## SurPad4.0 Software

# **User Manual**

(Android version)

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## CONTENT

Chapter 1 Software Introduction1
1.1 Software introduction1
1.2 Software interface2
1.3 Software installation and uninstallation3
Chapter 2 Quick Start Guide5
Chapter 3 Project
3.1 Project Manager8
3.2 File Manager9
3.3 Coordinate System11
3.4 Calibrate Point15
3.5 Coordinate point Library18
3.6 File Export21
3.7 Scan
3.8 Cloud Settings23
3.9 Software Settings23
3.10 Software About25
Chapter 4 Device
4.1 Communication27
4.2 Rover mode
4.2.1 Rover-RTK Network

4.2.2 Rover-Internal Radio	1
4.2.3 Rover-External Radio3	2
4.2.4 Rover-Bluetooth Data Link	2
4.3 Base mode	2
4.3.1 Base-RTK Network	5
4.3.2 Base-Internal Radio	6
4.3.3 Base-External Radio3	6
4.3.4 Base-Dual	6
4.4 Static mode	7
4.5 Work Mode Status	9
4.6 Configurations4	1
4.7 Information4	2
4.8 Device Setting	2
4.9 Calibrate Sensor	3
4.10 Re_Position	8
4.11 Device Register	9
4.12 Default radio settings	9
Chapter 5 Survey	0
5.1 Point Survey50	0
5.2 Detail Survey5	7
5.3 CAD	8

	5.4 Point Stakeout	61
	5.5 Line Stakeout	64
	5.6 Stake road	68
	5.7 Stake road by point	70
	5.8 Stake road by cross section	73
	5.9 Stake road by bridge section	75
	5.10 Conical Slope Stakeout	78
	5.11 Electric Lines Survey	80
	5.12 Tower Stake	86
	5.13 Elevation Control	88
	5.14 Curve Stakeout	89
	5.15 Existing Stakeout	91
	5.16 Railway Stakeout	93
	5.17 Survey Range Settings	97
	5.18 Layers Settings	99
Cha	pter 6 Tools	01
	6.1 Site Calibration	01
	6.2 Coordinates Converter	03
	6.3 Angle Converter10	03
	6.4 Perimeter and area10	04
	6.5 COGO Calculation	05

	6.5.1 Coordinate inverse calculation	106
	6.5.2 Point line calculation	106
	6.5.3 Vector	107
	6.5.4 Two Lines Angle	107
	6.5.5 Intersection calculation	108
	6.5.6 Resection	108
	6.5.7 Forward intersection	109
	6.5.8 Coordinate positive calculation	109
	6.5.9 Offset point calculation	110
	6.5.10 Equal point calculation	110
	6.6 Calculator	111
	6.7 External Radio configuration	111
	6.8 Station Refresh	114
Cha	apter 7 Total Station	116
	7.1 Communication	116
	7.2 Height	116
	7.3 Measure Mode	117
	7.4 Orientation setup	125

## **Chapter 1 Software Introduction**

## **1.1 Software introduction**

SurPad4.0 is a GNSS surveying and mapping software which is developed by the Geoelectron company. Based on years of accumulating market experience, in combination with the international mainstream of surveying and mapping data acquisition function of the software, integrating RTK control, GIS data collection and road design and layout into one role. The main feature of the software is very outstanding graphic interaction, very powerful function and humanizes operation process. This manual mainly introduces all the menu functions and the field operation procedure of the SurPad software.

SurPad4.0 main menu contains four settings: [Project], [Device], [Survey], [Tools].

[Project] It mainly manages project operation. Its main menu includes Project Manager, File Manager, Coordinate System, Calibrate Point and other items. It can create new project in project management, set coordinate parameters in coordinate system and check points collected in survey in coordinate library.

[Device] It mainly sets operation mode and check receiver's information after connecting to receiver. Its main menu includes Communication, Rover, Base, Static and other items. After successfully connecting to receiver through Bluetooth or WIFI in Communication and choosing base, rover or static operation mode, it can check operation information and datalink status of receiver in Work Mode Status. If it needs to calibrate receiver, it should enable Tilt Survey (E-Bubble or Pole Tilt Correction) in Device Setting and then calibrate E-Bubble and Magnetic Declination in Calibrate Sensor.

[Survey] Its main menu includes Point Survey, Detail Survey, CAD, Point Stakeout, Line Stakeout, Stake Road, Electric Lines Survey and other items.

[Tools] It includes various calculation methods and External Radio Configuration, mainly containing Site Calibration, Coordinates Converter, Angle Converter, Perimeter and Area, COGO Calculation, Calculation, External Radio Configuration, Volume Calculation and Station Refresh.

## 1.2 Software interface

Main interface: On Android device installing and running this software, if there exists existing project in it, it would directly enter into main interface, as shown in Figure 1.2-1. Sliding to the left in turn will bring you to the next navigation menu interface.

Main interface title bar:

Title bar mainly displays current project name, solution states after connection with receiver and some quick function.

S: About software. Press to enter into interface as shown in Figure 1.2-2. It can check software copyright information, update software, activate software and submit your feedback about the software.

Communication. Press to enter into interface as shown in Figure 1.2-3 and connect to receiver. This icon shows two states: blue for successful connection with receiver, and white for no connection.

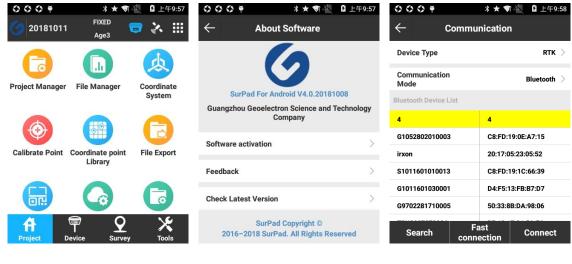






Figure 1.2-3

Nown in Figure 1.2-4 and it can check current positioning information. Press Base below the screen as shown in Figure 1.2-5 and it can check base information, and then press Save to save current base coordinate. Press Sate Map below the screen as shown in Figure 1.2-6, and it can check coordinate reference position with different colors representing different coordinate system and upper left circles showing satellite system represented by each color. Press Sate Info below the screen as

shown in Figure 1.2-7, and it shows current found satellites' number, L1\L2\L5 SNR, Elevation Angle, Azimuth Angle and other information. Press Sate SNR below the screen as shown in Figure 1.2-8, and it can check satellites' L1\L2\L5 SNR illustrated by bar graph.

B: Main interface setting. As shown in Figure 1.2-9, it can set interface style to List or Grid. Other options show whether to enable corresponding functions in survey interface, which are turned on by default.

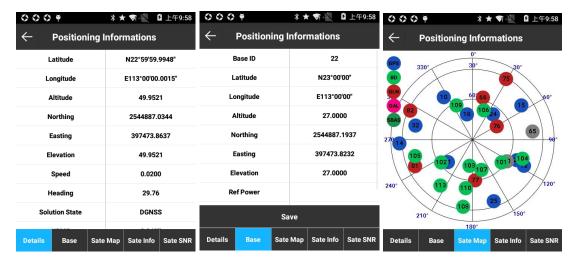


Figure 1.2-4

#### Figure 1.2-5

Figure 1.2-6

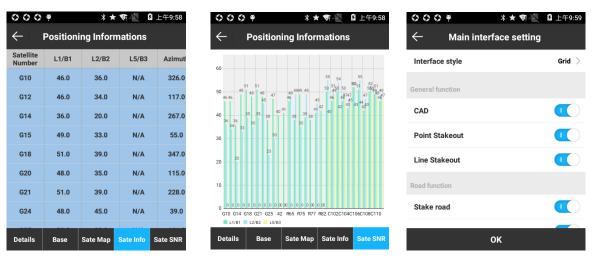


Figure 1.2-7



Figure 1.2-9

## 1.3 Software installation and uninstallation

Software installation:

(1) Download the Android SurPad4.0 installation package (\*.apk).

(2) Copy the installation package to Android device. Find the installer in File Manager in Android device as shown in Figure 1.3-1. Click the installer and pops up installation dialog box as shown in Figure 1.3-2. Click Install and pops up dialog box for preferred installation location as shown in Figure 1.3-3, and installation completion dialog box will pop up shortly as shown in Figure 1.3-4. Press Done to return to device desktop and press Open to run SurPad software.

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1	٩	CANCEL	NEXT			DONE	OPEN
Figure 1.	3-1	Figur	e1.3-2	Fig	ure1.3-3	Figure	1.3-4

. . .

Uninstallation:

Method 1: long press software icon on the desktop and drag it to Uninstall box. It pops up dialog box saying whether to uninstall as shown in Figure 1.3-5. Press Uninstall to complete uninstallation.

Method 2: press Settings  $\rightarrow$  find SurPad 4.0 in Apps as shown in Figure 1.3-6. Press SurPad $\rightarrow$  press Uninstall as shown in Figure 1.3-7. It pops up dialog box saying whether to uninstall as shown in Figure 1.3-8, and press Uninstall to complete uninstallation.



## **Chapter 2 Quick Start Guide**

Taking operation mode as handheld network with connection with RTK as example, this chapter introduces the steps of quickly connecting to receiver and performing survey. Detailed steps are as follows:

#### 1. Preparation

An RTK receiver, a P9A handheld with SurPad4.0 installed and network.

#### 2. Create new project

Run SurPad4.0 software, press [Project] -> [Project Manager] -> [New], create a new project, enter project name, and choose coordinate parameter type. Other items are additional information which can be left blank. Press [OK] and the screen jumps to interface of coordinate system parameters. In China, Ellipsoid Parameter is Beijing54 by default, and Projections Parameter is Gauss Kruger. You can set the coordinate system according to the actual situation.

#### 3. Connect to receiver and set operation mode

Press [Device] -> [Communications], choose device type as RTK and communication mode as Bluetooth/WIFI/Demo (taking Bluetooth mode as example), press [Search] to find receiver in Bluetooth Device List, press [Connect], and then pops up connection progress box which indicates successful connection.

Press [Device] -> [Rover], select data link as [Handheld network], set up IP and port of CORS server, and acquire and select access point. Other options can set as default values. Press [Apply] to finish operation mode setting. Return to main interface to see if there is a fixed solution.

4. Calibrate

Calibrate Point

In fixed solution state, press [Project] - > [Calibrate Point] - > [Marker Point Calibration], input known coordinates, set antenna parameters of current coordinates of the base station, and press [Calculate] to get calibration parameters.

#### • Site calibration

With a new surveying area, site calibration is required at the first if you want the measured points match the known points.

Here are general conditions to do site calibration: assuming that you use the known points A, B and C to calculate the transformation parameters, their GPS original records of WGS-84 coordinates and local coordinates should be recorded firstly. There are two ways to obtain the GPS original records of WGS-84 coordinates at points A, B and C: one is setting up static control network and recording coordinates by post-processing software; the other one is recording coordinates when GPS rover station in fixed solution without any parameters working.

Press [Tools] -> [Site Calibration], input the known points (select from Points Library or input manually) and WGS84 ellipsoid original coordinates (obtain current GPS data and select from Points Library or input manually), choose whether use Horizontal Control and Vertical Correction, and press [OK] to complete input of transformation parameters. And press [Calculate] to obtain GPS Parameters Reports in Site Calibration interface.

#### 5. Survey

Press [Survey] -> [Pont Survey]/[Text Survey], taking "topographic point" as example, press point types icon, choose Topo Point, press setting to set up topo point recording limit(Fixed solution, H: 0.05, V: 0.1, PDOP: 3.0, Delay: 5, Average GPS Count: 1), and press collect points icon lower right corner or collect points shortcut key on handheld to complete target points' acquisition and preservation.

6. Data import and export

#### 1) Data import

Copy the data file needs to import to SurPad folder on handheld, press [Project] -> [Coordinate point Library] ->[Import], select File Format, Angle format and Property type, find the data file and press [OK] to import data file.

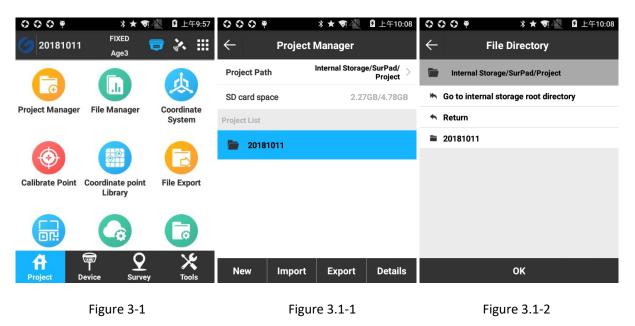
#### 2) Data export

Press [Project] -> [Fil Export], select data files, file format, angle format and point type, choose exported file storage path and press [Export] to export data file.

## **Chapter 3 Project**

In software main interface, press [Project] to display submenu as shown in Figure 3-1. Included in Project submenu are Project Manager, File Manager, Coordinate System, Calibrate Point, Coordinate Point Library, File Export, Scan, Cloud Settings, Software Settings and Software About.

SurPad4.0 manages data in the form of engineering documents, in which way all operation is controlled in a project. Every time open SurPad4.0, the software will automatically invoke engineering documents used last time. Under general circumstances, every time you begin to measure an area, it must create a project file matched with current project coordinates, and the file format should be \*.GSW. After the project has been created, in the device storage disk the software will create a file in which all data will be saved, whose file name is same with the project.



## 3.1 Project Manager

Press [Project] -> [Project Manager] to enter into interface as shown in Figure 3.1-1.

Project Path shows current project's storage position, which can be pressed to change as shown in Figure 3.1-2. If the workload is large in survey, please choose sufficient storage position to save project.

Press [New] to create a new project as shown in Figure 3.1-3. Input Project Name (required, defaults to created date), Operator, Device and Notes, select Coordinate systems parameters type (local parameters/ RTCM1021~1027 parameters/CORS encrypt parameters; please see Section 6.1

for more details), press [OK] to set up coordinate systems parameters, and press [OK] to complete new project creation.

If you need to check or modify current project's information, press [Details] as shown in Figure 3.1-4 to enter into Project Details interface.

If you need to open other projects, select the project and press [Open] to open it and use it as current project by default.

If you need to delete project, select the project and hold, press [Delete] as shown in Figure 3.1-5, press [OK] in Prompt to delete project. Current operating project cannot be deleted.

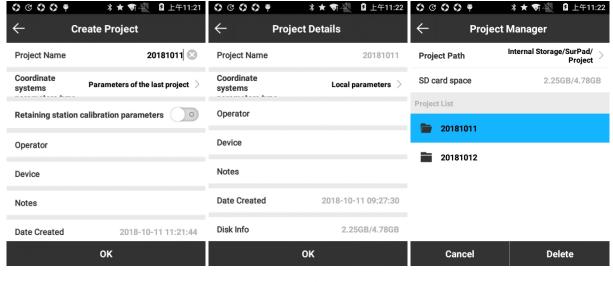


Figure 3.1-3

Figure3.1-4

Figure3.1-5

#### 3.2 File Manager

This function can be used in a project where there is too much data or when you want to distinguish between two different coordinate point libraries.

Press [New] to enter into interface as shown in Figure 3.2-1, and there pops up interface as shown in Figure 3.2-2. Create a data file to store the recorded survey data and the new file defaults to data file for current project storage record. The file name defaults to current data file name - 1, file suffix for \*. PD. The new document belongs to current project.

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Project data file list		Project data			
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			ite project ii		_
		Na	ame	20181011_2	8
				Cancel	ок
New Imp	ort Delete Open	New	Import	Delete	Open

Figure 3.2-1

Figure 3.2-2

Press [Import] to enter into interface as shown in Figure 3.2-3, choose file path, and it can import files with \*.RTK as suffix. Document name defaults to current data file name-2 (automatically accumulate). If a same file is imported twice, there will pop up a prompt as shown in Figure 3.2-4 saying "Current data file exists. Include backup data into current data file?" If the data format of the imported \*.RTK file is abnormal, there will pop up a prompt saying "RTK file import failed, please check!"

Select a file in the file list, press [Delete] as shown in Figure 3.2-4, and press [OK] to delete the data file.

When a project has multiple data files, select the data file in the data list and press [Open] to switch between different data files.

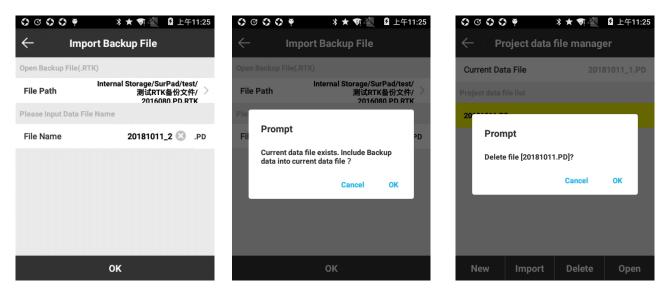


Figure 3.2-3

Figure 3.2-4

Figure 3.2-5

## 3.3 Coordinate System

1. Local coordinate parameters

Press [Project] - [Coordinate System] to enter into interface as shown in Figure 3.3-1. All options can be pressed to set up the parameter.

Press [Export] and choose [Local Disk] as shown in Figure 3.3-2 to save system data to the specified path as shown in Figure 3.3-3. It can also encrypt the file by setting up Expiry Date, General Password (data can't be viewed before expiry date) and Advance Password (data can be viewed before expiry date). Press [Export] and choose [QR Code] to share current coordinate system parameters.

Press [Use existing] as shown in Figure 3.3-4, choose [Local Disk] to apply coordinate system parameters stored in local disk. Parameter files are in two formats: \*.SP and \*.EP. Choose [QR Code] to scan QR code to apply coordinate system.

Ellipsoid Parameter: as shown in Figure 3.3-5, it can set up Target ellipsoid. Target ellipsoid supports defined or custom parameters. With custom ellipsoid, it needs to set up Semimajor axis and Reciprocal of flattening 1/f, which should be consistent with the ellipsoid used for parameter calculation.

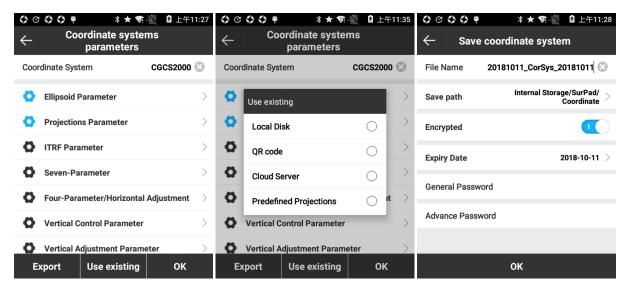


Figure 3.3-1

Figure 3.3-2

Figure 3.3-3

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Use existing	>	Semimajor axis	6378137	Central Meridian	114 🛛 📀
Local Disk	$\circ$ >	1/f	298.257222101	False Northing	0
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Cloud Server	$\circ$ >			Scale Factor	1
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Vertical Adjustmen	t Parameter				
Export Use ex	isting OK		ок	C	ж
			ок	(	ж



Figure 3.3-5

Figure 3.3-6

Projections Parameter: as shown in Figure 3.3-6, the frequently-used projections mode is Gauss Kruger, and after connecting to the device the Central Meridian can be acquired automatically via a press on  $\square$  or manually via inputting the exact value. Common projections parameters are set up as followed: False Northing-0, False Easting-500000, Scale Factor-1, Projection Height-0 at low altitudes and change it as needed at high altitudes, Latitude of Origin-0.

ITRF Parameter: ITFR is the International Earth Reference Framework. To enable ITRF conversion, it needs to choose Conversion type, input The target of epoch and enable/disable Input velocity. If enabling Input velocity, it needs to input values for Vx, Vy and Vz as shown in Figure 3.3-

$\leftarrow$ ITRF Pa	*★ ● ▲ □ 上午11:39 rameter				C C C C P * ★ ★ A Q L ± ± 11:4 ← Four-Parameter/Horizontal Adjustment	
Enable ITRF conversion		Whether to use		Whether to use	(I)	
Conversion type	ITRF2014->ITRF2008 >	Mode	Bursa-Wolf >	Translate Northing		
The target of epoch	2000	ΔΧ		Translate Easting		
Input velocity	0	ΔΥ	0	Rotation	0°00'0	
		ΔΖ	0	Scale		
		Δα(s)	0	Original Northing		
		Δβ(s)	0	Original Easting		
		Δγ(s)	0	Note: If only Four-Parameter is u Northing and Fasting must be set	sed, Original	
c	ж	ок	:	ОК		

Figure 3.3-7

7.

Seven-Parameter: as shown in Figure 3.3-8, it is used to perform Space rectangular coordinate transformation within two different ellipsoids. In general, at least three known points and six groups of XYZ coordinate values in two different space rectangular coordinate system are required to calculate the seven unknown parameters. With these seven parameters, by seven parameter equations, the XYZ coordinate value of a point in one space rectangular coordinate system can be converted to the XYZ coordinate value of another space rectangular coordinate system. Seven parameter model includes seven values:

(1) three coordinate shifts ( $\triangle X$ ,  $\triangle Y$ ,  $\triangle Z$ ), i.e. the difference between the coordinates of the two coordinate systems;

(2) rotation angles of three coordinate axes( $\triangle \alpha$ ,  $\triangle \beta$ ,  $\triangle \gamma$ ), the XYZ axis of two spatial rectangular coordinate systems can be recombined by rotating the three coordinate axes in order to specify the Angle;

(3) scale K, i.e. the length ratio of a same line in two space rectangular coordinate systems realizing scaling. Generally, K is almost equal to 1.

Four-Parameter/Horizontal Adjustment: as shown in Figure 3.3-9, in general at least two known points and four pairs of XY coordinate values in two different space rectangular coordinate system are required to calculate the four unknown parameters. With these four parameters, by four parameter equations, the XY coordinate value of a point in one space rectangular coordinate system can be converted to the XY coordinate value of another space rectangular coordinate system.

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A0	I	Adjustment Constant	0
A1	0	North Slope(ppm)	0
A2	0	East Slope(ppm)	0
A3	0	Original Northing	0
A4	0	Original Easting	0
A5	0		
X0	0		
ок		ок	

Figure 3.3-10

Figure 3.3-11

Vertical Control Parameter: GPS elevation system is earth height (ellipsoid height) while elevation system usually used in survey is normal height. As a result, height measured by GPS needs to correct to use, and Vertical Control Parameter is for this matching. Set up the parameter as shown in Figure 3.3-10.

Vertical Adjustment Parameter: elevation transformation model of Trimble TGO software includes five parameters: Adjustment Constant, North Slope, East Slope, Original Northing and Original Easting, as shown in Figure 3.3-11.

Geoid File: as shown in Figure 3.3-12, the essence of geoid measurement is to measure height difference between two points on the ground, and then calculate the height of unknown points through the height of known points. It's a way to calculate height of a point directly by height difference. SurPad4.0 imports geoid file (so far supports \*.GGF, \*.SGF, \*.UGF formats), and select transformation mode (Bilinear/Quadratic/ Bi Cubic Spline) to obtain accurate height of coordinate.

Local Offsets: a known point is required to calculate the local offsets. This parameter is used in a small range, and its accuracy is determined by operating range and decreases with the increase of operating distance.

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			ø	Vertical Contro	Parameter	$\sim$
			0	Vertical Adjustr	ment Parameter	$\rightarrow$
			0	Geoid File		>
			0	Local Offsets		>
	ок					

Figure 3.3-12

Figure 3.3-13

#### 2. RTCM1021~1027 parameter

RTCM1021~1027 is a way to send coordinate system parameter via differential data. When coordinate system parameters type is set up as RTCM1021~1027 parameters in project creation,

the software analyses coordinate parameters from received differential data. In this mode, parameters don't support manual set up as shown in Figure 3.3-13.

3. CORS encrypt parameter

CORS encrypt parameter is mainly used by CORS merchants, which can be used when merchants provide coordinate parameters and want to keep secret. When the CORS merchants provide this encrypt parameter to user, user does not know the specific coordinate system parameters.

## **3.4 Calibrate Point**

Press [Project] -> [Calibrate Point] to enter into interface as shown in Figure 3.4-1. There're 2 ways to calibrate: one is Base Point Calibration, with base coordinate before and after station change to perform calibration; the other is Marker Point Calibration, with the coordinates of the points collected before and after the station change.

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Marker Point Calibration	> Northing	2563098.47 😒	Antenna Measurement	Vertical height $>$
dX 2.61	Easting	441632.235	Antenna Height	1.874
	Elevation 845	67.554	Antenna Paramete	rs 🕒
	Current Base Coordinates		Antenna Type	STXS3SX062A
dH -1.	466 Latitude	N23°12'00"	R(mm)	72.5 <b>H(mm)</b> 49
	Longitude	E113°24'00"	HL1(mm)	25.3 HL2(mm) 16.3
	Altitude	25.126		
Clear OK	Base Information	ılate Apply		ОК

Figure 3.4-1

Figure 3.4-2

Figure 3.4-3

Base Point Calibration steps as follows:

(1) Press [Base Point Calibration] to enter interface as shown in Figure 3.4-2.

(2) Input the known points, i.e. coordinate before base change. There are two ways to input coordinate: one is to select existing base coordinate from Points Library, the other one is to directly input base coordinate x, y, h before base change. Press [Antenna Parameters] to set antenna parameters as shown in Figure 3.4-3.

(3) Input Antenna Measured Height, set Antenna Measurement Type (Vertical height, Height to phase center, Slant height, Slant height to altimetry), and Antenna Type is automatically selected according to current connected receiver, and press [OK] to return to Base Point Calibration interface.

(4) Press [Calculate] to check calculation result as shown in Figure 3.4-4. Press [Apply] and it would directly apply the calculation result. If the calculation result is in red font, it means translation parameter overrange (longitude difference over 1 degree or latitude difference over 1 degree or height difference over 1000), in which press [Apply] and there would pop up a prompt as shown in Figure 3.4-5 saying "High residuals error! Apply local offsets to current project?". If press [Apply] it would jump to Local Offsets interface as shown in Figure 3.4-6 to display the result. Press return key upper right and pops up prompt to ask whether to apply calculation result, and after selection it returns to Base Point Calibration interface.

Note: Base Point Calibration only can used in fixed solution.

