Stonex Cube-a
Field Software
User Manual

5.x

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www.stonex.it

Contents

Software Introduction

Cube-a is a GNSS surveying and mapping software which is developed by the Stonex srl 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 **Cube-a** software.

The main interface window is divided into the main menu bar and sub-menu bar.

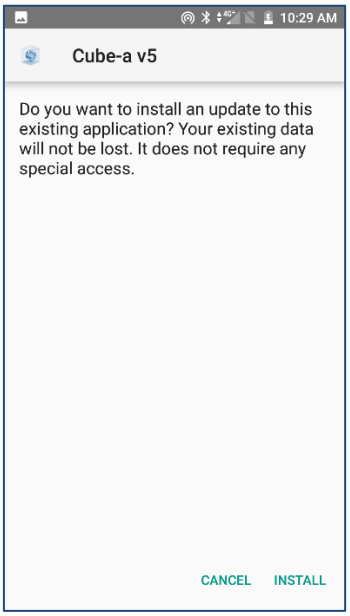
The main menu bar contains all the menu commands, content is divided into six parts: *Project*, *Device*, *Survey*, *Configure*, *Calibrate* and *Tools*. In this manual, we will introduce the functions of those menus in detail.

1. Cube-a installation and uninstallation

This chapter describes the installation and uninstallation instructions for **Cube-a** Software.

1.1. Cube-a Installation

1. Please download the Android **Cube-a** installation package (*.apk) and copy the installation package to your Android device.
2. Please find the **Cube-a** installation package (*.apk) in the "Files" of the Android device. Click the **Cube-a** installation package, there will pop-up the installation page. Then click "Install" to install the **Cube-a** software, after the installation successful, there will be the prompt page as shown in Figure.



1.2. Cube-a First Run

The software must be registered and unlocked at its first run. To unlock it you need to know which is your personal and unique *Purchase Code ID*.

The Purchase Code ID is in a form like A0X000000000000 and you should have got it by e-mail or printed. The software cannot be unlocked without entering the correct Purchase Code.

This operation must be done while your device (tablet or phone) has an active Internet connection.

To register the software:

- Launch the application as usual.
- Carefully read the shown End User License Agreement (EULA).
- Press the *Accept* button if you agree to be bound by the license agreement. Otherwise press the *Decline* button to terminate the application.
- Fill out the Software Activation form.
- Press *OK* to activate the software.

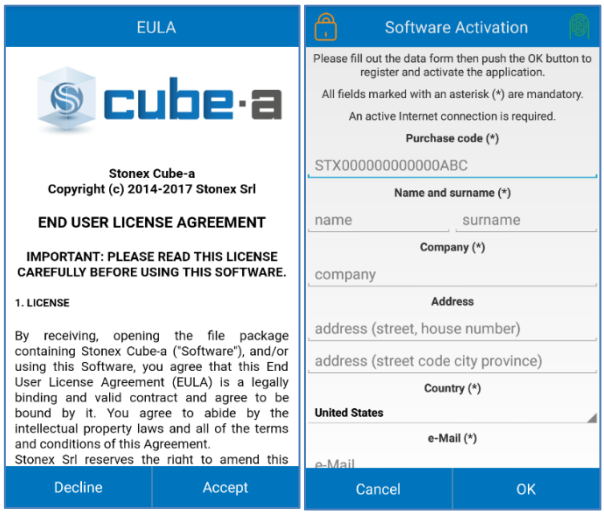
The above steps must be followed at each time the application is started and until the software has been successfully activated.

The Purchase Code, that must be entered in the first field of the form, is the proof of purchase required to identify and validate your software license.

To validate your software license and the authenticity of the Purchase Code itself the program will connect to our servers: at that time the Purchase Code is verified and, if all goes well, the program will get back the authorization to activate the software.

Notice that you cannot reuse the Purchase Code to unlock a copy of the program that has been installed onto another device. For that you will need to buy an additional license (thus, you will get another different Purchase Code).

In case of any problems during the activation of the program please contact your local dealer or the Stonex Support.



1.3. Cube-a Uninstallation

There are many ways to uninstall the software on the Android device. Here we mainly introduce two methods:

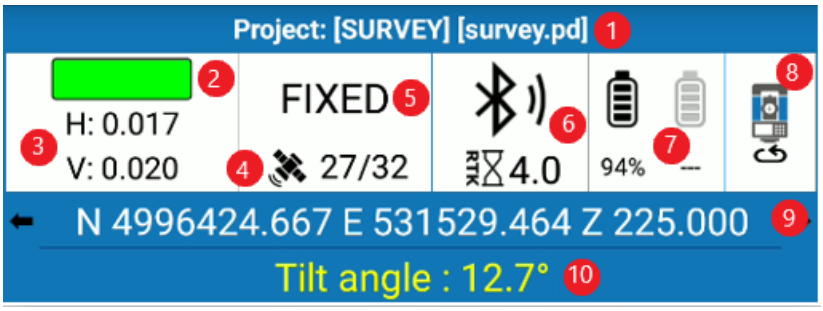
- Press the Cube-a icon on the desktop and drag it to the "uninstall" option box, there will pop-up a dialog box "Uninstall Cube-a?". Then click "uninstall" to uninstall the Cube-a software.
- Click the "Settings"— "Apps" to find the "**Cube-a**" in the submenu. Click the "**Cube-a**", there will enter the **Cube-a** information page. Then click the "uninstall" to enter the **Cube-a** uninstallation page. Click the "uninstall" to uninstall the **Cube-a** software.

2. Interface

2.1 Status Bar

The status bar is visible in any submenu of the software. It changes if you are working in GPS or Total Station mode.

If you are working on GNSS mode, the status bar looks like the screen:

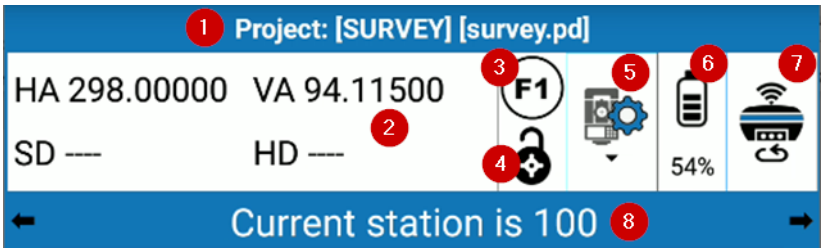


The bar in GNSS mode contains:

1) Name of the current project and the. pd file in use
2) Status bar respecting of the tolerances set in configuration
    - Green → tolerances respected
    - Red → tolerances not respected
3) SD horizontal and vertical of the current solution of the receiver

4) Satellites used and see by the receiver
5) Solution's state
6) Datalink mode and age of the corrections received
7) Battery power level
8) Switch to Total Station mode
9) Current position
10) Tilt angle (option available only with models with Tilt option)

If you are working on Total Station mode, the status bar looks in the following way:



It contains:

1) Project name
2) Total station measures:
   - *HA*: horizontal angle
   - *VA*: vertical angle, tapping on the box, vertical angles can be seen in percentage
   - *SD*: slope distance
   - *HD*: horizontal distance
3) F1 Face of total station currently used: *F1* is face left, *F2* is face right
4) Prism lock status:
   - the prism is not locked
   - the prism search is working
   - the prism is locked
5) Enter the *Total station control panel*
6) Battery status
7) Switch to GPS mode.
8) Current station name. Tapping on the bar, coordinates of the current station are shown.

2.2 Menu Bar

The Cube-a interface is composed also by the Menu Bar.

The Menu bar is placed in the lower part of the screen and allow the user to select the 6 submenus of the software.

Here below are mainly explained the features of the icons.

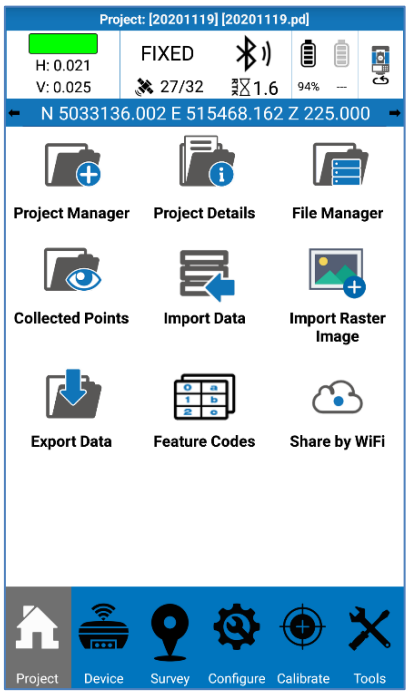
It contains:

1. Project → The project menu where the user can manage his project, import/export files and share files
2. Device → The device menu is dedicated to managing and set the device used. Users can manage and set their GNSS receivers and Total Stations
3. Survey → The survey menu is the area where the user can make measures and make his job
4. Configure → The configure menu is dedicate of the settings of software
5. Calibrate → The calibration menu is specific for some field operations like the site calibration or the calibration of device's sensors
6. Tools → Inside Tools the user can find the COGO calculations and other useful tools

Inside the next chapters all the main menus will be detailed explained.

3. Project

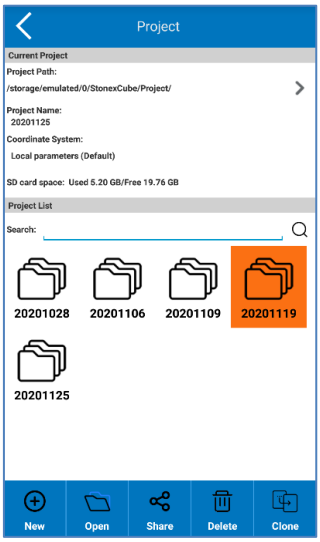
In the main interface of the software, click the "Project": the submenu shown in figure will appear. The project submenu contains seven items, which are *Project Manager*, *Project Details, File Manager, Collected Points, Import Data, Import Raster Image, Export Data, Feature Codes, Share by WIFI.*



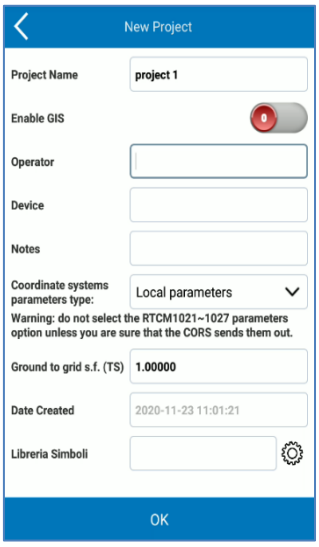
Cube-a stores all the data in the form of a set of files called *a project*. **Cube-a** remembers which the last used project and it was automatically reopens that project at the next run. Under normal circumstances, each time you begin to measure an area, you should create project file matched with the pre-construction engineering, and the file name should be "*.GSW". After the project has been created, the software will create a file in the device storage disk and the file name is same of the project, all data will be saved in this file.

3.1 Project Manager

Click "Project Manage" in the *Project* submenu: you will get to the "Current Project" page.



Click "New" in the left corner to create a new project.



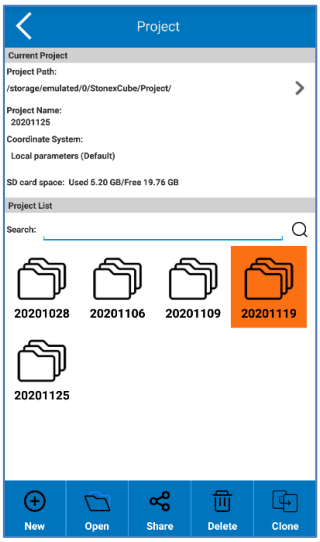
The page that create a project shown in the figure please click “ok” after entering the project name (required), operator name, instrument, and notes.

The *Enable GIS* function, disabled by default, is available from the Cube-a v5 with the GIS module. See the chapter *3.1.1 GIS Module* for further insight.

Then there will pop-up a prompt “Apply current coordinate system transformation parameters?”. If you select "OK", then the coordinate system parameters of new project are same with the current project settings. If you select "Cancel", you can select the coordinate system parameters manually according to the engineering survey, or you can apply the local parameters. Click "OK", the new project will default to the current work of the project and return to the software main interface.

If you want to change the project file, please press, and hold the project in the project list. Then if you click “Open”, this project will be open, and it will be also the default work open at program startup.

If you click “Delete”, this project will be deleted.

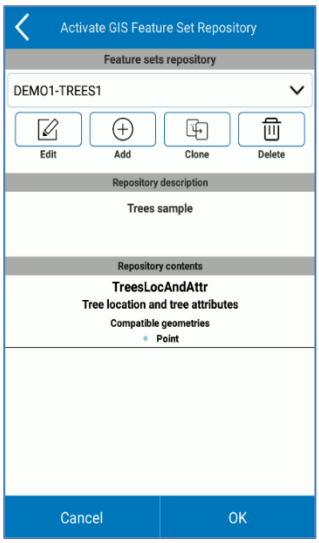


If you press Share you can share the project to other devices through services like Google Drive, WhatsApp etc.

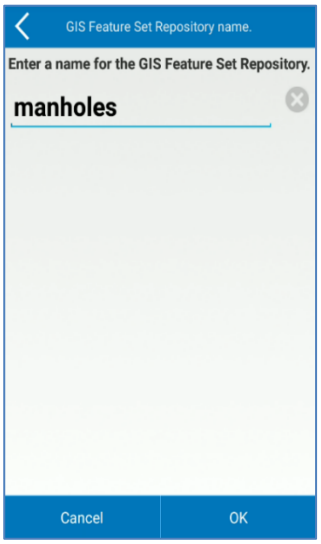
If you press "Clone" you will create a new project equal, then the project cloned.

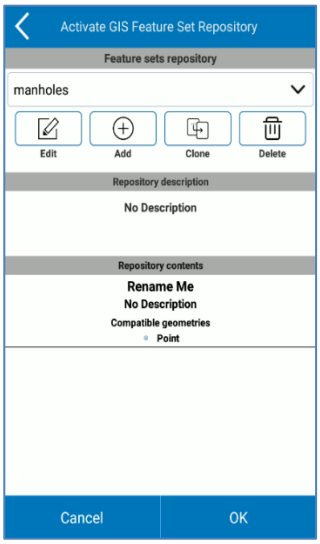
3.1.1 GIS Module

If you have the GIS Module, you can enable the GIS option when you create a project. If you enable the GIS option, then *Activate GIS Feature Set Repository* window appears. Here you can select a feature set repository from the drop-down menu to use it in the current project (select it and click on OK), or to edit it (select it and click on Edit), or to clone it (in this case you can edit the clone without modify the existing one), or to delete it.



If you want to import a feature set repository you should copy the repository in the XML format in the following folder: *Internal shared storage -> StonexCube -> GISFeatureSets*. Then you will see the repository in the drop-down menu. In the same folder you can find some sample file. You can create in Cube-a a new feature set repository clicking on Add, then you should type the name you want. The new repository appears in the drop-down menu, then you should select it and click on *Edit* to create the repository contents, the GIS feature classes.





In the *Repository description* box, you can add a description for the previous selected GIS feature set repository if you want.

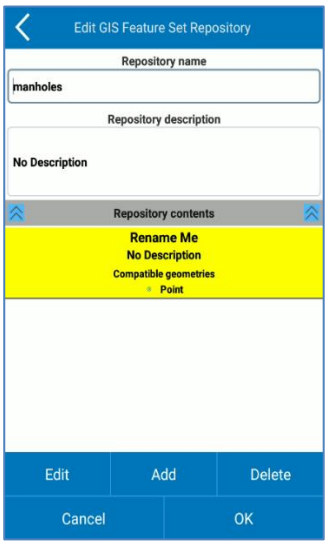
When you create a new repository, a class appears by default, his name is "Rename Me", so select this one and click on *Edit* to change the name and create the feature list for this class.

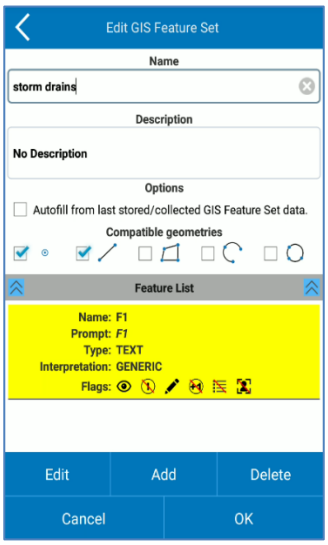
Click on *Add* to add a new GIS feature class. Click on *Delete* to delete the selected class. Click on *Cancel* to cancel the changes. Click on OK to confirm the changes and back to *Activate GIS Feature Set Repository* window.

If you select a class from the *Repository contents* box and click on *Edit*, *Edit GIS Feature Set* window appears. Here you can change the class name and description, select the compatible geometries, and create or change the feature list.

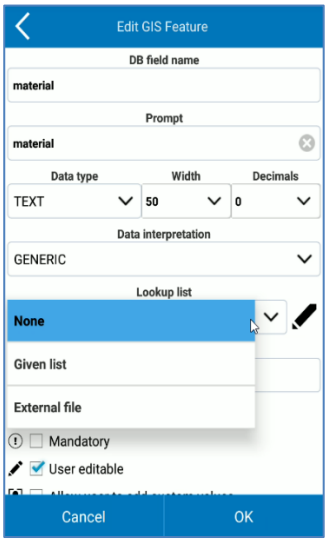
When you create a new class, a feature appears by default, his name is "F1", so select this one and click on *Edit* to change the name and customize the feature.

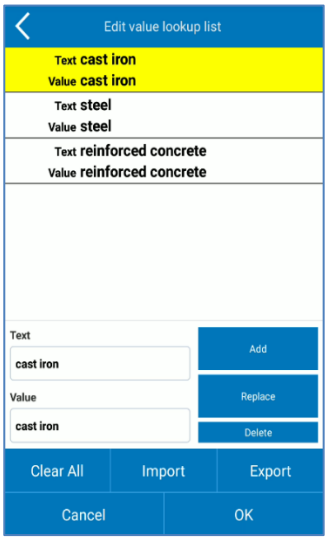
Click on *Add* to add a new feature in the current class. Click on *Delete* to delete a feature in the current class.





If you select a feature from the *Feature List* and click on *Edit*, *Edit GIS Feature* window appears. Here you can change the feature name and prompt, the data type, insert a lookup list and other options. You can create a lookup list in Cube-a: select *Given List* in the drop-down menu then click on the pencil, *edit value lookup list* window appears.



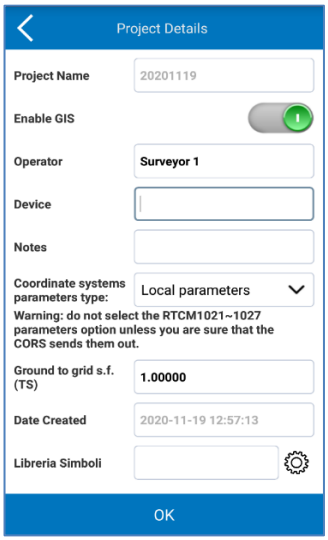


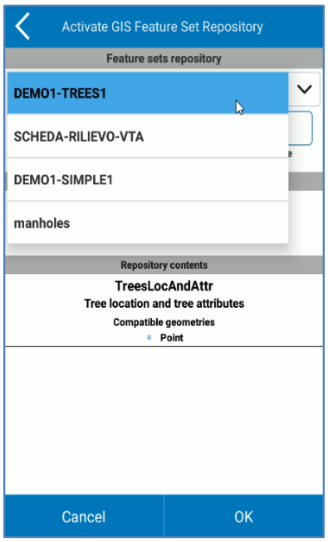
3.2 Project Details

Inside the Project Details menu, the user can check the details relative the project.

Inside this menu the user can enable the GIS option if it has not been activated during the creation of the project. If the option is enabled, after clicking on OK, the user can select or change the GIS feature set repository.

There is also the possibility to add information like Operator, Device used during the survey.





3.3 File Manager

If the data of a project is too large, or if you want to divide the data into two different “survey points libraries”, please click “data manager”, as showed in the figure. Click “New” on the upper right corner to create another file into which store the data: this new file will become the default file where to store new survey data.

The new data file is part of the current project.

If a project has multiple data files, select the data file in the data list, click "Open" to switch between different data files, and click "Delete" to delete the data file.

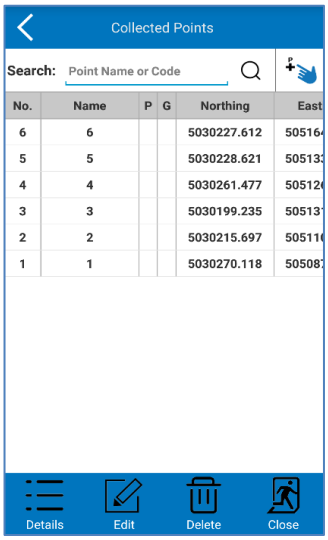
3.4 Collected Points

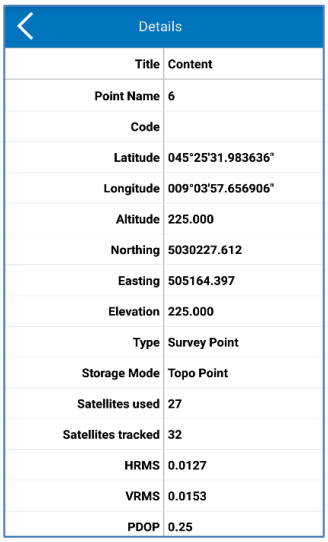
In the collected Points menu, there are all the points stored by the user during the survey.

There is the possibility to search code per name or code and also directly from the map using the blue hand control in the upper right corner.

After the selection of a point, the user can see the details of that specific point, edit some information.

Selecting delete, the point will be deleted.





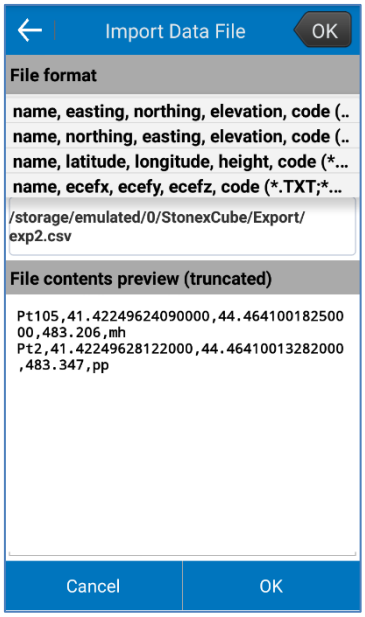
3.5 Import Data

Click “Project” -> “File Import” to start the import command.

This command allows you to import points in coordinates (either grid coordinates or geographic/geocentric coordinates).

Choose the proper format from the File Format list then click the “Open Data File” button to choose the source file.

The path of the chosen file will be shown right below the open button and, more below, a preview of the contents of the file will be shown.



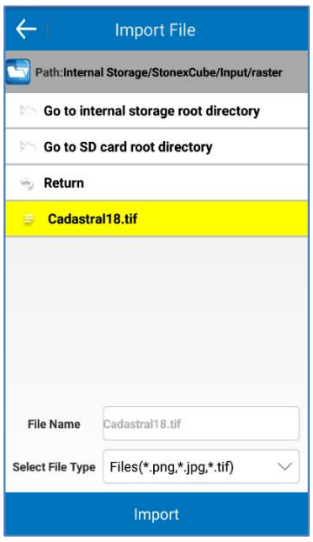
This preview allows you, if needed, to verify that the file contains compatible data.

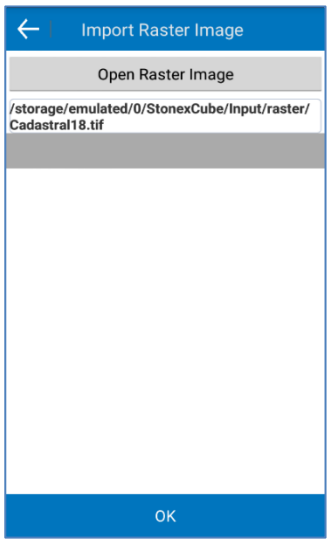
Click the “OK” button to proceed with the import or click the “Cancel” button to cancel.

The imported points will be of class “Input Point” so they will not show in the list of surveyed points (that is in the list shown by the “Collected Points” command). To see the points, you must open the “Points Library”: click “Tools” in the bottom part of the screen then select “Points Library”.

The imported points will be shown and possibly used when you start the stake out command.

3.6 Import Raster Image





Click “Project” -> “Import Raster Image” to import a georeferenced raster image. A page like the one shown in Image 2.7-1 with appear. Click the “Open Raster Image” button to choose a raster file to load (see Image 2.7-2).

The program supports raster images that have been stored into files of the following formats:

- PNG (Portable Network Graphics) – compressed, lossless
- JPG (Joint Photographic Experts Group) – compressed, not lossless
- TIF (Tagged Image File Format) – usually compressed, usually lossless

Having a raster image is not sufficient: your raster image must come with a “twin” file that stores the georeferencing parameters. This file is called “*World File*” and it must be created on a PC using a software that handles the image georeferentiation. In short, the following table shows which kind of World File you must store in the same folder that contains the raster image to import:

Raster Format	World File Format
*.PNG	*.PGW
*.JPG	*.JGW
*.TIF	*.TFW

Limits

Cube-a runs on Android and it must adhere to its limitations about memory allocation. One of such limitations is that any application should not allocate big blocks of memory and if an application does so then it must release that blocks of memory as soon as possible.

Taken from Android developer docs: “To allow multiple running processes, Android sets a hard limit on the heap size allotted for each app. The exact heap size limit varies between devices based on how much RAM the device has available overall. If your app has reached the heap capacity and tries to allocate more memory, the system throws an out of memory error”.

All that means that you must be careful when trying to load raster images. Even if a raster image file seems to be of small dimensions (some megabytes) the same is not true for the image data it contains. Remember that usually raster image files are compressed, and that Cube-a has to decompress them before displaying them and this operation could need more memory than the Android OS is able to give.

As a rule: an image of W x H pixels in size (width x height) needs an amount of free memory equal to: W x H * 3 bytes.

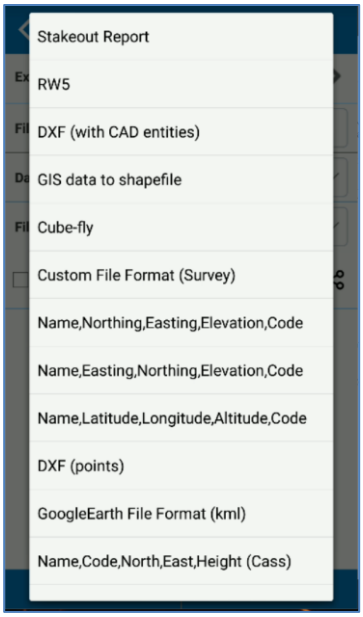
Example: a photo of 5 mega pixels (2560 x 1920) occupies, after decompression, 14745600 bytes or 14 megabytes.

3.7 Export Data

Click “Project” → “File Export”. Data file export is used to export the measurement data file into the format which the user makes maps.

You can export data to the specified format or a custom format. First fill in the (new) file name, select the export path, the source data file (*.PD) and the file format.

File formats include: **Stakeout Report**, RW5 (raw data), DXF with CAD entities, GIS data to shapefile, Cube Fly, Custom File customizable, .txt file, DXF only points, Google Earth™® file format (KML), GPX, Raw measurement data format (CSV), Pregeo DAT (Italy only), and so on. Click "Export" to export the file to the specified path.



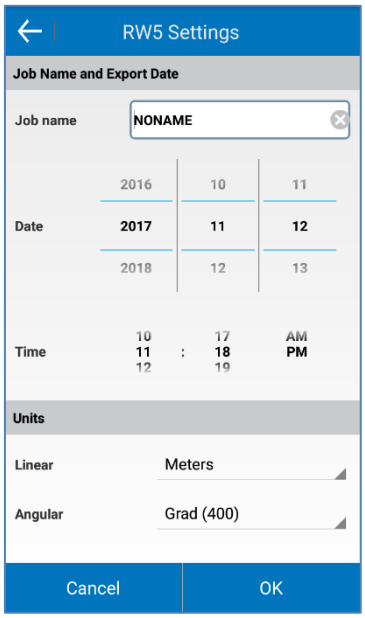
Custom file format settings

If you select "Custom File Format" and then click "New", you can create a new export template as shown in Figure. Set the field delimiter, extension name, angle format, whether to write the file header, and select the custom export format content. Select the content you want to export, click "Add" to add to the custom format description; click

"Delete" to delete the contents of the custom format description one by one. Click "OK" to complete the custom export formatting shown as Figure.

