
tSurvey2.0 User Manual

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1. An Overview of tSurvey2.0

1.1 Introduction

tSurvey2.0 is an engineering measurement application developed for high-precision GNSS (Global Navigation Satellite System) positioning. The development team, drawing upon years of surveying development and market experience, designed this application by integrating the usage habits of industry professionals and the operating style of Android. The result is a powerful yet user-friendly engineering measurement application that includes features such as high-precision point measurement, point and line stakeout, road design stakeout, CAD, and more. The software is characterized by its simple and user-friendly operation, easy-to-learn humanized workflow, robust road design and construction stakeout capabilities, powerful CAD mapping and stakeout functions, and a convenient user-customizable menu for feature display.

The software primarily consists of four main sections: Project, Device, Measurement, and Tools. Here is a brief overview of the basic functions within each section:

1.1.1 Project

This section is primarily focused on project configuration, data management, and software settings. It encompasses various functions, including project management, file management, coordinate systems, transformation parameters, base station translation, coordinate point database, data export, code management, software settings, and information about the software.

1.1.2 Device

This section primarily focuses on operations related to connecting high-precision GNSS instruments and configuring instrument. It includes functions such as communication settings, rover mode, base station mode, static mode, instrument information, instrument settings, repositioning, and instrument registration.

1.1.3 Measurement

This section primarily focuses on field data measurement, layout, and industry applications using GNSS positioning. It includes functions such as point measurement, partial measurement, control point measurement, CAD (Computer-Aided Design), point stakeout, line stakeout, road stakeout, and more.

1.1.4 Tools

This section primarily includes various practical tools related to field measurements. It encompasses functions such as coordinate transformation, file conversion, angle transformation, perimeter and area calculation, earthwork calculation, post-measurement correction, file sharing, eccentric point calculation, bearing and distance calculation, point-to-line calculation, three-point circle center calculation, average calculation, spatial distance, and more.

1.2 Installation&Uninstallation

Installation:

- 1、 Download the tSurvey2.0 software installation package (*.apk).
- 2、 Copy the tSurvey2.0 apk to your mobile device (controller). In the file manager of the controller, locate the apk and click it to install. (Subsequent version updates support online upgrades; refer to the "About Software" section for details.)
- 3、 Click the tSurvey2.0 on the desktop to launch the software. (For the first time, you need to create a project; subsequently, the software will automatically open the last used project each time it starts.)

2. Project

Enter the main menu of the software, click "Project", and the corresponding functional menu will be displayed, as illustrated in Figure 2-1. The "Project" menu encompasses various functions, serving as a hub for project manager, project data manager, coordinate system, localization, calibrate point, point database, export file, code library, software setting, and about software.

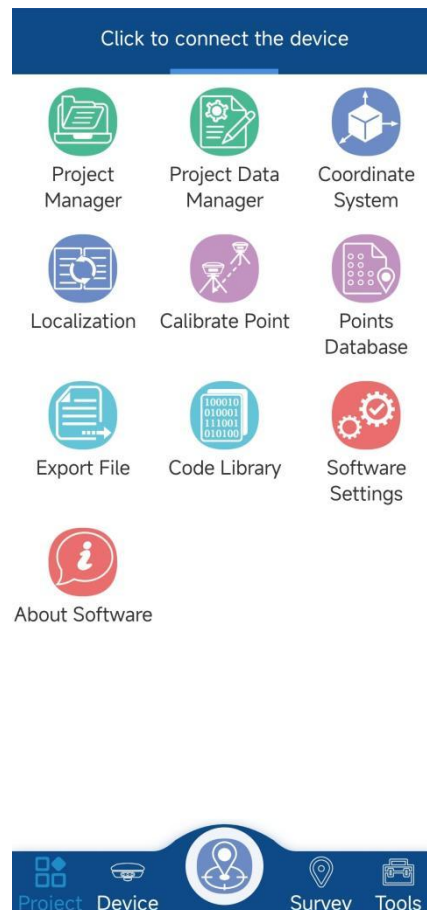


Figure 2-1

The software organizes and manages all data and operations on a project basis. Upon the initial entry into the software, it is essential to create a project. Subsequent entries will automatically load the last used project. Each project is stored in a folder format under the respective directory (default location: Internal Storage -> tSurvey2.0 -> Project). Basic project information is stored in the file named "ProjectName.job," while other data is stored in the corresponding subdirectories.

2.1 Project Manager

Click "Project" -> "Project Manager", as shown in Figure 2.1-1. Project Manager includes functions such as creating a new project, importing a project, exporting a project, deleting a project, and opening a project.

Click "Project Path" to modify the project's path. The default path is in Internal Storage -> tSurvey2.0 -> Project directory.

Click "Details", as shown in Figure 2.1-2, to modify the project's basic information, coordinate system parameters, code management, and other essential attributes.

Click on "New", as illustrated in Figure 2.1-3. When creating a new project, fill in details such as the project name, whether to apply a template, and choose a code template. Click "OK." Then, input or modify the coordinate system parameters for the project, as shown in Figure 2.1-4, and click "OK" to complete the project creation.

Clicking other projects in the list will provide an option to open them, as seen in Figure 2.1-5. Long-pressing on a project in the list will reveal a delete option, as shown in Figure 2.1-6 (Note: You cannot delete a project that is currently in use).

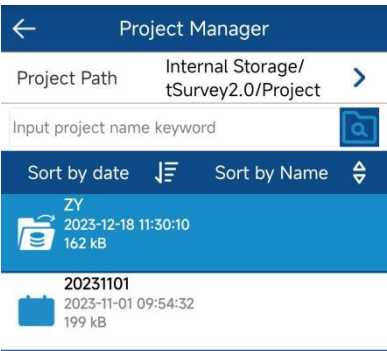


Figure 2.1-1

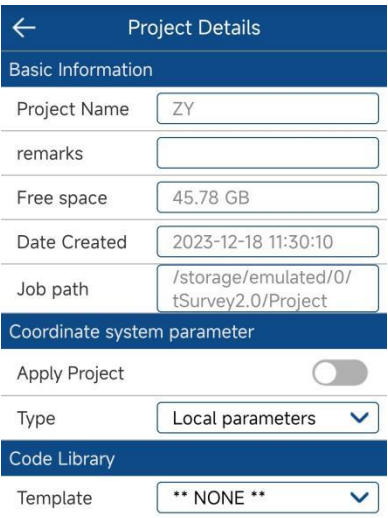


Figure 2.1-2

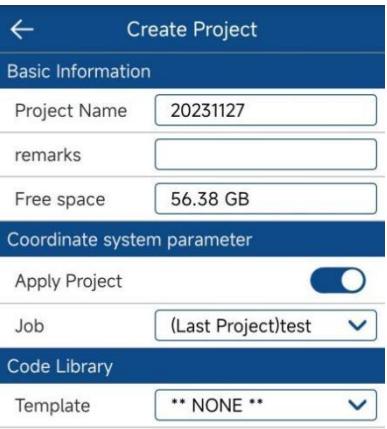


Figure 2.1-3

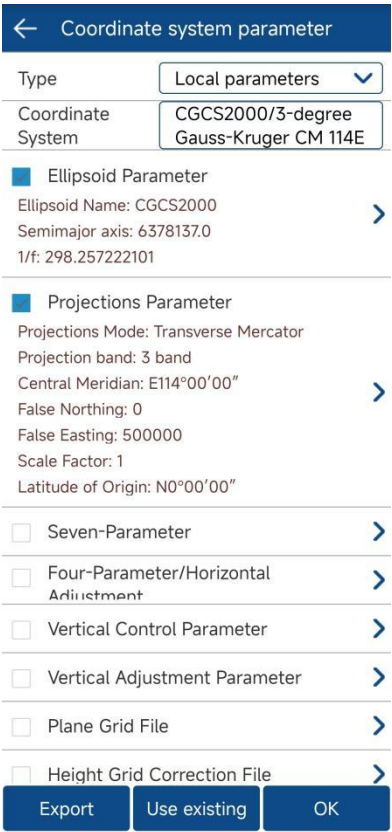


Figure 2.1-4

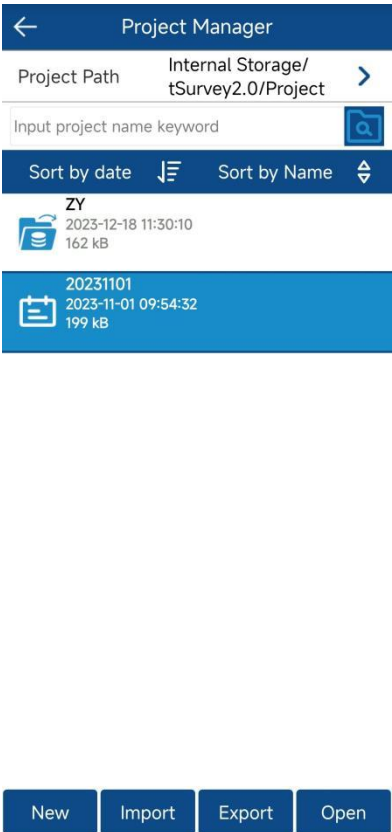


Figure 2.1-5

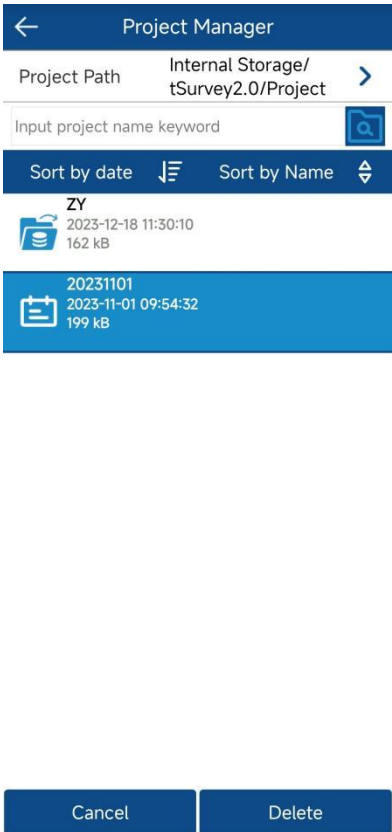


Figure 2.1-6

2.2 Project Data Manager

Click "Project" -> "Project Data Manager", as shown in Figure 2.2. File Management includes functions such as creating a new data file and opening existing data files.



Figure 2.2

2.3 Coordinate System

Click "Project" -> "Coordinate Systems Parameter", as shown in Figure 2.3-1. The coordinate system parameters are used to calculate and convert the latitude and longitude coordinates received from GNSS devices into the flat coordinates desired by the user. During this calculation and conversion process, specific parameters need to be set, and different parameter settings will yield different conversion results. The entire process of calculation and conversion includes:

1. Raw latitude and longitude coordinates -> Spatial rectangular coordinates on the CGCS2000 ellipsoid: Utilize CGCS2000 ellipsoid parameters;
2. Spatial rectangular coordinates on the CGCS2000 ellipsoid -> Spatial rectangular coordinates on the target ellipsoid: Employ benchmark transformation parameters;
3. Spatial rectangular coordinates on the target ellipsoid -> Target latitude and longitude coordinates: Use parameters specific to the target ellipsoid;
4. Target latitude and longitude coordinates -> Projected plane coordinates: Combine target ellipsoid parameters with projection parameters;

5. Projected plane coordinates -> Target plane coordinates: Apply plane correction and vertical correction parameters。

Click "Coordinate System Parameters" and, based on actual needs, choose whether to use RTCM parameters, as shown in Figure 2.3-2.

Click "Ellipsoid Parameters" to enter the ellipsoid management, as depicted in Figure 2.3-3. Choose the required ellipsoid from the ellipsoid list.;

Click "Projections Parameters" and select the desired projection method. There are various projection methods available, such as Gauss projection, UTM projection, Transverse Mercator projection, and Double Stereographic projection, as shown in Figure 2.3-4. If using Gauss projection, input the correct central meridian, northern constant, eastern constant, projection scale, and reference latitude parameters;

Click "Seven Parameters" to enter the seven parameters editing interface, as shown in Figure 2.3-5. The transformation models include the Bursa General Algorithm, Bursa Strict Algorithm, and other transformation models;

Click "Four Parameters/Horizontal Adjustment Parameters" to enter the four parameters editing interface, as shown in Figure 2.3-6. The transformation models include four parameters and horizontal adjustment models;

Click "Vertical Control Parameters" to enter the elevation fitting parameters editing interface, as shown in Figure 2.3-7;

Click "Vertical Adjustment Parameters" to enter the vertical correction parameters editing interface, as shown in Figure 2.3-8;

Click "Plane Grid File" to enter the plane grid model file interface, as shown in Figure 2.3-9. This supports grid conversion file conversion, importing grid offset files, and correcting coordinates based on the positions of transformation points in the grid.

Click "Height Grid Correction File" to enter the elevation grid file interface, as depicted in Figure 2.3-10. This supports geodetic level file conversion, importing geodetic level files, and correcting coordinate elevations based on the positions of transformation points in the level;

Click on "Geoid File" to enter the geodetic level parameters editing interface, as shown in Figure 2.3-11. Calculation modes include bilinear interpolation, biquadratic interpolation, spline interpolation, and other calculation modes;

Click "Local Offsets" to enter the base station translation parameters editing interface, as shown in Figure 2.3-12. In small-scale operations, sometimes there is only one control point, and a translation transformation is sufficient for converting from projected plane coordinates to target plane coordinates. You can set it here. The difference between translation parameters here and base station translation calibration lies in the fact that the coordinate system parameter settings here will affect all data in the entire project. If changed, it will recalculate the conversion between latitude and longitude coordinates and plane coordinates, whereas base station translation calibration only affects the measured coordinates after calibration operation.

Click "Export" to export the current coordinate system parameters, as shown in Figure 2.3-13. In addition to manually entering coordinate system parameters, you can also click on "Apply" below to import coordinate system parameters from local files or coordinate system templates, as shown in Figure 2.3-14. Coordinate system templates include commonly used coordinate system parameters for various countries and regions, as shown in Figure 2.3-15

Figure 2.3-1

Figure 2.3-2

Figure 2.3-3

←

Projections Parameter

Proj

Mod

Cent

Fals

Fals

Scal

Latit

Orig

Gauss Kruger(Average Latitude)

Gauss Kruger

UTM

UTM South Orientated

Transverse Mercator(Average Latitude)

Transverse Mercator

Transverse Mercator South Orientated

Lambert Conic Conformal(1SP)

Lambert Conic Conformal(2SP)

Oblique Stereographic(Double)

Romania Stereographic 1970

Romania Stereographic 1930

Cassini Soldner

Oblique Mercator

Hotine Oblique Mercator

Cancel

OK

Figure 2.3-4

←

Seven-Parameter

Use

Mode

ΔX

ΔY

ΔZ

$\Delta\alpha(s)$

$\Delta\beta(s)$

$\Delta\gamma(s)$

Scale(ppm)

Use

Helmert

0

0

0

0

0

0

0

Cancel

OK

Figure 2.3-5

←

Four-Parameter/Horizontal Adjustment

Use

Translate Northing

Translate Easting

Rotation

Scale

Original Northing

Original Easting

Use

0

0

0°00'00"

0

0

0

Note: If only Four-Parameter is used, Original Northing and Easting must be set to 0

Cancel

OK

Figure 2.3-6

←

Vertical Control Parameter

Use

Strict Model

A0

A1

A2

A3

A4

A5

X0

Y0

Use

Strict Model

0

0

0

0

0

0

0

0

Cancel

OK

Figure 2.3-7

←

Vertical Adjustment Parameter

Use

Adjustment Constant

North Slope(ppm)

East Slope(ppm)

Original Northing

Original Easting

Use

0

0

0

0

0

Cancel

OK

Figure 2.3-8

←

Plane Grid File

Use

Grid Type

Path

Use

.GDS,.GSB,*.GFS

>

Cancel

OK

Figure 2.3-9



Figure 2.3-10

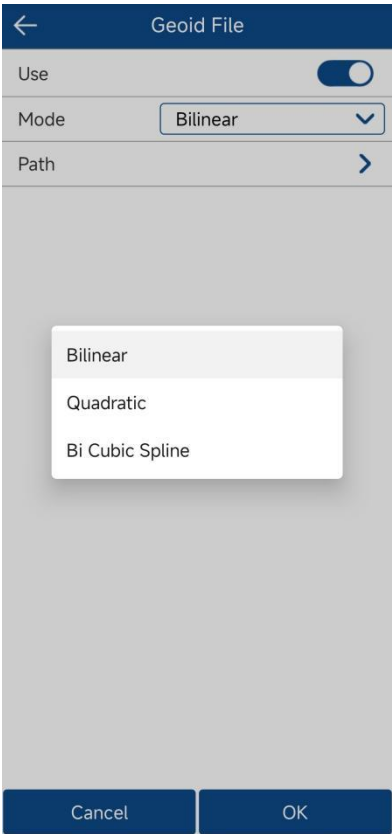


Figure 2.3-11

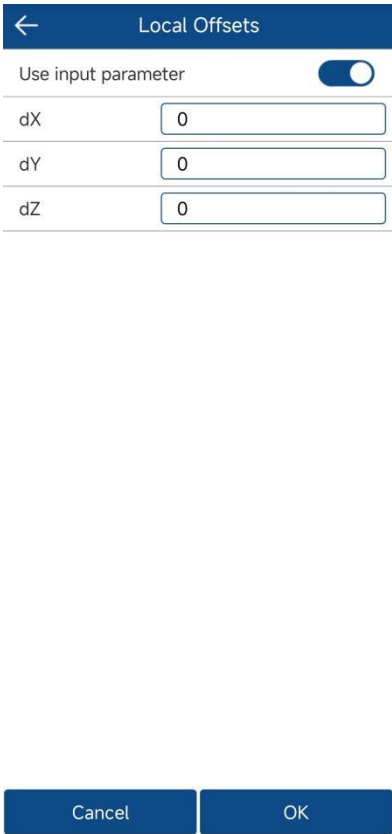


Figure 2.3-12

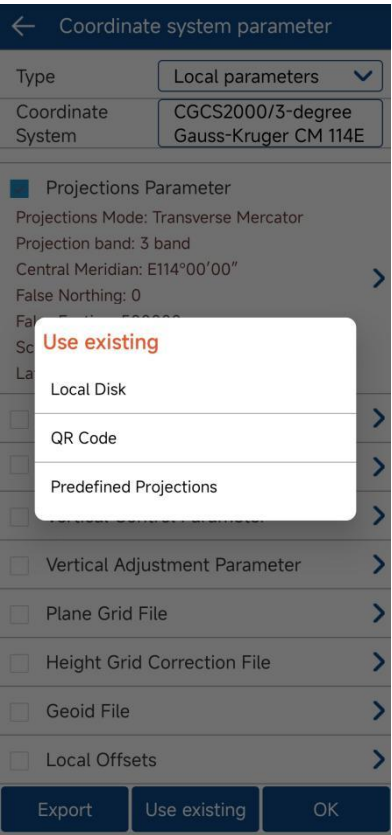


Figure 2.3-13

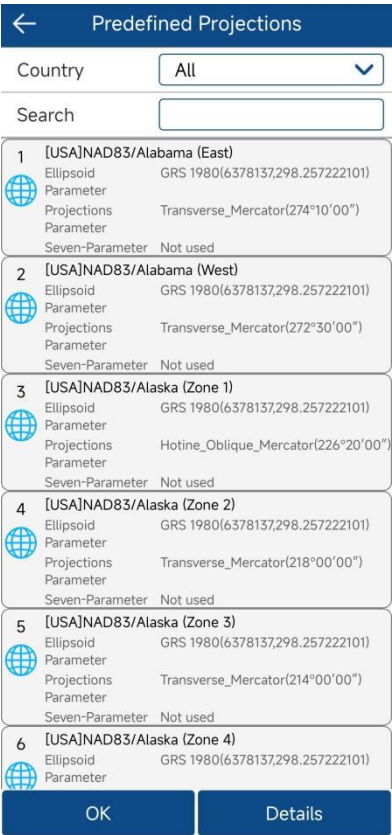


Figure 2.3-14

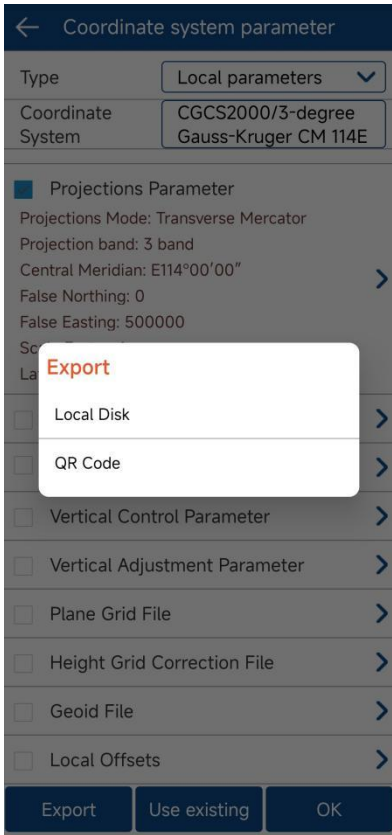


Figure 2.3-15

2.4 Localization

Click "Project" -> "Localization", as shown in Figure 2.4-1. You can import control point parameters in various formats and export control point data as files for use by third-party software. The high-precision position obtained from GNSS devices is in satellite positioning latitude and longitude coordinates. However, in actual project operations, ground plane coordinates are ultimately needed for measurement applications. If you have coordinated transformation parameters, they can directly set the coordinate system parameter values in the coordinate system section (refer to Section 2.3). If you do not have specific coordinate system parameters but have corresponding latitude and longitude coordinates and plane coordinate values, referred to as control points, this feature can be used to calculate the transformation parameters when control point data is available and apply them to project operations.

Click "Add," as shown in Figure 2.4-2. You can enter control points manually or choose to import them from the point database, as illustrated in Figure 2.4-3. In the control point list, selecting a data item allows you to modify, edit, and delete control point parameters, as shown in Figure 2.4-4.

After editing the control point parameters, calculate the transformation parameters for the control points by clicking "Convert Method," which will bring up the transformation parameter conditions setting, as shown in Figure 2.4-5. Coordinate transformation methods include plane correction, vertical correction, elevation fitting, and seven parameters. These methods can be used individually or in combination, and the calculated transformation parameters are considered usable as long as they fall within the permitted accuracy range. The plane correction model includes four parameters and horizontal adjustment, while the elevation fitting method includes weighted average, plane fitting, surface fitting, and vertical adjustment. Typically, if the working range is extensive, using the seven parameters may be necessary to meet the accuracy requirements for all control points. If the working range is relatively small, plane correction alone may achieve the required accuracy.

After configuring the calculation conditions, click on "Calculate." The results of the transformation parameter calculation and the residuals for each control point will be displayed, as shown in Figure 2.4-6. Once the transformation parameters are calculated, you can export a calculation report for project review. If the transformation parameters are qualified, you can apply them to the engineering project, enabling normal measurement operations.

← Localization

Calculate Mode Horizontal correction + Elev. correction

Import

Export

← control point

Known Coordinates

Name

North

East

Height

Geodetic Coordinates

Coordinates Type Geodetic Coordinate

Latitude 0°00'00"

Longitude 0°00'00"

Altitude

Options

Use Horizontal Control ☒

Use Vertical Control ☒

← Points Database

Point Library Stakeout point

Input name or code

Name	North	East	Height	
PPK p3	2562922.759	441774.925	28.601	N2
p2	2562922.766	441774.932	30.185	N2
p1	2562921.958	441775.532	26.112	N2
t9	2563061.444	441676.895	18.892	N2
t8	2563064.214	441632.112	18.656	N2
t7	2563148.178	441558.261	19.432	N2
t6	2563154.803	441670.117	19.385	N2
t5	2563103.008	441789.162	19.354	N2
t4	2563014.288	441794.819	18.121	N2
t3	2562917.758	441787.826	17.334	N2
t2	2562936.491	441707.220	16.931	N2
t1	2562960.967	441716.320	17.074	N2

Add Edit Delete Calculate

Figure 2.4-1

Cancel OK

Figure 2.4-2

IMPORT ADD OK

Figure 2.4-3

← Localization

Calculate Mode Horizontal correction + Elev. correction

No.	1	Name	t1
Horizontal...	0	Vertical...	0
Use Hori...	Use	Use Vert...	Use

No.	2	Name	t2
Horizontal...	0	Vertical...	0
Use Hori...	Use	Use Vert...	Use

No.	3	Name	t3
Horizontal...	0	Vertical...	0
Use Hori...	Use	Use Vert...	Use

Add Edit Delete Calculate

Figure 2.4-4

← Localization Settings

Convert Method Horizontal correction + Elev. correction

Horizontal correction Model Horizontal Adjustment

Vertical Control Automatic Selection

Horizontal Accuracy Limit 0.1

Vertical Accuracy Limit 0.1

Cancel OK

Figure 2.4-5

← GPS Parameters Report

Ellipsoid Parameter

Ellipsoid Name CGCS2000

Semimajor axis 6378137

1/f 298.257

Projections Parameter

Projections Mode Transverse Mercator

Central Meridian E114°00'00"

False Northing 0

False Easting 500000

Scale Factor 1

Projection Height 0

Latitude of Origin N0°00'00"

Standard Parallel 1 N0°00'00"

Standard Parallel 2 N0°00'00"

Four-Parameter/Horizontal Adjustment

Translate Northing 15.91112

Translate Easting -38.007505

Rotation 174°54'03.0964"

Scale 46.08128383656768

Original

Save Apply

Figure 2.4-6

2.5 Point Calibration

Click "Project" -> "Calibrate Point", as shown in Figure 2.5-1. In the actual application process, the GNSS device obtains high-precision positioning through differential data from reference stations. Here, we recognize that the coordinates of the reference station are known. In reality, the high-precision position output by the GNSS device is the relative position of the reference station. In practical applications, in addition to some users using differential data from CORS reference stations, a considerable number of users use differential data transmitted by their own GNSS devices.

