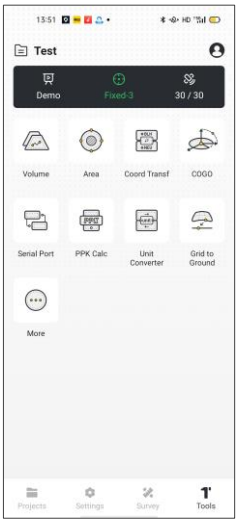


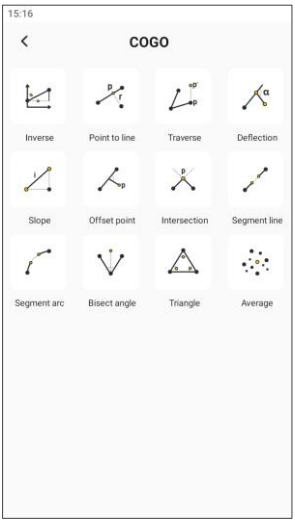
8.4 COGO

Coordinated Geometry, a coordinate geometry language, refers to a commonly used tool calculator in surveying and mapping controllers. Currently, COGO calculation tools support 12 commonly used calculation functions, all of which support preview and allow for intuitive viewing of results on the map.

The COGO tool page has image definitions that vividly describe the known conditions and calculation results of the tool.

Currently, SMA Survey supports the following COGO tools:

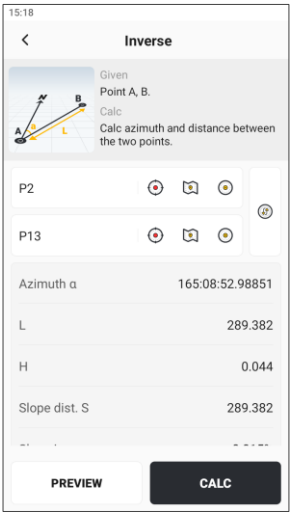


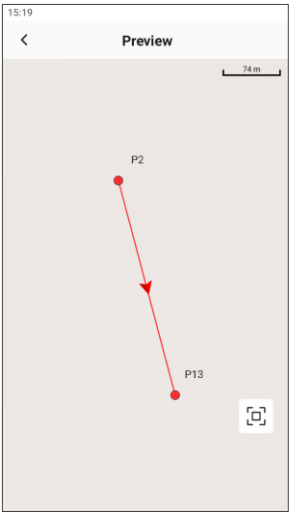


8.4.1 Inverse

Description:
Solve their relative relationship through two known points.

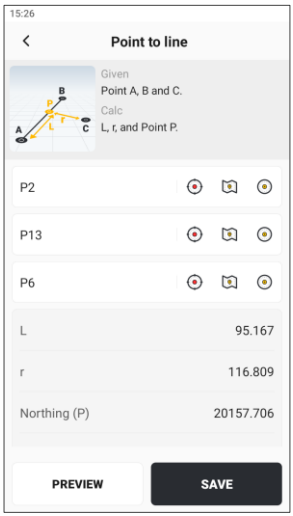
Calculation result:
1. Azimuth angle α
2. 2D distance L
3. Height difference H
4. Slope distance S
5. Slope i
6. Northing difference △ N
7. Easting difference △ E

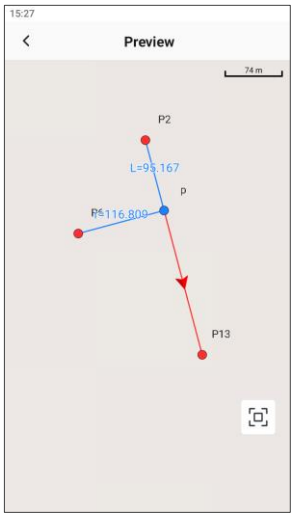




8.4.2 Point to Line

Description:
Solve their relative relationships through three known points.



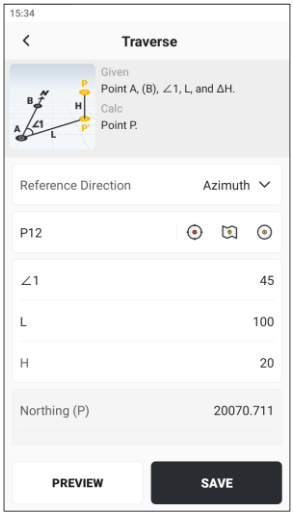


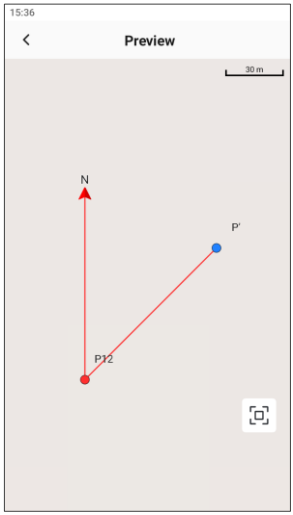
Calculation result:
1. Point C longitudinal offset L
2. cross offset r
3. P-coordinate of the vertical foot

Explanation:
Support the vertical foot P on the forward/reverse extension line of AB.

8.4.3 Traverse

Description:
Similar to wire measurement. Given a point and its relative relationship with the target point, the coordinate of the target point can be solved.





Calculation result:
Target point P coordinate

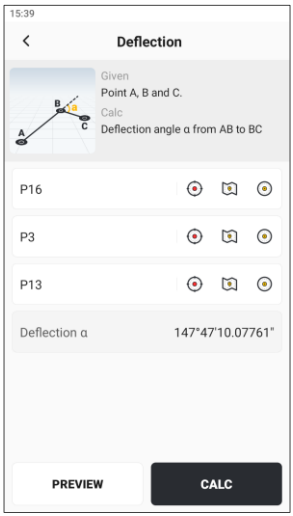
Explanation:
The angle of rotation from the reference direction is clockwise, and the reference direction can be selected from the north direction or two-point orientation.