You can also edit and delete the templates. To filter the points, click "Options" to select the class of points to export: tick the type of points that you want to export. The point classes include auxiliary point, survey point, control point, input point, calculated point, stake out point and screen point.

RW5 format settings: When you export in RW5 format, you will be asked to specify/enter some additional settings as shown in figure.

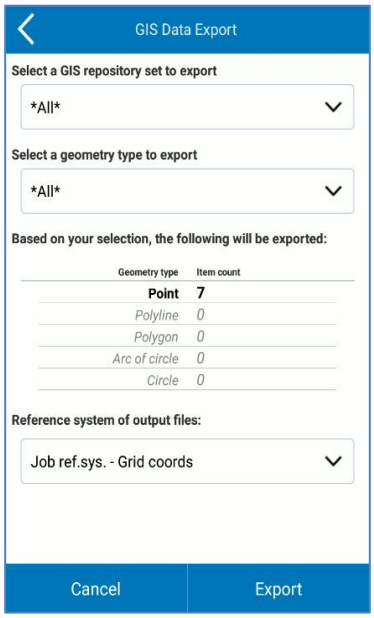


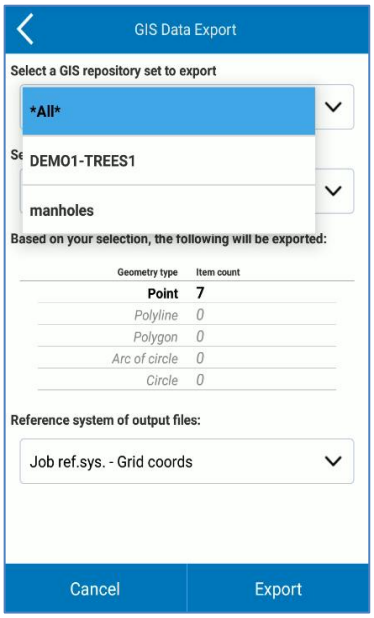
You must enter the *Job Name*, the *Date* and the *Time* of the job. If you need to work in feet, then you can change the unit of the exported coordinates/heights/distances from Meter to Feet (Imperial) or US Feet (Survey).

It is also possible to change the format of exported angles (but not for the geographic coordinates) between Degrees (360) and Grads/Gon (400).

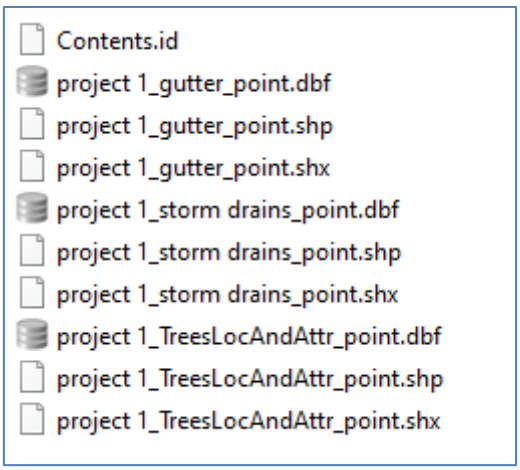
GIS data to Shapefile

Select *GIS data to Shapefile* to export a shapefile and a dbf file with all collected GIS data.



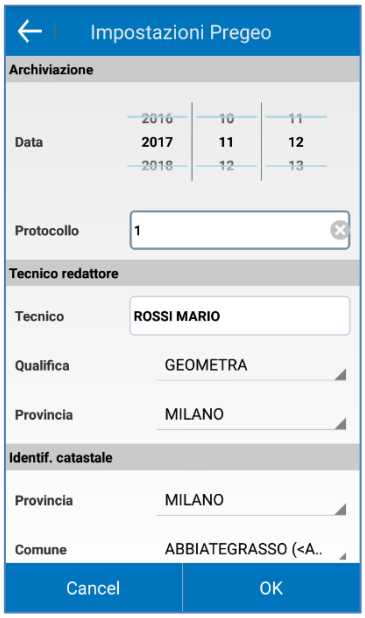


The software will create a dbf, shp and shx file for each feature class and geometry type selected, as in the following picture.



Pregeo DAT format settings (Italy)

When you export in Pregeo (DAT) file format, which the official cadastral file format of Italy, you will be asked to specify/enter some additional settings as shown in figure.



Enter:

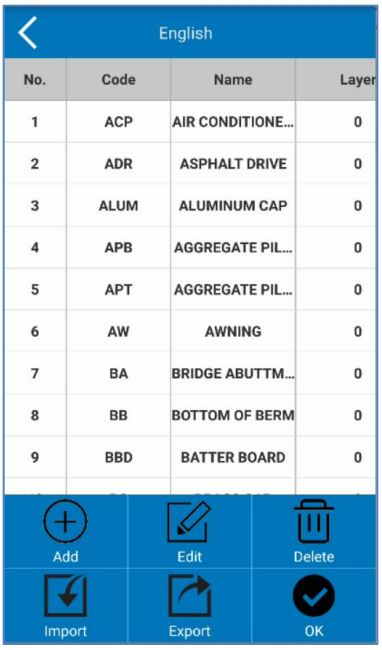
- Survey date
- Protocol number
- Name of the surveyor
- Qualification of the surveyor
- Province (of living) of the surveyor
- Cadastral identifier (province, city, sheet and map numbers)
- Average elevation and easting
- Instrumental precisions (linear and angular)
- Type of update (of the map)
- Notes

The last option at the bottom of the page allows to "merge" the baselines referring to possibly multiple GNSS bases of reference so that they will all refer to a single (selectable) GNSS base of reference.

This option is useful to overcome some limitations of the Pregeo program in handling surveys with multiple bases of reference.

3.8 Feature Codes

The Feature Code Library is the menu to manage the libraries of the codes of the points. Inside the menu is possibly create more than one group. To open and edit a group select and press Edit. To create a new group of code, select New.



3.9 Share by WIFI

The project can be share also via wifi. Select Share via WIFI to open the menu of this feature.

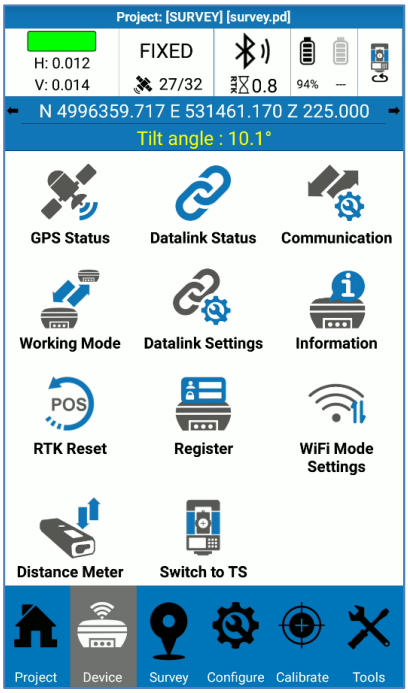
Inside the menu the user must set the user and password of the FTP server service, then set the port. When the settings are done you can start the share of the file selecting Start Service.

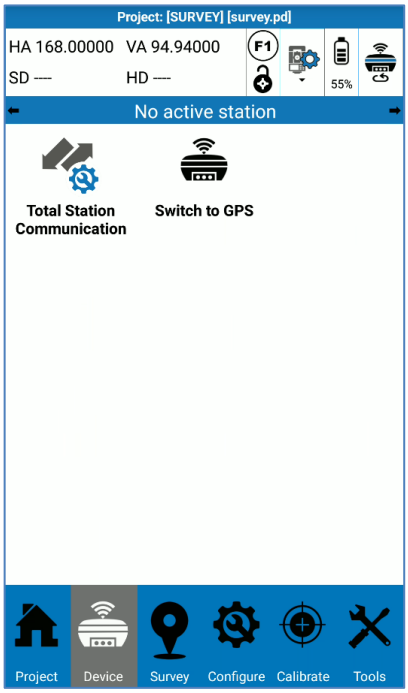
4. Device

Click "Device" in the main interface of the software, you will see the page shown in figures below. The Device submenu changes if you are in GPS or Total Station modes: from both, you can switch to the other.

The GPS mode contains the *GPS Status*, *Datalink Status*, *Communication*, *Working Mode*, *Datalink Settings*, *Information*, *RTK Reset*, *Register*, *WiFi Mode Settings and Distance Meter* commands.

The Total station mode contains the *Total Station Communication* command.





The following sections will describe each of the commands in the submenu.

4.1. GPS

4.1.1 GPS State

Click “Device” -> “GPS status”, you can view the relevant information about GPS positioning. Click "detail", you can see the page as shown in Figure. The information includes the latitude and longitude coordinates of current GPS, plane coordinates, speed, heading, solution, differential mode, differential delay, satellite, PDOP, HDOP, HRMS, VRMS, UTC time, local time, and the distance to base.

Solution state: including single solution, difference solution, float solution, fixed solution.

Single solution: it means that the receiver did not receive differential signal from the base, the accuracy is lowest.

Difference solution: it means that the receiver can receive differential signal from the base, but the data accuracy is low for various reasons, such as: mobile station location is too poor, too few satellites, and so on.

Float solution: it means that the receiver can receive differential signal from the base, it is the initial solution obtained by the carrier phase difference data solving, the accuracy is high, generally within 0.5 meters.

Fixed solution: It means that the receiver can receive differential signal from the base, it is the final solution obtained by the carrier phase difference data solving, with the highest accuracy, usually within 2 cm. With high-precision GPS measurement, it needs to achieve a fixed solution state to record data.

Differential mode: including CMR, RTCM and so on.

CMR: A type of differential message formats defined by Trimble.

RTCM: General differential transfer message format, including RTCM2.X, RTCM32 and so on.

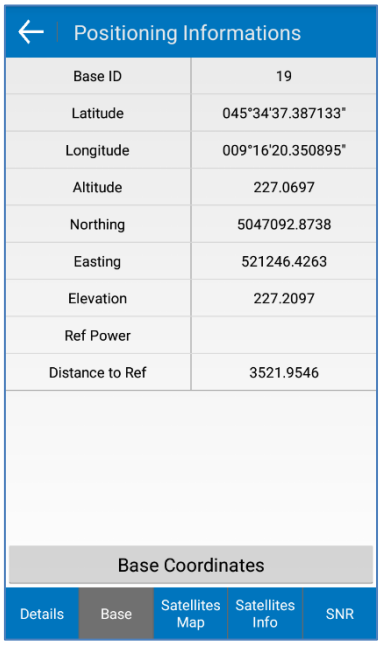
Differential delay: it indicates the time at which a rover receives differentials (for example, a differential delay of 10 seconds indicates that the rover receives a differential signal from the base station sending before 10 seconds), the unit is seconds. When the RTK is working, the differential delay is smaller, the result is better, generally require less than 10 seconds, preferably 1 second or 2 seconds.

PDOP: Position dilution of precision. When it is less than 3, it is in the ideal state. The smaller the PDOP value is, the better the satellites distribute, it is helpful to reach the fixed solution state.

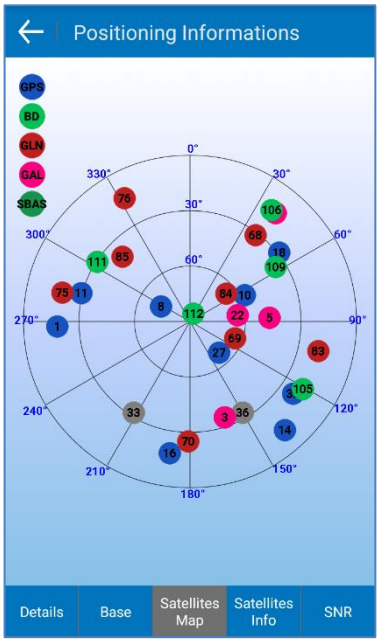
HDOP: Horizontal dilution of precision, which represents the component of PDOP in the horizontal direction.

VDOP: Vertical dilution of precision, which represents the component of VDOP in the vertical direction.

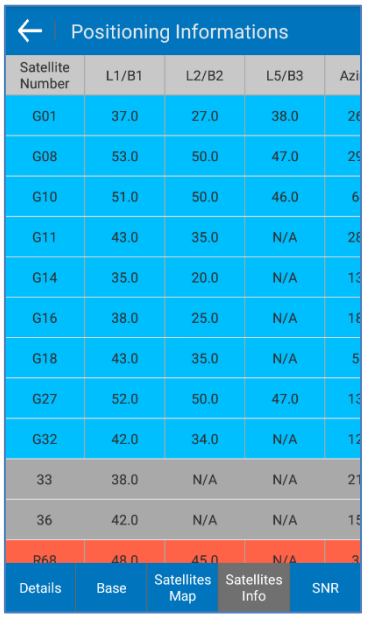
Base positioning information contains base ID, latitude and longitude, altitude, north coordinate, east coordinate, height, distance to the base, shown as Figure.



Satellite map indicates that the position of the satellites which receiver tracks, and it contains the azimuth angle and the height angle. The value on the circle represents the azimuth angle, and the value on the radius of the circle represents the height angle, shown as Figure below (Blue for GPS, red for GLONASS, light green for BEIDOU, red for Glonass, magenta for Galileo, dark green for SBAS)

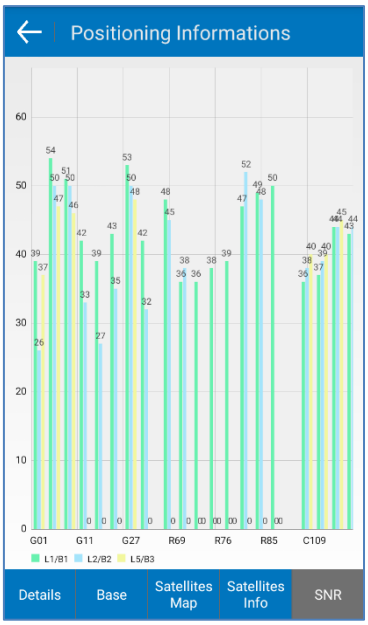


The satellite table contains the signal-to-noise ratio, the azimuth angle and the height angle of the six carrier signals of L1, L2, L5 in the GPS signal and B1, B2, B3 in Beidou signal, shown as in next Figure.



Satellite Number	L1/B1	L2/B2	L5/B3	Azi
G01	37.0	27.0	38.0	26
G08	53.0	50.0	47.0	29
G10	51.0	50.0	46.0	6
G11	43.0	35.0	N/A	28
G14	35.0	20.0	N/A	13
G16	38.0	25.0	N/A	18
G18	43.0	35.0	N/A	5
G27	52.0	50.0	47.0	13
G32	42.0	34.0	N/A	12
33	38.0	N/A	N/A	21
36	42.0	N/A	N/A	15
R68	48.0	45.0	N/A	3

Ephemeris is a histogram represents the signal to noise ratio of L1, L2, L5 three carrier signals, shown as next Figure.

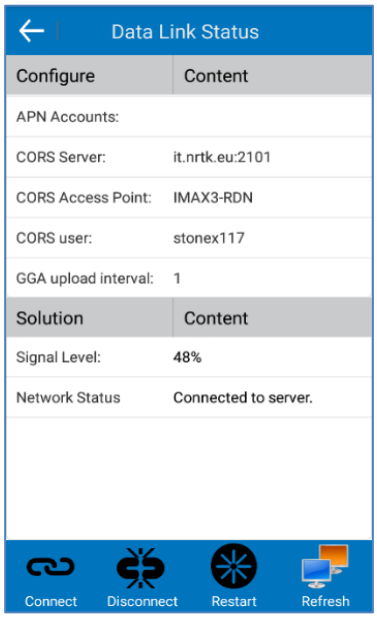


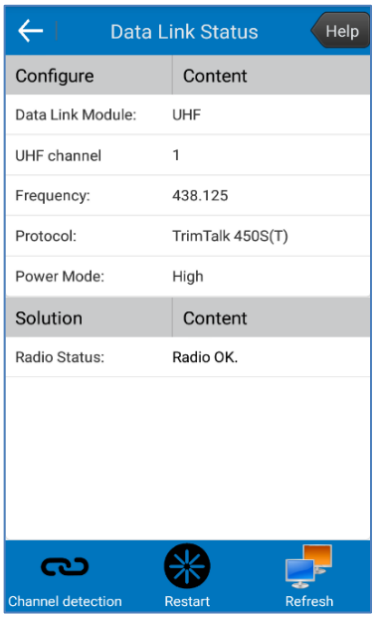
4.1.2 Data Link Status

Click "Device"-> "Data Link Status", you can view the configuration and status of data link about the current receiver. When the data link is network, the data link status is shown in next Figure.

There are four buttons (connect, disconnect, restart and refresh) in the bottom of the screen. Connect: click it to connect the data link. Disconnect: click it to disconnect the data link; Restart: click to re-initialize the network module; Refresh: click it to show the current data link status.

When the data link is internal radio, the data link status is shown in Figures. You can use the "restart" and "Refresh" buttons.





4.1.3 Communication

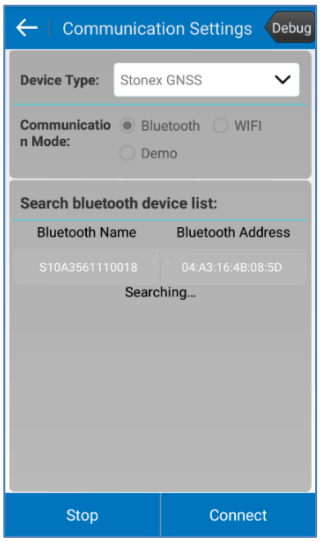
Click “Device” -> “Communication”, there will be the page shown in Figure. Communication settings are mainly used to select the communication mode between receiver and **Cube-a** software. Communication settings need to be done in the two steps: Firstly, select the Device type from the options of RTK, M series and internal GPS. Secondly, set the communication mode, communication mode includes Bluetooth and WIFI. In the case of internal GPS opening, it can read its own GPS signal to achieve positioning.

1. *Bluetooth connection*

Select "Bluetooth" communication mode in the communication settings interface, and then click "Search", you will see the page shown in Figure 3.3-2. If you already have a Bluetooth device in the list that you want to connect to, you can click "Stop" to stop searching, and select the name of the Bluetooth device to connect to the Device, click "Connect". When the Matching dialog box appears, please click “pair” and it could be connected successfully.

2. *WIFI connection*

Select "WIFI" communication mode in the communication settings interface, then click "search" to find the WIFI names of corresponding receivers (the default WIFI name is the receiver number), at last click the WIFI name to connect it. After the connection is successful, return to the communication settings interface, and click "Connect" to complete the WIFI communication connection, shown in Figure 3.3-3.

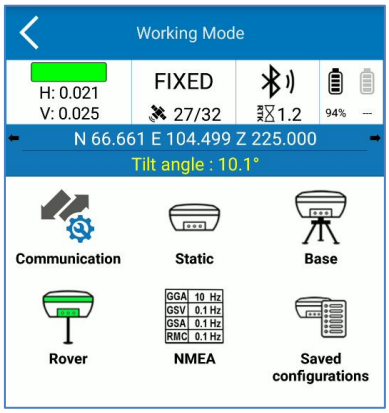


3. Demo Mode

When you select the communication mode as "Demo", then click "Connect" to enter the demo mode. You can try and view each function and don't need to connect the receiver.

4.1.4 Working mode

The working mode menu is mainly used to set the working mode of the receiver, click "Device" -> "working mode" to enter the working mode selection interface shown as next Figure. In the working mode interface, there are five options including communication settings, static mode, base mode, rover mode, and Preset configurations.



When doing static measurements, please set the working mode as static. When doing RTK measurements, please set the working mode as base or rover.

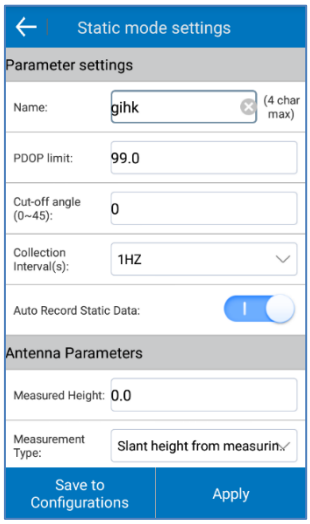
After connecting the Device and **Cube-a** software through communication settings, you can set the working mode, data link in the **Cube-a** software. The following sections describe the detailed settings in the working mode menu.

4.1.4.1. Communication

Click “Device” -> “Working Mode” -> “Communication”, you will enter the communication settings page same as the page in section 4.1.3. For the detailed description, please refer to *Communication*.

4.1.4.2. Static Mode

Click “Device” -> “Working Mode” -> “Static”, you will see the interface shown as next Figure. The static setting contains three aspects: parameter settings, antenna parameters and satellite system. The following describes the various parameter settings in detail.



Name: The name of static data is limited to 4 digits.

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-off angle: The angle between the connection between the satellite and the receiver and the horizon. The receiver does not receive satellite signals smaller than the cut-off angle. Value range: 0-45°.

Collection Interval: 1HZ said that the acquisition of a data per second, 5HZ said that the acquisition of five data per second, 5 seconds that five seconds to collect a data, and so on.

Auto record static data: If you select "Yes", receiver will start recording automatically when it is powered on and receiving satellites signal; If you select "No", you need to start recording static data manually after receiver is powered on.

Antenna height: Usually defined as vertical distance from the phase center of the antenna to the measurement point, because it cannot be directly measured, it is generally measured by other ways to calculate.

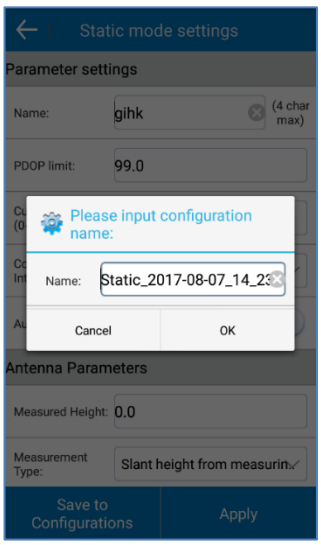
Satellites system: satellites system settings include five satellites systems, namely "GPS", "GLONASS", "BeiDou", “Galileo” and "SBAS" system. According to the needs of measurement work, you can choose whether to receive the corresponding satellites signal. (Note: only if the receiver supports the Galileo constellation then **Cube-a** will Galileo satellites in this page.)

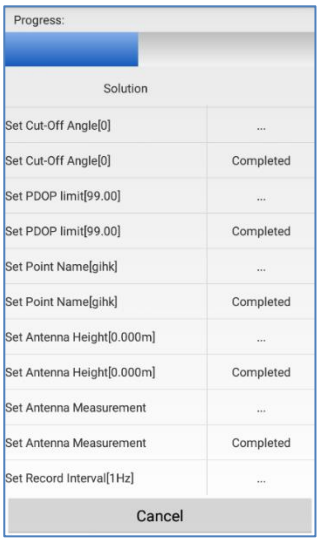
SBAS: Wide-area differential augmentation system (satellite-based augmentation system). The navigation satellites are detected by a large number of widely distributed differential stations and the acquired raw data is sent to the console. And then by the console through the calculation of the various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

In the static mode settings, after all parameters have been set, please click "Save to Configurations" to store the static parameters. As shown in next Figure, the static parameters of the current mode could be saved to the file,

so that you can recall the configurations next time when you need. The configuration name could be set by users.

After the parameters in the static mode settings are set, click "Apply" to change the working mode of the receiver to static mode.





4.1.4.3. Base Mode

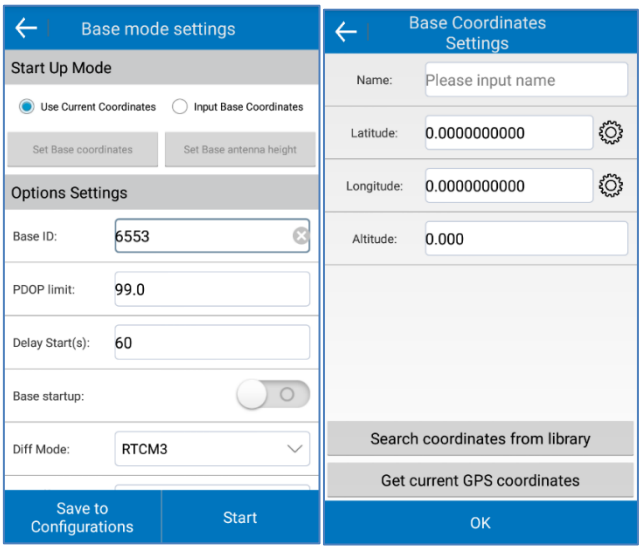
Click “Device – Working Mode - Base” to enter the “Base mode settings” page shown as next figure. The base mode settings contain four aspects: startup mode, option settings, data link settings, and satellites system settings.

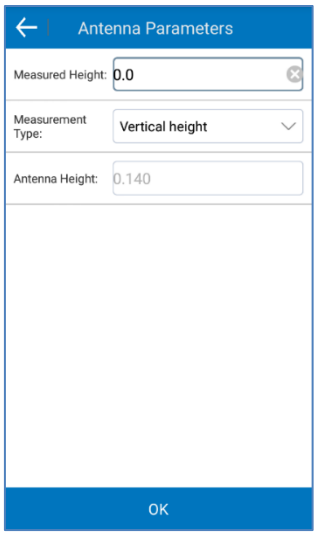
Start Up mode: There are two starting up modes, “use current coordinates” and “Input base coordinates”.

Use current coordinates: Base station takes the WGS-84 coordinates of current point as the base station coordinates.

Input base coordinates: The gap between input base coordinates and the accurate WGS-84 coordinates of current point should not be too large, otherwise the base station cannot work properly.

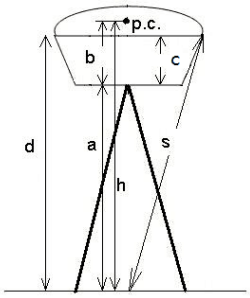
If you select “Input base coordinates”, Please click “Set base coordinates” to enter the base coordinates settings page shown as next figure. There are three ways to input the base coordinates: search coordinates from library, get current GPS coordinates and input the coordinates manually. Then click “Set base antenna height” to set the antenna parameters.





Measured height: The distance from the measured point to the ground.

Antenna height: Vertical height (h) from the antenna phase center to ground.



The known values which receiver provided are:

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

c: the height from the bottom of the device (ARP) to the rubber ring (SHMP);

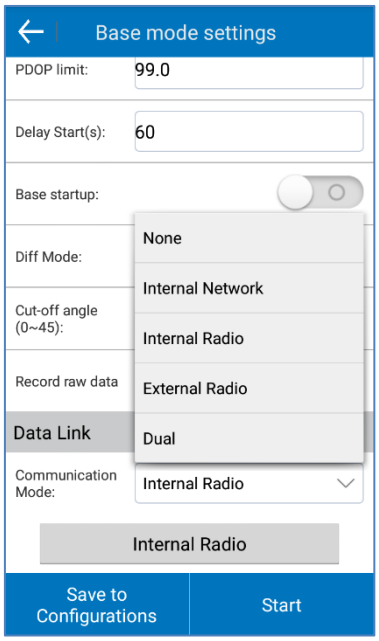
R: the radius of the device rubber ring (R).

If the measured height is the vertical height (a) from the bottom of device to the ground, the measured mode is “Vertical height”. And the antenna height: h = a + b.

If the measured height is the slant height (s) from the rubber ring to the ground, the measured mode is Slant height. Antenna height h = sqrt (s^2 - R^2) - c + b (sqrt means square root).