When using the self-established base station to transmit differential data, a project may involve multiple starts of the reference station. During the startup of the reference station, the startup position and coordinates of the base station may change, and the startup coordinates may not be correct. Without calibration, the coordinates obtained using the differential data from these base stations may be incorrect. Therefore, when the mobile station receives new differential data from the base station for measurement operations, translation calibration is needed to ensure that the coordinates obtained by the software match the coordinates obtained from the last connected base station.

After the startup coordinates or position of the base station change, it is necessary to use a known position to calibrate the coordinates correctly.

Click "Base Point Calibration," as shown in Figure 2.5-2. Click  and select a known point from the point database (using the coordinates measured by the last base station at a specific location), then click "Calculate" and apply to complete the calibration process.

Click "Marker Point Calibration," as shown in Figure 2.5-3. Click  and select a known point from the point database (using the coordinates measured by the last base station at a specific location). Then, place the device at the location of the known point, click  to measure a new point," and calculate the deviation value. Click "Apply," and the coordinates received by the software will now match the coordinates measured in the last session.

If there is a notification about changes in base station coordinates and you are receiving differential signals from a self-established base station, it indicates the need for base station translation recalibration. In such cases, it is advisable to perform the base station translation

calibration again to ensure accurate coordination between the received coordinates and the actual ground coordinates.

Note: CORS stations are Continuously Operating Reference Stations where both the position and startup coordinates remain unchanged. If using differential data from CORS stations, even if the received coordinates may change, the obtained coordinates are still correct, and there is no need for translation calibration.

←

Calibrate Point

Base Point Calibration

>

Marker Point Calibration

>

dX

0

dY

0

dH

0

←

Calibrate Point

Known Point Coordinates

☰

North

2562960.967

East

441716.32

Height

17.074

Current Base Coordinates

Latitude

23°09'54.484426"

Longitude

113°25'51.930324"

Altitude

56.624

Antenna Parameters

0m,Height to phase center >

Result

Shift dX

21.646

Shift dY

-28.374

Shift dZ

-39.55

←

Calibrate Point

Known Point Coordinates

☰

North

2562960.967

East

441716.32

Height

17.074

Current WGS84 Coordinates

📍

Latitude

23°09'53.953632"

Longitude

113°25'52.998492"

Altitude

28.409

Result

Shift dX

37.975

Shift dY

-58.757

Shift dZ

-11.335

Clear

OK

Figure 2.5-1

Base Information

Calculate

Apply

Figure 2.5-2

Cancel

Apply

Figure 2.5-3

2.6 Points Database

Click "Project" -> "Points Database", as shown in Figure 2.6-1. Here, you can view and manage point data in the project, including functions such as adding, editing, deleting, importing, etc.

Click , as shown in Figure 2.6-2, to switch the display style of point information.

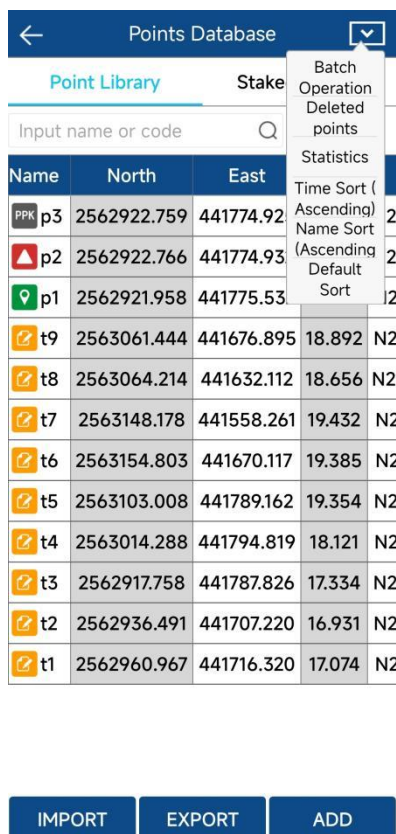
Click "Add," as shown in Figure 2.6-3. You can manually enter the point name, code, and corresponding coordinates;

Click "Import," as shown in Figure 2.6-4. Choose the file format for importing point data, then proceed to select the data file to complete the data import process;

Select the point, click "Edit," as shown in Figure 2.6-5, and you can edit and modify the name and code of the point;

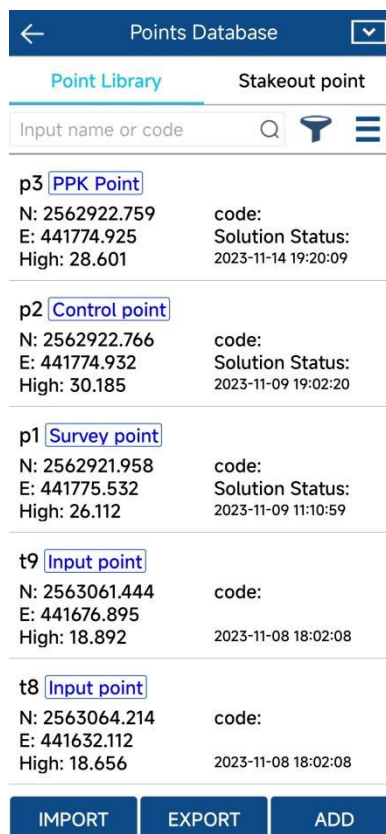
Click , as shown in Figure 2.6-6, to perform point type filtering.

Clicking  will pop up operations, as shown in Figure 2.6-1, where you can perform batch deletion, data statistics, sorting, and other functions as needed;



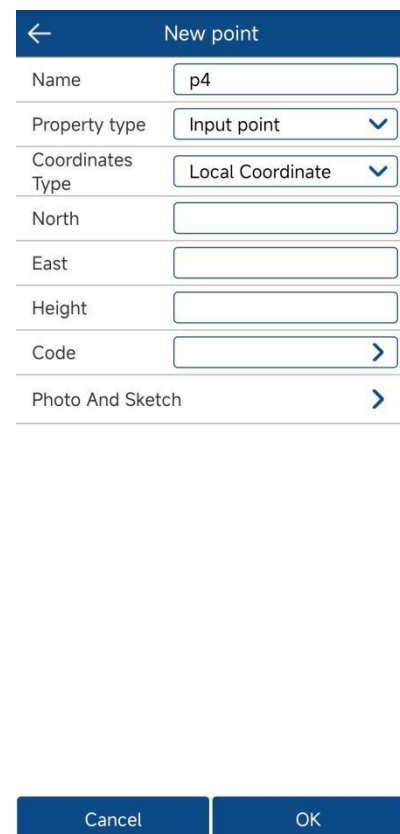
Points Database			
Point Library			Stake
Input name or code			
Name	North	East	
PPK p3	2562922.759	441774.92	
p2	2562922.766	441774.93	
p1	2562921.958	441775.53	
t9	2563061.444	441676.895	18.892 N2
t8	2563064.214	441632.112	18.656 N2
t7	2563148.178	441558.261	19.432 N2
t6	2563154.803	441670.117	19.385 N2
t5	2563103.008	441789.162	19.354 N2
t4	2563014.288	441794.819	18.121 N2
t3	2562917.758	441787.826	17.334 N2
t2	2562936.491	441707.220	16.931 N2
t1	2562960.967	441716.320	17.074 N2

Figure 2.6-1



Points Database	
Point Library	
Input name or code	
p3 PPK Point	
N: 2562922.759	code:
E: 441774.925	Solution Status:
High: 28.601	2023-11-14 19:20:09
p2 Control point	
N: 2562922.766	code:
E: 441774.932	Solution Status:
High: 30.185	2023-11-09 19:02:20
p1 Survey point	
N: 2562921.958	code:
E: 441775.532	Solution Status:
High: 26.112	2023-11-09 11:10:59
t9 Input point	
N: 2563061.444	code:
E: 441676.895	
High: 18.892	2023-11-08 18:02:08
t8 Input point	
N: 2563064.214	code:
E: 441632.112	
High: 18.656	2023-11-08 18:02:08

Figure 2.6-2



New point	
Name	p4
Property type	Input point
Coordinates Type	Local Coordinate
North	
East	
Height	
Code	
Photo And Sketch	

Figure 2.6-3



Figure 2.6-4

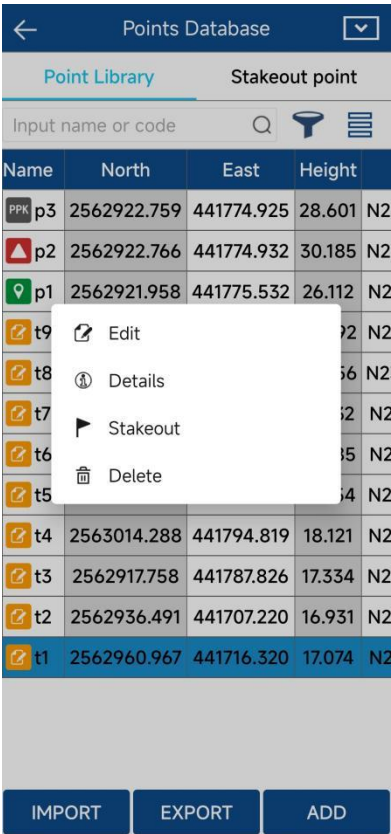


Figure 2.6-5

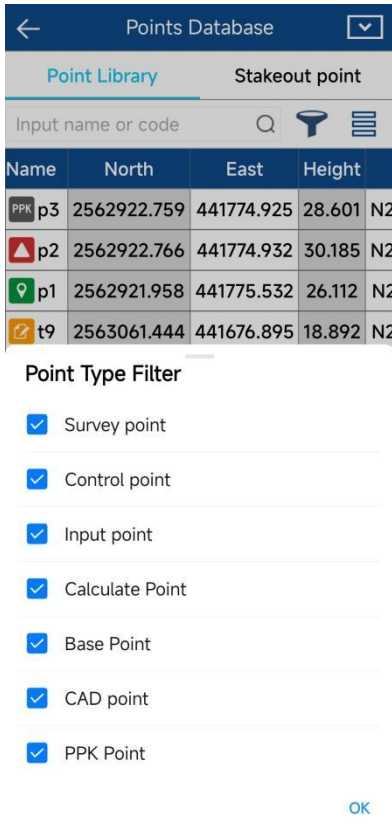


Figure 2.6-6

2.7 Export File

Click "Project" -> "Export File", as shown in Figure 2.7-1. Choose the type, file format, and angle format for exporting data as needed. Click on "Export File Manage," as shown in Figure 2.7-2, choose the file format for exporting data, and click "OK." Click on "User-Defined Format," as shown in Figure 2.7-3, to manually create and edit the file format for exporting data.

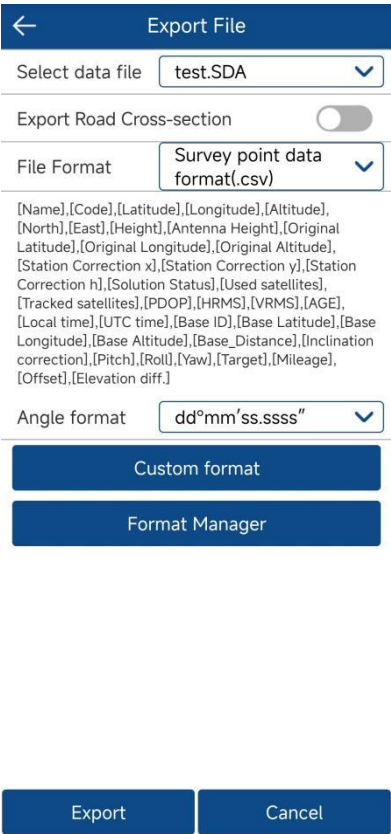


Figure 2.7-1

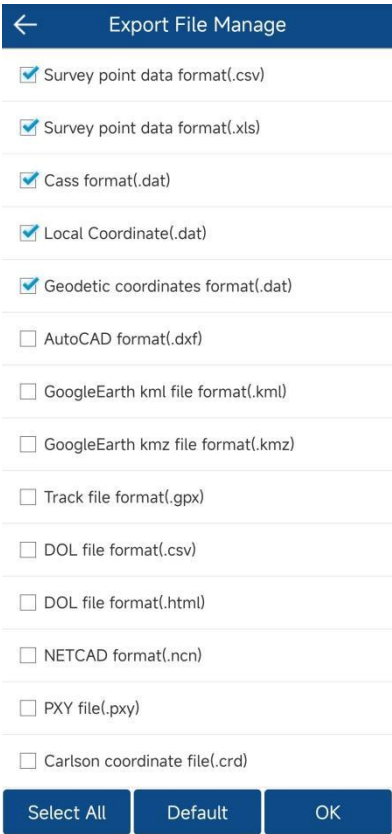


Figure 2.7-2



Figure 2.7-3

2.8 Code Library

Click "Project" -> "Code Library", as shown in Figure 2.8-1. The encoding library predefines the coding attributes for field-collected points, allowing for quick filling of code values through descriptive and intuitive selections;

Click  to the right of the code library name, as shown in Figure 2.8-2. Here, you can import, add, and delete code file names;

Click  to the right of the group name, as shown in Figure 2.8-3. Here, you can add, edit, and delete code library group names;

Select a group and click "Add," as shown in Figure 2.8-4, to manually enter the name and code;

Select a code and click "Edit," as shown in Figure 2.8-5, to edit the name and code;

Select a code and click "Delete," as shown in Figure 2.8-6, to delete the code;

Click "Close" to return to the main project interface.

← Encoding Library

Code library name

Test

Group Name

whole

test1

t1

← Encoding Library File Management

Serial number	Code library name
1	CASS
2	Test

← Group name management

1

T1

Add

Edit

Delete

Close

Figure 2.8-1

Import

Add

Delete

Close

Figure 2.8-2

Add

Edit

Delete

Close

Figure 2.8-3

← Addcode

Group Name

T1

Name

code

← Editcode

Group Name

T1

Name

test1

code

t1

← Encoding Library

Code library name

Test

Group Name

T1

Cancel

OK

Figure 2.8-4

Cancel

OK

Figure 2.8-5

Add

Edit

Delete

Close

Figure 2.8-6

2.9 Software Settings

Click "Project" -> "Software Settings", which includes settings for system, speech, storage, and shortcuts.

System: As shown in Figure 2.9-1, this includes settings for language, text encoding, angle display format, length units, coordinate display order, map display, interface style, and more;

Speech: As shown in Figure 2.9-2, this includes settings for layout tolerance, volume, voice prompts, solution status, and other sound-related configurations;

Storage: As shown in Figure 2.9-3, this involves settings for storing conditions such as terrain points, control points, fast points, continuous points, etc.;

Shortcut Keys: As shown in Figure 2.9-4, this section allows you to predefine functions triggered by physical keyboard shortcuts on the device. You can add shortcuts, choose the function to define a shortcut for, set the shortcut value, and quickly trigger the corresponding function during measurement applications.

Software Settings			
system	speech	storage	Shortcut keys
Language	English		
Text encoding	ANSI		
Angle Format	dd°mm'ss.ssss"		
Angle decimal	4		
Station. Format	0.000		
Distance Unit	Meter		
Distance decimal	3		
Coordinate order habit	North-East		
CAD Background color	White		
Display Map	No Map		
Interface style	Grid		
Full screen display		☐	

CANCEL OK

Figure 2.9-1

Software Settings			
system	speech	storage	Shortcut keys
Prompt tone			
Stakeout range error		☒	
Save Point		☒	
Volume		<input type="range"/>	
Voice broadcast		☐	

CANCEL OK

Figure 2.9-2

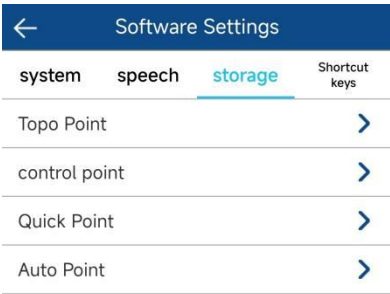


Figure 2.9-3

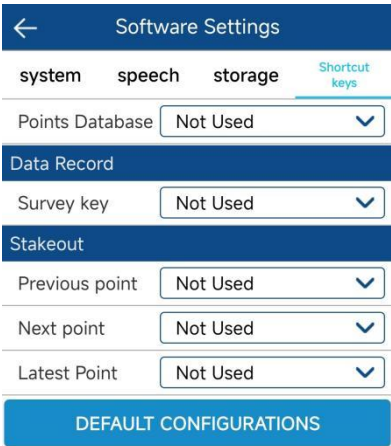


Figure 2.9-4

2.10 About Software

Click "Project" -> "About Software", as shown in Figure 2.10-1, to view the software's version information and registration authorization details.

Click "Check for New Versions". If there is a new version, a popup with information about the update will appear. Click "Update" to install the latest version of the software. If there is no new version, a message will indicate that the software is already up to date.

Click "Software Registration", and it will take you to the software registration interface, as shown in Figure 2.10-2. Here, you can view the activation ID and expiration date.

For the first-time software installation, click on "Online Activation." This allows you to activate the software for free for three month directly.

Click on "Manual Code Activation", as shown in Figure 2.10-3. Here, you can input the authorization code or scan the QR code to activate the software.

If you need to change to a new controller, you can click "Transfer Registration Code" in the old controller. After that, enter the transferred activation code in the software registration of the new controller to activate the software.



Figure 2.10-1



Figure 2.10-2

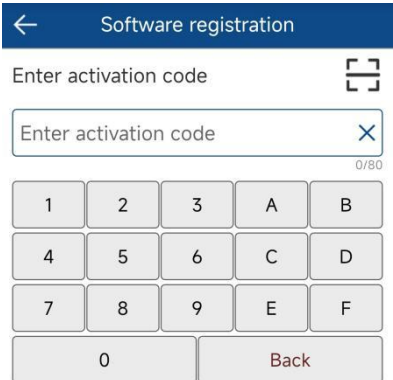


Figure 2.10-3

2.11 Grid To Ground

Click "Project" ->"Grid To Ground" , as shown in Figures 2.11-1 and 2.11-2. This function calculates the grid correction factor at a reference point, which is then applied to other points in the coordinate point database. This allows the GNSS measured points to match with the total station points. The corrected coordinates can be exported during data export.



Figure 2.11-1

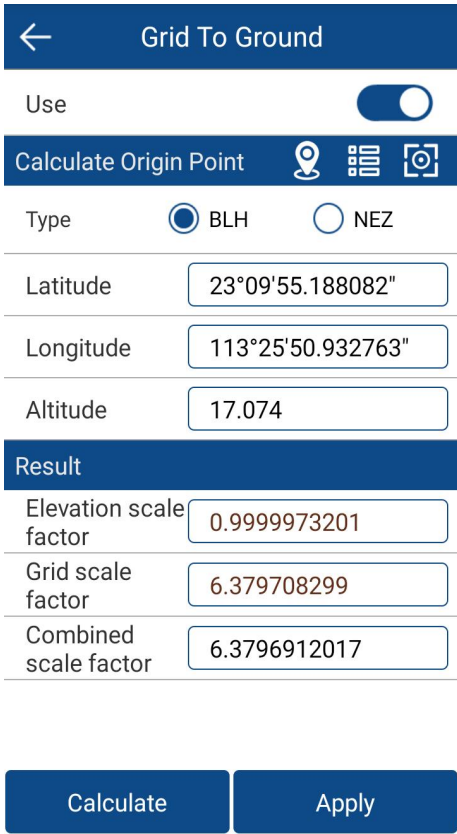


Figure 2.11-2

2.12 Sharing Code

Click on "Project" -> "Sharing Code" , as shown in Figure 2.12-1. On one controller, select the project or files you wish to share. Once the sharing is complete, as shown in Figure 2.12-2, other controllers can enter the share code or scan the QR code in the software's main interface to receive the shared files, as shown in Figure 2.12-3.

Note: Whether sharing or receiving files, the controller must first be connected to the internet.

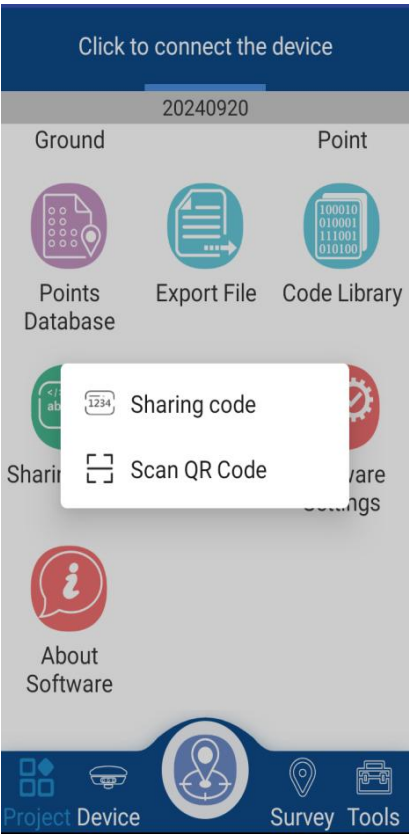


Figure 2.12-1

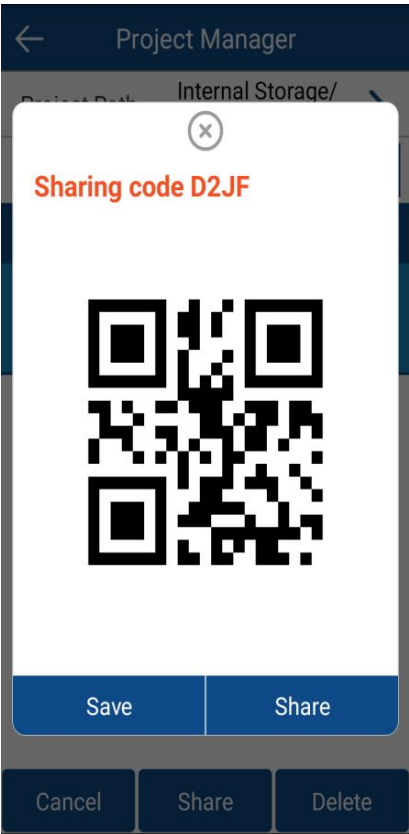


Figure 2.12-2

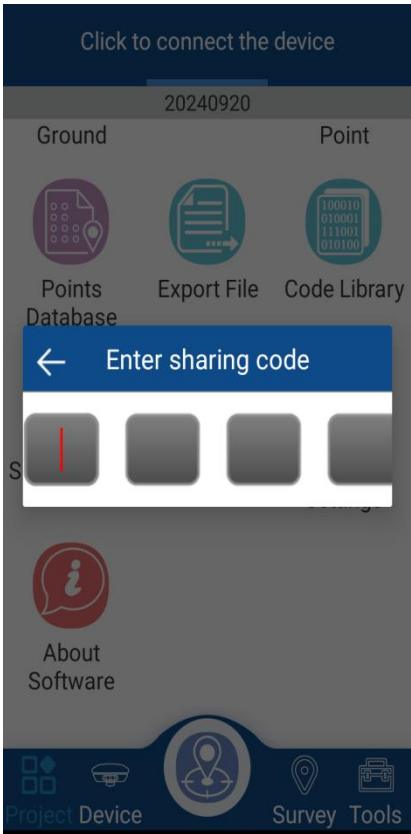


Figure 2.12-3

3. Device

On the software's main menu, click "Device", as shown in Figures 3-1 and 3-2. The "Device" section includes functions such as Communication, Rover, Base, Static, Device Information, Device Settings, Restart Positioning, and Device Activation.



Figure 3-1

Figure 3-2

The software's data measurement collection and application are based on high-precision GNSS positioning. Before starting the operation, it is necessary to establish communication with the GNSS positioning device. The software retrieves high-precision location data from the device, and certain conditions must be met for the device to obtain high-precision location. This involves configuring parameters for the device

3.1 Communication

Click "Device" -> "Communication" to enter the communication settings, as shown in Figure 3.1-1. Select the instrument type ("RTK"), communication mode ("Bluetooth"), then click "Search," as shown in Figure 3.1-2, to view the Bluetooth device list. Select the corresponding device serial number, click "Connect" to complete the device connection, as shown in Figure 3.1-3 After

successfully connecting the device, it will directly return to the menu, as shown in Figure 3.1-4. To re-enter communication settings, as shown in Figure 3.1-5, clicking "Stop" will disconnect the device connection. Clicking "Debug" allows you to view the data communication between the software and the device, as shown in Figure 3.1-6.

- 1、Communication modes include Bluetooth, Port, TCP client, etc;
- 2、Click "Search" to enter Bluetooth search and selection. Click on the corresponding device serial number to choose the device you want to connect to;
- 3、After successfully connecting the device, click "Debug" to view the data communication between the software and the device. You can also send debug commands to the device to troubleshoot and analyze location-related issues.