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$\leftarrow$ Calibrat	e Point	$\leftarrow$ Cal	ibrate Point		$\leftarrow$ Local (	Offsets
Current Base Coordinates		Current Base Coordina	ates		Whether to use	
Latitude	N23°12'00"	Latitude		N23°12'00"	North in a	
Longitude	E113°24'00"	Lo		E44000 "70"	Northing	-3714.889971 🔀
Altitude	25.126	Al		26	Easting	3055.535644
Antenna Parameters	1.8m,Vertical height $\geq$	High residuals Ar current project	error! Apply local o	offsets to	Elevation	10042.4283
Result		Re	No	Apply		
Shift dX	-3702.098	Shift dX		-3702.098		
Shift dY	3070.689	Shift dY		3070.689		
Shift dZ	42.428	Shift dZ		10042.428		
Base Information	ılate Apply	Base Information	Calculate	Apply	C	ж

Figure 3.4-4

Figure 3.4-5

Figure 3.4-6

Marker Point Calibration steps as follows:

(1) Press [Marker Point Calibration] as shown in Figure 3.4-7, input Known Point Coordinates (x, y, h), and press [Current WGS84 Coordinates] to obtain current WGS84 coordinates. Press [Measure] to enter interface as shown in Figure 3.4-8, set Saved Conditions as shown in Figure 3.4-9 and set Antenna Parameters, and then press [OK] to acquire current WGS-84 coordinates.

(2) Press [Calculate] as shown in Figure 3.4-10 to get calculate result. If the calculation result is in red font, there would pop up a prompt saying "High residuals error! Apply local offsets to current

project?". Press return key upper right and pops up prompt as shown in Figure 3.4-11, press [No] to return to Calibrate Point interface while press [Apply] to return to Calibrate Point interface and display calibration result as shown in Figure 3.4-12.

← Calibrate	Point	← Record	d point	↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔	* ★ ¶ 4 11:50
Known Point Coordinates		Antenna Parameters	0m,Vertical height >	Solution Limit	FIXED >
Northing	2563098.47 🙁	Progress	<0/1>Not in Fixed solution!	HRMS Limit	0.1 >
Easting	441632.235	Solution State	<27/30>DGNSS	VRMS Limit	0.2 >
Elevation	10067.554	HRMS	0.05		5 >
Current WGS84 Coordinates		VRMS	0.09	Delay Limit	5 /
		Northing	2563100.284	Point Name Increment	1 >
Latitude	N23°12'00"	Easting	441632.029	Default Code	The same as last point $ > $
Longitude	E113°24'00"	Elevation	69.103		
Altitude	25.126	Latitude	N23°09'59.7059"	Average GPS Count	1 >
		Longitude	E113°25'47.9503"		
Measure Calcula	ate Apply	Settings St	art OK	Default Configurations	ок
	3 4-7	Figure	3 4-8	Figure	3 4-9
ç	3.4-7 ★ ज ☆ û 上午11:51 Point	0000¥	3.4-8 *★ জ 🏩 û 上午11:51 te Point	Figure : ひひ♂♂♀ ← Calibrate	⊁★ रू 🏠 🛿 上午11:51
0000¥ *	★ ज़ 🌉 🛿 上午11:51	0000¥	券★ रो ▲ 🛛 上午11:51	0000¥	⊁★ रू 🐴 🛿 上午11:51
Calibrate	★ 新公 _ û 上午11:51 Point	Calibrat	<b>३★ 領 ④</b> 且午11:51 te Point 67.554	େତେତଙ ← Calibrat	¥ ★ ज 🔌 û 上午11:51 e Point
Calibrate Elevation	★ 新公 _ û 上午11:51 Point	Calibrat	<b>३★ 領 ④</b> 且午11:51 te Point 67.554	Calibrate Calibrate Base Point Calibration	¥★ \$P4   2 上午11:51 e Point > >
Calibrate Elevation Current WGS84 Coordinates Latitude	★ <b>新</b> <sup>4</sup> <sup>1</sup> <sup>1</sup> 上午11:51 Point 67.554 <sup>(</sup>	Calibrat	<b>३★ 領 ④</b> 且午11:51 te Point 67.554	Calibrate	¥★ ज 🖄 û 上午11:51 e Point >
Calibrate Calibrate Elevation Current WGS84 Coordinates Latitude Longitude	★ ★ ▲ 월 上午11:51 Point 67.554 ② N23°09'59.6905" E113°25'47.969"	Calibrat Calibrat Elevation Current WGS84 Coordinates La Prompt Lc Whether the calculat	★ < <p>★ &lt; <p>◆ &lt; <p>◆ &lt; </p> ◆ &lt; <p>◆ &lt; </p> ◆ &lt; </p> ◆  ◆  ◆  ◆  ◆  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●  ●</p>	Calibrate Calibrate Base Point Calibration	* ★ ● ▲
Calibrate Calibrate Elevation Current WGS84 Coordinates Latitude Longitude Altitude	★ ★ ▲ û 上午11:51 Point 67.554 ②	Calibrat Elevation Current WGS84 Coordinates La Prompt Lc Whether the calculat	★ ● ▲ ② 上午11:51 the Point 67.554          11"         10"         11"         10"         10"         10"         10"         10"         10"         11"         11"         12"         13"         14"         15"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         16"         <	Calibrate Calibrate Base Point Calibration Marker Point Calibration	* ★ < ▲ @ 上午11:51 e Point > > -1.34 ②
Calibrate Calibrate Elevation Current WGS84 Coordinates Latitude Longitude Altitude Result	★ ★ ▲ 월 上午11:51 Point 67.554 ② N23°09'59.6905" E113°25'47.969' 69.188	Calibrat Calibrat Elevation Current WGS84 Coordinates La Prompt La Whether the calculat applied?	★ ● ▲ 日上午11:51 te Point 67.554 ion parameters are No Apply	Calibrate Calibrate Base Point Calibration Marker Point Calibration dX dY	* ★ 新公 월 上午11:51 e Point > > > -0.319
Calibrate Calibrate Elevation Current WGS84 Coordinates Latitude Longitude Altitude Result Shift dX	★ ★ ▲ 월 上午11:51 Point 67.554 ⊗ N23°09′59.6905″ E113°25′47.969″ 69.188 -1.34	Current WGS84 Coordinates	★ ● ▲ ② 上午11:51 te Point 67.554 ion parameters are No Apply -1.663	Calibrate Calibrate Base Point Calibration Marker Point Calibration dX dY	* ★ 新公 월 上午11:51 e Point > > > -0.319
Calibrate Calibrate Elevation Current WGS84 Coordinates Latitude Longitude Altitude Result Shift dX Shift dY	<ul> <li>★ ●▲ ▲ ▲ 上午11:51</li> <li>Point</li> <li>67.554 ▲</li> <li>N23°09'59.6905"</li> <li>E113°25'47.969"</li> <li>69.188</li> <li>-1.34</li> <li>-0.319</li> </ul>	Current WGS84 Coordinates	★ ● ▲ 日本11:51 te Point 67.554 11 <sup>4</sup> 17 <sup>4</sup> ion parameters are No Apply -1.663 -0.651	Calibrate Calibrate Base Point Calibration Marker Point Calibration dX dY	* ★ • ▲
Current WGS84 Coordinates Latitude Longitude Altitude Result Shift dX	<ul> <li>★ ●▲ ▲ ▲ 上午11:51</li> <li>Point</li> <li>67.554 ※</li> <li>N23°09'59.6905"</li> <li>E113°25'47.969"</li> <li>69.188</li> <li>-1.34</li> <li>-0.319</li> <li>-1.634</li> </ul>	Current WGS84 Coordinates	★ ● ▲ ② 上午11:51 te Point 67.554 ion parameters are No Apply -1.663	Calibrate Calibrate Base Point Calibration Marker Point Calibration dX dY	* ★ 新公 월 上午11:51 e Point > > > -0.319

Figure 3.4-10

Figure 3.4-11

Figure 3.4-12

Calibrate Point performs on the basis of fixed solution and opened transformation parameters. The essence is three parameters using a common point to calculate two different coordinates, also known as the calibration parameter in the software. This function can be used in the following situations:

1. When with [Use Current Coordinates] in the startup mode parameters of base, and the base have been restarted or its position has been moved, the rover should calibrate point.

2. When the user knows the conversion parameter of the work area, base could be set up at any place. Please input the conversion parameter, and the rover should calibrate point.

Note: The calibrate point parameters will not refresh the current point coordinates in the library. When display the current point coordinates, it will also display the calibrate point parameters, the subsequent measurement of the coordinates will be corrected by the calibrate point parameters. Transformation parameters by calculating the parameters of the library will refresh the current coordinates of the point. The WGS-84 coordinates of the measurement point are converted to local coordinates by conversion parameters.

## 3.5 Coordinate point Library

Press [Project]-> [Coordinate point Library] to enter into interface as shown in Figure 3.5-1.

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÷	-	Poir	nts Library	<b>y</b>		< н №	ew Point		÷	Point Edit
PI	ease in	put name or c	ode		0	Name		Pt8 🕲	Name	Pt6 🕃
	Name	Northing	Easting	Elevation	Latitu	Northing			Code	
*	Pt7	2563097.743	441633.765	69.958	N23°09'5					
*	Pt6	2563097.909	441633.494	69.660	N23°09'5	Easting			Photo And Sketch	1
*	Pt5	2563098.116	441633.019	69.110	N23°09'5	Elevation			Antenna Measure	ed Height 1.84
*	Pt4	2563098.180	441632.420	68.000	N23°09'5	Code			Antenna Measurement	Vertical height
*	Pt3	2563098.470	441632.235	67.554	N23°09'5			U	T	
*	Pt2	2563098.709	441632.162	67.072	N23°09'5	Coordinates Type	Local Coo	ordinate 🗦	Antenna Height	1.914
*	Pt1	2563099.561	441632.178	67.056	N23°09'5	Property type	Inp	ut point $>$		
	Add	Edit	Details	ок			ок			ок



Figure 3.5-2

Figure 3.5-3

The Coordinate point Library is used to uniformly manage all types of coordinate points. It can input coordinate points used in survey, which offers convenient to invoke in Point Stakeout. It can enter point name or code in the lookup to quickly search for coordinate points. It contains Add, Edit, Details, Import, Delete, Options and Recovery operation.

Press [Add] to enter into interface as shown in Figure 3.5-2. Coordinate points can be divided into Local Coordinates and Geodetic Coordinates according to Coordinate type, and Assistant point, Control point, Input point and Stakeout point according to Property type. After selecting Coordinate type and Property type, input the point name and horizontal coordinates (x, y, h) or longitude and latitude coordinates and code to add a new point.

Select any coordinate point and press [Edit] as shown in Figure 3.5-3. It can edit Name, Code, Photo And Sketch and Antenna Parameters, and press [OK] to complete edition. Inputted point can be edited its coordinate while measured point can only edit Name and Code.

Press [Details] as shown in Figure 3.5-4 to check the point name, code, longitude and latitude coordinates, horizontal coordinates (x, y, h), point type and other information.

∦★ ♥ 🐴 💈 上午11:53 000 C 0 ¥ ∦★ ♥ 4 11:53 0000 ¥ \$ \$ @ @ \$ ¥ \*★ 🤜 🏧 💈 上午11:53 **Point Details**  $\leftarrow$  $\leftarrow$ **Points Library** Import File Title Content Please input name or code  $\bigcirc$ File Format Cass format(.dat) Point Name Pt6 Latit Na [Point Name],[Code],[Easting],[Northing],[Elevation] Options Code P 23°09'5 Property type Input point > Import Latitude N23°09'59.6289" 23°09'5 Preview E113°25'48.0021" Longitude Delete 123°09'5 Altitude 69.660 Options  $\bigcirc$ 123°09'5 Northing 2563097.909 123°09'5  $\bigcirc$ Recovery 441633.494 Easting Pt2 2563098.709 441632.162 67.072 N23°09'5 Elevation 69.660 2563099.561 441632.178 Pt1 67.056 N23°09'5 Photo And Sketch Add Edit Details ок Format Manage ок

Press [...] as shown in Figure 3.5-5 to import, delete and set options of points.

Figure 3.5-4

Figure 3.5-5

Figure 3.5-6

Press [Import] as shown in Figure 3.5-6, select File Format, Property type and whether to Preview and press [OK]. Select file path and find the file and press [OK] as shown in Figure 3.5-7 to preview the data. If the data is correct, then press [OK]to import coordinates. File Format includes Measurement data file (not support to preview), Cass format, Geodetic coordinates format, Local coordinates format, COT format, NETCAD format and user-defined format (press Format Manage to create user-defined format).

Press [Format Manage] to enter interface as shown in Figure 3.5-8, press [New] to enter interface as shown in Figure 3.5-9, input Format name, select Field delimiter (, @ Space) and Extension name (dat, csv, txt), select Custom format description (to select [Point Name] and press [Add] means format includes point name), press [OK] to return to interface as shown in Figure 3.5-8 and created data formats list in it. Press upper left return key to return to interface as shown in Figure 3.5-6 and it can see user-defined format in File Format.

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← Preview		$\leftarrow$ Us	$\leftarrow$ User-defined format			Custon	n format		
[Point Name]	[Code]	[Easting]	[Northing]	No. Format name	Extension name	e	Custom format d	escription	
1		441689.119	2563139.705						
2		441676.412	2563142.931				Format name		Point Name
3		441665.520	2563137.992						Code
4		441655.334	2563144.141				Field delimiter		Latitude
5		441641.618	2563141.016				ı	$\sim$	Longitude
6		441682.087	2563176.121				Extension name		
							dat	$\sim$	Altitude
									Northing
Cano	cel	o	к	New	Edit Im	port Delete	Add	De	elete OK
	Figure 3.5-7				Figure 3.5	5-8		Figure	e 3.5-9

Press [Delete] as shown in Figure 3.5-10 to delete one or more points. Select points by press on points or press on Select All below, press [Delete] and [OK] in the pop-up prompt to delete selected points. Deleted points can be recovered with [Recovery] as shown in Figure 3.5-11. Select points need to recover and press [Recovery], and then the selected points would be displayed in Coordinate point Library. Long press point will also enter the bulk delete mode.

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$\leftarrow$		Points I	ibrary			÷			Recover	y data			÷	Filter Operation	
Pleas	e input	name or code		(	0	<b>⊘</b>	I	Name	Northing	Easting	Elevation			Auxiliary Point	
$\bigcirc$	Nam	e Northing	Easting	Elevation		0	★	Pt4	2563098.180	441632.420	68.000	N23	+	Survey Point	
$\bigcirc$	Pt7	2563097.743	441633.765	69.958	N23	$\bigcirc$	★	Pt5	2563098.116	441633.019	69.110	N23			
	Pt6	2563097.909	441633.494	69.660	N23	$\bigcirc$	★	Pt6	2563097.909	441633.494	69.660	N23		Control Point	
0	Pt5	2563098.116	441633.019	69.110	N23								٠	Input Point	
0	Pt4	2563098.180	441632.420	68.000	N23								•	Calculate Point	
$\bigcirc$	Pt3	2563098.470	441632.235	67.554	N23								-	Stake Point	
$\bigcirc$	Pt2	2563098.709	441632.162	67.072	N23									Stake Politi	
0	Pt1	2563099.561	441632.178	67.056	N23								+	Screen Point	
C	ancel	Selec	t All	Delete			Can	cel	Select	None	Recovery	,		ок	

Figure 3.5-10

Figure 3.5-11

Figure 3.5-12

Press [Options] as shown in Figure 3.5-12. Enabling the point types need to display can filter those types disabled. It includes point types: Auxiliary Point  $\clubsuit$ , Survey Point  $\bigstar$ , Control Point  $\clubsuit$ , Input Point  $\clubsuit$ , Calculate Point  $\bigstar$ , Stake Point  $\blacksquare$ , Screen Point  $\bigstar$ , Base Point  $\blacktriangle$ .

## 3.6 File Export

1. Data file export

Press [Project] -> [File Export] to enter into interface as shown in Figure 3.6-1. Data file export is to export measurement data file into the data format that user needs to graph.

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← Expor	t File	$\leftarrow$	User-defin	ed format		← 0	Custom	format	
Select Data Files	20181011_1.PD 🗦	No. Format na	me Extension	name		Custom format de	scription		
Export Road Cross-section	on					Format name		Point Name	e
File Format Surve	ey point data format(.csv) $ ightarrow$							Code	
[Point Name],[Code],[Origin Longitude],[Original Altitud						Field delimiter		Latitude	
	on Correction h],[Latitude], nna Height],[Northing],					,	~	Longitude	
satellites],[Tracking satellit [AGE],[Local date],[Local tin	es],[PDOP],[HRMS],[VRMS],					Extension name	$\mathbf{\mathbf{v}}$	Altitude	
	,[Inclined angle],[Projected ction y],[Correction h],					uat	•	Northing	
Format Manage	Export	New	Edit	Import	Delete	Add	Del	ete	ок

Figure 3.6-1

Figure 3.6-2

```
Figure 3.6-3
```

It can export in specified format or user-defined format. It requires to select data file and file format. File Format includes user-defined formats, AutoCAD file format (\*.DXF), GoogleEarth file format (\*.KML), Cass format, raw survey data (\*.CSV) and other formats. Press [Export], choose file storage path and input file name to complete export.

Different file formats can select types of export point with press on corresponding types. Point type includes Auxiliary Point, Survey Point, Control Point, Input Point, Calculate Point, Stake Point and Screen Point.

User-defined format setting: press [Format Manage] as shown in Figure 3.6-2, and press [New] to set up items as needed as shown in Figure 3.6-3. Setting up Field delimiter, Extension name, Angle format, whether to write File header, and select custom export format content. Select the content as needed, press [Add] to add the content to the Custom format description; press [Delete] to delete the content of the custom format description one by one. Press [OK] to complete the custom export formatting as shown in Figure 3.6-4.

Select custom file format to do [Import], [Edit], And [Delete] operations on the file format.

#### 2. Export Road Cross-section

Press [Export Road Cross-section] to enter into interface as shown in Figure 3.6-5. Select Data Files, File Format, Sort Type and Height Diff Type. Press [Export], choose file storage path and input file name to complete export. Export settings varies with File Format.

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÷	- Use	er-defined format	:	<del>с</del> е	xport File
No.	Format name	Extension name		Select Data Files	20181011_1.PD >
1	1	dat		Export Road Cross-	-section
				File Format	Hintsoft Format(DH)(.hdm) >
				diff.]	ation diff.] [Offset] [Elevation ation diff.] [Offset] [Elevation
				Sort Type	Sort $>$
				Height Diff Type	Relative to last point $>$
	New	Edit Import	Delete	Format Manag	e Export

Figure 3.6-4

Figure 3.6-5

File Format includes Hintsoft Format (DH), TianZhen Format(H), SOUTH CASS Cross-section File and Haiti. Hinsoft Format needs to set Sort Type and Height Diff Type. TianZhen Format only needs to set Sort Type while Haiti only needs to set Height Diff Type. SOUTH CASS Cross-section needs to set nothing.

Height includes Relative to last point and Relative to road crown.

## 3.7 Scan

In SurPad, it's mainly to scan coordinate system QR code and configuration set. After scanning QR code, as shown in Figure 3.7-1, it can view content. Press [Apply] to apply the data in current project while press upper left return key to not apply parameters.

0000¢	券★ ♥ 🦄 🛿 上午11:58	0000¥	℁★ 🐴 💈 上午11:58			
$\leftarrow$ Detail Inf	ormation	← Cloud Settings				
Work mode	Rover	Used				
Diff Type	RTCM3	Cloud Settings				
Cut-off Angle	5	IP	1			
Record raw data	No	Port	0			
Data Link	Bluetooth Data Link		-			
CORS Server	183.61.109.76:6060	Connect Status	Device not connected!			
CORS MountPoint	blk_RTCM3.2	Cloud User Information				
CORS User	test	User Group	test			
CORS Password	1234	Password	test			
Save	Apply		ок			
Figure	2 3.7-1	Figur	e 3.8-1			

## **3.8 Cloud Settings**

Press [Project] -> [Cloud Settings], and enable Cloud as shown in Figure 3.8-1. Input Cloud IP and Port, input user information and set up upload data settings. The server must be set up in accordance with PC terminal to upload survey data and download files from the server. Then the coordinate system file can be uploaded and downloaded quickly. In [Coordinate System], coordinate system parameters can be set to quickly uploaded Shared coordinate system parameters in real time.

#### 3.9 Software Settings

Press [Project] -> [Software Settings] to enter into interface as shown in Figure 3.9-1. It includes Antenna Parameters, shortcuts Settings, Record Settings, Display Settings and other settings.

Shortcuts Settings: as shown in Figure 3.9-2, set up shortcut key for Points Library, set up shortcut keys for saving Topo Point, Control Point, Quick Point, Auto Point, Corner Point, Tilt Point and Tower Point, set up shortcut keys for Latest Point, Farthest Point, Last Point, Next Point in Stakeout. For P9A handheld, shortcut keys for collecting points default to Topo Point (1), Control Point (2), Quick Point (3), Auto Point (4), Corner Point (5), Tilt Point (6) and Tower point (7). It can customize the shortcut key as needed.

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← Software	Settings	$\leftarrow$ shortcut	s Settings	← Software Set	tings
General Settings		Points Library	Not Used $>$	Record Settings	
shortcuts Settings	>	Topo Point	1 >	Topo Point Settings	>
Record Settings		Control Point	2 >	Control Point settings	$\rightarrow$
Topo Point Settings	>	Quick Point	3 >	Quick Point Settings	>
Control Point settings	>	Auto Point	4 >	Auto Point Settings	>
Quick Point Settings	->	Corner Point	5 >	Corner Point Settings	>
Auto Point Settings	>			Stop & Go Point Settings	>
Corner Point Settings	>	Tilt Point	6 >	Tilt Point Settings	>
Stop & Go Point Setting	s >	Tower point	7 > 0K	System Settings	

Figure 3.9-1

Figure 3.9-2

Figure 3.9-3

Record Settings: as shown in Figure 3.9-3, it can respectively set up storage condition and record options for Topo Point (as shown in Figure 3.9-4), Control Point, Quick Point, Auto Point, Corner Point, Stop & Go Point and Tilt Point, which also can use the default configuration.

System Settings: as shown in Figure 3.9-5, it can set up Distance Unit, Angle Format, Mileage Format, Language, Text encoding and whether Voice broadcast as needed.

Display Settings: as shown in Figure 3.9-6, it sets up the display status of coordinate points in Survey interface and set whether to display the map. It can set up Display Content, Display Type and whether to display map. If enabling map display, it can download offline maps to facilitate survey.

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🔶 Торо	Point	← Software S	ettings	$\leftarrow$ Software	Settings
Solution Limit	FIXED >	System Settings		Voice broadcast	00
HRMS Limit	0.05 >	Distance Unit	Meter 🗦	Display Settings CAD Background	White >
VRMS Limit	0.1 >	Angle Format	dd°mm'ss.ssss" $>$	color Display Content	Point Name
PDOP Limit	3.0 >	Station Format	0.000 >	Display Type	Last (0 to 100) Points
Delay Limit	5 >	Language	English $>$	Last (0 to 100) Points	100 🔇
Point Name Increment	1 >	Text encoding	EUC_KR >	Screen orientation	Vertical screen $>$
Default Code	The same as last point $ ightarrow$	Voice broadcast		Full screen display	
Average GPS Default Configurations	ок	Display Settings CAD Background color	White $>$	Google Map Display	

Figure 3.9-4

Figure 3.9-5

Figure 3.9-6

## 3.10 Software About

Software About as shown in Figure 3.10-1 includes three functions: Software activation, Feedback and Check Latest Version.

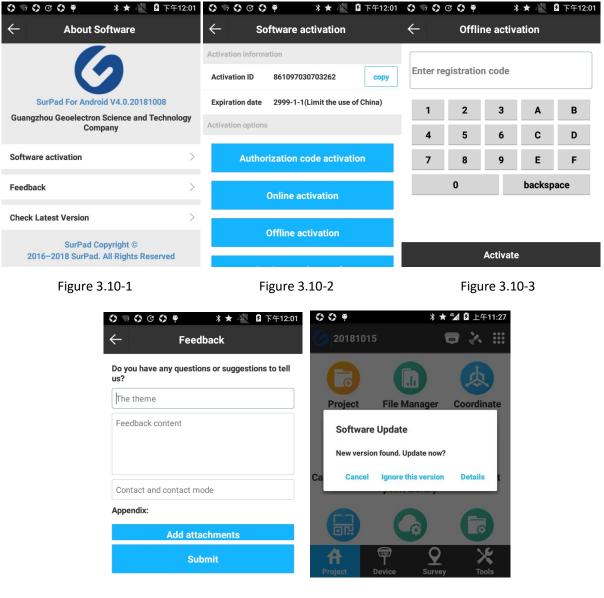


Figure 3.10-4

Figure 3.10-5

Software activation: press [Software activation] to enter interface as shown in Figure 3.10-2. There're mainly two ways to activate: Online activation and Offline activation. When with internet, it can use online activation while without it can use offline activation. As shown in Figure 3.10-3, input registration code and press [Activate] to complete offline activation. Registration code transfer helps use our software on different devices.

Feedback: Thank you for using our software. Please leave your valuable comments. We will take your feedback seriously. As shown in Figure 3.10-4, you can write your feedback in the textbox and leave your contact information. It can also send us with appendix, which supports image and text. Press [Submit] and your feedback would automatically send to us.

Check Latest Version: press [Check Latest Version] to check if current software in latest version. If there is a new version, there would pop up Software update prompt as shown in Figure 3.10-5, and press [Details] to update software. If there is no new version, there would notice it's the latest version.

## **Chapter 4 Device**

## 4.1 Communication

Press [Device]->[Communication] to enter into interface as shown in Figure 4.1-1. Set up Device Type, select Communication Mode, and press [Connect] to complete the device connection. When communication is not connected, the icon is grey. And the icon will turn blue after communication.