In option settings, you can set the Base ID, PDOP limit, Delay starts time, difference mode, cut-off angle and if to record raw data.

Data Link: There are four communication modes in datalink, including no data link, internal network, internal radio, external radio. Please refer to next figure.



None: No differential data is sent.

Internal Network: Transmitting differential data through network, the receiver should be inserted in SIM card to transmit data.

Internal Radio: Transmitting differential data through internal radio. RTK base and rover are all with built-in radio, which could receive and transmit differential data. Base could transmit differential data through internal radio, and rover could receive differential data through internal radio.

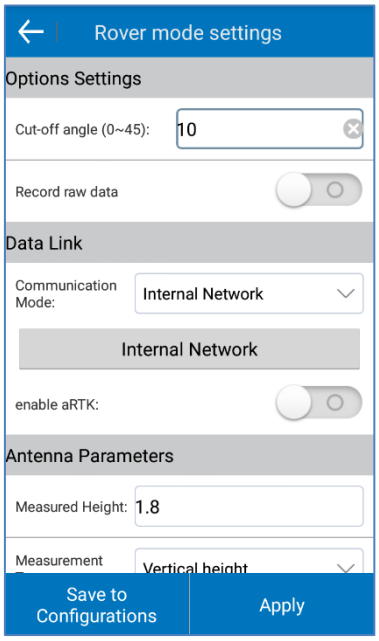
External Radio: The receiver is connected to external radio and transmitting differential data through the external radio.

After all parameters of base have been set, please click "Save to Configurations" to store the parameters. The base parameters of the current mode could be saved to the file, so that you can recall the configurations next time when you need. The configuration name could be set by users.

After the parameters in the base mode settings are set, click "Apply" to change the working mode of the receiver to base.

4.1.4.4. Rover Mode

Click "Device – Working Mode - Rover" to enter the "Rover mode settings" page shown as next figure. The Rover mode settings contain four aspects: option settings, data link settings, antenna parameters settings and satellites system settings.



Options settings: If you enable the option "record raw data", you can set the number of points names. Then you can collect the "Stop and go points" in point survey page.

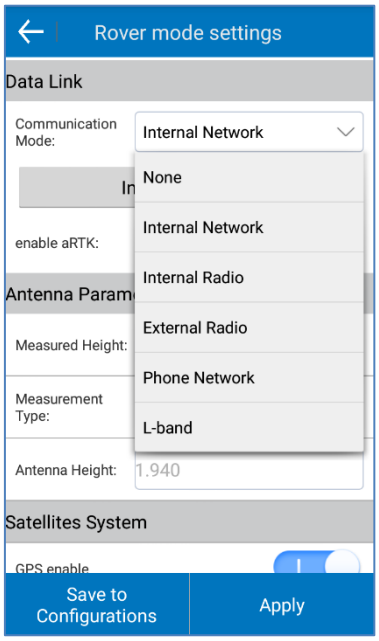
Data Link: There are six communication modes in datalink, including no data link(none), internal network, internal radio, external radio, phone network and L-band. Please refer to next figure.

The meaning of none, internal network, internal radio, external radio is same with which in base mode settings.

Phone Network: Transmitting differential data through the network of handheld. In this communication mode, the handheld should be inserted in SIM card or connected to Wi-Fi.

L-band: Using the Chinese precision satellite-based enhancement system, the geostationary communication satellite L-band broadcast differential signal, to achieve stand-alone 5-12 cm accuracy. Do not relies on ground base stations, CORS or network, in the non-differential signal area, desert, ocean, mountain, no differential signal area fast stand-alone positioning, easy to achieve high precision.

After the parameters have been set, please click "apply" to change the working mode to rover mode, then the rover could receive the differential data from the base. If the communication mode is radio, the frequency and protocol of base and rover should be the same.



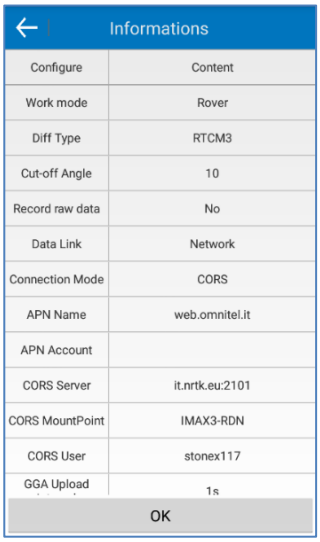
4.1.4.5. NMEA

Inside NMEA menu is possible set the NMEA output of the single messages.

Obviously following the maximum rate available of the specific unit.

4.1.4.6. Saved Configuration

Click “device – working mode – preset configurations” to enter the “preset configurations” interface shown as next figure. If all configurations of various working mode of current project are saved, then these configurations can be viewed in this menu.



If you select one configuration and click “OK”, then device will work with the configuration which you selected.

If you select one configuration and click “details”, then all parameters of this configuration will be displayed.

If you select one configuration and click “delete”, then this configuration will be deleted.

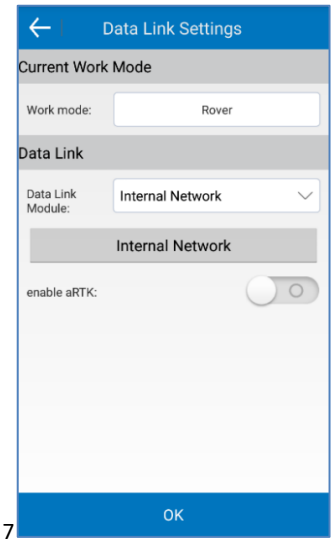
4.1.4.7. Data Link Settings

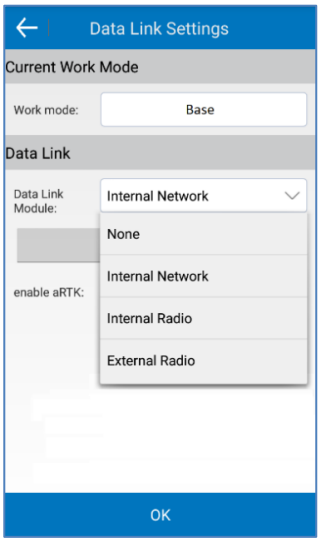
Data link settings is mainly used to set the data transmission mode between the base and the rover. Click “device-> data link settings”, there are two options in the data link settings menu, current working mode, and data link settings, please refer to next figure. Depending on the different working mode, the data link settings are divided into two types, base data link settings and rover data link settings.

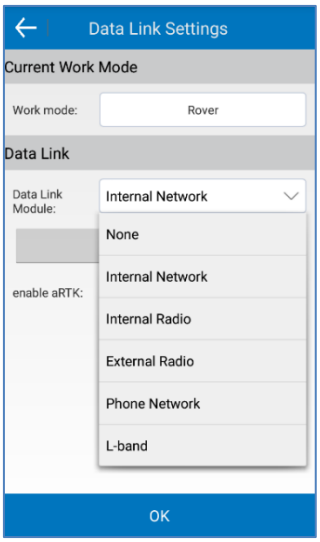
When current working mode is base, there are four data link modules, including None, internal network, internal radio, external radio. Please refer to next figure.

When current working mode is rover, there are six data link modules, including None, internal network, internal radio, external radio, phone network and L-band. Please refer to next figure.

After you select the data link module, you can click the button below the data link module to set corresponding parameters.

7 

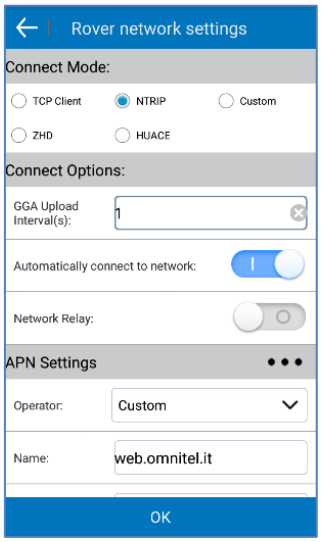




4.1.4.8. Internal Network

There are two kinds of network, internal network and phone network. When the working mode is base, the network only can be the internal network. When the working mode is rover, the network could be internal network and phone network.

When you select internal network in base mode, the content of settings includes connect mode, connect options, network mode, APN settings, CORS settings. When you select internal network in rover mode, the content of settings includes connect mode, connect options, network mode, APN settings, CORS settings, mountpoint settings, CORS account, get mountpoint settings. When you select phone network in rover mode, the content of settings includes connect mode, CORS settings, CORS account, and mountpoint.



TCP: Transmission control protocol, a communication protocol which is connection-oriented, reliable and byte-based.

NTRIP: Through internet protocol, a standard protocol used to transmit differential data via network, always used for CORS network.

Custom: User defined.

In "connect options" settings, the default value of GGA upload interval is 5s, and you can also set the GGA upload interval to other values. You can enable/disable the "Automatically connect to network". In rover mode, you can set the "network relay".

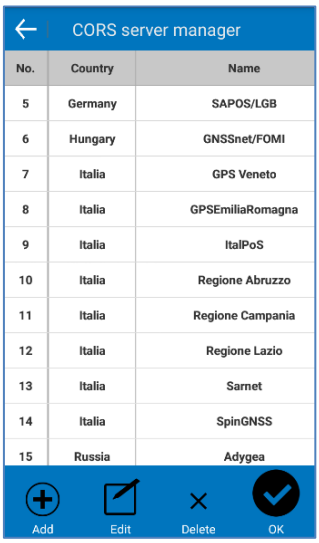
In "APN settings", you can set the operator/name/user/password of the SIM card in receiver. Some settings are preloaded as shown in next figure. In addition, you can click the ••• on the right side to add or edit custom SIM card information.

Base network settings: Please set the IP, port, base access point (In general, the base access point is the device serial number of the base) and password in CORS settings. In addition, you can click the ••• on the right side to add or edit the parameters of the CORS server.

Rover network settings: Please set the IP and port in CORS settings, and you can also click ••• on the right side to add or edit the parameters of the CORS server. Some CORS settings have been preloaded in the software as shown in next figure.

Then set the mountpoint, you can use "RTK network" or "mobile phone network" to get the mountpoint and select a mountpoint in mountpoint settings. At last, set the user and password in CORS account. If the base is set up by yourself, the user and password could be entered as any characters. But if you are using someone else's CORS account, please enter the corresponding user and password.

Click "Ok", you will finish the base network settings or the rover network settings.



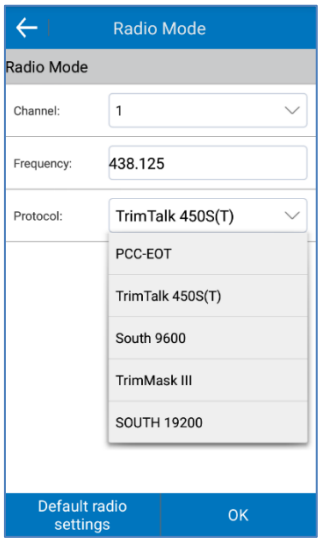
No.	Country	Name
5	Germany	SAPOS/LGB
6	Hungary	GNSSnet/FOMI
7	Italia	GPS Veneto
8	Italia	GPSEmiliaRomagna
9	Italia	ItalPoS
10	Italia	Regione Abruzzo
11	Italia	Regione Campania
12	Italia	Regione Lazio
13	Italia	Sarnet
14	Italia	SpinGNSS
15	Russia	Adygea

Note: The IP in base and rover network settings should be the same.

4.1.4.9. Internal Radio

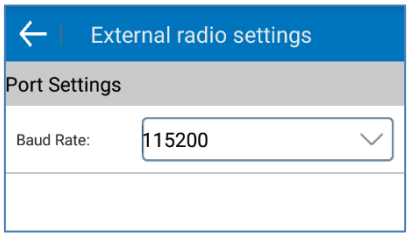
Select the data link as "Internal Radio", then click "internal radio" to set the parameters. The parameters in base and rover mode are the same, including channel, frequency and protocol. The channel 1-7 are the fixed channel, the frequency can't be modified; the channel 8 is the customized channel, the frequency could be set as your actual need. Click "default radio settings", you could set the frequency of 1-8 channel.

If the datalink of base and rover is internal radio, the frequency and protocol of base and rover should be the same. In base mode, the radio power will affect the transmission distance of the single. Low power, low power consumption, the signal transmission distance is close; High power, high power consumption, the signal transmission distance is far.



4.1.4.10. External Radio

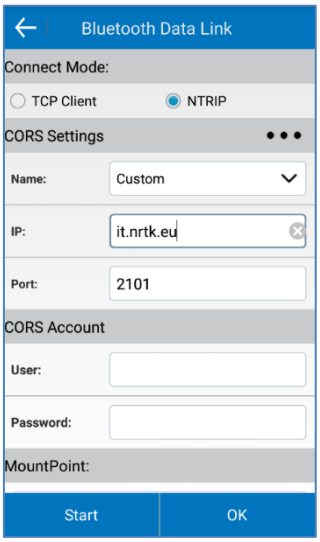
Select the datalink as "external radio" and click external radio to set the parameters. The external radio parameters of base and rover mode are the same, only need to set the baud rate. The default value of bard rate is 38400.



4.1.4.11. Phone Network

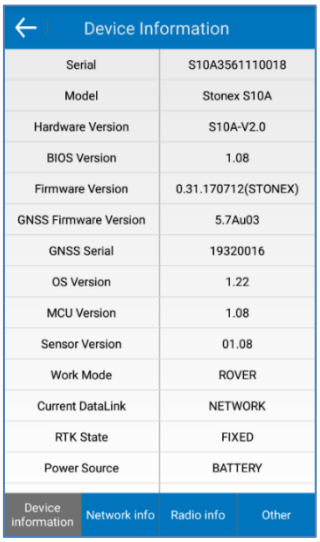
Phone network is only available in rover mode. Please select the datalink as "phone network" and click the phone network to set the parameters (next figure), the parameters include CORS settings and mountpoint. If you click ••• on the right side of the CORS settings, you can add or edit the parameters of the CORS server.

These settings are the same as the internal network mode, except that network used in phone network mode is from the mobile device (handheld), which requires mobile devices to access the internet.



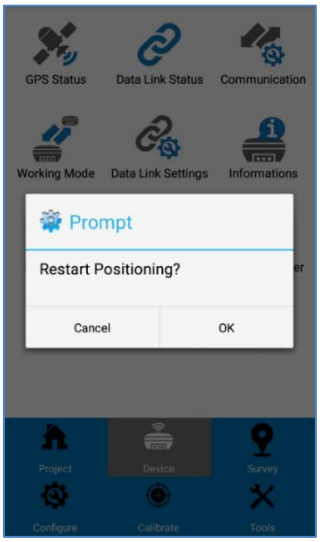
4.1.5 Information

Contains the detailed parameters and status of device, antenna, network, radio and satellites systems. Please refer to next figure.



4.1.6 RTK Reset

Its function is to force an OEM board re-initialization, thus, to force a complete recalculation of the location starting from fresh satellite signals. Click “Re_ position”, there will be the prompt dialog box shown as in next figure, then click “Ok”, receiver will restart positioning.


GPS Status
Data Link Status
Communication
Working Mode
Data Link Settings
Informations
Prompt
Restart Positioning?
Cancel
OK
Project
Device
Survey
Configure
Calibrate
Tools

4.1.7 Register

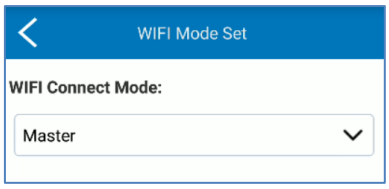
You can view the device serial number and registration date in this interface. “Register” is to register the RTK, and when the receiver is connected with the **Cube-a,** then you can enter the activation code and click “registration” to register the RTK.

4.1.8 Wifi Mode Settings

To change the Wi-Fi settings of the receiver the user can open this menu and change the status of the connection.

Status available are two:

- **Master**



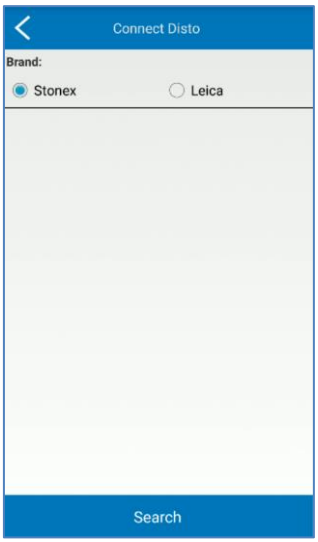
- **Client**

If the user sets Master, the receiver wifi will be available for configuration instead if he sets the mode Client, the wifi of the receiver will connected to a Master Wifi device and the connection to the web UI won't be available.

4.1.9 Distance Meter

The Cube-a supports the connection to a disto to measure length on field.

To pair the device, select the model, Stonex or Leica and Search the disto via Bluetooth.

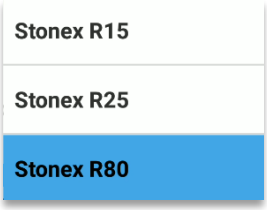


4.2 Total Station

4.2.1 Total Station Communication

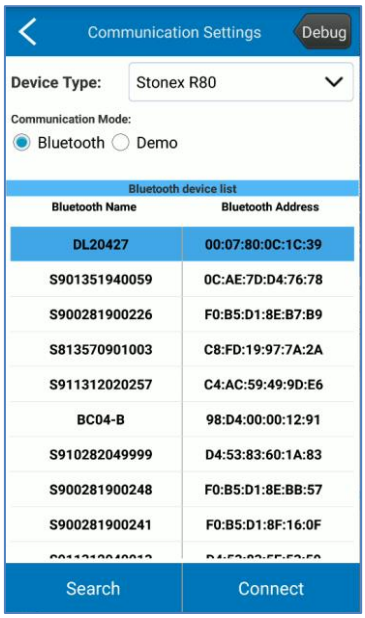
Click “Device” -> “Total Station Communication”, there will be the page shown in next Figure. Communication settings are mainly used to select the communication mode between total station and **Cube-a** software.

Select the “Device Type” between Stonex R15, R25 and R80 models:



1. *Bluetooth connection*

Select "Bluetooth" communication mode in the communication settings interface, and then click "Search", you will see the page shown below. If you already have a Bluetooth device in the list that you want to connect to, you can click "Stop" to stop searching, and select the name of the Bluetooth device to connect to the Device, click "Connect". When the Matching dialog box appears, please click “pair” and it could be connected successfully.



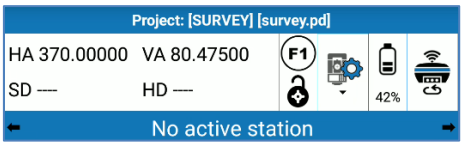
2. *Demo Mode*

When you select the communication mode as “Demo”, then click “Connect” to enter the demo mode. You can try and view each function and do not need to connect the total station. NOTE: Demo Mode works with R80 as Device Type only.

NOTE: to successfully connect the total station and the controller check if:

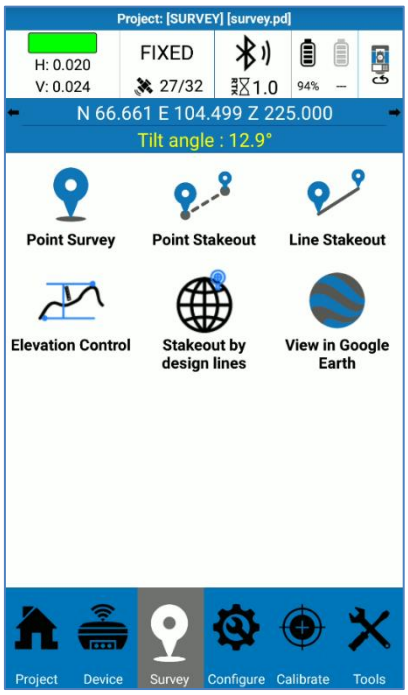
- (For R15 and R25 only) You have set the following command settings:
    - Baudrate: 9600
    - Bluetooth: ON
- You have levelled the total station
- (For R15 and R25 only) You are in the measure page.

You will have confirmation that the connection has been successful if the angles' values are shown in the bar status.



5. Survey

This chapter provides information on using the commands from the survey menu. You will see some submenus after you click "Survey", including *Point Survey*, *Point Stakeout*, *Line Stakeout, Elevation Control, Stakeout by designed lines* and *View in Google Earth.*



5.1 Point Survey

Click "Survey" -> "Point Survey" to enter the user interface of point survey. Some commands may change in this page, depending on which modules of **Cube-a** you are currently using and enabled. This chapter will explain the **common commands in all modules**. Refer to subchapter *Point Survey with GPS*, *GIS Survey* and *Point Survey with Total Station* for the description of the commands specific to each module.

Zoom in on the map

Adapt all the survey in the screen

Zoom out on the map

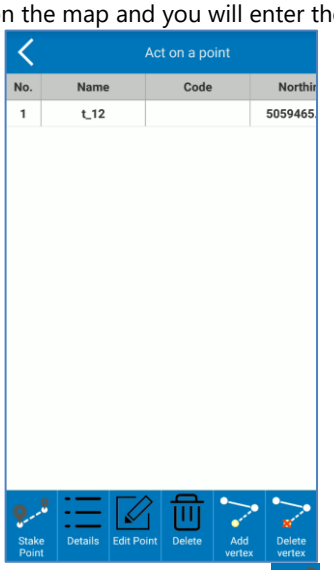
Compass showing the magnetic north. The compass information comes from the controller where **cube-a** is installed.

Evaluate distances and area between points on the map. Tap on it to enable the tool: the icon becomes yellow and you can tap on the map to define the first point. Distance between two segments is shown in green on the center of the segment, progressive distances are shown in green on the points and the area is in red in the center of the geometry.

Tap again on the yellow icon to exit the tool: measures will disappear.

Enable the tool and select a line on the map and you will enter the *Line Stakeout*.

Enable the tool and select a point on the map and you will enter the following page:



Where, after selecting the point from the list, you can tap on to enter the *Point Stakeout*. Otherwise you can check *Details*, *Edit* or *Delete* the point; if the point is a vertex of a CAD entity, you can *Add* or *Delete vertex*.

Change the Google maps type:

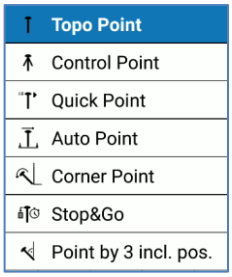
- disable the map;
- set the predefined map;
- set the satellite map.

Enable the tool to keep the current point in the center of the screen. Tap on it to disable it and to be free to move on all the map; the following icon will be shown .

Remove all the icons from the screen, leaving only the button to register points. To restore the icons, tap on the upward arrow .

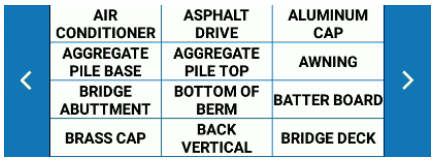
Define the drawing tools to draw vector CAD elements while you survey. Refer to *Draw while acquiring points*.

Define the type of point you will survey:



- GPS mode: refer to *Record Settings*;
- TS mode: *Topo point* is only available.

Quickly define the code by scrolling through the available ones:



The list of codes comes from the library you had chosen in *Feature Codes*.

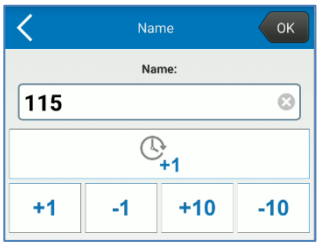
Enter the *Survey tools* page.

If you are working with the drawing tools, you can close entities.

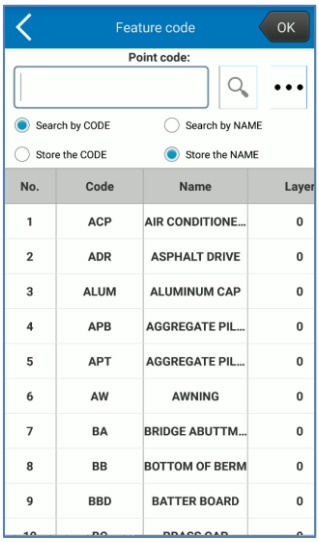
Enter the *Point Library*.

In the lower part of the screen, you can define:

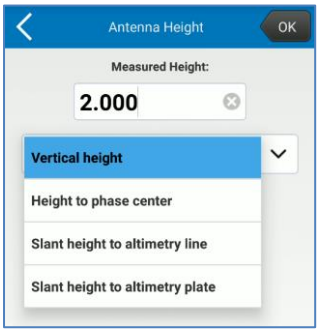
1) the name for the next point. Insert the name in the cell or increase/decrease it using the *+1/+1/+10/-10*. The icon +1 uses the name next to the last measured point name.

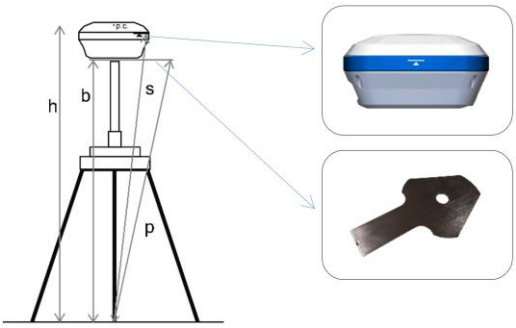


2) the code for the next point. You can search the code entering the name or scrolling the list or enter a code which does not exist on the Code Library. You can search by *code* (e.g CL) or by the code *name* (e.g. Center Line). The ••• icon allows to enter the *Feature Codes*. Choose if you want to save the code or the name in the fieldbook of measures.



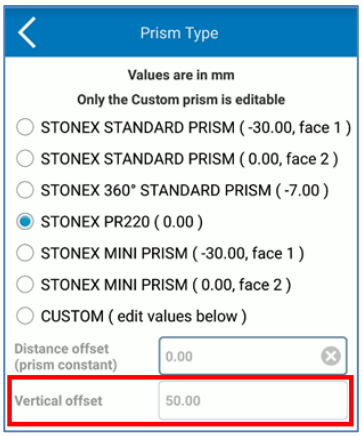
3) the antenna/pole height for the next point.
If you are working with GPS, you can choose between:





- *Vertical height*: **b**
- *Height to phase center*: **h**
- *Slant height to altimetry line*: **s**
- *Slant height to altimetry plate*: **p**

If you are working with Total station, the value refers to the pole height.
NOTE: only enter the height of the pole if in the prism settings (refer to *Total* station Settings) you already considered the vertical offset of the prism.



5.1.1 Point Survey with GPS

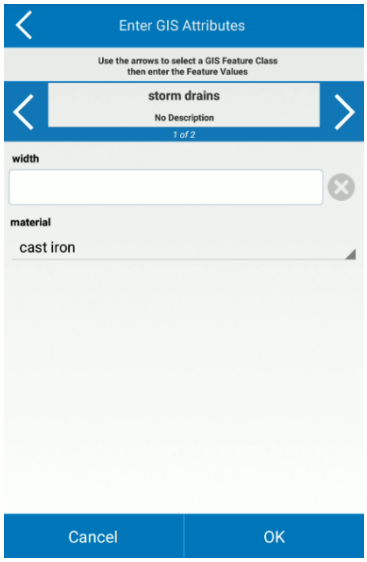
Click “Survey” -> “Point Survey” to enter the user interface of point survey. If you are in GPS mode, you will have the following screen.

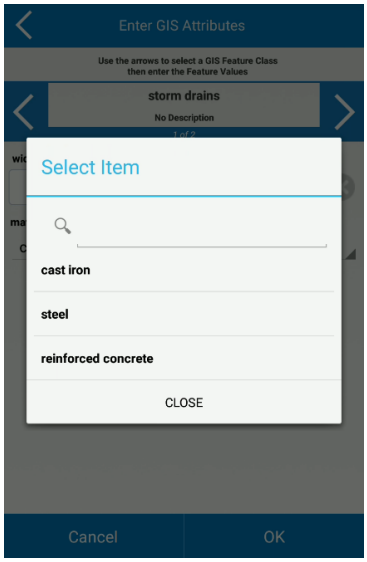
In addition to the tools described in *Point Survey* chapter, in GPS mode you have:

It collects point coordinate by using the recording type you have selected.