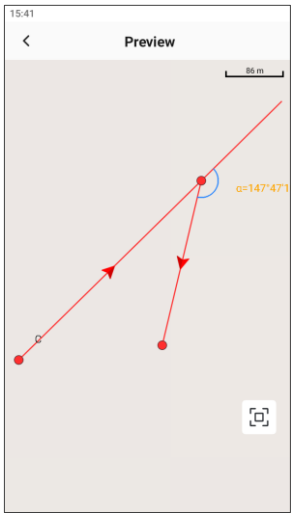
8.4.4 Deflection

Description:
Given three points, solve for the relative deflection angle.

Calculation result:
Deflection angle α

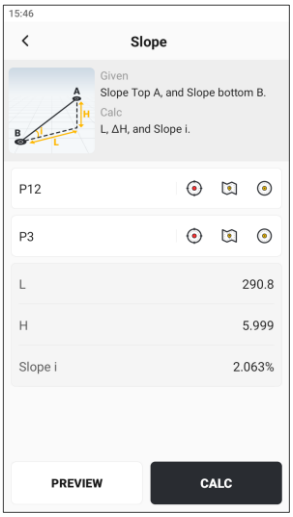
Explanation:
Angle range: -180 ° < α ≤ 180 °.

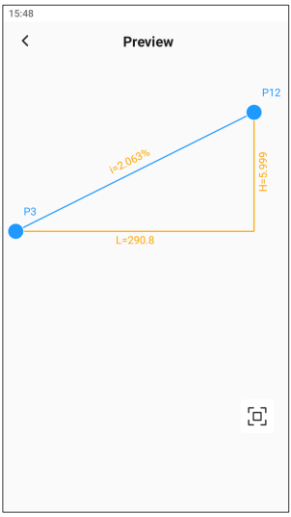


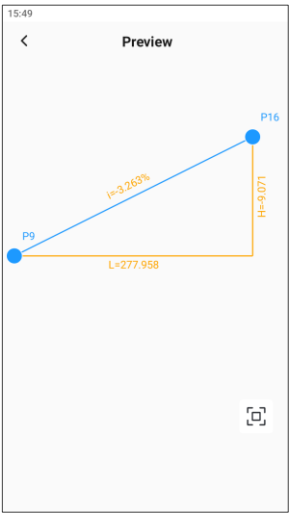


8.4.5 Slope

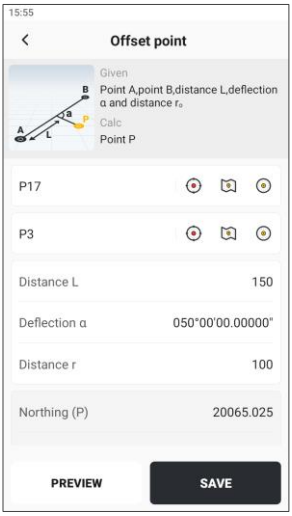
Description:
Given two points, calculate the slope value of the line connecting the two points.
Calculation result:
1. 2D distance L
2. Height difference H
3. Slope i
Description:
1. There are four ways to represent the slope, which can be configured in the general settings. The default is the commonly used percentage method.
    A. Percentage, i = H/L * 100%
    b. Degree, i = arctan(H/L)
    C. Mil, i = angle/0.06
    D. Fraction, i = H: L
2. If the input elevation at the bottom of the slope is greater than the elevation at the top of the slope, the slope and elevation difference are displayed as negative values.







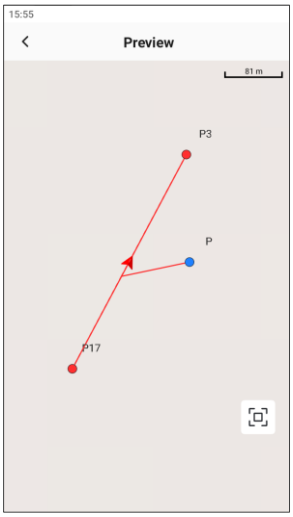
8.4.6 Offset Point



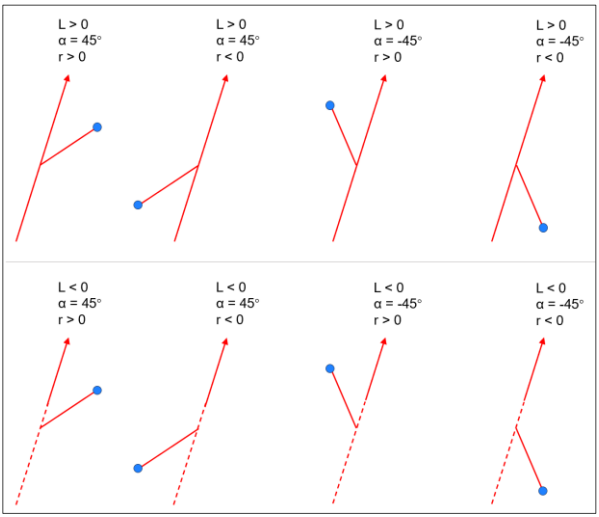
Description:
Given two points and the relative relationship between the third point and the line connecting these two points.

Calculation result:
Point P coordinate

Explanation:
1. When the distance L along the line is less than 0, the starting deflection point is on the reverse extension line;
2. Deflection angle: The angle format is unified with the whole, -180 ° < α ≤ 180 °, default is 90 °, when α > 0, it is the right turn angle along the line, and vice versa;
3. Offset distance: When r > 0, it extends outward along the deflection position, and when r < 0, the direction is opposite.

