STONEX

Stonex Cube-a

Field Software

User Manual

cube·a 7.0

(April 2025) - Ver. 7.0

Content

1. Introduction

Cube-a is a Stonex field software for professional surveying and GIS which has been designed and developed for the Android platform. Thanks to the flexibility of the Android environment, the user interface is very simple and intuitive, and this makes surveyors ready for any work, saving time and increasing productivity. With Cube-a is possible to perform a GNSS, GIS and Total Station survey. The software can be installed on any device equipped with Android operating system. (Minimum Android OS compatible version is Android 7 / "N"). Cube-a version 7 is also compatible with the latest devices running the 64-bit only Android 14 operating system as well as compatible with previous versions of Android with both 32-bit and 64-bit application support

This manual introduces all the functions available in Cube-a software.

1.1 Install and uninstall

This paragraph describes how to install and uninstall Stonex Cube-a.

Install

I. Download the file with extension *.apk for installing the software and copy it into the internal memory of the Android device.
II. Click on the apk file from your Android device to start the installation, and then click *Install*.

Uninstall

There are two possibilities to uninstall Cube-a:

a) Hold down the Cube-a icon on the screen, click *App info*, then click *Uninstall*.
b) Go to Android device settings, click *Apps & notifications*, then search for Cube-a application. Select Cube-a, then click *Uninstall*.

1.2 Registration of the user license

You need to know your personal license code, it looks like A07000000000000000. The software cannot be unlocked without entering the correct license code.

Follow the steps below to register your license.

I. Start the software.
II. Read the end user license agreement.
III. Click *Accept* if you accept the contract, otherwise click *Decline* to terminate the application.
IV. Fill out the data form correctly and click *OK*.

Note: you cannot use the same purchase code to unlock a copy of the program that is installed on another device. For this, you need to purchase an additional license (so, you will get another different license code).

If you have any problem activating the program, please contact your local dealer.

1.3 Cube-a data storage

As soon as you install the program, the StonexCube folder is created in the device internal memory; within the latter there are several folders whose use is summarized in the following table.

/StonexCube/Config	Configuration files. Do not change it!
/StonexCube/Config/Codes	The folder where Cube-a looks for and stores codes libraries.
/StonexCube/Config/Symbols	The folder where Cube-a looks for and stores point symbols.
/StonexCube/Coordinate	The folder where Cube-a looks for coordinates files (for survey area settings).
/StonexCube/Export	The folder where Cube-a stores exported files.
/StonexCube/Geoid	The folder where Cube-a looks for geoids; copy geoid files here if they are not already included in Cube-a.
/StonexCube/GISFeatureSets	The folder where Cube-a looks for files for GIS attributes; copy the files here for the new GIS tabs (.xml files). We suggest using the integrated Feature Set Editor to create new attribute tabs or modify the existing ones.
/StonexCube/Input	The default folder where Cube-a looks for the data you want to import; you can copy the files you want to import here or in other folders.
/StonexCube/ItalyIGM	The folder where Cube-a looks for grid files (*.gr1/gr2 and *.gk1/gk2/gk3); only for Italy.
/StonexCube/Map	The default folder where Cube-a looks for external drawings you want to import; you can copy the files here or in other folders.
/StonexCube/Project	The projects storage folder.
/StonexCube/RefSys	Internal configuration files. Do not change it!

For each project, Cube-a creates a folder with the same name of the project, within the Project folder.

For example, considering that the project name is "MyProject1", the resulting structure of the subfolders in the project folder will be as described in the following table.

/StonexCube/Project /MyProject1	Project folder that contains subfolders, described below, and configuration files. Do not modify the configuration files.
/StonexCube/Project /MyProject1/Config	Configuration files. Do not change them!
/StonexCube/Project /MyProject1/Data	Survey files (files *.PD).
/StonexCube/Project /MyProject1/Log	NMEA messages or TS log files if the debug function in enabled (see 4.3 Communication).
/StonexCube/Project /MyProject1/Photos	Photos taken during the survey.
/StonexCube/Project /MyProject1/RawData	If the controller is equipped with an internal GNSS which allows raw data recording (for example Stonex

	S70G) this folder will contain the raw data to be used in the post-processing. Raw data is recorded only if you enable the option. Note: raw data of external GNSS receivers are stored in the internal memory of GNSS and not in the handheld.

1.4 Cube-a first boot

The first time you open the software, you are prompted to create a project. Each time the user creates a new project in Cube-a, a folder with the same name is created in the device memory (File/StonexCube/Project) where there are all project data, the surveys, all photos associated to the points, etc.

Each time the user creates a new project, Cube-a automatically creates a file with extension *.PD, with the same name of the project, in the Data folder in the project folder (File/StonexCube/Project/Data); PD is the extension of the surveys created with Cube-a.

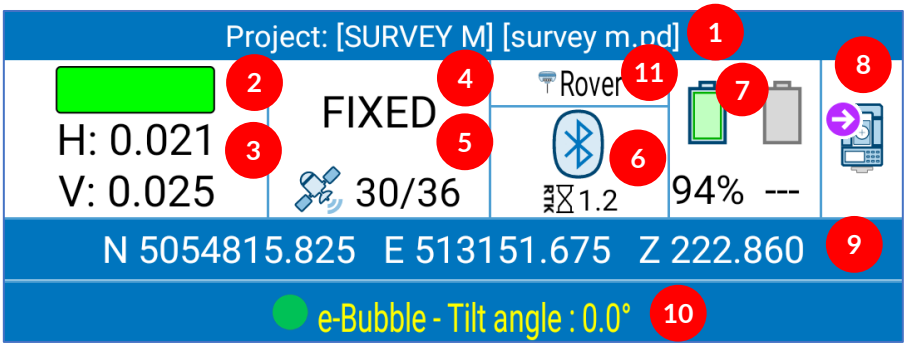
2. Main Interface

The main interface of the software consists of the Status Bar always visible at the top and the Menu Bar at the bottom, described in detail in the following paragraphs.

The Status Bar is always visible, even switching menus, and is continuously updated in real time, based on the signal received and the location of the instrument you are connected to. It looks different depending on whether you are in GPS mode or Total Station mode.

2.1 Status Bar – GNSS Module

In the GPS mode, the status bar is as follows.

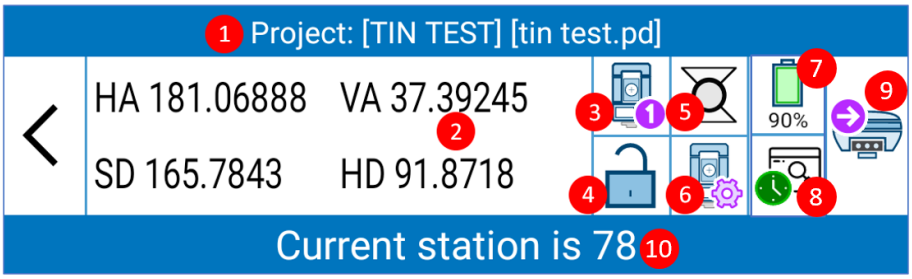


1. The name of the current Project and the PD file currently in use (see 3 Project).
2. Indicator of conformity to tolerances set by user (see 7.5 Point type).
    a. Green: tolerances respected.
    b. Red: tolerances not respected.
    c. Yellow: tolerances respected only in part.
3. Horizontal and vertical root mean square (see 4.1 GNSS Status).
4. Type of solution (see 4.1 GNSS Status).
5. Number of satellites used/ number of satellites visible.
6. Data transmission mode (see 4.5 Datalink Settings) and age of differential corrections (see 4.1 GNSS Status).
7. GNSS receiver battery/ batteries level.
8. Switch to Total Station mode.
9. Local or geodetic coordinates of the current position (click to switch between views).
10. Pole tilt angle (available only if connected to a receiver equipped with IMU technology and with active tilt correction). Hold down to enable or disable the sensor (see 9.5 Sensor Options)
11. Working Mode, The GNSS top bar shows the active working mode (rover, base, static). Clicking on the working mode area open the working mode settings page.

If the connected GNSS device has been enabled using a temporary license code, Cube-a will warn the user if the temporary license is going to expire in less than 30 days.

2.2 Status Bar – TS Module

In the Total Station mode, the status bar changes in accordance with the type of total station connected to Cube-a. There are some common commands between the different TS models and some specifical options typical of motorized total stations. Here below their description:



1. The name of the current Project and the PD file currently in use (see 3 Project).
2. Total Station measurements:

   HA -> horizontal angle.

   VA -> vertical angle (by clicking on the angle it's possible to view it as a percentage).

   SD -> slope distance (by clicking on the angle twice it's possible to view the VD).

   HD -> horizontal distance.
3. Face of the station in use. Click to rotate the total station (option available only for motorized TS)
   a. F1 face.
   b. F2 face.
4. Prism state (option available only for motorized TS):

Prism is not locked.

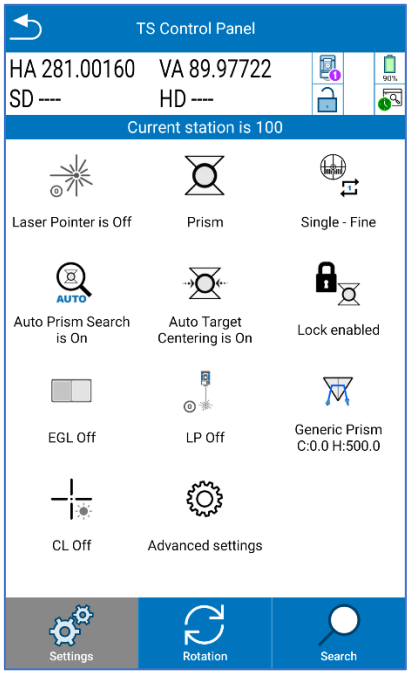
Prism is locked.

Prediction state. When the station loses the prism due to an obstacles, it predicts prism position by rotating with the same angular velocity as the movement of the prism to re-lock it easily, after passing the obstacles (option available only for motorized TS R180 and R120) (see 2.2.1 TS Control Panel for enabling/disabling procedure).

5. Select target type icon. Click to change the target type (see 2.2.1 TS Control Panel).
6. Click to access the control panel of the total station (see 2.2.1 TS Control Panel).
7. Total Station battery level.
8. Enter the prediction configuration page (option available only for motorized TS R180) (see 2.2.1 TS Control Panel).
9. Switch to GNSS mode.
10. Name of the current station (click on the name to see the coordinates of the point).

2.3 TS Control Panel

The TS control panel contains three submenus, *Settings*, *Rotation* and *Search*, depending on the user is working with a motorized total Station, or with a mechanical one.



Total Station Settings

Define the total station settings. They can change depending on the total station model used.

- Laser pointer -> can be turned off/on
- Target type -> In this section the user can choose and change the survey target.
  - *No Prism* if you are measuring points without prism
  - *Tape* if you are measuring a point identified by a reflective sheet
  - *Prism* up to 2,500 meters
  - *Remote prism* between 2,500 and 5,000 meters
- Measuring mode -> In this section the user can choose the mode of measurement (*Note*. The available measure modes depend on the TS used).
  - *Single - Fine*: the station will measure a single and precise measurement point
  - *Single - Coarse*: the station will measure a single and fast measurement point
  - *Tracking - Fine*: The station will continue to make precise measurements point, until it is stopped
  - *Tracking - Coarse*: The station will continue to make fast point measurements point, until it is stopped

- *Tracking - Coarse + Fine Shot*: The station will continue to make fast measurements until a precise measurement is made
- *Average (3)*: the station will survey 3 points measurements and Cube-a will average them.
- *Average (n)*: the station will *survey n* points measurements and Cube-a will average them. Press over the icon to enter as many measures as you want

- Auto Prism Search -> This option enables /disables the automatic prism search and centering (only available with robotic total station). In this way the user can use the robotic TS as a mechanical one.

- Auto Target -> Can be enabled /disabled . If the Autotarget is enabled the total station aims and centers automatically the prism precisely before measuring. If Lock is enabled, Autotarget has to be enabled.

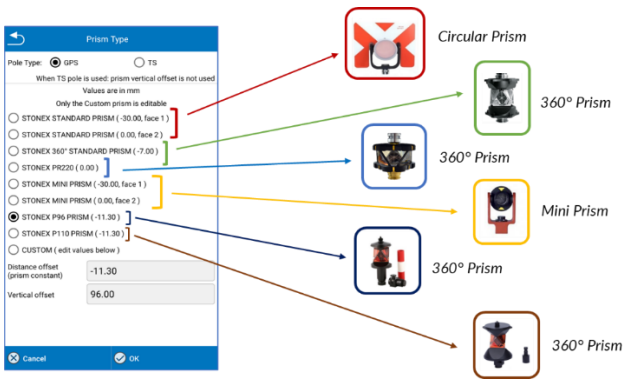
- Lock -> Can be enabled / disabled . If enabled the user can Lock and track the prism, after searching it.

- Electronic Guidelight -> This option is useful to help the user to locate the prism in total station telescope direction. Can be enabled /disabled.

- PL (Laser Plummet) -> This option can enable/disable the Laser Plummet (several levels available depending on the TS model) /disabled .

- Prism Type -> In this section the user can insert the prism to use in the survey. It's possible to choose between some predefined prisms or add a custom one (clicking on CUSTOM). Click on ***OK*** to confirm your selection.

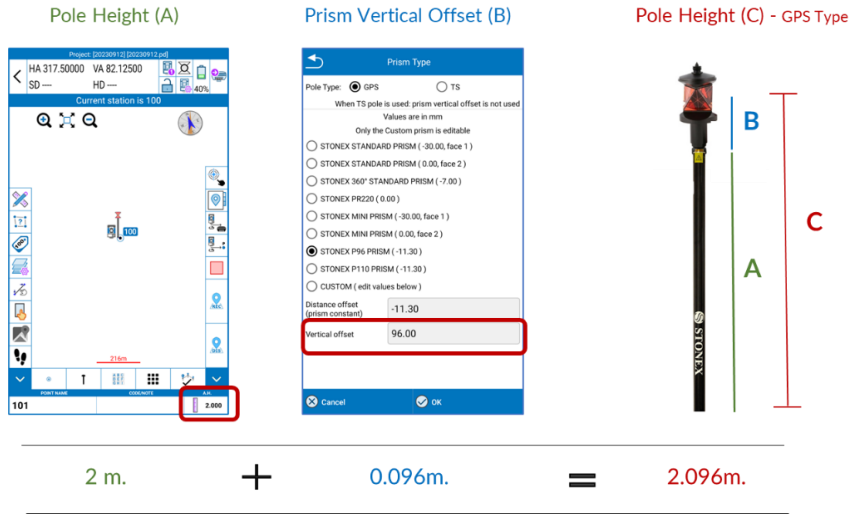
- If the user selects one of the prisms from the list, the prism constant and the vertical offset are automatically associated to that prism type.
  In the image below, it's possible to see the photos of the different prisms already stored in Cube-a prism list.