← Communi	ication					
	ication	← Commu	inication			
Device Type	<b>RTK</b> >	Device Type	Total Station $>$	Device Type	rtk >	
Communication Mode	Bluetooth $>$	Make	Stonex $>$	Communication Mode	Bluetooth >	
Bluetooth Device List		Model	R1+ >	Bluetooth Device List		
4	4			S322880313114	50:33:8B:67:38:2D	
G1052802010003	C8:FD:19:0E:A7:15	Communication Mode	Bluetooth $>$	DESKTOP-XJGDB	00:28:F8:5D:F2:09	
irxon	20:17:05:23:05:52	Bluetooth Device List		LAPTOP-1AHAKJ1R	00:E1:8C:BF:8B:F4	
S1011601010013	C8:FD:19:1C:66:39	4	4	MQL	00:15:83:3D:0A:71	
G1011601030001	D4:F5:13:FB:B7:D7	G1052802010003	C8:FD:19:0E:A7:15	SYOHUB-51ed	22:22:EE:20:03:4F	
G9702281710005	50:33:8B:DA:98:06	irxon	20:17:05:23:05:52	红米手机	94:87:E0:EB:3C:60	
Search Fas connec	Connect	Search	Connect	Ston	Fast Connect	

Figure 4.1-2

Figure 4.1-3

Device Type: RTK, M5, South, South(S82T/S86T), Internal GPS (only display this option when device has internal GPS) and Total Station.

The following is introduction of communication mode with connection to RTK and Total Station. RTK Communication Mode: Bluetooth, WIFI and demo; Total Station Communication Mode: Bluetooth and Serial Port, with interface as shown in Figure 4.1-2.

(1) Bluetooth connection

Figure 4.1-1

Select [Bluetooth] and press [Search] as shown in Figure 4.1-3. If the Bluetooth of device need to connect is displayed in "Bluetooth Device List", you can press [Stop] to stop searching. Select the device Bluetooth needs to connect and press [Connect]. When there pops up matching dialog box, press [Pair] to connect. [Fast connection] is to search the Bluetooth signal around and automatically connect to the one with largest signal intensity. Bluetooth communication mode of Total Station is the same with that of RTK.

(2) WIFI connection

With Device Type of RTK, select [WIFI] as Communication Mode and press [Search]. WIFI Device would be listed with its WIFI name (defaults to receiver SN). Select WIFI name to connect to the device WIFI and press [Connect] to complete connection as shown in Figure 4.1-4. [Fast connection] is to search the WIFI signal around and automatically connect to the one with largest signal intensity.

(3) Serial Port

With Device Type of Total Station select [Serial Port] as Communication Mode. Then connect handheld and device with data cable, set up Port and Baud, and press [Connect] to complete connection as shown in Figure 4.1-5.

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← Comm	unication	← Comm	unication	← Commu	nication
Device Type	rtk $>$	Device Type	Total Station $>$	Device Type	<b>RTK</b> >
Communication Mode	WIFI >	Make	Stonex >	Communication Mode	Demo 🗦
WIFI Device		Model	R1+ >	Start Point coordinates	ß
S322880313114	50:33:8B:67:38:2D	Communication		Latitude	N23°09'59.6235"
		Mode	Bluetooth >	Longitude	E113°25'48.0117"
		Bluetooth Device List		Longitude	EII3 2348.0117
		4	4	Altitude	69.958
		G1052802010003	C8:FD:19:0E:A7:15	Options	
		irxon	20:17:05:23:05:52	random	Ţ
	Fast Connect	Debug	Stop	Debug	Disconnect

Figure 4.1-4

Figure 4.1-5

Figure 4.1-6

(4) Demo

With Device Type of RTK, select [Demo]. As shown in Figure 4.1-6, set up Start Point coordinates and Direction (random or manually input) and press [Start] to enter into Demo mode. In Demo mode, it can check and try out various functions of the software.

## 4.2 Rover mode

Press [Device] ->[Rover] to enter into interface. As shown in Figure 4.2-1, Rover mode settings include Cut angle, whether to record raw data, Data link and advanced settings. The following is detailed introduction.

0 0 0 0 ¥	券★ ♥ 🐴 💈 下午2:06	0000¥	🕏 ★ 🖣 🐴 🛛 🖄 下午2:0
- Rover mo	ode settings	Advanced s	ettings
Cut angle	5 >	GPS	I (
Record raw data		GLONASS	•
ata Link	Bluetooth Data Link $\geq$	BEIDOU	Ţ
Connect Mode		Galileo	C
ORS Settings	•••	SBAS	C
lame	192.168.21.54(7079) >		
Jser	atest		
Password	1234		
Stop adv	anced Apply	ок	

Figure 4.2-1



Cut angle: The angle between the connection line between satellite and receiver and the horizon. The receiver does not receive satellites that are below the elevation mask. Value range: 0- $45^{\circ}$ .

Record raw data: when it's enabled, it can input Point name and collect post-differential point in Point survey interface.

Data Link: enable/disable data link, RTK Network, Internal Radio, External Radio, Bluetooth Data Link.

- 1. None: no differential signal is transmitted.
- 2. RTK Network: transmit differential signal through RTK internal network. It needs to insert SIM card to transmit data.
- 3. Internal Radio: transmit differential signal through RTK internal radio. Base transmits differential signals through internal station, and rover receives differential signals from base through internal radio.
- 4. External Radio: transmit differential signal through large radio connected with receiver.
- 5. Bluetooth Data Link: transmit differential signal through handheld's network. It needs to insert SIM card to transmit data.

Select appropriate data link mode, and when set up successfully, rover can receive differential signals from the base. If internal radio mode is used, the frequency and protocol settings of rover and base must be consistent.

Advanced: as shown in Figure 4.2-2, it includes 5 satellite systems, namely GPS, GLONASS, BEIDOU, Galileo (only displays when receiver supports) and SBAS. It can select whether to receive signal from corresponding systems as needed.

## 4.2.1 Rover-RTK Network

Select Data Link as RTK Network to enter into interface as shown in Figure 4.2.1-1. It needs to set up Connect Options, WIFI Settings or APN Settings, CORS Settings and MountPoint Settings.

Connect Options needs to set up Connect Model, GGA upload intervals (defaults to 5 s, can be user-defined), whether to Automatically connect to network (when enable, receiver would automatically connect to the Internet once powered on), Network system (Auto, GSM and CDMA1x), Network mode (WIFI or GPRS. Selecting WIFI would appear WIFI Settings and selecting GPRS would appear APN Settings) and whether to use Network Relay. Connect Mode option details are as follows:

TCP: transmission control protocol. It is a connection-oriented, reliable, byte flow-based transmission communication protocol.

NTRIP: standard network transmission differential mode, commonly used in CORS networks.

Custom: user-defined.

ZHD: differential transmission mode of HI-TARGET network, which needs to set group number and subgroup number.

0000 ¥ \*★ € 4 12 下午2:14 00000 \*★ ●▲ 🛛 下午2:14 Rover mode settings  $\leftarrow$ CORS server manager No. Name IP Port User Password Connect Mode NTRIP >GGA Upload 5 > Interval(s) Automatically connect to network Network mode wifi >0 Network Relay •••• WiFi Settings WIFI hotspot Password Delete Import Add Edit οк advanced Apply Figure 4.2.1-1 Figure 4.2.1-2

HUACE: differential transmission mode of CHC network.

WIFI Settings requires receiver with WIFI function. Press •••• to search WIFI, select WIFI hotspot and input password to connect WIFI.

CORS Settings needs to set IP, Port, User and Password. For User and Password, if you set up your own base, User and Password can be set at will; if you are using someone else's CORS account, you need to enter the password for that account. In addition, you can press •••• on the right to customize information about the CORS server.

MountPoint Settings needs to press [Get Access Point] and enable Automatically connect to network so that it can choose rover access point in the MountPoint list (generally access point defaults to base receiver number).

When everything is set up for rover, press [Apply] to complete rover receiver network data link setting.

## 4.2.2 Rover-Internal Radio

Select Data Link as [Internal Radio] to enter into interface as shown in Figure 4.2.2-1. It needs to set Channel, Frequency and Protocol. Channel 1-7 is fixed channels, whose frequency is unchangeable; Channel 8 is user-defined channel, whose frequency can be set as needed. Radio Protocol includes SATEL, PCC-EOT(4FSK), PCC-EOT(GMSK) and Trim Talk 450S(T).

9 0 0 0 9	∦★ रों 🖞 🛿 上十5:20	
← Rover mo	de settings	
Cut angle	5 >	
Record raw data	•	
Data Link	Internal Radio >	
Channel	3 >	
Frequency	441.125	
Protocol	TrimTalk 450S(T) >	
advanced	Apply	

Figure 4.2.2-1

Figure 4.2.3-1

### 4.2.3 Rover-External Radio

Select Data Link as [External Radio] to enter into interface as shown in Figure 4.2.3-1. It needs to set Baud Rate, which defaults to 38400.

### 4.2.4 Rover-Bluetooth Data Link

← Rove	er mode settings
Cut angle	5 >
Record raw data	0
Data Link	Bluetooth Data Link >
Connect Mode	NTRIP $>$
CORS Settings	
Name	122.13.16.137(6070) >
User	tes5t
Password	
MountPoint Settings	
MountPoint	1000_RTCM32 >
Start	advanced Apply

Figure 4.2.4-1

Select Data Link as [Bluetooth Data Link] to enter into interface as shown in Figure 4.2.4-1. It needs to set Connect Mode, CORS Settings and MountPoint Settings. The setup method is the same as RTK Network, except that the network used comes from the mobile device, which requires the mobile device to be able to access the Internet.

### 4.3 Base mode

Press [Device] -> [Base] to enter into interface as shown in Figure 4.3-1, set up all parameters and press [Apply] to set receiver as base. If receiver does not open in base mode, its base parameters can be modified and receiver can be set to be base; If receiver opens in base mode, it can stop base and then set base parameters.

Base mode settings include Base ID, Start Up Mode, Diff Mode, Base Startup, Record raw data and Data Link. The following introduces various parameter settings.

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← Base n	node settings	← Base Coordin	ates Settings
Base ID	01 😒	Input Base Coordinates	
Start Up Mode	Use Current Coordinates $>$	Coordinates Type	Geodetic Coordinate 🗦
Diff Mode	RTCM3 >	Latitude	
Base startup	•	Longitude	E0°00'00"
Record raw data		Altitude	0
Data Link	None >	Antenna Parameters	1.8m,Vertical height
advanced	Apply	c	Ж

Figure 4.3-1



Start Up Mode: Base mode settings includes 2 Start Up Modes: Use Current Coordinates and Input Base Coordinates.

- a) Use Current Coordinates: base uses WGS-84 coordinate of current point as base coordinates.
- b) Input Base Coordinates: user determines base coordinate. User-defined base coordinate cannot be too different from the exact WGS-84 coordinate of current point, otherwise the base station cannot work normally.

Press [Input Base Coordinates] as shown in Figure 4.3-2, base coordinate can be selected from points library, or acquired current GPS coordinate, or input manually. Press [Antenna Parameters], select Antenna Measurement Type and input Antenna Measured Height to obtain antenna height.

Differential Mode: includes RTCM2, RTCM3, CMR, CMRPLUS, DGPS and RTCM32.

Data Link: set up current data link, including None, RTK Network, Internal Radio, External Radio and Dual.

- 1. None: no differential signal is transmitted.
- RTK Network: transmit differential signal through RTK internal network. It needs to insert SIM card to transmit data.

- 3. Internal Radio: transmit differential signal through RTK internal radio. Base transmits differential signals through internal station, and rover receives differential signals from base through internal radio.
- 4. External Radio: transmit differential signal through large radio connected with receiver.
- 5. Dual: base transmits differential signal simultaneously through network and external radio, and rover receives differential signal from any way as needed.

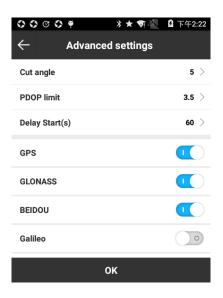
Select appropriate data link mode, and when set up successfully, rover can receive differential signals from the base. If internal radio mode is used, the frequency and protocol settings of rover and base must be consistent.

Advanced: as shown in Figure 4.3-3, set up Cut angle, PDOP limit, Delay Start and Satellite systems.

Cut angle: The angle between the connection line between satellite and receiver and the horizon. The receiver does not receive satellites that are below the elevation mask. Value range: 0-45 $^{\circ}$ .

PDOP limit: Position Dilution of Precision. The smaller the PDOP value is, the better the satellites distribute. When it is less than 3, it is in the ideal state.

Satellite systems: it includes 6 satellite systems, namely GPS, GLONASS, BEIDOU, Galileo (only displays when receiver supports), SBAS and L-band. It can select whether to receive signal from corresponding systems as needed. L-band, the satellite communication band with frequency range from 0.39 to 1.55GHz, is often called 1.5GHz band.



34

#### Figure 4.3-3

#### 4.3.1 Base-RTK Network

Select Data Link as RTK Network to enter into interface as shown in Figure 4.3.1-1. It needs to set up Connect Options, WIFI Settings or APN Settings and CORS Settings.

Connect Options needs to set up Connect Model, whether to Automatically connect to network (when enable, receiver would automatically connect to the Internet once powered on), Network mode (WIFI or GPRS) and Network system. Connect Mode option details are as follows:

NTRIP: standard network transmission differential mode, commonly used in CORS networks.

Custom: user-defined.

ZHD: differential transmission mode of HI-TARGET network, which needs to set group number and subgroup number.

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$\leftarrow$ Base mod	e settings	l	$\leftarrow$		← CORS server ma	← CORS server manager
WIFI hotspot	>		No. Name	No. Name IP Port	No. Name IP Port	No. Name IP Port
Password						
CORS Settings						
Name	Custom $>$					
IP	122.13.16.137					
Port	6060					
Base access point	861097030703262					
Password	pass					
advanced	Apply		Add	Add Edit	Add Edit Delete	Add Edit Delete Import
Figure 4.	3.1-1			Fig	Figure 4.3.	Figure 4.3.1-2

HUACE: differential transmission mode of CHC network.

WIFI Settings requires receiver with WIFI function. Press •••• to search WIFI, select WIFI hotspot and input password (if needed) to connect WIFI.

CORS Settings needs to set IP, Port, Base access point (generally access point defaults to base receiver number) and Password. In addition, you can press •••• on the right to customize information about the CORS server.

# 4.3.2 Base-Internal Radio

Select Data Link as RTK Network to enter into interface as shown in Figure 4.3.2-1. It needs to set Channel, Frequency, Protocol and Power. Channel 1-7 is fixed channels, whose frequency is unchangeable; Channel 8 is user-defined channel, whose frequency can be set as needed. Radio Protocol includes SATEL, PCC-EOT(4FSK), PCC-EOT(GMSK) and Trim Talk 450S(T). The power level of base will affect the operating distance of radio: low power and low power consumption lead to close range of action; high power and high power consumption lead to long operating distance.

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← Base mode	e settings	← Base m	node settings	$\leftarrow$ Base mod	e settings
Base startup	$\bigcirc \circ$	Base ID	01	CORS Settings	(···)
Record raw data	$\bigcirc \circ$	Start Up Mode	Use Current Coordinates >	Name	Custom >
Data Link	Internal Radio $ ightarrow$	Diff Mode	<b>RTCM3</b> >	IP	122.13.16.137
Channel	3 >	Base startup	•	Port	6060
Frequency	441.125	Record raw data	•	Base access point	861097030703262
Protocol	TrimTalk 450S(T) 🗦	Data Link	External Radio	Password	pass
Power	High >	Baud Rate	38400 >	External Radio Port Settings	
ote: When Base station pow elow, RTK range will be redu	er is set to Low or 500mW & ced!			Baud Rate	38400 >
advanced	Apply	advanced	Apply	advanced	Apply

#### Figure 4.3.2-1

Figure 4.3.3-1

Figure 4.3.4-1

### 4.3.3 Base-External Radio

Select Data Link as [External Radio] to enter into interface as shown in Figure 4.3.3-1. It needs to set Baud Rate, which defaults to 38400.

### 4.3.4 Base-Dual

Select Data Link as [External Radio] to enter into interface as shown in Figure 4.3.4-1. Dual data link means base transmits differential signal simultaneously through network and external radio. Its set-up method is the same as Base-RTK Network and Base-External Radio, only that this mode needs to use internal network of device (with SIM card inserted).

### 4.4 Static mode

Press [Device] -> [Static] to enter into interface as shown in Figure 4.4-1. Static mode settings include Options Settings and Antenna Parameters. The following introduces all parameter settings in detail.

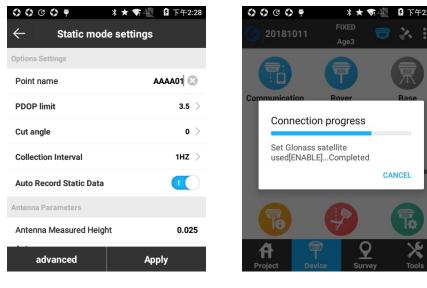


Figure 4.4-1



• Options Settings

Point name: point name of static data.

PDOP limit: The geometric strength factor of the satellite distribution. The smaller the PDOP value is, the better the satellite distribution is. PDOP value less than 3 is the ideal state.

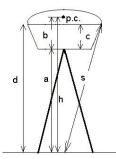
Cut angle: The angle between the connection line between satellite and receiver and the horizon. The receiver does not receive satellites that are below the elevation mask. Value range: 0-45°.

Collection interval: 1HZ represents that the acquisition of a data per second, 5HZ represents that the acquisition of five data per second, 5s represents that two seconds to collect a data, and so on.

Auto record static data: If it's enabled, receiver will start recording automatically when it is powered on and receiving satellites signal; If it's disabled, you need to start recording static data manually after receiver is powered on. Antenna Parameters

Antenna Measured Height: height of the measured point above ground.

Antenna Height: vertical height(h) from the phase center of the antenna to ground.



The known values which receiver provided as follows:

b: The height from the bottom of the device to the phase center p.c;

c: The height from the bottom of the device to the rubber ring;

R: The radius of the device rubber ring.

If the measured height is the vertical height (a) from the bottom of device to the ground, its measurement mode is Upright height from device bottom. The antenna height: h=a+b.

If the measured height is the height from the phase center to the ground, its measurement mode is Height from Phase Center. The antenna height: h=h.

If the measured height is the slant height (s) from the rubber ring to the ground, its measurement mode is Slant height from measuring line. Antenna height:  $h = sqrt (s^2 - R^2) - c + b$  (sqrt means open square).

Altimetry piece is an accessory fixed to the bottom of device. If the measured height is the slant height(S) from the altimetry piece to the ground, and with the known radius of altimetry piece Rc, its measurement mode is Slant height from Altimetry piece. Antenna height:  $h = sqrt (S^2 - Rc^2) + b$ .

Antenna height is usually defined as the vertical distance from the phase center of antenna to measuring point. Since it cannot be directly measured, it is usually calculated by other measurement methods. The antenna height can be obtained by inputting measured height and selecting measurement mode.

After setting all parameters in static mode setting, press [apply] to set receiver to static mode.

advanced

Satellite systems: it includes 5 satellite systems, namely GPS, GLONASS, BEIDOU, Galileo (only displays when receiver supports) and SBAS. It can select whether to receive signal from corresponding systems as needed.

SBAS: Wide-area differential augmentation system (satellite-based augmentation system). The navigation satellites are detected by a large number of widely distributed differential stations and the acquired raw data is sent to console. And then console calculate to acquire various satellite positioning correction information and sent to the GEO satellites through the upload station. Finally, GEO satellites will send the correction information to users, which facilitates to improve the positioning accuracy.

After setting all parameters in static mode setting, press [apply] as shown in Figure 4.2-2 to set receiver to static mode.

#### 4.5 Work Mode Status

Work Mode Status can view operation information and status of data link selected by current receiver. Press [Device] - > [Work Mode Status] to enter into interface as shown in Figure 4.5-1. It divides into two parts: Working Information and Work Mode Status. In Working Information it can view the detailed information of data link, such as IP port. In Work Mode Status it can set up current data link. In None data link and Static mode it can only view Working Information. The following introduces work mode statuses of different working modes in detail.

When data link of base or rover is set as RTK Network, Work Mode Status is shown in Figure 4.5-2. [Connection]: connect data link; [Disconnect]: disconnect data link; [Restart]: reinitialize network module; [Refresh]: refresh current data link status.

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$\leftarrow$ Rover-RT	K Network	- Rover-RT	K Network	← Rover-Inte	ernal Radio
Working Information	Work Mode Status	Working Information	Work Mode Status	Working Information	Work Mode Status
Cut angle	5	Signal Level		Radio Status	Radio OK.
Record raw data	No	Network Status	GPRS power off		
Connection Mode	CORS				
APN Name	cmnet				
APN Accounts					
CORS Server	122.13.16.137:6060				
CORS Access Point	RTCM30				
CORS user	S322880313114	Connect Disconnect	Restart Refresh	Channel Res	start Refresh
Figur	Figure 4.5-1		e 4.5-2	Figure	e 4.5-3

When data link of base or rover is set as Internal Radio, Work Mode Status is shown in Figure 4.5-3. [Channel detection]: detect the signal strength of current frequency; [Restart]: reinitialize radio module; [Refresh]: refresh current radio status.

For channel detection result, if it comes out as shown in Figure 4.5-5, it means the device connected has no channel detection function; if it comes out as shown in Figure 4.5-6, it means detection successes, in which red stands for strong signal ( $\geq$ -95dBm), orange stands for weak signal (-95dBm ~ -105dBm), and green stands for no signal ( $\leq$ -105dBm). Red is not suggested setting as radio frequency, while orange and green are able to set as radio frequency and green is suggested setting as stransmitting frequency of current base.

· ●         · ●         · ●	0 9 0 0 C ¥	* ★ 🐴 🛿 下午2:57	0 9 0 0 C 9	* ★ 🐴 💈 下午2:56
← Rover-Internal Radio	← Rover-Inte	rnal Radio	← Rover-Inte	rnal Radio
Working Information Work Mode Status	Working Information	Work Mode Status	Working Information	Work Mode Status
	Radio Status	Radio OK.	[441.000000]	-109.625dBm(No signal)
Channel detection			[442.000000]	-108.500dBm(No signal)
Type Default frequency			[443.000000]	-110.375dBm(No signal)
Note: the antenna must be			[444.000000]	-108.875dBm(No signal)
connected to this function			[445.000000]	-102.250dBm(Weak signal)
Cancel OK			[446.000000]	-108.875dBm(No signal)
			[447.000000]	-109.375dBm(No signal)
			[447.000000]	-109.000dBm(No signal)
Channel Restart Refresh	Channel Res	start Refresh	Channel Res detection	start Refresh
Figure 4.5-4	Figure	e 4.5-5	Figure	4.5-6

When data link of base or rover is set as External Radio, Work Mode Status is shown in Figure 4.5-7.

When data link of rover is set as Bluetooth Data Link, Work Mode Status is shown in Figure 4.5-8. [Stop]: disconnect network; [Start]: reconnect network.

When data link of base is set as Dual, Work Mode Status is shown in Figure 4.5-9. [Connection]: connect data link; [Disconnect]: disconnect data link; [Restart]: reinitialize network module; [Refresh]: refresh current data link status.

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← Rover-Exte	ernal Radio	$\leftarrow$ Rover-Blueto	oth Data Link	$\leftarrow$	Base-Dual
Cut angle	5	Working Information	Working Information Work Mode Status		tion Work Mode Status
Record raw data	No	Connect Mode	NTRIP >	Signal Level	
		CORS Settings		Network Status	GPRS power off
External Port Baud Rate	38400	Name	192.168.21.54(7079) >		
GPS Enable	Yes	User	atest		
DeiDou Enable	Yes	Password	1234		
GLONASS Enable	Yes	MountPoint Settings			
GALILEO Enable	No	MountPoint	rtcm23 >		
SBAS Enable	No	Stop	ок	Connect Disco	nnect Restart Refresh
		etop		Disco	Refresh

Figure 4.5-7

Figure 4.5-8

Figure 4.5-9

### 4.6 Configurations

Press [Device] -> [Configurations] to enter into interface as shown in Figure 4.6-1. In the list display device's configuration set, which includes all work mode settings for receiver. Under most circumstances, default settings can satisfy daily use.

Configurations contains six operation, namely New, Edit, Details, Apply, Import and Delete.

Press [New] to create a new configuration set.

Press [Import] to import configuration set file in \*.set format.

Select one configuration set of work mode and press [Apply] to apply the configuration set.

Press [Details] as shown in Figure 4.6-2 to view the specific settings for this configuration set.

Press [QR code] as shown in Figure 4.6-3 to generate QR code and press [Save] to select file path and then the QR code would save in \*.jpg format.

Press [Delete] to delete the configuration set from Configuration. Defaulted configuration set cannot be deleted.

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← Preset Configurations	:	← Information		← Information
Name	Туре	Configure	Content	Please scan the qr code
Base_External_Radio_38400	Base	Work mode	Base	
Rover_Internal_Radio_8	Rover	Start Up Mode	Single Point	
Base_Internal_Radio_8	Base	Base ID	1	
		PDOP Limit	3.50	
		PDOP Limit	60s	
		Automatically start when power on	Yes	
		Diff Type	RTCM32	
		Cut-off Angle	5	Cancel Save
New Edit Details	and to			
New Edit Details A	pply	QR code	ок	QR code OK
Figure 4.6-1		Figure 4.6-2		Figure 4.6-3

# 4.7 Information

Press [Device] -> [Information] to enter into interface as shown in Figure 4.7-1. When handheld connects to receiver, it can read receiver information, including Device information, Network info, Radio info and Other information.

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	← Device Setti	ng
03262	Solution Mode	Normal Mode
311	Tilt Survey	Disable
30	The Survey	Disable
	Enable Voice	
21	Enable WIFI	
RN0000		
299Y	Base Coordinates Change Pro	npt 💶
Other	ок	
0	ther	ther OK

Figure 4.7-1

Figure 4.8-1

### **4.8 Device Setting**

Press [Device] -> [Device Setting] to enter into interface as shown in Figure 4.8-1.

Solution Mode: for Novatel OEM board, it divides into Normal Mode, Strict Mode and Extra Safe Mode. Under special environment, using Strict Mode can improve reliability of solution.

Tilt Survey: set whether to use tilt survey and select E-Bubble or Pole Tilt Correction.