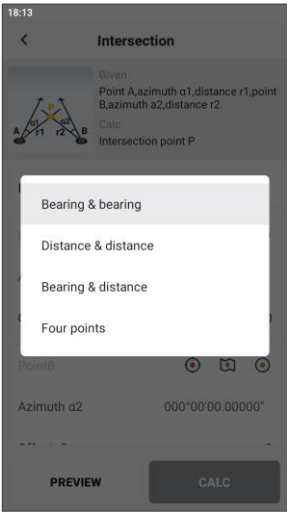


Preview



Different conditions, different results

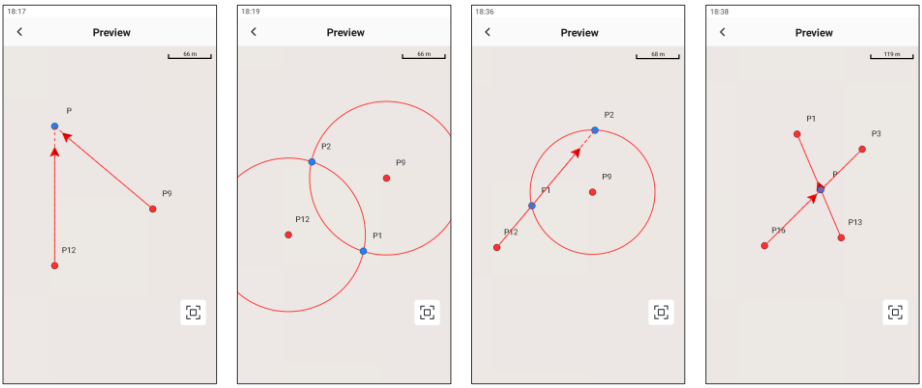
8.4.7 Intersection



Description:
Intersection provides four methods. After selecting a method, the graphic and text definitions on the page will switch accordingly. Intersection methods can be selected: two bearings, two distances, bearing & distance and four points.

Calculation result:
Intersection P coordinates. If there are two intersections, the coordinates of the two intersections can be saved.

Explanation:
1. Azimuth conditions can be set to offset, left negative and right positive;
There are three types of intersection results: 1 intersection, 2 intersections, and no intersection.
3. Four kinds of results preview images are shown as follows:



8.4.8 Segment Line

Description:

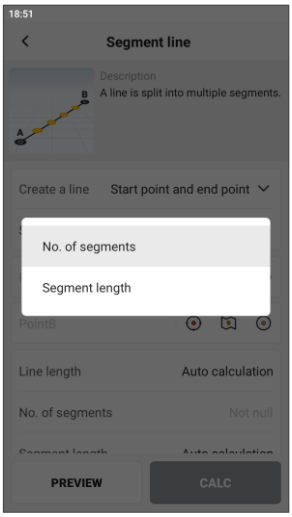
Given a line and the number of segments or the length of the segments it is divided into, find the segmentation node.

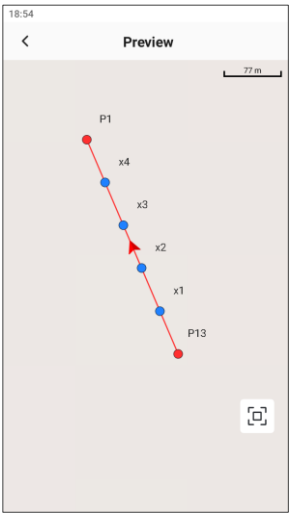
Calculation result:

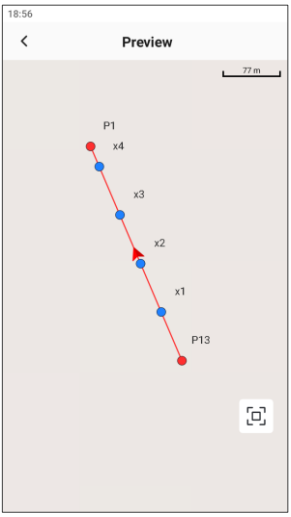
Coordinates of segmented nodes.

Description:

1. There are two ways to create a straight line, consistent with line library:
   A. Start point + end point
   B. Start point + azimuth + length
2. There are two types of segmentation methods:
   A. Segment Nums, input range [2,1000];
   B. Segment Length, input range [0.001, line length].
   When automatically naming, if there are duplicate names, add (1) after them.







8.4.9 Segment Arc

Description:

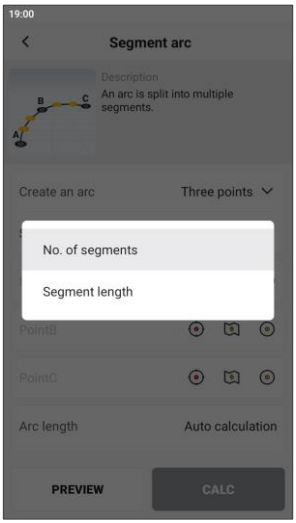
Given an arc and the number of segments or segment length it is divided into, find the segment nodes.

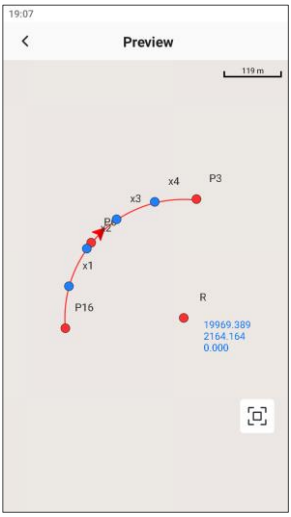
Calculation result:

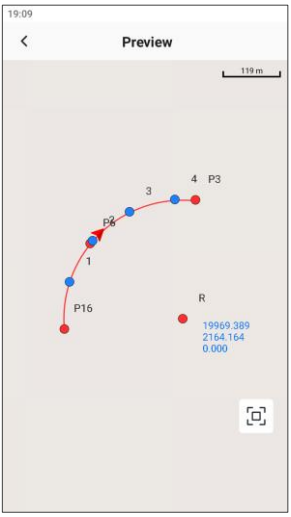
Coordinates of segmented nodes.

Description:

1. There are three ways to create an arc, consistent with line library:
   A. Three points
   B. Two points + radius
   C. Start point + azimuth + length + radius
2. There are two types of segmentation methods:
   A. Segment nums, input range [2,1000];
   B. Segment length, input range [0.001, arc length]
3. When automatically naming, if there are duplicate names, add (1) at the end;
4. The preview shows the arc center point and arc center coordinates only, not saved.







8.4.10 Bisect Angle

Description:

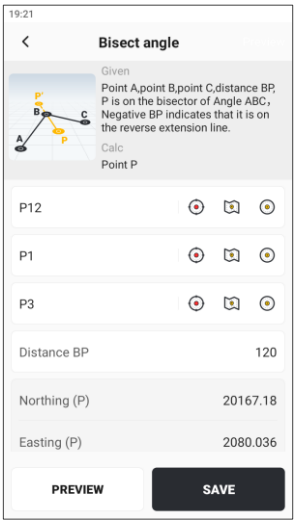
Given points A, B, and C, the BP distance, P is on the ABC angle bisector, and BP is negative, indicating that it is on the reverse extension line.