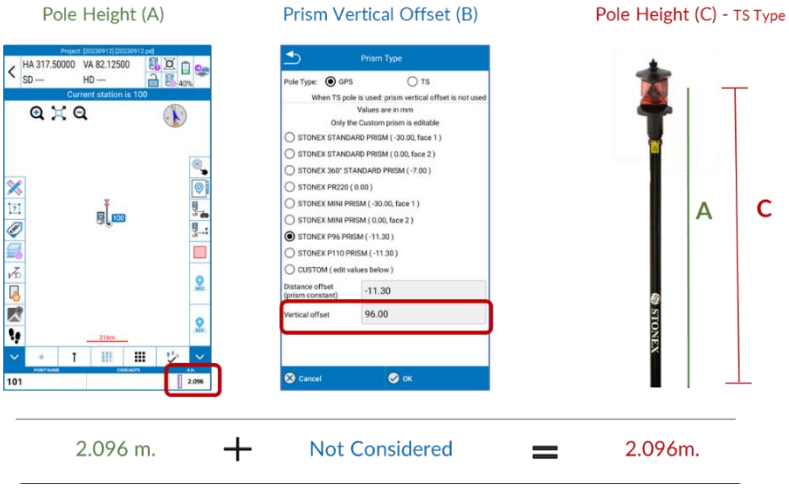
- If the user selects CUSTOM.
  He must insert manually the prism constant (available on the prism datasheet) and the prism vertical offset.

In this section the user can also select the Pole Type, choosing between *GPS Pole* (Cube-a considers the prism vertical offset) and the *TS Pole* (Cube-a doesn't consider the prism vertical offset).

- If the user selects *GPS Pole*, the pole height will be calculated as the sum of the pole height inserted in Cube-a survey page (6 Survey) + prism vertical offset. In this case, the user has to select the right prism (B in the image below) and insert the height of the pole from the ground to the prism basement (A in the image below). Cube-a automatically adds the prism vertical offset (B) to the pole height (A) to relate the measurements to the prism center (C in the image below) (A+B = C).



- If the user selects *TS Pole*, Cube-a doesn't consider prism vertical offset (B) but it considers only prism constant. In Cube-a survey page (6 Survey), the user has to insert the pole height as the height of the pole from the ground to prism center (A = C).



The choice between GPS and TS Pole depends on user needs. GPS pole type is selected by default.

- CL (Cross Light) -> Can be enabled 

/disabled 

.

- Advanced Settings  -> This section is available only for R180-R120 Motorized total Station and can be used by the user to configure the station for the survey. In this page the user can:

  - Enable/Disable the *Quick Lock* function. If enabled the first lock is faster and the fine adjust is performed inside centering and lock-in operation. If disabled, the first lock is slower, but the fine adjust is performed separately from the lock-in operation. We suggest disabling it only for monitoring operation. The *Quick Lock* function is enabled by default in Cube-a.

  - Configure the behavior of the station after losing the prism to re-lock the prism easily. Cube-a offers different solutions, giving the possibility to the user to choose the best configuration according to its needs and to the survey conditions.

    1. In this section the user can enable/disable the predicted position function (red square image below).

       - ☑ *If enable* -> when the station loses the prism due to an obstacle (tree, buildings, cars…), the station continues rotating for the searching the prism using last known prism direction. If the prism returns in the telescope field of view after passing the obstacle, the station re-locks it immediately and it's not necessary to restart the prism search routine.

       - ☐ *If disable* -> the station stops on the point where it loses the prism.
         If the prism returns in the telescope field of view, the station re-locks it immediately and it's not necessary to restart the prism search routine.

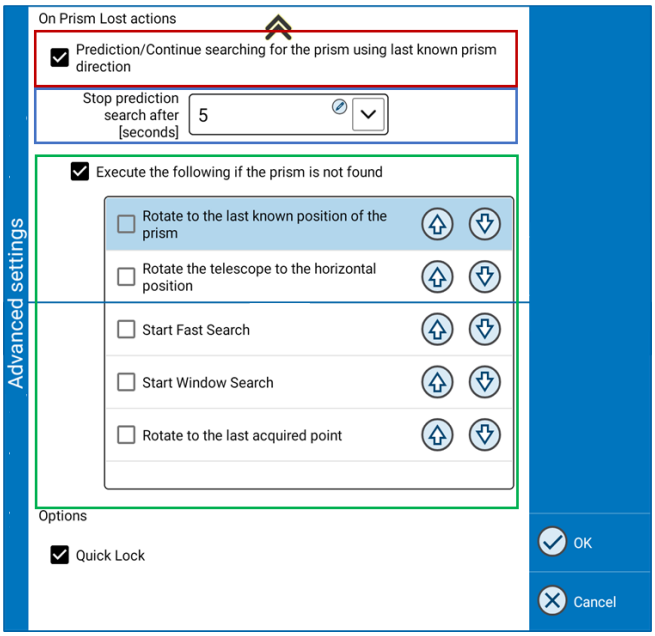
    2. In this section the user can set a prediction time, choosing between some predefined values (5, 10, 15, 20, 25, 30 seconds) or inserting a custom value (blue square image below).

    3. In this section the user can set a series of operations to automatically re-lock the prism if prediction fails (green square image below).

       - ☑ *If enable* -> If the station doesn't re-lock the prism after the prediction time, it's possible to define a series of operations to be performed sequentially and automatically to lock the prism again.

       - ☐ *If disable* ->If the station doesn't re-lock the prism after the prediction time, the TS stops rotating and it's necessary to re-start the prism search routine.

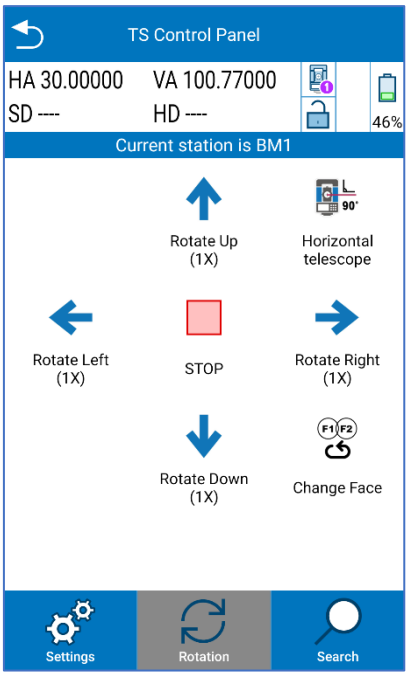
       Click on the check boxes to choose what actions you want the station to perform automatically and click on the arrows to change the order of execution.



Total station rotation

From here the user can manage the motorized station remotely. It's possible to rotate the the telescope up /down /left /right ; movements can be stopped by pressing stop.

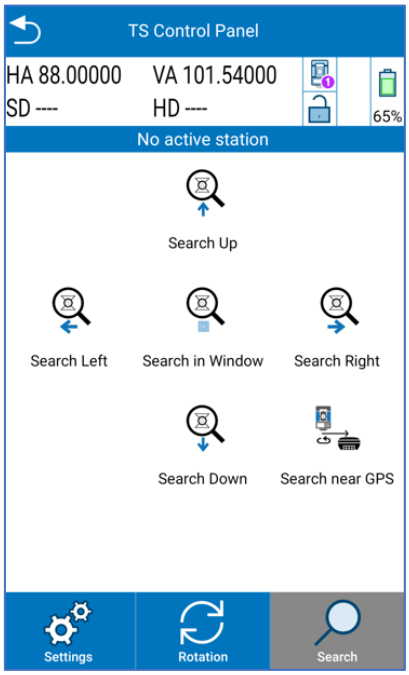
From this page the user can also change the face of the instrument (from face I to face II and vice versa). and move the telescope horizontal to make it easier the following prism search.



Prism Search – R80

From this page the user can manage the search for the prism with a motorized total station. It's possible to start searching for the prism at the top/bottom/left/right or within larger and larger area, starting from where the telescope is positioned.

The Search *Near GPS Location* allows you to rotate the telescope in the direction of the GNSS or the location of the point, respectively. They can be used during the survey, after the location of the station has been defined and its *orientation Search near GPS location can* be used if you have the Cube-a GPS module and if the antenna has the *fixed* solution.



Press anywhere on the screen to stop the search. If the prism search is successful and lock settings are enabled, the prism will remain locked and the lock icon changes like described in 2.2 Status Bar – TS Module

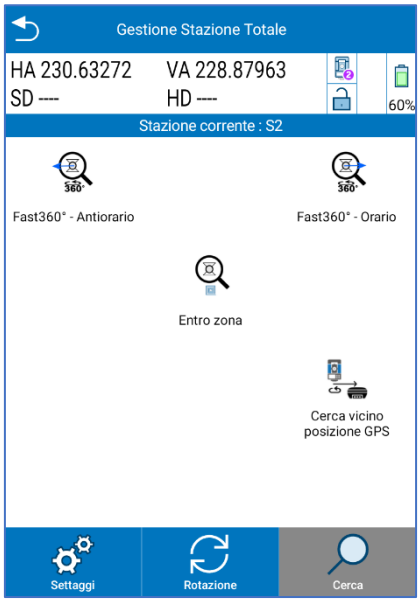
Prism Search – R180/R120

From This page the user can manage the search for the prism with R180 total station. It's possible to start searching for the prism using FAST360° (search in every direction with clockwise 

and counterclockwise 

rotation of the instrument around its vertical axis) or within larger and larger area  , starting from where the telescope is positioned.

The Search *Near GPS Location*  allows you to rotate the telescope in the direction of the GNSS or the location of the point, respectively. They can be used during the survey, after the location of the station has been defined and its *orientation Search near GPS location can* be used if you have the Cube-a GPS module and if the antenna has the *fixed* solution.



Press anywhere on the screen to stop the search. If the prism search is successful and lock settings are enabled, the prism will remain locked and the lock icon changes like described in 2.2 Status Bar – TS Module.

Prism LOCK

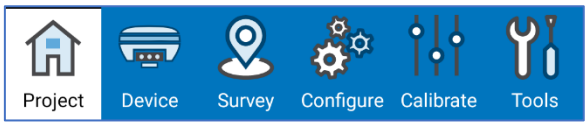
To LOCK the prism with a robotic TS is necessary to configure the station as follow:

- *Measuring Mode* -> Tracking-coarse or Tracking - Coarse + Fine Shot (for R80); Tracking Coarse/Fine or Fine (for R180/R120)
- *Lock Enabled*
- *Auto Target Centering is ON*

Search for the prism following the indications in the paragraph above to find it and lock it.

2.4 Menu Bar

The menu bar, at the bottom of the screen, allows you to access the six main menus of the software.



Project: Project management and sharing, import and export.

Device: Connection and configuration of the GNSS receiver and the total station.

Survey: Point and line survey and stakeout, CAD environment.

Configure: Coordinate reference system, system settings, external drawings import.

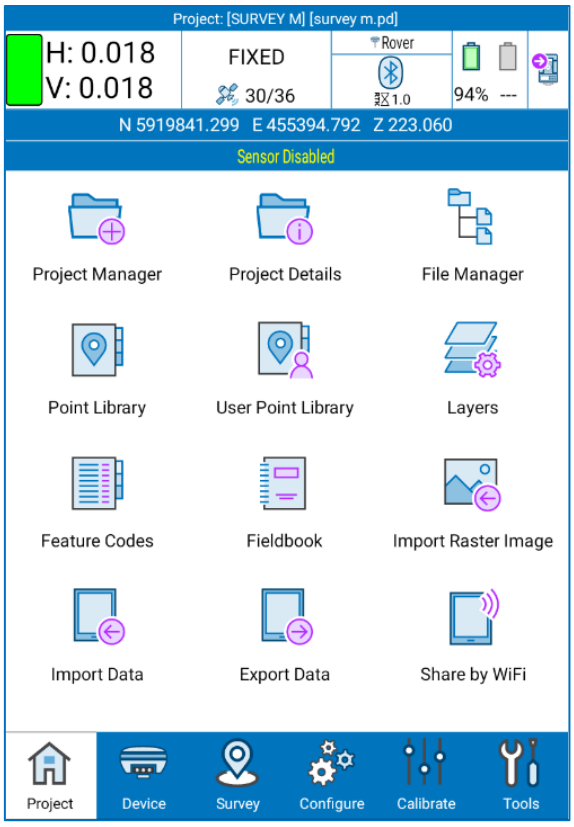
Calibrate: Site calibration, total station calibration, calibration of the electronic bubble and tilt.

Tools: COGO and volume calculations, Cube-a updates.

These features are described in detail in the following chapters

3. Project

In this menu there is everything related to project management, import and export of data and point code libraries.

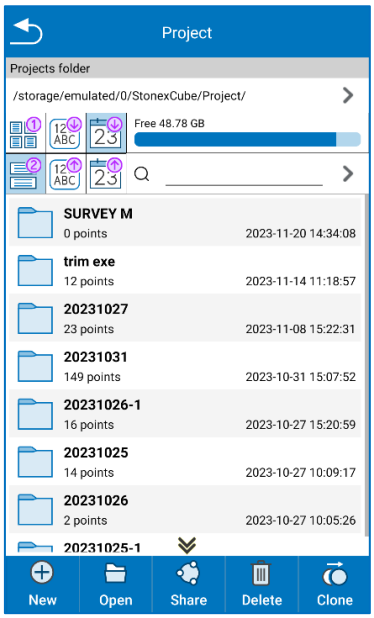


Each project can contain multiple PD files, so multiple surveys. Once the program is launched, you are automatically in the last project and in the last used file; Cube-a always opens a project, whose name is always visible in the status bar at the top.

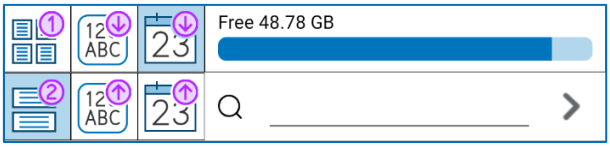
Whenever you create a new project in Cube-a, a folder with the same name is created in the device memory (File/StonexCube/Project) in which there are all project-related data, surveys, any photos associated with points, etc.

3.1 Project Manager

This page contains the list of the projects.

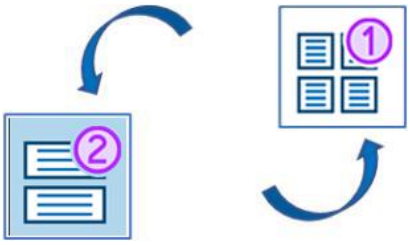


At the top there is the path where you can find all projects visible below in the project list; you can click on the arrow on the right to change the path. In the Project List section, there are as many folders as there are projects created or imported in Cube-a; you can sort these projects alphabetically or by creation date using the following icons.

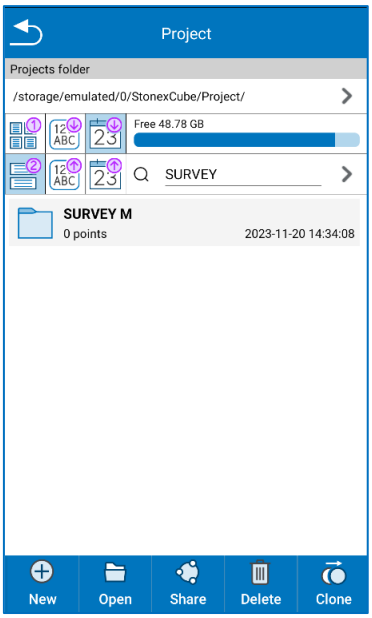


On the right is visible the free memory space in blue.

You can see the projects in a grid view or in a list view, using the following icons.