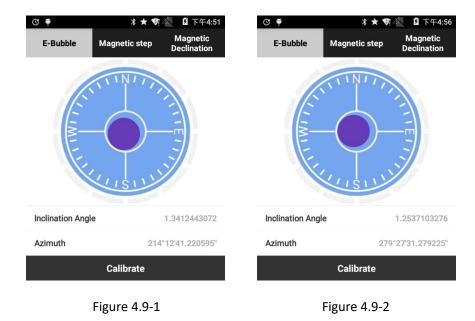
Enable Voice: set whether to use voice prompt for stakeout

Enable WIFI: set whether to open WIFI connects to receiver.

Base Coordinates Change Prompt: set whether to prompt surveyor when base changes.

### 4.9 Calibrate Sensor

Press [Device] -> [Calibrate Sensor] to enter into operation main interface. Main interface includes three function keys, namely E-Bubble, Magnetic step and Magnetic Declination. It needs four steps to perform magnetic north calibration, and the following introduces the operation in detail.



#### 1. Open Pole Tilt Correction

Press [Device] -> [Device Setting], select [Pole Tilt Correction] in Tilt Survey, and press [OK] to open it.

#### 2. E-Bubble

(1) Press [E-Bubble] to enter into E-Bubble calibration interface as shown in Figure 4.9-1.

(2) Center the bubble on the retractable pole and press [Calibrate]. E-bubble and bubble on the retractable pole are in center at the same time and E-Bubble is shown in green as shown in Figure 4.9-2.

3. Magnetic step calibration

Press [Magnetic step] as shown in Figure 4.9-3.

(1) Record Horizontal data: install the device on retractable pole as shown in Screen (align the retractable pole with the red point on device connector). Press [Horizontal] and rotate the device with retractable pole as axis (no limit to rotation direction). Rotation speed should be not more than 15°/s, taking more than 30 seconds for one rotation. When data has been collected, receiver will beep. The horizontal data recording process is shown as Figure 4.9-4. After the horizontal data recording is shown as Figure 4.9-5.

(2) Record vertical data: install the device on retractable pole and notice that the limited block should be stuck in the groove of RTK as shown in Figure 4.9-6. After installation, press [Vertical], and rotate the device with retractable pole as axis (no limit to rotation direction). Rotation speed should be not more than 15°/s, taking more than 30 seconds for one rotation. When data has been collected, receiver will beep. The vertical data recording process and result are shown in Figure 4.9-7 and Figure 4.9-8.

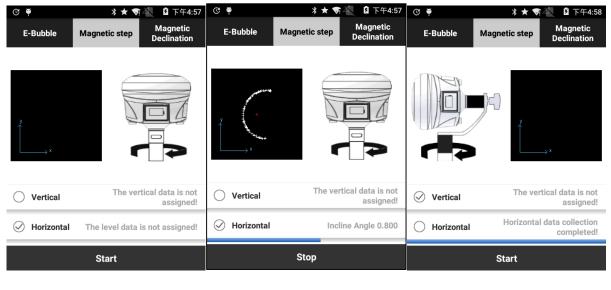


Figure 4.9-3

Figure 4.9-4

Figure 4.9-5

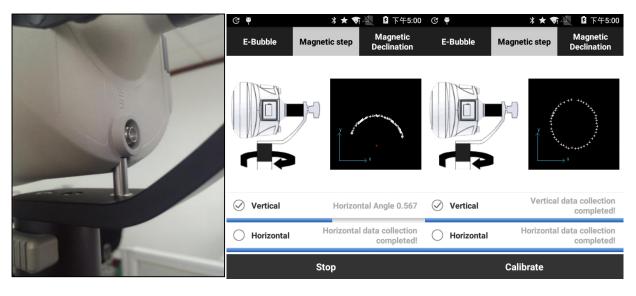




Figure 4.9-7

Figure 4.9-8

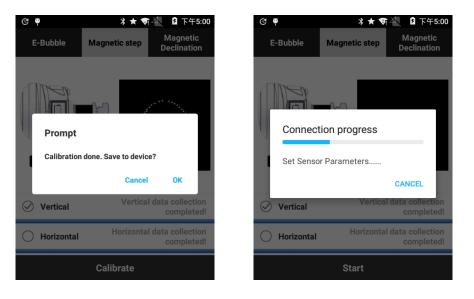


Figure 4.9-9



Note:

A. In rotation, the software will display the real-time status of current data recording.

B. If data of some positions is not recorded (rotating in too fast will lead to data missed recorded), it needs to rotate again to the position for second recording.

C. When the recording is complete, there will be a beep and "Vertical Data recording is Complete" or "Horizontal data recording is complete!" displayed on the screen.

D. When recording horizontal data, the tilt angle must be less than 3 degrees. When recording vertical data, the tilt angle must be less than 5 degrees.

(3) Calibrate parameter: After the vertical and horizontal data recording is complete, press [Calibrate], and there will pop up the dialog box of the calculating result of parameters, as shown in Figure 4.9-9. Press [OK] to use the calibration parameter, as shown in Figure 4.9-10, to complete Calibrate Sensor.

4. Magnetic declination calibration

Press [Magnetic Declination] to enter the interface shown as Figure 4.9-11.

(1) Record center points: press [Center] to record center points. It needs to record the coordinates of 10 static points. The recording process and result are in Figure 4.9-12 and Figure 4.9-13.

Recording condition: a. relative static state b. inclination angle <0.3°

c. fixed solution

d. recorded 10 points

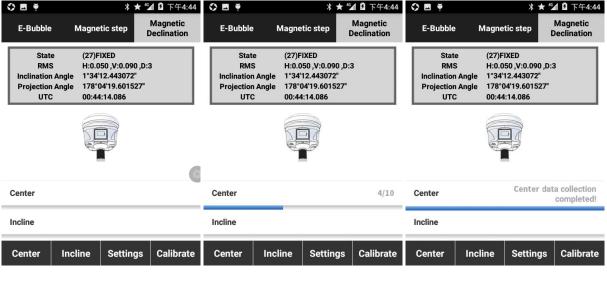


Figure 4.9-11

Figure 4.9-12

Figure 4.9-13





(2) Record incline points: Press [Incline] to record the incline points. It needs to record points in four directions (east, south, west and north) in order, and record coordinates of 10 static points in each direction. The recording process and result are shown in Figure 4.9-14 and Figure 4.9-15.

Recording condition:

- a. relative static state
- b. inclination angle 25°-35°
- c. fixed solution

d. record data in four directions (northeast, southeast, southwest, northwest) in order as shown in Figure 4.9-16 (respectively projection angle for each direction: 45 °, 135 °, 225 °, 225 °) (plus or minus 10° within above-mentioned angles is acceptable)

e. record 10 points in each direction (please keep as stable as possible when collecting in each direction)

Note:

A. When do the magnetic incline calibration, it is recommended that the retractable pole be extended to 2m or more.

B. Keep the device as stable as possible when recording data.

(3) Calibrate parameter: After center points and incline points have finished recording, press
 [Calibrate] to calculate Magnetic declination parameters, and there will pop up the dialog box of
 47

antenna parameter settings as shown in Figure 4.9-17. Input the antenna parameter and press [OK], then there will pop up the prompt about the projection correction as shown in Figure 4.9-18. And press [OK] to finish the sensor calibration.

(4) After sensor calibration, it can press [Settings] to view the magnetic declination. If you know the magnetic declination of survey area, then the sensor calibration can be ignored, please just input the magnetic declination in [Settings].

Note: If there is a prompt that error is over limit, please check whether the antenna height is correct. Then extend the retractable pole to redo the sensor calibration.

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E-Bubble	Magne		Magnetic Declination		E-Bubble	e Magne	tic step	Magnetic Declination
Stat RMS Inclination	6 H:1.4 Angle 86°47	INGLE 43 ,V:2.002 ,D:( 733.986535"	D		Sta RM	,-	IXED 50 ,V:0.090 ,D	:3
Projection	Angle 306°3	52'32.560751"			Pror	npt		_
Magı Magn Declir					2.66 The a is:0.0 (0.02	brojection cor 5383,2.698754 average error 022,0.033,0.02 (6,0.019,0.027 his projection e?	4, 27 7), do you wa	nt to
		No	Yes				Cancel	OK
Center					Center			completed!
Incline					Incline			ta collection completed!
Center	Incline	Settings	Calibrate		Center			Calibrate



Figure4.9-18

### 4.10 Re\_Position

Press [Device] -> [Re\_Position] to enter into interface as shown in Figure 4.10-1, and press [OK] to get reposition. It controls receiver to research and lock satellites, whose function is to initialize OEM board and re-receive satellite signals to positioning.

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Static	Work Mode	Configurations	Registratio	n Informati	on			Factory	Stonex
	Status		Device Se	erial no		8610970	30703262	1	438.125 🔇
			Registrat	ion Date			20990101	2	440.125
Prompt In Restart Posi	tioning?	ing	Enter activa	ation code				3	441.125
Restart Posi	Cance	н ок					;	4	442.125
	(To)		1	2	3	A	В	5	443.125
Default radio	Re_Position	Device Register		5	6	С	D	6	444.125
settings		<b>\6</b>	7	8	9	E	F	7	446.125
Π	T Y evice Surve	ay Tools		R	egistrati	on			ок

Figure 4.10-1

Figure 4.11-1

Figure 4.12-1

### 4.11 Device Register

After connection between handheld and receiver, it can view device SN and registration date as shown in Figure 4.11-1. When it needs to register the RTK, in one way it can input activation code manually, and in the other way it can press  $\Box$  to scan QR code to acquire activation code. After inputting activation code, press [Registration] to complete registration. For activation code of device, you can contact GeoElectron or dealer.

### 4.12 Default radio settings

Press [Device] -> [Default radio settings] to enter into interface as shown in Figure 4.12-1. Select radio factory and radio channels will correspond to the default frequency one by one. It can also change as needed.

# **Chapter 5 Survey**

# **5.1 Point Survey**

Press [Survey] -> [Point Survey] to enter into interface as shown in Figure 5.1-1.

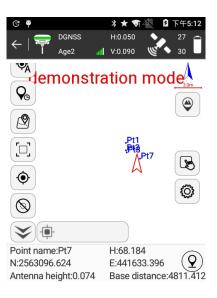


Figure 5.1-1

The icons in upper toolbar describe as follows:



Close/exit Point Survey interface.

Receiver operation mode, pressing to jump to Base/Rover/Static setting interface.



Receiver signal.

Receiver positioning information, pressing to jump to satellite positioning information interface.

Receiver battery power.

Solution status: includes single, float, differential and fixed.

[Age9]: current differential delay is 9.

[Single, 0]: current solution is single, and differential delay is 0.

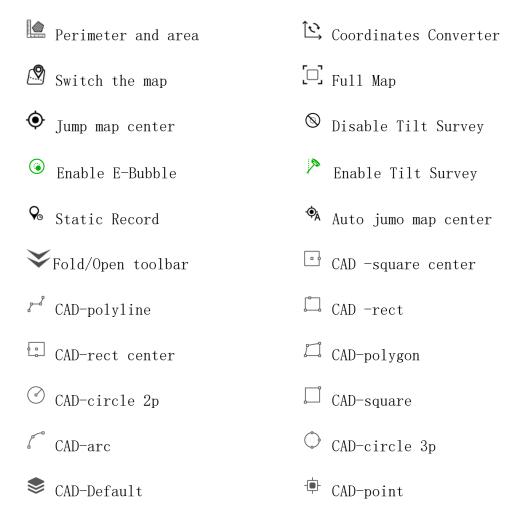
[Static, 0]: "Static" shows sensor status when the pole tilt survey is enabled, and "0" means that the tilt angle is 0.

[H]: HRMS, the value represents the horizontal accuracy of current point.

[V]: VRMS, the value represents the vertical accuracy of current point.

[27/30]: current number of satellites which used to solution, and the total tracked satellites number.

• The icons in left toolbar describe as follows:



• The icons in right toolbar describe as follows:

Coordinate point library: as shown in Figure 5.1-2, points collected by SurPad are stored in coordinate point library.

Press [New] to create a new point.

Select any coordinate point and press [Edit] to edit the point information.

Press [Details] to view detailed information of the point.

Press [Delete] to delete the point.

Press [Import] to import coordinate file.

Press [Options] to enable/disable point types to filter points in the coordinate point library by point type.

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Ple	ease in	put name or co	ode		Q	TOPO POINT	INFORMATION BAR	TOOLBARS
I	Name	Northing	Easting	Elevation	Latitu	Solution Limit	t	FIXED
r	Pt7	2563097.743	441633.765	69.958	N23°09'5	HRMS Limit		0.05
r	Pt6	2563097.909	441633.494	69.660	N23°09'59	VRMS Limit		0.1
r	Pt5	2563098.116	441633.019	69.110	N23°09'5	PDOP Limit		3.0
r	Pt4	2563098.180	441632.420	68.000	N23°09'59			
r	Pt3	2563098.470	441632.235	67.554	N23°09'59	Delay Limit		5
r	Pt2	2563098.709	441632.162	67.072	N23°09'59	Permission to survey	o repeat the name of	the
ł	Pt1	2563099.561	441632.178	67.056	N23°09'59	Point Name		1
1	Add	Edit	Details	ок		DEFAU	ILT	ок





<sup>©</sup> Display information (with interface as shown in Figure 5.1-3):

TOPO POINT: settings for display limit of collected points on the basis of set point type that defaults to topo points.

INFORMATION BAR: it can select the displayed information in the status bar at interface bottom. Select an item in the Options list, then press to move this item to the Display item list. In the same way, select an item on the Display item list, and press to move this item to the Options list. If press [Default], the default items will be added to the Display item list, including point name, H, N, E, Antenna height and Base distance.

TOOLBARS: settings what function keys to display in left toolbar in Point Survey interface.

Static Record. As shown in Figure 5.1-4, set Point name (point name of point in static record), Cut angle, Collection Interval, Observation Time and Antenna Parameters, press [Start] and as shown in Figure 5.1-5 it starts static record. When static record is finished, it would save a static record file in receiver. The static collection data here is the same as that collected under static mode except for it can also collect topo points under rover mode as shown in Figure 5.1-6.

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← Stati	c Record	← Stati	c Record		← Торо Р	Point
FIXED Age0	H:0.0497 V:0.0900	FIXED Age1	H:0.0497 V:0.0900	27 30	Name	Pt9 😒
Point name	AAAA01 📀	Cut angle		0 >	Code	
PDOP limit	3.5 >	Collection Interval		1HZ >	Antenna Parameters	0m,Vertical height
Cut angle	0 >	Observation time	14min		Detail Information	
Cut angle	0 /				Record	<1/1>Collected
Collection Interval	1HZ >	Antenna Parameters			Solution	(27/30)FIXED
Observation Time	1Emin \	Antenna Measured H	eight	0.025	Northing	2531135.5044
B : N23°09'59.3909"	X : 2531135.776	B : N23°09'59.3802"	X : 2531135.447		Easting	505404.0473
L : E113°25'47.8788"	Y : 505403.67	L : E113°25'47.8898"	Y : 505403.982		Elevation	68.4675
H: 70.315	Z : 68.116	H: 70.244	Z : 68.046			08.4075
	Start	Stop	Record		Photo And Sketch	ок
Figur	re 5.1-4	Figu	re 5.1-5		Figure	5.1-6

© Collect point coordinates: this icon changes along with open/close status of tilt survey. Open tilt survey <sup>®</sup> and then this icon would show E-Bubble status and also collect points by pressing on it.

• The icons in right toolbar describe as follows:

Point name: point name of collected point.

N, E, H: horizontal coordinates (projection point) of the current point.

Antenna height: antenna height set in survey.

Base distance: The distance from current rover to the base.

Code: code for last point.

Press <sup>(a)</sup> to set the point type (Topo Point, Control Point, Quick Point, Auto Point, Corner Point and Tilt Point). The following introduces collecting process of all point types.

Topo point: The "average GPS count" in record options refers to the number of points which could be consecutive recorded. Please refer to the Figure 5.1-7, it means that it could collect one point every time and this point should meet record limit. When you press  $\mathcal{P}$  to record the topo point, if the measured point does not meet record limit, there will be a prompt message. If the measured point meets record limit, the measured point info (HRMS, VRMS, delay, PDOP, date and time) will be displayed in the screen. Then press [OK] to save the topo point.

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$\leftarrow$ Display Information		🔶 Торо	Point	$\leftarrow$		Photo Aı	nd Ske	etch		
TOPO POINT INFORMATION BAR T	TOOLBARS	Name	Pt9 😒							
Solution Limit	fixed $>$	Code								
HRMS Limit	0.05 >	Antenna Parameters	0m,Vertical height $\geq$							
VRMS Limit	0.1 >	Detail Information								
PDOP Limit	3.0 >	Record	<1/1>Collected							
		Solution	(27/30)FIXED							
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Point Name	1 >			undo	Note	Point info	Arrow	Drawing	Photo	м
DEFAULT O	К	Photo And Sketch	ок		Canc	el		ок		
Figure 5.1-7		Figure	5.1-8			Figure	5.1-	9		

[Photo and Sketch] It can make information note on collected points, such as documents, pictures and graphs as shown in Figure 5.1-9.

 $\bigcirc$  : Undo and return to previous step.

I : Add text. Font size and text color can be set.

Add point information. Font size and color and point information to be added (name, code, north, east, height) can be set.

: Add arrow. Arrow color and style can be set.

Add drawing. Similar to the pencil function in Windows Paint, color and thickness can be set.

Add photo. Directly invoke camera to take a picture to add into information.

\*\*\* : Move. It can move any added information.

 $^{\circ}$  : Rotate. It can rotate any added information.

L : Zoom. It can zoom in or out any added information.

 $\overline{\mathbb{W}}$  : Clear. It can clear away all information.

Control point: to collect control points will enter into interface as show in Figure 5.1-10. Press [Control Point] and wait for 15s delay for fixed solution, then it starts to collect data. It records one point every 2s, continuously records 10 points and collects 2 sets of 10 points (the above data is taken for example according to the control points record settings). When collection is finished, press [OK] and it will pop up prompt [Control points report generated, name as XXX, would you like to view it now?] as shown in Figure 5.1-11. Press [OK] to check control point survey report as shown in Figure 5.1-12.

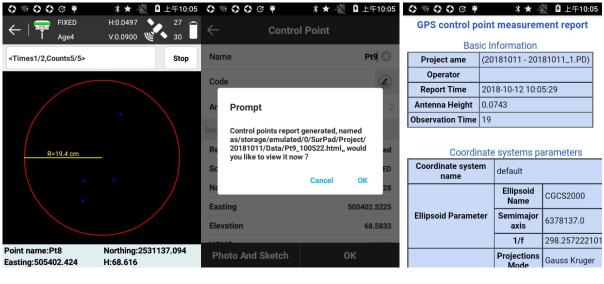






Figure 5.1-12

Quick point: When you collect quick point, if the measured point meets record limit, then it will finish collection after prompt voice, and there will not pop up storage interface.

Auto point: To collect auto point, choose [Auto Point] and press <sup>(2)</sup> to set record parameters and then press collect key to start collection as shown in Figure 5.1-13. If you want to pause the recording progress, please press [pause], and press [start] to start recording, press [Stop] to end the auto points recording.

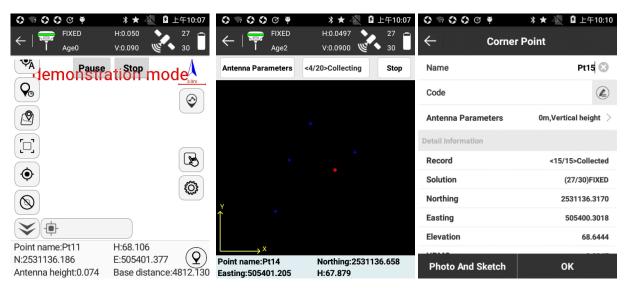


Figure 5.1-13

Figure 5.1-14

Figure 5.1-15

Corner point: Corner point collecting interface as shown in Figure 5.1-14. Every time it records corner point, it should record at least 15 points, and distance between two points should be greater than 1/10 of pole height. Then it can calculate the unknown point coordinates by these corner points. Press [Antenna Parameters] to set Antenna Measured Height and Antenna Measurement Type, press [OK] to start collection, and after collecting 15 points there will pop up interface as shown in Figure 5.1-15 to complete collection.

Tilt point: press  $\mathcal{Q}$  to enter into collection interface as shown in Figure 5.1-16. If RTK has tilt survey function, it can calculate the unknown point by collecting two tilt points; it RTK only has E-Bubble function, it can calculate the unknown point by collecting three points. Set up Antenna Measured Height, place mounting pole in the unknown point, tilt in one direction and it automatically collect the first tilt point (interface of successful collection of first point as shown in Figure 5.1-17). Then tilt in another two directions and it automatically collect the second and the third tilt point. Its collection interface is shown in Figure 5.1-18. Three circles intersect with each other and press [Save] to calculate the unknown point.

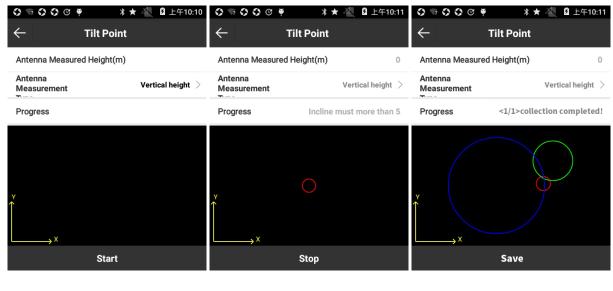


Figure5.1-16

Figure5.1-17

Figure5.1-18

## 5.2 Detail Survey

Press [Survey] -> [Detail Survey] to enter into interface as shown in Figure 5.2-1. Its upper toolbar information is same as that of Point Survey. Detail Point is a simplified point survey mode, which is suitable for rapid and continuous coordinate survey.

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←   ¬	FIXED Age0	H:0.0497 V:0.0900	30 27	$\leftarrow$ Device Se	tting
N:	2531135.496	B: N2	3°09'59.3815"	Tilt Survey	Disable 🗦
E:	505401.66	L: E11	3°25'47.8081"		
Z:	69.051	H:	71.249	Solution Limit	FIXED >
Name			Pt16 🙁	HRMS Limit	0.05 >
Code				VRMS Limit	0.1 >
Antenn	a Measured Heig	ht(Meter)	0	PDOP Limit	3.0 >
Antenn Measu	-	Ve	rtical height $ ightarrow$	Delay Limit	5 >
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	Sett	tings	$\mathbf{Y}$	Default Configurations	ок

Figure 5.2-1

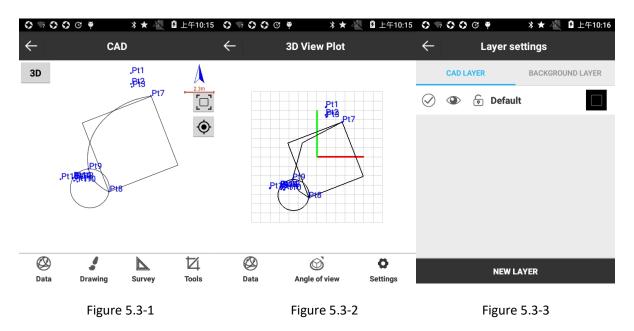
Figure 5.2-2

Taking topo point collection as example, press [Settings] as shown in Figure 5.2-2, select whether to enable Tilt Survey, set recording limit (can use default settings) and press [OK] to return to interface as shown in Figure 5.2-1. Press [Antenna Parameters] to set Antenna Measured Height and Antenna Measurement Type, press [OK] to return to collection interface. If it needs to use Code library, press <sup>(®)</sup> to edit code. Press [Start] to complete point collection.

# 5.3 CAD

CAD is mainly used to import and edit the existing CAD graphics, and stakeout lines in the existing CAD graphics.

Press [Survey] -> [CAD] to enter into interface as shown in Figure 5.3-1. The following introduces this interface in detail. Press [3D] to enter 3D view as shown in Figure 5.3-2.



[Data] It can manage layer and import/export \*.DXF files. To export \*.DXF file it needs to set whether to export Coordinate point Library, Point Name, Code and Elevation.

Press [Data]->[layer] to enter interface as shown in Figure 5.3-3. Press [NEW LAYER] to enter interface as shown in Figure 5.3-4, input Layer Name, set layer color, select whether to set up as a work layer, whether visible and whether lock, and press [OK] to complete creating a new layer. Press layer and as shown in Figure 5.3-5, it can perform Rename, Delete, Batch delete and Delete all. Long press layer and it can perform batch delete as shown in Figure 5.3-6.  $\bigcirc$  represents current work layer. P represents layer is visible. P represents layer is invisible. P represents layer is locked and layer locked cannot be deleted. P represents layer is unlocked.

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← New I	ayer	$\leftarrow$	Layer s	ettings	$\leftarrow$		Layer se	ettings
Layer Name			CAD LAYER	BACKGROUND LAYER		CAD	AYER	BACKGROUND LAYER
colour	>	$\oslash$	Options		$\oslash$	۲	lefaul	t
Is it set up as a work laye	r	$\bigcirc$	Rename		$\bigcirc$	٩	ē 2	
Is it visible		$\bigcirc$	Delete		$\bigcirc$	٩	<b>5</b>	
Whether or not to lock	0		Batch delete	0				
			Delete all	0				
Cancel	ок		NEW	LAYER		CAN	ICEL	DELETE
<b>Figure F</b>			[					c

Figure 5.3-4 Figure 5.3-5

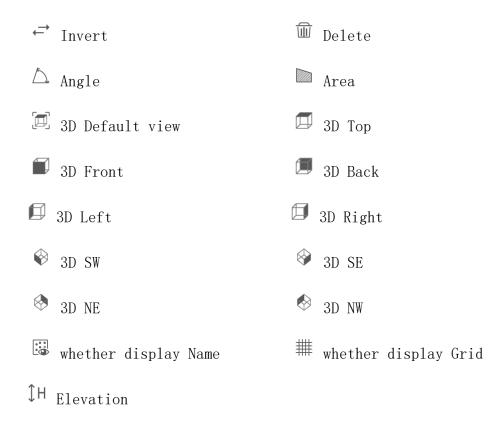
Figure 5.3-6

[Drawing] It can draw layer according to points.

[Survey] It can calculate intersection point, distance offset and perform other functions.

[Tools] It can calculate angle and area.