5.1.2 GIS Survey

If the GIS option is enabled, when you save a point or a CAD entity, *Enter GIS Attributes* window appears. Here you can choose the feature class clicking on the right arrow or left and insert the attributes. Click on *Cancel* to cancel the inserted attributes or click on OK to confirm.



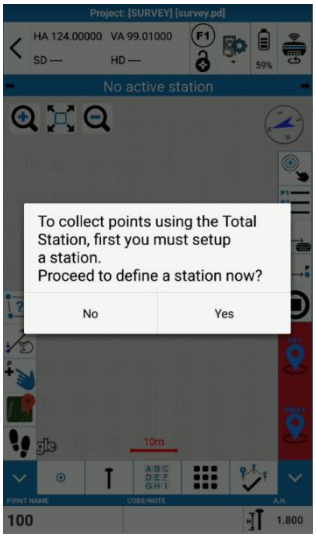


5.1.3 Point Survey with Total Station

Click “Survey” -> “Point Survey” to enter the user interface of point survey. If you are in total station mode, you will have the following screen.

When creating the project, the *MEAS* and *REC* icons are red because the station has not yet been declared. Cube-a will not allow you to survey points, but tapping on one of them, you will have the following popup which will direct you to the station definition. Click on *Yes* and refer to *Total Station*

Station on point and *Resection/Free Station* chapters.



Going back to the survey page, in addition to the tools described in *Point Survey* chapter, in total station mode you have:

It measures distance.

It saves the point if a measure has already been performed, otherwise it measures and save the point.

It stops the tracking measure mode or the prism search.

It rotates the telescope to the position of the point. It can be used during the survey, after that the station position and its orientation has been defined.

It rotates the telescope to the direction of the GPS. It can be used during the survey, after that the station position and its orientation has been defined; it works if you own the GPS module of **Cube-a** and if the antenna is in *fixed* solution.

5.1.4 Draw while acquiring points

It is possible to draw vector CAD elements while surveying points. The vertices of the vector CAD elements are the points acquired while a drawing tool is active.

To activate a drawing tool, refer to the "popup" tools grid as shown in following figure.

It enables the "standard acquisition", the ***simple point*** acquisition. No vector CAD entities will be created.

It enables the acquisition of ***polylines***. While this tool is active, the program will connect all acquired points to form a polyline. Tap the button to end the acquisition of the polyline.

It enables the acquisition of parcels/closed polylines. While this tool is active, the program will connect all acquired points to form a ***polygon***. Tap the button to end the acquisition of the polygon.

It enables the acquisition of a ***square*** by means of two acquired points which are at the extremes of the diagonal of the square. The acquisition automatically ends as soon as the second point has been acquired.

Enables the acquisition of a ***rectangle*** by means of two acquired points that defined the end points of one side plus a third point that defines the distance of the opposite parallel side. The acquisition automatically ends as soon as the third point has been acquired.

It enables the acquisition of a ***rectangle*** by means of 3 acquired points: the first point defines the "center" of the rectangle, the second point defines the position of the midpoint of one of the sides, the third point defines the position of the midpoint of one of the two orthogonal sides to the previous side. The acquisition automatically ends as soon as the 3rd point has been acquired.

It enables the acquisition of an ***arc of circle*** by means of the acquisition of 3 points that define (in order) the starting point of the arc, a constraint point for which the arc must pass through, the end point of the arc. The acquisition automatically ends as soon as the third point has been acquired. The 3 points must not be aligned along a straight line.

It enables the acquisition of a ***circle*** by means of 2 acquired points: the first point defines the center of the circle; the second point defines the radius of the circle. The acquisition automatically ends as soon as the second point has been acquired.

It enables the acquisition of a ***circle*** feature by means of 3 acquired points: the 3 points must be acquired in order, walking either in a clockwise or anti-clockwise direction along the circular feature to be acquired. The acquisition automatically ends as soon as the third point has been acquired. The 3 points must not be aligned along a straight line.

It ***commits*** or ***cancels*** the entity. The action performed by this button depends on the kind of the active drawing tool and on how many points/vertices have been already stored. See the table below

It enters the *Survey tools*, where you can find some helper commands.

Drawing Tool	***# of vertices stored***	***COMMIT action***
	-	None
	< 2	Cancel acquisition
	>= 2	Store & Restart
	< 3	Cancel acquisition
	>= 3	Store & Restart
	< 2	Cancel acquisition
	< 3	Cancel acquisition
	< 3	Cancel acquisition
	< 3	Cancel acquisition
	< 2	Cancel acquisition

	< 3	Cancel acquisition

5.1.5 Survey tools

By clicking the icon from Survey or Stakeout pages. You may have the following tools:

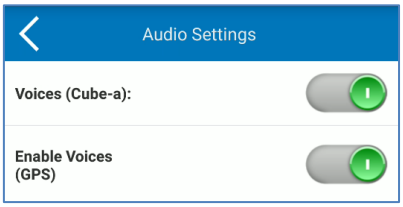
CAD Layers It enters the CAD layers management:

Layer "0" is by default and it cannot be renamed/deleted.
Each layer you can set as visible/no visible, locked/no locked and you can modify color, line type and symbol for points.

Entity list Refer to *Entity List.*

Sensor Options Refer to *Sensor Options*.

Audio Settings It allows to enable/disable cube-a and GPS voices:



Record Settings These settings change in accordance if you are surveying or staking out points or staking out lines: refer to *Point stake out Record settings*, Point stake out Record settings and *Line stake out Record* settings, respectively.

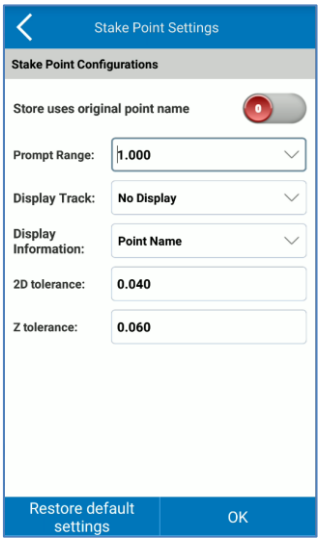
Display Settings Refer to *Display Settings*.

Use last collected point* If you *Draw while acquiring points*, you may need to use the last collected point as starting point of the entity you are drawing.

	**Use point from list***	If you *Draw while acquiring points*, you may need to use a point from the list as point of the entity you are drawing.
	**Use point from CAD***	If you *Draw while acquiring points*, you may need to use a point from the CAD/map as point of the entity you are drawing.
	**Pause entity – Collect points***	If you *Draw while acquiring points*, you may need to pause the drawing in order to collect some points which are not part of your drawing.
	**Resume paused entity***	If you *Draw while acquiring points* and you paused the entity, you may need to restore the acquisition of points of the entity you were drawing.
	**Distance***	Refer to *Distance*.
	**Hidden Point – Dist-Dist***	Refer to *Hidden Point - Two Points Two Distances*.
	**Hidden Point - Two alignment***	Refer to *2 Alignments Interception*.
	**Pt by Polar (from Dir)***	Refer to *Point by Polar (from Direction)*.
	**Point averaging***	Refer to *Point averaging*.

5.1.5.1 Point stake out Record settings

Entering the Record settings from the point stake out page, you will have to define the following values:



- *Store uses original point name*: enable or disable it, depending if you want to store staked out point with the same original name or not;

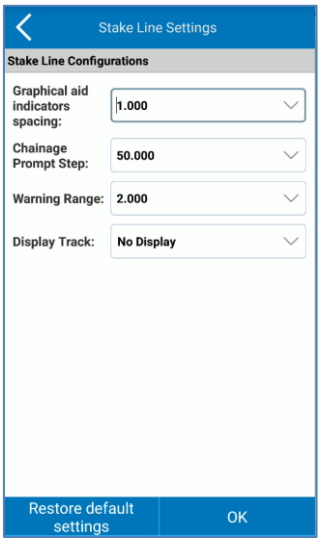
* Available only from the Survey page

- *Prompt Range*: on the screen you can see three concentric purple circles around the point (the center is the point to be stake out). Define the range (maximum distance from the point) to see them;
- *Display Track:* display it to see dots of the last positions (track of the executed path).
- *Display Information:* select which information you want to see on the display (NoDisplay, Point Name or Point Code);
- *2D tolerance:* enter the tolerance for planimetry;
- *Z tolerance:* enter the tolerance for the elevation.

By clicking on "Restore default settings", the point stake out configuration will be reset to default configuration.

5.1.5.2 Line stake out Record settings

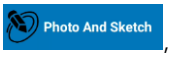
Entering the Record settings from the line stake out page, you will have to define the following values:



- *Graphical aid indicators spacing*: it is the space between the reference lines added to the side of the line to stake out;
- *Chainage Prompt Range*: it is the step for displaying the progressive along the line;
- *Waring range:* it alerts you are approach to destination point, when you enter within the distance you have set. If you move away alerts you are moving away from the point of destination;
- *Display track:* display it to see dots of the last positions (track of the executed path).

5.1.6 Photo and Sketch

The *Photo and Sketch* feature allows you to associate a photo to a point.

To launch *Photo and Sketch* command you must push the relative button that you can find in the bottom part of the screen 

, while you are:

1. reviewing the details of point that you just collected.
2. editing the data of a point from the Survey Points Library.

The photo will be taken using the integrated camera of the handheld and it will be stored in a jpg file in the Photos folder of the active project.

The image file will have the name equal to the name of the collected point.

You can also draw over the image and insert:

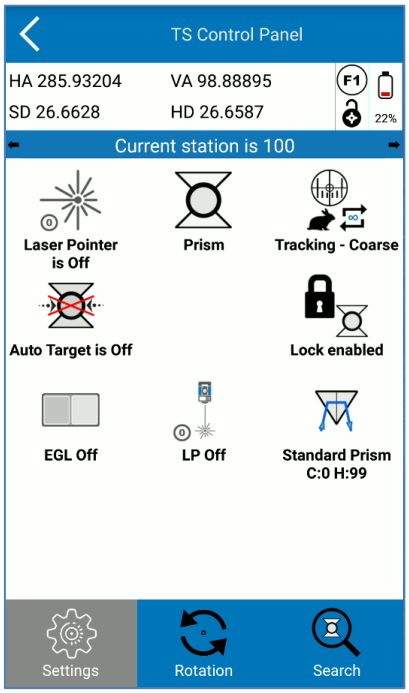
- Text notes
- Point information (name, coordinates)
- Arrows
- Simple sketches (polylines drawn by hand).

Any of the above elements can be freely moved and rotated.

Images can also be re-shot or deleted.

5.1.7 TS control panel

Enter the Total station control panel using the following icon . It contains three sub-menus (*Settings*, *Rotation* and *Search*) if you are working with a Motorized Total Station or only *Settings* if you are working with a Manual Total Station.



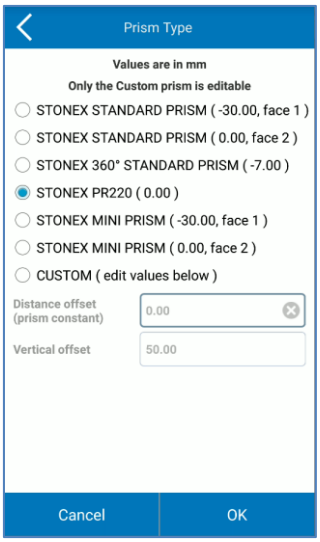
5.1.7.1 Total station Settings

Define the settings of the total station. They may change depending on the total station model.

- Laser pointer: it can be switched off / switched on .
- Target type, define:
  - No Prism if you are measuring in reflectorless mode
  - Reflector if you are measuring a reflector sheet
  - Prism till 2.500 meters
  - Remote Prism between 2.500 and 5.000 meters.
- Measure mode:
  - Single - Fine : total station will take a single and precise measure
  - Tracking - Fine : total station will continue taking precise measures, till you stop it
  - Tracking - Coarse : total station will continue taking raw measures, till you stop it
  - Tracking – Coarse + Fine shot : total station will continue taking raw measures, till you take a measure which will be performed in precise mode
  - Averaging (3) : total station will take 3 measures and **Cube-a** will average them
  - Averaging (?) : total station will take *n* measures and **Cube-a** will average them. Tapping on it, you have to enter the number of measures you want to perform.
- Autotarget: it can be enabled /disabled . If enabled it corrects the decentralization of the target with respect to the axis of aim: it calculates angular corrections (horizontal and vertical) in order to correct

the angles without having to aim exactly at the center of the prism. If Autotarget is enables, lock is disabled and vice versa.

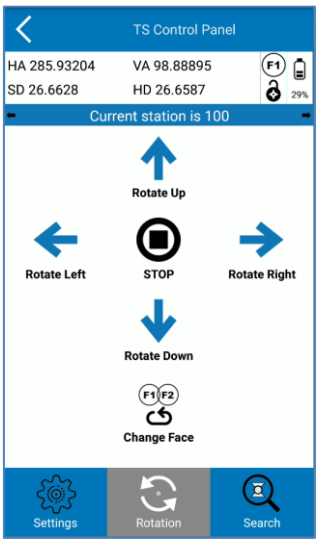
- Prism lock: it can be enabled /disabled. . Enable it only if you are using a prism as target type.
- Electronic Guide Light: it can be enabled (3 levels available) /disabled .
- Laser Plummet: it can be enabled (3 levels available) /disabled .
- Prism type : select the model of your prism from the window or choose the *CUSTOM* prism to insert your own offset values.
  NOTE: since *Vertical offset* of prism is define on this page, this value should not be considered during the survey; when you set the *Target height*, insert the pole height only.



5.1.7.2 Total station Rotation

Manage the Motorized Total Station by remote. You can rotate the telescope Up / Down / Left / Right ; movements can be arrested by tapping on *STOP* .

From this page you can also change instrument face (from left to right face and vice versa).

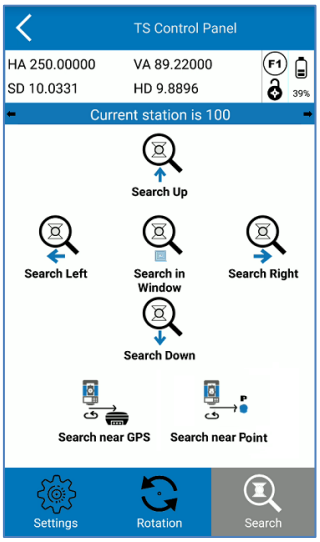


5.1.7.3 Total station search

Manage the prism search of Motorized Total Station. You can start the prism search up / down / left /right or defining a window of ever larger dimensions, starting from the point where the telescope is located.

The *Search near GPS* and *Search near Point* commands allow to rotate the telescope to the direction of the GPS or to the position of the point, respectively. They can be used during the survey, after that the station position and its orientation has been defined. *Search near GPS* works if you own the GPS module of **Cube-a** and if the antenna is in *fixed* solution.

Tap everywhere on the screen to stop the search. If the prism search is successful and lock setting has been enabled, the prism will remain locked.



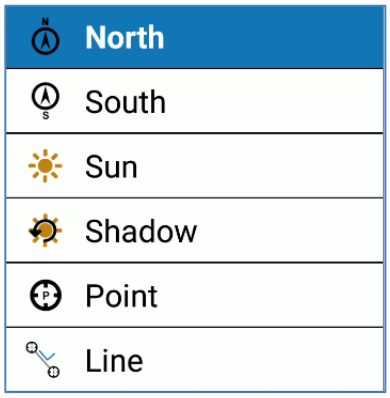
5.2 Point Stakeout

Click "Survey" -> "Point Survey" to enter the points library, then select one point and click "OK" to enter the stake point interface shown as next figure.

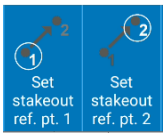
In addition to the tools you find in the *Point Survey* page, there are:

Zoom on your position and on the point you are staking out.

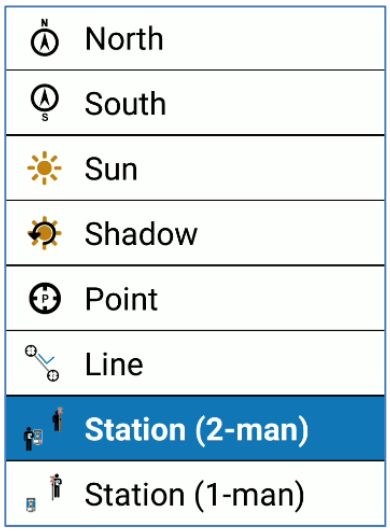
Define the item to use as reference during the stake out.
If you are working with a GPS, you will have:



- ***North***: referring to the compass, the magnetic north has to be in front of you;
- ***South***: referring to the compass, the magnetic south has to be in front of you;
- ***Sun***: the sun has to be in front of you;
- ***Shadow***: the sun has to be behind you;
- ***Point***: choose a point from your survey to refer to. The Point Library opens to select the point;
- ***Line***: choose a line to refer to. The line must be defined choosing two points from your survey. Enable the point selection by tapping on blue hand icon. Below the list, have to *Set stakeout ref. pt 1* or *2*, depending to which direction you want to give to your line:



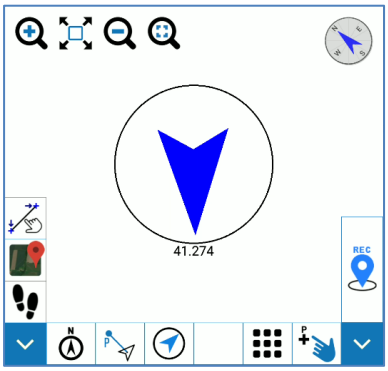
If you are working with a Total station, in addition to GPS you will have:

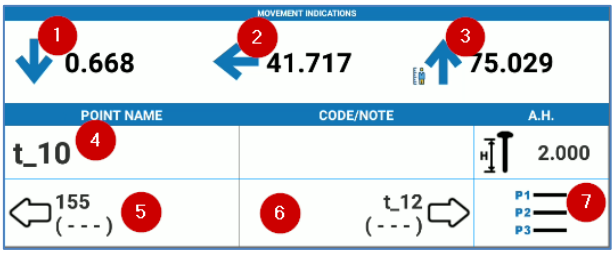


- ***Station (2-man)***: choose these setting if 2 men are in the field: one person measures at the total station and gives instructions to the second man which holds the pole with the prism. This mode is very common if you are working with a manual total station;
- ***Station (1-man)***: choose these setting if a single surveyor is staking out. He has to refer to the total station position and move holding the pole with the prism. This mode is very common if you are working with a motorized/robotic total station.

It shows the current position on the map by using a red arrow. The point to stake out is highlighted with a red and blue circle and a purple line connecting the position and the point shows the distance.

It shows the direction in which you are moving by a blue arrow and the distance between the current position and the point to stake out.





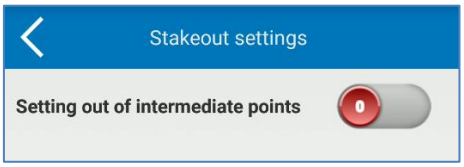
1) Move backward or forward for the distance shown so that you find the point: once found with the declared tolerance, the arrow will become green
2) Move to the right or to the left for the distance shown so that you find the point: once found with the declared tolerance, the arrow will become green
3) It shows the elevation of the point you are staking out: the point can be upwards or downwards And it will suggest you cut or fill: once found the correct position with the declared tolerance, the arrow will become green
4) ID of the point you are staking out
5) Stake out the previous point
6) Stake out the next point
7) Enter the point library to select another point.

5.3 Line Stakeout

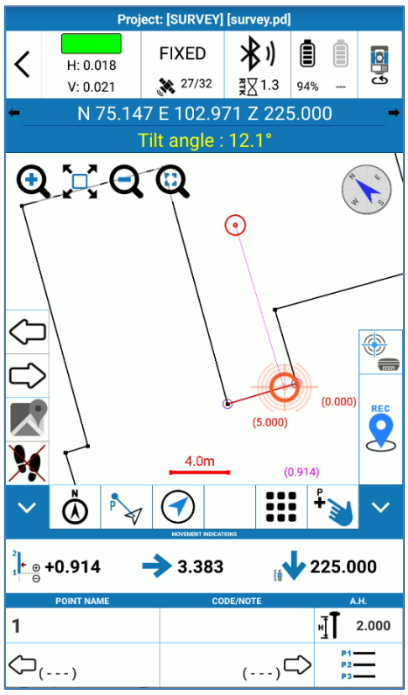
Click "Survey" -> "Line Stakeout" to enter the lines library and select one line.

If you want to stake out a line coming from a *.*dxf* file, consider that lines from *.*dxf* are not listed in the line library, but it has to be selected from the map using the icon.

You will have the following option:



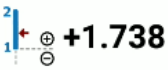
- Leaving it disabled  you will stake out the line: it will not matter which point of the line you will find, simply position yourself on the line to consider the operation finished.



The current position is shown with a red dot & circle  , the line to stake out is in red as well, with indications of the starting point (0.000) and the end point (e.g. 5.000), and you can see the projection of the current position on the line indicated by the following icon: 

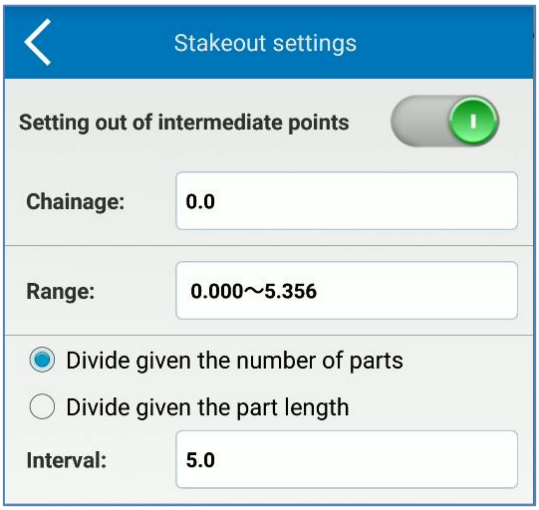
The tools on the page are the same as on *Point Stakeout*, with exception for:

 Stake out the previous/next line.

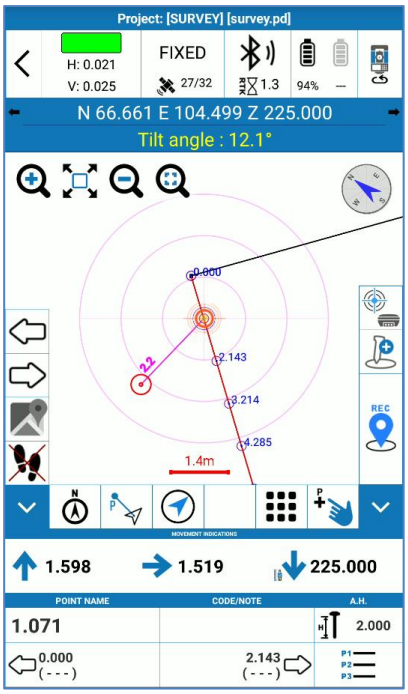


It shows the position along the line: it can be positive (if between the starting and the end points) or negative (if before the starting point).

- Enabling it  you will stake out points on the line or offsets from the line. You have to define the following parameters:



- *Chainage*: entering ***N*** value you add a point along the line at distance ***N*** from the starting point.
- *Range*: it shows the starting and end point of the line you are staking out. It is a no-editable value
- *Divide given the number of parts*: ticking it, whatever is the length of the line, it will be divided into ***N*** equal intervals (value defined in the *Interval* cell). With the parameters shown on screen, the line will be divided as: 0.000 – 1.071 – 2.143 – 3.214 – 4.285 – 5.356.
- *Divide given the part length*: ticking it, whatever is the length of the line, it will be divided into ***N*** wide intervals (value defined in the *Interval* cell). With the parameters shown on screen, the line will be divided as: 0.000 – 5.000 – 5.356.



The current position is shown with a red dot & circle  , the line to stake out is in red as well, with indication of the subdivision points of the line 

and the currently selected point  .

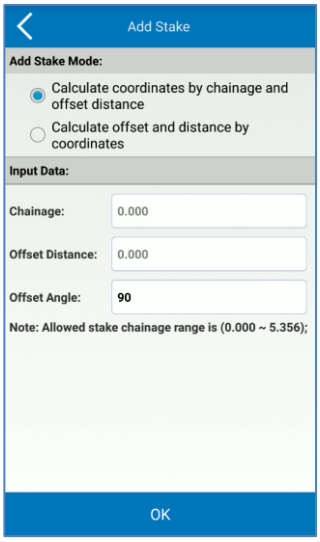
The tools on the page are the same as on *Point Stakeout*, with exception for:

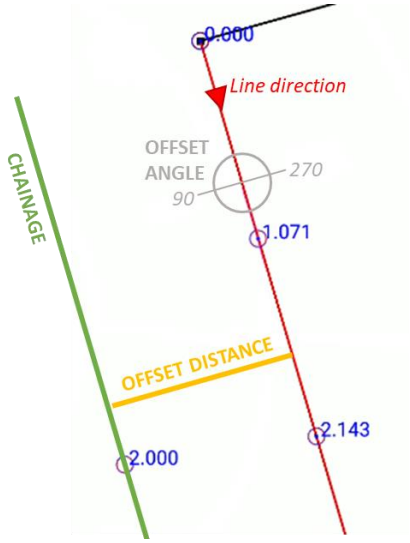
Stake out the previous/next line.

Stake out the previous/next point on the line.

Define offsets for the stakeout. You can:

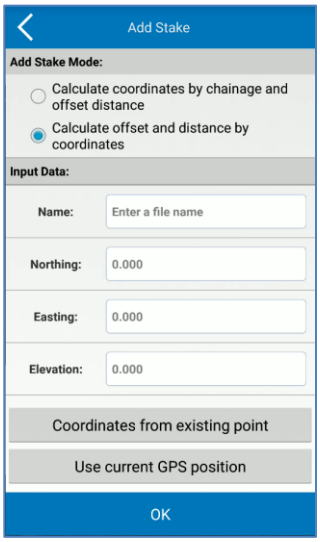
- ***Calculate coordinates by chainage and offset distance***





Chainage is the distance along the line starting from point 0 of the line
Offset distance is the lateral offset with respect the line
Offset angle is the direction for the lateral offset. Referring to the line direction: 90° means on the right, 270° on the left

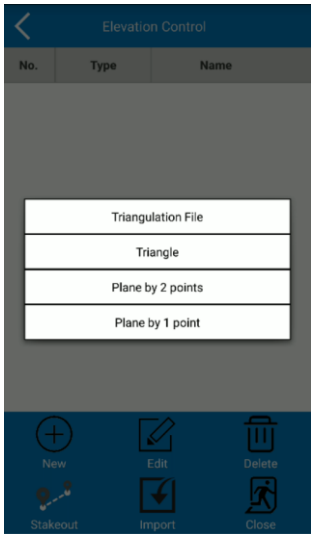
- ***Calculate offset and distance by coordinates***



Enter the coordinates or use coordinates from existing point or use current GPS position.

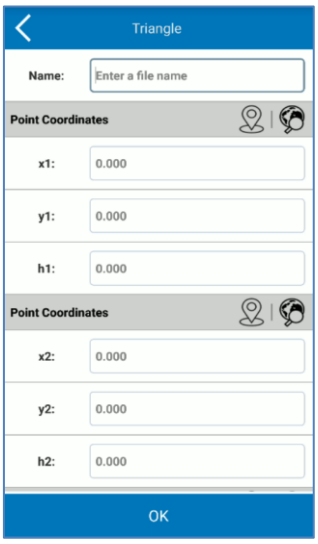
5.4 Elevation control

The elevation control feature allows the user to check the elevation live on field calculated by the device respect 4 different referments.

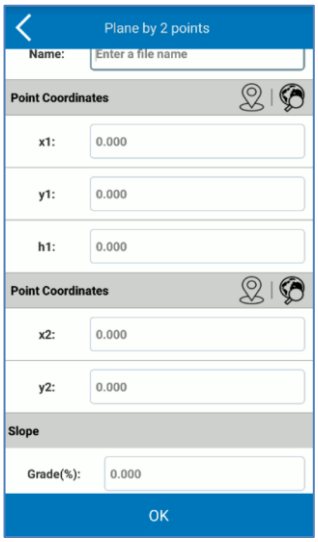


User can check the elevation respect a triangulation file in.dxf file. To set it, it is necessary import a .dxf and then select it.