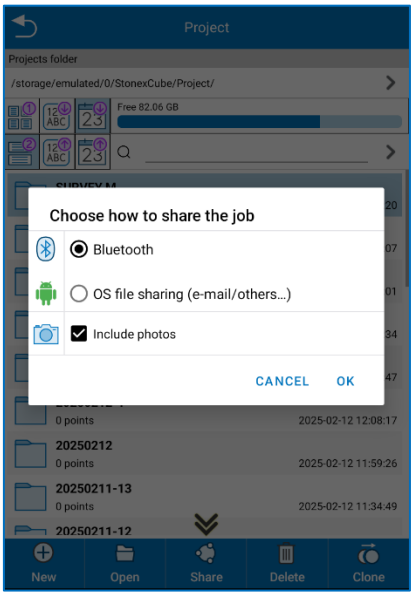


The search bar immediately under the memory bar allows you to search for projects by typing the name and by clicking on the arrow on the right. After searching for projects, click on the cross and again on the arrow on the right to go back and view all projects.

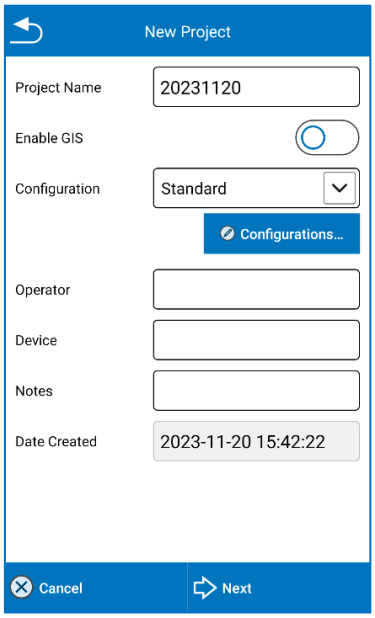


The icons at the bottom bar are described in the following list.

- *New*: Create a new project.
- *Open*: Open a project after selecting it in the list.
- *Share*: Share the selected project using the communication channels shown below. It is possible to share the project via Bluetooth and via OS file sharing such as e-mail/others. To use this function via Bluetooth, first enable Remote Control in the Device>>Remote Control page. During the sharing process, it is possible to exclude all photos in order to reduce the size of the shared job.
- *Delete:* Delete the selected project.
- *Clone*: Duplicate the selected project.



By clicking *New* it opens the following window.



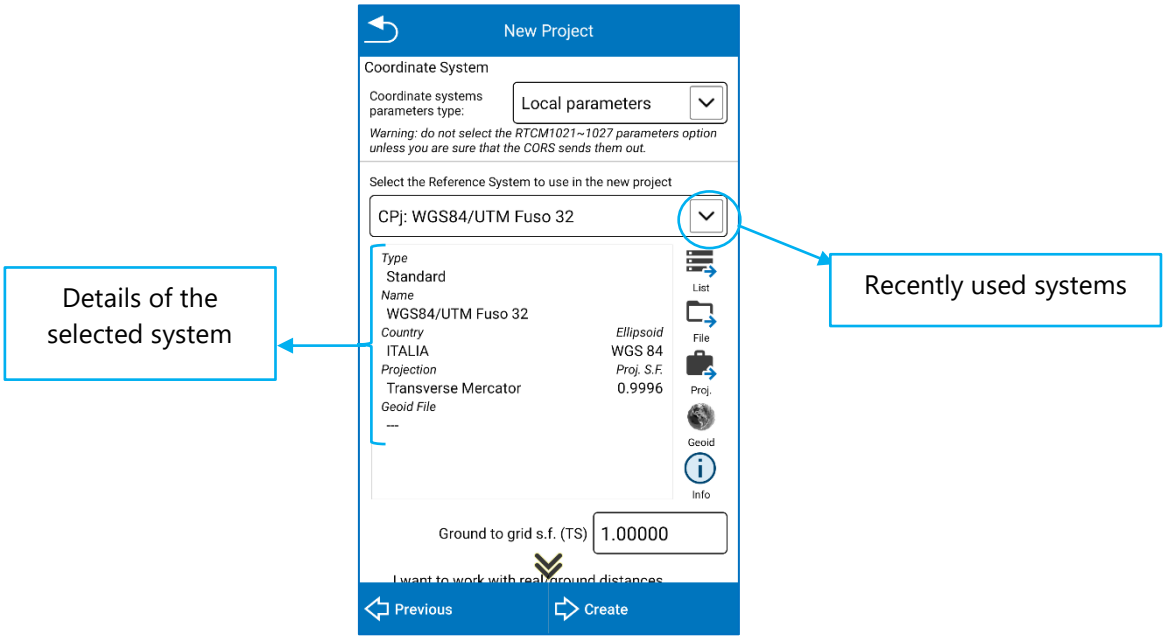
The default project name is the project creation date, but it's possible to change it by simply clicking on the name bar. In Cube-a, you can no longer change the name of the project, you can assign a different name only when you export. All other fields are optional.

The Enable GIS feature is visible only if you have the GIS module and is disabled by default; see section 3.1.1 GIS Project for more information.

In the drop-down menu *Configuration*, there are the standard configurations already included in the program and all the ones created by the user. Click on the blue key *Configuration* to create a new configuration.

Configuration means the symbol library and layers that can be used in the project. Example: if the user usually uses a dozen layers defined in the same way each time, it is not convenient to recreate them for each project, is instead very useful to create a new configuration including these layers (defined so one time) and recall that configuration for each project in which it is to be used.

By clicking *Cancel*, the project is not created. Click *Next* to continue the project creation.



In the Coordinate System section at the top, you can select RTCM 1021-1027 messages if the CORS you use sends them out.

Warning: if you are operating in Italy, do not select the "RTCM1021-1027" option in the *Coordinate system parameters type* drop-down menu, because they are not provided by the Italian permanent stations.

Select the coordinate system you want to use in the new project.

Click *File* to import an external coordinate system: the compatible formats are *.SP, *.JXL, RMGEO*.*,

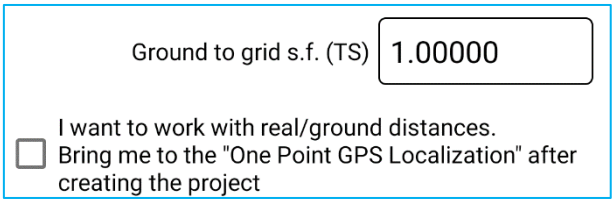
Click *Project* to take the coordinate system from an existing project.

Click *List* to select the coordinate system from the list of predefined reference systems that you already find in Cube-a; you can search the system by country or key words.

The scale factor from ground to grid allows you to adapt the measurements made with total station to the active reference system. For example, if the projection adopted is UTM then the scale factor is 0.9996.

Note. If creating the project in total station module, Cube-a does not consider the reference system, and the scale factor is assumed to be equal to 1.0000. The reference system will be defined during stationing operation 10 Calibrate – TS Module.

Check the following option to perform a “one-point localization” as soon as you create the project. See 9.1 One Point Localization for more information.

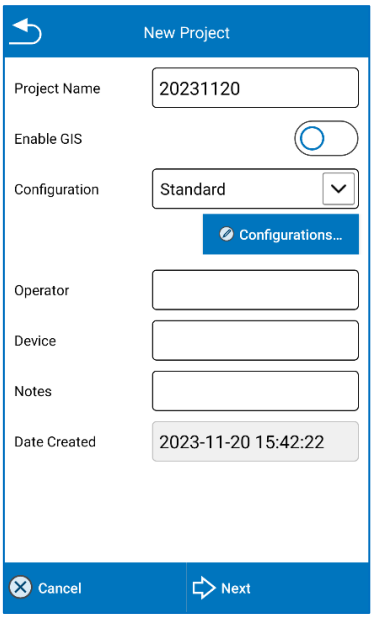


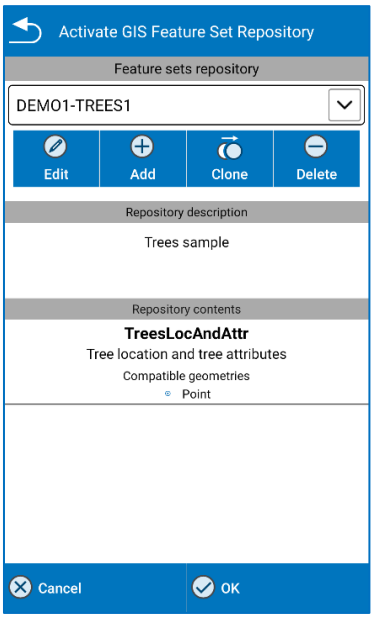
Click *Previous* to back to previous page (project name, symbol library…).

Click *Create* to create the project.

3.2 GIS Project

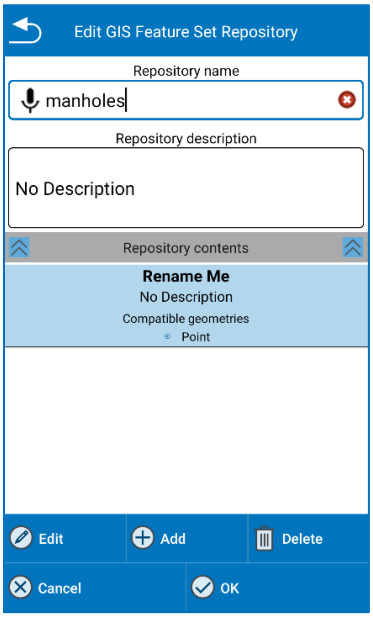
If the user has the GIS module, it’s possible to enable the GIS function when creating a project, or later from *Project Details* menu. After enabling the GIS function, the “*Activate GIS Feature Set Repository window*” appears. Here it’s possible to select a group of GIS features from the drop-down menu to use it in the current project (select it and click *OK*), or to edit it (select it and click *Edit*), or to clone it (in this case it’s possible to modify the clone without changing the existing one) or delete it.





For importing a GIS features group, the user has to copy it in XML format in the following folder: *Internal Memory -> StonexCube -> GISFeatureSets*. Then the group will be visible in the drop-down menu. In the same folder there are also some sample files.

The user can create a new group in Cube-a: after clicking *Add* and typing the name desired, the new group will appear in the drop-down menu. Select it and click *Edit* to create the group contents and GIS attributes.



In the group description box, it's possible to add a description for the previously selected GIS features group if desired.

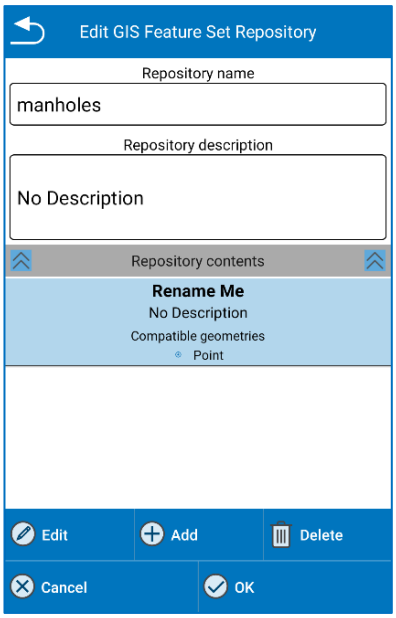
When creating a new group, a class is displayed by default, its name is "Rename me"; select this one and click *Edit* to change the name and create the list of attributes for this class.

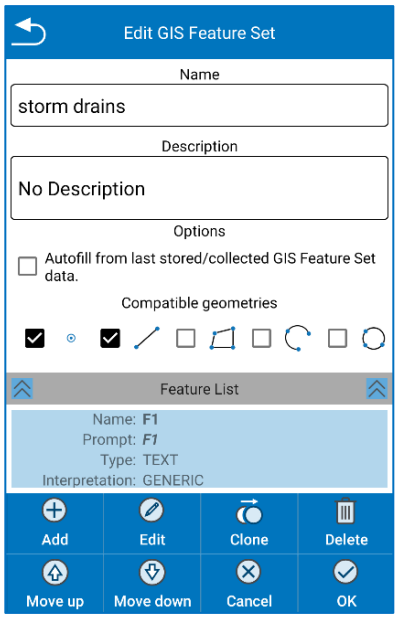
Click *Add* to add a new class. Click *Delete* to delete the selected class. Click *Cancel* to undo the changes. Click *OK* to confirm the changes and return to the "*Edit GIS Feature Set Repository*" window.

If you select a class from "Repository contents" and click *Edit*, the "*Edit GIS Feature Set*" window appears. Here it's possible to change the name and description of the class, select compatible geometries, and create or edit the list of attributes, the Feature List.

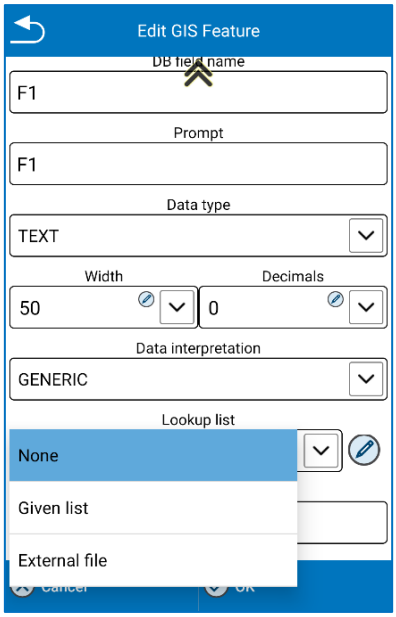
When creating a new class, an attribute appears by default, its name is "F1", select this and click *Edit* to change the name and customize it.

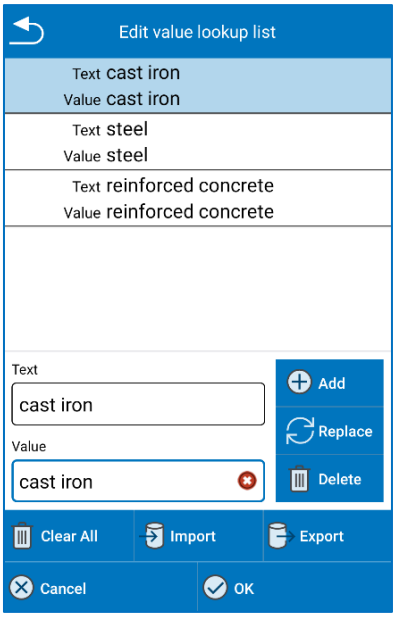
Click *Add* to add a new attribute to the current class. Click *Delete* to delete an attribute in the current class



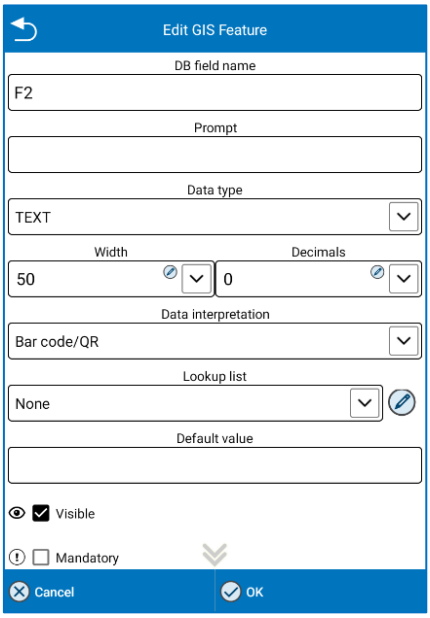


If the user selects an attribute from the attribute list (Feature List) and click *Edit*, the "*Edit GIS Feature*" window appears. Here it's possible to change the name and the prompt for the attribute, data type, enter a list of values, and other options. It's possible to create a list of values in Cube-a: select "Given List" from the drop-down menu, then click the pencil, and the "Edit value list" window appears.