\$	Layer (creating new	DXF	Import *.dxf file
layer)			•
DXF	Export *.dxf file	2-0	Polyline
6	Arc		Polygon
	Square	•	Square center
ŗ.	Rect		Rect center
ď	Circle 2p	$\bigcirc$	Circle 3p
$\bigcirc$	Int 2 Dist	$\times$	Int 4 Point
	Dist offset	//	Dist offset
	Divide	<.	Measure



CAD delete data and stakeout:

Press point or figure needs to delete on the screen, select the target and target turns to be in blue as shown in Figure 5.3-7, and press [Delete] to delete target as needed. Press [Stakeout] to enter interface as shown in Figure 5.3-8, select [Use selected polyline] or [Use selected segment], set whether to enable [Setting out by pile by coordinate], press [OK] to enter stakeout interface and perform stakeout. Press [List] and it can view selected Object information as shown in Figure 5.3-9, and it can select point in Object Info to stakeout.

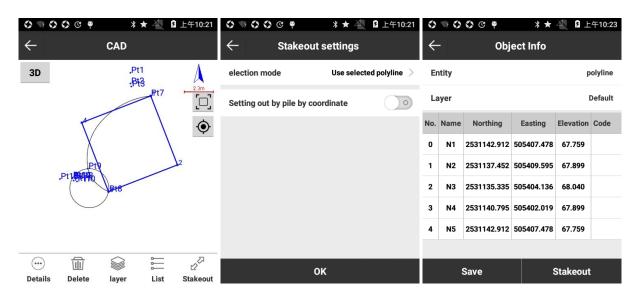


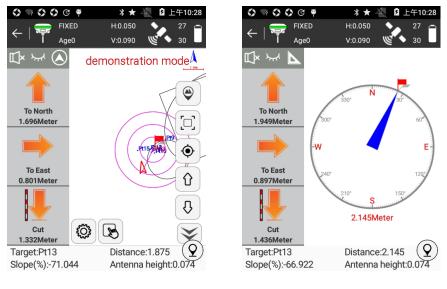
Figure5.3-7 Figure5.3-8

Figure 5.3-9

# **5.4 Point Stakeout**

Point stakeout is the process of inputting target coordinate in software and stakeout in field.

Press [Survey] -> [Point Stakeout] -> [Point Library], select the point and press [OK] to enter interface as shown in Figure 5.4-1.







Arrows in left bar describe as follows:

To North/South: distance that receiver needs to move North/South from current position to stakeout point. To North arrow shows up and To South arrow shows down.

To West/East: distance that receiver needs to move West/East from current position to stakeout point. To West arrow shows left and To East arrow shows right.

Fill/Cut: dig in stakeout point position. If the value is positive, perform excavation; if not, perform fill. If current height is higher than stakeout point arrow shows down. If current height is higher than stakeout point arrow shows up.





: hide or show left arrow bar.

Switch compass mode or distance mode. Distance mode is as shown in Figure 5.4-1 and compass mode is as shown in Figure 5.4-2. There are two states for compass mode. State 1 is as 61

shown in Figure 5.4-2. Red flag represents target point, blue arrow represents moving direction from current receiver position to stakeout point, and red words below represents distance to target point. State 2 is as shown in Figure 5.4-3. In gray circle the red flag represents stakeout target, and blue circle represents receiver position. When stakeout distance doubles Prompt Range, it would change state 1 into state 2; when stakeout distance meets Collection scope, state 2 blue circle would turn into green.

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	w - E	Automatic scaling	$\bigcirc \circ$
To East	240°	Automatic Stakeout	Latest Point
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	0.225Meter	Display Information	Point Name
Fill 0.271Meter	$\sim$		
Target:Pt Slope(%):120.662	Distance:0.225 (Q) Antenna height:0.074	DEFAULT	ок
Fi	gure 5.4-3	Fig	ure 5.4-4

The icons in side toolbar describe as follows:

💌 : Coordinate point library. Points collected by SurPad are stored in coordinate point library.

- $\hat{U}$ : Stakeout last coordinate.
- $\overline{\mathbb{Q}}$  : Stakeout next coordinate.
- : The closest point, the point closest to stakeout point.

©: Point stakeout settings: as shown in Figure 5.4-4, it can set stakeout settings, including Prompt Range, Collection scope and Display Information (No Display, Point Name, Code); settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey. Press [DEFAULT] and it can restore the changed settings.

Automatic scaling: when automatic scaling is enabled, point stakeout will zoom screen according to distance between stakeout point and current point to full display the points.

Prompt Range: taking stakeout point as center of a circle and drawing three concentric circles with radii are multiples of 1, 2 and 3 times of the prompt range, area covered by these three concentric circles is prompt range.

Collection scope: prompt range of distance between stakeout point and current point, which defaults to 0.2m. When the collected point is in this range, it will not be prompted; if not, it will be prompted.

 $(\mathbf{Q})$ : collect topo point.

Defaulted items in bottom status bar describe as follows:

Target: point name of current stakeout point.

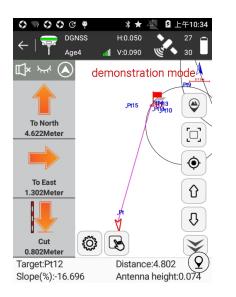
Distance: distance between receiver and stakeout point.

To North: distance that receiver needs to move north from current position to stakeout point.

To East: distance that receiver needs to move east from current position to stakeout point.

Fill: dig in stakeout point position. If the value is positive, perform excavation; if not, perform fill.

Antenna height: antenna height in survey.



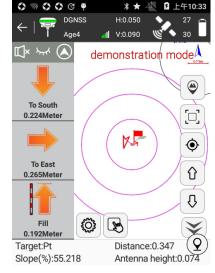


Figure 5.4-5



#### Point stakeout steps:

1. Select a point to stakeout in the points library, then press [OK] to enter stakeout interface as shown in Figure 5.4-5. Red flag is target stake point. Circle is current position of receiver. Arrow is direction indicator, indicating the direction of current receiver. When the arrow direction is same with the direction to the target point, please move in this direction, then you can reach the target point.

2. According to bottom status bar, move from the current point to the coordinate of stakeout point, and excavate or fill the soil according to the height difference of the elevation.

3. When current point is within prompt range, there will be three concentric circles as shown in Figure 5.4-6, which indicate it enters precise stakeout.

4. The adjacent stakeout points in the points library can be switched automatically by  $\, ^{\textcircled{}}$  and  $\, ^{\textcircled{}}$  keys.

5. After you reach the stakeout point, please stake it.

#### 5.5 Line Stakeout

Line stakeout is the stakeout of designed line, including line mileage, left and right offset and elevation control within line.

Press [Survey] -> [Line Stakeout] -> [Lines Library], select the line and press [OK] to enter interface as shown in Figure 5.5-1.

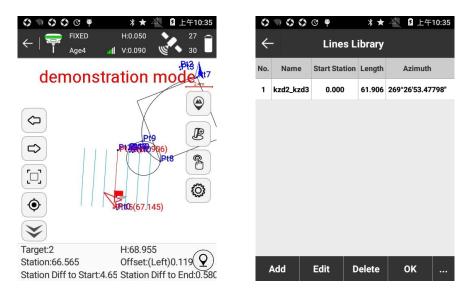


Figure 5.5-1

Figure 5.5-2

The icons in right toolbar describe as follows:

<sup>®</sup>: Lines library. As shown in Figure 5.5-2, Lines library includes six operations, namely Add, Edit, Delete, OK, Import and Export.

Press [Add] to enter interface as shown in Figure 5.5-3, input line name and start mileage, select input type, input parameters, and press [OK] to complete line parameter settings of new line. There are two ways to input line parameters: one is to set start point and end point of line, and it automatically calculates azimuth and length (start mileage defaults to 0); the other one is to set start point, azimuth and length.

Select any line in Lines library and press [Edit] to edit the line information, and press [OK] to save the change.

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Select any line in Lines library and press [Delete] to delete the selected line.





Press [import] to enter interface as shown in Figure 5.5-4. If you select Data Type as [Lines File] and set File Format (defaults to Line Library File, and it can be defined by press on [Format Manage]), then you can import the file with\*. SL suffix. If you select Data Type as [Coordinates File] and set File Format (defaults to Local coordinates format, and it can be defined by press on [Format Manage]), then you can import the file with \*.dat suffix. The imported line file can be a line file in another project or a pre-edited line file, avoiding duplicate entries.

Press [Export], select export path and input file name to complete export. The line file (\* .SL) in the project can be exported to specified path and used for other data processing or project import. 65

#### □: stakeout last line.

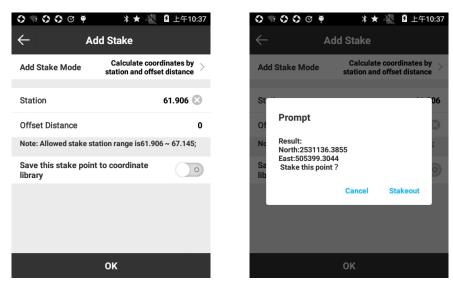
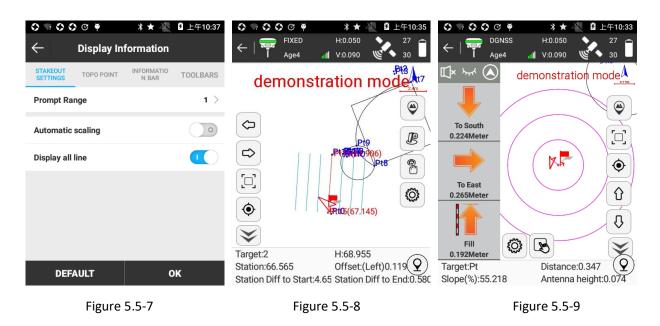




Figure 5.5-6

B: Add stake. As shown in Figure 5.5-5, it can add stake in line stakeout. There are two modes to add stake. First mode, calculate coordinates by mileage and offset distance, in which it needs to input mileage, offset distance. Second mode, calculate offset and distance by coordinates, in which it needs to input northing, easting and elevation, or search coordinates from library, or get current GPS coordinates. After setting up parameters, please press [OK], and there will pop up the prompt to display the calculate result. Then it can press [Stakeout] to stake.

<sup>©</sup> : Display information. Set up display information, including Prompt Range and Display all line, as shown in Figure 5.5-7. Press [DEFAULT] and it can restore line stakeout settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.



Prompt range: Taking the line as center and prompt range as spacing on both sides, it generates six parallel lines. The area within these six parallel lines is prompt range.

Automatic scaling: when automatic scaling is enabled, line stakeout will be displayed in full screen automatically.

(Q): collect TOPO point.

Defaulted items in bottom status bar describe as follows:

Target: The name of the stakeout line.

H: The height of current point.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

Mileage Diff to Start: Draw a vertical line from current point to stakeout line, and Mileage Diff to Start is the distance from foot point to start point.

Mileage Diff to End: Draw a vertical line from current point to stakeout line, and Mileage Diff to End is the distance from foot point to end point.

Target peg: The name of the current stakeout peg.

### Line stakeout steps:

- 1. According to the engineering design, please edit the stakeout line in the line library or import line file in advance.
- Select the Stakeout line and press [OK] to enter line stakeout interface. Start point shows mileage 0.000 and end point shows actual mileage. Red flag represents vertical distance from current point to line. Arrow indicates the direction of RTK. Please refer to Figure 5.5-8.
- 3. Moving direction: Move along the vertical line from current point to the stakeout line, you can return to the stakeout line. Or according to the prompt direction in the bottom status bar, you can also find the correct direction to reach the stakeout line (You can change the items in the bottom of the status bar).
- 4. Please stakeout according to the prompt in the bottom status bar.
- 5. When the line offsets on both sides are within the prompt range, the parallel lines are generated on both sides of the stakeout line according to the setting of Prompt Range. It indicates that you are in precise stakeout.
- 6. If you need to add stake to line during stakeout process, press  $\checkmark$  to set stake mode and position, then press [OK] to acquire calculation result. Press [Stakeout] to enter line stakeout interface as shown in Figure 5-21. Then you can stake out according to the prompts in the bottom status bar. When the distance between stakeout point and current point is less than 3 meters, it will take stake point as center and generate prompt circles to get into precise stakeout.
- 7. The adjacent stakeout lines in Lines library can be switched automatically by  $\,\widehat{\,\,}$  and  $\,\widehat{\,\,}$  keys.

## 5.6 Stake road

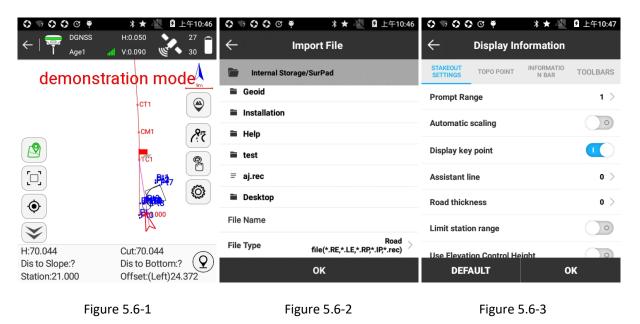
Stake road is the specific program for stakeout of line and channel median line and slope construction in line engineering and hydraulic engineering.

Press [Survey] -> [Stake road], select the stakeout road and press [OK] to enter interface as shown in Figure 5.6-1.

<sup>®</sup> : Road Library. It includes [New], [Edit], [Delete], [Import] and [OK] five operations. Press [New] and input Road Name, select Road type and input corresponding parameters to create a new stakeout road. Select any road in Road Library, press [Edit] and it can edit name and parameters of the road. Press [Delete] and it can delete the road from Road Library. Press [Import], change path and select stakeout road file (\*.RE, \*.LE, \*.RP, \*.IP, \*.rec, \*.dat, \*.csv, \*.txt) and it can import stakeout road file as shown in Figure 5.6-2. The imported road file can be a stakeout road file in another project, to avoid duplicate entries.

 $\ell^{R_{\overline{c}}}$ : central line of road. It can switch to slope stakeout  $\overset{P}{\rightarrow}$  by press. Slope stakeout: it is to stakeout the designed road on the drawing to the corresponding ground in accordance with the design requirements in order to instruct surveyor to mark the excavation line and filling line for construction.

©: Display information. It can set stakeout road configuration, including Prompt Range, Display key point, Assistant line, Road thickness and Limit mileage range as shown in Figure 5.6-3. Press [DEFAULT] and it can restore changed items. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.



**?**: collect TOPO points.

## The items in the bottom status bar description:

Target: The name of the stakeout road.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

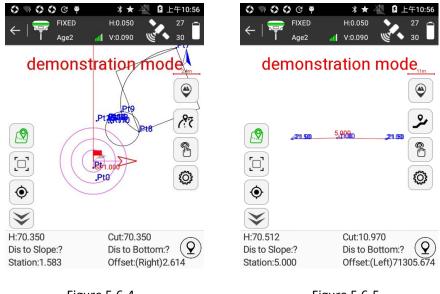


Figure 5.6-4

Figure 5.6-5

### Road stakeout steps:

- 1. According to the engineering design, please edit the stakeout road in Road Library.
- 2. Select the stakeout road and press [OK] to enter road stakeout interface. And stakeout according to the prompt in the bottom status bar as shown in Figure 5.6-4. Draw vertical line of stakeout line over current point. Red flag indicates foot point, circle indicates current point, and arrow indicates direction of RTK.
- 3. Press to enter slope stakeout interface as shown in Figure 5.6-5. It will automatically display slope graph in the range of current mileage based on the currently calculated mileage. In screen it displays current point's position in slope in real time, and bottom status bar displays specific data of Distance to Slope, Distance to Top/Bottom, Height and Cut and Fill. In graph the middle red of cross section shows current mileage, and the blue number shows the offset at the intersection of related plates

# 5.7 Stake road by point

Stake road by point is the specific program for continuous stakeout of specific stakes with fixed stake distance like 20/50/100 or with specific stake number as engineering required.

Press [Survey] -> [Stake road by point], select the stakeout road to stakeout and to enter interface as shown in Figure 5.7-1.

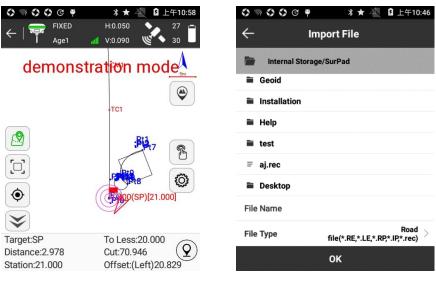




Figure 5.7-2

<sup>®</sup> : Road Library. It includes [New], [Edit], [Delete], [Import] and [OK] five operations. Press [New] and input Road Name, select Road type and input corresponding parameters to create a new stakeout road. Select any road in Road Library, press [Edit] and it can edit name and parameters of the road. Press [Delete] and it can delete the road from Road Library. Press [Import], change path and select stakeout road file (\*.RE, \*.LE, \*.RP, \*.IP, \*.rec, \*.dat, \*.csv, \*.txt) and it can import stakeout road file as shown in Figure 5.7-2. The imported road file can be a stakeout road file in another project, to avoid duplicate entries.

<sup>(P)</sup>: Add stake. It can add stake in road stakeout. There are two modes to add stake: one is to calculate coordinates by chainage and offset distance, and the other one is to calculate offset and distance by coordinates.

<sup>(2)</sup>: Display information. Set up display information, including Prompt Range and Display all line, as shown in Figure 5.7-3. Press [DEFAULT] and it can restore line stakeout settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

 $(\mathbf{Q})$ : collect TOPO point.

Defaulted items in bottom status bar describe as follows:

Target: name of the stakeout road.

To Less: distance from current point to target peg. "To Less" means that if you want to reach the target peg, the distance to the direction of the small mileage.

Distance: distance between receiver and stakeout point.

Fill: dig in stakeout point position. If the value is positive, perform excavation; if not, perform fill.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

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DEFAULT	ок		ок	Distance:2.363 Station:21.000	Cut:70.648 Offset:(Left)20.684

Figure 5.7-3

Figure 5.7-4

Figure 5.7-5

### Road stakeout steps:

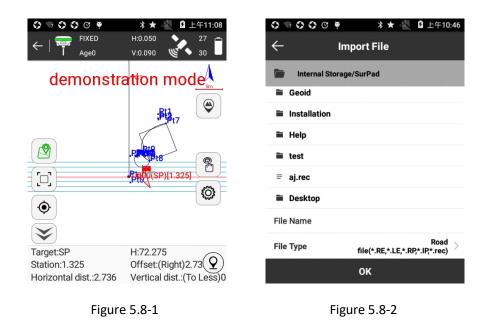
- 1. According to the engineering design, please edit the stakeout road in Road Library.
- 2. Select the stakeout road and press [OK] to enter road stakeout interface as shown in Figure 5.7-4. Mileage can be set as needed, that is, when entering stakeout interface, the position of stakeout point. Set stakeout interval, and then perform stake road by points. Press [OK] to enter road stakeout interface as shown in Figure 5.7.5. And according to arrow direction and the prompt of mileage and offset in the bottom status bar, stakeout roads in Road Library at stakeout interval by points. The adjacent stakeout points in the points library can be switched automatically by <sup>①</sup> and <sup>③</sup> keys. Press <sup>®</sup> , input mileage and it will

automatically calculate coordinate of added stake, then press [OK] to return to stakeout interface for stakeout.

### 5.8 Stake road by cross section

Stake road by cross section is the specific program for measurement of surface relief vertical to road middle line on middle stake after design of line so as to meet early requirement of line engineer or hydraulic engineering. Cross section drawing is the basis for design of subgrade cross section and determining the excavation and filling of roadbed in construction. SurPad would export specific cross section file format used in related design software.

Press [Survey] -> [Stake road by cross section], select the stakeout road and enter interface as shown in Figure 5.8-1.



<sup>®</sup> : Road Library. It includes [New], [Edit], [Delete], [Import] and [OK] five operations. Press [New] and input Road Name, select Road type and input corresponding parameters to create a new stakeout road. Select any road in Road Library, press [Edit] and it can edit name and parameters of the road. Press [Delete] and it can delete the road from Road Library. Press [Import], change path and select stakeout road file (\*.RE, \*.LE, \*.RP, \*.IP, \*.rec, \*.dat, \*.csv, \*.txt) and it can import stakeout road file as shown in Figure 5.7-2. The imported road file can be a stakeout road file in another project, to avoid duplicate entries. Add stake. It can add stake in road stakeout. There are two modes to add stake: one is to calculate coordinates by chainage and offset distance, and the other one is to calculate offset and distance by coordinates.

<sup>(Q)</sup>: Display information. Set up display information, including Prompt Range and Display all line, as shown in Figure 5.8-3. Press [DEFAULT] and it can restore line stakeout settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

 ${\boldsymbol{\mathbb{Q}}}$  : collect TOPO point.

Defaulted items in bottom status bar describe as follows:

Target: The name of the stakeout line.

H: The height of current point.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

Horizontal distance: Draw a vertical line from current point to cross section, and Horizontal distance is the distance from foot point to intersection of cross section and road.

Vertical distance: Draw a vertical line from current point to cross section, and Vertical distance is the distance from foot point to current point. "To more" means that if you want to reach the target peg, the distance to the direction of the big mileage. "To Less" means that if you want to reach the target peg, the distance to the direction of the small mileage.

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Figure 5.8-4

Figure 5.8-5

### Stake road by cross section steps:

Figure 5.8-3

Select target road and press [OK] to enter interface as shown in Figure 5.8-4. Set whether auto select mileage, Calculation mode, Interval and Normal (distance between middle line of road and side point of cross section). Press [OK] to enter stakeout interface as shown in Figure 5.8-5. When vertical distance of road is less than 3 meters, parallel lines are generated on both sides of the cross section to enter precise positioning. Move current point according to the arrow direction and vertical and horizontal distance prompt in bottom status bar. When current point is on cross section, perform data collection and stakeout according to engineer requirements. The adjacent cross section can be switched automatically by  $\hat{U}$  and  $\hat{V}$  keys. Press  $\mathcal{B}$ , input mileage and it will automatically calculate coordinate of added stake, then press [OK] to return to stakeout interface for stakeout. When cross section is located in the position of pile mileage, it can be measured. Collected data can be exported through [Project]-> [File Export] to export in Hintsoft Format(DH), Haiti, TianZhen Format(H), SOUTH CASS Cross-section File Format.

## 5.9 Stake road by bridge section

Stake road by bridge section is the specific program for line stakeout of orthogonal culverts, oblique culverts and culvert median line. Oblique culvert describes culvert median line and line form a fixed angle.

Press [Survey] -> [Stake road by bridge section], select the stakeout road and add a bridge section as shown in Figure 5.9-1. (Notes: please select bridge-crossing road in Bridge management library, and create a new road according to road design if none.)

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<sup>®</sup> : Bridge management library. As shown in Figure 5.9-2, it includes Add, Edit, Delete, Import, Export and OK operation. Press [Add], as shown in Figure 5.9-3, set coordinates A and B, it will automatically calculate Intersecting Mileage and intersecting Angle and other parameters. And press [OK] to create a new bridge section. Select any bridge section and press [Edit] and it can edit every parameter. Press [Delete] and it can delete the selected bridge section. Press [Import]/[Export] and it can import/export bridge file in \*.XDM format.

<sup>(Q)</sup>: Display information. Set up display information, including Prompt Range, Automatic scaling and Limit mileage range, as shown in Figure 5.9-4. Press [DEFAULT] and it can restore changed settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

Defaulted items in bottom status bar describe as follows:

Target: The name of the stakeout line.

H: The height of current point.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

Horizontal distance: Draw a vertical line from current point to cross section, and Horizontal distance is the distance from foot point to intersection of cross section and road.

Vertical distance: Draw a vertical line from current point to cross section, and Vertical distance is the distance from foot point to current point. "To more" means that if you want to reach the target peg, the distance to the direction of the big mileage. "To Less" means that if you want to reach the target peg, the distance to the direction of the small mileage.

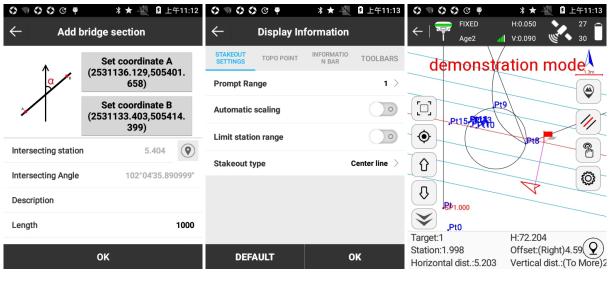




Figure 5.9-4

Figure 5.9-5

Stake road by bridge section is to create a new oblique section and then collect oblique section data. Oblique section is fixed angle between cross section and road.

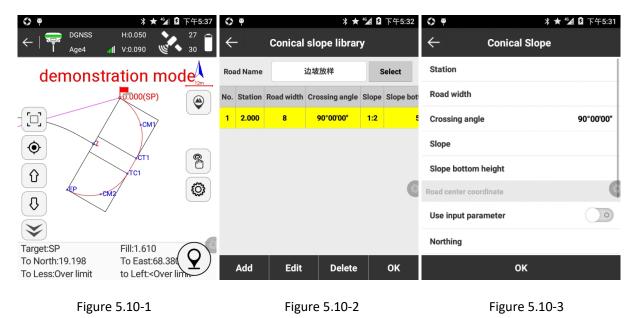
#### Stake road by bridge section steps:

Press [Survey] -> [Stake road by bridge section] to enter interface as shown in Figure 5.9-2. Press [Add] to create a new oblique section as shown in Figure 5.9-3. Set coordinates A and B, and their connection line should intersect with road; or set Intersecting Mileage (directly input mileage values or press to acquire current point), Intersecting Angle and Length. Press [OK] to return to Bridge management library, select bridge section and press [OK] to enter stakeout interface as shown in Figure 5.9-5. Taking data in Figure 5.9-5 for example, mileage between current oblique section and road is 2.62 meters (according to intersecting mileage settings). Move current point and when vertical distance of road is less than 3 meters, parallel lines are generated on both sides of the oblique section to enter precise positioning. Measure and stakeout oblique section according to the arrow direction and vertical and horizontal distance prompt in bottom status bar. When the distance between stakeout point and current point is less than 3 meters, it will take stake point as center and generate prompt circles to get into precise stakeout. When the distance between cross section and current point is less than 3 meters, it will take cross section as center and generate prompt circles to get into precise stakeout.