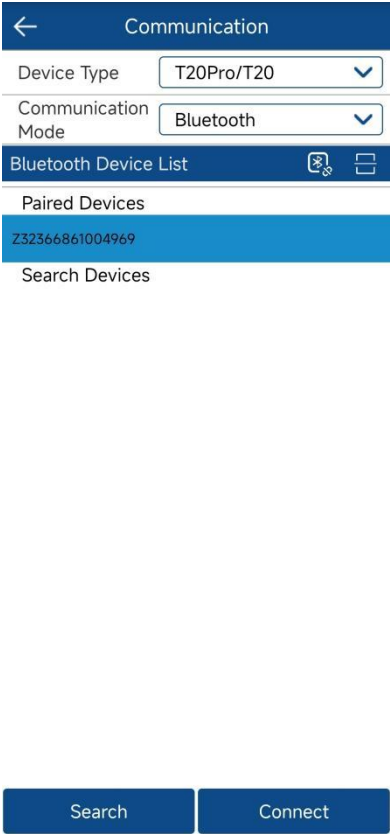


Figure 3.1-1

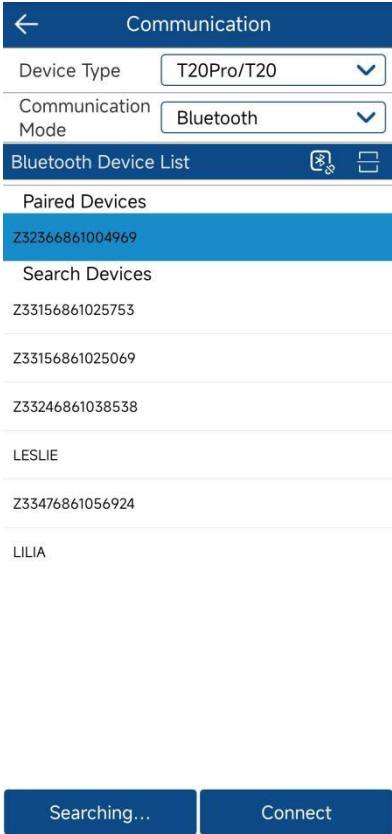


Figure 3.1-2

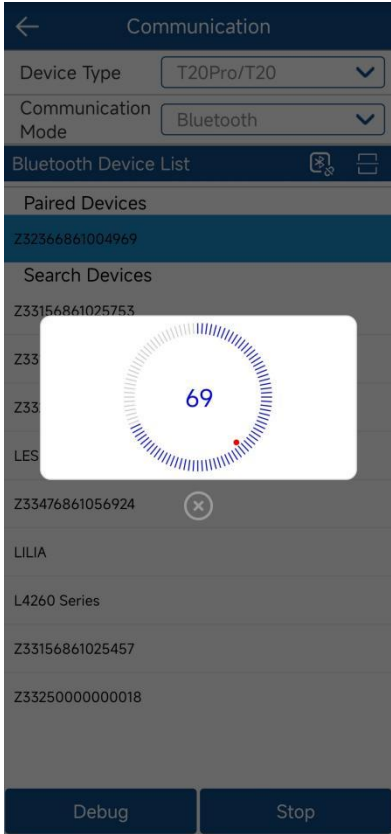


Figure 3.1-3

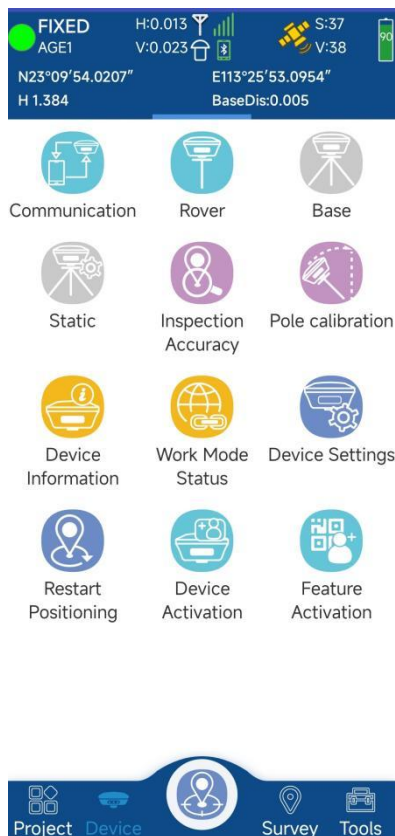


Figure 3.1-4

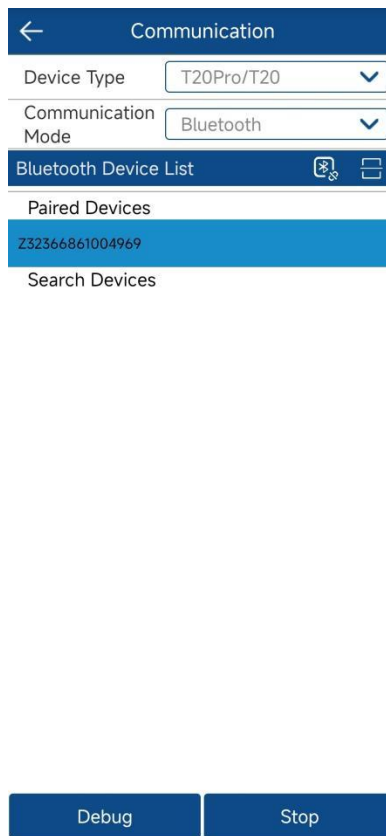


Figure 3.1-5



Figure 3.1-6

3.2 Rover

Click "Device" -> "Rover", as shown in Figure 3.2-1. GNSS positioning devices can calculate the position coordinates by receiving satellite signals, normally, due to atmospheric effects on signals, the positioning device can only obtain coordinates with a single-point solution, resulting in low accuracy. To ensure high-precision positioning with GNSS, in addition to the GNSS device itself receiving and calculating positions from satellite signals, it also needs to receive signals from another nearby fixed-position GNSS device. This second device's signal serves as the reference signal. Since the atmospheric effects on signals are generally consistent within a certain area, with the known coordinates of the reference signal, the two sets of GNSS can calculate high-precision positions. The GNSS device with a fixed position is called the reference station, while the one with a variable position is called the mobile station. The data transmitted from the reference station to the mobile station is referred to as differential data, and the data transmission method is known as a data link. The Mobile Station Mode setting configures the GNSS device as a mobile station, establishing certain parameters to transmit the reference station's GNSS satellite signals to the GNSS device through a specific method, allowing the GNSS device to achieve high-precision positioning.

In addition to configuring the differential data transmission, you can also set basic information for GNSS, such as the elevation cutoff angle, differential delay, and whether to enable PPK (Post-Processed Kinematics), as shown in Figure 3.2-1. Setting the elevation angle below a certain value will exclude the reception of satellite signals at low angles. In situations with poor signal quality at low angles, this can be beneficial for precision calculation. PPK parameters involve recording raw observational data from GNSS receivers and using post-processing algorithms to calculate high-precision coordinates.

Differential data parameter settings are primarily for configuring the transmission of differential data from the reference station to the current device through a specific method. This provides necessary conditions for the device to calculate high-precision coordinates. Data transmission methods mainly include Phone Internet, Device Internet, Internal Radio, and other options:

1、Phone Internet: As shown in Figure 3.2-1, it refers to obtaining differential data through the network of the device where the software is located. The data is acquired from a specified server address according to a certain protocol, and then transmitted to the device through the software's communication connection for high-precision calculation. Click the  at the right of CORS setting to enter CORS settings, as indicated in Figure 3.2-2. Here, you can directly select, edit, or delete existing CORS servers, or manually add CORS server, as shown in Figure 3.2-3. After correctly configuring the server address, retrieve the mount point list, as shown in Figure 3.2-4, and select the corresponding Mount point to obtain differential data. Click "Start," and if the configuration is correct, the data reception progress bar will start moving. If the progress bar shows no data, check whether the configuration is correct.

2、Device Internet: As shown in Figure 3.2-5, it refers to obtaining differential data through the SIM card network of the GNSS device. This is done according to a certain protocol from a specified server address for high-precision calculation. The connection mode involves the transfer protocol for differential data, typically using NRTIP, TCP client, etc. Enter server IP, port, username, and password. The SIM network is a dedicated network, and APN parameters need to be configured, as shown in Figure 3.2-6. CORS settings are similar to Phone Internet settings. After correctly configuring the server address, retrieve the mount point list and select the corresponding mount point to obtain differential data. Mount points can be obtained through the device network, or if a mobile phone has a network, it can also be obtained through the corresponding network of the mobile phone.

3、Internal Radio: As shown in Figure 3.2-7, it refers to obtaining differential data through the built-in radio of the GNSS device. According to a certain protocol and frequency, the device receives differential data from the radio for high-precision calculation. In this case, it is necessary to ensure that the protocol and frequency of the built-in radio match those of the transmitting radio to receive the radio data normally. If the frequency of the channel does not match the channel frequency of the transmitting radio, you can click "Set Radio Frequency" to modify the frequency corresponding to each channel of the radio, as shown in Figure 3.2-8.

4、XLINK: As shown in Figure 3.2-9, it is a differential forwarding system built on the CORS network of Qianxun/Sixents/China Mobile. After configuring the XLINK data link, the device can access the differential data normally as long as it can connect to the Internet, without the need for the user to manually enter CORS account information.

Note: Every data link has the baseline coordinate change prompt enabled by default. This is because receiving incorrect base station signals may lead to inaccurate coordinates, and it is recommended to check and confirm.

←

Rover mode settings

Basic Information

Cut-off angle5

AGE60

Record raw data

Base Coordinates Change Alert

Data linkPhone Internet

Connect modeNTRIP

CORS Settings

Nameb

User*

Password•

MountPoint Settings

MountPointAA_Z32243660000387

GET ACCESS POINT LIST

Receive data878 bytes/s

←

CORS server manager

1b

IP120.77.83.81Port6060

User Name*Password*****

←

Server Address

Name

IP

Port

User

Password

START

ADVANCED

APPLY

Add

Edit

Delete

OK

Cancel

OK

Figure 3.2-1

Figure 3.2-2

Figure 3.2-3

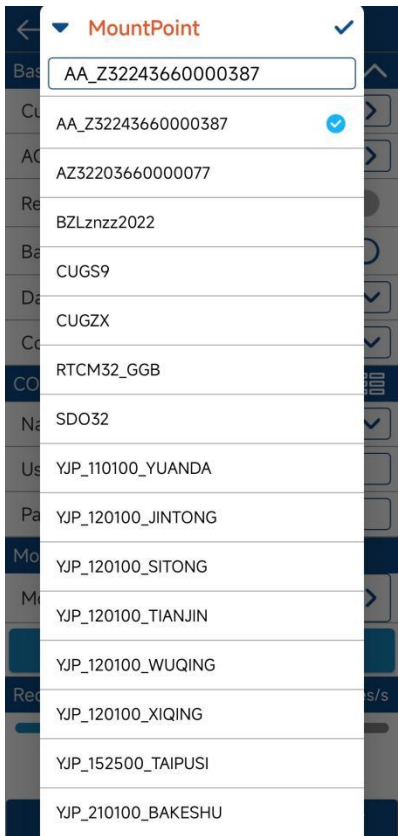


Figure 3.2-4



Figure 3.2-5



Figure 3.2-6

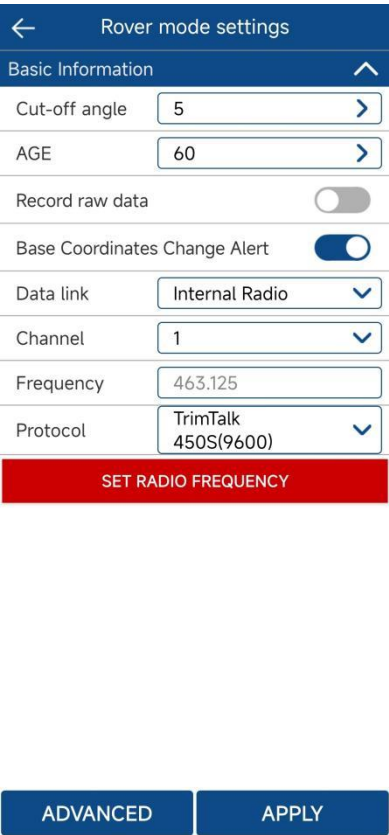


Figure 3.2-7

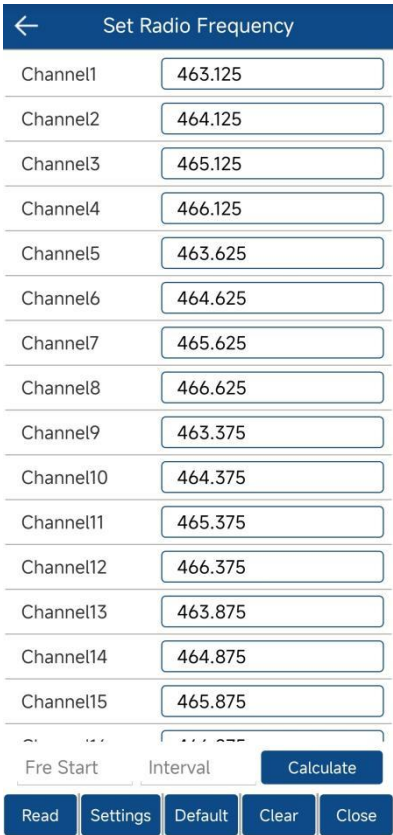


Figure 3.2-8

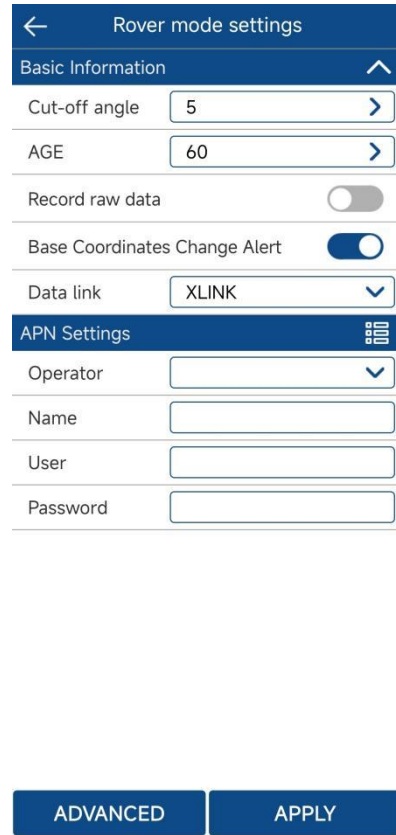


Figure 3.2-9

3.3 Base

Click "Device" -> "Base", as shown in Figure 3.3-1. This function allows the GNSS device to act as a base station, sending satellite information data in a certain way to provide high-precision calculation conditions for the receiving rover station. The main station as a base station needs to set parameters such as startup conditions, startup mode, and data broadcast parameters.

Note: During the base station startup period, the device is not allowed to move; otherwise, it may cause errors in the coordinates calculated by the rover station.

Startup conditions include parameters such as base station ID, differential data format, elevation mask angle, PDOP limit, etc. Click "Advanced," as shown in Figure 3.3-2, to configure parameters such as elevation mask angle and PDOP limit. The differential data formats include commonly used formats such as CMR, RTD, RTCM23, RTCM30, RTCM32, RTCM33;

The startup mode includes using a single-point coordinate and specifying the base station coordinate:

1、Using a single-point coordinate: This means that the GNSS device outputs differential broadcast data based on the current position (with low accuracy) as the startup coordinate;

2、Specifying the base station coordinate: This involves the user specifying the coordinates based on the location where the device is set up. The user pre-knows the coordinates of this position, and these coordinates are used as the startup coordinates for outputting differential broadcast data.

Click  to measure a point, or click  to measure a point in real-time or select a coordinate value from the coordinate point library, as shown in Figure 3.3-3.

Data broadcast mainly involve how the base station, after startup, outputs the differential data for the mobile station to receive and use. The main methods include the Device Internet, Internal Radio, external radio, etc. Settings are similar to those for the rover station, with the following differences:

1、The Internal Radio has a transmission power, and the higher the transmission power, the farther the effective range, but it also consumes more power;

2、For the Device Internet NTRIP protocol, the base station sets the starting transmission base station access point, as shown in Figure 3.3-1, while the rover station obtains a list of mount points and selects the corresponding base station mount point for connection;

- 3、 The base station uses an external radio for differential data broadcast, as shown in Figure 3.3-4. The baud rate must match that of the connected external radio;
- 4、 CORS settings refer to the corresponding configuration of the rover station's data link

← Base mode settings

Base ID0

Start up mode

☒ Use Current Coordinates

☐ Input Base Coordinates

Base station parameters

Diff modeRTCM32

Record raw data

Data linkDevice Internet

APN Settings

OperatorAuto

CORS Settings

Nameb

Base access pointRTCM32

Password...

ADVANCED

APPLY

Figure 3.3-1

← Satellites System

Cut-off angle5

PDOP limit3.0

GPSToggle

GLONASToggle

BEIDOUToggle

GALILEOToggle

SBASToggle

QZSSToggle

IRNSSToggle

Cancel

OK

Figure 3.3-2

←

Base mode settings

Base ID

0

Start up mode

Use Current Coordinates

☐

Input Base Coordinates

☒

Base station coordinates

Latitude

23°09'54.085032"

Longitude

113°25'52.992552"

Altitude

23.9759

Coordinates Type

BLH

☒

NEZ

☐

Antenna Parameters

0m,Pole Height

>

Base station parameters

Diff mode

RTCM32

▼

Record raw data

☐

Data link

Internal Radio

▼

Channel

1

▼

Frequency

463.125

Protocol

TrimTalk 450S(9600)

▼

Power

High

▼

SET RADIO FREQUENCY

ADVANCED

APPLY

Figure 3.3-3

←

Base mode settings

Base ID

0

Start up mode

Use Current Coordinates

☐

Input Base Coordinates

☒

Base station coordinates

North

2562926.804

East

441774.7775

Height

23.9759

Coordinates Type

BLH

☐

NEZ

☒

Antenna Parameters

0m,Pole Height

>

Base station parameters

Diff mode

RTCM32

▼

Record raw data

☐

Data link

External Radio

▼

Baud Rate

115200

>

ADVANCED

APPLY

Figure 3.3-4

3.4 Static

Click "Instruments" -> "Static", as shown in Figure 3.4-1. This feature is designed to store the satellite's raw observation data from the GNSS device into a designated disk file, recording observational data over a period for later use with static post-processing software to calculate high-precision coordinates. It is typically used for control point collection. To initiate static mode, you need to set the point name for the static file, as well as conditions for recording such as PDOP limit, elevation cutoff angle, collection interval, antenna parameters, and file format, etc, as shown in Figure 3.4-2.

Click "Start" to start static collection, as shown in Figure 3.4-3, and click "Stop" to end static collection. In the status, information such as record status, start time, number of epochs, and record file name is displayed.

Note: During static recording, device movement is not allowed, as it may result in inaccuracies in the coordinates calculated during post-processing.

←

Static mode settings

Options Settings

Name

4969

PDOP limit

3.0

>

Cut-off angle

10

>

Collection Interval

1Hz

▼

Observation time

30min

>

File Format

GNSS

▼

Execute after completion

Switch to Rover

▼

Antenna Parameters

Antenna Measured Height

1.8

Antenna Measurement Type

Vertical height

▼

Antenna Height

1.86

Status

Record Status

Non static mode

Start Time

End Time

Advanced

Start

Figure 3.4-1

←

Static mode settings

Options Settings

Name

4969

PDOP limit

3.0

>

Cut-off angle

10

>

Collection Interval

1Hz

▼

Observation time

30min

>

File Format

GNSS

▼

Execute after completion

Switch to Rover

▼

Antenna Parameters

Antenna Measured Height

1.8

Antenna Measurement Type

Vertical height

▼

Antenna Height

1.86

Status

Record Status

Non static mode

Start Time

End Time

Advanced

Start

Figure 3.4-2

←

Static mode settings

Options Settings

Name

4969

PDOP limit

3.0

>

Cut-off angle

10

>

Collection Interval

1Hz

▼

Observation time

30min

>

File Format

GNSS

▼

Execute after completion

Switch to Rover

▼

Antenna Parameters

Antenna Measured Height

1.8

Antenna Measurement Type

Vertical height

▼

Antenna Height

1.86

Status

Record Status

Static mode, writing file

Start Time

20240104-033132

End Time

20240104-040110

Epoch number

68

Record file

4969-03-20240104-033132.gnss

28min

Advanced

Stop

Figure 3.4-3

3.5 Inspection Accuracy

Click "Instruments" -> "Inspection Accuracy", as shown in Figures 3.5-1, 3.5-2, and 3.5-3. This feature involves using the inertial navigation measurement function to collect data from inclined measurement points at a fixed location. It calculates the maximum coordinate differences among the collected points to assess the accuracy of the device when utilizing the inertial navigation measurement function.

Note: This function can only be used when the instrument has achieved a fixed solution and the inertial navigation convergence is completed.

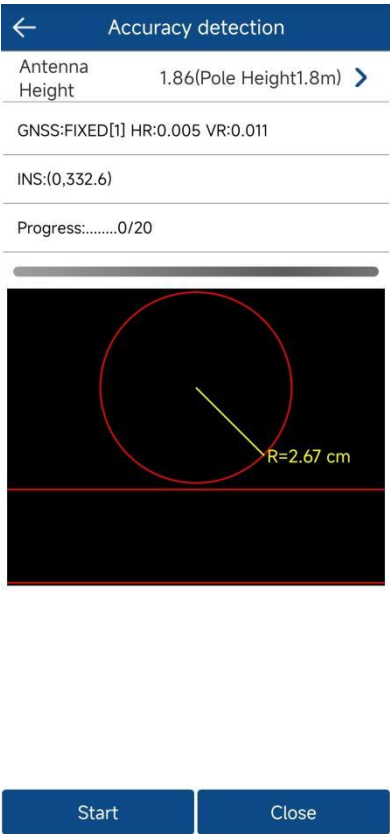


Figure 3.5-1

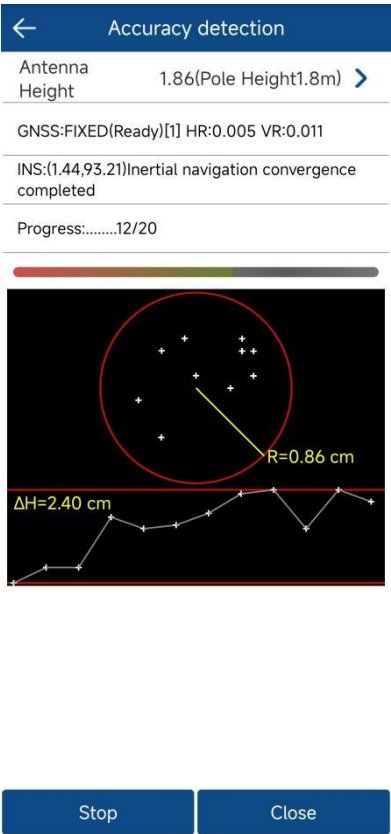


Figure 3.5-2

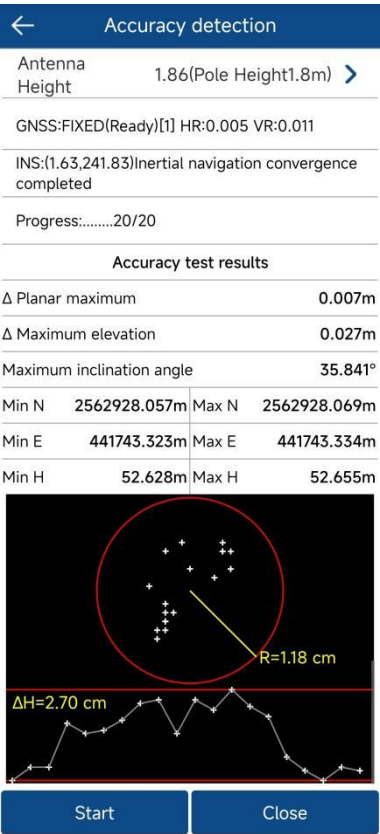


Figure 3.5-3

3.6 Pole Calibration

Click on "Device" -> "Calibrate Sensor", as shown in Figures 3.6-1, 3.6-2, and 3.6-3. If the accuracy check reveals poor results, you can use the collimation pole calibration function to correct the measurement errors caused by the curvature changes of the pole.

Pole calibration needs to be performed only once for the same instrument and the same pole. Each device is calibrated before leaving the factory, and if the pairing remains unchanged, there is no need to perform pole calibration again.