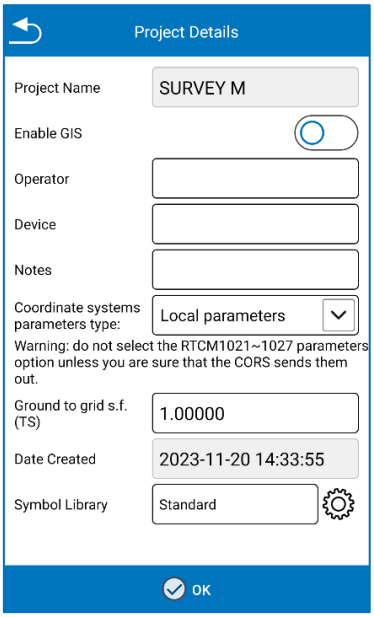


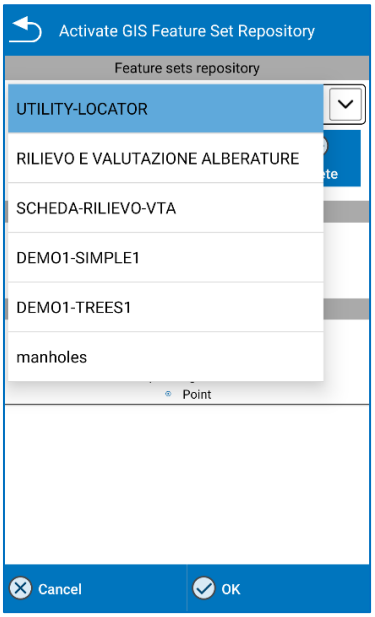
In addition, it is possible to scan QR codes or barcodes and store the read text as an attribute. From "*Edit GIS feature set*", in the field of "Data Interpretation" select Bar code/QR,



3.3 Project Details

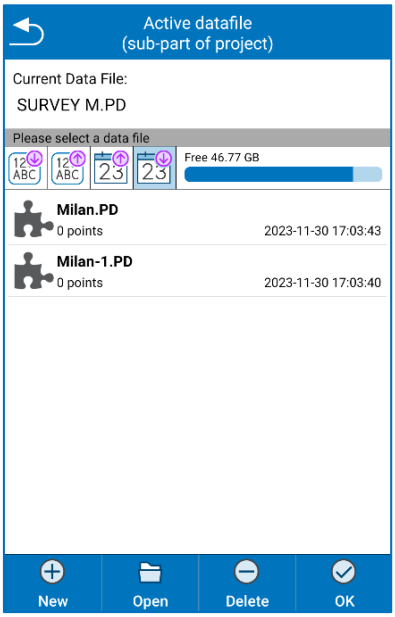
In the *Project Details* submenu, the user can verify and edit some details of the current project. In this page, the user can enable the GIS function if it was not activated during project creation or turn it off. If the function is enabled, after clicking OK, it's possible to select or edit the GIS feature group.





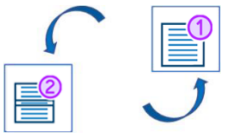
3.4 File Manager

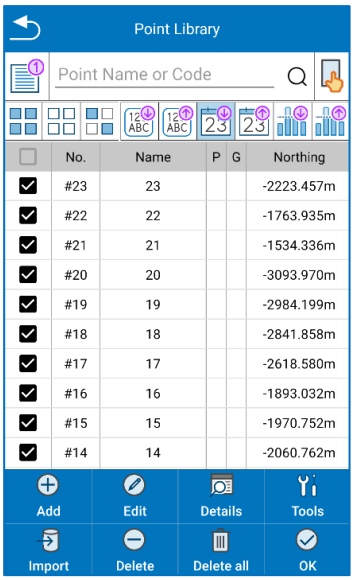
As anticipated in the previous paragraphs, a project can contain multiple surveys. In the *File Manager* submenu, the user will find all the .PD files, then the various surveys contained in the current project. Each time the user creates a new project, Cube-a automatically creates a .PD file with the same name as the project. In this page it's possible to add new .PD files to the current project, or open or delete an existing file after selecting it. Once created, it's not possible to change the file name in Cube-a, it's possible to do it only during export.

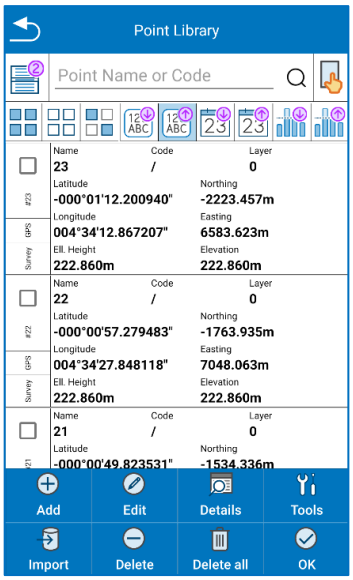


3.5 Point Library

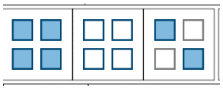
In the Points Library submenu, the user will see the list of all points that are surveyed, calculated, imported, and added manually. Switch from *List view* to *Grid view* by clicking on the icon at the top left shown in the following figures.





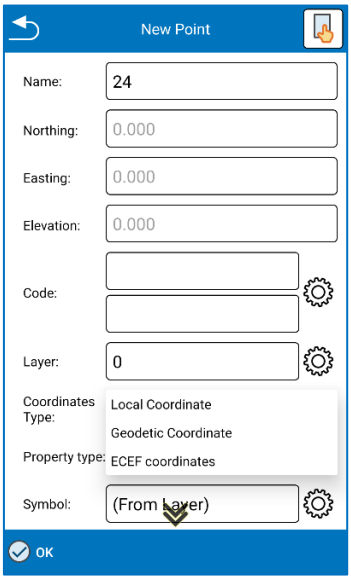


It's possible to search for a point by using the "select point" icon represented by a blue hand that indicates (icon in the upper right). It's possible to filter the points by point type, remove filters, select by layer, unselect by layer and move to layer by clicking *Tools*. It's possible select or clear multiple points at the same time and reverse selections using the selection icon in the upper left.

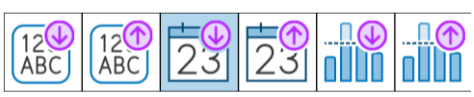


After selecting a point, the user can see the details of the point, edit it or delete it using the functions in the bottom bar. From the latter it's also possible to add new points by clicking *Add* and access the Import Data submenu by clicking *Import*.

By clicking *Add* opens the following window where the user can add a point by entering local or geodetic coordinates.

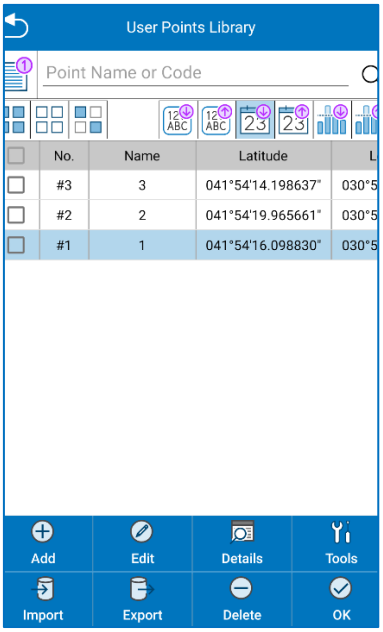


All points can be sorted by name, acquisition date, or elevation using the following icons in the upper right.



3.6 User Points Library

The *User Points Library* is an archive of points created or imported accessible from all projects, so it's useful to store common points. The user can import points to use in other projects. To see the points in the survey area in other projects, simply export them to the outside. If the points are not exported to the survey area, they will not be visible in the survey area.



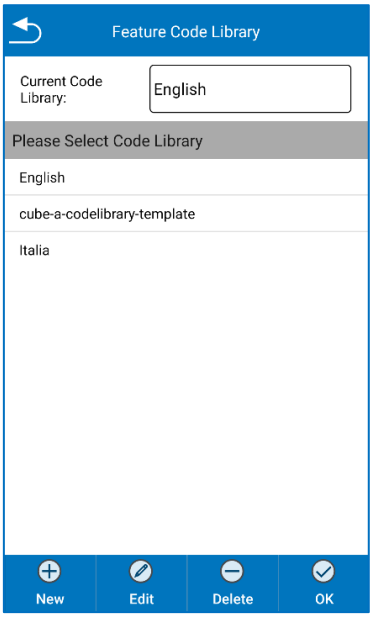
3.7 Layers

See 7.2 Layers

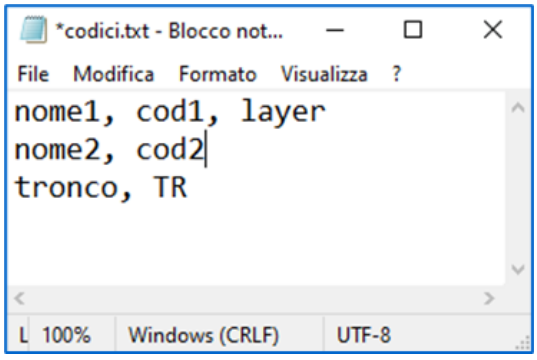
3.8 Feature Codes

In the Feature Code submenu, it's possible to manage point code libraries. There are already standard libraries, but it's possible to add new ones by clicking *New* or editing present by clicking *Edit*.

The feature code assigned to the first point of a graphical entity is also assigned to the graphical entity.



A new library can be created in Cube-a, manually adding codes, or importing it after copying it the Android device. In the latter case, it's necessary to import a .fcl or .txt as in the following figure.

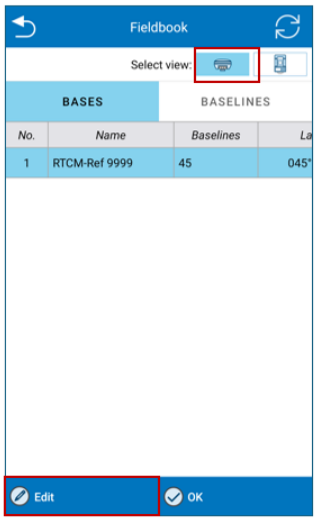


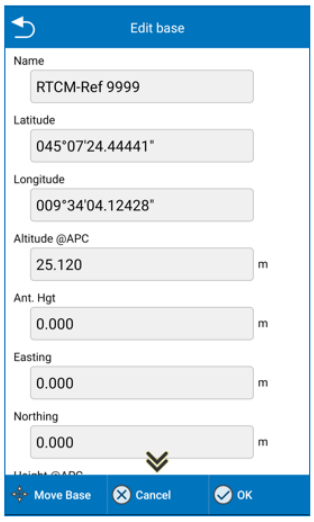
3.9 Fieldbook

In the *Fieldbook* section, the user can manage the raw data of the survey. This is a dynamic Fieldbook with the possibility to modify the data and correct mistakes (e.g. wrong pole height or prism constant) directly on the field, with a complete recalculation of the entire Fieldbook. The user can surf inside the Fieldbook scrolling horizontally, to see all the information/raw data associated to a point or scrolling vertically, to see the entire list of the points. It's divided in two sections: GNSS and TS

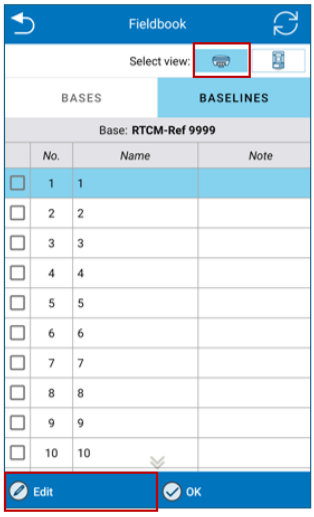
- *GNSS section* -> contains all the information about the GNSS base and the baselines related to the collected points.

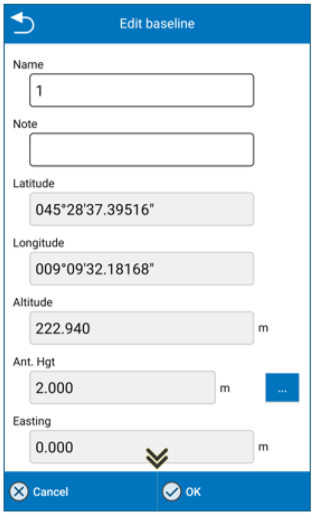
    - In *Bases* section, the user can read the GNSS reference bases information. Clicking on *Edit*-> *Move Base*, it's possible to change the GNSS reference base coordinates entering directly in "*Change Station Coordinate*" function (9.4 Change Station Coordinates). After changing the reference base coordinate, the Fieldbook is recalculated.



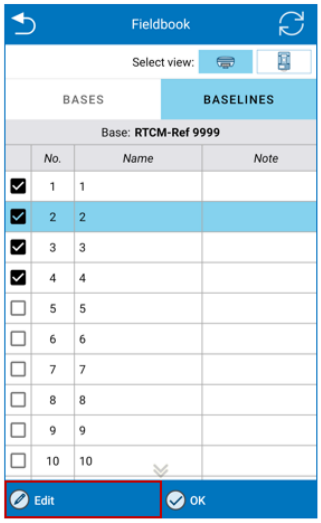


    - In *Baselines* section, the user can read the information about the GNSS points collected. Clicking on *Edit* it's possible to modify the GNSS points collected. Scroll in vertical direction to read all the data associated to a GNSS points and click on *OK* to confirm the changings. After pressing *OK* the Fieldbook is recalculated.



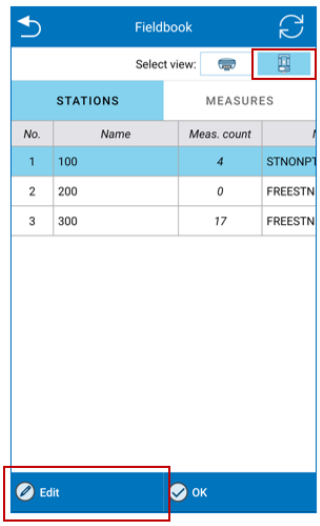


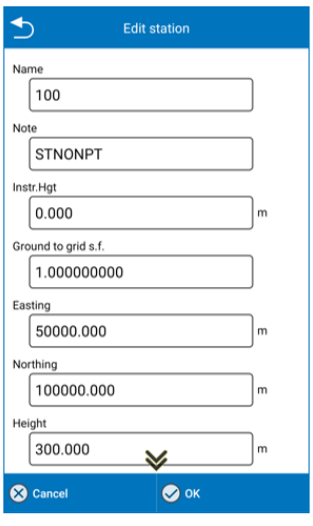
Note. in *Baselines* section, it's possible to modify the Name and the Pole Height of more than one point simultaneously. Click on the squares in the first column to select the points to modify simultaneously.



- *TS section* -> contains all the information about TS measurements (angles/distances/prism constant…) and the stations from which the points were collected.

    - In *Stations* section, the user can read the TS station position information. Clicking on *Edit* it's possible to change the station coordinates, the instrument height and the TS Scale Factor associated to a station. After changing them, the Fieldbook is recalculated.