It is possible check the elevation respects a plane defined per 3 points. To do that select Triangle and choose the points.



The user can also set a referment a slant plane per 2 point or a horizontal plane per 1 point. If the user set a plane per 2 points, there is also the possibility to set the slope instead if the choice is Plane per 1 point, the slope can be set in direction x,y.



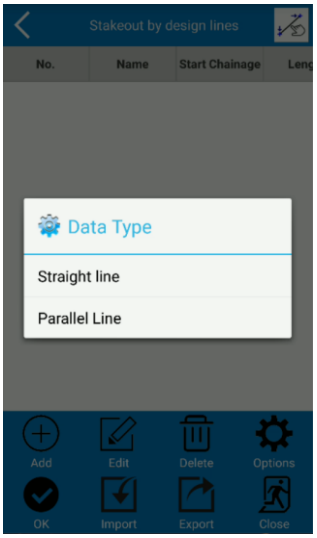
After the importation of the file or the definition of the plane, to start the elevation check press Stakeout.

You will always have the elevation different respect the current position and the referment set before.

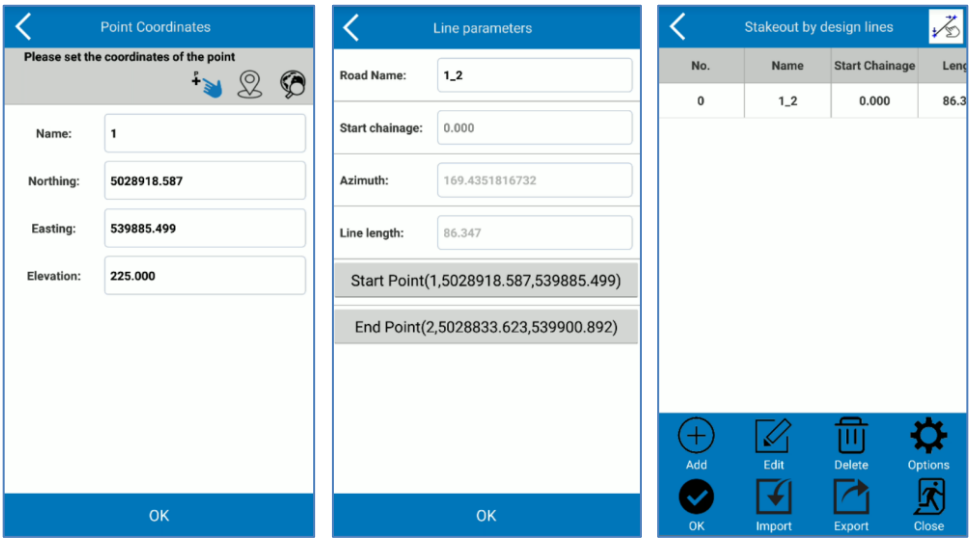
5.5 Stakeout by design lines

With this feature is possibly create parallel lines starting by one as referment and then stake all the lines.

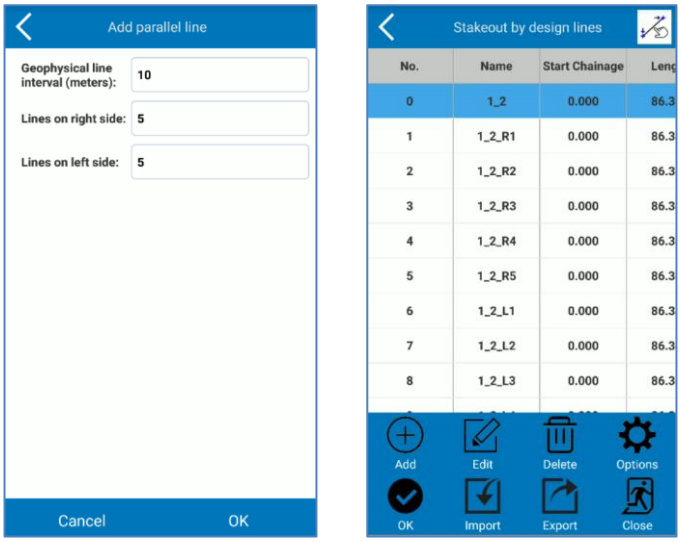
To do that open the tool and select Add. Then select Straight line to define the referment line.



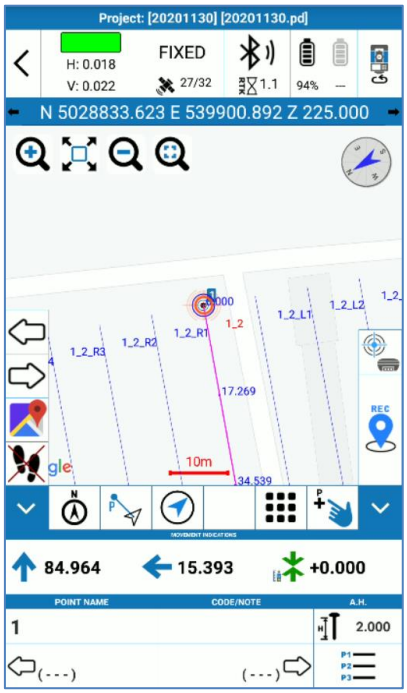
Then set the start point and the end point and give a name to the line.



Now to create the parallel lines select the referement line and press Add. A prompt menu will popup. In this menu the user can set the distance between the lines and the parallels on the right and on the left respect the referment line. After the confirm the user will have all the lines ready for the stake.

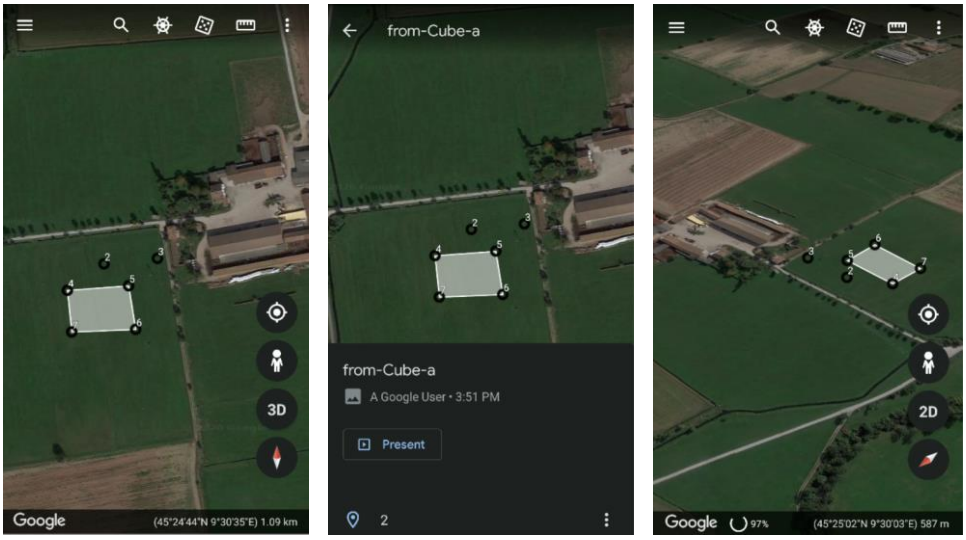


To start the stake, select the line and press ok.



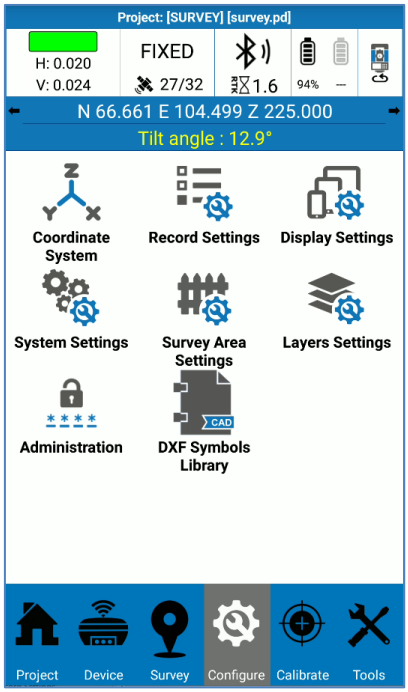
5.6 View in Google Earth

This command opens immediately your current project in Google Earth. As is possible see from the screen here below, the Cube-a export and dialog with Google Earth exporting all features stored through a .kml file.



6. Configure

Click "Configure". It consists of 8 submenus, namely *Coordinate System*, *Record Settings*, *Display Settings*, *System Settings*, *Survey Area Settings*, *Layers Settings*, *Administration* and *DXF Symbols Library*.



6.1 Coordinate System

Local coordinate parameters

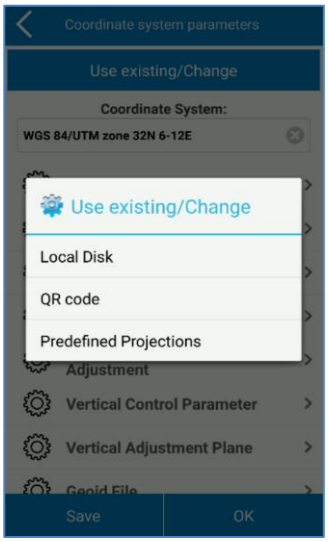
Click "Configure"- "Coordinate System" as shown in next Figure. All options can be clicked in to set up the parameter.

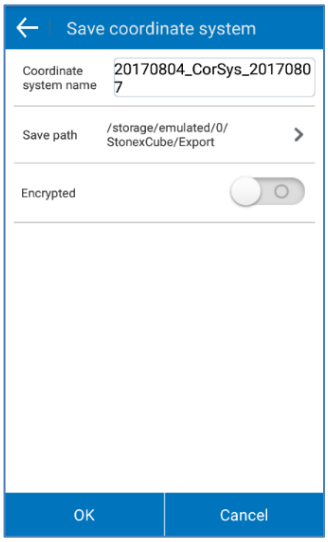
Click "Save" and choose "Local Disk" as shown in Figure to save system data to the specified path as shown in Figure. It can also encrypt the file by setting up Expiry Date, General Password (data cannot be viewed before expiry date) and Advance Password (data can be viewed before expiry date). Click "Save" and choose "QR Code" to share current coordinate system parameters.

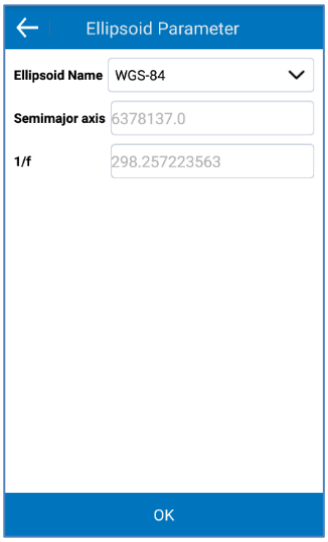
Click "Predefined Projections" as shown in Figure and choose "Local Disk" to import local-saved coordinate system parameters. It supports *.SP and *.EP files. Click "Predefined Projections" and choose "QR Code" to scan QR code to acquire coordinate system parameters.

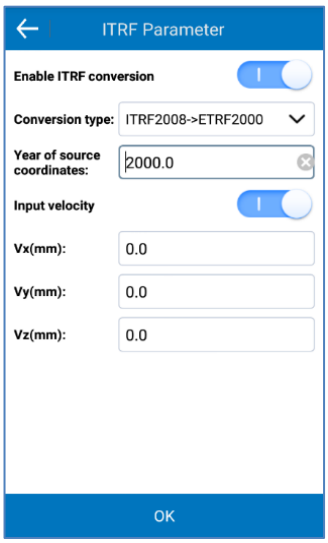
Ellipsoid Parameter:

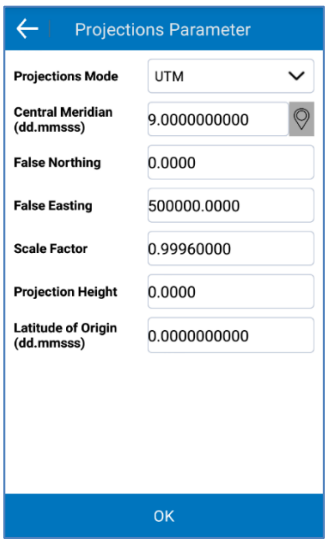
As shown in Figure, it can set up Target ellipsoid and enable/disable ITRF conversion. Target ellipsoid supports defined or custom parameters. With custom ellipsoid, it needs to set up Semimajor axis and Reciprocal of flattening 1/f, which should be consistent with the ellipsoid used for parameter calculation. To enable ITRF conversion, it needs to choose Conversion type, input Year of source coordinates and enable/disable Input velocity. If enabling Input velocity, it needs to input values for Vx, Vy and Vz as shown in Figure.











Projections Parameter

The frequently used projections mode is Gauss Kruger, and after connecting to the device the Central Meridian can be acquired automatically via a click on 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.

Seven-parameter, Four-parameter/Horizontal Adjustment, Vertical Control Parameter, Vertical Adjustment Parameter and Local Offsets can be set up as needed.

1. RTCM1021~1027 Parameters

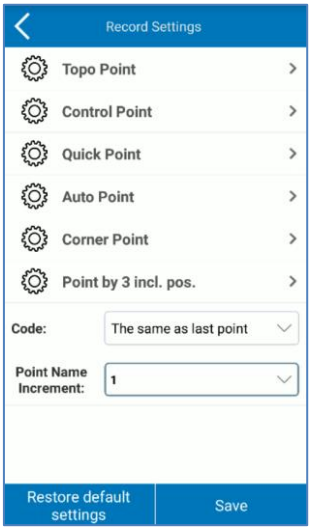
RTCM1021~1027 is a way to send coordinate system parameters via differential data. When coordinate system parameters type is set up as RTCM1021~1027 parameters in project creation, the software analyses coordinate parameters received with the differential data. In this mode, parameters cannot be set manually.

6.2 Record Settings

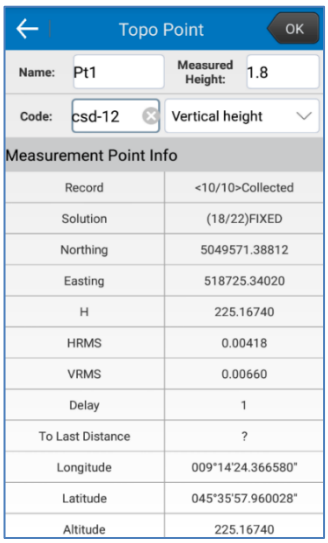
Click "Configure"- "Record Settings" as shown in Figure. It can set up Saved Conditions and Record Options of Topo Point, Control Point, Quick Point, Auto Point and Corner Point. It can set up Code and choose Point Name Increment. It also supports Default Configurations.

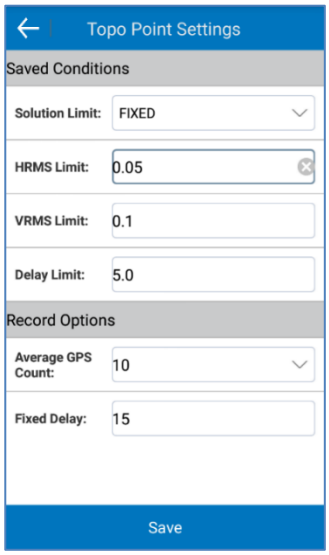
Code: it can choose the same as last point, Mileage assignment code and Code is empty by default.

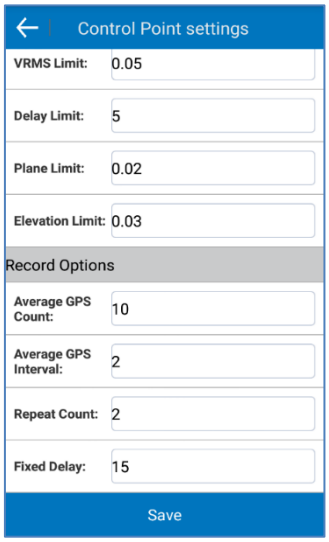
Point Name Increment: naming rule for saved points. For instance, Point Name Increment is 2, then the default point name of the first saved point is pt1, the second is pt3, and so on.



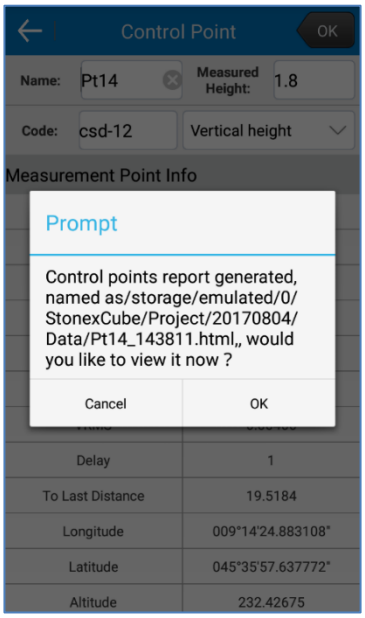
Topo point: The "average GPS count" in record options refers to the number of points which could be consecutive recorded. Please refer to the next Figure, it means that it could collect one point every time and this point should meet the saved conditions. When you click to record the topo point, if the RTK does not meet the saved conditions, there will be a prompt message. If the RTK meet the saved conditions, the measurement point info (HRMS, VRMS, delay, PDOP...) will be displayed in the screen. Then click OK to save the topo point.

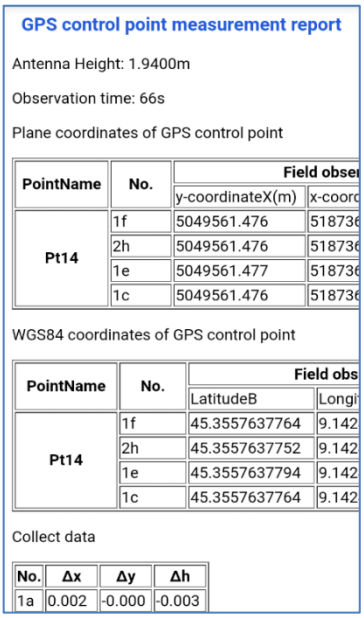






Control point: In the control point settings interface, you can set the saved conditions and record options of control point, please refer to last Figure. In record options, we can set the parameters average GPS count, Average GPS interval, repeat count and fixed delay. If the fixed delay is 15, it means that it should wait for 15s after you click  to record control point. If the average GPS interval is 2s and average GPS count is 10, it means that it could record a point every 2s and continuous record 10 points. If the repeat count is 2, it will collect 2 data sets. After the control points collection is finished, there will pop-up the prompt "The control point report has been generated" when you click "OK". If you want to view the report, please click "OK".





GPS control point measurement report

Antenna Height: 1.9400m

Observation time: 66s

Plane coordinates of GPS control point

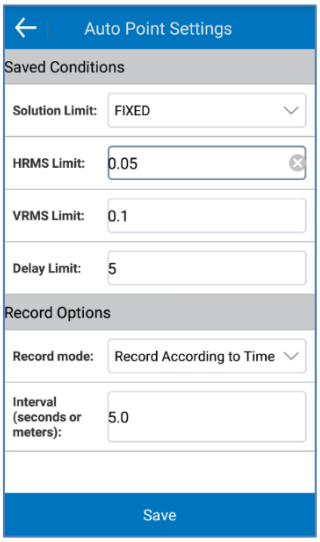
PointName	No.	Field obser	
		y-coordinateX(m)	x-coord
Pt14	1f	5049561.476	518736
	2h	5049561.476	518736
	1e	5049561.477	518736
	1c	5049561.476	518736

WGS84 coordinates of GPS control point

PointName	No.	Field obs	
		LatitudeB	Longi
Pt14	1f	45.3557637764	9.142
	2h	45.3557637752	9.142
	1e	45.3557637794	9.142
	1c	45.3557637764	9.142

Collect data

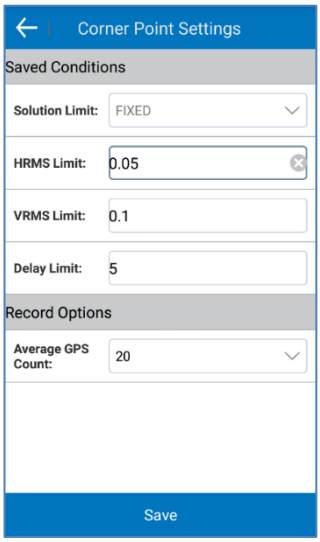
No.	Δx	Δy	Δh
1a	0.002	-0.000	-0.003

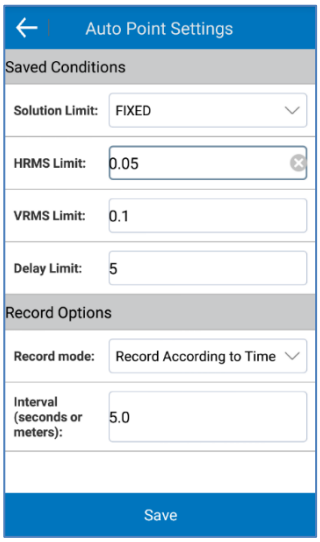


Quick point: When you collect the quick point, if the RTK meet the saved conditions, then the quick point will be collected after you click , and there will not pop-up the saved interface.

Auto point: When the record mode is "record according to time" and interval is 5s, it means that recording a point every 5s. Click to record the auto points, and if you want to pause the recording progress, please click "pause". Then if you want to start recording, please press "start". And you can click "close" to end the auto points recording.

Corner point: In corner point settings interface, you can set the saved conditions and average GPS count. Every time you record the corner point, you should record at least 15 points, and the distance between one point and another point should be greater than 1/10 of pole height. Then you can calculate the coordinates of the ball center by these corner points, the coordinates of the ball center are the corner point coordinates which you record.





6.3 Display Settings

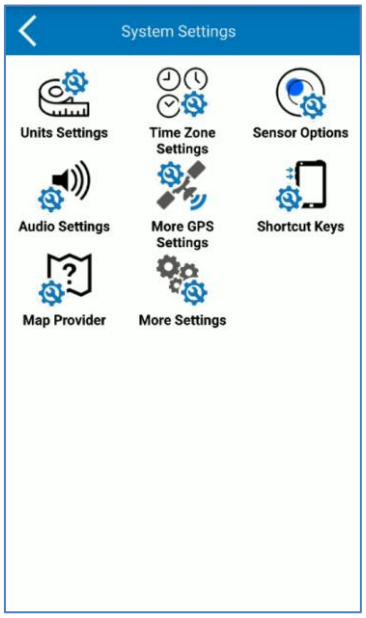
Click "Configure"- "Display Settings" as shown in Figure. Display Settings is for display set up on coordinates displayed in Survey interface. It can set up Display Content and Display Type as needed.

Display Content: Display Point Name, Display Code.

Display Type: Display All Points, Display Specified Point/Code, Display Last (0 to 100) Points.

6.4 System Settings

Click "Configure"- "System Settings" as shown in Figure. It can set up Time Zone, Solution, Units, Stakeout Voice Prompt, Base Prompt, Tilt Survey, Device, Shortcut Key, Stakeout Shortcut Key and Map and other more things.



Units Settings: Distance Unit can be set up as Meter, US Survey Feet, or International Feet. Angle Unit is ddd.mmssss. It can set up units according to different environment.

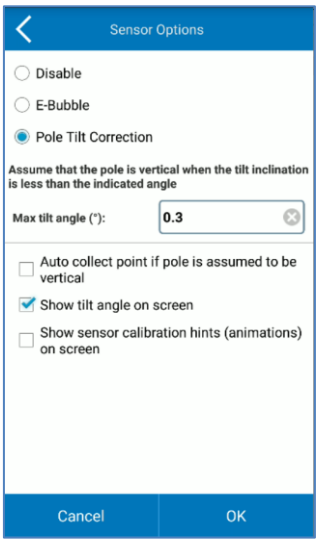
Time Zone Settings: set up device's Current Time Zone. The user can choose also to set it automatically following the OS time.

Sensor options: user can enable/disable the use of the e-bubble/IMU following the configurations available on the specific receiver. To enable the e-bubble/pole tilt correction feature is enough select it and confirm with ok. Inside this menu is possible also define a maximum tilt angle to consider the pole in vertical. So, this will be the tolerance for the verticality of the pole during the survey. Within this limit the software will consider the pole vertical then will proceed eventually with the measure of the points.

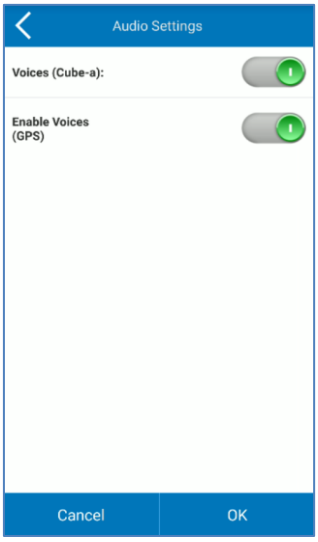
There is also the possibility to set the automatically collection of points if the pole is assumed to be in vertical respecting the limit set.

It is possible shows during the survey the live tilt angle of the receiver.

If the user prefers, there is also the opportunity to shows the animations of the initialization of the IMU sensor every time it goes out calibration during the survey. Once the user knows how to work with the sensor is possible disable them remove the check on this option.



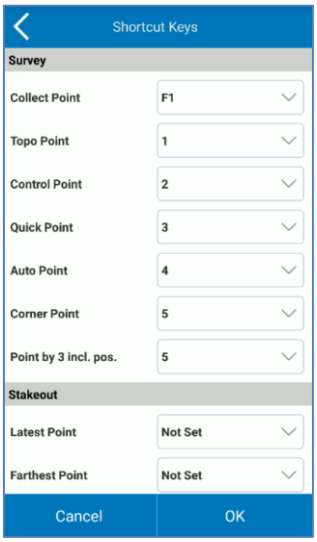
Audio Settings: this menu is to enable/disable the vocal messages of the receiver and software. User can customize the configuration following his needs.



More GPS settings: Here the user can choose as solution mode the normal mode or the strict mode in base of the survey is doing. In the specific it is possible enable for the receivers with Novatel board the extra-safe mode or the SureFix mode for the receivers with the Hemisphere board inside.

Always for receivers with the Hemisphere board inside it can be set the L-Band zone following the position in use on field.

Shortcut keys: it sets up shortcut keys for Topo Point, Control Point, Quick Point, Auto Point and Corner Point. For P9A, default shortcut keys are respectively (1) for Topo Point, (2) for Control Point, (3) for Quick Point, (4) for Auto Point, and (5) for Corner Point. It also supports custom defined.

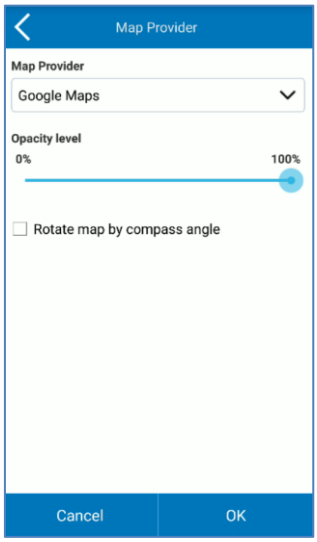


Map provider: in map provider is possible select the map services preferred between different map providers. Services supported are:

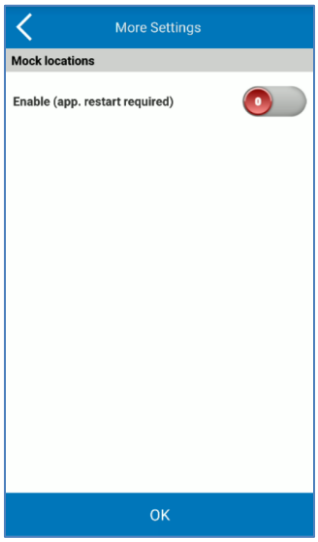
- **Google Map**
- **Open Street Map**
- **Bing**

It is possible also set the opacity level of the map in background setting the level of the opacity.