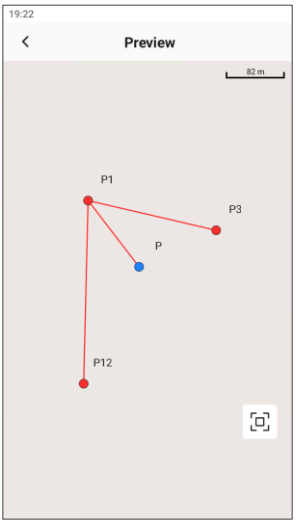
Calculation result:

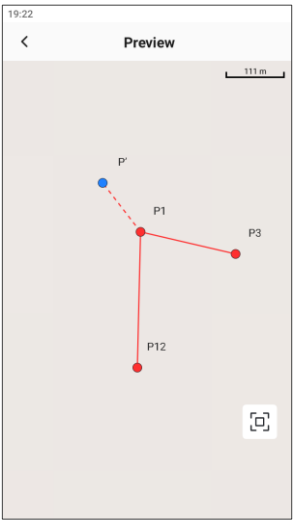
Point P coordinate.

Description:

P is on the angle ABC bisector. It should be noted that when BP is positive, it is displayed as P on the preview chart. When BP is negative, it is displayed as P 'on the preview chart.



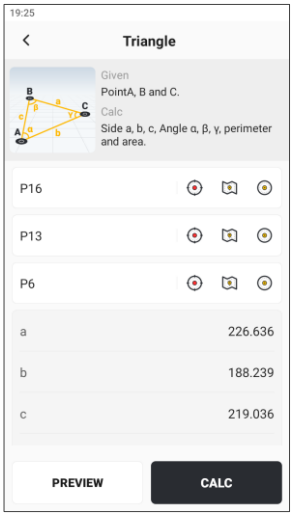


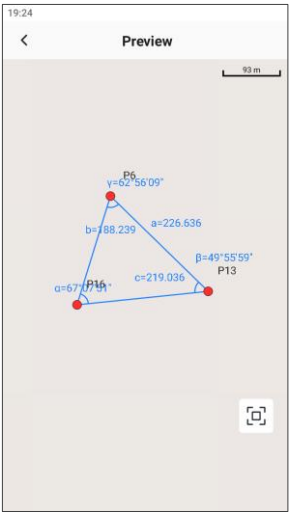


8.4.11 Triangle

Description:
Given three points, solve for the side length, interior angle, perimeter, and area of the triangle.

Calculation result:
1. Three side lengths
2. Three internal angles
3. Perimeter
4. Area

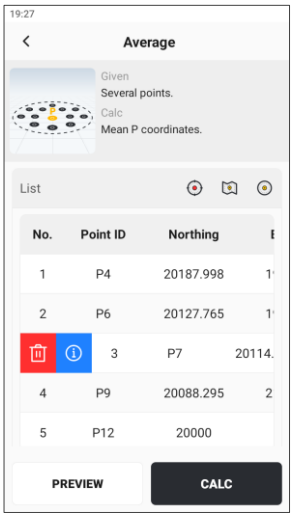


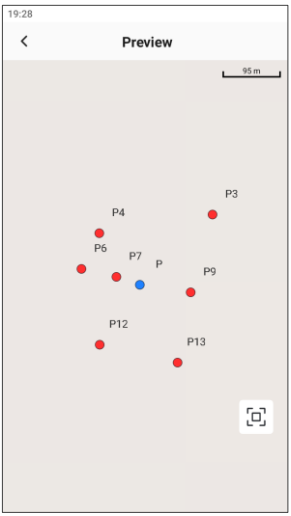


8.4.12 Average

Description:
Given several points, find the average.

Calculation result:
Mean coordinate





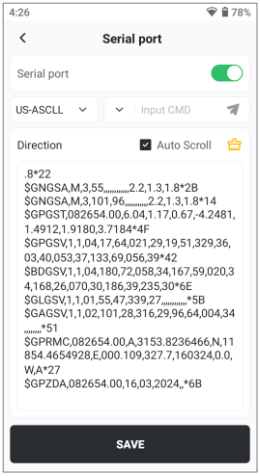
8.5 Serial Port

The intelligent serial port is used to view the message data of the current GNSS receiver and display it in the app window, which can be saved with one click. It is often used as a debugging tool for professionals.

Click [**Tools**] → [Serial Port], open the page, the function description is as follows:

1. Switch: Turn on the serial port, default is off, can be manually turned on.
2. Message format: Optional US-ASCLL and HEX.
3. Auto Scroll: When there are many messages, the scrolling will be automatically refreshed by default. You can also uncheck it and manually swipe to view them.
4. Clear: The data in the window can be cleared and re-recorded.
5. Send: Configuration commands can be sent manually.

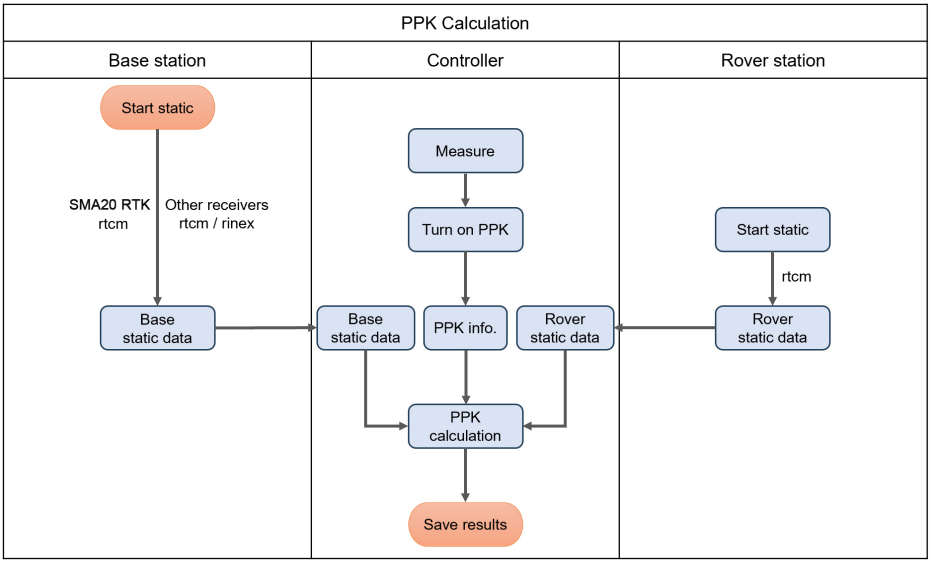
Note: Non-professionals, please do not modify the receiver configuration through instructions to avoid inaccurate positioning data caused by configuration changes. Please operate with caution.