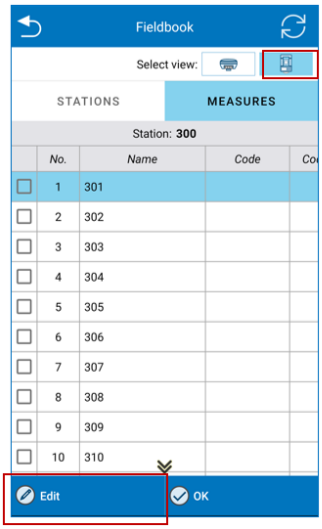


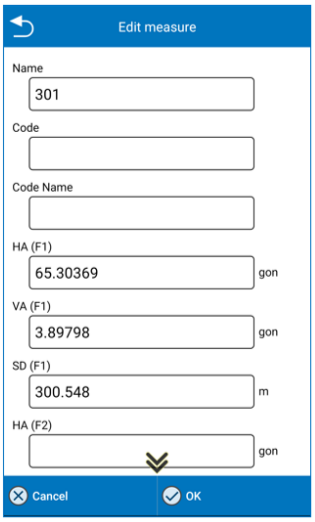


Note 1. In this section the user can manage also the free station calculation. When clicking on Edit the *'Free Station'* page in Calibrate menu is displayed (10.3 Resection/Free Station)

Note 2. If a station is changed and other stations are connected to it, those stations (and consequently the points collected by them) are also recalculated according to the new station point.

- In *Measures* section, the user can read the information about the points collected with the TS. Clicking on *Edit* it's possible to modify the TS measurements and manage it. Scroll in vertical direction to read all the data associated to a TS point and click on *OK* to confirm the changings. After pressing *OK* the Fieldbook is recalculated.

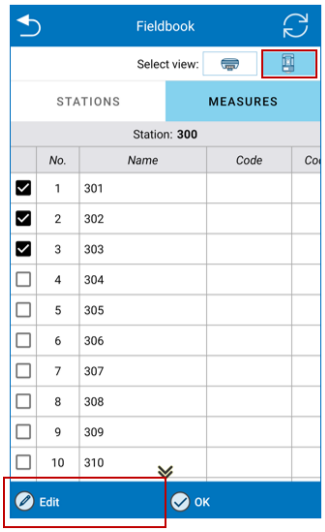


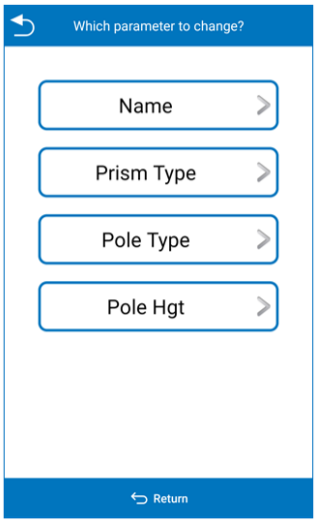


Note 1. If the user collects some points with F1/F2 routine, the raw data (angles/distance) displayed in the main table are the mean of these readings. Clicking on *Edit*, the user can visualize both measurement and analysed them.

Note 2. To make it simpler the comparison between several data, angles in the main tables are visualize like in F1.

Note 3. in *Measures* section, it's possible to modify the Name, Pole Height, Prism Type and Pole Type of more than one point simultaneously. Click on the squares in the first column to select the points to modify simultaneously.





3.10 Import Raster Image

The Import Raster Image submenu allows the user to import a raster georeferenced image. By clicking “Open Raster Image”, the default path is StonexCube → Input, but it’s possible to move to other folders. After selecting the image, some information related with the image will appear (width, height, file size, required free RAM size).

Cube-a supports raster images in the following formats:

- Portable Network Graphics (PNG) – lossless compression.
- JPG (Joint Photographic Experts Group) – non-leak-free compress.
- TIF (Tagged Image File Format)– usually compressed, usually without data loss.

Having a raster image is not enough to have georeferencing: the raster image must have a "twin" file that stores georeferencing parameters. This file is called "Word File" and must be created using software that manages image georeferencing (e.g., Stonex Cube-desk).

The following table shows what type of Word file it’s necessary to store in the same folder that contains the raster image to import:

Raster file Format	Word File Format
*.PNG	*.PGW
*.JPG	*.JGW
*.TIF	*.TFW

Limits on raster import

Cube-a is developed on Android operating system and must comply with its limits on memory allocation. One of these limitations is that any application does not have to allocate large blocks of memory and if an application does, it must release those memory blocks as soon as possible.

Taken from Android developer documents: "To allow multiple running processes, Android sets a strict limit on the size of the heap assigned to each app. The exact limit of heap size varies between devices depending on the amount of RAM available on the device. If your app has reached a heap capacity and tries to allocate more memory, the system generates insufficient memory errors.

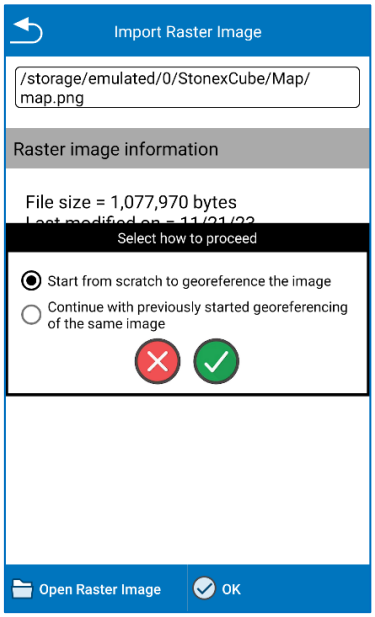
All this means that it’s necessary to be careful when trying to upload raster images. Although a raster image file appears to be small (a few megabytes) the same does not apply to the image data that it contains. Remember that raster image files are usually compressed, and that Cube-a must be uncompressed before viewing them, and this may require more memory than the Android operating system can provide.

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

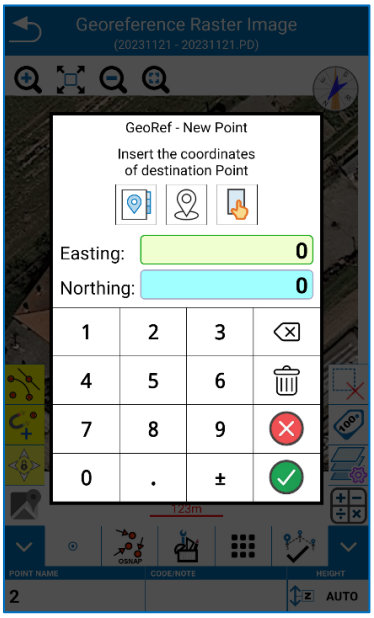
Example: a photo of 5 megapixels (2560 x 1920) occupies, after decompression, 14745600 bytes or 14 megabytes.

3.11 Raster image georeferencing

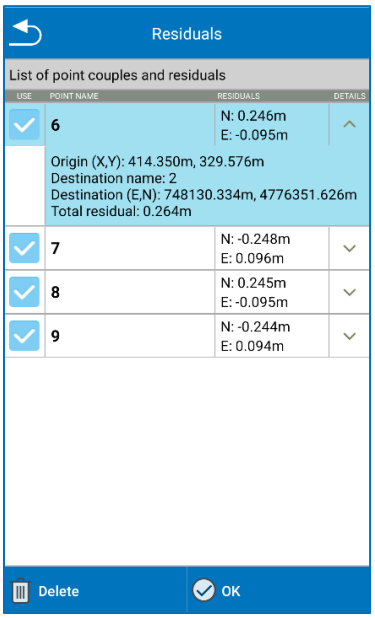
When importing a raster image, it's also possible to perform the georeferencing directly in Cube-a, by clicking on georeferencing option as in the following figure.



4 points couples at least are needed to perform the georeferencing. It's necessary to associate the coordinates to 4 points not aligned in the raster image. It's possible to take the coordinates from point library, from current GNSS position or from survey area.



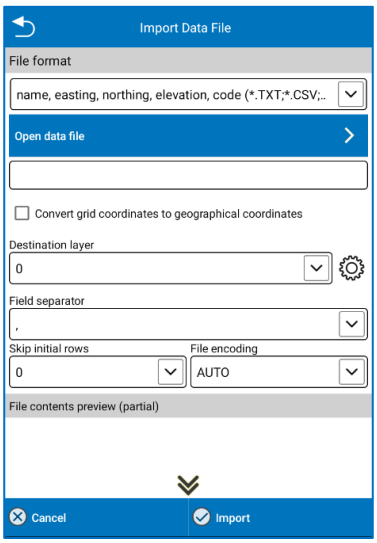
Click *Calculate* icon below on the right to see the list of point couples and residuals.

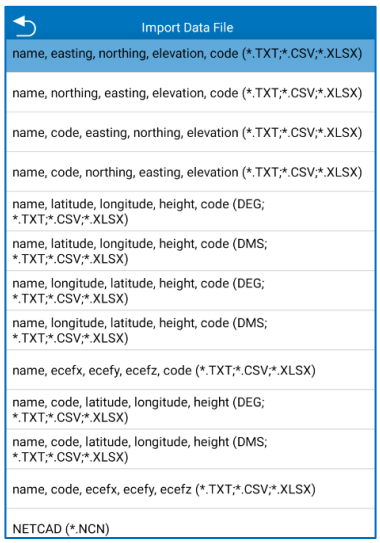


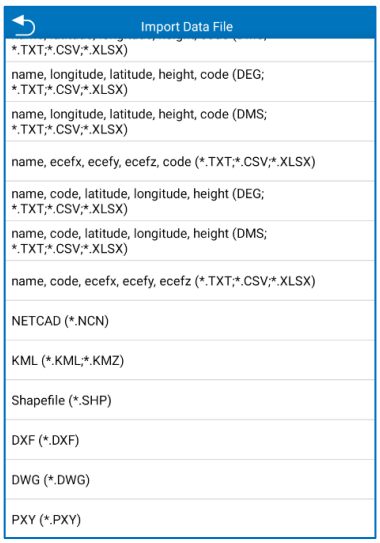
Click *OK* in the *Residuals* page to perform the georeferencing.

3.12 Import Data

In the Import data submenu, the user can import external files that were previously uploaded in our own device in various formats as in the following figures.







At the bottom it's possible to see the preview of the file the user is importing so that it's possible choose the field separator correctly and whether to skip the start lines because of the header. It is possible to select a layer where to store the imported points.

Import Format accepted by Cube-a: *ASCII* (.TXT, .CSV, .XLSX) – *NETCAD* (.NCN) – *Shapefile* (.SHP) - *DXF* (.DXF) – *DWG* (.DWG) – *PXY* (.PXY)

3.13 Import a Cube-a Project or a *.PD file

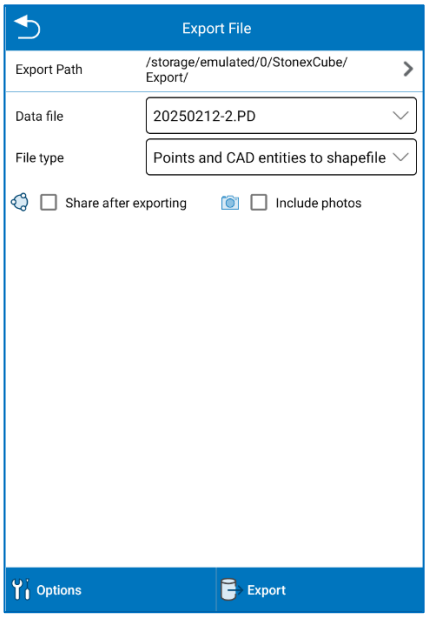
To import a project into your program, copy the project folder, as it appears, in the folder created by Cube-a, *StonexCube -> Project*. The project will then be visible in the Project Manager submenu in the Project menu.

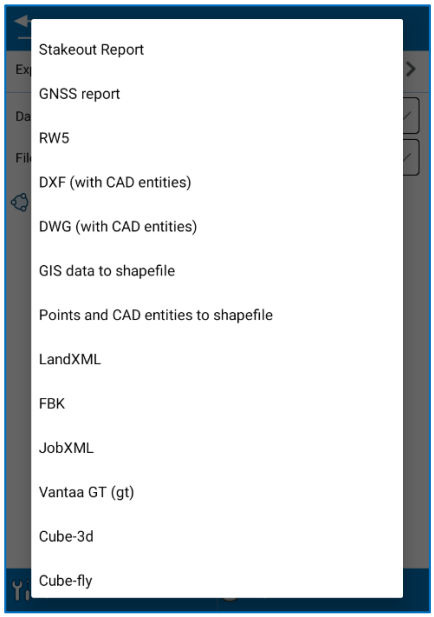
To import a *.PD file within an existing project in Cube-a, copy the *.PD file in the path *StonexCube -> Project -> (Existing Project folder) ->* ***Data***.

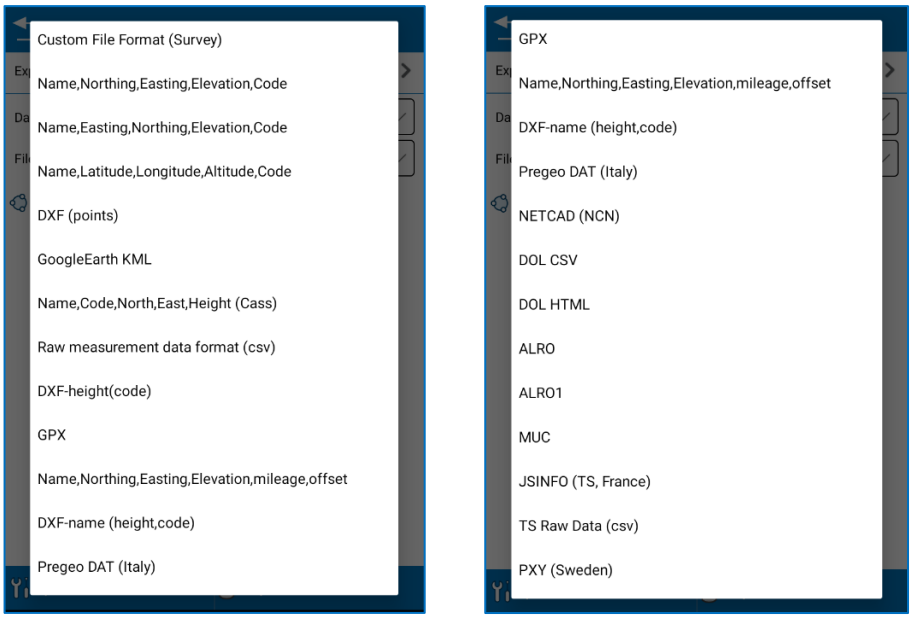
Note. if you do not copy the *.PD file in the Data subfolder then it will not be visible in the program. Once copied, select it from the File Manager submenu to open it in Cube-a.

3.14 Export Data

Export Data submenu is used to export the survey in a certain format, which is chosen by the user through the File type drop-down menu. The user can export data in a default format or custom format. It is necessary to enter the name of the file you want to export, the survey (.PD file) and the format in which you want to export. Click *Export* to export the file to the export location shown at the top (click to edit the path if you want). Depending on the selected file format, there may be some advanced options to select (For example exporting into dxf file format).