# 5.10 Conical Slope Stakeout

Conical slope stakeout is the specific program for stakeout of conical slope of abutment in the combining site of the road and bridge in road engineering.

Press [Survey] -> [Conical Slope Stakeout], select the stakeout road and add a conical slope as shown in Figure 5.10-1.



<sup>®</sup> : Conical slope library. As shown in Figure 5.10-2, it includes Add, Edit, Delete and OK operation. Press [Add], as shown in Figure 5.10-3, set Mileage, Road width, Crossing angle, Slope and Slope bottom height. If it needs to use Road center coordinate, enable the option and input center point coordinate. And then after Conical Slope settings, press [OK] to create conical slope. Select any conical slope and press [Edit] and it can edit all parameters of conical slope. Press [Delete] and it can delete the conical slope from conical slope library.

<sup>(2)</sup>: Display information. Set up display information, including Prompt Range, Display key point and Display calculate Point, as shown in Figure 5.10-4. Press [DEFAULT] and it can restore changed settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

 ${}^{Q}$  : collect topo point.

Defaulted items in bottom status bar describe as follows:

Target: point name of current stakeout point.

Fill: dig in stakeout point position. When the current elevation is greater than that of the stakeout point, perform excavation.

To North: distance that receiver needs to move north from current position to stakeout point.

To East: distance that receiver needs to move east from current position to stakeout point.

To Less: distance from current point to target peg. "To Less" means that if you want to reach the target peg, the distance to the direction of the small mileage.

To Right: distance from the current point to the left relative to the midline of the line.

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Display ke	y point				
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Figure 5.10-4

Figure 5.10-5

Generally, a bridge has two bridge abutments, 0# and 1#. Usually see abutment with small number as 0#, and abutment on the other side as 1#. Conical slope is a construction between abutment and embankment, which is for bridge protection. If there is barricade behind abutment, then conical slope is not necessary.

#### **Conical Slope Stakeout steps:**

Press [Survey] -> [Conical Slope Stakeout] to enter interface as shown in Figure 5.10-2. Press [Add] to create a new oblique section as shown in Figure 5.10-3. Then Press [OK] to return to Bridge management library, select bridge section and press [OK] to enter stakeout interface as shown in Figure 5.10-5. Taking data in Figure 5.10-5 for example, mileage between current oblique section

and road is 2.62 meters (according to intersecting mileage settings). Move current point and when vertical distance of road is less than 3 meters, parallel lines are generated on both sides of the oblique section to enter precise positioning. Measure and stakeout oblique section according to the arrow direction and vertical and horizontal distance prompt in bottom status bar. When the distance between stakeout point and current point is less than 3 meters, it will take stake point as center and generate prompt circles to get into precise stakeout. When the distance between cross section and current point is less than 3 meters are generate prompt circles to get into precise stakeout.

# **5.11 Electric Lines Survey**

Electric power line survey is the specific program to survey and measure the natural environment along the designed line before the power line design and finally the handheld measured data would be converted via PC and output to the special format data of power software.

Press [Survey] -> [Electric Lines Survey] as shown in Figure 5.11-1, select an electric line from the electric lines library to stakeout.

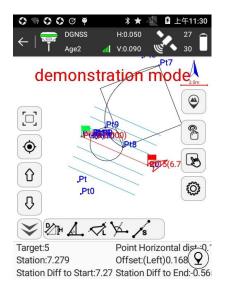
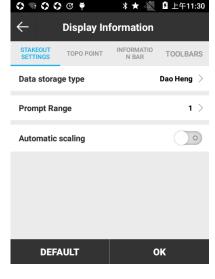


Figure 5.11-1





The icons in side toolbar describe as follows:

 $^{igodold{n}}$  : Electric Lines Library. Its operation is as same as that of Lines library.

 $\hat{U}$  : stakeout last electric line.

 $^{\bigcirc}$  : stakeout next electric line.

©: Display information. Set up display information, including Data storage type, Prompt Range and whether to enable automatic scaling, as shown in Figure 5.11-2. Data storage type includes Dao Heng and Si Wei two formats. Press [DEFAULT] and it can restore electric line stakeout settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

Prompt range: Taking the line as center and prompt range as spacing on both sides, it generates six parallel lines. The area within these six parallel lines is prompt range.

 ${}^{Q}$  : collect TOPO point.

Defaulted items in bottom status bar describe as follows:

Target: The name of the stakeout line.

Point Horizontal distance: horizontal distance from current point to last collected point.

Mileage: draw a vertical line from current point, and mileage is the distance from current point to the start point  $\pm$  start point mileage.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

Mileage Diff to Start: distance from current point to start point.

Mileage Diff to End: distance from current point to end point.

: calculate distance and height difference between two points. Select two points in map and it can calculate distance and height difference between these two points

\*: calculate distance from offset point to line and offset direction. Select three points in Map, the first two points form a line and see the third point as offset point. And it can calculate distance from the third point to the line formed by the first two points and offset direction.

Control con

☆: calculate distance. Select two points in Map, and it can calculate the total length of route between two points.

Calculate and stakeout angular bisector of J peg. Select a point from J peg on electric lines and it can calculate and stakeout angular bisector of angle between connection lines front and back.

Ine offset storage. Select a point in line and it pops up setting dialog. Take selected point as base point, input distance, height difference and orientation (current point and the base point can be selected), and it can calculate coordinate of offset point and store in point library.

### **Electric Lines Survey steps:**

1. Enter Electric Lines Survey, add electric line, select one line and start survey.

2. Record survey data. File format can be set in STAKEOUT SETTINGS, including Dao Heng and Si Wei. Data storage type can switch when project is created and is not allowed to switch once collection starts.

During operation, it only needs to select reference line as needed, press<sup>®</sup> to collect TOPO point on detail points that needs collection and save survey data. Select Object type, select Pole Type, input width, angle, pole height and other items, and press [OK] to save. Then software will save these topographic information and property in survey file so as to record the information through direct selection instead of tedious code.

Press  $^{\circ}$  to enter into Electric Lines Survey interface and press [Add] to create a new electric line as shown in Figure 5.11-3. It sets start point and end point of the line, or set line name, start mileage, line length and start point.

Select target electric line and press [OK] to enter electric line survey interface as shown in Figure 5.11-4. According to stakeout prompt in bottom status, press O to collect TOPO point or press handheld defined shortcut key to collect and save power property data as shown in Figure 5.11-5.

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Figure 5.11-3

Figure 5.11-4

Figure 5.11-5

When in storage, according to current point type to select Object Type. Object Type includes: J pile (turning point stake), Z pile (straight line stake), Auxiliary point, 1 point measurement marker, 1 point road measuring river pond, 2 point road measuring river pond and 3 point measuring room.

[J pile] Turning point stake.

[Z pile] Straight line stake.

[Auxiliary point] General detail points.

[1 point measurement marker] It includes power line, communication line, optical cable, road, railway.

[1 point road measuring river pond] It's used for road, railway, river, pond and house.

[2 point road measuring river pond] It's used for 2-point measurement for road, river, pond and house. See detailed introduction in the following.

[3 point measuring room] It's used for 3-point measurement for house. See detailed introduction in the following.

A、 To collect J pile, Z pile, auxiliary point and general point it only needs to input point name and antenna height.

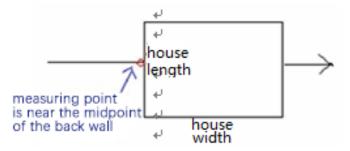
B、 During operation, when the road meets power lines, communication lines, optical cables and other lines, it needs to store power line type, span angle and other information so as to display

in plan and sectional drawing of DaoHeng CAD. For instance, forward line encounters 220KV power line, Angle: acute angle of 45 degrees to the right, Height 30 meters, and perform storage.

C、1 point measurement marker

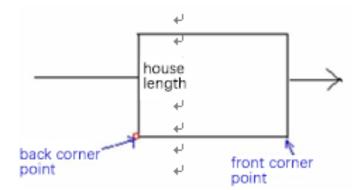
The forward line encounters road, railway, river, pond, house and other objects, it can store by 1 point measurement marker.

For instance, in the forward direction, it encounters a road, Angle: acute angle of 60 degrees to the right, Width 10 meters. After selecting the point at one end of the physical object, collect and store data, and input the width in the storage dialog box. [Note]: when the back section point is not easy to measure, it can be measured at the front section point, and width is input negative value.



### D、2 point road measuring river pond

It's a second way to store span object and it can measure object width in more precision. On one end of the object collect and store data, choose 2-point measurement and it sets the point as point 1. After storage, collect and store data on the other end, and it sets the point as point 2. Select Gutter and input angle and other information to store. (Measurement sequence at both ends of the object can be arbitrary because software will automatically determine the front and back interrupt points of the object according to the line direction. It is important to note that it must first store point 1 and then point2, which software will automatically process it without any choice by user.)



E、3 point measuring room

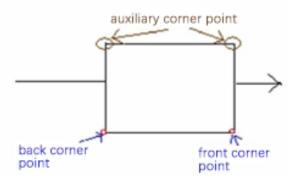
When in house measurement, there are three ways, 1-point measurement, 2-point measurement and 3-point measurement.

(1) 1-point house measurement, that is to select [1 point road measuring river pond], select[House] as Gutter and input house length, width and height.

(2) 2-point measurement. It needs separative measurements in back corner point and front corner point in arbitrary sequence. Select [2 point road measuring river pond], select [House] as Gutter and input house length and height.

Note: house length can input positive or negative values. The positive and negative value of house length means: see forward direction of road as reference, house slants to the left or to the right, and left is positive and right is negative.

(3) 3-point measurement. It needs separative measurements in back corner point and front corner point in arbitrary sequence and then another measurement in auxiliary corner point. Note: auxiliary corner point must be a third, i.e. measurement sequence is first front and back corner points and then auxiliary point. Select [3 point measuring room] and input house length.



85

For collected power data, Geoelectron provides professional power conversion software ElectricPro. It converts project file (\*.PD) into DeoHeng ORG data format through data edition.

## 5.12 Tower Stake

Tower stake is for engineering stakeout of four or eight reference points of tower foundation of high-voltage transmission line in electric construction.

Press [Survey] -> [Tower Stake] to enter into interface as shown in Figure 5.12-1. Select a point and press [Calculate] to enter interface as shown in Figure 5.12-2. Select its type (4-cross-section or 8-cross-section), input length and width, and press [Calculate] to acquire result as shown in Figure 5.12-3. Press [OK] to return to interface as shown in Figure 5.12-4. Select a tower and press [Stakeout], and stakeout interface as shown in Figure 5.12-5. Perform stakeout according to bottom status bar. During tower stake, it can collect tower section data and when distance shows 0 it means current point is on the selected line. Press P to collect tower point as shown in Figure 5.12-6.

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Figure 5.12-1

Figure 5.12-2

Figure 5.12-3

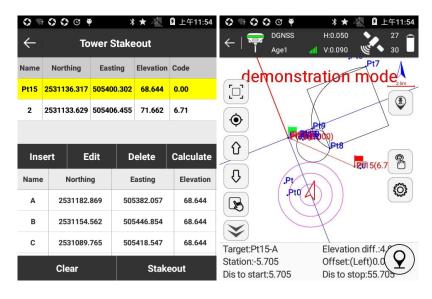


Figure 5.12-4

Figure 5.12-5

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Easting	505401.9642				
Elevation	72.9579				
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Figure 5.12-6

Figure 5.12-7

The icons in side toolbar describe as follows:

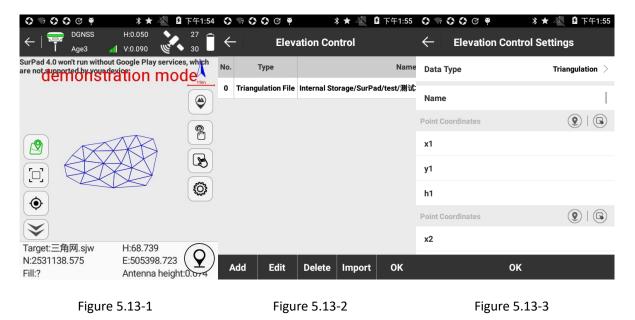
- 👻 : Topo point/Tower point switch icon.
- 🔀 : Coordinate point library. Points collected by SurPad are stored in coordinate point library.
- $\widehat{U}$  : Stakeout last coordinate.
- $\[equation]$  : Stakeout next coordinate.
- $\mathbb{N}$  : The closest point, the point closest to stakeout point. (add in the toolbar in  $\mathbb{Q}$  )

Display information: as shown in Figure 5.12-7, it can set stakeout settings, including Prompt Range and whether to enable automatic scaling; settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

# **5.13 Elevation Control**

Elevation control can calculate the design height of points within the range according to the design plane parameters, which is conducive to site leveling and earthwork calculation in the project.

Press [Survey]-> [Elevation Control], select the stakeout file and press [OK] to enter elevation control stakeout interface as shown in Figure 5.13-1.



The icons in side toolbar describe as follows:

<sup>®</sup> : Elevation Control library interface as shown in Figure 5.13-2. Press [Add] as shown in Figure 5.13-3 and it can create a new elevation control. Data type includes import triangulation file, triangulation, two points area and one point area. Select item in list and it can delete and edit the selected item. Press [Import] and it can import \*.TIN file. \*.TIN file is a comprehensive file formed by all triangulation, two points area and one point area.

### **Elevation control steps:**

(1) Enter Elevation Control library, press [Add] to create triangulation, two points area and one point area or import triangulation file as engineer design required.

88

A. To create a one point area, it needs to input a point coordinate (x, y, h), xGrade and yGrade. Coordinate and xGrade and yGrade form a plane.

B. To create a two points area, it needs to input two point coordinates with same height and Grade which together with two points forms a plane. Taking connection line of two points as boundary (starting from the point with elevation), when grade is positive, right elevation is larger than h and left elevation is smaller than h; when Grade is negative, on the contrary, right elevation is smaller than h and left elevation is larger than h.

C. To create a triangulation, input three point coordinates (x, y, h) and three points form a plane.

(2) Press [OK] to return to Elevation Control library, select stakeout target (triangulation plane), press [OK] to enter stakeout interface as shown in Figure 5.13-1. If current point is in design plane projection, it can view elevation, design height (according to design plane) and cut and fill. Perform site leveling as engineer design required.

# 5.14 Curve Stakeout

Curve Stakeout is a simple line stakeout tool. Software provides three types of curves, namely straight line, circle and curve. Curvature and radius of any point on circle are the same. Curvature and radius of any point on curve are changing.

Press [Survey] -> [Curve Stakeout], select a line from Curve Stakeout list to stakeout as shown in Figure 5.14-1.

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Figure 5.14-1

Figure 5.14-2

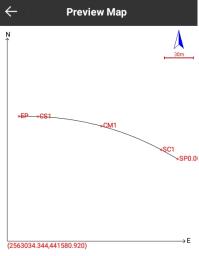
Figure 5.14-3

The icons in side toolbar describe as follows:

<sup>16</sup>: Curve Stakeout list as shown in Figure 5.14-2. Press [Select] to enter Curves Library as shown in Figure 5.14-3. Press [Add] and it can create Straight line, Circle (known offset angle and intersection), Circle (known coordinates and radius), Circle (known three coordinates) and Curve as shown in Figure 5.14-4. Press [Import] and it can import curve file in \*.SC format. Select a curve and press [Edit] and it can edit the selected curve parameters. Press [Map] and it can view the drawn graph as shown in Figure 5.14-5. Press [Delete] and it can delete the selected curve.

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Figure 5.14-4



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- $\hat{U}$ : Stakeout last coordinate.
- $^{\bigcirc}$  : Stakeout next coordinate.
- <sup>B</sup>: Add stake. It can add stake on stakeout curve according to mileage during stakeout curve.
- <sup>(Q)</sup>: Display information.
- (2) : collect TOPO point.

### Stakeout curve steps:

- (1) Enter Curve Stakeout list.
- (2) Press [Select] to enter Curves Library and create curve or import curve file.

Parameter settings for new line are as follows:

Straight line: set Road Name, Mileage, Start Point and End Point. 90

Circle (known offset angle and intersection): set Name, Radius, Mileage, Corner, Intersection Point and Reference type (Reference Angle and Start Point coordinates). Corner: turning angle of line.

Circle (known coordinates and radius): set Name, Radius, Mileage, Center Point, Start Point and End Point. Center point: connection line of start point and end point, and turn left represents center point is in the left of line and turn right represents center point is in the right of line.

Circle (known three coordinates): set Name, Mileage, Start Point, Second Point and End Point.

Curve: set Name, Radius, Gradual Curve, Mileage, Corner, Intersection Point and Reference Type (Reference Angle and Start Point coordinates).

<sup>(3)</sup>Select target curve, press [OK], set Calculation mode (Calculate by integer number or Calculate by integer distance) and Interval, and press [OK] to return to Curve Stakeout list. In list it displays main points of the curve (QD, QZ, ZD, JD, HH) and coordinates and mileage according to interval settings.

(4) Select one point in Curve Stakeout list and press [OK] to enter stakeout interface as shown in Figure 5.14-1. According to interval settings, it displays mileage at the corresponding position of the line. When the distance between stakeout point and current point is less than 3 meters, it will enter into precise stakeout, and stakeout according to arrow direction and prompt in bottom status.

(5) Press  ${\ensuremath{\mathbb P}}$  to add stake on stakeout curve.

 $^{(6)}$  The adjacent stakeout points in the points library can be switched automatically by  $\,^{\textcircled{}}$  and  $^{\textcircled{}}$  keys.

### 5.15 Existing Stakeout

Existing stakeout is essentially the reversal process of line stakeout. Line stakeout is to stakeout the designed line to the field, and stakeout the line according to calculated line elements, length and azimuth. And existing lines stakeout is to survey and map out the existing roads of in detail, and then based on the data of surveying and mapping to calculate the starting point of linear range, azimuth, length, starting point and end point coordinates and other elements, in order to modify or design based on the data.

This function is usually used to collect center point of line in field. The center points are connected into polylines and the parameters of each line can be viewed in the line library. The section can also be measured.

Press [Survey]-> [Existing Stakeout] and select an existing line to stakeout as shown in Figure 5.15-1.

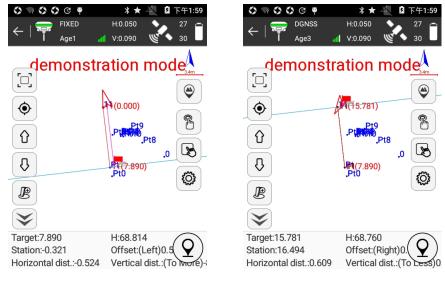


Figure 5.15-1

Figure 5.15-2

The icons in side toolbar describe as follows:

- <sup>8</sup> : Stake Existing Lines.
- $\hat{U}$  : stakeout last line.
- <sup>(1)</sup>: stakeout next line.
- <sup>B</sup> : connect end point and current point of line.
- Output: Contraction in the second second
- <sup></sup> €: collect point.

### **Existing stakeout steps:**

(1) Enter Stake Existing Lines and set start line or import line files.

(2) Select target line and press [OK] to enter stakeout interface as shown in Figure 5.15-1. The normal line is generated at the center point, which is conducive to measuring cross section. The

vertical line of normal line is formed by overturning the front point, which can help to distinguish the direction.

(3) Measure cross section of mileage at current point according to line mileage, line offset, horizontal distance and vertical distance in bottom status.

(4)  $Press^{(2)}$  to collect data at current coordinate, that is, cross section.

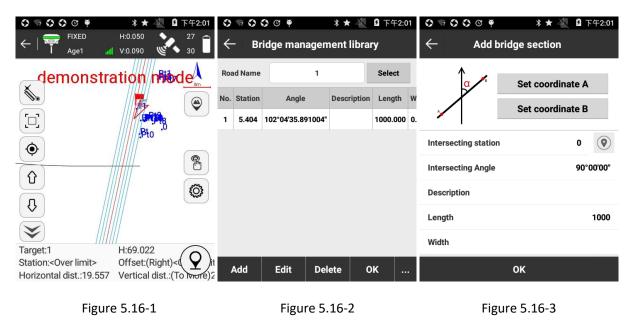
(5) Press <sup>®</sup> to connect end point and current point of stakeout line as shown in Figure 5.15-2. Press Stake Existing Lines and it can view parameters of connection line.

(6) Move current point and repeat step 4 and 5 until complete all existing line stakeout.

(7) The adjacent center points can be switched automatically by  $^{\circ}$  and  $^{\circ}$  keys to measure cross section.

# 5.16 Railway Stakeout

Press [Survey]-> [Railway Stakeout], select a road in Roads Library and press [OK] to enter line centerline stakeout interface as shown in Figure 5.16-1. Before measurement of longitudinal section of railway bridge, it must perform line centerline stakeout. Before measurement of longitudinal section of road bridge, it must design and stakeout road data file.



<sup>8</sup> : Bridge management library. As shown in Figure 5.16-2, it includes Add, Edit, Delete, Import, Export and OK operation. Press [Add] to enter interface as shown in Figure 5.16-3, set coordinate A

and B, and it can automatically calculate intersecting mileage, intersecting angle and other parameters. And then press [OK] to create a new bridge section. Select any bridge section and press [Edit] and it can edit every parameter. Press [Delete] and it can delete the selected bridge section. Press [Import]/[Export] and it can import/export bridge file in \*.XDM format.

©: Display information. Set up display information, including Prompt Range, Automatic scaling, Display key point, Assistant line, Road thickness and Limit mileage range, as shown in Figure 5.9-4. Press [DEFAULT] and it can restore changed settings. Settings for [TOPO POINT], [INFORMATION BAR] and [TOOLBARS] are the same as that of Point Survey.

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← Display Information		$\leftarrow$ Survey Point C	Collection
STAKEOUT SETTINGS TOPO POINT INFORMATIO N BAR	TOOLBARS	Name	12 🔇
Prompt Range	1 >	Specified station	
Automatic scaling	0	Data Type	Vertical section point $>$
Display key point		property	none $>$
Assistant line	0 >	Antenna Parameters	0m,Vertical height $\geq$
Road thickness	0 >	Whether or not to use the w	ridth O
Limit station range	0	Width	0
Use Elevation Control Height	0	Two point fixed Two po line interse	· · · · · · · · · · · · · · · · · · ·
	К	ок	

Figure 5.16-4

Figure 5.16-5

 $^{\textcircled{O}}$ : collect TOPO point. Its interface is shown in Figure 5.16-5.

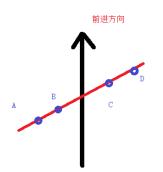
Data type: Vertical section point, Intersect point, Adjacent point and Adjacent points.

Vertical section point: point type for longitudinal section stakeout.

Intersect point: point type for measurement of intersecting angle and intersecting point mileage during longitudinal section measurement.

Adjacent point and Adjacent points: point type for elevation measurement of nearby dam top, beam bottom, existing piers, flood water level points and other design relative points or point system position during longitudinal section measurement. In measurement, point type should be adjacent point. In point system measurement, point type of all points except the first point (point type as adjacent point) should be adjacent point system.

[Two point fixed line]: in line stakeout, according to site conditions, it measures two points to determine the cross section on stakeout cross section direction. These two points should measure the left one at first and then the right one. They also can be on one side or on either side of road. Image as shown in the following figure:



There are several ways to measure the points: point A and B; point C and D; point B and C.

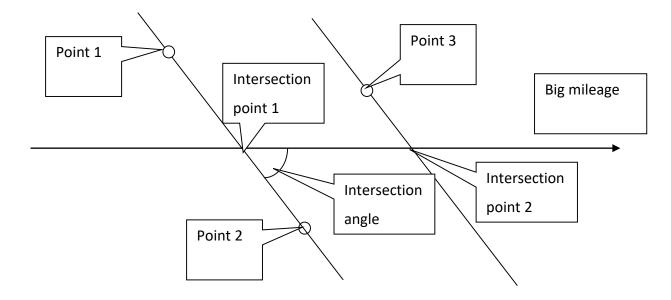
[Two point intersects] and [Three point intersects]:

Measure intersecting angle and intersecting point mileage of intersecting railways, roads or rivers during cross section survey. In measurement it only needs to measure two points on one side of intersecting building to determine intersection angle and intersection point mileage of intersecting building and line. And then measure one point on the other side of intersecting building to determine the width of building and intersection point mileage of the measured side and line (it can directly input width).

#### **Measurement step:**

1. When measuring only two points, press [Two point intersects] to calculate angle. If the width is known, it can input directly. If the width is unknown, then width is not necessary to input.

2. When measuring three points, measure two points on one side of the intersection object and one point on the other side. When measuring the third point, press [Three point intersects] to calculate the angle and width.



Measure method sketch map

Set Measure point. Culvert measurement is in some positions cannot get GPS satellites fixed, to measure a datum point in position can get fixed solution and measure distance and elevation from datum point to the unknown point by measurement type, then to calculate coordinate and elevation of the unknown point by software. This can help measure some blind spots that GPS cannot measure. Press to collect a Datum point as shown in Figure 5.16-6, and press [OK] to enter measure point interface as shown in Figure 5.16-7.

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$\leftarrow$	Datum point	$\leftarrow$	Mea	sure point	
Datum point		Number	of scales:		0
Name	11	Meas	ure type	Measure ve	rtical section $>$
Northing	2531139.92	Meas	ure direction	Mea	sure the right $ ightarrow$
Easting	505399.059	prope	rty		none $>$
Elevation	68.614	Statio	n difference		
		Elevat	ion diff.		
		Name	11	Eleva	68.614
		Station	0.000	Offset	0
	ок		N	leasure	

Figure 5.16-6

Figure 5.16-7

Number of scales: number of point continuous measurement. When in continuous measurement, it needs to be based on previous measure point and measure type should be same.

Measure type: [Measure vertical section] includes Mileage difference and Elevation difference; [Direct addition] incudes Mileage, Horizontal distance and Elevation.

Measure direction: [Measure the left] is small mileage; [Measure the right] is big mileage.

Defaulted items in bottom status bar describe as follows:

Target: The name of the stakeout line.

H: The height of current point.

Mileage: Draw a vertical line from current point to stakeout line, and mileage is the distance from the vertical point to the start point.