Last check is for enable the rotation of the map following the compass angle. If it is disabled, the map will be fixed respect the North.

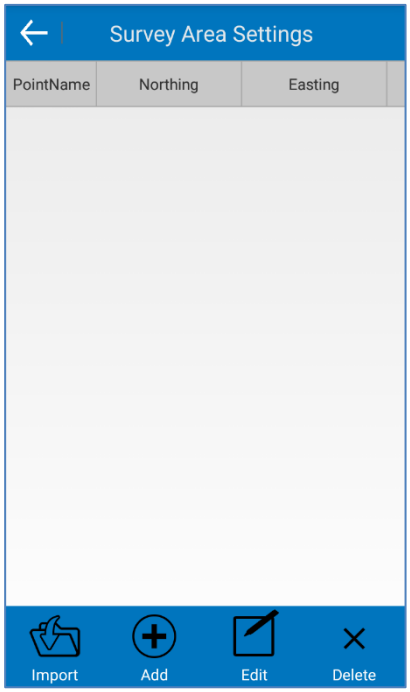


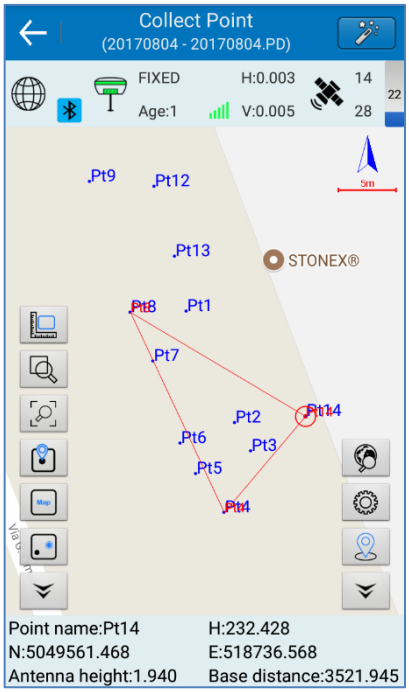
More Settings: here is possible enable the mock location feature. This will require the restart of the application



6.5 Survey Area Settings

Click "Configure"- "Survey Settings" as shown in Figure. Click "Add" to set up Point Coordinates or Search coordinates from library or Get current GPS coordinates. Generally, survey area set up needs at least three points. Points can be chosen to edit and delete. Click "Import" to import coordinates files (*.dat, *.txt, *.csv). Survey area shall display with red lines in measurement interface after survey area set up, as shown in Figure. It can check if the current point is in survey area when in survey.



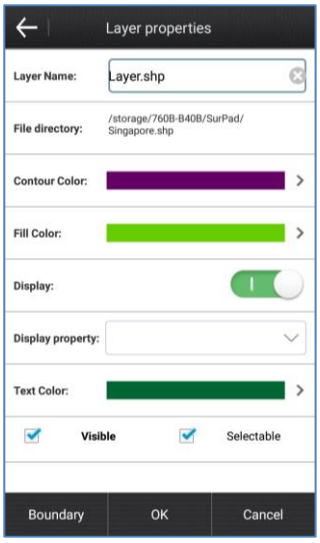


6.6 Layers Settings

Click "Configure"- "Layers Settings" as shown in Figure. Click "Add" to import layer. It supports *.shp (ArcGIS™ data type) and *.dxf (AutoCAD™® drawing exchange file) files. Choose layer and click "Edit" to edit Layer properties as shown in Figure. It can set up Contour Color and Fill Color, enable/disable layer properties display, choose which property to display and set up correspondent Text Color, choose if the layer visible and if selectable. Click "Boundary" to check the boundary of the layer as shown in Figure.

Multiple layers can be overlapped. Layers can edit, deleted, moved up and down. It can view imported layers in Survey interface after Layer settings, as shown in Figure.

In Survey, use to choose layer and it shows Layer Element as shown in Figure. Click "Property" to check detailed layer element information. It can stakeout the chosen point on the layer via a click on "Stakeout". It can save the chosen point to coordinate library via a click on "Save".



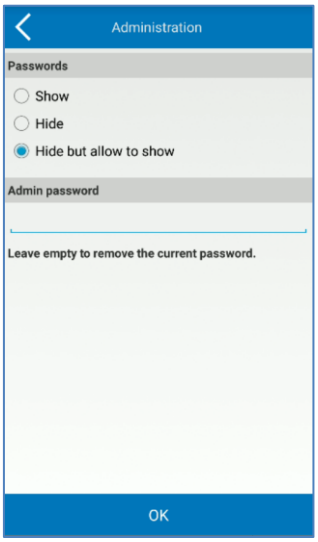
6.7 Administration

In Administration menu is possible to set the visibility of the password used inside the software.

Possibility are three:

- Password showed
- Password hided
- Password hided but possible to be viewed

When the user set this option, it is necessary also set a general password.



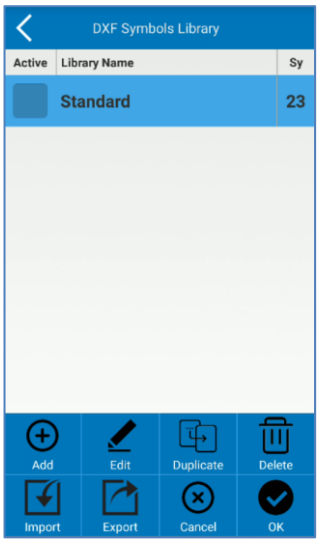
6.8 DXF Symbols library

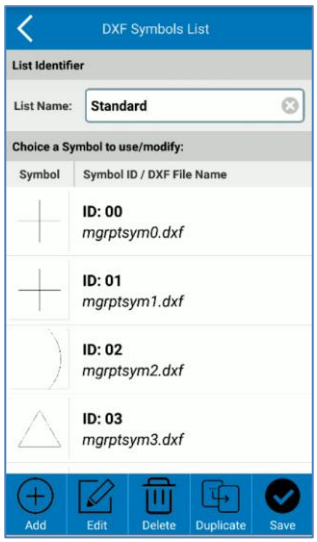
The DXF Symbols library is dedicated of the Symbols for the points.

Inside the library as default is present the Standard group with 23 symbols for the points.

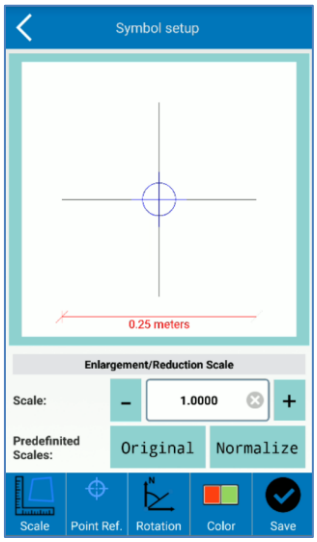
The user can add a new library, edit a present library, create a duplicate or delete. It is possible also import and export libraries.

Inside a selected library the user can see the preview of all symbols available.





User can select a symbol and edit it changing the scale, the rotation, the color and the shape. After the modification select ok to confirm the changes.

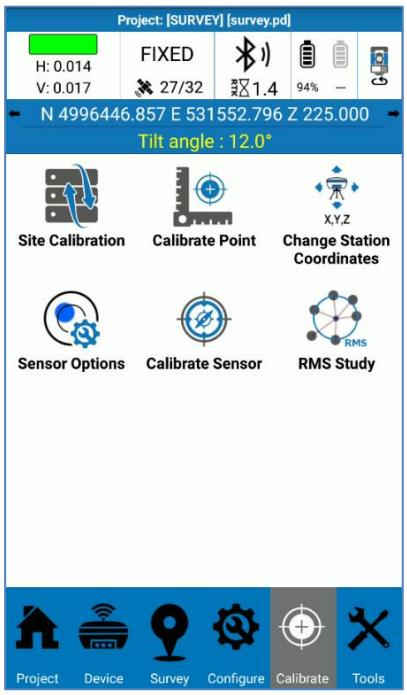

Symbol setup
0.25 meters
Enlargement/Reduction Scale
Scale:
1.0000
Predefinited Scales:
Original
Normalize
Scale
Point Ref.
Rotation
Color
Save

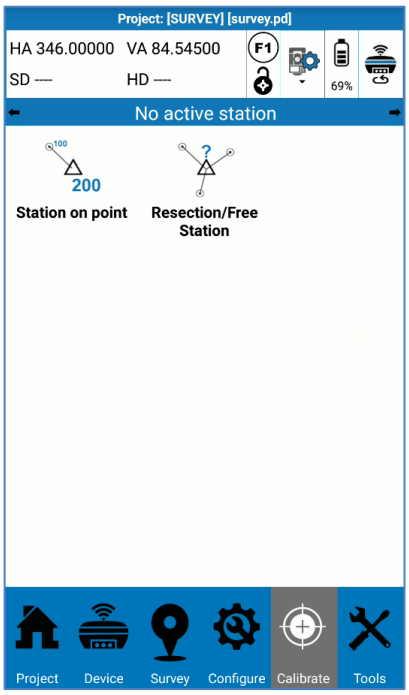
7. Calibrate

Click “Calibrate”, there will pop up the interfaces shown below.

If you are in GPS mode, the Calibrate includes *Site calibration, calibrate point, Change Station Coordinates, Sensor Options, Calibrate Sensor* and *RMS Study*.

If you are in Total Station mode, the Calibrate includes *Station on point* and *Resection/Free Station.*





7.1 GPS

7.1.1 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 coordinate conversion parameters are calculated and set the conversion parameters of software, it is the main tool to complete this work.

There are three coordinates convert methods, including “four parameters + elev. correction”, “seven parameters + four parameters + elev. correction” and “seven parameters”. The user need to consider which method should be used based on the known point.

Four parameters: At least two coordinates of control point should be known, which are in arbitrary coordinate system. It is the parameter that is used to perform a plane conversion between different coordinate systems within the same ellipsoid. Parameters include: four values (translate northing, translate easting, rotation and scale), the scale should be infinitely close to 1.

Seven parameters: At least three coordinates of control point should be known, which are in arbitrary coordinate system. It is the parameter that is used to perform space rectangular coordinate transformation within different ellipsoids. Parameters include 7 values (ΔX, ΔY, ΔZ, Δα, Δβ, Δγ, scale).

In general, the control point distribution directly determines the level of high and low and four parameters to control. Using four parameters for RTK measurement method can be in a small range (20-30 square kilometers), make the measurement point in plane coordinate and cooperate between the precision of elevation control net with known very well, as long as the coordinate point collection of two or more than two places, but in a wide range of measure (for example, dozens of hundreds of square kilometers), transformation parameters often can't play for increasing accuracy of plane and elevation in part of the scope, seven parameter method should be used at this moment.

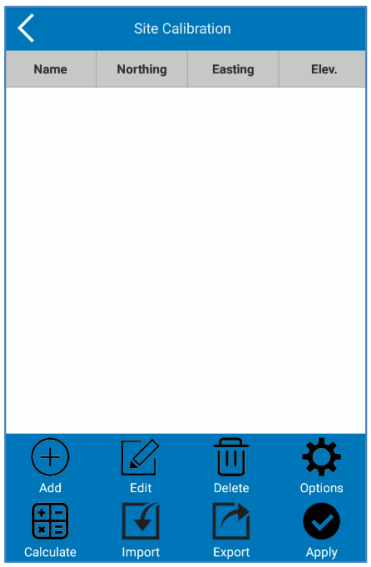
You first need to make measurements and leveling control, in the area known control point coordinates do static control, and then the network adjustment prior to the survey area is selected a control point A as static net adjustment WGS84 reference station. Use A static Device at A fixed point measure single point positioning of more than 24 hours (this step in the test zone is relatively small, relatively low accuracy of cases can be omitted), and then imported into the software in single point positioning point at which total recorded, the average as A point of WGS84 coordinate, as A result of long time observation, the absolute accuracy should be within 2 meters, and then to three dimensional control network adjustment, you need take point A WGS84 coordinate as known coordinate, to calculate other points of 3 d coordinates, but at least more than three group, after the input to calculate the seven parameters.

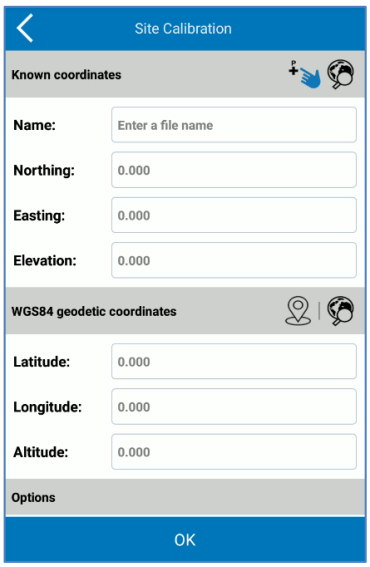
The four parameter is used to plane conversion, it also needs to horizontal adjustment. When using horizontal adjustment, if there are less than three points elevations used to calculate, the parameter of horizontal adjustment is weighted average. If there are 4-6 points elevations used to calculate, the parameter of horizontal adjustment is plane fitting. If there are more than 7 points elevations used to calculate, the parameter of horizontal adjustment is surface fitting.

How to calculate the convert parameter?

In general, if we use three known points A, B, C to calculate the conversion parameters, then first we should know the GPS original record WGS-84 coordinates and local coordinates of A, B, C three points. There are two methods to get the GPS original record WGS-84 coordinates of A, B, C points. First method set up static control network, then get the WGS 84 coordinates from the GPD recording of the post-processing software. Second method, GPS rover records the GPS original WGS-84 coordinates in a fixed solution when no correction parameters are active.

Click calibrate -> site calibrate, there will be the interface shown as Figure. You can do eight operations in this interface, including add, edit, delete, options, calculate, import, export and close.





Click “Add”, there will pop-up the interface shown as Figure.

There are two methods to set the know point coordinates: first method, click ••• to get the coordinates from the points library; second method, input the name, northing, easting and elevation directly.

Then set the WGS84 geodetic coordinates and click “OK” to add the first group of coordinates. The remaining coordinates can be added in this way, until you have added all the coordinates which are participated in the parameter calculation.

Select a coordinate in “Site calibration” and click “edit”, you can edit the parameters of this point, including known coordinates, WGS84 geodetic coordinates and options. Then click “OK” to save the changes.

Select a coordinate in “Site calibration” and click “delete”, then all the data about this point could be deleted from site calibration.

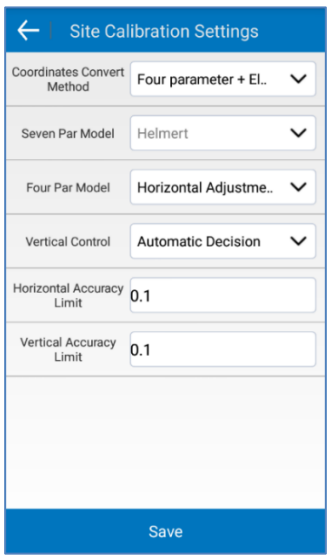
Click “Options”, there will pop up the site calibration settings shown as Figure. There are three coordinates convert methods, including “four parameters + elev. correction”, “seven parameter + four parameters + elev. correction” and “seven parameters”. The four parameters model includes “horizontal adjustment” and “four parameters”. Vertical control includes “weighted average”, “plane fitting”, “surface fitting”. The “horizontal accuracy limit” and “vertical accuracy limit” can be changed according to actual needs.

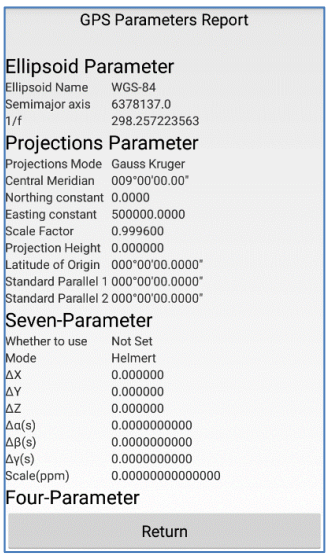
Click “Import”, you can import the “* .COT” file, which convenient coordinate input.

Click “export”, you can export and save the coordinates in site calibration to “* .COT” file. When you need to use these coordinates next time, you can import and don’t need to re-input.

After all the coordinates are entered, please click “calculate”, there will pop up the GPS parameter report shown as Figure. Click “return”, it will return to the site calibration interface, and when you click “Close”, there will pop up the prompt “are you sure to apply calculated parameter model to the current project?” shown as Figure. If you want to apply this parameter, please click “OK”. If you don’t like to apply this parameter, please click “cancel”.

After you apply the parameter, the original WGS-84 coordinates in the current project points library will be converted to the same coordinate system coordinates as the known points according to the parameters. Whether the calculation results are accurate or reliable, it can be checked by going to another known point.



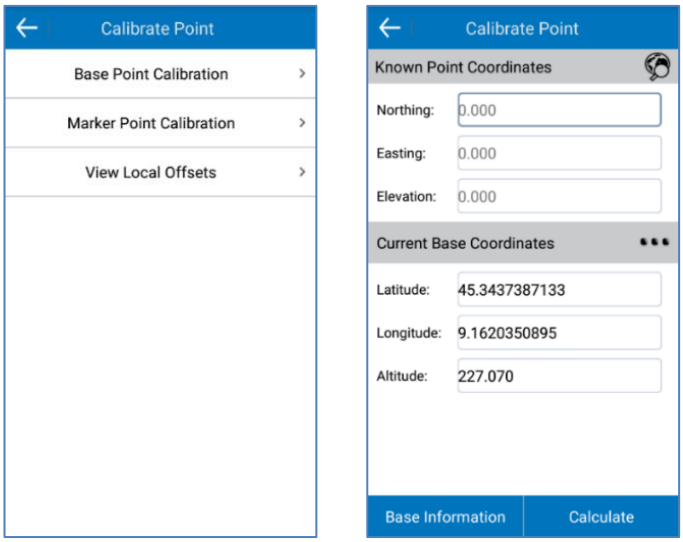


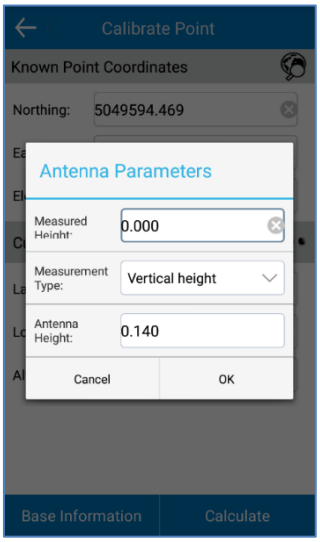
7.1.2 Calibrate Point

Click calibrate-> calibrate point, there will pop up the interface as shown in Figure. **Cube-a** has two kinds of calibrate point methods. Base point calibration, using the base coordinates before conversion and the current base coordinates to calibrate. Marker point calibration, using the coordinates of the points before conversion and the coordinates of the point after conversion to calculate.

Base point calibration steps:

1. Click "base point calibration" to enter the interface shown as Figure.
2. Please input the known point coordinates (the base coordinates before conversion). There are two methods to input the coordinates: Click to get the coordinate from the points library. Or input the northing, easting and elevation directly. Click "current base coordinates" to set the antenna parameters, please refer to Figure.





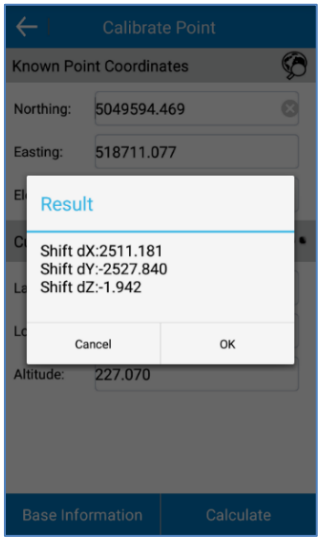
3. Input the measured height and select the measurement type.
4. Click "Calculate" to pop up the result as shown in Figure. Then click "Ok" to return to the calibrate point interface.

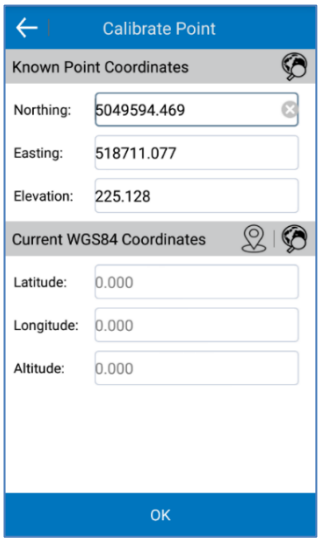
   Note: The base point calibration should be used in a fixed solution.

Marker point calibration steps:

1. Click “marker point calibration” to enter the calibration point interface shown as Figure. Then input the known point coordinates and click to get the current WGS84 coordinates.
2. Click “OK” to pop up the result. Then click “OK” to return to the calibrate point interface.

Click “view local offsets” to view the local offsets, please refer to Figure.





Calibrate point should be done on the basis of the already open transformation parameters. Local offsets are commonly used in the transformation parameters switch machine operations have been carried out and the base, or a work area of transformation parameters, can be directly input and local offsets parameters is, in fact, the use of a common point calculation of two different coordinates "three parameters", referred to as the local offsets in software.

The following is the case where the calibrate point is used.

1. In the startup mode parameters of base, the “use current coordinates” is selected, and the base have been restarted or the position has been moved, the rover should calibrate point.

2. When the user knows the conversion parameter of the work area, the base could be set up at any place. Please input the conversion parameter, and the rover should calibrate point.
3. In the startup mode parameters of base, the "input base coordinates" is selected, and the base has been moved, the rover should calibrate point.
4. In the startup mode parameters of base, the "input base coordinates" is selected. If the base hasn't been moved, it just be restarted, the rover doesn't need to 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.

7.1.3 Change Station Coordinates

The feature *Change Station Coordinates* is useful in Base-Rover RTK working mode. When you save a point with the rover, Cube-a also saves the coordinates of the base of the point, so, if you want to move the base to a different place, you can use the *Change Station Coordinates* to change the base coordinates, then Cube-a will calculate the saved points coordinates in order to keep the same baselines length.

Warning: this feature is in BETA PREVIEW. Do not use it on real surveys to avoid any possible data loss.

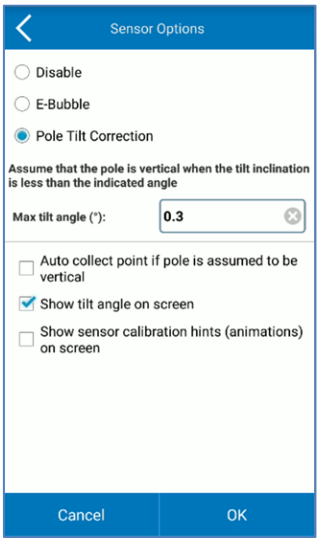
7.1.4 Sensor Options

User can enable and disable the e-bubble and IMU following the configurations available on the specific receiver. To enable the e-bubble/ pole tilt correction feature is enough select it and confirm clicking on OK. Inside this menu is possible also define a maximum tilt angle to consider the pole be vertical. So, this will be the tolerance for the verticality of the pole during the survey. Within this limit the software will consider the pole vertical then will proceed eventually with the measure of the points.

There is also the possibility to set the automatically collection of points if the pole is assumed to be in vertical respecting the limit set.

It is possible shows during the survey the live tilt angle of the receiver.

If the user prefers, there is also the opportunity to shows the animations of the initialization of the IMU sensor every time it goes out calibration during the survey. Once the user knows how to work with the sensor is possible disable them remove the check on this option.



7.1.5 Calibrate Sensor

Calibrate Sensor page depends on the connected receiver.

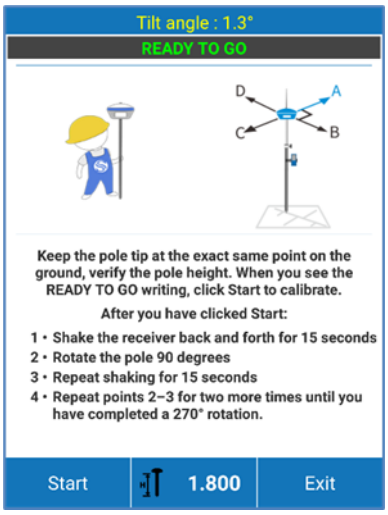
Stonex receivers with the new IMU technology

Follow the shown instructions to perform the calibration.

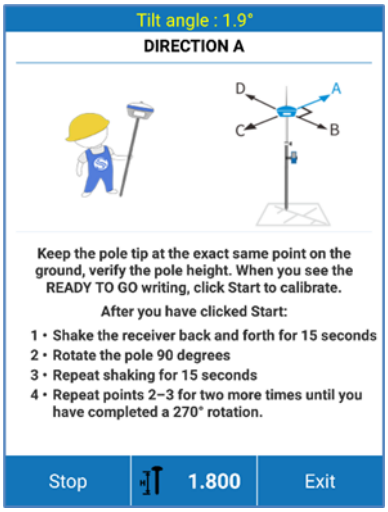
A Fixed GNSS solution is mandatory.

Check the antenna height: a wrong antenna height will make the calibration not accurate.

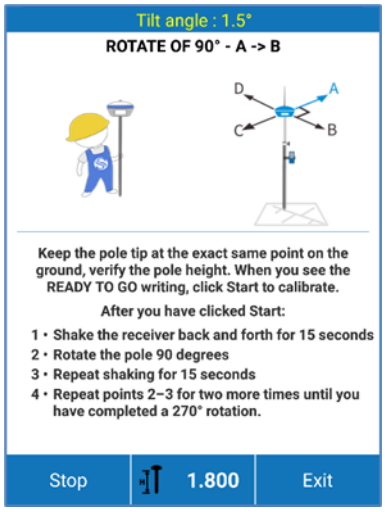
Wait for the message *Ready To Go*, start the calibration by clicking on the *Start* button**.**



As shown in the picture below, to correctly calibrate the sensor, it's necessary to choose an arbitrary first direction as a reference (direction A), then start to move the receiver back and forth along that direction and until a message asking to change the direction appears.



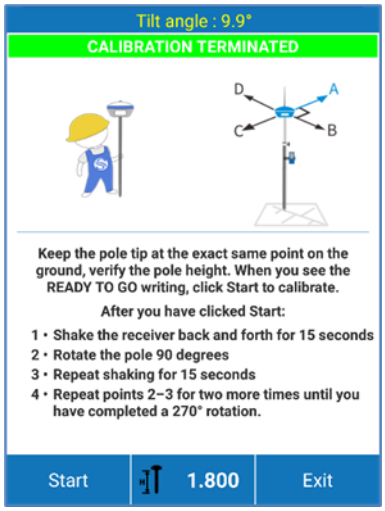
Rotate the receiver 90 degrees clockwise, reaching the direction A+90° = B, and continue to move back and forth the device.



This operation must be repeated for 3 times, thus every 90 degrees up to a total of 270° clockwise.

After moving the device back and forth along the direction D, the message Calibration Terminated will appear.

If the calibration fails, an error message will be shown. In this case, repeat the calibration procedure.



Stones receiver with the old Tilt Sensor

Click "Calibrate"-> "Calibrate sensor" to enter the page shown as Figure. There are three function keys in this interface, including *e-bubble calibration*, *magnetic azimuth calibration* and *magnetic declination calibration*. There are four steps to perform sensor calibration, and the operation of these four steps will be described in detail below.

1. Enable pole-tilt correction

Click *Configure* -> *System settings*, select "*Pole – Tilt correction*" in tilt survey, then click "OK".

2. E-bubble calibration

① Click "calibrate -> calibrate sensor ->  " to enter the e-bubble calibration interface shown as Figure.

② After the bubble centered on the retractable pole, please click the "calibrate" button. At this time, the e-bubble in RTK and the bubble on the retractable pole are both centered, the bubble in **Cube-a** turns to green shown as Figure.

Note: The values displayed in the bottom of the screen.