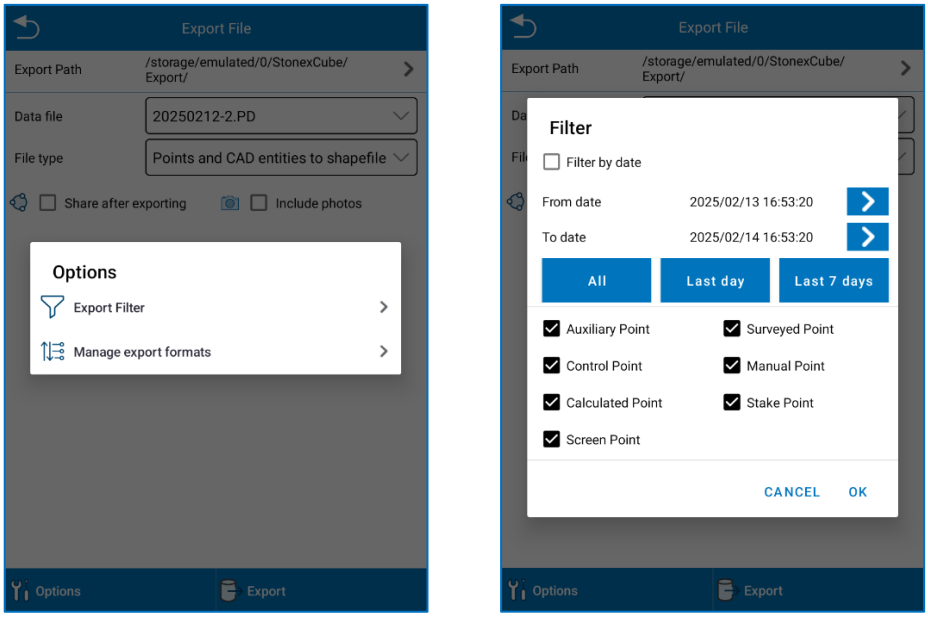


If the user enables the "*Share after exporting*" option, before clicking *Export*, the same file that will be exported to the export location (tablet internal memory) and it will also be shared in real time through the communication channel that will be chosen (e-mail or Cloud Services for example). In thi second cas, it's possible to use Android options/applications for sharing data using wireless method. If the user has installed applications like e-mail services or Cloud Drive, it's possible to use them for sharing data easily using Internet Connection.

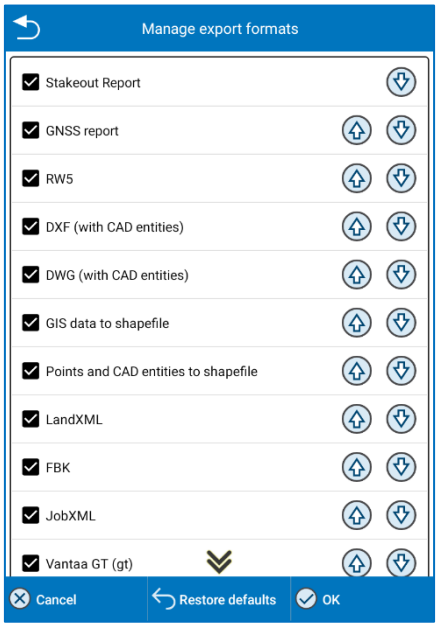
If the user enables "Include photos", a folder containing the photos associated with the points during the survey will be received by the user.

For some export formats, by clicking on 'Options' it's possible to see *'Export filter'* option. *Export Filter* allows to filter the export by selecting a time frame by enabling the Filter by date option. You can specify the date or, as a shortcut, select one of the options All, Last day or Last 7 days.

It is possible to filter the exports by selecting the types of points to be exported.



With the "*Manage Export Formats*" option users can customize the order of export formats based on their preferences. It's possible to move formats up or down using the arrows next to each option. This feature allows quick access to frequently used formats. Restore defaults option allows to restore the default exportation format list.

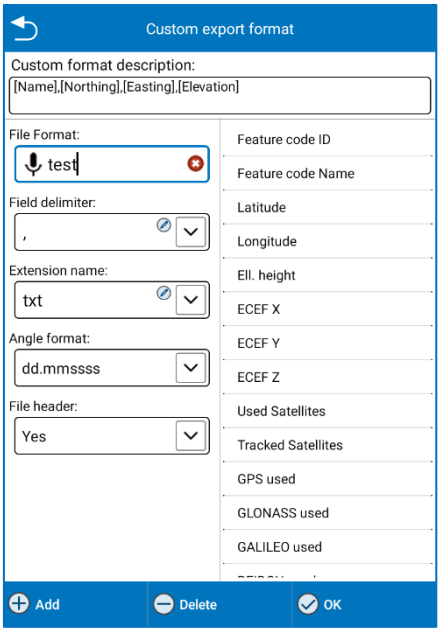


Export Format available in Cube-a: *Stakeout Report (.CSV) – GNSS Report (.html) – RW5 (.RW5) – DXF with CAD entities (.DXF) – DXF points (.DXF) – DXF name (height, code) (.DXF) - DWG with CAD entities (.DWG) – GIS data to shapefile (.SHP) – Points and CAD entities to shapefile (.SHP) – LandXML (.XML) – FBK (.FBK) – JOBXML (.JXL) – Vantaa GT (.GT) – Cube 3D (.XC3D) – Cube fly (.FLY) – Custom File Format (.TXT/.DAT/.CSV)* – CSV – XLSX – GPX (.GPX) – Pregeo DAT (.DAT) – NETCAD (.NCN) – DOL CSV (.CSV) – DOL HTML (.html) – ALRO (.CSV) – ALRO1 (.CSV) – MUC (.CSV) – JSINFO (TS, France) (.CSV) – TS Raw Data (.CSV) – PXY (Sweden) (.CSV)*

*Custom File Format is explained in the following paragraph.

Custom File Format

In Cube-a it is possible to customize the data will be exported in the Export Data page. After selecting the custom file format in the related page, the user can Add, Edit, Import (in .DED file format) or Delete the custom file format. To create a custom file format user should click Add and define the custom file description. Users can also define the field delimeter (, ; I @ space tab), extension name (dat, csv, txt), angle format and file heater (yes or no).



3.15 Share by WiFi

Through the “Share via Wi-Fi” submenu, the project can also be shared via Wi-Fi. This feature allows wireless connection between the Android device on which Cube-a is installed and the PC, to browse the contents present in the program and download the files from the device to the PC and vice versa.

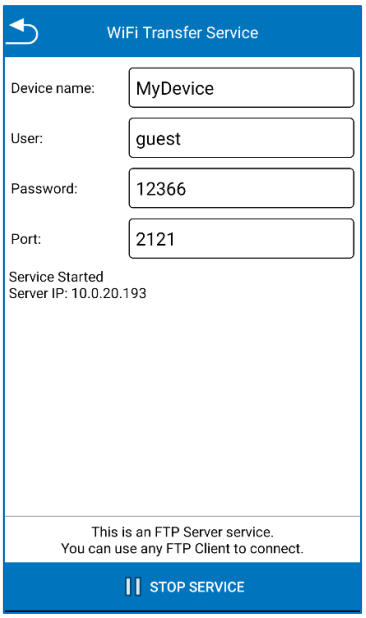
On the Wi-Fi Sharing page, you must:

a) Enter the device name (not required).

b) Choose a username (the default username is "guest").

c) Choose a password (the program shows by default a randomly generated numeric password, which can also be maintained if you prefer).

d) Choose an IP port number whose value is in the range 1025-65535 (you can think of the port number as the home address while the IP address is the name of the street where the house is located).



Before proceeding further, verify that:

- The Android device is connected to a Wi-Fi network.
- Your PC is connected, wirelessly or by cable, to the same Wi-Fi network to which your device is connected.

Note: If your Android device and PC are not connected to the same network, you cannot use the function, except if the network has been configured to allow communication between multiple networks (for example, if your company has more than one internal network).

When you are sure that all network constraints are satisfied, click *Start FTP Server*, after which the *Start FTP Server* key will change to *Stop FTP Server*.

Just below the "IP Port" field, the following messages will appear:

The FTP server service is running.
IP Server: AAA. BBB. CCC.DDD.

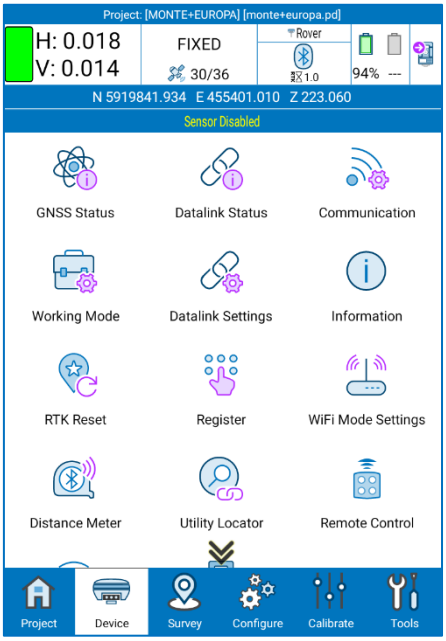
Where AAA. BBB. CCC.DDD is the IP address that must be entered later into the FTP client by PC. Note that the exact value of the IP address depends on the network: the common values for part AAA. BBB are 192.168 and 10.0 for local private networks.

After you set up the various settings correctly and start the "Share via Wi-Fi" feature from Cube-a, you need to follow additional simple steps from PC.

On the client (your PC) you can use any FTP client (such as FileZilla) to connect to the Android device.

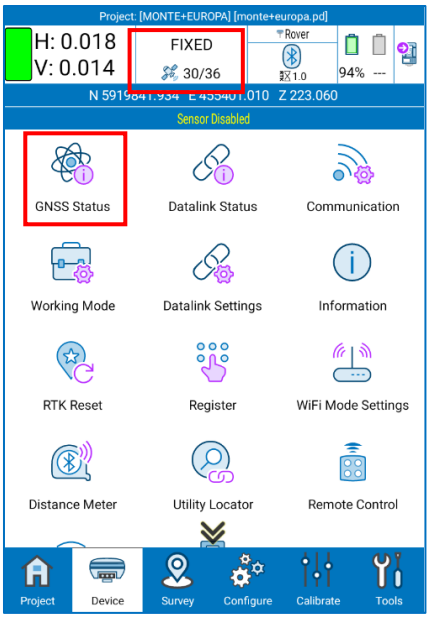
4. Device – GPS Module

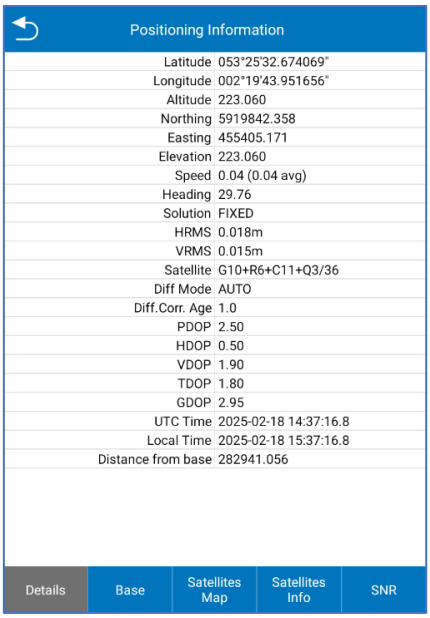
The Device menu contains all the functions concerning the communication and configuration of the GNSS receiver and the Total Station. It looks different depending on the GPS or TS module. This chapter will be dedicated to the description of the GPS module interface (see 5 Device – TS Module for TS interface description).



4.1 GNSS Status

The *GNSS Status* page contains GNSS positioning information. It's possible to access this page also by clicking on solution/satellites on the status bar. The *Details* tab is shown in the following figure.





The **Solution** can be NO FIX, SINGLE, DGNSS, FLOAT, FIXED.

- *NO FIX*: the GNSS position is not available (you are not connected to GNSS receiver, or the receiver does not see any satellites)
- *SINGLE*: the GNSS is not receiving differential corrections from the base, so the accuracy is low.
- *DGNSS*: the GNSS is receiving differential corrections from SBAS satellites, or from the base but it could not calculate a better solution; the causes can be various, e.g., a limited number of tracked satellites or slow data connection.
- *FLOAT*: the GNSS is receiving differential corrections from the base, but the RTK algorithm has not been solved yet and it is always a less accurate position than a FIXED solution. It's a good solution for GIS surveys but not for measurements with expected centimetre accuracy. We suggest you wait to obtain a FIXED solution.
- *FIXED*: the GNSS is receiving differential corrections from the base, it is the final and best solution for corrections with maximum possible accuracy, usually within 2 cm.

HRMS and **VRMS** stand for horizontal and vertical root mean square. They are in meters or feet (depending on system settings) and can be used to have an idea of accuracy level. They are the horizontal and vertical distance within which 63% of positions are predicted to fall, to be exact. Twice RMS is the distance which 98% of positions are predicted to fall.

The **differential mode** is the format of differential messages (CMR, RTCM…). In Cube-a you always read AUTO because the decoding is made by GNSS receiver.

Differential correction age is the time (in seconds) taken by rover to receive corrections (e.g, 10 sec delay means that the base has sent a signal that rover has received after 10 seconds of submission). When RTK mode is running, the fix delay is low, so the result is better, generally the delay is less than 5 seconds.

PDOP: Position dilution of precision. The lower PDOP value, the better satellite distribution, which facilitates the achievement of FIXED solution.

HDOP: Dilution of horizontal precision.

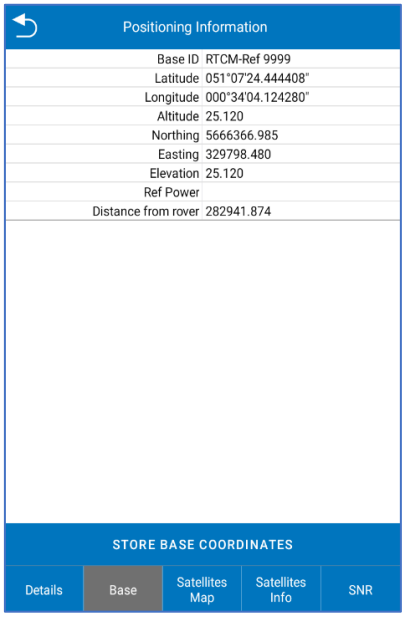
VDOP: Dilution of vertical precision.

TDOP: Time dilution of precision.

GDOP: Geometric dilution of precision.

DOP Value	Rating	Description
1	Ideal	Highest possible confidence level corresponding to the highest possible precision.
1-2	Excellent	Measurements can be considered accurate enough to fulfill all civil/engineering/cadastral applications.
2-5	Good	Minimum appropriate for calculating usable but not so accurate point positions.
5-10	Moderate	The positional accuracy is not good enough for any civil applications. If possible, move to get a more open view of the sky.
10-20	Fair	Low confidence level. Positional measurements should be discarded, unless the position is used to get only some rough estimate of the point location.
>20	Poor	Measurements are inaccurate and they should be discarded.