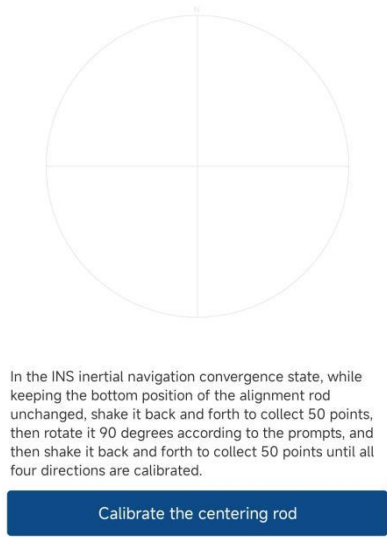
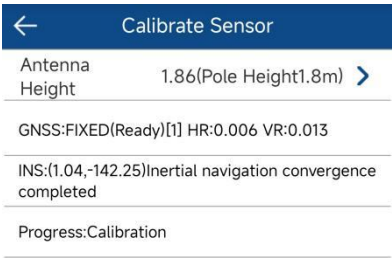


Figure 3.6-1

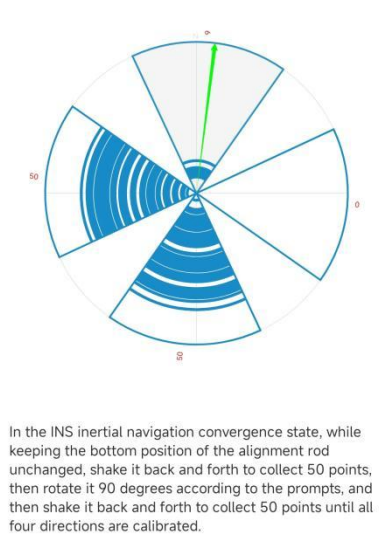
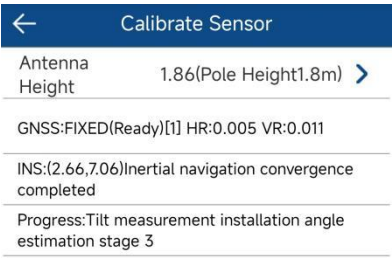


Figure 3.6-2

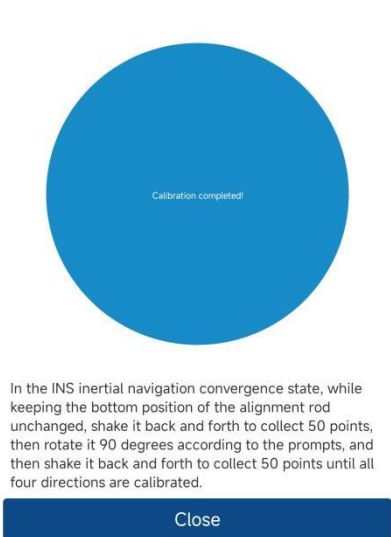
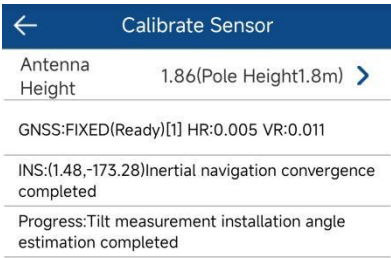


Figure 3.6-3

3.7 Device Information

Click "Device" -> "Device Information", as shown in Figure 3.7. Here, you can view basic information about the GNSS device, including its operating mode, device serial number, firmware version, battery status, expiration time, satellite systems, antenna parameters, and more.

Details	
Basic Information	
Working Mode	Rover
Device Serial no	Z32366861004969
Firmware Version	M68-FMW3.1.473.2311.1 829
Current DataLink	Phone Internet
Battery Power	89%
Expiry date	20240221
IMEI	868343049829653
Satellites System	
Enable GPS	Enable
Enable BEIDOU	Enable
Enable GLONASS	Enable
Enable GALILEO	Enable
Antenna Parameters	
Antenna Type	ZX-M68-K4T4
Radius	130mm
SHMP Offset	0mm
L1 Offset	60.07mm
L2 Offset	57.09mm

OK

Figure 3.7

3.8 Device Settings

Click "Device" -> "Device Settings", as shown in Figure 3.8-1. Here, you can choose the output frequency of positioning and inertial navigation data, toggle device voice, and switch the WIFI mode. When operating as a client, you can connect to an external hotspot to access the network, as illustrated in Figure 3.8-2. (Note: The device currently supports only 2.4G external hotspots.)

Click "Factory Reset" to restore the device to factory settings.

Click "VPN Settings" to enter the VPN settings. ZXVPN can establish a virtual local network, connecting the device to the server. This allows for remote technical support and services through WEBUI access in the background. Before connecting to the ZXVPN server, the device itself must have internet access (insert a SIM card or connect to an external hotspot). Click "Default," as shown in Figure 3.8-3, and then click "Apply."

←

Device Settings

Solution Mode

Normal Mode

▼

Tilt Survey

Sensor output frequency

5HZ

▼

Positioning data output frequency

1HZ

▼

Voice

Base Coordinates Change Alert

Factory Reset

>

VPN

>

WIFI Connect Mode

WIFI hotspot

▼

User

Z32366861004969

Password

←

Device Settings

Solution Mode

Normal Mode

▼

Tilt Survey

Sensor output frequency

5HZ

▼

Positioning data output frequency

1HZ

▼

Voice

Base Coordinates Change Alert

Factory Reset

>

VPN

>

WIFI Connect Mode

Client

▼

User

MI

Password

.....

←

VPN Setting

Sim card network

APN Settings

Operator

Auto

▼

VPN

Enabled

IP

zxvpn.devecent.com

Port

8222

Name

TEST

User

zxvpn

Password

.....

Status

Network Status

Disable

IP

Cancel

OK

Figure 3.8-1

Cancel

OK

Figure 3.8-2

Default

Apply

Figure 3.8-3

3.9 Repositioning

Click "Device" -> "Restart Positioning", and you can directly clear the mainboard ephemeris, reset the positioning engine of the GNSS device, achieving the effect of repositioning.

3.10 Device Activation

Click "Device" -> "Device Activation", as shown in Figure 3.10, to view the device serial number and expiration date. If the GNSS device has expired, you can obtain the registration code from the dealer and authorize the device registration here.



Figure 3.10

3.11 Others

1、Click the  in the software's top title bar to access the communication settings, as shown in Figure 3.1-5.

2、Click the  in the software's top title bar to enter the rover station settings, as shown in Figure 3.2-1.

3、Click the "Advanced" button in the lower-left corner of the rover station, base station, or static mode, entering the advanced settings, as shown in Figure 3.3-2. Use the buttons to enable or disable the satellite systems of the GNSS device.

4、Click the  in the software's top title bar to view the device's output positioning information, base station information, and star chart information, as shown in Figure 3.11-1, Figure 3.11-2, Figure 3.11-3, and Figure 3.11-4. Since the differential data does not transmit the antenna parameters of the base station and only transmits the phase center coordinates of the base station's transmission, to obtain the ground coordinates corresponding to the base station's startup, you can input the antenna parameters corresponding to the base station.

←

Position Information

Position Information

Base Information

SAT Map

FIXED

AGE: 1

HRMS

0.006

VRMS

0.01

North

2562922.768

East

441774.929

Height

28.383

Latitude

N23°09'53.9538"

Longitude

E113°25'52.9984"

Altitude

28.383

Satellite Number

40/41

BDS

19

GPS

9

GLN

6

GAL

6

QZSS

0

SBAS

0

Speed

0.003

Heading

271.05

HDOP

0.7

VDOP

1.8

UTC time

2023-12-01 09:40:00.000

Local time

2023-12-01 17:40:00.044

Figure 3.11-1

←

Position Information

Position Information

Base Information

SAT Map

Base ID

0

Base Latitude

N23°09'54.4844"

Base Longitude

E113°25'51.9303"

Base Altitude

56.624

Altitude

56.564

North

2562939.209

East

441744.611

Height

56.564

Base_Distance

44.568

BASE ANTENNA

DAP ΔMETER

SAVE

Figure 3.11-2

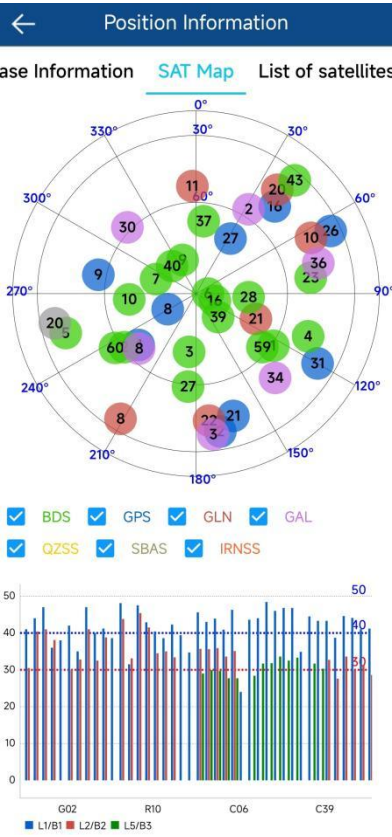


Figure 3.11-3

←

Position Information

Base Information

SAT Map

List of satellites

GPS	L1/B1: 41.5	L2/B2: N/A	L5/B3: N/A
G02	Elevation Angle:	Azimuth: 170	Locked.: Yes
GPS	L1/B1: 44.7	L2/B2: 39.5	L5/B3: N/A
G04	Elevation Angle:	Azimuth: 227	Locked.: Yes
GPS	L1/B1: 46.8	L2/B2: 40.0	L5/B3: N/A
G08	Elevation Angle:	Azimuth: 241	Locked.: Yes
GPS	L1/B1: 39.3	L2/B2: 35.9	L5/B3: N/A
G09	Elevation Angle:	Azimuth: 281	Locked.: Yes
GPS	L1/B1: 38.2	L2/B2: 29.1	L5/B3: N/A
G16	Elevation Angle:	Azimuth: 42	Locked.: Yes
GPS	L1/B1: 41.5	L2/B2: 29.6	L5/B3: N/A
G21	Elevation Angle:	Azimuth: 163	Locked.: Yes
GPS	L1/B1: 35.0	L2/B2: 31.6	L5/B3: N/A
G26	Elevation Angle:	Azimuth: 65	Locked.: Yes
GPS	L1/B1: 47.2	L2/B2: 39.7	L5/B3: N/A
G27	Elevation Angle:	Azimuth: 32	Locked.: Yes
GPS	L1/B1: 40.2	L2/B2: 32.5	L5/B3: N/A
G31	Elevation Angle:	Azimuth: 120	Locked.: Yes
BDS	L1/B1: 40.3	L2/B2: 35.2	L5/B3: N/A
C01	Elevation Angle:	Azimuth: 124	Locked.: Yes
BDS	L1/B1: 38.6	L2/B2: 35.3	L5/B3: N/A
C02	Elevation Angle:	Azimuth: 233	Locked.: Yes
BDS	L1/B1: 42.3	L2/B2: 33.7	L5/B3: N/A
C03	Elevation Angle:	Azimuth: 187	Locked.: Yes

Figure 3.11-4

4. Survey

In the software's menu, click the corresponding "Survey", as shown in Figure 4-1. The survey functions include point survey, detail survey, control point survey, CAD, point stakeout, line stakeout, road stakeout, and more.



Figure 4-1

In the software, the "Project" section is used for project data management and parameter configuration, preparing necessary conditions for field measurements, and exporting measurement results. The "Device" section is essential for the software to obtain high-precision positions. The "Survey" section is the primary function of the software, addressing questions related to what to do and how to do it using high-precision coordinates.

4.1 Point Survey

Click "Survey" -> "Point Survey", as shown in Figure 4.1-1. Measure and store the location output by the GNSS device into the point database according to certain precision limiting conditions. In the Point Survey menu, the top title bar displays basic information about the current location

output by the GNSS device, including the current solution status, differential delay, HRMS, VRMS, and the number of received satellites. Below the title bar is the status bar displaying other important information, and the displayed content can be set according to user preferences in the settings. In the Point Survey, it defaults to displaying North, East, Height coordinates, and base station information. The middle area shows measurement data plotting information, and you can also set to display online maps.

In the upper-left corner of the plotting area, the  represents the map orientation, making it convenient for users to determine direction when needed. In the lower-left corner of the plotting area, the scale of the drawing is displayed, and you can click the  or  on the right to zoom in or out on the drawing scale. Below the plotting area are the displays of the functionality collected, and these functional menus can also be customized in the settings according to the user's needs to quickly operate certain functions here.

In the lower-right corner of the plotting area, the  is the trigger button for initiating measurement and collection. This button can be moved to a more convenient location based on the user's habits. Clicking the button initiates the measurement function, as shown in Figure 4.1-2. You can input a point name and code, and by clicking the , you can choose a preset code from the code library, facilitating quick filling of attributes for the feature. If there are many codes in the code library, the codes used more frequently will be displayed at the beginning for the user's quick selection

Below the plotting area are the measurement type selection, entrance to the coordinate point library, antenna height settings, and the tools menu.

Clicking "Topo Point," as shown in Figure 4.1-3, will display four types: Topo Point, Control Point, Quick Point, and Auto Point. You can choose the corresponding point type for measurement based on your actual needs.

Click on "Points Database" to enter the point library, as shown in Figure 4.1-4. Here, you can view information about the measured points.

Click the  to edit antenna height, as shown in Figure 4.1-5. Antenna height settings are used to subtract the antenna height from the phase center coordinates of GNSS to obtain the actual location of the ground measurement target. If the antenna information is incorrect, you can click

antenna parameters to select the correct antenna type(used when GNSS devices do not output antenna information or when using an external antenna).

Click "Tools," as shown in Figure 4.1-6, to quickly operate certain functions from the menu based on your needs. You can also add or remove functions from the toolbar in the settings according to your preferences.

Click the , as shown in Figure 4.1-7, to enter the measurement settings. Here, you can set the limiting conditions for measurement collection, such as status limits, HRMS limits, VRMS limits, PDOP limits, delay limits, etc. You can adjust these limitations based on the accuracy requirements of your tasks. Setting the smoothing point count averages multiple positioning points to improve accuracy.

Additionally, you can set default point names and default codes. The information bar allows you to customize the display of status information, focusing on the details you find most important, as shown in Figure 4.1-8. The toolbar allows you to display commonly used functions for quick and easy access during operations. This includes features such as automatic centering of measurement points, toggling the map, compass mode, screen point selection, CAD text, coordinate transformation, perimeter and area calculation, CAD background color, and more. Clicking the icons in the toolbar triggers the corresponding functions, as shown in Figure 4.1-9.

Click the  to automatically center the current location on the screen. Click  to display all current measurement points on the screen.

Click , as shown in Figure 4.1-10, to toggle the tilt measurement on/off.

Click , as shown in Figures 4.1-11 and 4.1-12, to choose the desired online map for display.

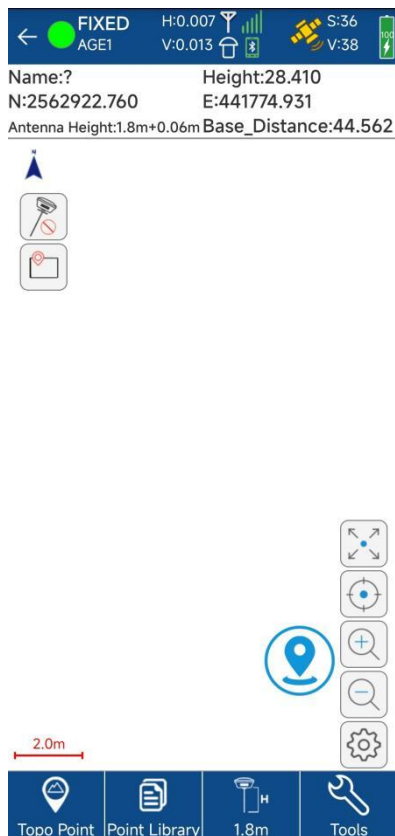


Figure 4.1-1

Figure 4.1-2

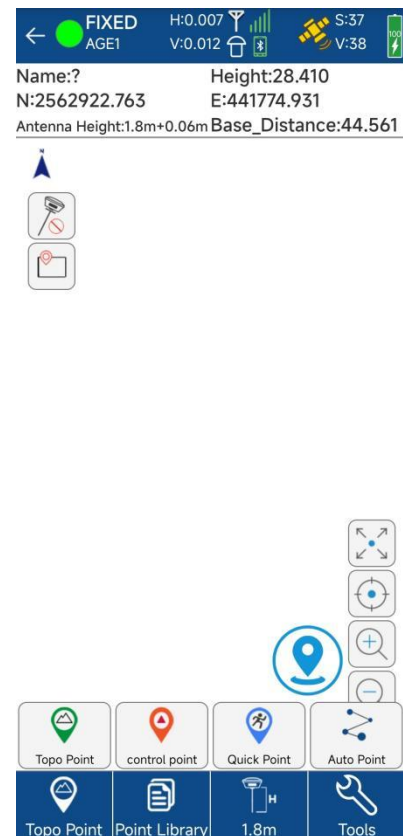


Figure 4.1-3

Name	North	East	Height	Status
PPK p3	2562922.759	441774.925	28.601	N2
p2	2562922.766	441774.932	30.185	N2
p1	2562921.958	441775.532	26.112	N2
t9	2563061.444	441676.895	18.892	N2
t8	2563064.214	441632.112	18.656	N2
t7	2563148.178	441558.261	19.432	N2
t6	2563154.803	441670.117	19.385	N2
t5	2563103.008	441789.162	19.354	N2
t4	2563014.288	441794.819	18.121	N2
t3	2562917.758	441787.826	17.334	N2
t2	2562936.491	441707.220	16.931	N2
t1	2562960.967	441716.320	17.074	N2

Figure 4.1-4

Figure 4.1-5

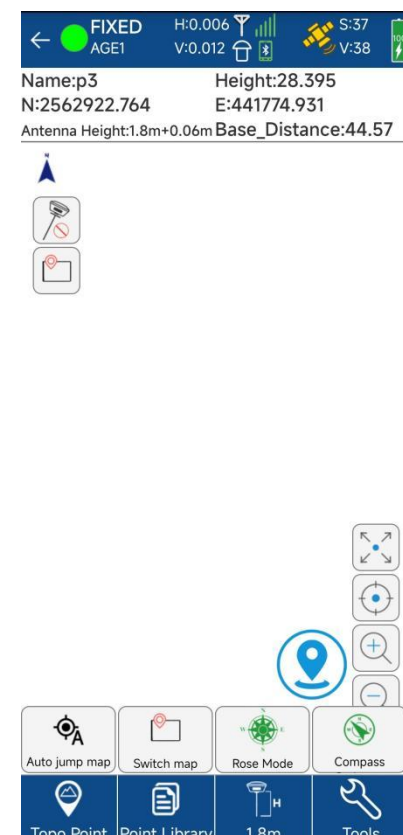


Figure 4.1-6

←

Display Information

Topo Point

Information bar

Toolbars

Solution Limit	FIXED	▼
HRMS Limit	0.050	➤
VRMS Limit	0.100	➤
PDOP limit	3.000	➤
AGE Limit	5	➤
Allow same point name	☐	
Point Name Increment	1	➤
Default Code	same as last point	▼
Average GPS Count	1	➤

DEFAULT

DELETE

OK

Figure 4.1-7

←

Display Information

Topo Point

Information bar

Toolbars

Name:p3

Height:28.398

N:2562922.767

E:441774.930

Antenna Height:1.8m+0.06m

Base_Distance:44.567

Code	+	Longitude	+
Latitude	+	Altitude	+
Forward azi...	+	Speed	+
Time	+	Point dist.	+
Pt. H dist.	+	Pt. Elevatio...	+
Pt. slope(%)	+	σN	+
σE	+	PDOP	+
HDOP	+	VDOP	+
Record Mode	+	Incline Angle	+
Projection A...	+	Real radius	+

DEFAULT

DELETE

OK

Figure 4.1-8

←

Display Information

Topo Point

Information bar

Toolbars

AUTO JUMP

SWITCH MAP

ROSE MODE

COMPASS

Object View

+

Automatic scaling

+

Take screen point

+

CAD Text

+

Screen measurement

+

Coordinates Converter

+

Perimeter and Area

+

Static and collect points

+

Restart Positioning

+

Coordinate inverse calculation

+

Point line calculation

+

DEFAULT

DELETE

OK

Figure 4.1-9

←

FIXED

AGE1

H:0.006

V:0.012

S:37

V:38

Name:p3

Height:30.258

N:2562922.761

E:441774.932

Antenna Height:1.8m+0.06m

Base_Distance:43.416

Topo Point

Point Library

1.8m

Tools

Figure 4.1-10

←

FIXED

AGE1

H:0.006

V:0.012

S:37

V:38

Name:p3

Height:28.411

N:2562922.762

E:441774.928

Antenna Height:1.8m+0.06m

Base_Distance:44.559

Topo Point

Point Library

1.8m

Tools

Figure 4.1-11

←

FIXED

AGE1

H:0.006

V:0.012

S:37

V:38

Name:p3

Height:28.412

N:2562922.765

E:441774.928

Antenna Height:1.8m+0.06m

Base_Distance:44.557

Topo Point

Point Library

1.8m

Tools

Figure 4.1-12

4.2 Tilt Survey

The IMU function requires the device to have a tilt module. Devices equipped with this function can achieve:

1. Ensuring accuracy within 2cm in a tilt range of up to 60 degrees;
2. The calibration process is straightforward, requiring only shaking the pole back and forth in place;
3. Supports pole calibration to eliminate measurement errors caused by pole curvature, as explained in Section 3.6.

Click "Survey" -> "Point Survey" to enter the point survey page. Click the top-left corner



for turning on tilt measurement. When it is turned on, the icon appears as . Follow the prompts that appear, as shown in Figure 4.2-1, and enter the antenna height (height of the pole) based on the actual situation.

At this point, the device needs to be in a fixed solution. Refer to the animated guide that appears, as shown in Figure 4.2-2. Shake the pole back and forth for 5-10 seconds, then rotate it 90°,

and continue shaking it back and forth. Repeat this process until the icon changes to , as shown in Figure 4.2-3. Now you can proceed with tilt measurement.

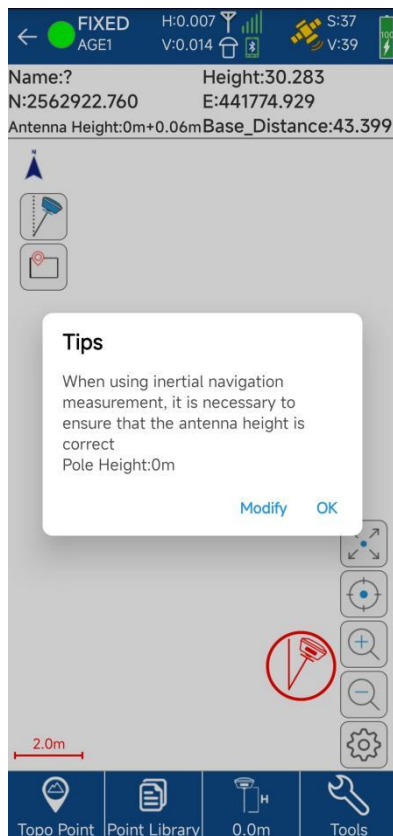


Figure 4.2-1

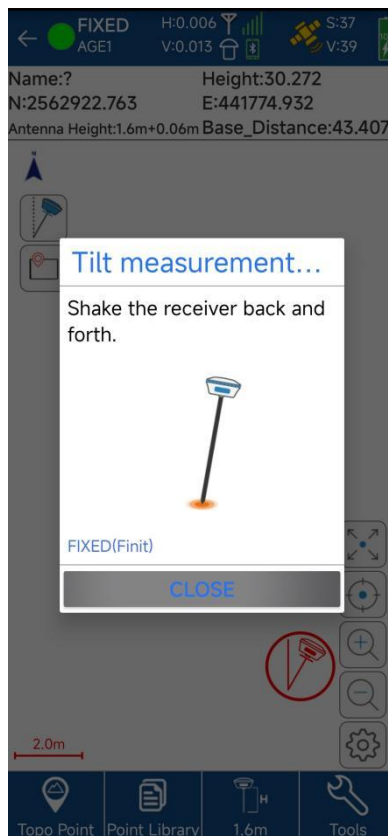


Figure 4.2-2

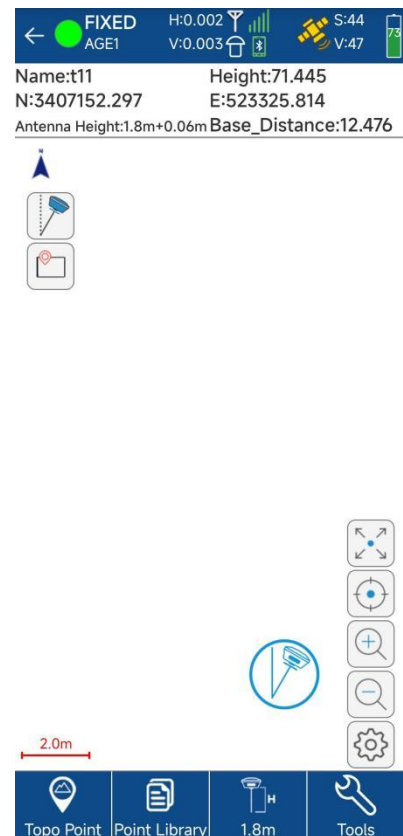


Figure 4.2-3

4.3 Detail Survey

Click on "Survey" -> "Detail Survey", as shown in Figure 4.3. This function is similar to point survey but without the graphical interface of point survey, providing a more concise and intuitive display of the information needed for measuring and collecting points. Below the interface are the entrances to the point database, measurement setting, and antenna setting.

Name		Pt1	
Code			
N:	2562922.763	B:	N23°09'53.9537"
E:	441774.933	L:	E113°25'52.9986"
h:	28.607	H:	28.607
Tilt Survey		Disable	



Figure 4.3

4.4 Control Point

Click on "Survey" -> "Control Point", as shown in Figure 4.4-1. Sometimes it is necessary to measure a point with very high accuracy. Collecting this measurement point requires multiple device resets, with the requirement of achieving a fixed solution for a certain period before collection. Moreover, many points need to be collected. Through a certain calculation method, points with significantly deviated values from the average are excluded, and the basic optimal values are taken to obtain an average with high precision. Points measured in this way have a high level of accuracy assurance, and we refer to such points as control points. In the control point interface, the middle area displays all coordinate points collected for this control point in real-time. You can see the graphical distribution of measurement points for this control point, providing a way to judge the accuracy of the control point to some extent. Above the graph are the point library and measurement setting;

Measurement setting, as shown in Figure 4.4-2, not only involves setting collection restriction conditions but also controlling the collection parameters for control points, such as smoothing point count, smoothing interval, and repetition count.

After completing the control point measurement, a measurement result page will appear, as shown in Figure 4.4-3. It displays the measurement analysis and results for the control point, including observation time, pass rate, and whether the control point meets the accuracy requirements.