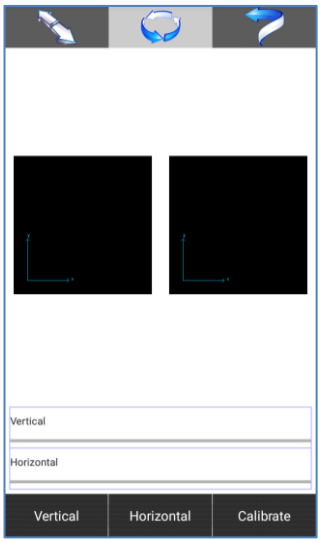
Left——inclination angle

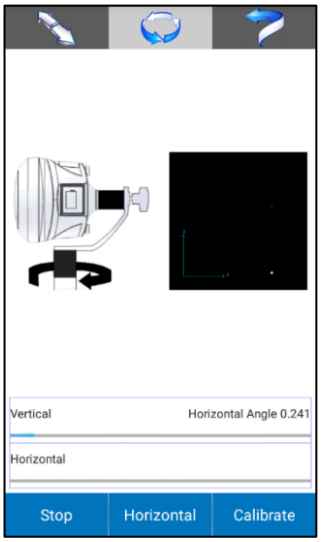
Right——Azimuth

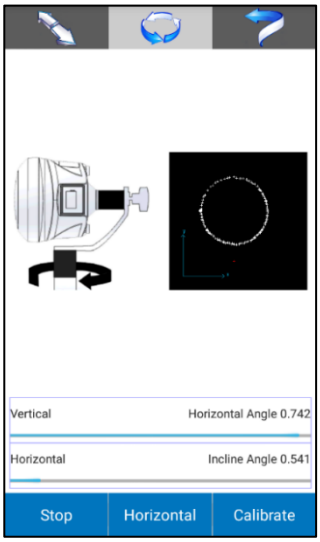
3. Magnetic azimuth calibration

Click "  " to enter the interface shown as Figure.

① **Record vertical data** : follow the Figures to install the calibration support pole, the limited block should be stuck in the groove of RTK. After you install the calibration support pole, please click "vertical", and do circular motion centered on the retractable pole and the speed cannot more than 15 ° / s. The retractable pole rotated a circle, after finish the data record, the receiver will beep. The vertical data recording process shown as Figure. After the vertical data recording shown as Figure.

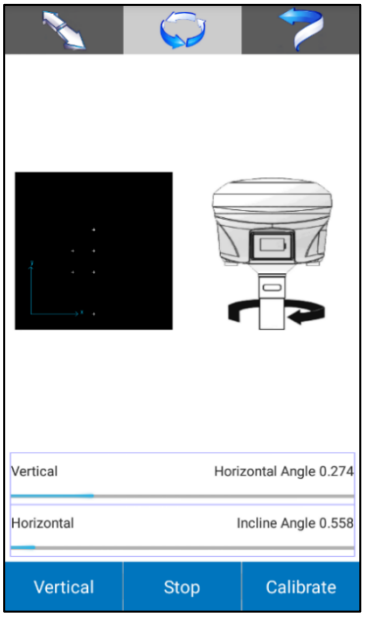


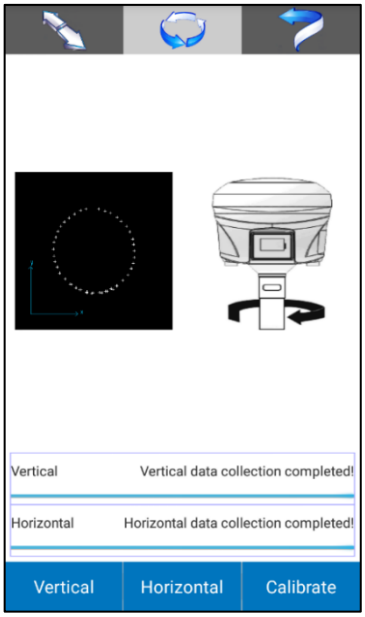




4. Record Horizontal data: Follow the Figure to install the calibration support pole. Click "horizontal", and do circular motion centered on the retractable pole while keeping an angular speed lower than 15°/s. When a complete

rotation around then retractable pole has been completed, data recording will stop, and the program will beep. The horizontal data recording process shown as Figure. After the horizontal data recording shown as Figure.





Note:

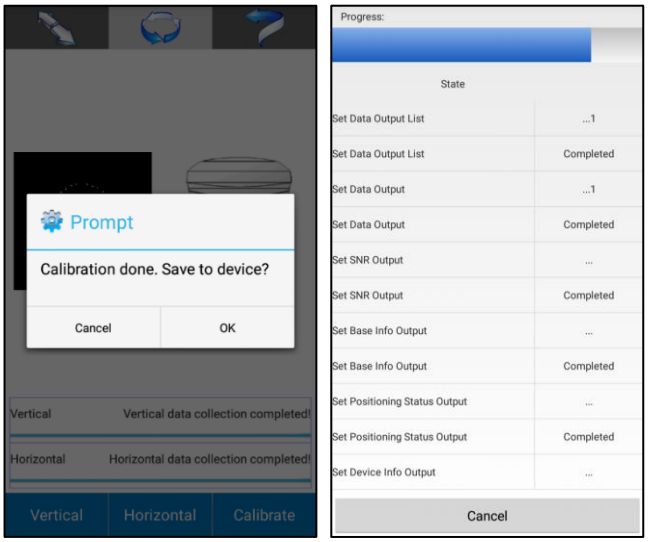
A. When rotated, the software will display the real-time status of the current data recording.

B. If the data of some locations is not recorded (too fast rotation will lead to data missed recorded), you need to rotate again to the location for the 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.

③ **Calibrate parameter:** After the vertical and horizontal data recording is complete, click "Calibrate", there will pop up the dialog box of the calculating result of the parameters, as shown in Figure. Click "OK" to use this calibration parameter, as shown in Figure, to complete the "calibrate sensor".



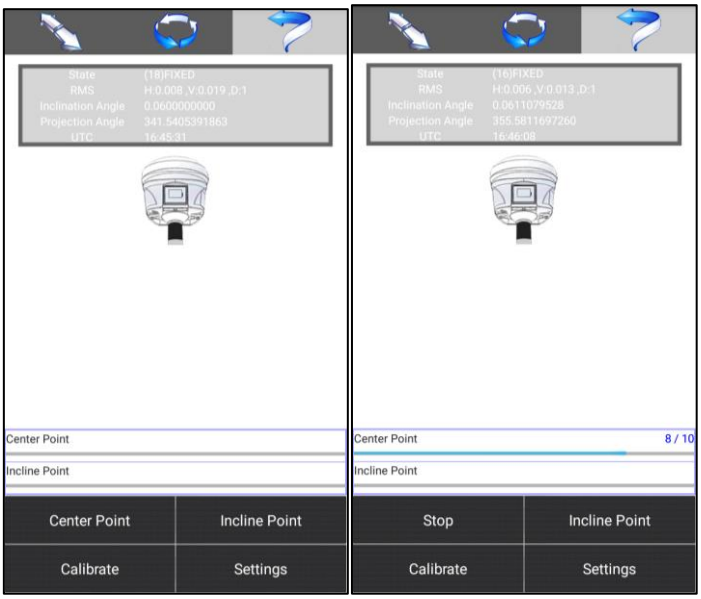
④.**Magnetic declination calibration**

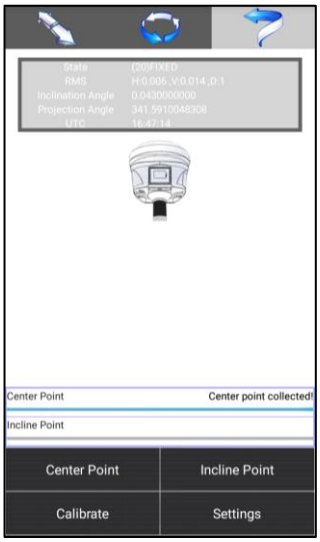
Click "  " to enter the interface shown as Figure.

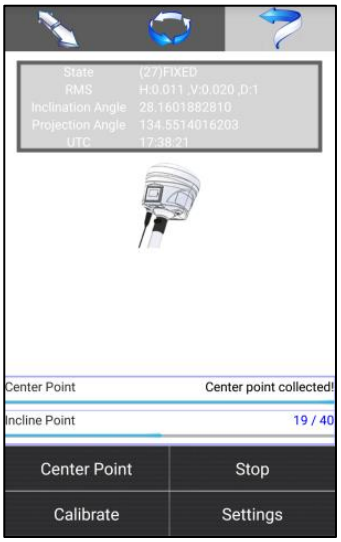
① **Record center points:** click "center point" to record center points, it need to record the coordinates of 10 static points. In the recording process and after the recording, please refer to the Figure and.

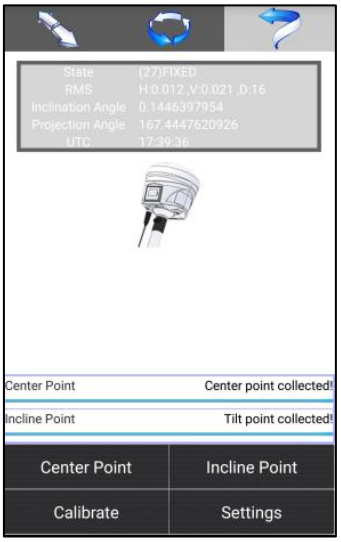
Recording condition: a. relative static state b. inclination angle <0.3°

c. fixed solution d. recorded 10 points









② **Record incline points:** Click "incline point" to record the incline points, it needs to be recorded in four directions (east, south, west and north), and should to record coordinates of 10 static points in every direction. In the recording process and after the recording, please refer to the Figure.

Recording condition:

a. relative static state

b. inclination angle 25°-35°

c. Fixed solution

d. Recorded data in every direction (east、south、west、north)

e. Recorded 10 points in every direction

Note:

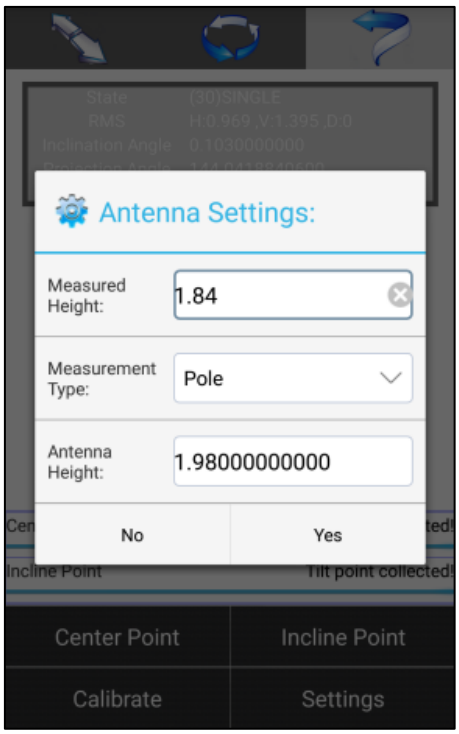
A. When do the magnetic incline calibration, it is recommended that the retractable pole be extended to 2 m or more.

B. Keep the Device as smooth as possible when recording data.

③ **Calibrate parameter:** After the center point and the incline point have finished recorded, click "calibrate" to calculate Magnetic declination parameters, there will pop up the dialog box of antenna parameter settings, shown as Figure. After you input the antenna parameter, please click "OK", then there will pop up the prompt about the projection correction. Please click "OK" to finish the sensor calibration.

④ After the sensor calibration, you can click "Settings" to view the magnetic declination. If you know the magnetic of the work area, you do not need to do the sensor calibration, please just input the magnetic declination in "settings".

Note: If there is a prompt that the error overrun, please check the antenna height is right or not. Then extend the retractable pole to redo the sensor calibration.

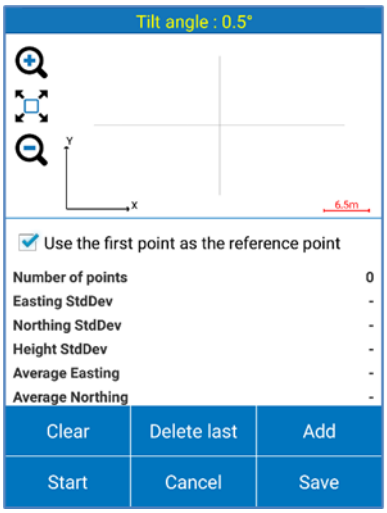


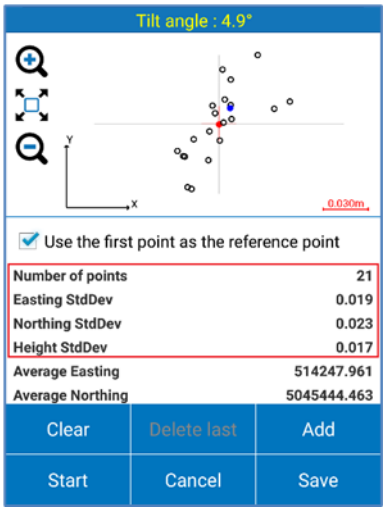
7.1.6 RMS Study

You can check the accuracy of the tilt compensation through the RMS quality check. If the accuracy (RMS) is good, then you can continue working. If the accuracy (RMS) is not good, then calibrate the sensor using the Calibrate Sensor function. The RMS Study performs the study of the quality/accuracy of repeated measures (keep the pole tip at the same exact position on the ground).

How to use it? Open the Calibrate menu, then select the RMS Study command. When inside the RMS Study screen, click Start to collect the measures.

The application will collect measures/positions at an average frequency of 1Hz. Collected positions will be averaged and RMS values will be computed. The RMS values let the user to verify if the accuracy of the device falls within some required accuracy upper limit. If the RMS values are not satisfactory then the user can, and he should, proceed with the calibration.





The user has the control of the number of sample positions used in the RMS calculation. When the user decides to complete the check, he can press Stop to stop the automatic position acquisition.

As said, if the RMS values are not satisfactory then the user can, and he should, proceed with the sensor calibration.

This operation is also suggested when the user changes the pole height and/or the pole type (there could be a change in the straightness of the pole).

7.2 Total Station

7.2.1 Station on point

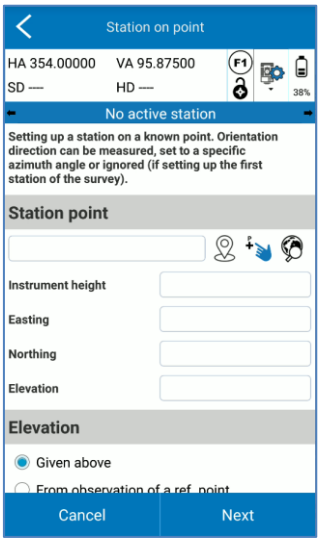
Click Calibrate-> Station on point: there will pop up the interface as shown in figure below.

Coordinates of point station can be inserted manually, by filling in the *Easting Northing* and *Elevation* cells, or:

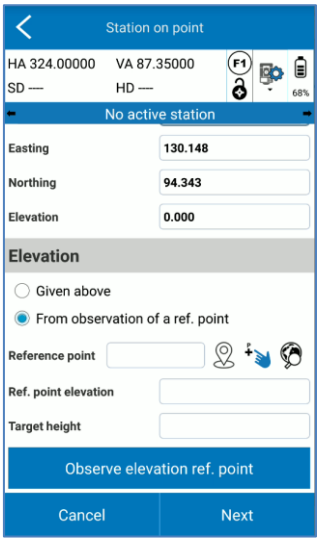
- Measured by GNSS antenna (if available). Tapping on it, **Cube-a** will directly collect coordinates as a Topo Point;
- Selected from the map, including CAD entities;
- Selected from the point list.

If you want to change the point name, edit the cell on the left.

Insert the *Instrument height* (total station height).

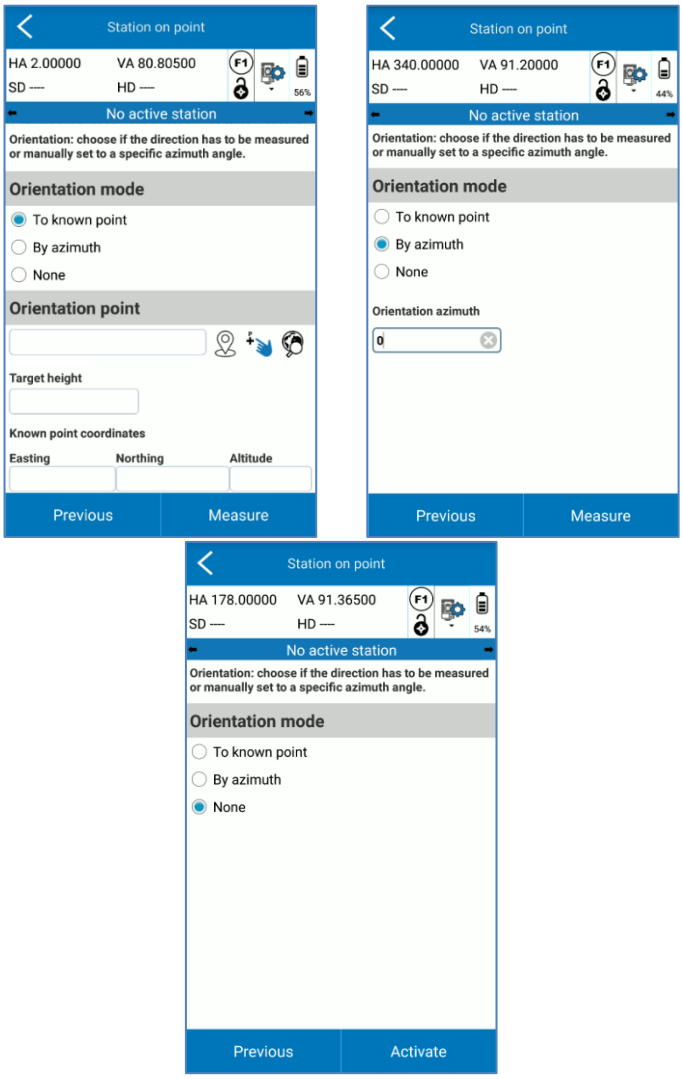


As an alternative to inserting the elevation, it is possible to use the observation of a reference point. Define the reference point in the same way as you did for the station point and insert its target height; then, observe it. Click on *Next*.



In the next page, define which orientation mode you want to use:

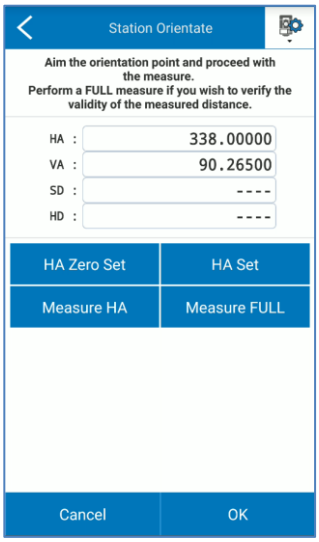
- *To known point*: it orients the station on a point whose coordinates are known. Insert coordinates of a point or measure it or select it from the project (in the same way as you did for the station point and define the target height;
- *By azimuth*: it orients the station to a direction. Insert the reference angle with respect to the North of the local system (not to be confused with the horizontal/azimuth angle read by instrument);
- *None*: it does not care the orientation. As default, **Cube-a** will use default horizontal angle of the total station.



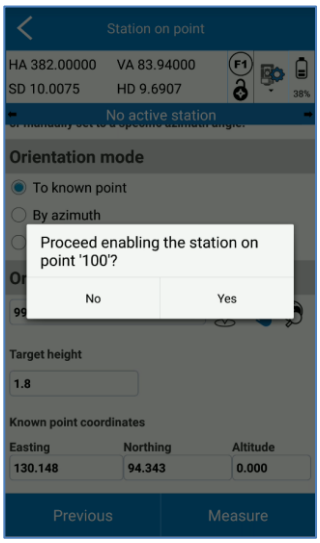
If you have selected *None*, you can directlty *Activate* the station, otherwise you have to *Measure* the orientation point:

- *HA Zero Set*: it sets the horizontal angle of the instrument to zero;
- *HA Set*: it allows to enter the desired horizontal angle;
- *Measure HA*: it shows the horizontal angle measured by the instrument;
- *Measure FULL*: it measures the distances of the orientation point.

Click on OK, once measured.



At the end of the procedure, **Cube-a** will ask you if you want to proceed enabling the station on the defined point. Click on *Yes* to proceed.

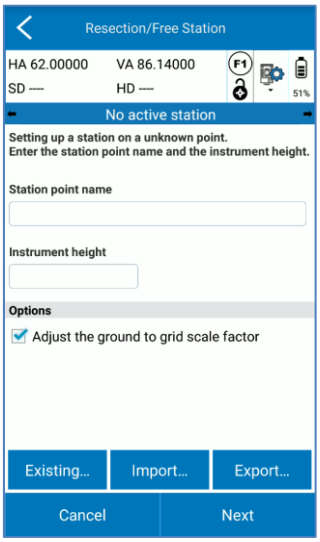


7.2.2 Resection/Free Station

Click Calibrate-> Resection/Free Station: there will pop up the interface as shown in figure below.

Insert the *Station point name* and the *Instrument height*.

Choose to tick or not "*Adjust the ground to grid scale factor*". Enabling it, all the measures made with the total station will be scaled by using the scale factor of the Reference system you have defined in the project. If you are only working with total station in a local reference system, it is advisable to do not tick the setting, to have real distances, without corrections applied.

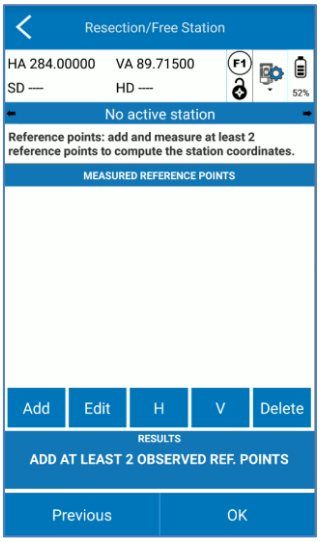


You can select an *Existing* free station or *Import/Export* a calculation.

Click on *Next* to insert and measure the points for the calculation. **Cube-a** asks you to satisfy one of the following requirements:

- 3 or more angular readings.
- 2 or more full readings (angles + distance);
- 2 or more mixed readings (angles + distance/ only angles).

Click on *Add* to insert the first point.

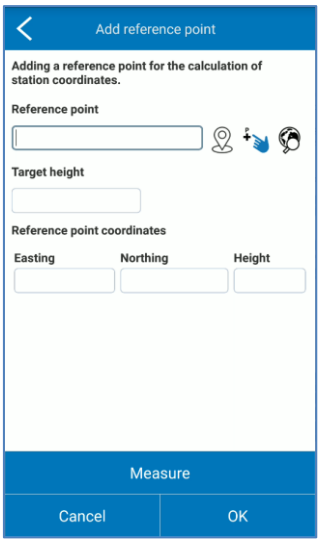


Coordinates of point can be inserted manually, by filling in the *Easting Northing* and *Elevation* cells, or:

- Measured by GNSS antenna (if available). Tapping on it, **Cube-a** will directly collect coordinates ad a Topo Point;
- Selected from the map, including CAD entities;
- Selected from the point list.

If you want to change the point name, edit the cell on the left.

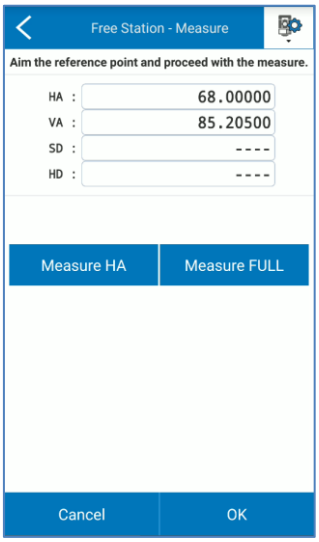
Insert the *Target height* and click on *Measure*.



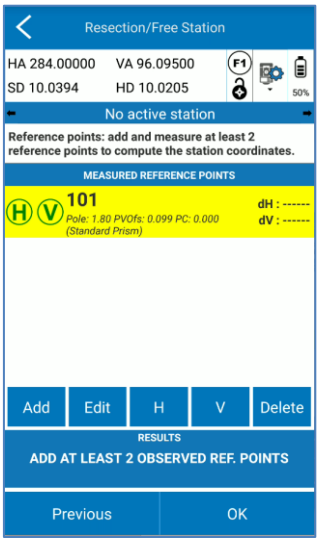
Aim the point and proceed with the measure, which can be:

- *Measure HA*: only angle measure;
- *Measure FULL*: angles and distance.

Proceed pressing *OK*.



The first point observation will be listed in the following page.



Continue adding the next point(s), proceeding in the same way as before.

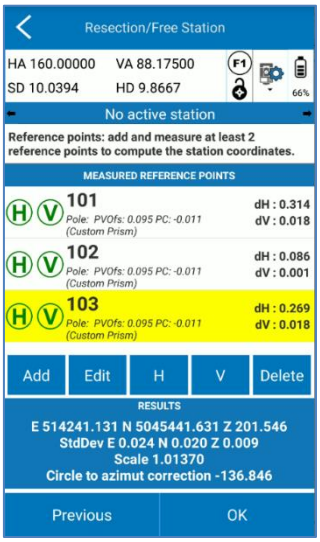
You can see the results of the calculations:

- Calculated E, N, Z coordinates of the station;
- Station E, N, Z standard deviations, which defines the estimated possible error of the coordinates. They can be positive or negative values;
- Planimetric and Vertical coordinates residuals (Measured- Known). They are absolute - in metres declared values.
  dH is the difference between the calculated and the known point in 2D
  dV is the difference in altitude between the calculated and the known point.
- *Scale factor* is reported
- *Circle to azimuth correction* is the horizontal angle correction which the free station program calculates with respect the horizontal circle of the total station.

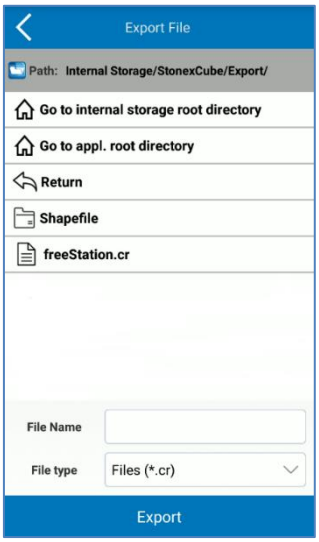
If needed, you can tap on H and V to deactivate the Horizontal and/or Vertical angular reading and check if the results quality increases. The same command is performed by the *H* and *V* on the blue icons.

You can click on *Edit* to modify a point or re-perform its measure. Or you can click on *Delete* to remove a point.

Before confirming with *OK*, you can tap on *Previous* to go back to the where it is possible to export the free station calculation.

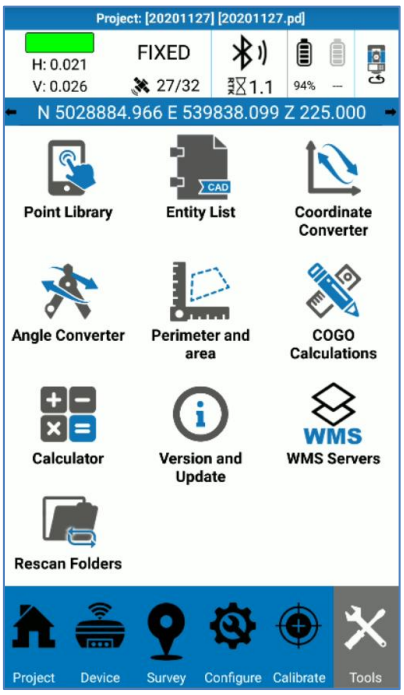


A free station file can be exported with *.cr* extension:



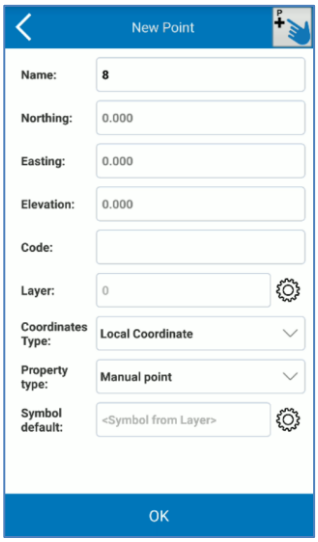
8. Tools

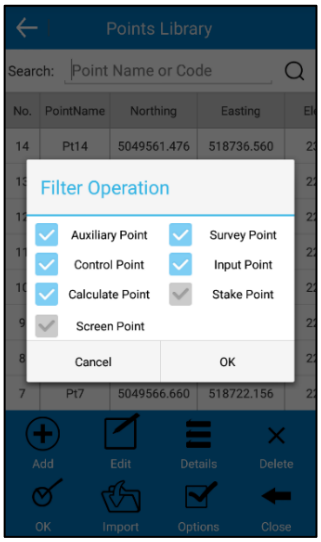
Click “Tools” as shown in Figure. It consists of 10 submenus, namely Points Library, Entity List, Coordinates Converter, Angle Converter, Perimeter, and area, COGO Calculation, Calculator, Version and Update, WMS Servers, Rescan Folders



8.1 Point Library

Click “Tools”-” Point Library”.