8.6 PPK Calc

Differential positioning is divided into real-time differential and post-processing differential. When stable communication cannot be established on the surveying and mapping site, post-processing differential is often used as an effective measurement method. SMA Survey supports recording PPK data while RTK working, and can directly perform PPK calculation on the controller, and the calculation results can be stored in the project with one click.

8.6.1 Operation process



8.6.2 PPK measure

First, please confirm that both the SMA Survey version and the receiver version are the latest versions.

1) Create a new project

Create a project and define the correct coordinate system. Both PPK measure and PPK calculation are operated under this project.

2) Base configuration

This article takes the simultaneous operation of RTK + PPK as an example to introduce. If the current project only needs to collect PPK data, then the RTK benchmark station can be omitted.

The base station needs to complete two configurations in sequence: RTK radio broadcast and static configuration. It should be noted that the radio is configured first, followed by static configuration. After the configuration is completed, the controller and receiver will be automatically disconnected.

a) RTK radio broadcast configuration

Please start with a known point so that the static file can store accurate base station coordinate.

b) Static configuration

Main parameters: sampling interval 1Hz; recording time (minutes) needs to be longer to prevent the rover station from stopping before it finishes collecting, such as inputting 1440; file type rtcm.

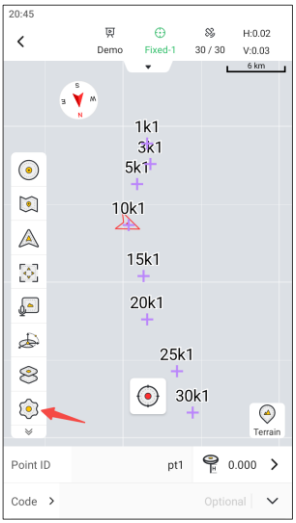
3) Rover configuration

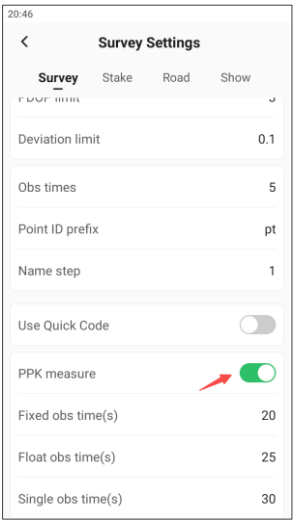
a) Receive base differential data

Configure the rover station to internal radio mode, set the same protocol and channel as the base station, and obtain a fixed solution.

b) Entry [**Measure**], turn on PPK function switch

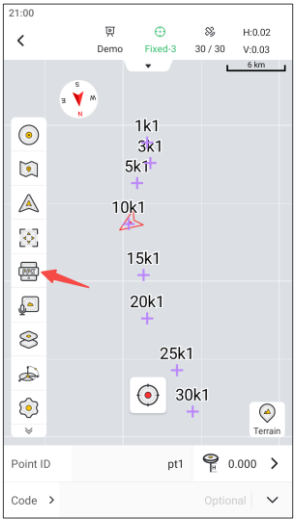
The PPK measure function is integrated into the Measure module. This function is turned off by default and needs to be manually turned on in the measurement settings. Click the settings button, turn on the [**PPK measure**] function switch at the bottom of the measurement settings, and you can set the default PPK measure time under different solution states. After setting, simply click the back button in the upper left corner.

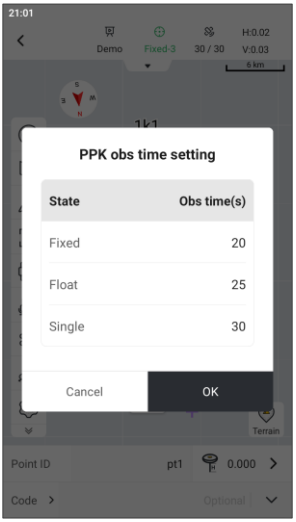


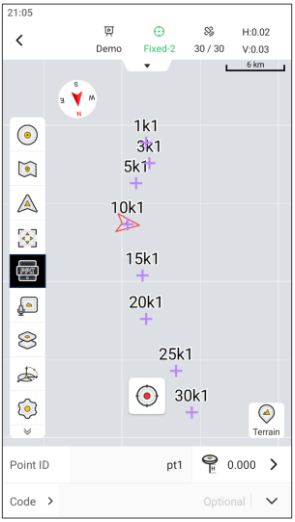


4) Measure operation

After the PPK measure function switch is turned on, a PPK button will appear in the map toolbar. Click the button to confirm the observation time of different solution states again. By default, it takes 20 seconds to collect fixed solutions, 25 seconds to collect float solutions, and 30 seconds to collect single solutions. In order to ensure the calculation effect of PPK post-processing, it is recommended to use default parameters or more. That is, when point measurement, static data corresponding to the collection time will be synchronously recorded for PPK calculation. Click [**OK**] to start PPK collection.







The PPK button on the toolbar will remain active, indicating that the PPK data is being recorded. At this time, users do not need to pay attention to the PPK information, just like normal RTK Data Acquisition. During the operation, please keep the PPK button active. If you need to change the area to continue the operation or need to interrupt for a long time, you can turn off the PPK button first. Click start again when you work next time. Each time you click PPK to close, an rtcm file will be created in the receiver.

It should be noted that the app has some restrictions on RTK results by default. If not closed or modified, it will frequently prompt that the result exceeds the limit when collecting in the float/single solution state. Users can adjust according to the actual situation.

8.6.3 PPK calculation

1) Data preparation

Copy both the static data of the base station and the PPK collected data to the specified directory of the controller. When copying, you can use the controller OTG function to directly connect the receiver, and then access the receiver's memory for copying. Alternatively, copy the file to the computer first and then to the controller directory.