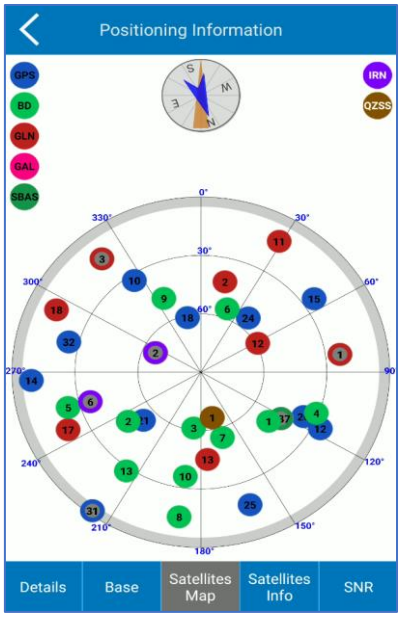
The *Base* tab is shown in the following figure. It contains information about the base to which the rover is connected. Click *Store Base Coordinates* to save base point in the point library.



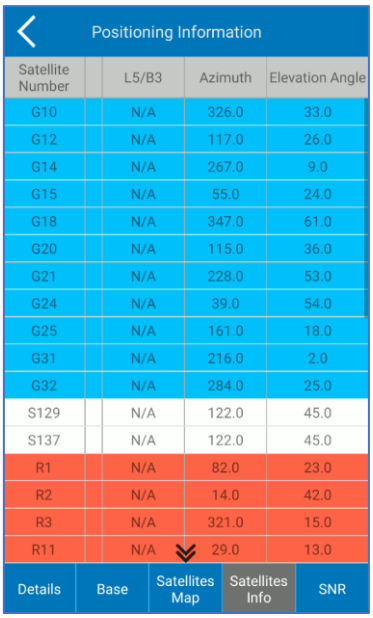
The *Satellites Map* tab is shown in the following figure. It contains the skyplot, so the position of satellites with respect to the GNSS receiver that is the center of the skyplot.

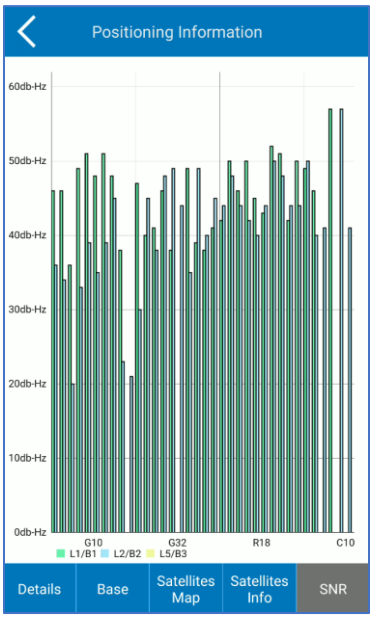
Legend: GPS-blue (GPS); BD-light green (BEIDOU); GLN-red (GLONASS); GAL-pink (GALILEO); SBAS-dark green (SBAS); ATL-yellow (ATLAS); IRN-purple (IRNSS); QZSS-brown (QZSS).

Seen satellites are colored grey. Tracked satellites are fully colored with the respective color.



The *Satellites Info* tab and the *SNR* tab are shown in the following figures. They contain the name of the satellites, the L1, L2, L5 frequencies, the azimuth and the elevation angle, and the signal to noise ratio.





4.2 Datalink Status

The *Datalink Status* page contains the datalink details, depending on working mode (see 4.4 Working Mode) and datalink type (see 4.8 Datalink Settings).

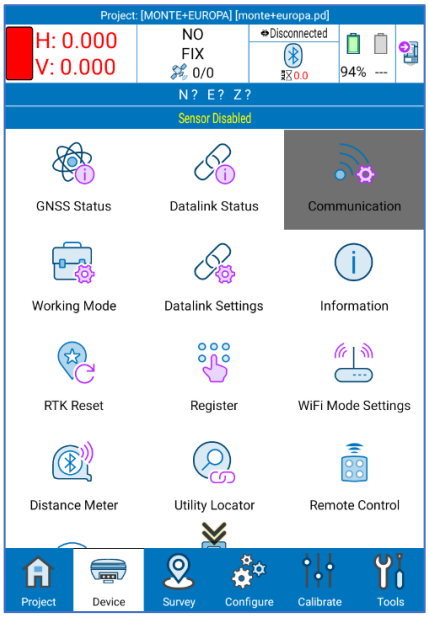
4.3 Communication

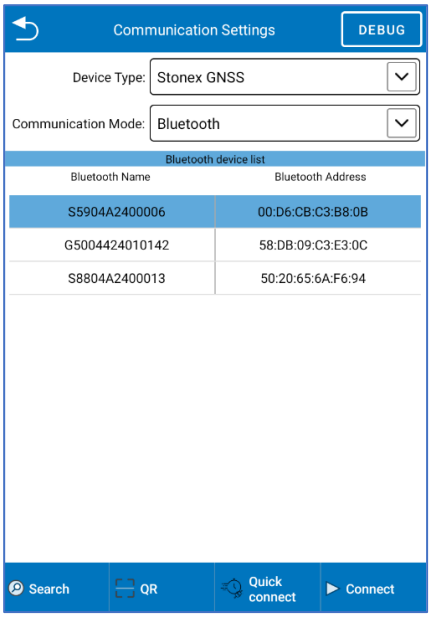
In the *Communication* page, the user can establish the connection between the instrument and the controller.

Bluetooth or WIFI

Here below the procedure for connecting a GNSS receiver to Cube-a:

1. First, select the device type from the dropdown menu between:
   - Stonex GNSS for all the latest generation Stonex GNSS receivers and the old Stonex S8 receivers.
   - Generic NMEA to connect a non-Stonex GNSS receiver.
   - Internal GPS to use the GPS inside the controller.
   - The remaining types according to the receiver model.





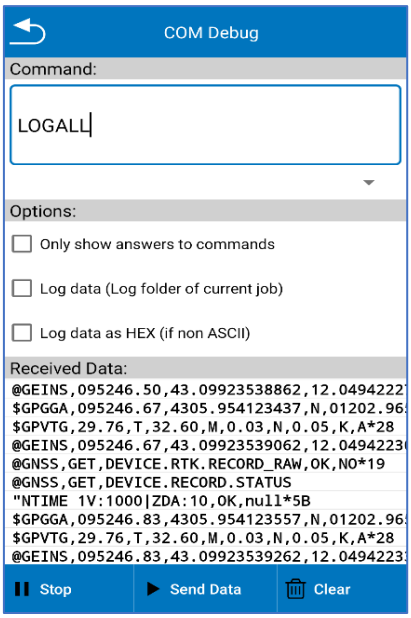
2. Set the mode of communication between Bluetooth and Wi-Fi. Click *Search* to search for nearby devices, select the device; the user can recognize its own device from Serial Number that will appear in the Bluetooth Name column.

3. Select the Serial Number corresponding to its own device and click on *Connect* to establish the connection.

   Note. It is possible to scan the QR code or barcode on the bottom of the device to select the device to connect (first it's necessary to do the Bluetooth search, because then looks for the serial among the visible devices).

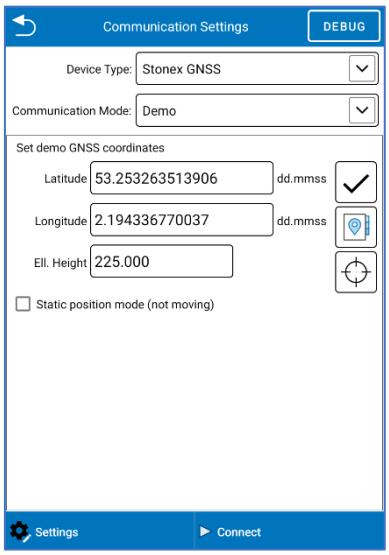
The command at the top "Debug" (active with each mode of communication) allows to consult the outputs of the GNSS receiver; this data can also be recorded by checking the box Record data. By clicking on *Information output*, it's possible to see the list of possible commands to send to the GNSS receiver to read its output (the box only show answers to commands works as a filter, you will see the outputs related only to the command sent).

At the bottom, the command *Start* starts receiving data; the command *Send Data* sends the command in the top window to the GNSS receiver (the window is editable); the command *Clear* cleans the data received window.



Demo mode

This option in *"Communication Mode"* section simulates the connection to a receiver, a useful function to show the functions of the program without having a GNSS receiver connected. The location of the "fake" GNSS can be set through geographic coordinates, it can be read from a point in memory or set with the target by clicking on the map and then on *Apply*; by pressing connect the simulation begins. The GNSS will simulate a motion and above the map you can set the static mode.

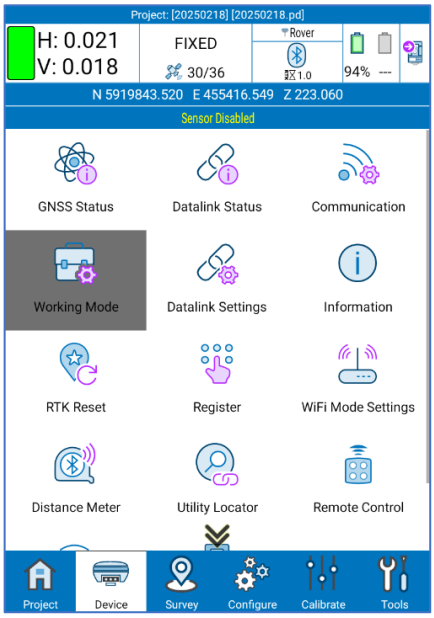


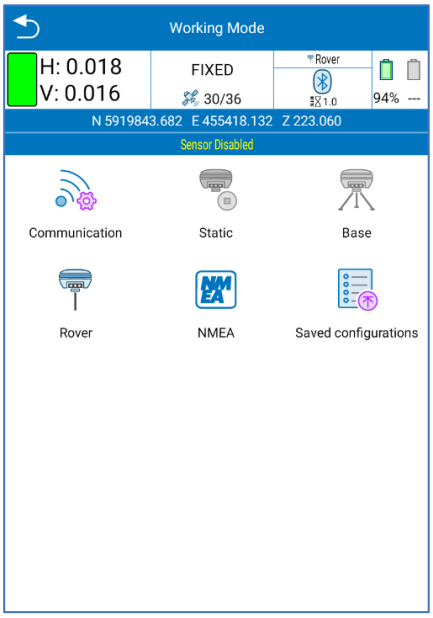
Demo playback

Plays a NMEA stream read from files as if it comes from a real GNSS device.

4.4 Working Mode

The *Working Mode* page allows the user to configure the receiver as rover or base for RTK survey or for static survey. It's possible also to set NMEA messages and launch configurations saved previously.



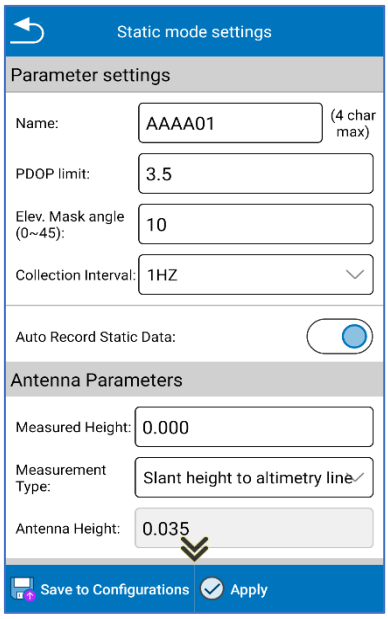


Saved Configurations

If the user saves the static, base, or rover configurations, he'll find all of these in *Saved configurations* page. Here simply selecting the configuration and clicking *OK*, it's possible to launch the configuration. Click D*etails* to see details of the selected configuration; click D*elete* to delete the selected configuration.

4.5 Static

The Static mode settings window is shown in the following figure.

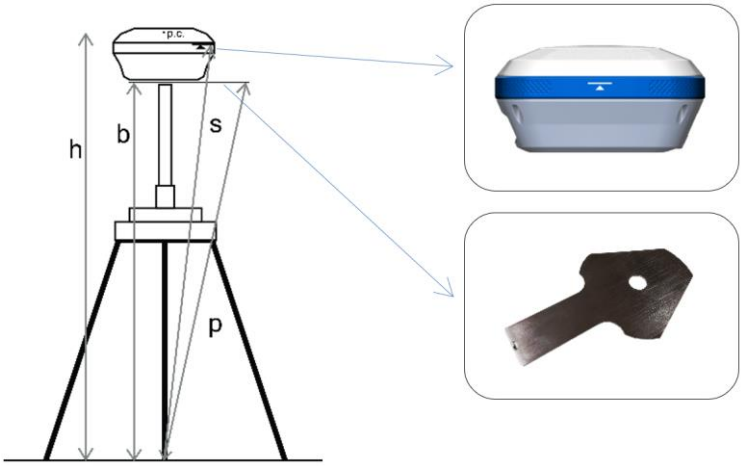


Parameter settings

- *Name*: The name of the points in static is limited to 4 characters.
- *PDOP limit*: the maximum PDOP accepted. PDOP meaning at 4.1 GNSS Status.
- *Elevation Mask angle*: the cut off angle starting from horizon. The receiver will not consider satellites in this angle.
- *Collection Interval*: 1 Hz indicates the acquisition of one data per second, 5 HZ indicates the acquisition of five data per second, 5 s indicates that the receiver collects data every five seconds, and so on.
- *Auto Record Static Data*: if enabled, the receiver starts recording automatically when it is turned on, otherwise you need to manually start raw data recording.

Antenna Parameters

In this section the user can insert the measured height and set how the measurement is done. The antenna height value used in the survey will be calculated automatically by the program, depending on GNSS phase center position, and it will be visible in the text box "*Antenna Height*".



Measurement Type:

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

Satellite Systems

This section includes seven satellite systems: GPS, GLONASS, BEIDOU, GALILEO, NAVIC/IRNSS, QZSS and SBAS. Depending on needs, it's possible to choose whether to receive the signal from a constellation or not.

The Satellite Based Augmentation System (SBAS) is a large-scale differential improvement system (improvement system based on the quality of satellite signal). Navigation satellites are surveyed by many widely distributed different stations and the acquired raw data is sent to a computing center. Then from the calculation center, correction information is sent to geostationary satellites of the covered area, and finally, geostationary satellites send corrections to users, helping to improve positioning accuracy.

The user can save the configuration by clicking on the corresponding button; this allows to launch the same configuration later (or in a new project) without having to reinsert all parameters.

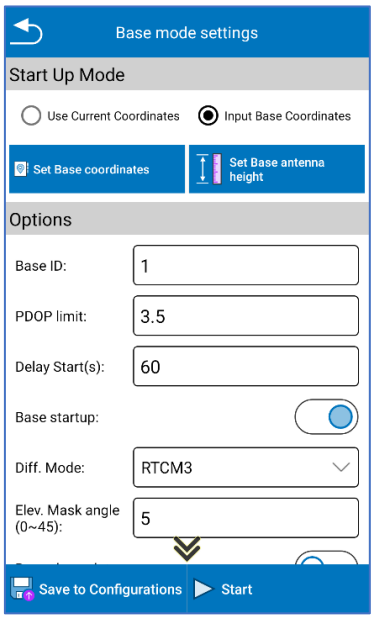
Click *Apply* to start the receiver to static working mode.

4.6 Base

There are two *"Start Up Mode"* for base configuration.