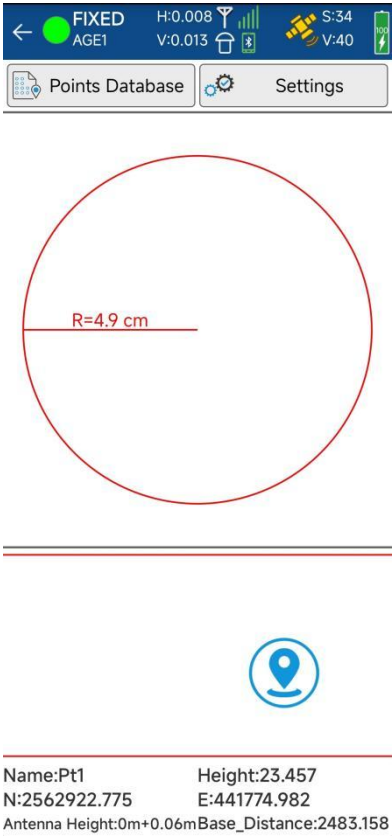


Figure 4.4-1

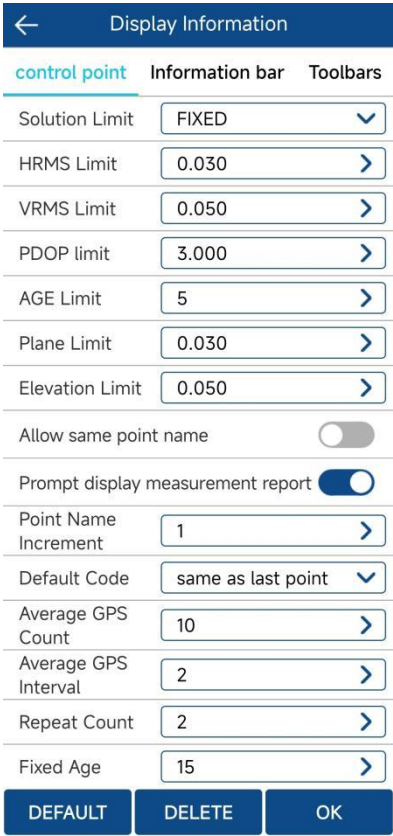


Figure 4.4-2

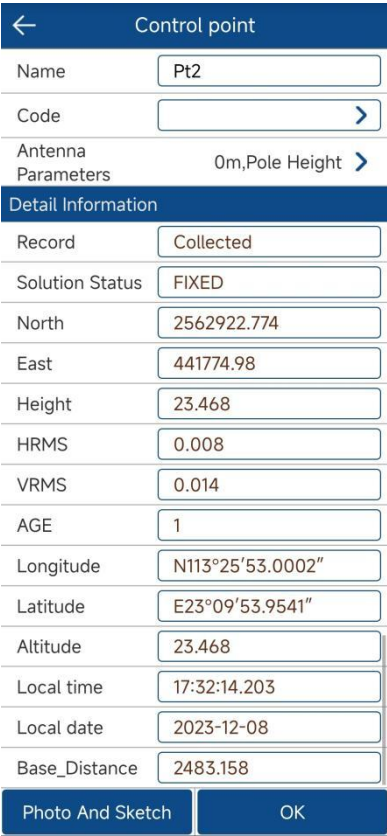


Figure 4.4-3

4.5 CAD

Click "Survey" -> "CAD", as shown in Figure 4.4-1. The CAD involves CAD graphic display, drawing icons such as lines, polylines, arcs, polygons, and graphic calculations. It also includes the import and export of DXF and DWG graphics, layer management, and layout operations on various CAD graphics.

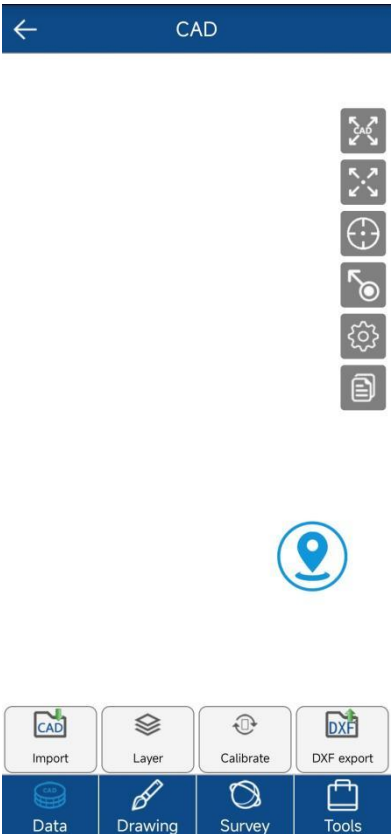


Figure 4.5-1



Figure 4.5-2

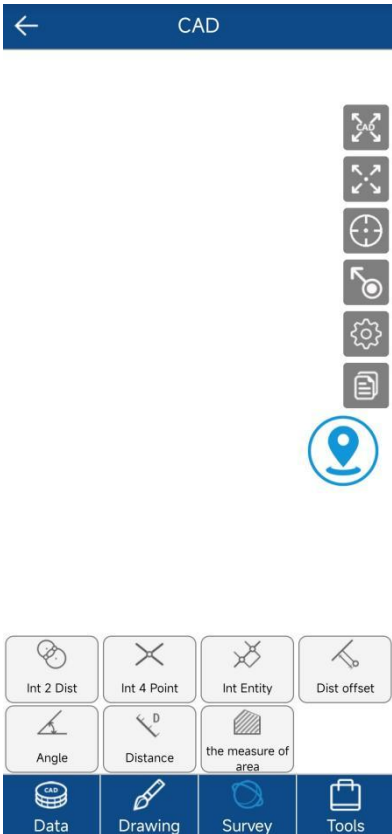


Figure 4.5-3

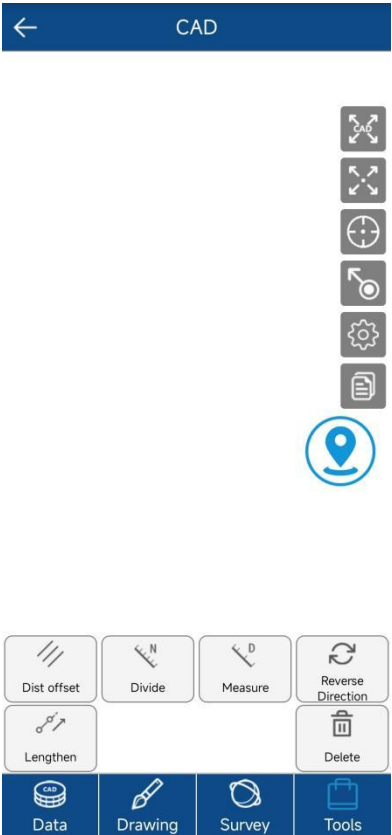


Figure 4.5-4

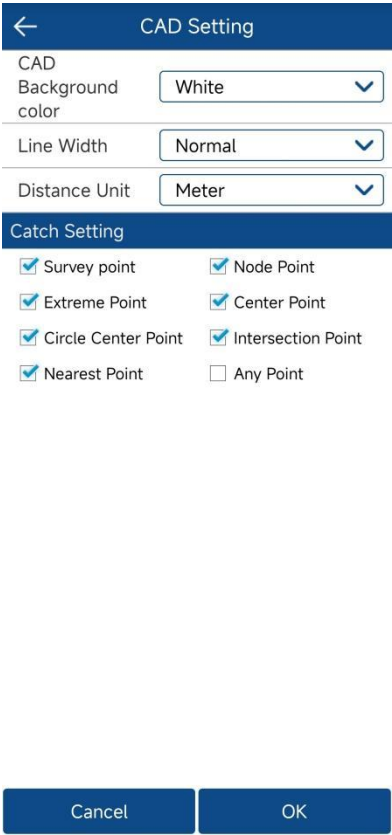


Figure 4.5-5



Figure 4.5-6



Figure 4.5-7

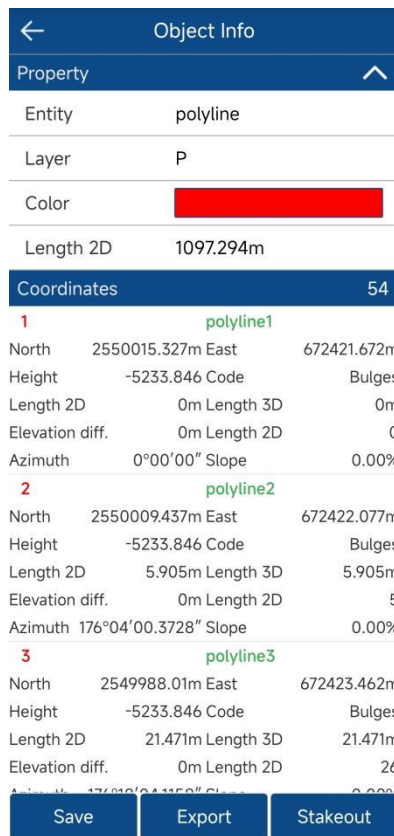


Figure 4.5-8

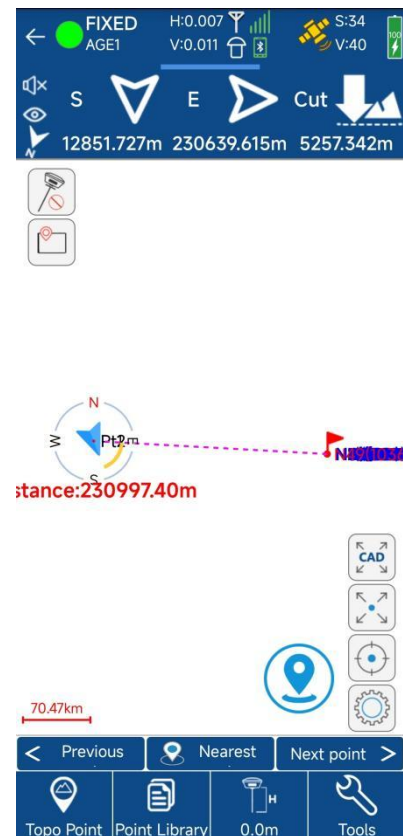


Figure 4.5-9

4.6 Point Stakeout

Click "Survey" -> "Point Stakeout" entering the stakeout point library, as shown in Figure 4.6-1. Stakeout refers to finding the location of a point on-site when the coordinates of the point are known. The pending stakeout points display both unstaked and staked points. Clicking a staked point allows for editing, viewing details, stakeout, and deletion, as shown in Figure 4.6-2. The pending stakeout points are part of the point library, and the addition, removal, import, and export operations for staked points are the same as for points library. Removing a point from pending stakeout does not actually delete the point in the point library. Stakeout can also be performed by selecting points from the coordinate points (all points in the coordinate point library). After selecting points for stakeout, enter the stakeout interface, as shown in Figure 4.6-3.

Click  to enter the stakeout setting, as shown in Figure 4.6-4. Here, you can set parameters such as the alert range, stakeout tolerance, and choose the reference azimuth according to the cardinal directions (east, south, west, north) or relative directions (front, back, left, right). Additionally, you can configure voice prompts.

The layout of the stakeout menu is similar to the point survey menu, with some differences. The status bar displays the deviation values in the east, south, west, and north directions from the target. The compass is aligned with the current position. In addition to the measurement type, coordinate point library, antenna height, and tools at the bottom of the drawing area, there are also functions such as stakeout the nearest point, stakeout the previous point, and stakeout the next point.

Click "Nearest," as shown in Figure 4.6-5, to stakeout the nearest point.

Click , as shown in Figure 4.6-6, to manually add stakeout points at any time.

If you want to reach the target point more quickly:

For users with a good sense of direction who can distinguish between east, south, west, and north in real-time fieldwork, you can directly observe the continuous connection between the current location point and the target point in the stakeout compass display. Walk in the direction indicated to reach the target point. Refer to Figure 4.6-3, where walking southwest will lead to the target point Pt4.

If the user has difficulty distinguishing between east, south, west, and north, you can rely on the orientation arrow at the current location. The arrow points in the same direction as the controller when it is flat. As shown in Figure 4.6-3, if the controller points south, rotate the controller until its direction aligns with the line connecting the current point and the target point. Once aligned, follow the direction indicated by the controller to reach the target point.

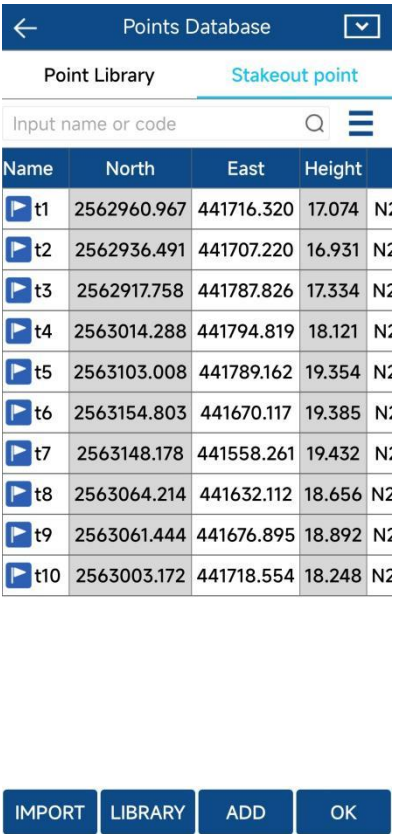


Figure 4.6-1

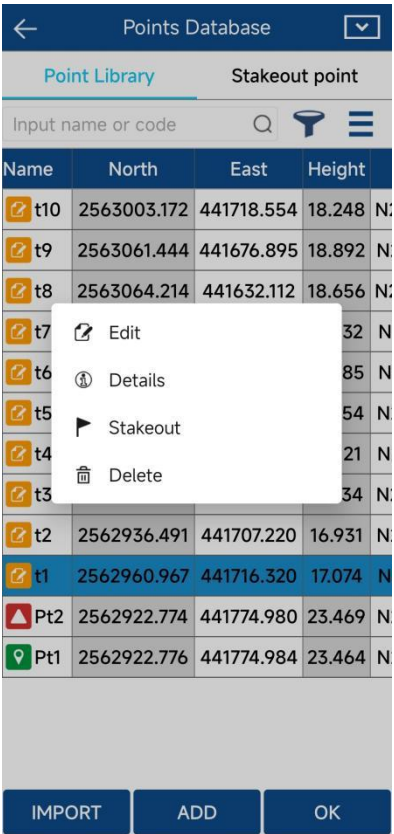


Figure 4.6-2

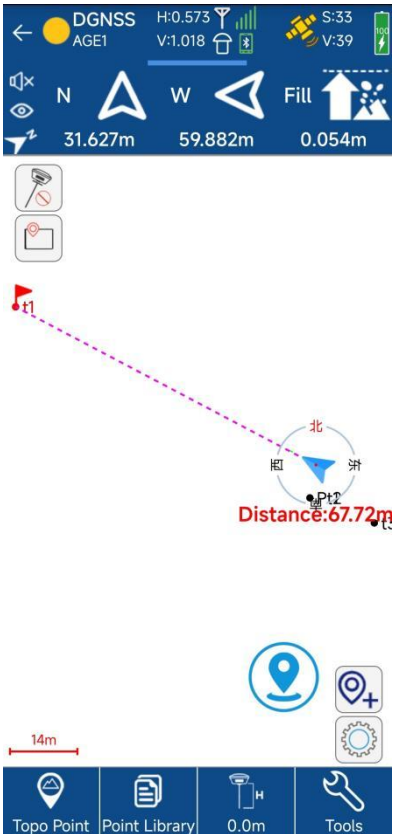


Figure 4.6-3

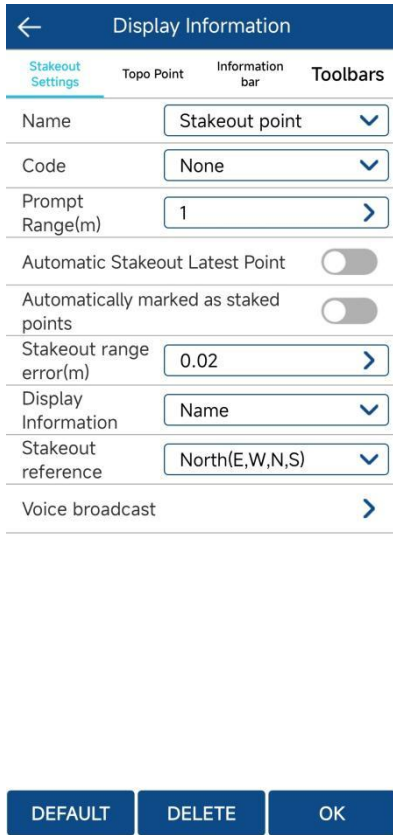


Figure 4.6-4

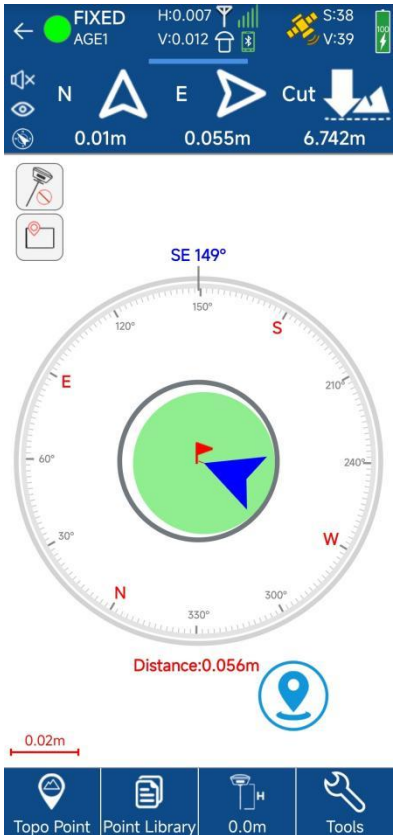


Figure 4.6-5

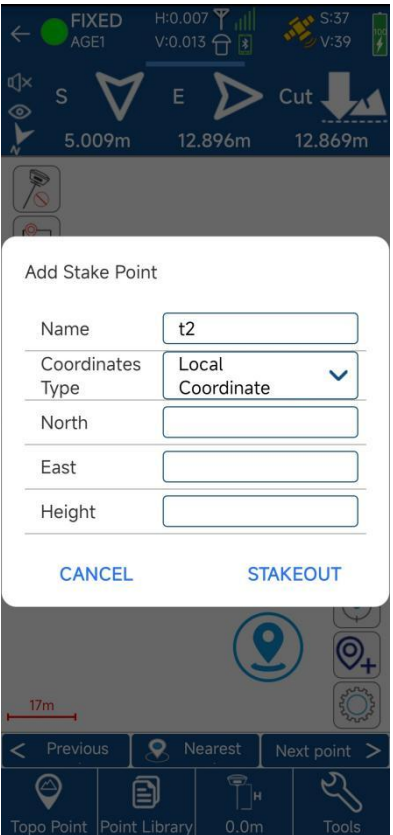


Figure 4.6-6

4.7 Line Stakeout

Click "Survey" -> "Line Stakeout", as shown in Figure 4.7-1, to enter the line stakeout menu. Line stakeout involves taking pre-designed straight lines stored in a line database and staking them out in the field. You can stake out the straight line in real-time for distances, offsets, height differences, and more. Additionally, you can divide the straight line into points at regular intervals and stake out each point individually.

For line database management, you can add, edit, or delete line data. To create a new straight line, as shown in Figure 4.7-2, enter the line name and set the starting and ending coordinates. Create the straight line using the starting point's mileage, azimuth, and length.

Select the line list to edit, insert, delete, or stake out the straight line, as shown in Figure 4.7-3

Click "OK" to enter the line stakeout setting, as shown in Figure 4.7-4. You can choose whether to stake out point by point or based on cross-section data. If you choose point-by-point, you need to set the calculation method, whether by whole station number or whole station distance, the distance interval, and whether to automatically stake out the nearest point.

Click "OK" to enter the line stakeout menu, as shown in Figure 4.7-5, where you can stake out the nearest point, the previous point, the next point, etc., through the menu.

Staking out points by point-by-point sometimes requires staking out points beyond the calculated ones. To stake out a specific point by specifying the mileage and offset, click  to add stakeout as shown in Figure 4.7-6.

←

Lines Database

1

L1

Mile...

0.000

azi...

200°23'41"

2D

26.113

3D

26.113

← Line parameters

Name: L2

Start Station: 26.113

Input Type: Start Point+End Point

Set Start Point

Name: t3

North: 2562917.758

East: 441787.826

Height: 17.334

Set End Point

Name: t4

North: 2563014.288

East: 441794.819

Height: 18.121

Add parallel line

← Lines Database

1

L1

Mile... 0.000

azi... 200°23'41"

2D 26.113

3D 26.113

2

L2

Mile... 26.113

azi... 4°08'37"

2D 96.783

3D 96.786

Add Edit Delete OK

Figure 4.7-1

OK

Figure 4.7-2

Insert Edit Delete OK

Figure 4.7-3

← Stakeout Settings

Setting out by pile by coordinate

Automatic Stakeout Latest Point

Target station: 26.113

Range: 26.113 ~ 122.896

Calculate Mode: Stakeout by station number

Spacing(m): 10

OK

Figure 4.7-4

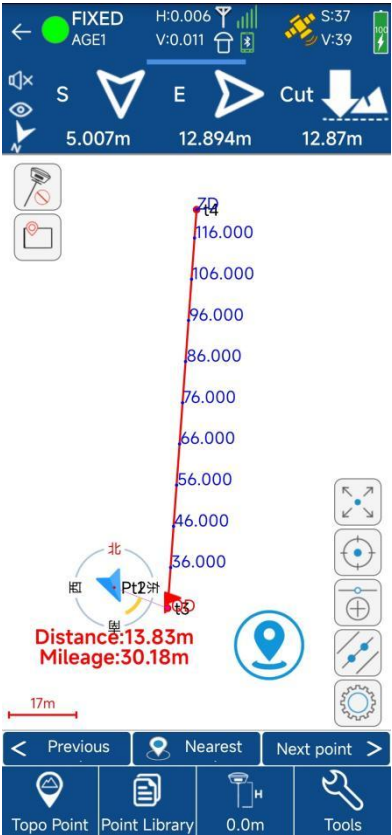


Figure 4.7-5

← Add Peg

Add Stake Mode: Calculate coordinates by mileage and offset distance

Mileage: 26.113

Offset: 0

Add the lofting coordinates to the coordinate point library

Cancel OK

Figure 4.7-6

4.8 Elevation Control

Click on "Survey" -> "Elevation Control" to enter the surface library, as shown in Figure 4.8-1. Surface staking involves staking out designed surfaces recorded in the surface library for on-site stakeout, allowing real-time staking for cut and fill operations, among other applications.

Surface library management allows for adding, editing, deleting, and importing surface data. To create a new surface, as shown in Figures 4.8-2 and 4.8-3, choose the data type and create or import the surface data file accordingly.

Once a surface is selected from the list, as shown in Figure 4.8-4, click on "OK" to enter the surface staking, depicted in Figure 4.8-5.

Click  to enter the staking setting, as shown in Figure 4.8-6. In addition to measurement setting, information bar setting, and toolbar setting similar to those in point measurement, you can also configure options such as hiding the triangular mesh and lifting the reference surface.