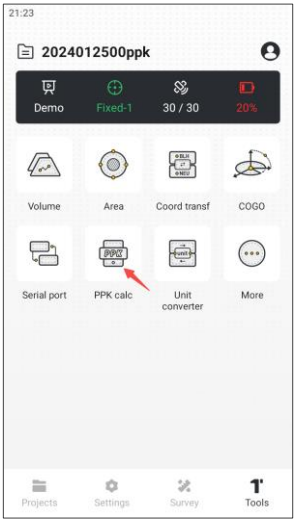
Name	Description
Base data	1. When the base station is SMA20 the copied file format is rtcm. 2. When the base station is a third-party receiver, the copied file format is rinex / rtcm, and the coordinate and antenna height in the header of the file must be accurate; 3. The base station data can be multiple.
Rover data	1. Stored in the receiver, please choose the correct RTCM file according to the observation time and file name; 2. The rover station PPK file can be multiple.
Controller directory	1. Copy the base data to:.../SMAJAYU/SMASurvey/Projects/{Project Name}/PPK/PPK_base 2. Copy the rover station data to:.../SMAJAYU/ SMASurvey/Projects/ {Project Name}/PPK/PPK_rover

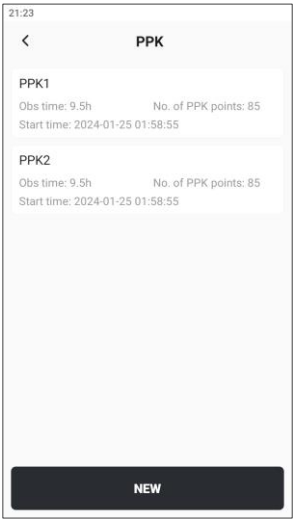
2) PPK calculation

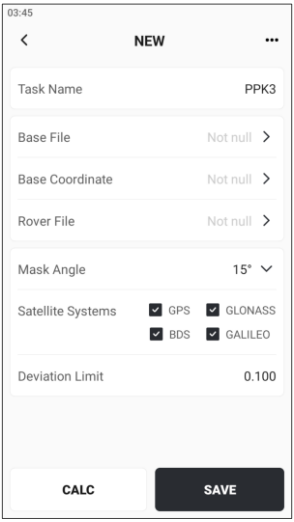
PPK calculation does not require post-processing software, it can be solved directly on the controller. After completing the data copy, go to [**Tools**] → [**PPK Calc**], click the [**NEW**] button at the bottom, and set it as follows:

Name	Description
Task Name	Required field
Base File	Required, can select one or more files
Base Coordinate	Optional modify the coordinate of the base

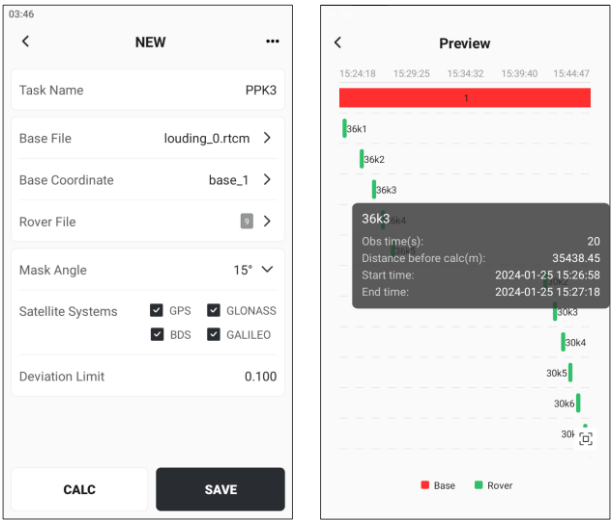
Rover File	Required, can select one or more files
Mask Angle	Required, default 15 °
Satellite systems	Default all satellite systems
Deviation Limit	Default 0.1 m, control the reliability of the results





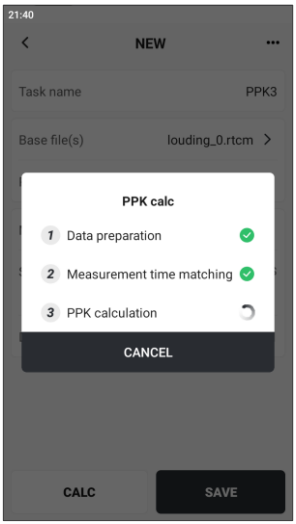


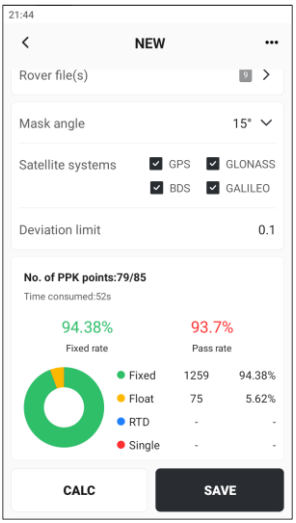
After selecting the data of the base station and the rover station, you can click on the upper right corner [**...**] → [**Preview**] to view the relative relationship between the observation time of the base station and the rover station. The view can be zoomed, scrolled, and dragged back and forth.

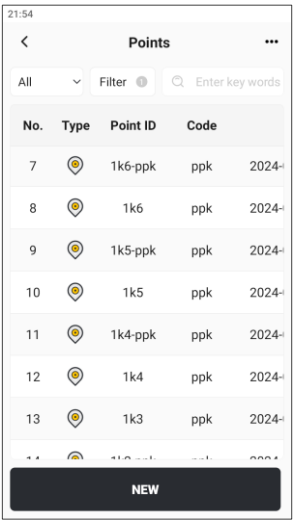


Click the [**CALC**] button at the bottom, and the app starts to calculate PPK data. Users can see the calculation process, including data preparation, measurement time matching, and PPK calculation.