Offset: Draw a vertical line from current point to stakeout line, and offset is the distance from foot point to current point. When current point is on the left in the direction of line, offset is negative; when current point is on the right in the direction of line, offset is positive.

Horizontal distance: Draw a vertical line from current point to cross section, and Horizontal distance is the distance from foot point to intersection of cross section and road.

Vertical distance: Draw a vertical line from current point to cross section, and Vertical distance is the distance from foot point to current point. "To Less" means that if you want to reach the target peg, the distance to the direction of the small mileage.

# 5.17 Survey Range Settings

Survey range settings is a prompt settings of survey area for the purpose of surveyor's understanding of the working area.

Press [Survey] -> [Survey Range Settings] to enter interface as shown in Figure 5.17-1, which displays point list.

Generally, survey area set up needs at least three points. As shown in Figure 5.17-2, press [Add] to set up Point Coordinates. It can press () to acquire current coordinate, or press () select from point library or input manually. After point setting, press [OK] to return to previous interface, and press [OK] to display the survey range with red line in Survey interface as shown in Figure 5.17-3. Press [Select] to select points in Points Library to form survey range. Press [Import] and it can import coordinates files (\*.dat, \*.txt, \*.csv).

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÷	← Survey Range Settings				$\leftarrow$	Point Coord	dinates				H:0.050 V:0.090		<sup>27</sup> 🗍
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					Easting					Pt	.Pt9	Pt8	
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									Point name:11 N:2531142.026		H:70.377 E:50539		$\overline{\mathbf{O}}$
Ad	d Select	Edit	ок			ок			Antenna height:			stance:48	<b>⊻</b> / 00.033
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Figure 5.17-1

Figure 5.17-2

Figure 5.17-3

Select any coordinate point and press [Edit] to edit the point information.

Press [Delete] and it will pop up a prompt as shown in Figure 5.17-4 and press [OK] to delete the point.

Press [Move up] and [Move down] to move the point.

Press [Preview Map] and it can show graph formed by points in list as shown in Figure 5.17-5. And press [CAD] to enter CAD interface as shown in Figure 5.17-6.

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$\leftarrow$	$\leftarrow$ Survey Range Settings			$\leftarrow$ Survey Ran	$\leftarrow$	CAD					
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No					P18 P199 P120		.11	.11			
No			Cancel	ОК		1940/7 1946/6 19 <b>94625</b>	PH24 PH23 PH22_PH21		PPD	t8	
No.	Pt5	2562968.022	441580.364	43.734					Pt0	.0	
No.	Pt6	2562968.036	441574.373	43.760							
No.	Pt7	2562968.058	441568.371	43.768							
Ad	ld	Select	Edit	OK		C/	AD	🐼 Data	Drawing	<b>N</b> Survey	ゼ Tools
	Figure 5.17-4					Figure	Figure 5.17-6				

# 5.18 Layers Settings

Layer settings of SurPad is same as that of CAD used on PC, which sets up and edits imported CAD layer. And it also supports to import \*.shp layer in ArcGIS data format.

Press [Survey] -> [Layers Settings] to enter interface as shown in Figure 5.18-1. Layer is divided into CAD LINE and BACKGROUND LAYER.

CAD LINE: interface as shown in Figure 5.18-1. Press [NEW LAYER] as shown in Figure 5.18-2, input Layer Name, select color, set whether set up as a work layer, whether visible and whether lock. Press [layer] and it can delete layer or rename it.

 $\odot$ : work layer. Only one layer is work layer.

•: layer is visible.

💿 : layer is locked. Locked layer cannot be deleted.

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÷	L	ayer sett.	tings	$\leftarrow$	New lay	er		$\leftarrow$	La	ayer settin	igs	
	CAD LAYER		BACKGROUND LAYER	Layer Name			Ι		CAD LAYER	B	ACKGROUN	D LAYER
$\oslash$	•	Default		colour			>	۲	l 三角网	X		
				Is it set up as a	work layer		0					
				Is it visible								
				Whether or not	to lock		0					
		NEW LAY	/ER	Cance		ОК		ADD	EDIT	MOVE UP	MOVE DOWN	DELETE
	Fi	gure 5.	18-1		Figure 5.	.18-2			Fi	gure 5.1	.8-3	

BACKGROUND LAYER: interface as shown in Figure 5.18-3. It includes five operations, namely ADD, EDIT, MOVE UP, MOVE DOWN, DELETE.

Press [ADD] and it can import layer. It supports \*.shp (ArcGIS data type) and \*.dxf (AUTOCAD drawing exchange file) files. When importing layer, it can view layer properties. As shown in Figure 5.18-4, it can set Contour Color, Fill Color, whether Display Label, Property, Text Color, whether is Visible and whether is Selectable. Press [Boundary] and it can check layer's boundary as shown in Figure 5.18-5. Multiple layers can be overlapped. Layers can be chosen to Edit, Delete, Move up and

Move down. It can view imported layers in Survey interface after Layer settings, as shown in Figure 5.18-6.

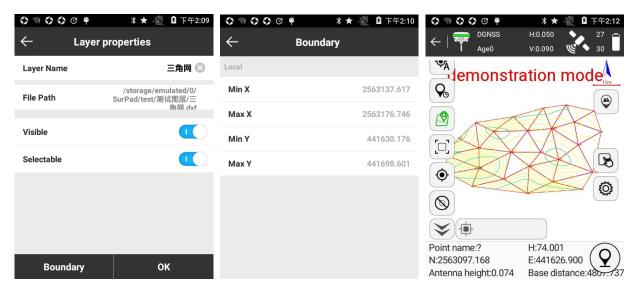


Figure 5.18-4



Figure 5.18-6

# **Chapter 6 Tools**

## 6.1 Site Calibration

In general, GPS receiver output data is WGS-84 latitude and longitude coordinates. The coordinates need to be converted to the construction measure coordinates, which requires software to calculate and configure coordinate conversion parameters. Site calibration is the main tool to complete this conversion.

Press [Tools]-> [Site Calibration] to enter into interface as shown in Figure 6.1-1. It contains Add, Edit, Delete, Calculate, Import, Export and Options operation.

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÷	← Localization					$\leftarrow$	Localizat	ion	
No.	Name	Northing	Easting	н	Latitude/N	Known coordinate	S		(
0	KZD2	2531145.751	505467.822	57.438	23°09'59.7	Point name			
1	KZD3	2531145.155	505405.919	53.813	23°09'59.6	Northing			
2	KZD4	2531144.767	505427.315	53.809	23°09'59.6	Easting			
						Elevation			
						geodetic coordina	tes		9 0
						Coordinates Ty	ре	Geodetic Co	oordinate
						Latitude			N0°00'00
,	Add	Edit	Delete	Calcu	late		ок		

Figure 6.1-1

Figure 6.1-2

Press [Add] to enter into interface as shown in Figure 6.1-2.

There are two ways to set the know point coordinates: one is to press (1) to get coordinates from the points library, the other one is to input name, northing, easting and elevation directly. Set the known coordinate to complete inputting point coordinate in first coordinate system.

Then set WGS84 geodetic coordinate. There are three ways to set WGS-84 geodetic coordinates: the first one is press () to collect point, the second one is to press () to get coordinates from the points library, and the third one is to input name, northing, easting and elevation directly. Then it completes inputting first WGS-84 geodetic coordinate. Set whether to use horizontal control and vertical control, and then press [OK] to complete first group of coordinates.

The remaining coordinates can be added in this way, until all the coordinates which are participated in the parameter calculation have been added.

Select a coordinate in [Site Calibration] and press [Edit], you can edit the parameters of this point. Then press [OK] to save the changes.

Select a coordinate in [Site Calibration] and press [Delete], then all the data about this point could be deleted from Site Calibration.

Press [Import] to import pre-edited \* .COT file and \*.LOC file of SurveCE, which is convenient to coordinate input.

Press [Export] to export the coordinates in Site Calibration in \* .COT file. When you need to use these coordinates next time, you can import and don't need to re-input.

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$\leftarrow$ Localiza	ntion Settings	← GPS Parame	eters Report		
Convert Method	Horizontal correction + Elev_correction	Ellipsoid	Parameter		
Horizontal	Horizontal Adjustment >	Ellipsoid Name	CGCS2000		
correction Model	nonzona Agaotinent	Semimajor axis	6378137		
Vertical Control	Automatic Decision $ ightarrow$	1/f	298.257		
Horizontal Accuracy Limit	0.1 >	Projection	ons Parameter		
Vertical Accuracy		Projections Mode	Gauss Kruger		
Limit	0.1 >	Central Meridian	E114°00'00"		
		Northing constant	0		
		Easting constant	500000		
	ок	Save	Apply		

Press [Options] to enter interface as shown in Figure 6.1-3.

Figure 6.1-3

Figure 6.1-4

Convert Method: it includes [Horizontal correction+ Elev\_correction], [Horizontal Adjustment+Vertical Adjustment], [Seven parmeter+Horizontal correction+Elev\_correction] and [Seven Parameter]. Horizontal correction includes Horizontal Adjustment and Four Parameter. Elevation correction includes height fitting and vertical adjustment.

Horizontal correction Model: it includes [Horizontal Adjustment] and [Four Parameter]. Horizontal Adjustment is defined format of Situoli. Four Parameter is suitable for four parameter compatible format like HI-TARGET. Vertical Control: it includes [Automatic Decision], [Weighted Average], [Plane Fitting], [Surface Fitting] and [Vertical Adjustment]. Horizontal Accuracy Limit and Vertical Accuracy Limit could be changed as needed.

After all the coordinates are inputted, press [Calculate] to acquire the GPS parameter report as shown in Figure 6.1-4. Press [Apply], it will refresh the data in the coordinate point library. If the result is not applied, press return key upper left, it will return to Site Calibration interface. To ensure whether the calculation results are accurate or reliable, it can check with other known points.

# **6.2 Coordinates Converter**

Press [Tools]- [Coordinates Converter] to enter interface as shown in Figure 6.2-1. Set up source coordinate and there are three ways to input coordinate: 1. Press (\*) to collect point; 2. Press (\*) to select from coordinate point library; 3. Directly input point name and coordinate value. Select Transform type (BLH or xyh), input coordinates, and press [Transform] to accomplish coordinate conversion and check result as shown in Figure 6.2-2. If it needs to save the converted coordinates, press [OK] and input the point name to save it to the coordinate library as shown in Figure 6.2-3.

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← Coordinates Co	nverter	← Coordinates Converter		- New Point	
Source Coordinate		Transform type 💿 BLH	🔿 xyh	Name	
Transform type 🔘 BLH	🔿 xyh	Latitude	23.09596235 🛞	Northing	2531142.912
Latitude		Longitude	E113°25'48.0117"	Easting	505407.478
Longitude	E0°00'00"	Altitude	69.958	Elevation	67.759
Altitude		Target Coordinate		Lievation	01.107
Target Coordinate		Northing	2531142.912	Code	
Northing		Easting	505407.478	Coordinates Type	Local Coordinate $>$
Easting		Elevation	67.759	Property type	Calculate Point $>$
Transform	Save	Transform	Save	o	к

Figure 6.2-1

Figure 6.2-2

Figure 6.2-3

# **6.3 Angle Converter**

Press [Tools]-> [Angle Converter] as shown in Figure 6.3-1. It includes 5 angle formats, namely dd(Decimal), dd.mmssss, dd:mm:ss.ssss, dd:mm:ss.ssss' and Radian.

The conversion goes in the following sequences:1. select input angle format; 2. input angle; 3. check result.

For instance, select angle format as dd (Decimal), input angle 23.25, press [Calculate] and the result is as shown in Figure 6.3-2.

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Format	dd°mm'ss.ssss" $ ightarrow$	Format	dd°mm'ss.ssss" >
dd°mm'ss.ssss"		dd°mm'ss.ssss"	23 🕄
Result		Result	
dd (Decimal)	0	dd (Decimal)	23
dd.mmssss	0	dd.mmssss	23
dd:mm:ss.ssss	0:00:00	dd:mm:ss.ssss	23:00:00
Radian	0	Radian	0.401425727959
Calc	culate	Calc	culate

Figure 6.3-1

Figure 6.3-2

#### 6.4 Perimeter and area

Press [Tools]-> [Perimeter and area] to enter interface as shown in Figure 6.4-1. In List it displays points in list, and in Preview Map it displays graph formed by points in list.

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		List	Р	review Map		Please set coo	ordinate point	(	9   3			List	Р	review Map	
No.	Name	Northing	Easting	Elevation		Name				No.	Name	Northing	Easting	Elevation	
0	Pt1	2562967.915	441604.383	43.810		Northing				0	Re	sult			
1	Pt2	2562967.934	441598.380	43.834		Easting				1	Are	a:277.826054	m²		
2	Pt3	2562967.955	441592.372	43.828		Elevation				2		a:0.027783hm imeter:204.19			
3	Pt4	2562968.002	441586.381	43.728						3					
4	Pt5	2562968.022	441580.364	43.734						4				ок	
5	Pt6	2562968.036	441574.373	43.760						5	Pt6	2562968.036	441574.373	43.760	
6	Pt7	2562968.058	441568.371	43.768						6	Pt7	2562968.058	441568.371	43.768	
	Add	Select	Edit	Calculat	e		ок			ļ	٨dd	Select	Edit	Calculate	e

Figure 6.4-1

Figure 6.4-2

Figure 6.4-3

Press [Add] to enter interface as shown in Figure 6.4-2. At least 3 coordinates need to set up to calculate perimeter and area. To add points, it can press solve to acquire current coordinate, or press select from point library or input manually. After point setting, press [OK] to return to previous interface, and press [Calculate] to calculate perimeter and area of the graph formed by points as shown in Figure 6.4-3.

Points can be selected to Edit, Delete, Move Up and Move Down. As shown in Figure 6.4-4, Import, Export, Delete, Move Up and Move Down need to show when press .

Press [Select] and it can select points from Points Library as shown in Figure 6.4-5. It also supports Select All.

Press [Import] to enter interface as shown in Figure 6.4-6, choose import coordinates file (\*.cvs, \*.dat and \*.txt) and Distance Unit (Meter, US Survey and International Feet) and press [OK] to find the file and press [OK] to import file and return to List or Preview Map interface.

←       Points Library       ←       Import File         Import        Please input name or code       O       File Format       Local coordinates of format(.csv/datitxt)         Export        Name       Northing       Easting       Elevation       Points Library         Move up	ଙ୍ 🛉	*	★ ♥ ▲ 🗵 下午5:30	¢ ¥		*★ ¶4	☑ 下午5	5:35	¢	∦★ ♥! 🐴 💈 下午5:35
Options         Name         Northing         Easting         Elevation         [Point Name],[Northing],[Easting],[Elevation],[Code]           Import	$\leftarrow$	Calculate	Area	$\leftarrow$	Points L	ibrary			$\leftarrow$	Import File
Import       ○       ★ Pt7       2531142.912       505407.478       67.759       N23         Export       ○       ★ Pt3       2531143.638       505405.876       64.873       N23         Delete       ○       ★ Pt1       2531144.729       505405.876       64.873       N23		List	Preview Map	Please inp	out name or code		(	2	File Format	
Import       O       Import       Distance Unit       Meter >         Export       ○       ★ Pt3       2531143.638       505405.949       65.356       N23         Delete       ○       ★ Pt2       2531143.678       505405.876       64.873       N23         Move up       ○       ★ Pt1       2531144.729       505405.892       64.858       N23		Options		() N	ame Northing	Easting	Elevation		[Point Name],[Nort	hing],[Easting],[Elevation],[Code]
Export       ○       ★       Pt2       2531143.878       505405.876       64.873       N23         Delete       ○       ★       Pt1       2531144.729       505405.892       64.858       N23		Import	0	$\bigcirc \bigstar$	Pt7 2531142.912	505407.478	67.759	N23	Distance Unit	Meter >
Delete     →     Pt1     2531144.729     505405.892     64.858     N23		Export	0	$\bigcirc \bigstar$	Pt3 2531143.638	505405.949	65.356	N23		
Move up		Delete	0		Pt2 2531143.878	505405.876	64.873	N23		
Move down		Move up		() <b>★</b> I	Pt1 2531144.729	505405.892	64.858	N23		
		Move down	0							
			_							
Add         Select         Edit         Calculate          Cancel         Select All         OK         Format Manage         OK	Add	l Select Ec	lit Calculate	Canc	el Selec	t All	ок		Format Mana	age OK

Figure 6.4-4

Figure 6.4-5

Figure 6.4-6

### 6.5 COGO Calculation

Press [Tools]-> [COGO Calculation] to enter interface. According to the known coordinates, it can figure out position relations between point and point as well as between point and line. It includes Coordinate inverse calculation, Point line calculation, Vector, Two Lines Angle and other calculation, which will be introduced in the following. The following three icons in COGO Calculation mean:

(B): store calculation point.

I acquire current coordinate.

(
 Points Library.

There are three ways to set points: 1. extract coordinates from Points Library; 2. acquire current GPS coordinates; 3. directly input values of Northing, Easting and Elevation.

Calculation result in COGO calculation can be stored in Points Library with press on B.

### 6.5.1 Coordinate inverse calculation

As shown in Figure 6.5-1, set Start Point A and End Point B, and press [Calculate] to check the result of Plane distance, Azimuth, Elevation difference, Ratio of slope and Vector, as shown in Figure 6.5-2.

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$\leftarrow$ Coordi	nate inverse calculation	$\leftarrow$ Coordinate inverse	calculation
N			
	Explanation: the known coordinates of points A and B, AB two azimuth plane, AB distance, AB distance, AB	Northing	2531144.729
A	point elevation difference, slope.	Easting	505405.892
Set Start Point		Elevation	64.858
Northing		Result	
Easting		Plane distance	4.765
Flowetion		Azimuth	348°01'13.090679"
Elevation		Elevation difference	-1.265
Set End Point		Ratio of slope	-26.549
Northing		Vector	4.93
	Calculate	Calculate	•
	Figure 6.5-1	Figure 6.5	5-2



As shown in Figure 6.5-3, set Start Point A, End Point B and Offset Point C, and then press [Calculate] to check the result of Start distance, End distance, Start Vertical Distance, End Vertical Distance, Offset Distance and Offset Angle as shown in Figure 6.5-4.

© 🏺	∦★ रज़ 🐴 🛿 下午5:36	C 🏺	咪★ ♥ 🐴 💈 下午5:38
← Р	oint line calculation	← Point li	ne calculation
C	Explanation: A, B coordinates known	wortning	2531143.638
	starting point, end point side point of C, which is the starting point for the pedal, AC distance, BC end point	Easting	505405.949
ĂPB	distance, vertical distance AP starting point, end point vertical distance BP, offset distance CP, angle	Elevation	65.356
	alpha.	Result	
Set Start Point		Start Dis	1.092
Northing		End Dis	1.693
Easting		Start Vertical Distar	nce 0.859
		End Vertical Distance	e 1.552
Elevation		Offset Dis	0.674
Set End Point		Offset Angle	(Right)38°07'33.278176"
	Calculate		Calculate
	Figure 6.5-3	Fig	ure 6.5-4

#### 6.5.3 Vector

As shown in Figure 6.5-5, set Start Point A and End Point B, and then press [Calculate] to check the result as shown in Figure 6.5-6.

¢ ¥	券 ★ रज़ 🐴 💈 下午5:38	œ 🏺	* ★ 👽 🐴 🛿 下午5:38
÷	Vector	$\leftarrow$	Vector
	Explanation: the latitude and	Latitude	23.09596235 🕓
<b>₽</b> <sup>B</sup>	longitude coordinates of the starting point A and the end point B are known, and the distance between the	Longitude	E113°25'48.0117"
►A►	two points of AB is calculated.	Altitude	69.958
Set Start Point		Set End Point	
Latitude		Latitude	N23°09'59.6824"
Longitude	E0°00'00"	Longitude	E113°25'47.9556"
Altitude		Altitude	67.056
Set End Point		Result	
Latitude	N0°00'00"	Vector	3.775
	Calculate		Calculate
	Figure 6.5-5	F	igure 6.5-6

## 6.5.4 Two Lines Angle

As shown in Figure 6.5-7, set Start Point A, End Point B, Start Point C and End Point D, and then press [Calculate] to check the result as shown in Figure 6.5-8.

¢	券★ ♥評 🖄 💈 下午5:39	¢	*★ र्ज् 🐴 🛿 下午5:39
$\leftarrow$	Two Lines Angle	← Two Lin	es Angle
A	Explanation: the coordinates of the line AB starting point A and the end	Point A	
Å.	point B are known, the coordinates of the line CD starting point C and the	Northing	2531143.878
ОВ	end point D are obtained, and the angle between the straight line AB and the line CD intersection is	Easting	505405.876
Point O	calculated.	Point B	
		Northing	2531144.729
Northing		Easting	505405.892
Easting		Result	
Point A			17°47'36.72211"
Northing		Angle(clockwise)	342°12'23.27789"
		Angle compl.	342 12 23.27789
	Calculate	Calc	culate
	Figure 6.5-7	Figure	6.5-8

#### **6.5.5 Intersection calculation**

As shown in Figure 6.5-9, set Point A, Point B, Point C and Point D, and then press [Calculate] to obtain the point coordinates as shown in Figure 6.5-10.

¢	券 ★ € 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	¢ ¥	券★ रा 🌉 💈 下午5:40
← Inte	ersection calculation	$\leftarrow$ Intersec	tion calculation
в	Note: known line AB starting point A and terminal B coordinates, line CD	Point D	
A A C	starting point C and terminal D coordinates, find the coordinates of linear AB and linear CD intersection point P.	Northing	2531143.638
Point A	( <b>9</b> )   ( <b>3</b> )	Easting	505405.949
Northing	0 0	Elevation	65.356
Easting		Result	B
		Northing	2531143.674
Elevation		Easting	505405.872
Point B		Elevation	65.114
Northing		Angle	114°19'19.902078"
	Calculate		Calculate
	Figure 6.5-9	Figu	ire 6.5-10

#### 6.5.6 Resection

As shown in Figure 6.5-11, set Line L1, L2, Point A and Point B, and then press [Calculate] to obtain the point coordinates as shown in Figure 6.5-12.

œ ♥	券★ ♥ 🦄 💈 下午5:40	¢ ¥	* ★ 👽 🖳 💈 下午5:41
$\leftarrow$	Resection	÷	Resection
Р	Note: the known coordinates,	Elevation	64.858
$A^{L1} A^{L2} B^{L2}$	triangle ABP points A and B AP=L1, BP=L2, and P coordinates.	Point B	
Line L1,L2		Northing	2531142.912
L1	1	Easting	505407.478
L2		Elevation	67.759
Point A		Result	B
		Northing	2531176.691
Northing		Easting	505444.343
Easting		Elevation	66.308
	Calculate		Calculate
	Figure 6.5-11		Figure 6.5-12

#### **6.5.7 Forward intersection**

As shown in Figure 6.5-13, set Angle  $\alpha$ ,  $\beta$ , Point A and Point B, and then click [Calculate] to obtain the point coordinates as shown in Figure 6.5-14.

ଙ <b>ଡ଼</b>	∦ ★ रो 🐴 💈 上十5:41	C 🏺	* ★ 👽 🐴 💈 下午5:41
← ғ	orward intersection	← ।	Forward intersection
Р	Note: the known coordinates of the	Elevation	67.759
ΑαβΑΒ	triangle ABP points A and B / A= / B=, alpha, beta, and P coordinates.	Point B	
Angle α,β		Northing	2531144.729
a	1	Easting	505405.892
β	0°00'00"	Elevation	64.858
Point A		Result	(8)
March 14 a		Northing	2531142.447
Northing		Easting	505405.111
Easting		Elevation	66.308
	Calculate		Calculate
	Figure 6.5-13		Figure 6.5-14

# 6.5.8 Coordinate positive calculation

As shown in Figure 6.5-15, set Line L1, Angle  $\alpha$ , Point A and Point B, and then press [Calculate] to obtain the point coordinates as shown in Figure 6.5-16.

¢ ¢	∦★ र्ज् 🔌 💈 下午5:42	¢ ¥	券★ ♥! 🐴 💈 下午5:42		
$\leftarrow$ Coordi	$\leftarrow$ Coordinate positive calculation		$\leftarrow$ Coordinate positive calculation		
в∮ "₽	Note: the starting point and end point	Elevation	64.858		
A L1	A of known coordinates B, angle A= alpha, AP=L1, and P coordinates.	Point B			
Line L1,Angle a	Line L1 Angle a		2531143.878		
L1	1	Easting	505405.876		
۵	0°00'00"	Elevation	64.873		
Point A		Result	(8)		
Marcal Area		Northing	2531093.341		
Northing		Easting	505374.921		
Easting		Elevation	65.774		
	Calculate		Calculate		
	Figure 6.5-15	Figu	re 6.5-16		

#### ligure 0.5 1

### 6.5.9 Offset point calculation

As shown in Figure 6.5-17, set Line L1, Angle  $\alpha$  and Point A, and then press [Calculate] to obtain the point coordinates as shown in Figure 6.5-18.

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← Offset point cale	culation	$\leftarrow$ Offset point	calculation
	linates of known line	Easting	505407.478
A L1 P B AB starting point are calculated.	nt A and terminal B	Elevation	67.759
et Start Point		Parameter settings	
Northing		Station	56
Easting		Offset Distance	3 😒
Flevation		Result	B
		Northing	2531100.567
et End Point		Easting	505440.457
Northing		Elevation	132.216
Calculate	•	Calc	ulate



Figure 6.5-18

### 6.5.10 Equal point calculation

As shown in Figure 6.5-19, set Start Point A and End Point B, and Number of segmentation, and then press [Calculation] to obtain n-1 coordinates as shown in Figure 6.5-20.

¢ ¥	券 ★ र्ज़ 🖄 🛿 下午5:44	C 🏺	\$ ★ ♥ 🐴 🛿 下午5:45
← Equ	al points calculation	$\leftarrow$ Equal points c	alculation
Be	Note: known line AP storting point A	Elevation	67.759
An	Note: known line AB starting point A and terminal B coordinates, and the line segments are divided into N	Parameter settings	
×	parts coordinates.	Number of segmentation	3 😒
Set Start Point		Result	(8)
Northing		Northing1	2531144.123
Easting		Easting1	505406.421
Elevation		Elevation1	65.825
Lievation		Northing2	2531143.518
Set End Point		Easting2	505406.949
Northing		Elevation2	66.792
	Calculate	Calcula	ate
Fi	gure 6.5-19	Figure	6.5-20

### 6.6 Calculator

This function is for the convenience of some simple data calculation.