Figure 4.8-1

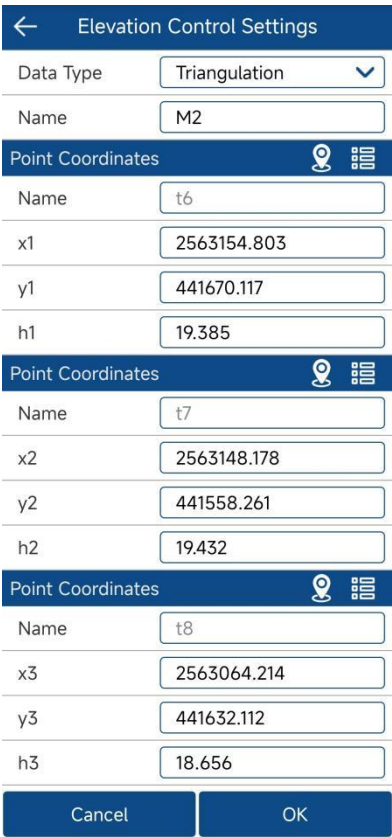


Figure 4.8-2

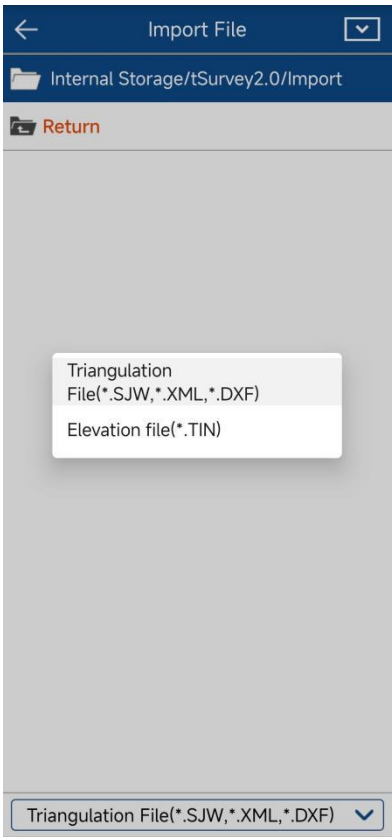


Figure 4.8-3

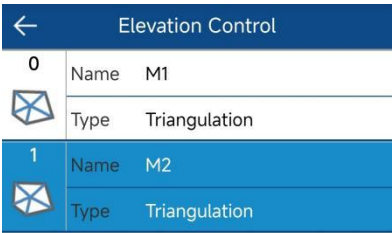


Figure 4.8-4

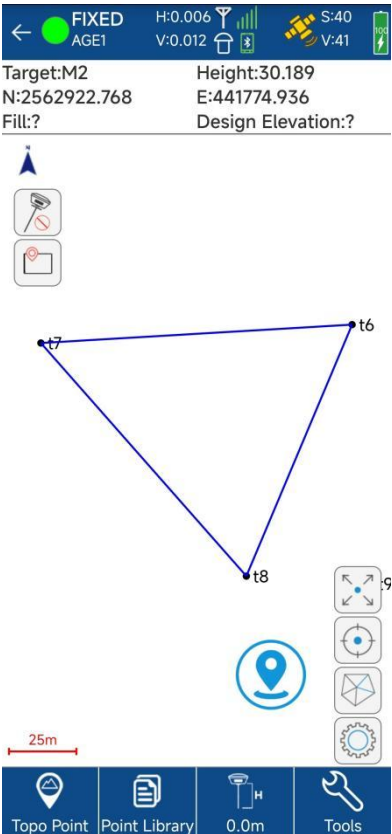


Figure 4.8-5

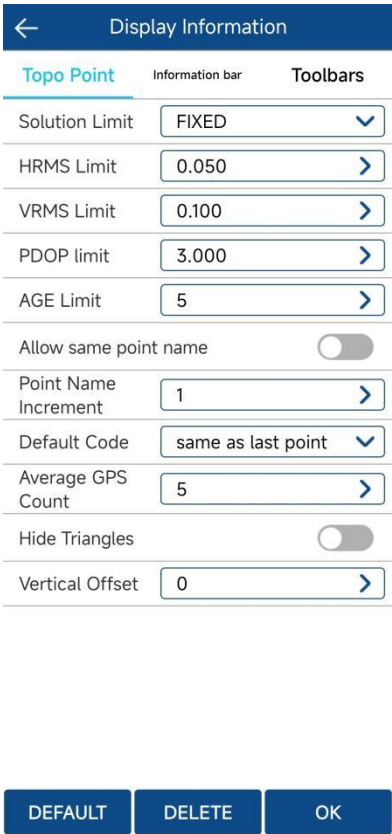


Figure 4.8-6

4.9 Road Stakeout

Click "Survey" -> "Stake Road" to enter the road library, as shown in Figure 4.9-1. The road design staking function involves designing a route file based on elements such as road alignments, vertical curves, breaks, standard cross-sections, clear zones, widening, and slopes. With the designed route file and GNSS satellite positioning, various applications related to road alignment, cross-section data collection, and other tasks in road construction and surveying can be performed. This is suitable for surveying and collecting data for various levels of roads, railways, and other linear projects, as well as for tasks like construction and acceptance of road alignments.

For easy road design editing, the software supports the import of roads in various formats, as shown in Figure 4.9-2.

Road design, as shown in Figure 4.9-3. The road design elements include horizontal curves, vertical curves, chain breaks, standard cross-sections, and slopes. The standard cross-section includes data for super elevation and widening of the cross-section blocks.

1. Horizontal Curve Design: As shown in Figure 4.9-4. The horizontal curve is the centerline of the road, representing the overall alignment of the road. Methods for designing horizontal curves

include the element method, intersection method, and coordinate method. All roads are composed of road starting points, straight lines, transition curves, and circular curves. The element method involves directly inputting the elements of the road, where the starting point includes the starting mileage and coordinates, the straight line includes the initial bearing and length of the element, the transition curve includes the initial bearing, the radius, and the length from the starting point to the endpoint, and the circular curve includes the initial bearing, radius, and length. In the element method, the endpoint bearing of one element is usually equal to the starting bearing of the next element, and the radius connecting the transition curve to the straight line has an infinite value. The radius connecting the transition curve to the circular curve is equal to the radius of the circle. The intersection method calculates the combination of road design elements through the coordinates of control points, the length of transition curves corresponding to control points, parameters of transition curves, and circle radius using a certain algorithm. The coordinate method calculates the combination of road design elements through the coordinates of points on the road and the radius of circular arcs before each coordinate point, using a specific algorithm. Roads generated by the coordinate method only have starting points, straight lines, and circular arcs, forming a simplified road without transition curves.

2. Vertical Curve Design: As shown in Figure 4.9-5. The vertical curve represents the elevation changes of the centerline of the road at various mileages. It is the designed height of the centerline of the road, and it requires inputting the elevations corresponding to various mileages of the road's slope change points and the radii of the corresponding circular arcs of the slope change points. The software calculates the elevation values of the road at various mileages based on these design elements.

3. Gap Design: As shown in Figure 4.9-6. During the road design process, there are situations where a pre-designed road cannot be constructed due to unfavorable construction conditions or high costs. In such cases, it becomes necessary to make local modifications to the road design. After modifying the road, the road may become longer or shorter. To ensure that the design mileage data after the modification remains unchanged, the gap feature is used, which can be either a long gap or a short gap. A new mileage value is started at a certain mileage point, keeping the mileage data after this point unchanged.

4. Standard Cross-Section Design: As shown in Figure 4.9-7. In actual road construction, the centerline of the road is only the planned direction of the road, and the actual road includes various sections for motorized lanes, non-motorized lanes, green belts, sidewalks, etc. These sections are

collectively designed with parameters such as width and slope, referred to as the standard cross-section. In real road construction, due to environmental conditions, it is often impossible to build according to the standard cross-section. Sometimes, a section may need to widen or narrow at a certain point, or due to excessive road curvature, the slope may need to be increased at a certain location for safety reasons. Here, parameters for super-elevation and widening of the cross-section blocks are set. Super-elevation and widening are set based on the needs of each block, adding changes in mileage as needed.

5. Slope Design: As shown in Figure 4.9-8. In the actual road construction process, besides constructing the main road, the road may pass through terrain with significant elevation differences, such as mountains or lakes. If cutting through a mountain causes the mountain to collapse and damage the road, it is necessary to construct slopes for the mountain and embankment according to certain standards to protect the road.

After the road is designed with the above elements, it becomes a complete road design. Sometimes, different construction units only need basic parts and may not have all the design data. Users can design based on their actual project needs. Once the road is designed, it can be used for construction using the road design file.

Road Stakeout: Carrying out construction operations based on the designed road route file, as shown in Figure 4.9-9. Click "Apply," as shown in Figure 4.9-10, to access the stakeout menu and operations similar to point stakeout and line stakeout. Click  in the bottom right corner, as shown in Figure 4.9-11, to view cross-sectional diagrams of road construction.

Click , as shown in Figure 4.9-12, to switch to other stakeout modes, including point-by-point stakeout, road stakeout, cross-section stakeout, and other road stakeout-related operations

Cross-section measurement involves collecting elevation data at certain mileage intervals along the road route and its surroundings. This data is used for preliminary survey work in road construction, calculating earthwork volumes, and assessing construction costs.



Figure 4.9-1

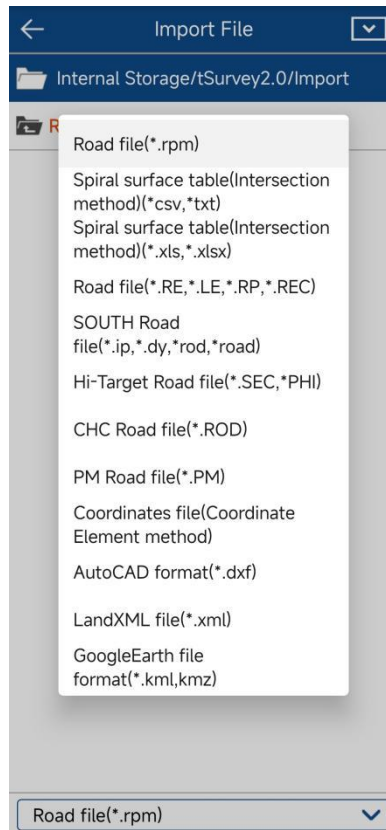


Figure 4.9-2

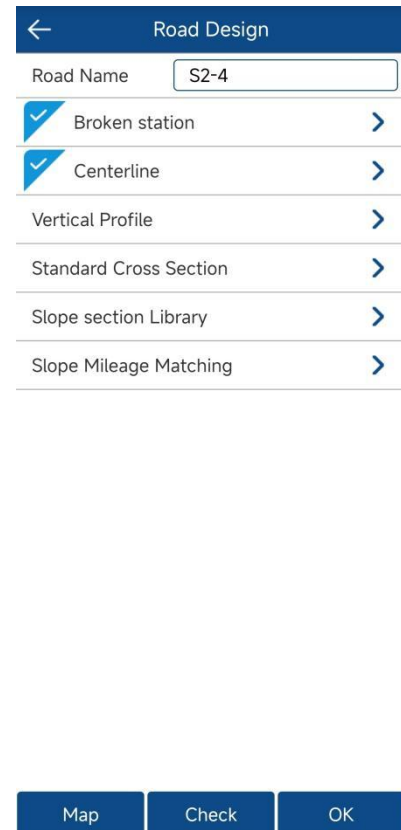


Figure 4.9-3

Centerline

Road Design Intersection method

BP	N:3407147.585	E:523357.57
K:368350	LS1:0	LS2:0
LineL:0	R:0 A1:0 A2:0	
JD1	N:3407175.105	E:523230.604
K:368479.914	LS1:0	LS2:35
LineL:74.08	R:628.228 A1:0 A2:148.283	
JD2	N:3407180.146	E:523096.714
K:368613.607	LS1:35	LS2:50
LineL:0	R:107.708 A1:61.399 A2:73.385	
JD3	N:3407288.411	E:522991.626
K:368759.743	LS1:40	LS2:40
LineL:0	R:60 A1:48.99 A2:48.99	
JD4	N:3407167.895	E:522875.326
K:368897.305	LS1:35	LS2:35
LineL:0	R:80.669 A1:53.136 A2:53.136	
JD5	N:3407236.118	E:522769.939
K:369006.531	LS1:0	LS2:0
LineL:0	R:768.457 A1:0 A2:0	
JD6	N:3407262	E:522718.683
K:369063.873	LS1:0	LS2:0
LineL:0	R:1746.431 A1:0 A2:0	
JD7	N:3407323.642	E:522602.064
K:369195.78	LS1:35	LS2:35

Add Edit Delete Calculate

Figure 4.9-4

Broken station

1	Before station:368993.621
Short	After station:369000.000
	length:6.379
2	Before station:100.000
Long	After station:50.000
	length:50

Add Edit Delete OK

Figure 4.9-5

Vertical Profile Database

200.000	R: 30	T: 0
50	I1: 0%	I2: 0%
400.000	R: 60	T: 0
100	I1: 0%	I2: 0%

Add Edit Delete Import OK

Figure 4.9-6



Figure 4.9-7



Figure 4.9-8

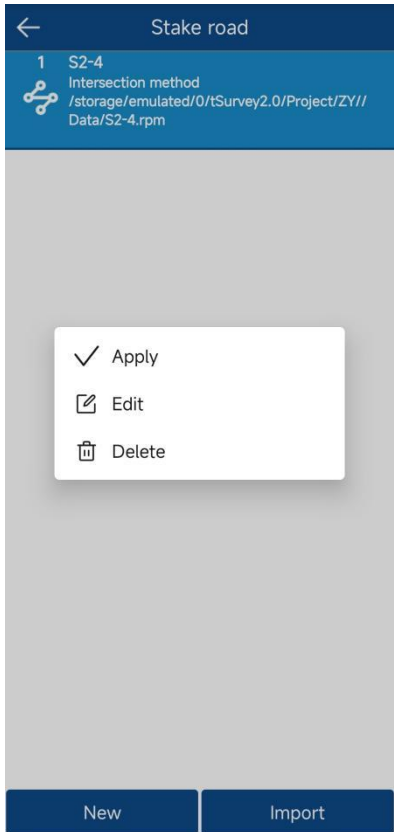


Figure 4.9-9



Figure 4.9-10

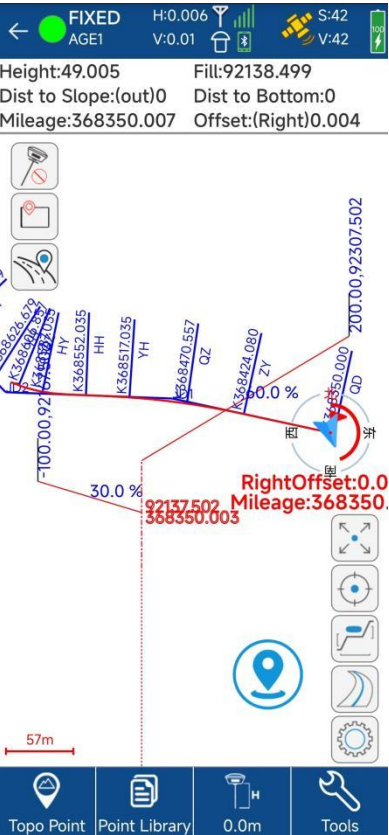


Figure 4.9-11

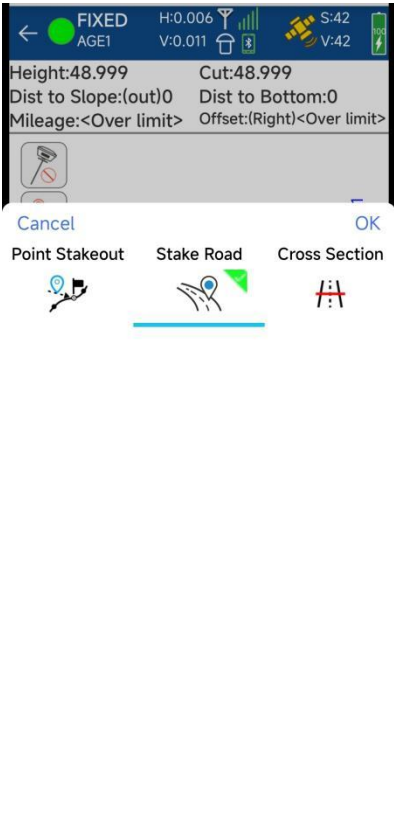
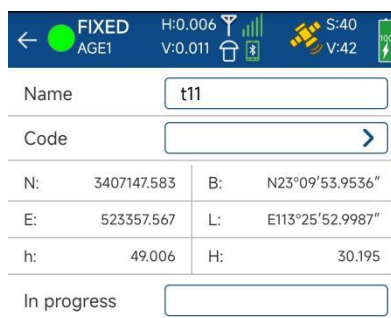


Figure 4.9-12

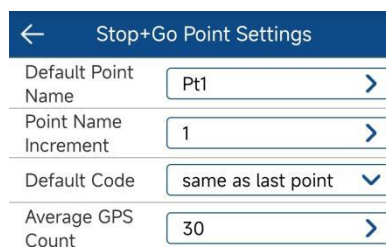
4.10 PPK Survey

Click "Survey" -> "Stop&Go", as shown in Figures 4.10-1, 4.10-2, and 4.10-3. This function utilizes post-processed kinematic (PPK) GNSS positioning technology based on carrier phase differentials. It falls under dynamic post-processing measurement techniques. This technology employs dynamic initialization On the Flying (OTF) for fast resolution of integer ambiguities. During field measurements, observing for 10 to 30 seconds is sufficient to calculate centimeter-level spatial three-dimensional coordinates. With this feature, you can directly measure and collect points without establishing a real-time communication link between the rover station and the base station. After completing field observations, you can perform post-processing on the raw observation data collected by the GNSS receivers on the rover and base stations. This process calculates the three-dimensional coordinates of the rover station.



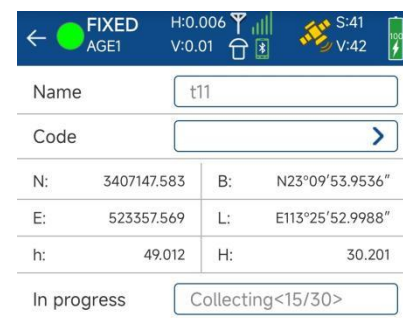
FIXED AGE1 H:0.006 V:0.011 S:40 V:42			
Name	t11		
Code			
N:	3407147.583	B:	N23°09'53.9536"
E:	523357.567	L:	E113°25'52.9987"
h:	49.006	H:	30.195
In progress			

Figure 4.10-1



Stop+Go Point Settings	
Default Point Name	Pt1
Point Name Increment	1
Default Code	same as last point
Average GPS Count	30

Figure 4.10-2



FIXED AGE1 H:0.006 V:0.01 S:41 V:42			
Name	t11		
Code			
N:	3407147.583	B:	N23°09'53.9536"
E:	523357.569	L:	E113°25'52.9988"
h:	49.012	H:	30.201
In progress	Collecting<15/30>		

Figure 4.10-3

4.11 Survey Settings

Click on "Survey"->"Survey Settings", as shown in Figure 4.11-1. This function allows you to set a coordinate range and, during field survey operations, it will monitor in real-time whether the

current position is within the set survey area. If the position exceeds this range, the user will be notified to avoid working outside the designated area.

The survey area can be managed by adding coordinates or selecting points in bulk from the point database, as shown in Figure 4.11-2. You can also import or export the coordinates of the survey area. The approximate shape of the survey area can be previewed on a map, as shown in Figure 4.11-3.



Figure 4.11-1

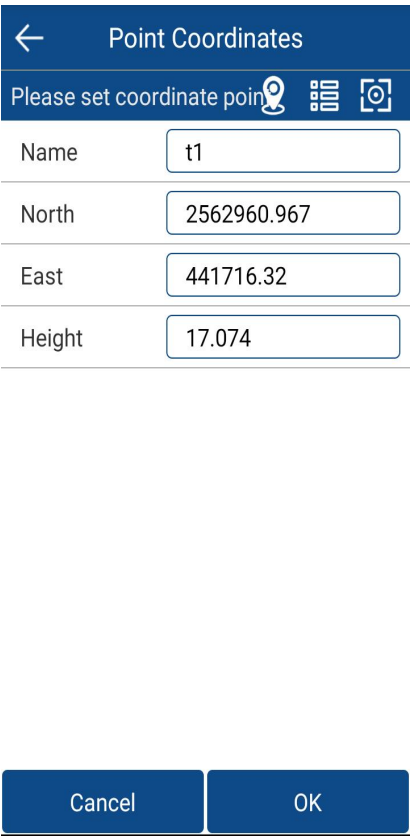


Figure 4.11-2

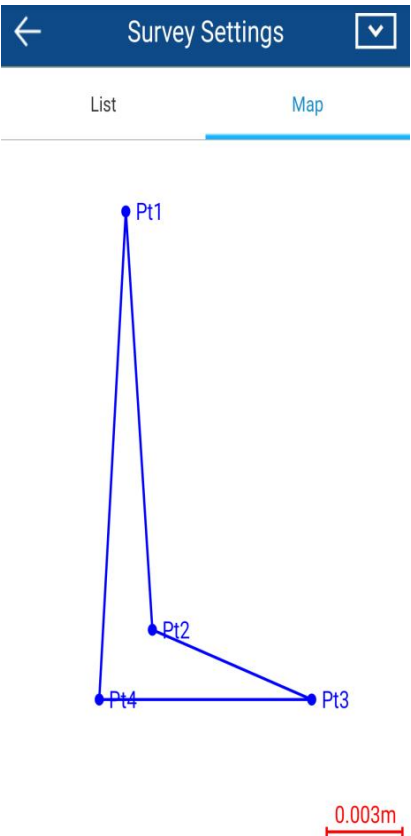


Figure 4.11-3

4.12 Layers Settings

Click on "Survey."-> "Layers Settings", as shown in Figures 4.12-1, 4.12-2, and 4.12-3. This function allows you to import background maps as reference base maps for survey operations, supporting formats such as dxf/dwg, shp, xml, and others.



Figure 4.12-1

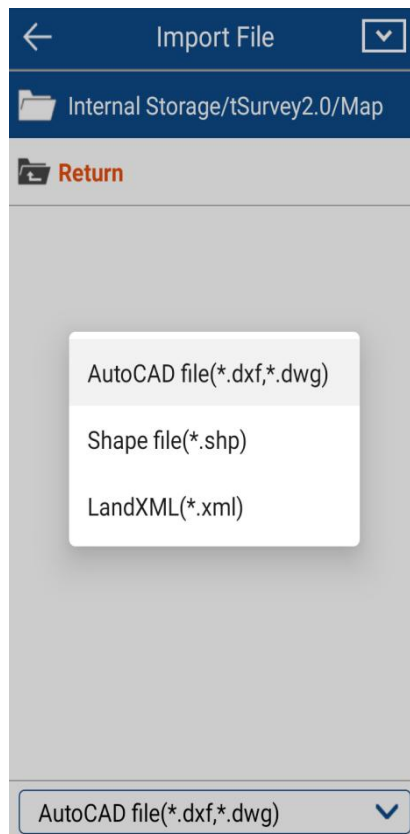


Figure 4.12-2



Figure 4.12-3

4.13 AR Stakeout (WiFi communication mode required)

AR stakeout requires **WiFi connection to an instrument with AR functionality** for display. It provides a high-definition, real-world stakeout experience, offering more accurate AR-based stakeout to help you achieve precise pole placement in one go.

1. Click on "Device"->"Communication" to enter the communication settings interface, as shown in Figure 4.13-1. Select the instrument type (RTK) and **communication mode (WiFi)**, then click "Search", as shown in Figure 4.13-2, to view the list of WiFi devices. Select the corresponding device serial number (default device number), and click "Connect" to complete the device connection, as shown in Figure 4.13-3. Once the connection is successful, you will return to the main instrument interface.

2. Configure the rover station to achieve a fixed solution status, as referenced in Section 3.2.

Note: For using the controller network, the controller must have a SIM card inserted for internet access.

3. Click on "Survey"->"Point Stakeout" to enter the stakeout point database interface, as shown in Figure 4.13-4. The database will display un-staked and already staked points. Click on a point to

edit, view details, stakeout, or delete it, as shown in Figure 4.13-5. After selecting a point for stakeout, you will enter the point stakeout interface, as shown in Figure 4.13-6. Click the tilt measurement icon at the top left  to enable the tilt measurement feature, as shown in Figure 4.13-7, and the icon will change to  when the feature is enabled. Then follow the on-screen prompts and input the antenna height (pole height), as shown in Figure 4.13-8. At this point, with the instrument in a fixed solution state, shake the pole back and forth for 5-10 seconds, then rotate 90°, and continue shaking the pole until the measurement icon changes to , as shown in Figure 4.13-9. Click the AR icon at the top left , as shown in Figure 4.13-10, to enter the AR real-world stakeout. Follow the arrow direction and distance indicators to navigate near the stakeout point, as shown in Figure 4.13-11. When the tip of the pole overlaps with the marked point, as shown in Figure 4.13-12, the AR real-world stakeout is complete. At this point, you can click the measurement icon and follow the prompts to choose to stake out the next point, the previous point, or re-stake.