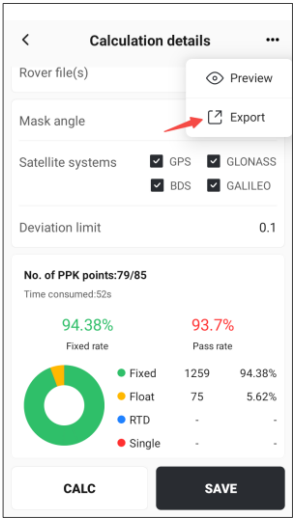
After the calculation is completed, the calculation results will be displayed on the page, including: the number of PPK measurement points (qualified /total), calculation time, fixed rate (the proportion of fixed solutions for all epochs), qualified rate (the proportion of qualified solutions for all fixed epochs, which needs to meet the deviation limit), and pie chart (showing the number and proportion of various calculation states). Click [**Save**], and the qualified calculation results will be automatically saved to the point library. Add the suffix ppk to the point name to distinguish it from the points measured by RTK.

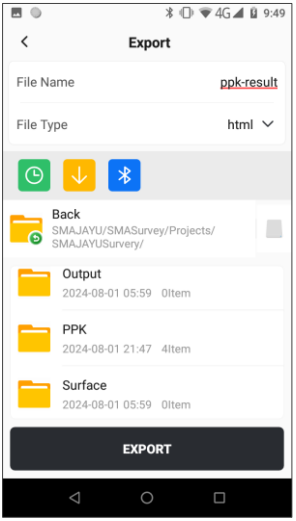




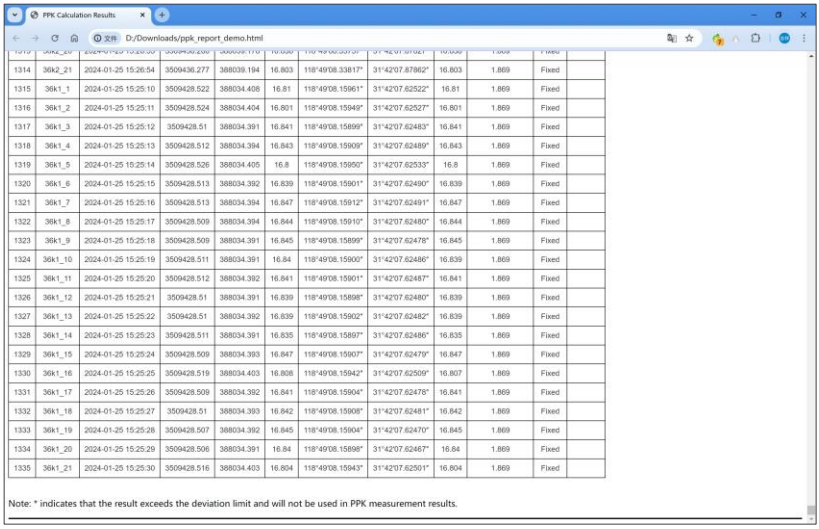


Click on the top right corner [...] → [**Export**] to export the PPK calculation report, with the file extension * .html.





The PPK calculation report consists of the following parts: project information, coordinate system, PPK calculation results, and PPK measurement details. The PPK measurement details record the results of each epoch calculation in detail.



1314	36k2_21	2024-01-25 15:26:54	3509436.277	388039.194	16.803	118°49'08.33817"	31°42'07.87862"	16.803	1.869	Fixed	
1315	36k1_1	2024-01-25 15:25:10	3509428.522	388034.408	16.81	118°49'08.15961"	31°42'07.62522"	16.81	1.869	Fixed	
1316	36k1_2	2024-01-25 15:25:11	3509428.524	388034.404	16.801	118°49'08.15949"	31°42'07.62527"	16.801	1.869	Fixed	
1317	36k1_3	2024-01-25 15:25:12	3509428.51	388034.391	16.841	118°49'08.15899"	31°42'07.62483"	16.841	1.869	Fixed	
1318	36k1_4	2024-01-25 15:25:13	3509428.512	388034.394	16.843	118°49'08.15909"	31°42'07.62489"	16.843	1.869	Fixed	
1319	36k1_5	2024-01-25 15:25:14	3509428.526	388034.405	16.8	118°49'08.15950"	31°42'07.62533"	16.8	1.869	Fixed	
1320	36k1_6	2024-01-25 15:25:15	3509428.513	388034.392	16.839	118°49'08.15901"	31°42'07.62490"	16.839	1.869	Fixed	
1321	36k1_7	2024-01-25 15:25:16	3509428.513	388034.394	16.847	118°49'08.15912"	31°42'07.62491"	16.847	1.869	Fixed	
1322	36k1_8	2024-01-25 15:25:17	3509428.509	388034.394	16.844	118°49'08.15910"	31°42'07.62480"	16.844	1.869	Fixed	
1323	36k1_9	2024-01-25 15:25:18	3509428.509	388034.391	16.845	118°49'08.15899"	31°42'07.62478"	16.845	1.869	Fixed	
1324	36k1_10	2024-01-25 15:25:19	3509428.511	388034.391	16.84	118°49'08.15900"	31°42'07.62486"	16.839	1.869	Fixed	
1325	36k1_11	2024-01-25 15:25:20	3509428.512	388034.392	16.841	118°49'08.15901"	31°42'07.62487"	16.841	1.869	Fixed	
1326	36k1_12	2024-01-25 15:25:21	3509428.51	388034.391	16.839	118°49'08.15898"	31°42'07.62480"	16.839	1.869	Fixed	
1327	36k1_13	2024-01-25 15:25:22	3509428.51	388034.392	16.839	118°49'08.15902"	31°42'07.62482"	16.839	1.869	Fixed	
1328	36k1_14	2024-01-25 15:25:23	3509428.511	388034.391	16.835	118°49'08.15897"	31°42'07.62486"	16.835	1.869	Fixed	
1329	36k1_15	2024-01-25 15:25:24	3509428.509	388034.393	16.847	118°49'08.15907"	31°42'07.62479"	16.847	1.869	Fixed	
1330	36k1_16	2024-01-25 15:25:25	3509428.519	388034.403	16.808	118°49'08.15942"	31°42'07.62509"	16.807	1.869	Fixed	
1331	36k1_17	2024-01-25 15:25:26	3509428.509	388034.392	16.841	118°49'08.15904"	31°42'07.62478"	16.841	1.869	Fixed	
1332	36k1_18	2024-01-25 15:25:27	3509428.51	388034.393	16.842	118°49'08.15908"	31°42'07.62481"	16.842	1.869	Fixed	
1333	36k1_19	2024-01-25 15:25:28	3509428.507	388034.392	16.845	118°49'08.15904"	31°42'07.62470"	16.845	1.869	Fixed	
1334	36k1_20	2024-01-25 15:25:29	3509428.506	388034.391	16.84	118°49'08.15898"	31°42'07.62467"	16.84	1.869	Fixed	
1335	36k1_21	2024-01-25 15:25:30	3509428.516	388034.403	16.804	118°49'08.15943"	31°42'07.62501"	16.804	1.869	Fixed	

Note: * indicates that the result exceeds the deviation limit and will not be used in PPK measurement results.