¢		* +	t TA	፟ Σ 午5:45	φ <b></b>	≭ เ⊡ ♥ 🐴 🗳 14:43
$\leftarrow$	C	Calculato	r		$\leftarrow$ Radio N	Mode
					Radio type	Geoelectron $>$
				0	Connection mode	Serial port $>$
					Serial port information	
~	(	)	С	DEL	Serial port	ttyHSL0 $>$
π	7	8	9	÷	Baud Rate	<b>38400</b> >
tan	4	5	6	*		
cos	1	2	3	-		
sin	0	•	=	+	Conn	ect

Figure 6.6-1

Figure 6.7-1

## 6.7 External Radio configuration

Press [Tools]-> [External Radio configuration] to enter interface as shown in Figure 6.7-1. Connection mode for SurPad on handheld are Bluetooth and serial port, and for SurPad on PC is only Bluetooth. Select [Serial Port] as shown in Figure 6.7-1, connect external radio and handheld by GK-186 cable, and then select serial port and baud. Press [Connect] and it would prompt connection fails if connection fails while it would appear [Settings] if connection succeed.

Select [Bluetooth] as shown in Figure 6.7-2, press [Search] to search external radio Bluetooth, select the Bluetooth and press [Connect]. When connection succeeds, [Search] would turn to be [Settings].

ę	≭ 🕩 🎔 싶 🗳 14:44	♥ X ⊕ ♥ 🖄 🖬 14		φ	∦ 🕩 🎔 🐴 💈 14:45	
$\leftarrow$ Radio	Mode	$\leftarrow$ Functional selection		← Paramet	ter setting	
Radio type	Geoelectron	Parameter setting	>	Parameter setting		
Connection mode Bluetooth >		Channel detection >		Receiving channel frequency	Custom >	
Search bluetooth device li	st	Equipment information	×.	1: 441.000000	<b>2</b> : 442.000000	
HAVIT I3S	56:11:67:11:48:1A	Equipment information		<b>3</b> : 443.00000	<b>4</b> : 444.000000	
小米手机	94:87:E0:9C:90:8C	Temperature control	>	<b>5</b> : 445.000000	<b>6</b> : 446.000000	
红米手机	94:87:E0:EB:3C:60	Radio control	5	7: 447.000000	<b>8</b> : 448.000000	
SYOHUB-51ed	22:22:EE:20:03:4F			Transmission	Custom >	
MQL	00:15:83:3D:0A:71	Firmware update		channel frequency		
TRU3038050683	BF:18:18:11:53:92			1: 441. Read c	ompletion 442.000000	
红水主和	00-05-41-50-45-54			3: 443.000000	<b>4</b> : 444.000000	
Stop	Connect			Get	Settings	

Figure 6.7-2



Figure 6.7-4

Press [Settings] to enter interface as shown in Figure 6.7-3.

Press [Parameter setting] to enter interface as shown in Figure 6.7-4, and press [Get] to obtain parameters of current connected external radio, which can be user-defined. Press [Settings] and then the parameters are set.

Press [Channel detection] as shown in Figure 6.7-5. Channel test needs external radio antenna. Press [Help] as shown in Figure 6.7-6 and it can view channel test report. As shown in Figure 6.7-7, input acquired frequency 439 and press [Query], and the result saying weak represents the channel is accessible. Press [Check] and it can acquire default frequency low noise signal intensity as shown in Figure 6.7-8.

## 6 Geoelectron

♥	<b>•</b>	∦ ս⊡ս 🎔 📉 💈 14:45	ē	∦ ս⊡⊧ 💎 Հ	<b>14:4</b>
← Channel detection	$\leftarrow$ Channel de	etection	← Chann	el detection	
Note: this function needs to be connected Help o the antenna	Not to t Help	р	Note: this function ne to the antenna	eeds to be connec	ted Help
Custom frequency bottom noise signal intensity	Cue The result of channel	detection :	Custom frequency bo	ottom noise signal	intensity
Query frequency(MHz):	Q signal is stronger: ≥ - signal is weak: -95d	95dBm 3m ~ -105dBm	Query frequency(	MHz):	439 🕄
Strength(dBm):	signal is very weak (i St -105dBm	no signal): ≤	Strength(dBm):	Very weak	(-110.625
Query Default frequency bottom noise signal Check	> strong signal, weak that the channel is in suggested that the ch Def result should not be u	use, it is nannel of this	Default frequency bo	Query ttom noise signal	Check
The intensity of the bottom noise signal of the eceived frequency point	inter the signal very weak The channel to use.	(no signal)	intensity The intensity of the b received frequency p		
he intensity of the bottom noise signal of the	The	ок		/ery weak(-111.62	25 dBm)
ransmission frequency point	tra			/ery weak(-112.87	· · · ·
			2 [442 0 MH-] · · ·	/on/wook/-112 2	75 dBm)
Figure 6.7-5	Figure	6.7-6	Fig	ure 6.7-7	
¥ •□• ❤ 🐴 🗳 14:46	œ				
	Ŧ	≭ ⊕ ♥Ҳ 🛛 14:47	φ.	∦ Ռ ♥Հ	I 14:4
← Channel detection	Equipment in			* •⊡ ▼ <sup>2</sup>	
Channel detection	Equipment in			rature contro	
Channel detection Channel detection Channel detection Check The intensity Check			- Temper	rature contro	)
Channel detection Check	Equipment information	formation	First order temperatu	rature contro	)
Channel detection Check	Equipment information Device serial number	formation TRU3038050683	Temper First order temperature Temperature three	rature contro re control shold	60.000
Channel detection Check	Equipment information Device serial number BOOT version	formation TRU3038050683 v1.13	First order temperature Temperature three Power gain(dB)	rature control shold	60.000 -6 🛇
Channel detection Check	Equipment information Device serial number BOOT version APP firmware version	formation TRU3038050683 v1.13 1.1.0	Temper First order temperature Temperature three Power gain(dB) Two stage temperature	rature control shold	60.000
Channel detection Check	Equipment information Device serial number BOOT version APP firmware version Board	formation TRU3038050683 v1.13 1.1.0 TRU35_MB	Temper      First order temperature      Fower gain(dB)      Two stage temperature      Power gain(dB)      Note: 1, temperature	rature control shold ure control shold	60.000 -6 S 85.000 -6
Channel detection Check	Equipment information Device serial number BOOT version APP firmware version Board Board version Radio module	formation TRU3038050683 v1.13 1.1.0 TRU35_MB V1.1 TRM100	Temperature     First order temperature     Temperature three     Power gain(dB)     Two stage temperature     Temperature three     Power gain(dB)     Note: 1, temperature     degrees Celsius;     2, power gain range	rature control shold ure control shold threshold range [ -60~60]dB;	60.000 -6 3 85.000 -6 -100~1000]
Channel detection Cheault frequency bottom noise signal Check The intensity of the bottom noise signal of the ecceived frequency point 1 [441.0 MHz]: Very weak(-111.625 dBm) 2 [442.0 MHz]: Very weak(-112.875 dBm) 3 [443.0 MHz]: Very weak(-113.275 dBm) 4 [444.0 MHz]: Very weak(-113.25 dBm) 5 [445.0 MHz]: Very weak(-111.5 dBm)	Equipment information Device serial number BOOT version APP firmware version Board Board version	formation TRU3038050683 v1.13 1.1.0 TRU35_MB V1.1	Temper      First order temperature      Fower gain(dB)      Two stage temperature      Power gain(dB)      Note: 1, temperature     degrees Celsius;	rature control shold are control shold threshold range [- 60~60]dB; perature threshole	60.000 -6 3 85.000 -6 -100~1000] d value must





Figure 6.7-10

Press [Equipment information] to enter interface as shown in Figure 6.7-9, and press [Get] and it can view settings information of connected external radio.

Press [Temperature control] to enter interface as shown in Figure 6.7-10, and press [Get] and it can view temperature control of connected external radio. It can modify temperature control information as needed, and press [Settings] to successfully modify temperature control information.

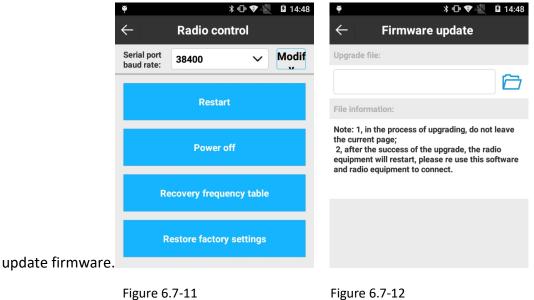
Notes: 1. Temperature threshold range [-100~1000]Celsius degree.

2. Power gain range [-60~60]dB.

3. Temperature threshold for first order must be smaller than that of two stage.

Press [Radio control] to enter interface as shown in Figure 6.7-11, it can change baud of serial port. Select baud and press [Change] and it can successfully change serial port baud of external radio. Press [Reboot] and it can reboot external radio. Press [Off] and it can switch off external radio. Press [Restore frequency table] and it can restore the changed frequency table to its defaulted settings. Press [Reset] and it can eliminate all user-defined information for external radio.

Press [Firmware update] to enter interface as shown in Figure 6.7-12, select \*.bin firmware file and it would display firmware file information. After information confirm, press [Update] to



### 6.8 Station Refresh

Station refresh is usually used when data is collected without Site Calibration and after collection it needs to calibrate data of a certain period. Press [Tools]-> [Station Refresh]to enter into interface as shown in Figure 6.9-1. Press [Marker Point Calibration] to acquire x, y, h values and press [Refresh]. In the interface as shown in Figure 6.9-2, repress [Refresh] and enter into interface as shown in Figure 6.9-3. Select Refresh Date, Start Time and End Time and press [Refresh] to calibrate data of the period as shown in Figure 6.9-2.

C 🏺	* *	▼ ♥ ▲ 2 下午5:52	C 🏺	*	★ 🖣 🐴 🛽 ৗ	午5:58	¢ ¥	∦ ★ 🦣 🐴 💈 下午5:58
$\leftarrow$	Station Refre	esh	$\leftarrow$	Station Ref	resh		$\leftarrow$	Station Refresh
Marker Poi	nt Calibration	>	Base ID	Start Time	Base Latitude	Base	Refresh Date	2016-08-03 🗦
dX			0	2016-08-03 10:32:35.00	N23°07'12.0588"	E113°2	Start Time	10:32:35 🗦
dY		0					End Time	10:33:04 >
dH		0					Note: the allowat 10:33:04(+1).	ole refresh range is: 10:32:35(-1) ~
Cle	ear	Refresh		Refrest	1			Refresh

Figure 6.9-1

Figure 6.9-2

Figure 6.9-3

# **Chapter 7 Total Station**

Connect SurPad to total station and set total station in distance measurement mode, and it can control total station. The following introduces operation in detail.

### 7.1 Communication

Press [Device]-> [Communication], select [Total Station] as Device Type as shown in Figure 7-1. Make: Stonex, KOLIDA (taking Stonex as example); Model: R1+(Stonex), KTS400(KOLIDA); Communication Mode: Bluetooth, Serial port (taking Serial port as example) as shown in Figure 7-2. Please note that Baud Rate should be the same as that of Total Station configuration.

00 ¥	≱ ★ 🖆 ၨ᠘ 上午9:50	0 0 ¥	券 ★ ‴⊿ 월 上午9:50
← Commu	nication	$\leftarrow$	Communication
Device Type	Total Station $ ightarrow$	Device Type	Total Station $>$
Make	Stonex >	Make	Stonex >
Model	R1+ >	Model	R1+ $>$
Communication Mode	Bluetooth $>$	Communicat Mode	on Serial port
Bluetooth Device List		Port	ttyHSL0 $>$
G1011601030001	D4:F5:13:FB:B7:D7		
G1052802010003	C8:FD:19:0E:A7:15	Baud	9600 >
irxon	20:17:05:23:05:52		6
Search	Connect		Connect

Figure 7-1



### 7.2 Height

Press [Survey]-> [Point Survey] to enter interface as shown in Figure 7-3. Press to enter interface as shown in Figure 7-4 and set Instrument height and Prism height. Reflector includes Prism, Reflectorless and Sheet. Title bar will display current reflector in different icons for user to know current settings.

<sup>A</sup> Prism: It needs to input Prism height, Instrument height and Prism Constant. Prism constant is divided into two types. Usually Chinese prism is-30mm and international prism is 0mm.

Reflectorless: It applies to distance measurement where it is not suitable to place a reflection prism or reflector, such as measurement for cliffs, rock walls and other landslides, deformation measurement and tunnel construction.

Sheet: Using sheet in distance measurement, please note that signal will weaken as distance become far. It's better to measure in good weather and light vision. And there may be deviation in height measurement, so it should measure for several times to acquire average value.

00 ¥	՝ ★ ≝⊿ 🖪	上午9:55	00 ¥	;	🕏 ★ 🛀 🗳 上午9:56
$\leftarrow   \stackrel{0.000}{=} 0.000 \qquad ( \uparrow \uparrow$	) ∦	₽¶ ₼	÷	High	
SurPad 4.0 won't run without Goo are not supported by your device		9.83km	Reflector		Prism >
			Prism heigh		
			Instrument height		0
	<b>.</b> a		Prism Constant(mn	n)	0
•					
	A:55°35'41"	$\bigcirc$			e
Slant distance:0.067 H Fill:0.000	lorizontal dist	₽ DE		ок	

Figure 7-3

Figure 7-4

#### 7.3 Measure Mode

SurPad provides 7 measure modes for total station.

Press to enter interface as shown in Figure 7-5. The following introduces measure modes in detail.







• Sideshot (polar coordinate method): In measurement, it needs to set up station at first and then measure distance and angle to calculate another coordinate. Taking point stakeout as example, it needs to find the stakeout point position, press [Sideshot] as shown in Figure 7-6 and press to collect points as shown in Figure 7-7. In Figure 7-6, triangle represents current coordinate and it doesn't coincide with stakeout point. Adjust total station and re-collect point until collecting point coincide with stakeout point, i.e. device is on stakeout point as shown in Figure 7-8.

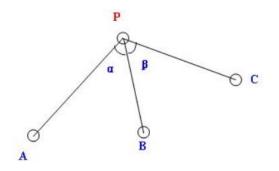
0 0 ¥	≭ ★ 🖅 🖬 上午10:53	00 ¥	≭ *≦⊿ Β	上午10:14
- Survey Point C	ollection	$\leftarrow   \stackrel{1.530}{=} 1.400$		1
Name	Pt2 🔇			A
Code				0.31m
Target heigh	1.4m >			J
etail Information		[ <b>9</b> ]		$\frown$
Northing	1001.9039		B	
Easting	998.7307			3
Elevation	51.5613	٢		2222
HA	20°02'07"			$(\mathbf{Q})$
VA	57°58'24"			$\bigcirc$
ок		HA:359°53'25" Slant distance:0.074 Fill:0.000	VA:55°35'41" Horizontal dis	tance:0.0

Figure 7-7

Figure 7-8

• Resection: With multiple known points, only measure angle or measure angle and distance to calculate the unknown points.

For instance, set station on the unknown point (P), with three known point (A, B, C) and two angles ( $\alpha$ ,  $\beta$ ) to calculate the unknown point (P), as shown in the following figure:



Press [Resection] to enter interface as shown in Figure 7-9, press [Add] to enter interface as shown in Figure 7-10, select point A or B or C and press [OK] to add three points involved in calculation as shown in Figure 7-11. Select point A, adjust total station to measure point A and press [Observe Dis.] to acquire distance PA by total station measurement as shown in Figure 7-12. Repeat the steps to acquire distance PB and PC, and press [Calculate] as shown in Figure 7-13 to calculate point P coordinate.

♥♥ *★ 12 上午10:1	000	i *	★ ⁴ ⊿ 월 上午10:36	O O ¥	≭ ⁺⊈ ն	上午10:37
← Resection	$\leftarrow$	Points Librar	у	$\leftarrow$	Resection	
Solution State NONE	Please in	put name or code	Q	Solution Sta	te	NONE
Point Error	Name	Northing Easting	Elevation Latitu	Point Error		
O Name Status Northing Easting Elevation H	• c	2562981.000 441586.000	0 50.165 N23°09'5!	O Name	Status Northing I	Easting E
	<b>b</b>	2562980.600 441587.500	0 50.000 N23°09'5!	< 🛧 a	No Measure 2562980.642 44	1586.547
	<b>•</b> a	2562980.642 441586.547	7 50.160 N23°09'5!	○ ● b	No Measure 2562980.600 44	1587.500
				○ ◆ c	No Measure 2562981.000 44	1586.000
Observe Observe Calculat			01/	Ob	serve Observe Calculat	0
Add Angle Dis. e Save	Add	Edit Details	ОК	Add	ngle Dis. e	Save

Figure 7-9

Figure 7-10

Figure 7-11

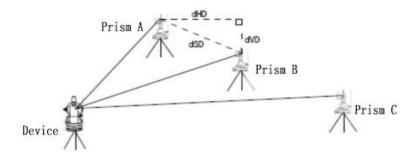
Point Error			0.000 mm	Poir	nt Error			0.149
) Name	Status	Northing	Easting	e 🕑	Name	Status	Northing	Easti
) <b>★</b> a	Measured	2562980.642	441586.547	<b></b>	🖈 a	Measured	2562980.642	441586
) <b>b</b>	Measured	2562980.600	441587.500	0	b	Measured	2562980.600	441587
) <b>(</b>	Measured	2562981.000	441586.000	<b></b>	¢ c	Measured	2562981.000	441586

Figure 7-12

Figure 7-13

#### • Opposite side

The principle of opposite side measurement is as shown in the following figure. It includes horizontal distance, vertical distance, slope distance and slope between measured station and target point, and between target points. Any target point can be set as new station.

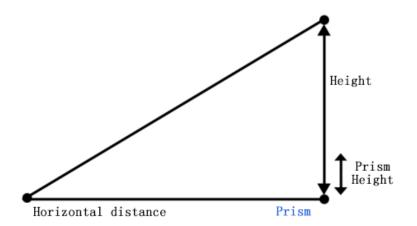


Press [Opposite side] to enter interface as shown in Figure 7-14, press [Observe] to acquire position of target point A, adjust telescope to target point B, press [Opposite] to acquire calculation result as shown in Figure 7-16. Press [New station] and it can set last measured point B as new starting point, so when target point is point C, it calculates distance BC. If it doesn't press [New station], when target point is point C, it calculates distance AC.

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$\leftarrow$ (	Opposite side		$\leftarrow$	Opposite side		$\leftarrow$	Opposite side	
Result			Result			Slope		0.000%
Slant distance			Slant distance	e	0.000	Measure		
Heigh Error			Heigh Error		0.000	НА		30°24'01"
Horizontal distar	nce		Horizontal dis	stance	0.000	VA		59°36'43"
Slope			Slope		0.000%	SD		2.819
Measure			Measure			HD		2.432
HA			HA		9°40'44"	н		1.530
VA			VA		58°31'44"	нт		1.400
Opposite	New station	Observe	Opposite	New station	Observe	Opposite	New station	Observe
	Figure 7-14			Figure 7-15			Figure 7-16	

#### • Remote height

The principle of remote height is as shown in the following figure. Taking power line measurement as example, method is: at first place the prism directly below power line, measure the prism position, raise telescope to the target and the device screen will automatically display height from ground to target point.

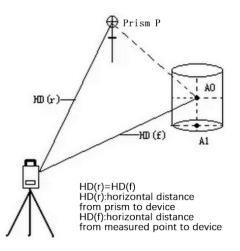


Press [Remote height] to enter interface as shown in Figure 7-17, press [Observe] as shown in Figure 7-18 to measure prism position, press [High] and set prism height, raise telescope to target point, press [Remote height] to acquire calculation result.

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<b>←</b> в	Remote height		←	Remote heigh	t	<b>←</b> ғ	Remote height	
Result			Remote heigh	nt	0.000	Remote height		2.270
Remote height		0.0	Measure			Measure		
Measure			НА		9°28'45"	НА		6°58'50"
HA		0.0	VA		58°23'27"	VA		45°20'28"
VA		0.0	SD		2.742	SD		2.081
SD		0.0	HD		2.742	HD		2.081
HD		0.0	н		1.530	н		1.530
н		0.0	нт		1.400	нт		1.400
Remote height	High	Observe	Remote heigh	nt High	Observe	Remote height	High	Observe
	Figure 7-17			Figure 7-18	3		Figure 7-19	

#### • Horizontal Angle Offset

The principle of Horizontal Angle Offset is as shown in the following figure. When it's hard to directly place prism, such as in the center of tree, Horizontal Angle Offset is very useful. It only needs to place prism on point P with same distance to device as that of target point, set device height/target height and perform Horizontal Angle Offset and it can acquire coordinate AO in the center of measured object.



Press [Horizontal Angle Offset] to enter interface as shown in Figure 7-20, press [Observe Dis.] as shown in Figure 7-21 to acquire prism position, adjust telescope to target point, press [Observe Angle] to acquire calculation result as shown in Figure 7-22. It also can firstly observe angle and then distance. Press [Save] and it can save the point coordinate.

0.178 0.178 1001.238 999.175
1001.238
999.175
Infinity

Figure 7-20

Figure 7-21

Figure 7-22

Distance Offsets

The principle of Distance Offsets: to calculate single distance eccentric point, firstly input offsets of front, back, left and right, measure the target point and software automatically calculate eccentric point.

Press [Distance Offsets] and total station will collect a point at first. As shown in Figure 7-23, input the backward, left, and right offset distance from the device perspective, press [Observe Again], measure target point as shown in Figure 7-24 and software will automatically calculate eccentric point. Press [Save] and it can save the point coordinate as shown in Figure 7-25.

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← Dis	stance Offsets	$\leftarrow$	Distance Offsets		$\leftarrow$ Survey Point	Collection
Offsets viewed fi	Offsets viewed from the instrument		Offsets viewed from the instrument		Name	Pt1 🔇
Back Offse	t	Back O	ffset	1	Code	
Left Offset	:	Left Offset 0.5		0.5	Target heigh	1.4m >
Up Offset	Up Offset		Up Offset 🛛 🛛 😣		Detail Information	
Measure		Measure			Northing	1002.4457
НА		НА		6°50'34"	Easting	999.3224
116		116		0 0004	Elevation	51.5933
VA		VA 45°28'55"		НА	6°50'34"	
SD		SD		2.087	VA	45°28'55"
Save	Observe Again Cancel	Save	Observe Again	Cancel	ок	(

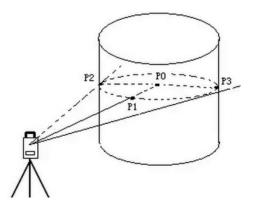
Figure 7-23

Figure 7-24

Figure 7-25

• Circle Offset

The principle of Circle Offset is as shown in the following figure. Place prism on point P1, P2, P3 and collect their coordinates and it can calculate coordinate P0.



Press [Circle Offset] to enter interface as shown in Figure 7-26, press [A Direction], measure target point P2 as shown in Figure 7-27, press [B Direction], measure target point P3 as shown in Figure 7-28, press [Center HDis.], measure point P1 as shown in Figure 7-29, and software will automatically calculate coordinate P0. Press [Save] and it can save the point coordinate as shown in Figure 7-30.

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$\leftarrow$ Circ	le Offset		Offset	$\leftarrow$ Circle O	ffset
Result		Result		Result	
Radius		Radius	0.0	Radius	0.000
Center North		Center North	0.0	Center North	1000.000
Center East		Center East	0.0	Center East	1000.000
Center Hight		Center Hight	0.0	Center Hight	50.000
A Direction		A Direction	0°00'00"	A Direction	0°00'00"
B Direction		B Direction		B Direction	0°00'00"
Center HDis.		Center HDis.	0.000	Center HDis.	0.000
Save	Cancel	Save	Cancel	Save	Cancel

Figure 7-26

Figure 7-27

Figure 7-28

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← Circle 0	ffset	$\leftarrow \qquad \text{Survey Point Collection}$			
tesult		Name	Pt2 🔇		
Radius	0.000	Code	(L		
Center North	1001.904	Target heigh	1.4m		
Center East	998.731	Detail Information			
Center Hight	51.561	Northing	1001.903		
A Direction	0°00'00"	Easting	998.7307		
A Direction	0 00 00	Elevation	51.5613		
B Direction	0°00'00"	НА	20°02'07		
Center HDis.	2.288	VA	57°58'24		
Save	Cancel	0	к		





### 7.4 Orientation setup

Press [Orientation setup <sup>(1)</sup>] to enter interface as shown in Figure 7-31 and set survey station point and backsight point to perform orientation. There are two ways to set backsight point: Coordinate Type and Azimuth Type. Coordinate Type needs to input Northing, Easting and Elevation of point. Azimuth Type needs to input azimuth. Taking Azimuth Type as example, as shown in Figure 7-31, input Occupy point coordinate and backsight point coordinate, press [Calculate] to check calculation result as shown in Figure 7-32, press [Observe] and total station will automatically measure distance, and result displays as shown in Figure 7-33. Press [Accept] and it applies the orientation result. Press [Observe Again] and it readjusts the total station to measure distance and acquires orientation result. This observation procedure can be repeated until satisfactory orientation result is obtained.

# 6 Geoelectron

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← Orient	ation setup	← c	Prientation setup	$\leftarrow$	Orientation Result
Occupy Pt		Set backsight	Coordinate Type $ ightarrow$	Backsight Obse	ervations
Northing	1000	Backsight Pt		НА	20°02'08"
Easting	1000 😒	Northing	1002.446	VA	57°58'24"
Elevation	50	Easting	999.322	SD	2.700
Set backsight	Coordinate Type $>$	Elevation	51.593	HD	2.700
Backsight Pt		Result		н	0.000
Northing	1003	HAR	344.3026298485	нт	0.000
Northing	uning 1005		2.538		0.000
Easting	998	Please aim backs	ight	Backsight Error	'S
Res	et Station	Cance	Observe	Acce	ept Observe Again

Figure 7-31

Figure 7-32

Figure 7-33