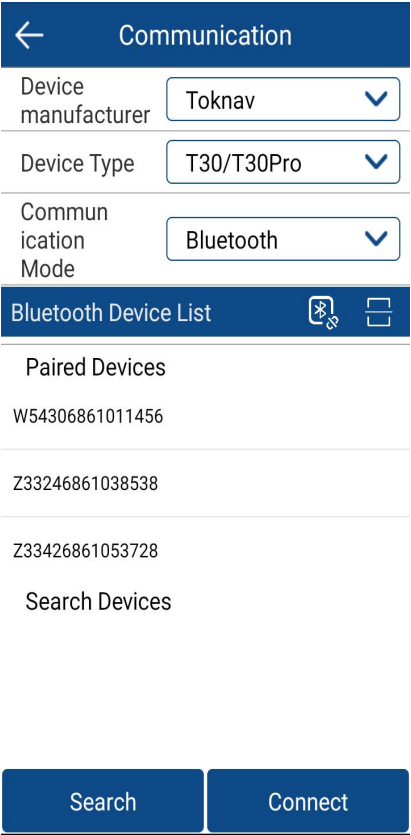


Figure 4.13-1



Figure 4.13-2

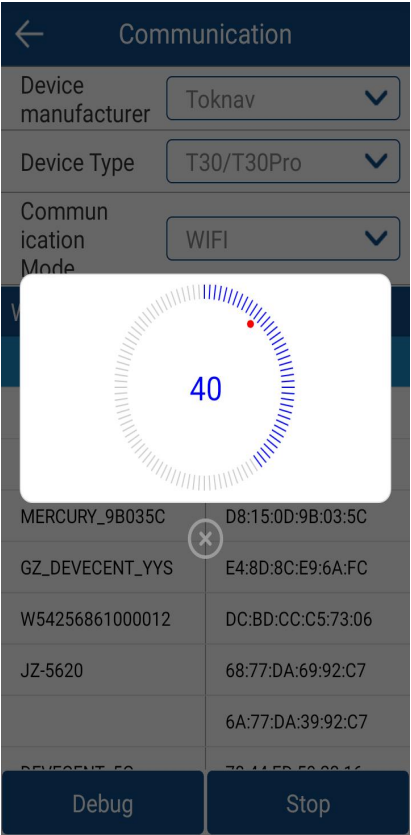


Figure 4.13-3

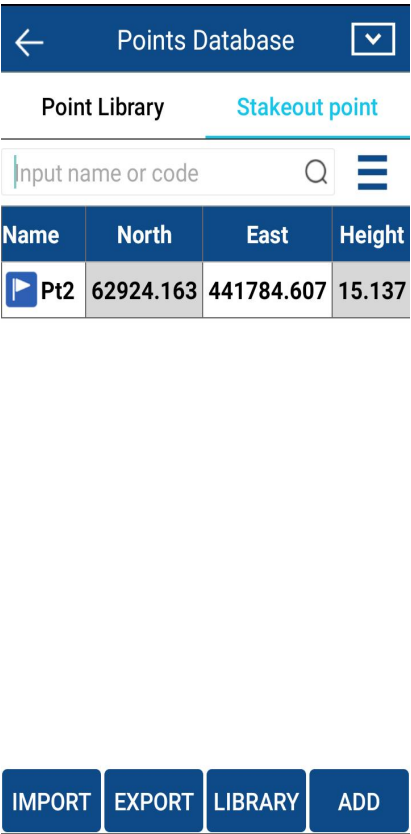


Figure 4.13-4

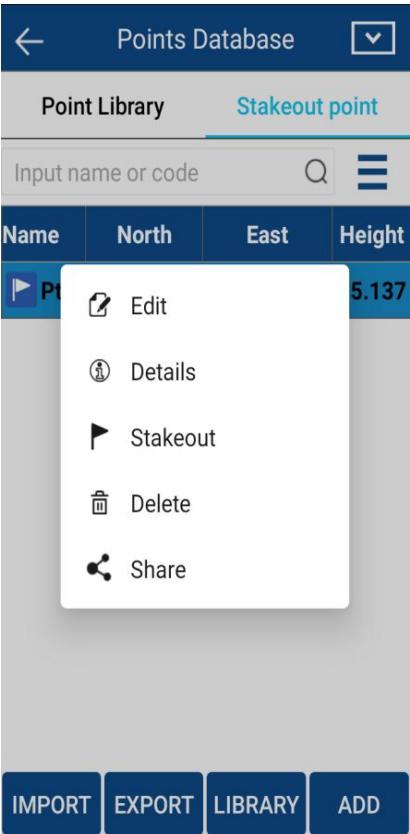


Figure 4.13-5

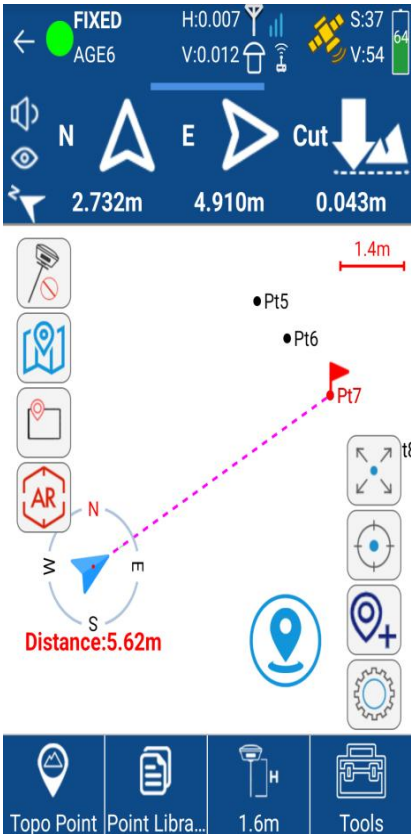


Figure 4.13-6

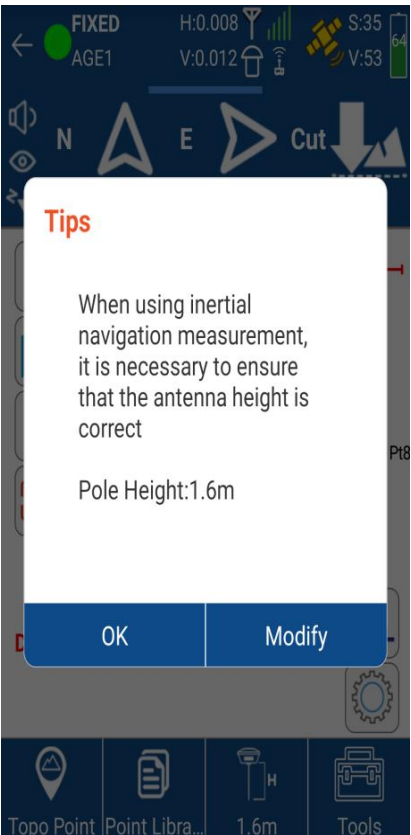


Figure 4.13-7

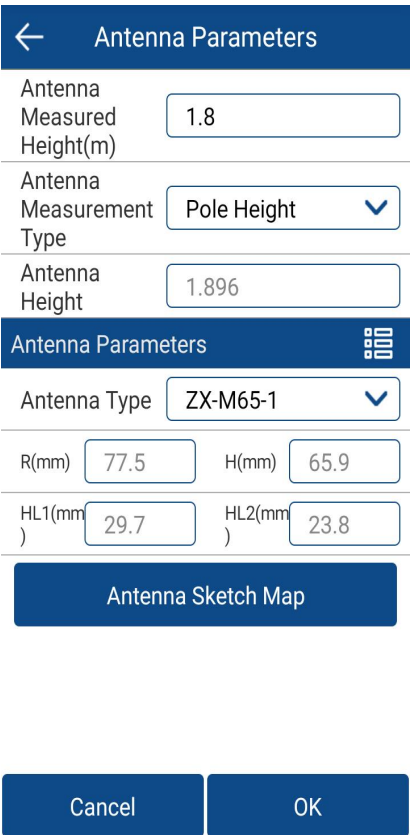


Figure 4.13-8

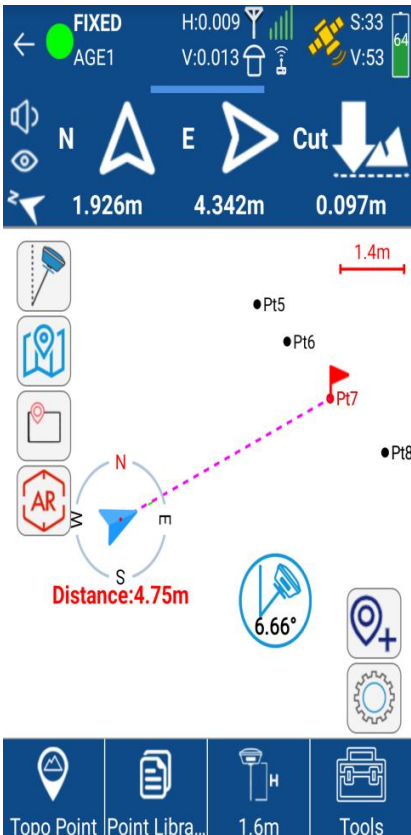


Figure 4.13-9

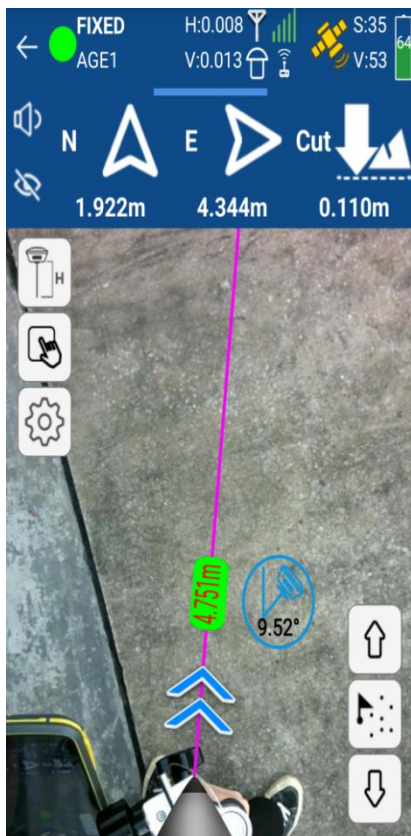


Figure 4.13-10

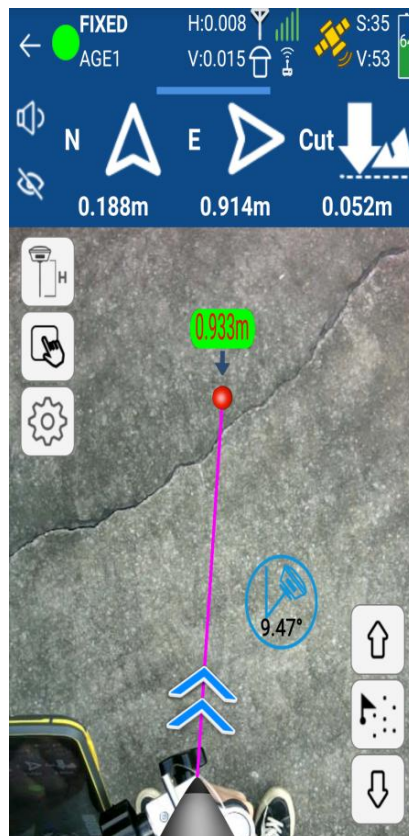


Figure 4.13-11

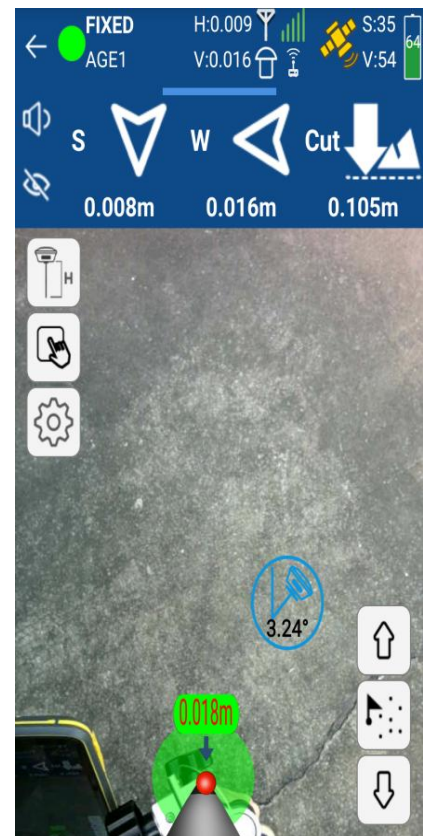


Figure 4.13-12

4.14 Laser Survey

Laser measurement requires connection to an instrument with laser functionality to display. It is a more convenient and efficient point measurement method—wherever the laser points, you can measure that location, allowing you to measure across obstacles and save time and effort. When connected to an instrument with laser functionality, an additional laser measurement icon will appear on the survey interface. When the laser measurement interface is opened, the instrument will emit a green laser. The location illuminated by the laser can be measured for coordinates.

Click on "Survey" -> "Laser Survey" to enter the laser measurement interface, as shown in Figure 4.14-1. Follow the prompts and input the antenna height (pole height) based on the actual situation, as shown in Figure 4.14-2. At this point, the instrument needs to be in a fixed solution

state, as shown in Figure 4.14-3. Click the icon , follow the animated instructions, as shown in Figure 4.14-4, and shake the pole back and forth for 5-10 seconds, then rotate it 90° and continue shaking it until the measurement icon changes to , as shown in Figure 4.14-5. Click the

icon  to complete laser measurement data collection. In this interface, you can name and code

the laser measurement points, view the laser measurement distance, and check the measurement accuracy.

Click "Point Database" to view both laser measurement points and regular measurement points, as shown in Figure 4.14-6.

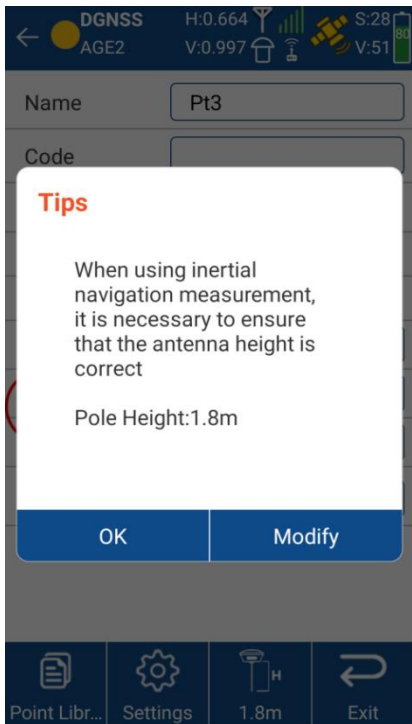


Figure 4.14-1

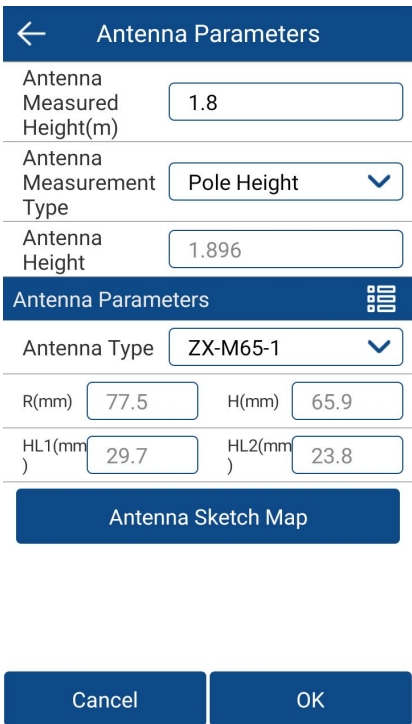


Figure 4.14-2

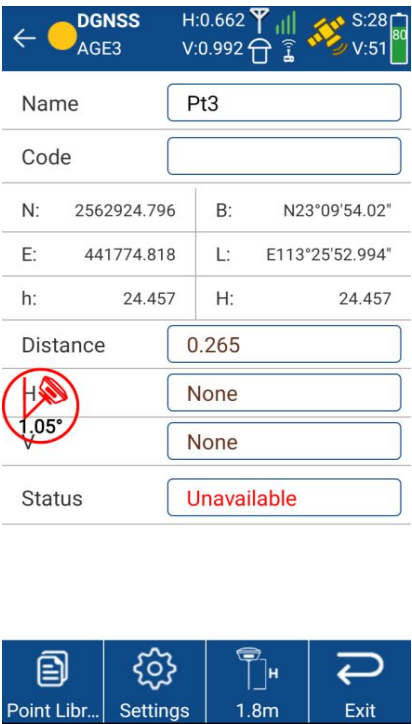


Figure 4.14-3

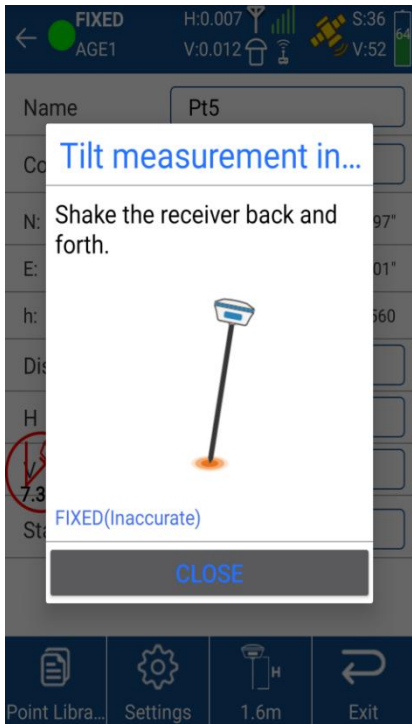


Figure 4.14-4

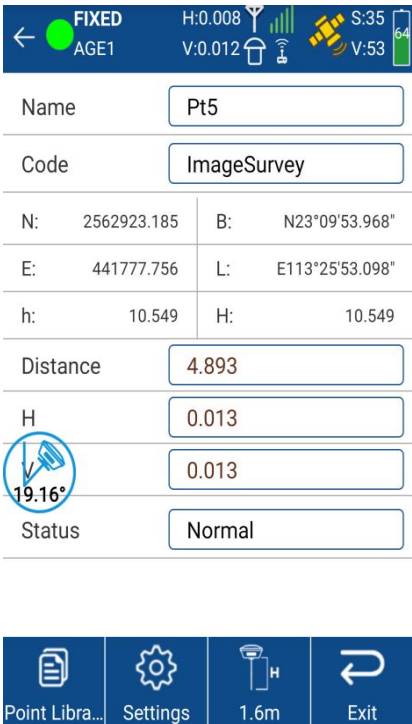


Figure 4.14-5

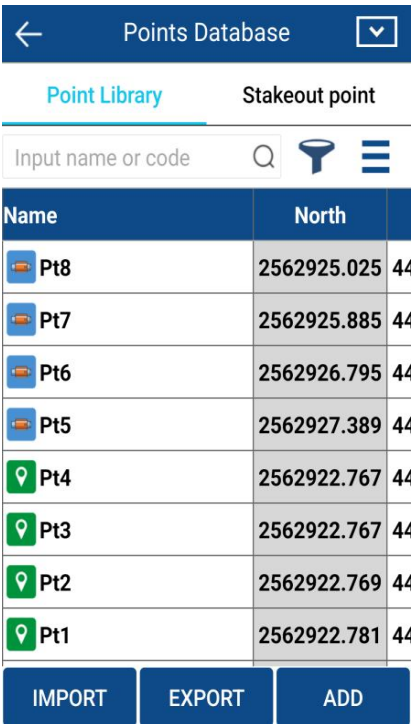


Figure 4.14-6

4.15 Photogrammetry (WiFi communication mode required)

Photogrammetry combines RTK positioning technology with close-range photogrammetry, leveraging the high real-time accuracy of RTK and the efficiency and richness of photogrammetric results. Without the need for fixed stations or control points, this method effectively addresses signal issues in RTK surveying environments and the reliance on control points in photogrammetry. It allows for quick data processing, and after completion, selecting a point on the photo provides the 3D coordinates of that point.

1. Click on "Device"-"Communication" to enter the communication settings interface, as shown in Figure 4.13-1. Select the instrument type (RTK) and **communication mode (WiFi)**, then click "Search", as shown in Figure 4.13-2, to view the WiFi device list. Select the corresponding device serial number (default device number) and click "Connect" to complete the device connection, as shown in Figure 4.13-3. Once connected, you will return to the main instrument interface.

2. Configure the rover station to achieve a fixed solution status, as referenced in Section 3.2.

Note : To use the controller's network, the controller must have a SIM card inserted for internet access.

3. **Photogrammetry requires the tilt feature to be enabled for proper use.** It is recommended to enable the IMU in the point measurement interface to complete initialization, as referenced in Section 4.2.

4. Click on "Survey"-"Photogrammetry" to enter the photogrammetry interface, as shown in Figure 4.15-1. Click the input box next to the task name to customize the task name. Click on the antenna parameters to modify the antenna height (pole height) based on the actual situation. When the image appears on the interface, click the auto-photograph button at the bottom center,  as shown in Figure 4.15-2, to begin photogrammetry. When the progress bar reaches 5 or more images, click the stop button  as shown in Figure 4.15-3, and a prompt will indicate that data processing was successful. Click the image library button on the bottom left , as shown in Figure 4.15-4, to enter the image management interface. Select the folder from the recent photographs to automatically enter the processing interface, as shown in Figure 4.15-5. In the images, select feature points by moving the image left or right, or zooming in and out, as shown in

Figure 4.15-6, to more accurately select the points for processing. When you find the desired point, click "Select" to process the point, as shown in Figure 4.15-7. If successful, the corresponding coordinate information will appear in the middle of the interface. Click "Save" to store the coordinates in the point database. If the selected point in the first image fails to process, try switching to other images, as shown in Figure 4.15-8. Once point processing is complete, click "Point Database" to check the photogrammetric point information in the coordinate point database, as shown in Figure 4.15-9.

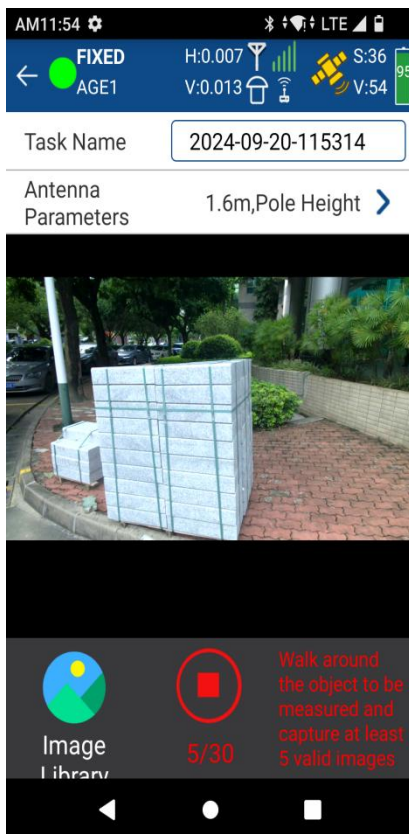


Figure 4.15-1

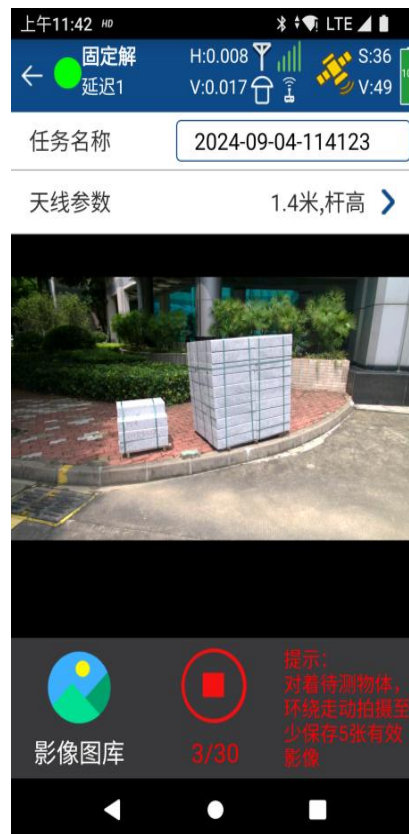


Figure 4.15-2



Figure 4.15-3



Figure 4.15-4

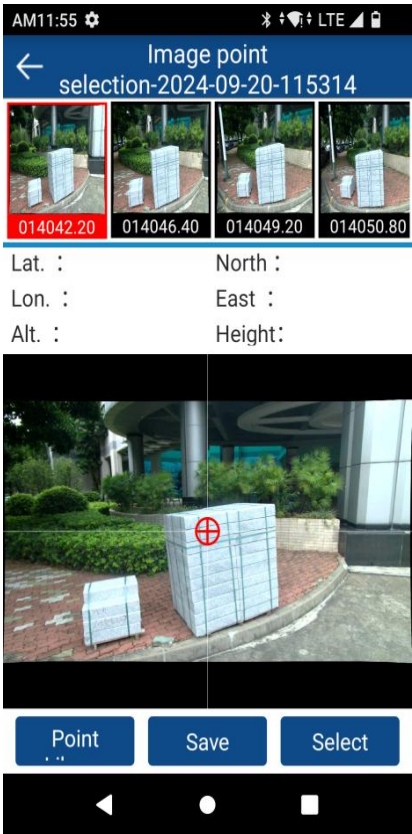


Figure 4.15-5

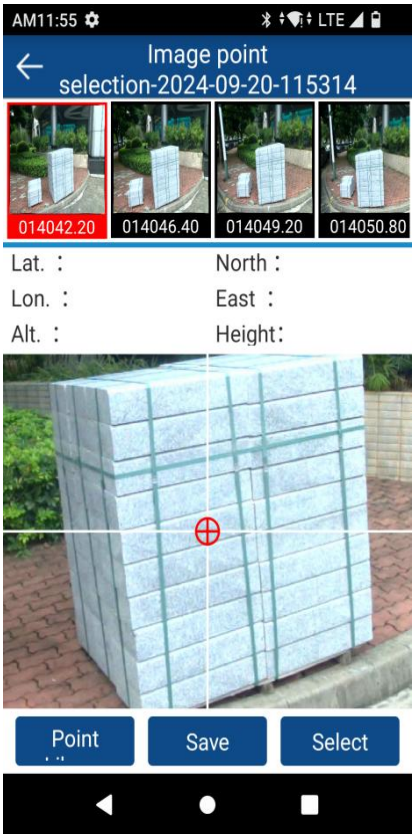


Figure 4.15-6



Figure 4.15-7

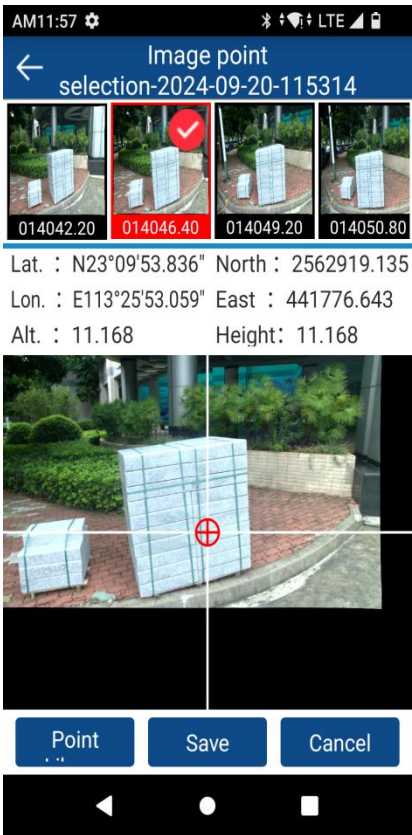


Figure 4.15-8



Figure 4.15-9

5. Tools

In the software menu, click "Tools", as shown in Figure 5-1. The "Tools" menu includes functions such as coordinate converter, file conversion, angle converter, perimeter and area, volume calculation, post-measurement correction, file sharing, offset point, coordinate inverse calculation, point line calculation, center of a circle, averaging, spatial distance, and more.