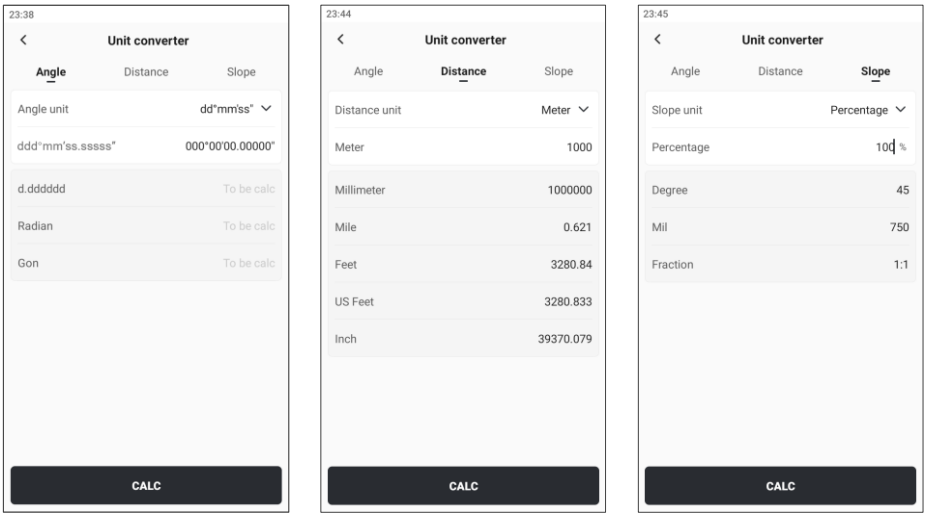
Note:

1. You can modify the calculation configuration and recalculate.
2. The calculation time depends on the performance of the end point, the number of epochs of a single measurement point, the total number of measurement points, the length of the base line, signal quality and other factors. Please be patient during the calculation process.
3. The recalculated result overwrites the original PPK result when you click Save to Points again.

8.7 Unit converter

The unit converter tool provides conversion between different units of angle, distance, and slope commonly used in surveying and mapping, which is very convenient.

1. Angle: It can achieve mutual conversion between dms, degrees, radians, and percentiles.
2. Distance: Can achieve mutual conversion of commonly used length units.
3. Slope: Four types of slope units can be converted to each other, with percentages and fractions formatted for display.



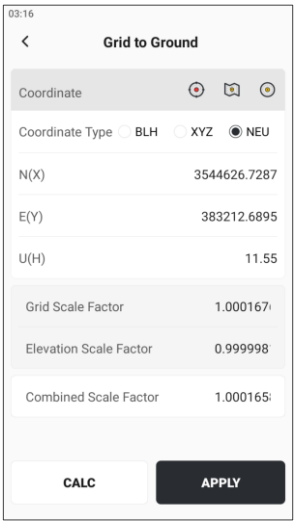
8.8 Grid to Ground

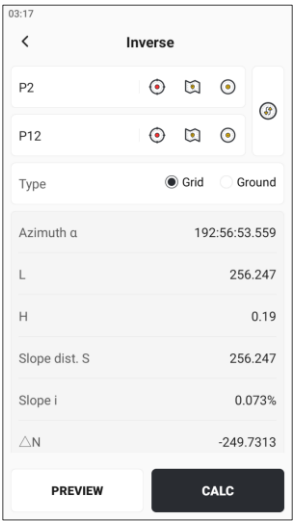
When GPS and total station work together, it is usually necessary to modify the distance measured by the total station so that it is consistent with the distance projected onto the Gaussian plane by GPS measurement. If GPS or total station work alone, there is no problem with distance modification. Near the central meridian, the distance modification value is small, and the farther away from the meridian, the larger the distance modification value. If you want to avoid distance modification, you can appropriately reduce the projection bandwidth. When providing coordinate results, special explanations should be made to ensure the accuracy and reliability of the data.

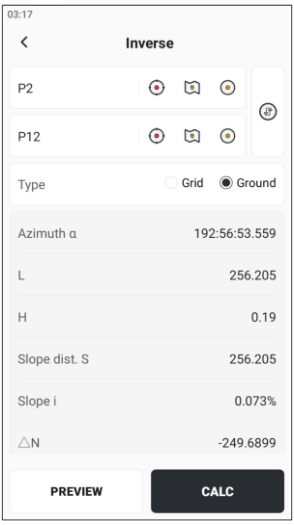
The following equation is the formula for calculating the distance D from the length S of the geodetic line to the straight line on the Gaussian plane. It can fully meet the requirements for the reduction of first-order side lengths, and can be omitted for the reduction of second-order side lengths. For the reduction of third and fourth-order side lengths, it can be further omitted.$y_m^4 \Delta y^2$

$$D = (1 + \frac{y_m^2}{2R^2} + \frac{\Delta y^2}{24R^2} + \frac{y_m^4}{24R^2}) \cdot S$$

In the app, select the current location to calculate the grid factor, elevation factor, and comprehensive factor. After clicking [CALC] and [APPLY], return to [**Inverse**] to view the grid data and plane data of the selected distance.







8.9 RSSI

RSSI (Received Signal Strength Indicator) is an indicator of the received signal strength. The RSSI value is usually a relative quantity used to measure the strength of the received wireless signal power. In wireless communication systems, the size of the RSSI value is very important for evaluating communication quality, signal coverage, and determining whether to adjust transmit power or receive sensitivity.

When RTK uses radio to transmit or receive differential signals, the RSSI function can be used to assist in checking the signal strength of the current radio station.