Points library is for unified management on all kinds of coordinates. It adds point coordinates used in operation, helping invoke them in point setting-out. It supports quick search on coordinate points through entering point name or point No. in the Search box. Points Library consists of 8 contents, namely Add, Edit, Details, Delete, OK, Import, Options and Close.

Click "Add" as shown in Figure. Coordinates type includes Local Coordinate and Geodetic Coordinate. Property type includes Assistant point, Control point, Input point and Stakeout point. Input point name, plane coordinates (x, y, h) or latitude/longitude coordinates and Code after setting up Coordinate type and Property type to accomplish parameter set up of new coordinates.

Choose any points in the Points Library. And click "Edit" to edit the Point name, plane coordinates (x, y, h) or latitude/longitude coordinates and Code, which applies to all points but Survey points. Click "Details" to check the Point name, Code, latitude/longitude coordinates, plane coordinates (x, y, h) and Type. Click "Delete" to delete the chosen point from the Points Library.

Click "Import" and choose file format to import coordinates file, helping search and invoke coordinates in point setting-out. It supports Measurement data file(*.PD) and Custom format file(*.cvs, *.dat and *.txt).

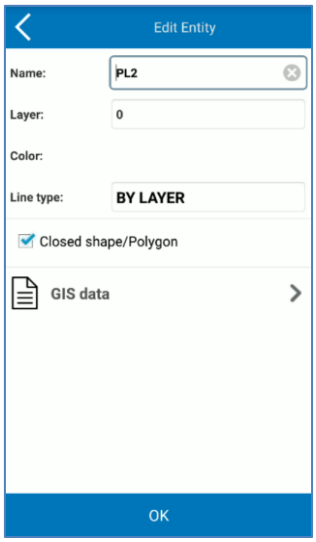
Click "Option" as shown in Figure. Tick the point types to present as needed to filter other unwanted point types. It includes 7 options, namely Auxiliary Point, Survey Point, Control Point, Input Point, Calculate Point, Stake Point and Screen Point.

8.2 Entity List

The Entity list includes the list of all enity inside the project exept the points. So, it includes polylines, parcels and other entities created.

Also, for the entities there is the opportunity to edit or delete them.

To edit an entity is necessary select it and press edit



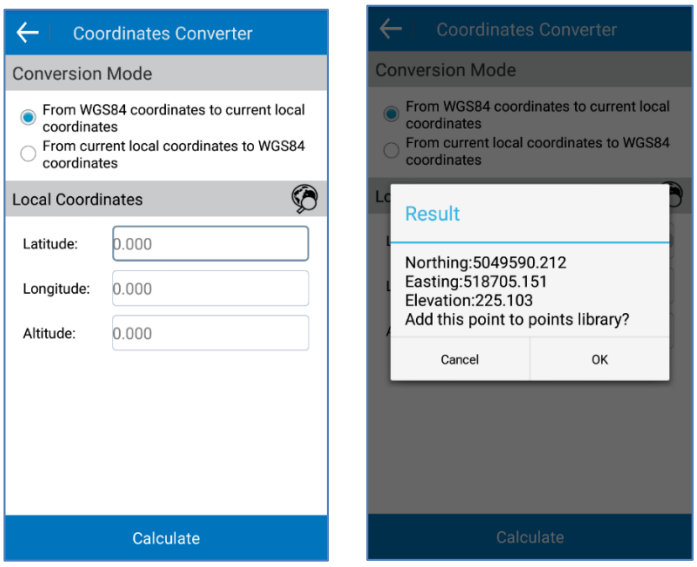
If the entity has GIS data is possible modify them after the closing of the item.

8.3 Coordinate Converter

Click "Tools"- "Coordinate Converter" as shown in Figure. Choose Conversion Mode, input coordinates, and click "Calculate" to accomplish coordinate conversion and check result as shown in Figure. If it needs to save the converted coordinates, click "OK" and input the point name to save it to the coordinate library.

There are two Conversion Modes: "*From WGS84 coordinates to current local coordinates*", and "*From current local coordinates to WGS84 coordinates*".

There are two ways to set up the converting coordinates: one is directly inputting the Latitude, Longitude and Altitude or plane coordinates (x, y, h); the other is extracting points from Points Library.

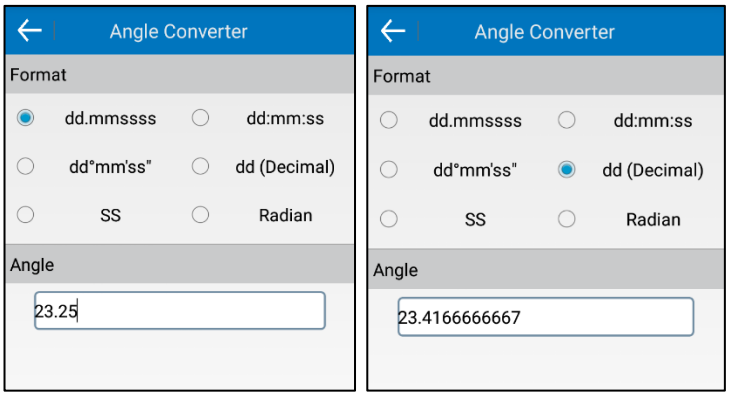


8.4 Angle Converter

Click "Tools"- "Angle Converter" as shown in Figure. It includes 6 angle formats, namely *dd.mmssss*, *dd:mm:ss*, *dd°mm'ss*, *dd(Decimal)*, *SS* and *Radian*.

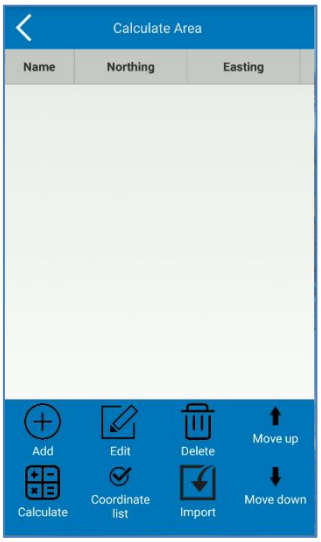
The conversion goes in the following sequences:1. choose input angle format; 2. input angle; 3. choose angle converted format; 4. angle conversion accomplished, converted result presented in the angle box.

For instance, input angle 23.25, convert it into dd(Decimal), and the result is as shown as in Figure.

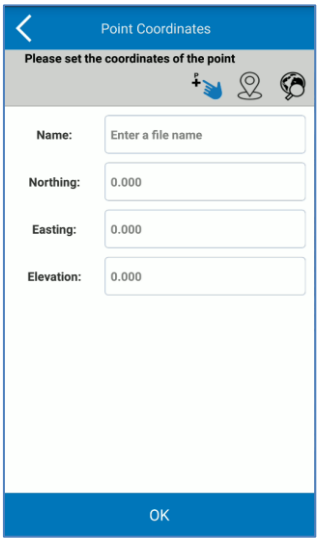


8.5 Perimeter and area

Click "Tools"- "Perimeter and area" as shown in Figure.



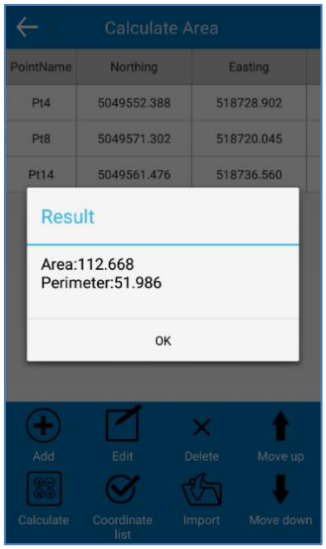
Click "*Add*" to set up at least 3 coordinates. You can enter the coordinates filling in the cells, or select a point from the map, or measure the point or select the point from the list.



Otherwise, click "*Import*" to choose import coordinates file (*.dat and *.txt). The imported data can be filtered (through PointName or Code), searched and selected to determine the points used for Perimeter and Area calculation.

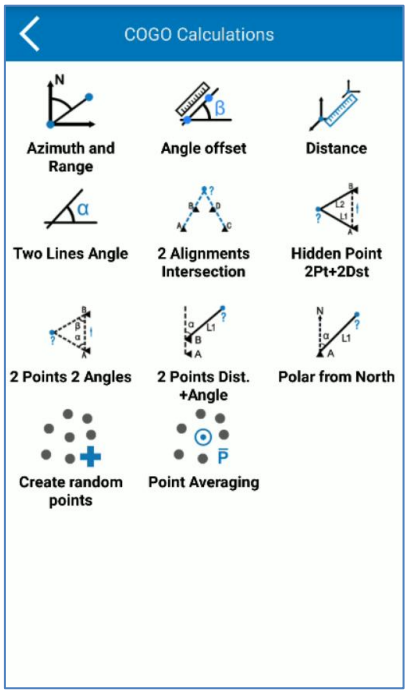
Points can be chosen to "*Edit*" and "*Delete*" or modify their order using "*Move up*" and "*Move down*".

Click "*Calculate*" to check the result, i.e., the Area and Perimeter of the graph composed by the set-up points as shown in Figure.



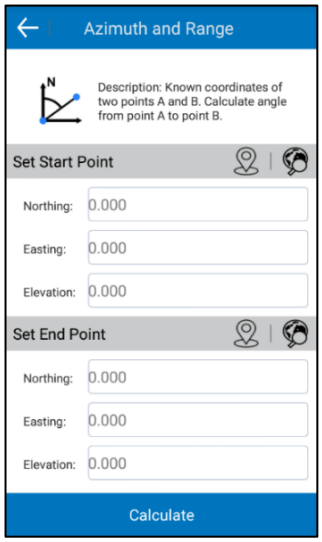
8.6 COGO Calculation

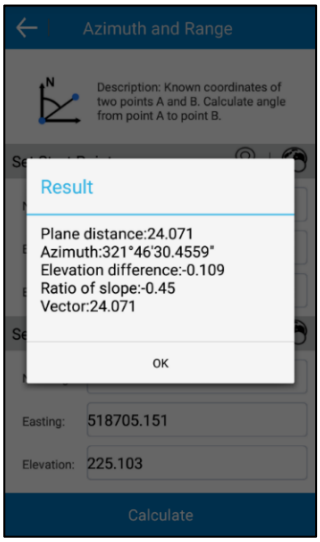
Click "Tools"- "COGO Calculation" as shown in Figure. According to the known coordinates, it can Figure out position relations between point and point as well as between point and line. It includes Azimuth and Range, Angle offset, Distance, Two Lines Angle, 2 alignments intersection, Hidden point Two Points Two distances, Two Points Two Angles, Two Points distances plus Angle, Polar from North, create random points and point averaging.



8.6.1 Azimuth and Range

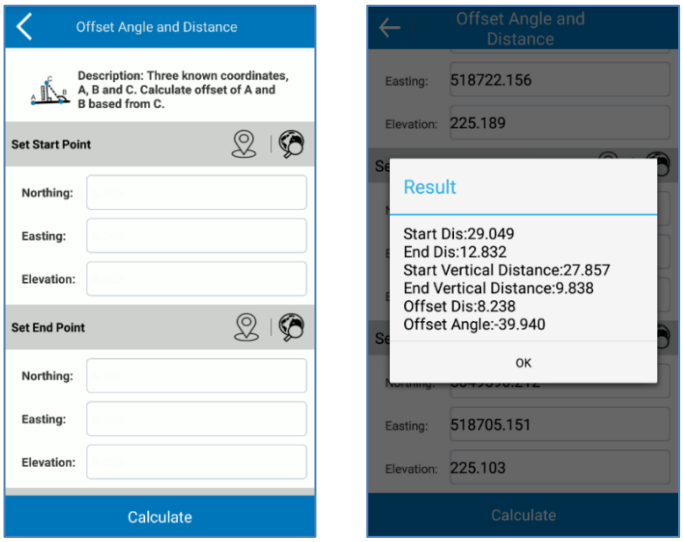
Click "Tools"- "COGO Calculation"- "Azimuth and Range" as shown in Figure. Set Start Point and End Point and click "Calculate" to check the result of Plane distance, Azimuth, Elevation difference, Ratio of slope and Vector, as shown in Figure. There are three ways to set points: 1. extract coordinates from Points Library; 2. acquire current GPS coordinates; 3. directly input values of Northing, Easting and Elevation.





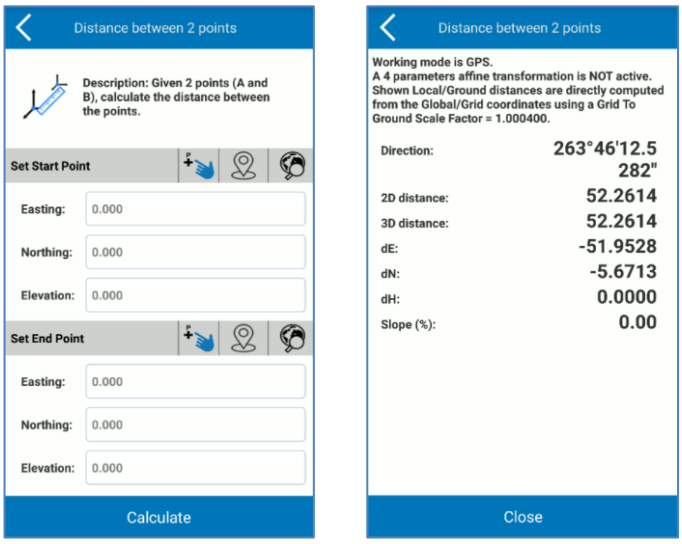
8.6.2 Angle offset

Click "Tools"- "COGO Calculation"- "Angle offset" as shown in Figure. Set Start Point, End Point and Offset Point, and then click "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.



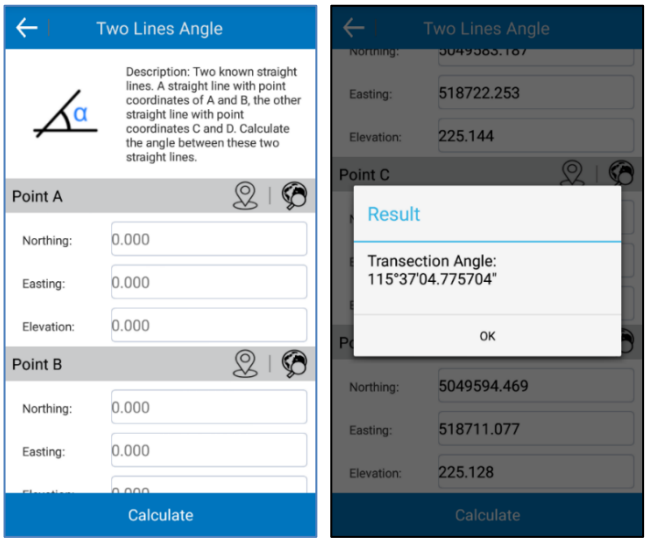
8.6.3 Distance

Click "Tools"- "COGO Calculation"- "Distance" as shown in Figure. Set Start Point and End Point, and then click "Calculate" to check the result as shown in Figure.



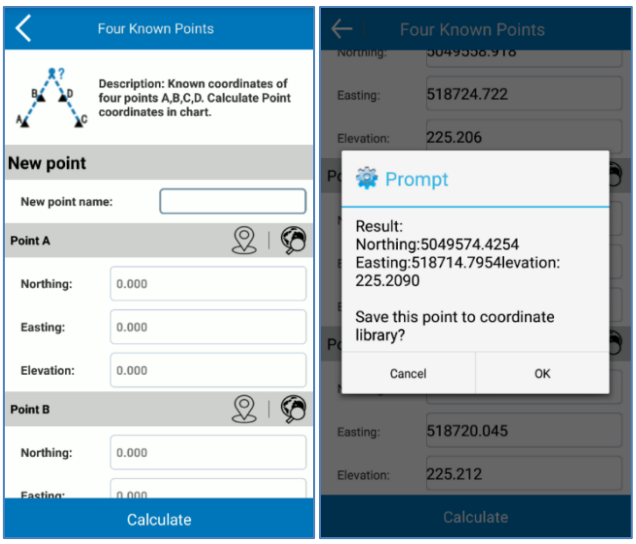
8.6.4 Two Lines Angle

Click "Tools"- "COGO Calculation"- "Two Lines Angle" as shown in Figure. Set Start Point A, End Point B, Start Point C and End Point D, and then click "Calculate" to check the result as shown in Figure.



8.6.5 2 Alignments Interception

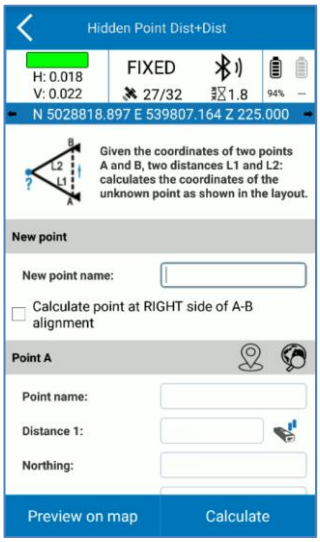
Click "Tools"- "COGO Calculation"- "2 Alignments Interception" as shown in Figure. Set Point A, Point B, Point C and Point D, and then click "Calculate" to obtain the point coordinates in chart as shown in Figure. If it needs to save the calculated point, click "OK" to save it to the coordinate library.

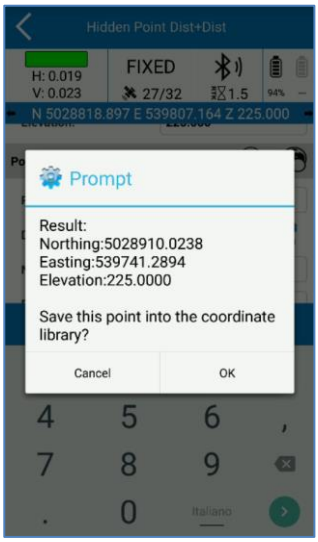


8.6.6 Hidden Point - Two Points Two Distances

Click "Tools"- "COGO Calculation"- "Hidden Point - Two Points Two Distances" as shown in Figure. Measure distances 1 and 2, Point A and Point B, and then click "Calculate" to obtain the point coordinates in chart as shown in Figure. If it needs to save the calculated point, click "OK" to save it to the coordinate library.

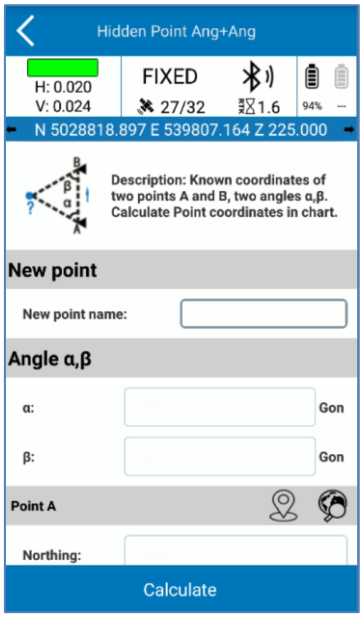
As default the software calcules the point at the left of Point A and Point B used for the calculi. There is the possibility the point at the right selecting the check before to start the calculi.





8.6.7 Hidden Point Ang + Ang

Click "Tools"- "COGO Calculation"- "Hidden Point Ang +Ang" as shown in Figure. Set Angle α, β, Point A and Point B, and then click "Calculate" to obtain the point coordinates in chart as shown in Figure. If it needs to save the calculated point, click "OK" to save it to the coordinate library.

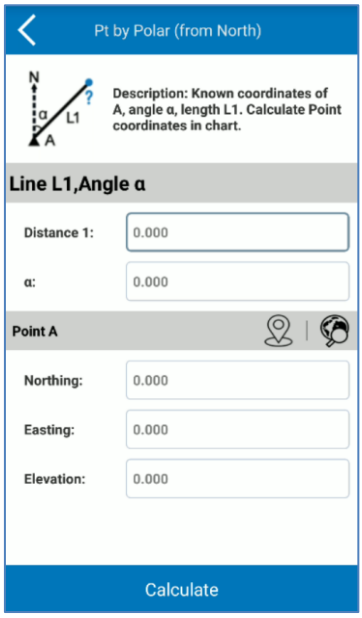


8.6.8 Point by Polar (from Direction)

Click "Tools"- "COGO Calculation"- "Point by Polar (from Direction)" as shown in Figure. Set Line L1, Angle α, Point A and Point B, and then click "Calculate" to obtain the point coordinates in chart as shown in Figure. If it needs to save the calculated point, click "OK" to save it to the coordinate library.

8.6.9 Point by Polar (from North)

Click "Tools"- "COGO Calculation"- "Point by Polar (from North)" as shown in Figure. Set Line L1, Angle α and Point A, and then click "Calculate" to obtain the point coordinates in chart as shown in Figure. If it needs to save the calculated point, click "OK" to save it to the coordinate library.

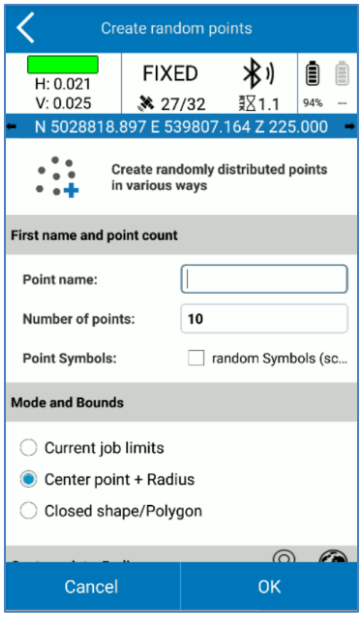


8.6.10 Create random points

This feature creates points random following the set rules.

User must set the name of the points and the number, then the symbol.

Select the mode and the limit of the area where he wants to create the points and the respective limits before to start the calculation.

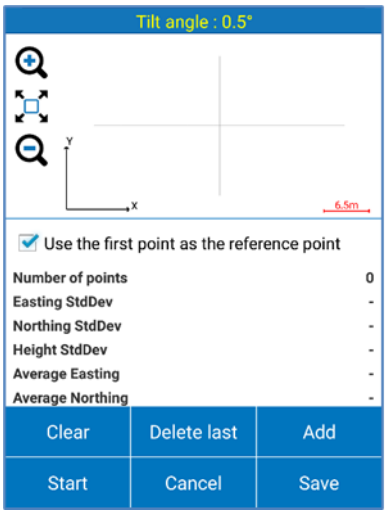


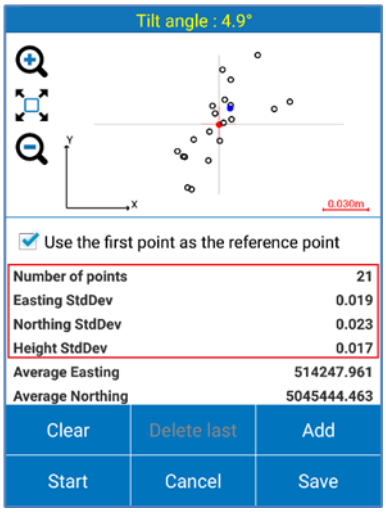
8.6.11 Point averaging

You can check the operation and the accuracy of the GNSS through the RMS quality check. The RMS Study performs the study of the quality/accuracy of repeated measures (keep the pole tip at the same exact position on the ground).

How to use it? Open the Calibrate menu, then select the RMS Study command. When inside the RMS Study screen, click Start to collect the measures.

The application will collect measures/positions at an average frequency of 1Hz. Collected positions will be averaged and RMS values will be computed. The RMS values let the user to verify if the accuracy of the device falls within some required accuracy upper limit.



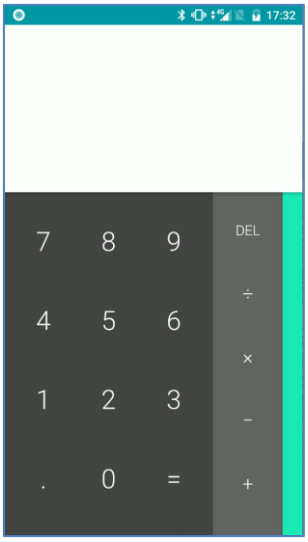


The user has the control of the number of sample positions used in the RMS calculation. When the user decides to complete the check, he can press Stop to block the automatic position acquisition.

This operation is also suggested when the user changes the pole height and/or the pole type (there could be a change in the straightness of the pole).

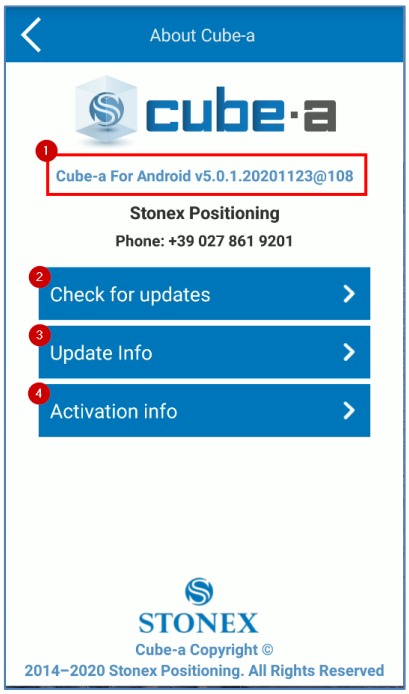
8.7 Calculator

This functionality directly invokes the calculator in handheld system, helping on data calculation.



8.8 Version and Updates

Click "Tools"- "Version and Update" to see the following figure:



It contains:

1) Current version installed on the device
2) *Check for updates*; tapping on it, a check is made to see if there is a new version of the software compared to the one currently installed. If a new version is available, a popup will suggest you download and install the latest version
3) *Update info*: tapping on it, you will have the historian of the "Bug fix"/"What's new" of the latest versions
4) *Activation info*: it enters the page where you can manage your license

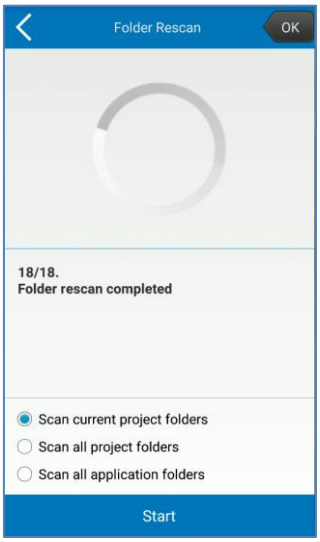
1) *Deactivate all*: tapping on it, all the codes will be cancelled. Note: if you have a working code, copy it or you will lose it.
2) *Main purchase code/activation*: it shows, or you have to insert, the purchase code.
3) *Active modules*
4) *Activate/Deactivate:* to activate the main purchase code or deactivate it (if already active)
5) *Optional purchase code/activation:* to insert an optional code.
6) *Activate/Deactivate:* to activate the optional purchase code or deactivate it (if already active)
7) *Export*: it allows to export the code in a *.txt file.

8.9 WMS Servers

The *WMS Servers* feature will be officially available in Q1 2021.

8.10 Folder Rescan

Click "Tools"- "Rescan Folders" to see update the folders of your projects and see the following figure:



Choose to:

- Scan current project folders
- Scan all project folders
- Scan all application folders

And click on *Start*.

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