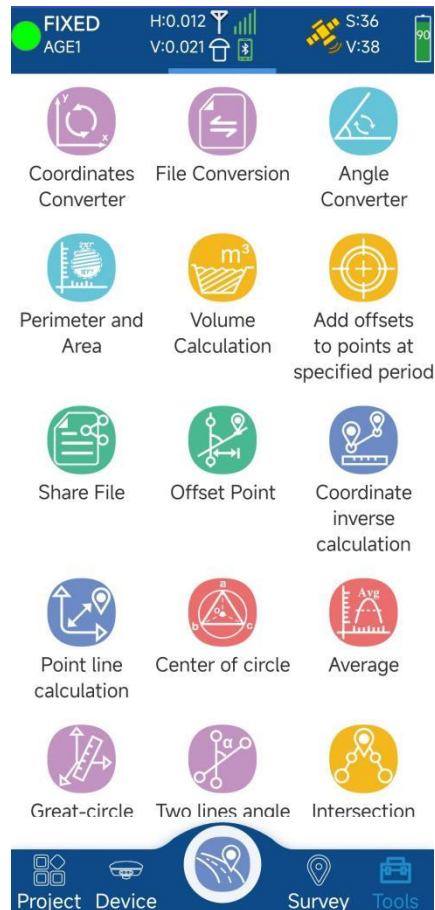


Figure 5-1

5.1 Coordinate Converter

Click "Tools" -> "Coordinate Converter", as shown in Figures 5.1-1, 5.1-2, and 5.1-3. Use the coordinate system parameters set in the current project to convert source coordinates to target coordinates as needed. Click  to choose a point from the point library or click  to measure a new point for calculation. Clicking "Save" will also save the conversion result to the point library.

←

Coordinates Converter

Source Coordinate

📍

📄

📷

Type

☒ BLH

☐ XYZ

☐ NEZ

Name

Latitude

Longitude

Altitude

Target Coordinate

Type

☐ BLH

☒ XYZ

☐ NEZ

X

Y

Z

←

Coordinates Converter

Source Coordinate

📍

📄

📷

Type

☒ BLH

☐ XYZ

☐ NEZ

Name

Latitude

Longitude

Altitude

Target Coordinate

Type

☐ BLH

☐ XYZ

☒ NEZ

North

East

Height

←

Coordinates Converter

Source Coordinate

📍

📄

📷

Type

☐ BLH

☒ XYZ

☐ NEZ

Name

X

Y

Z

Target Coordinate

Type

☐ BLH

☐ XYZ

☒ NEZ

North

East

Height

Transform

Save

Figure 5.1-1

Transform

Save

Figure 5.1-2

Transform

Save

Figure 5.1-3

5.2 File Conversion

Click "Tools" -> "File Conversion", as shown in Figure 5.2-1. Use the coordinate system parameters set in the current project to convert the source coordinate file to the target coordinate file as needed.

Click "File" and select the file format, as shown in Figure 5.2-2, to import the source coordinate file for conversion.

Click "Convert," select the file format, as shown in Figure 5.2-3, to export the converted target coordinate file.

←

File Conversion

Source Coordinate

Type

☐

BLH

☐

XYZ

☒

NEZ

Target Coordinate

Type

☒

BLH

☐

XYZ

☐

NEZ

File

>

←

Import File

File Format

Cass format(.dat)

▼

[Name],[Code],[East],[North],[Height]

Preview

←

Export File

File Format

Geodetic coordinates format(.csv|dat|txt)

▼

[Name],[Latitude],[Longitude],[Altitude],[Code]

Angle format

dd°mm'ss.ssss"

▼

Cancel

Transform

Figure 5.2-1

Format Manager

OK

Figure 5.2-2

Format Manager

OK

Figure 5.2-3

5.3 Angle Converter

Click on "Tools" -> "Angle Converter", as shown in Figure 5.3. Use this tool to transform angle display formats such as degrees, degrees and minutes, radians, etc. Select one input format, and the tool will calculate values in other formats.

←

Angle Converter

Format

dd°mm'ss.ssss" ▾

dd°mm'ss.ssss"

131.452

Result

dd (Decimal)

131.452

dd.mmssss

131.27072

dd:mm:ss.ssss

131:27:07.2

Radian

2.29427020833159

Gon

146.05777778g

dd mm ss.ssss

131 27 07.2

Cancel

Calculate

Figure 5.3

5.4 Perimeter and Area Calculation

Click on "Tools" -> "Perimeter and Area", as shown in Figure 5.4-1. You can perform operations such as moving up, moving down, adding, and deleting on coordinate points. Click on "Preview," as shown in Figure 5.4-2, to preview and view the shape of the polygon. Click on "Calculate," as shown in Figure 5.4-3, to obtain the corresponding perimeter and area.

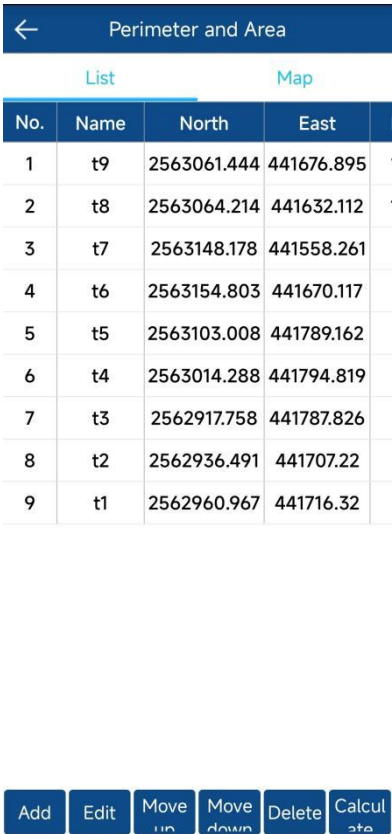


Figure 5.4-1

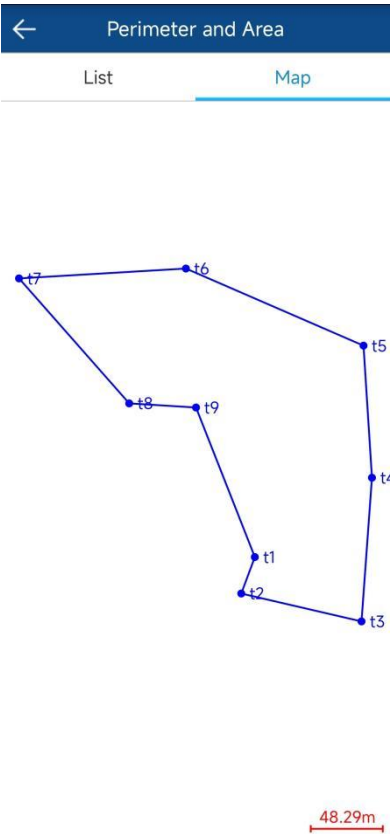


Figure 5.4-2

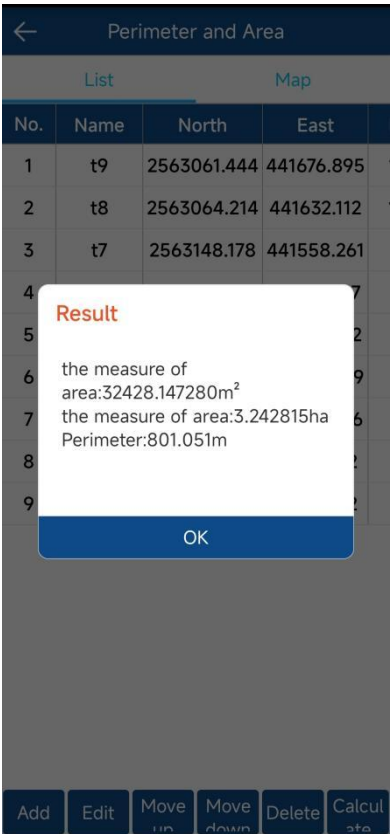


Figure 5.4-3

5.5 Volume Calculation

Click on "Tools" -> "Volume Calculation", as shown in Figure 5.5-1. Click to select the calculation surface to enter the surface library, as shown in Figure 5.5-2. In the surface library, you can create, edit, delete, and import triangular network data. After selecting the calculation surface, input the reference elevation or choose a reference point or surface. Calculate the cut and fill volumes for the data on that surface, as shown in Figure 5.5-3.

←

Earthwork calculation

Calculate data

Calculating area

>

computing method

☒ Reference elevation

☐ Reference point

☐ Reference slope

☐ Reference surface

Reference height

Result

Preview

Calculate

Figure 5.5-1

←

Triangle library

1

the bottom of the embankment

Path Internal Storage/Documents/document...

New

Edit

Delete

Import

OK

Figure 5.5-2

←

Earthwork calculation

Calculate data

Calculating area

the bottom of the embankment.txt

>

computing method

☒ Reference elevation

☐ Reference point

☐ Reference slope

☐ Reference surface

Reference height

274

Result

Fill

339.3595m³

Cut

106.9458m³

Area before excavation(2D)

1856.7154m²

Area before excavation(3D)

1857.8128m²

Minimum elevation before excavation

10000000000.0000m

Maximum elevation before excavation

-10000000000.0000m

Reference elevation

274.0000m

Save Results

Preview

Calculate

Figure 5.5-3

5.6 Correction after Measurement

Click on "Tools" -> "Add offset to pints at specified period", as shown in Figure 5.6-1, Figure 5.6-2, and Figure 5.6-3. Use the differential data from a self-established base station. Usually, calibration is needed using known points to match the coordinates of the moving station with the actual coordinates. If no calibration was done before measurement, you can use known points to recalibrate.

←

Add offsets to points at specified period

Marker Point Calibration

dX

0

dY

0

dH

0

←

Add offsets to points at specified period

Known Point Coordinates

North

2562960.967

East

441716.32

Height

17.074

Current WGS84 Coordinates

Latitude

23°09'54.391331"

Longitude

113°25'50.616211"

Altitude

16.931

←

Add offsets to points at specified period

Marker Point Calibration

dX

24.51

dY

9.004

dH

0.143

Clear

Update

Figure 5.6-1

Calculate

Figure 5.6-2

Clear

Update

Figure 5.6-3

5.7 File Sharing

Click "Tools" -> "Share File", as shown in Figure 5.7-1 and Figure 5.7-2. Choose the file you want to share and share it through the system's pop-up options.



Figure 5.7-1

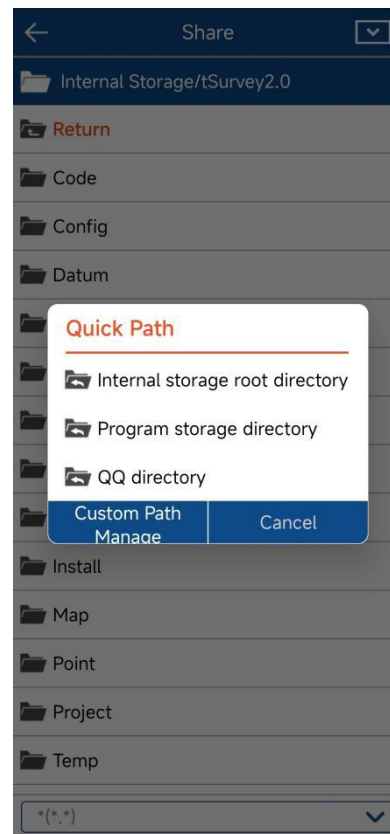


Figure 5.7-2

5.8 Eccentric Point

Click "Tools" -> "Offset Point", as shown in Figures 5.8-1 and 5.8-2. Given the coordinates of the starting point A and the ending point B, with angle $A=a$ and $AP=L1$, calculate the coordinates of point P, and save the result to the point library.

←

Offset Point

B

A

α

L1

P?

Note: Known point A and B, known angle α , known distance L1. Calculate point P.

Line L1, Angle α

L1

50

α

13°14'52"

Azimuth reference direction

Reference point direction

Point A

Name

t1

North

2562960.967

East

441716.32

Point B

Name

t2

North

2562936.491

East

441707.22

Calculate

Figure 5.8-1

←

Result

A

t1

B

t2

P

2PointDistanceAngle

13.26m

Name

p4

Code

2PointDistanceAngle

North

2562919.341

East

441688.62

Height

16.807

Save

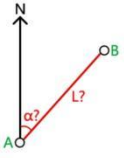
Close

Figure 5.8-2

5.9 Azimuth Distance

Click "Tools" -> "Coordinate Inverse Calculation", as shown in Figures 5.9-1 and 5.9-2. Use this function to select or collect the coordinates of two points and calculate the corresponding planar distance, azimuth, elevation difference, slope ratio, slope angle, and spatial distance.

← Coordinate inverse calculation



Note: Known point A and B. Calculate the AB(2D), A->B Azimuth(α), Elevation difference, Ratio of slope, Slope angle, AB(3D).

Coordinates Type

Local Coordinate

Set Start Point

Name

t3

North

2562917.758

East

441787.826

Height

17.334

Set End Point

Name

t4

North

2563014.288

East

441794.819

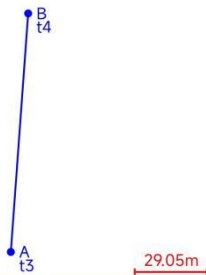
Height

18.121

Calculate

Figure 5.9-1

← Result



Result

Distance 2D

96.783

Azimuth

4°08'36.5482"

Elevation difference

0.787

Ratio of slope

0.8131596023431547%

Slope angle

0°27'57.2251"

Distance 3D

96.786

Close

Figure 5.9-2

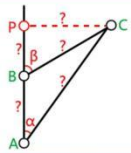
5.10 Point-Line Calculation

Click "Tools" -> "Point Line Calculation", as shown in Figures 5.10-1 and 5.10-2. Input/select three known points, calculate the distance, perpendicular distance, deflection angle, corner, etc., and save the result to the point library.

80

←

Point line calculation



Note: Known point A, B, C.
Calculate AC(2D), BC(2D),
AP(2D), BP(2D), PC(2D), α , β

Set Start Point

📍

📄

📷

Name

t5

North

2563103.008

East

441789.162

Set End Point

📍

📄

📷

Name

t6

North

2563154.803

East

441670.117

Set Offset Point

📍

📄

📷

Name

t7

North

2563148.178

East

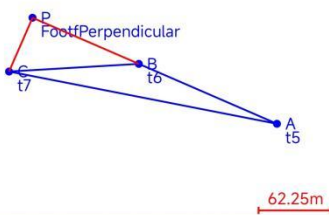
441558.261

Calculate

Figure 5.10-1

←

Result



Result

AC

235.278

BC

112.052

AP

229.75

BP

99.925

CP

50.701

α

(Left)12°26'40.4093"

β

(Left)26°54'10.1168"

Close

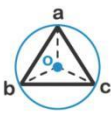
Figure 5.10-2

5.11 Three-Point Circle Center

Click "Tools" -> "Center of Circle", as shown in Figures 5.11-1 and 5.11-2. Input/select three known points, calculate the center of the circle passing through these three points, and save the result to the point library.

←

Center of circle



Note: Known point A and B and C,
Calculate point O.

Point A

📍

📄

📷

Name

t8

North

2563064.214

East

441632.112

Point B

📍

📄

📷

Name

t9

North

2563061.444

East

441676.895

Point C

📍

📄

📷

Name

t1

North

2562960.967

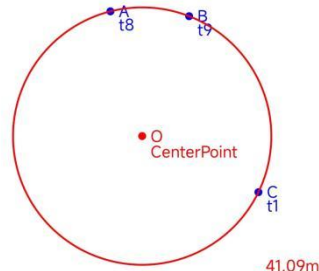
East

441716.32

Calculate

←

Result



Name

p4

Code

CenterPoint

➤

North

2562992.99

East

441650.184

Height

0

Save

Close

Figure 5.11-1

Figure 5.11-2

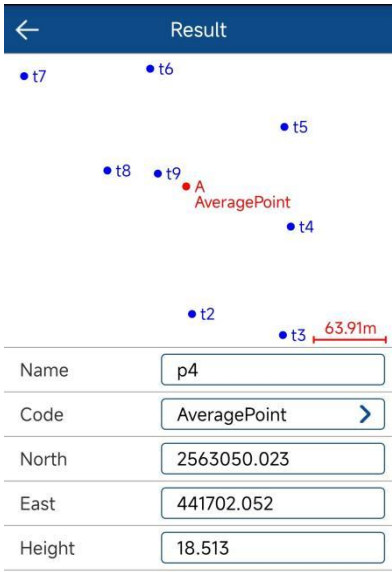
5.12 Average Value Calculation

Click "Tools" -> "Average", as shown in Figures 5.12-1 and 5.12-2. Calculate the average value of N points and save the result to the point library.

Average					Clear
No.	Name	North	East	Height	
1	t9	2563061.444	441676.895	18.892	
2	t8	2563064.214	441632.112	18.656	
3	t7	2563148.178	441558.261	19.432	
4	t6	2563154.803	441670.117	19.385	
5	t5	2563103.008	441789.162	19.354	
6	t4	2563014.288	441794.819	18.121	
7	t3	2562917.758	441787.826	17.334	
8	t2	2562936.491	441707.22	16.931	

AddEditDeleteCalculate

Figure 5.12-1



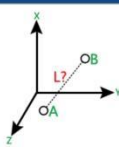
SaveClose

Figure 5.12-2

5.13 Spatial Distance

Click "Tools" -> "Great-circle Distance", as shown in Figures 5.13-1 and 5.13-2. Input/select two known points and calculate the spatial distance.

← Great-circle distance



Note: Known latitude, longitude and altitude for point A and B. Calculate the great-circle distance of AB.

Set Start Point

Name

t1

Latitude

23°09'55.188082"

Longitude

113°25'50.932763"

Altitude

17.074

Set End Point

Name

t2

Latitude

23°09'54.391331"

Longitude

113°25'50.616211"

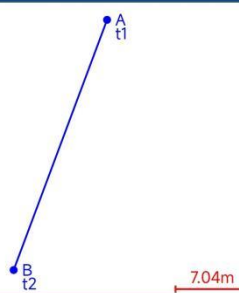
Altitude

16.931

Calculate

Figure 5.13-1

← Result



Result

Great-circle distance

26.112

Close

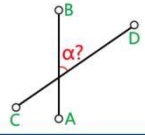
Figure 5.13-2

5.14 Angle Calculation

Click "Tools" -> "Two Lines Angle", as shown in Figures 5.14-1 and 5.14-2. Input/select four known points and calculate the angle.

84

← Two lines angle



Enter the points A, B, C, D on the two straight lines as shown in the figure, and calculate the included angle in the figure α .

Point A	
Name	t3
North	2562917.758
East	441787.826

Point B	
Name	t4
North	2563014.288
East	441794.819

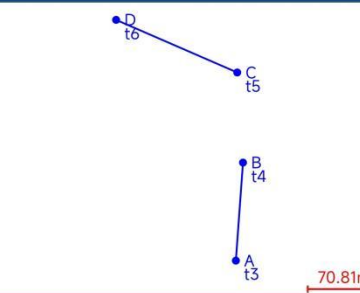
Point C	
Name	t5
North	2563103.008
East	441789.162

Point D	
Name	t6
North	2563154.803
East	441670.117

Calculate

Figure 5.14-1

← Result



Result	
Angle(clockwise)	289°22'11.185"
Angle compl.	-109°22'11.185"

70.81m

Close

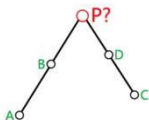
Figure 5.14-2

5.15 Intersection Calculation

Click "Tools" -> "Intersection Calculation", as shown in Figures 5.15-1 and 5.15-2. Find the intersection point of two lines and save the result to the point library.

←

Intersection calculation



Note: Known point A, B (on the first straight line) and C, D (on the second straight line). Calculate the coordinate of intersectional point P.

Point A

📍

📄

📷

Name

t6

North

2563154.803

East

441670.117

Point B

📍

📄

📷

Name

t7

North

2563148.178

East

441558.261

Point C

📍

📄

📷

Name

t8

North

2563064.214

East

441632.112

Point D

📍

📄

📷

Name

t9

North

2563061.444

East

441676.895

Calculate

←

Result



IntersectionPoint

Name

p4

Code

IntersectionPoint

North

2563109.341

East

440902.539

Height

19.162

Result

Angle

6°55'44.4182"

Save

Close

Figure 5.15-1

Figure 5.15-2

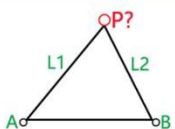
5.16 Backward Intersection

Click "Tools" -> "Resection", as shown in Figures 5.16-1 and 5.16-2. Given two points and their distances to the target, determine the target point and save the result to the point library.

86

←

Resection



Note: Known point A and B, know distance L1 and L2. Calculate point P.

Line L1,L2

L1

30

L2

60

Point A

Name

t1

North

2562960.967

East

441716.32

Point B

Name

t2

North

2562936.491

East

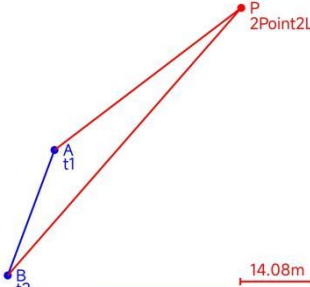
441707.22

Calculate

Figure 5.16-1

←

Result



Name

p4

Code

2Point2Line

North

2562988.699

East

441752.615

Height

17.003

Save

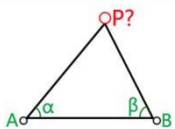
Close

Figure 5.16-2

5.17 Forward Intersection

Click "Tools" -> "Forward Intersection", as shown in Figures 5.17-1 and 5.17-2. Given two points and their included angle, determine the target point and save the result to the point library.

← Forward intersection



Note: Known point A and B, known angle α and β . Calculate the point P.

Angle α, β

α

23°29'07.6"

β

46°08'29"

Point A

Name

t3

North

2562917.758

East

441787.826

Point B

Name

t4

North

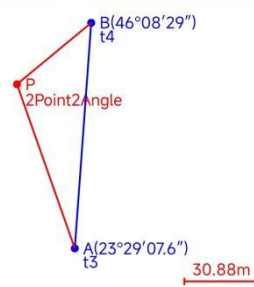
2563014.288

East

441794.819

Calculate

← Result



Name

p4

Code

2Point2Angle

North

2562987.999

East

441763.17

Height

17.728

Save

Close

Figure 5.17-1

Figure 5.17-2

5.18 Offset Point Calculation

Click "Tools" -> "Offset Point Calculation", as shown in Figures 5.18-1 and 5.18-2. Given two points, calculate the coordinates of the corresponding mileage and offset positions, and save the result to the point library

88

←

Offset point calculation

B

O

L2

OP?

L1

A

Note: Known point A and B, known distance AP(L1), known perpendicular offset distance L2. Calculate point P.

Set Start Point

Name

t5

North

2563103.008

East

441789.162

Set End Point

Name

t6

North

2563154.803

East

441670.117

Parameter Settings

Mileage

60

Offset

30

Calculate

←

Result

8

t6

P

OffsetPoint

A

t5

32.10m

Name

p4

Code

OffsetPoint

North

2563154.455

East

441746.113

Height

19.368

Save

Close

Figure 5.18-1

Figure 5.18-2

5.19 Midpoint Calculation

Click "Tools" -> "Equal Point Calculation", as shown in Figures 5.19-1 and 5.19-2. Input two known points, calculate the midpoint of the line segment, and save each midpoint to the point library.

89

← Equal point calculation

Set Start Point

Name

t7

North

2563148.178

East

441558.261

Height

19.432

Set End Point

Name

t9

North

2563061.444

East

441676.895

Height

18.892

Parameter Settings

Number of segmentation

10

Start Mileage

10

Calculate

Figure 5.19-1

← Result

Start a name

p4

Code

List

North	2563139.505	East	441570.124
Height	19.378	Mileage	24.696
North	2563130.831	East	441581.988
Height	19.324	Mileage	39.392
North	2563122.158	East	441593.851
Height	19.27	Mileage	54.088
North	2563113.484	East	441605.715

Save

Close

Figure 5.19-2

5.20 Extension Point Calculation

Click "Tools" -> " Extend Point Calculation", as shown in Figures 5.20-1 and 5.20-2. Input two known points, calculate points along the extended line, and save the result to the point library.

90

←

Extend point calculation

Note: there is a point P on the extension line of straight line AB. given the coordinates of point a and B, $BP = L1$, calculate the coordinates of point P.

Use Z ☐

Point A

Name

t1

North

2562960.967

East

441716.32

Point B

Name

t2

North

2562936.491

East

441707.22

L1

L1

15

Figure 5.20-1

←

Result

The diagram illustrates a line segment starting at point A (labeled t1) and ending at point B (labeled t2). A red line segment extends from point B to a point labeled P (labeled ExtendPoint). A dimension line indicates the distance from point B to point P is 11.97m.

Name	p4
Code	ExtendPoint >
North	2562922.431
East	441701.993
Height	0

Save

Close

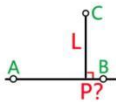
Figure 5.20-2

5.21 Vertical Distance Calculation

Click "Tools" -> "Vertical Distance Calculation", as shown in Figures 5.21-1 and 5.21-2. Input/select three known points, calculate the perpendicular foot and distance, and save the result to the point library

←

Vertical distance calculation



Description of vertical distance calculation: given the coordinates of points a and B on the straight line AB and the coordinates of point C outside the straight line, calculate the vertical distance L between point C and straight line AB and the coordinates of vertical point P.

Point A

📍

📄

📷

Name

t3

North

2562917.758

East

441787.826

Point B

📍

📄

📷

Name

t4

North

2563014.288

East

441794.819

Point C

📍

📄

📷

Name

t5

North

2563103.008

East

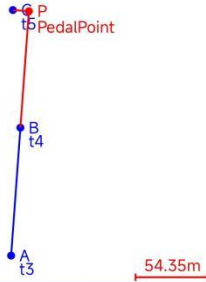
441789.162

Calculate

Figure 5.21-1

←

Result



Name

p4

Code

PedalPoint

North

2563102.137

East

441801.183

Height

0

Result

Vertical distance L

12.053

Save

Close

Figure 5.21-2