Use Current Coordinates

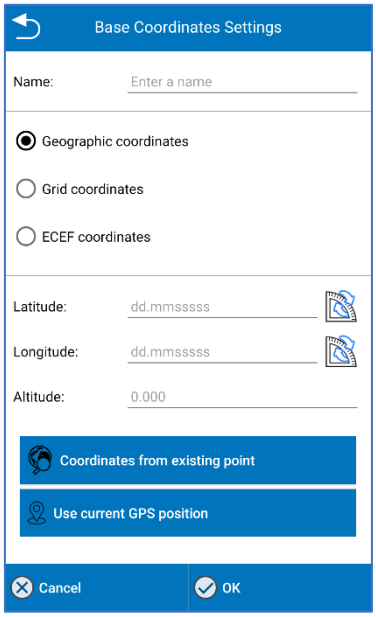
The program takes the current WGS-84 coordinates from the GNSS and sets them as base coordinates. They depend on the GNSS receiver current position and accuracy.



Input Base Coordinates

The user can manually set base coordinates. This way it's mandatory to insert even the antenna height.

After clicking on *"Set Base coordinates"* the following page opens.



The coordinates sent by program to base are always geographic, but it's possible to choose between different formats.

- If the user selects "*Geographic coordinates*", the coordinates will be sent as well as inserted, so the altitude is the ellipsoidal height. Click on square icon to change angle format.

- If the user selects "*Grid coordinates*", the coordinates inserted will be converted in geographic coordinates by using the coordinate system set in Cube-a, and the geoid also if it's enabled.

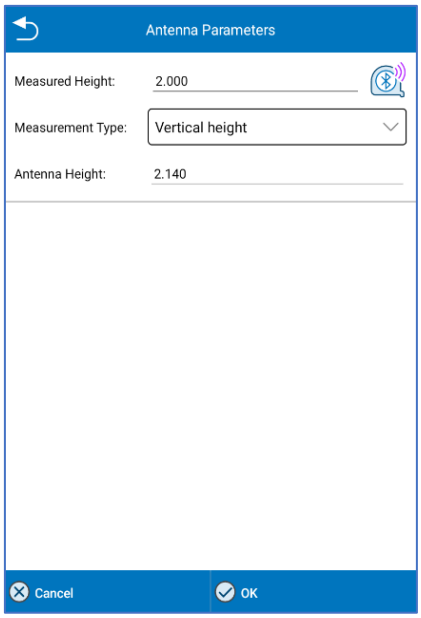
- If the user selects "*ECEF coordinates*", the coordinates inserted will be converted in geographic coordinates on WGS-84 ellipsoid (the coordinates system and the geoid set are not considered).

And therefore, if the user knows the local height above sea level, he has to select *Grid* option and previously set the Geoid (and the right coordinate system) in Cube-a.

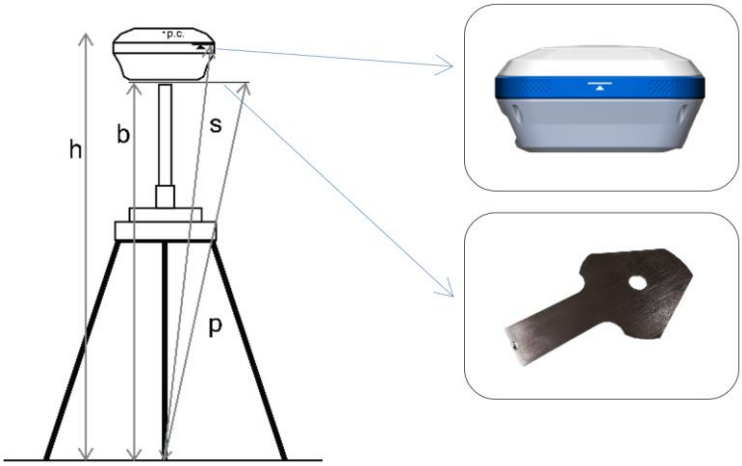
The user can also manually insert the coordinates in the format chosen or take from existing point (e.g., when previously saved the base point in RTK mode or when imported the point in the library).

Click *OK* to confirm the base coordinates.

After inputting the Base Coordinate, click on *Set Base antenna height* to set base height. The following page opens.



The user can enter the measured height and set how the measurement is done. The antenna height value used in the survey will be calculated automatically by the program, depending on GNSS phase center position, and it will be visible in the text box "*Antenna Height*".

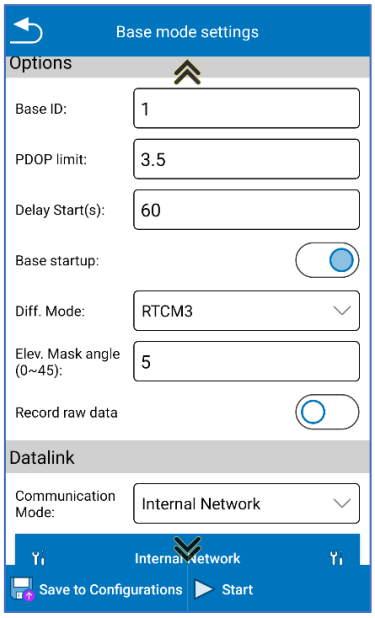


Measurement Type:

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

Options

In this section it's possible to set the Base ID, the PDOP limit value (PDOP meaning at 4.1 GNSS Status), the base start delay, the differential data format, the elevation mask angle (satellites in this angle starting from horizon will not be considered) and the raw data recording.



Datalink

Select communication mode from the dropdown menu. See 4.8 Datalink Settings for details on each communication mode.

Satellite Systems

This section includes seven satellite systems: GPS, GLONASS, BEIDOU, GALILEO, NAVIC/IRNSS, QZSS and SBAS. Depending on needs, the user can choose whether to use the signal from a constellation or not.

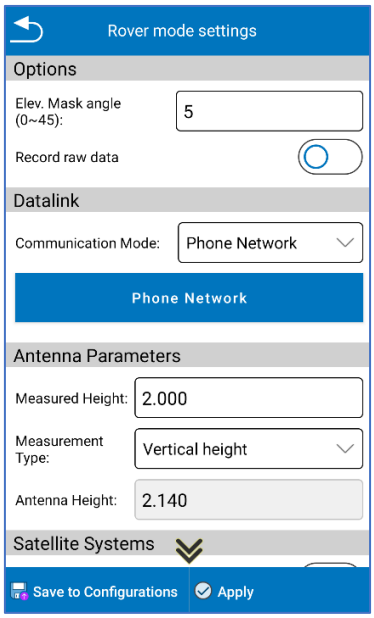
The Satellite Based Augmentation System (SBAS) is a large-scale differential improvement system (improvement system based on the quality of satellite signal). Navigation satellites are surveyed by many widely distributed different stations and the acquired raw data is sent to a computing center. Then from the calculation center, correction information is sent to geostationary satellites of the covered area, and finally, geostationary satellites send corrections to users, helping to improve positioning accuracy.

The user can save the configuration by clicking on the corresponding button; this allows to launch the same configuration later (or in a new project) without having to reinsert all parameters.

Click *Start* to start the receiver to base working mode.

4.7 Rover

Rover mode settings page is shown in the following figure.



Options

In this section, the user can set several option for the Rover mode:

- *Elevation Mask angle*: the cut off angle starting from horizon (satellites in this angle will not be considered).
- *Record raw data*: enable the GNSS raw data recording if needed.
- *Collection Interval:* 1 Hz indicates the acquisition of one data per second, 5 HZ indicates the acquisition of five data per second, 5 s indicates that the receiver collects data every five seconds, and so on.
- *Name*: The name of the raw data file is limited to 4 characters.

Datalink

Select communication mode from the dropdown menu. See 4.8 Datalink Settings for details on each communication mode.

When configuring the Rover, the user can find the “a-RTK” option in the Datalink section.

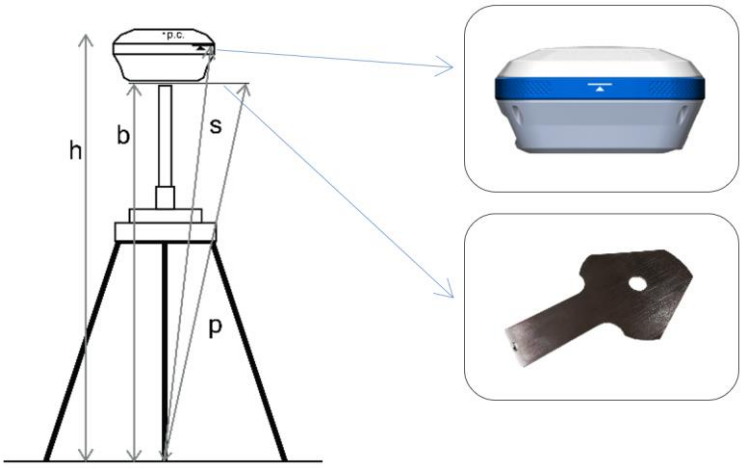
The a-RTK function does not mean ATLAS, even if also a-RTK makes use of ATLAS satellites. If you enable a-RTK, the receiver continues generating RTK positions up to 20 min from loss of the RTK correction source. This function does not require additional costs, and the points saved with a-RTK are in the same coordinate reference system defined by the user, so the same of the other points saved in RTK.

a-RTK stays in centimetre precision for 20 minutes after the GNSS has lost the correction signal, but the performance decreases as time increases; this is the reason why the user can configure the time for using the function. The GNSS receiver needs at least 1 minute of RTK correction to start the a-RTK feature. The countdown restarts when the GNSS receiver requires the correction signal, so the user can use the a-rtk feature every time you want during the survey.

Note. This functionality is only available with the GNSS A-Series receivers.

Antenna parameters

The user can enter the measured height and set how the measurement is done. The antenna height value used in the survey will be calculated automatically by the program, depending on GNSS phase center position, and it will be visible in the text box “*Antenna Height*”.



Measurement Type:

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

Satellite Systems

This section includes seven satellite systems: GPS, GLONASS, BEIDOU, GALILEO, NAVIC/IRNSS, QZSS and SBAS. Depending on needs, you can choose whether to receive the signal from a constellation or not.

The Satellite Based Augmentation System (SBAS) is a large-scale differential improvement system (improvement system based on the quality of satellite signal). Navigation satellites are surveyed by many widely distributed different stations and the acquired raw data is sent to a computing center. Then from the calculation center, correction information is sent to geostationary satellites of the covered area, and finally, geostationary satellites send corrections to users, helping to improve positioning accuracy.

PPP (Precise Point Positioning) Type

The user can select different PPP services (Galileo HAS, Beidou PPP and SBAS). The available PPP services depend on the device connected.

Note: The devices that currently support Galileo HAS and Beidou PPP are:

- S850+, S900+, S980+, S990+

GNSS board firmware version “R4.10Build11492” or above

Firmware version “0.24.231115” or above.

- S80 with RTK module

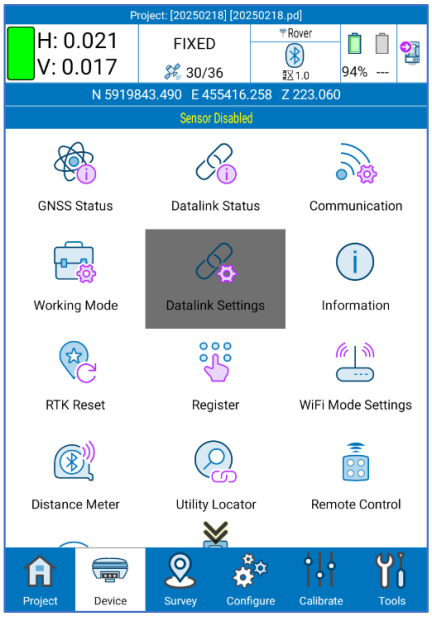
GNSS board firmware is updated to version “R4.10Build11833” or above.

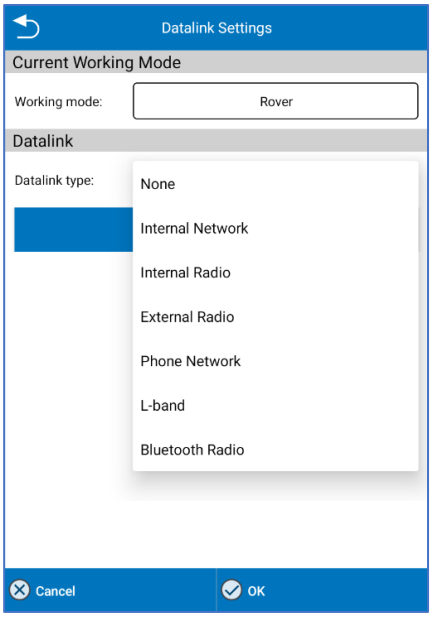
In the related page the user can save the configuration by clicking on the corresponding button; this allows users to launch the same configuration later (or in a new project) without having to reinsert all parameters.

Click *Apply* to start the receiver to rover working mode.

4.8 Datalink Settings

Different data transmission modes are available, and they depend on working mode (base or rover) and on GNSS you are connected. In the following paragraphs there is the description of all communication modes that the user can select in datalink section when configuring the base or rover.





None

No differential data is sent or received. Work with SINGLE solution.

Internal Network

See 4.5.1 Internal Network

Internal Radio

See 4.5.2 Internal Radio

External Radio

Connect an external radio to base and/or rover if the GNSS receiver doesn't have it or for increasing the range of data transmission. The external radio settings page is the same for base and rover. It's necessary to set only the Baud Rate. And configure the radio (protocol, channel...) from radio, or radio application.

Phone Network

See 4.5.3 Phone Network

L-band

Differential data is receiving by ATLAS satellite trough L-band signal. ATLAS is an exclusive PPP technology that provides real-time centimeter-level positions; once the corrections are calculated, they are delivered directly to the end user via geostationary satellite. ATLAS positions are referenced to ITRF08 current epoch.

Bluetooth Radio

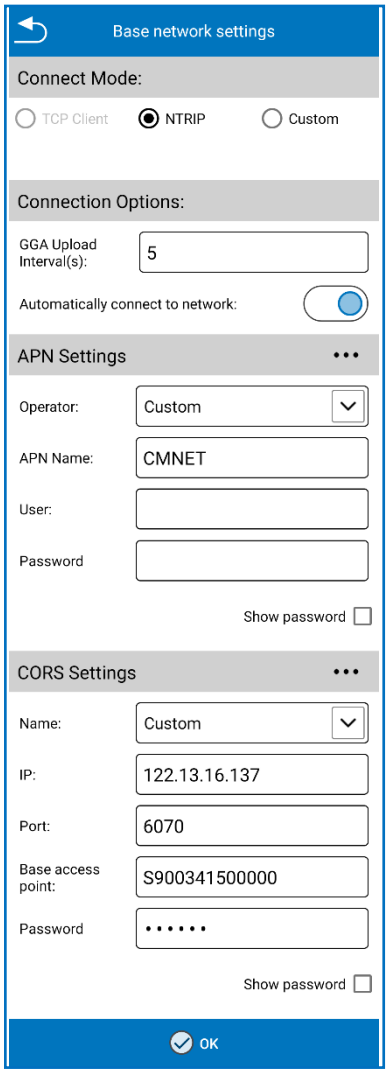
It's close to external radio. This way, the external radio is connected through Bluetooth, so when selecting this communication mode, the first (and only) step is to establish the Bluetooth connection between tablet and external radio. It's necessary to configure the radio (protocol, channel...) from radio.

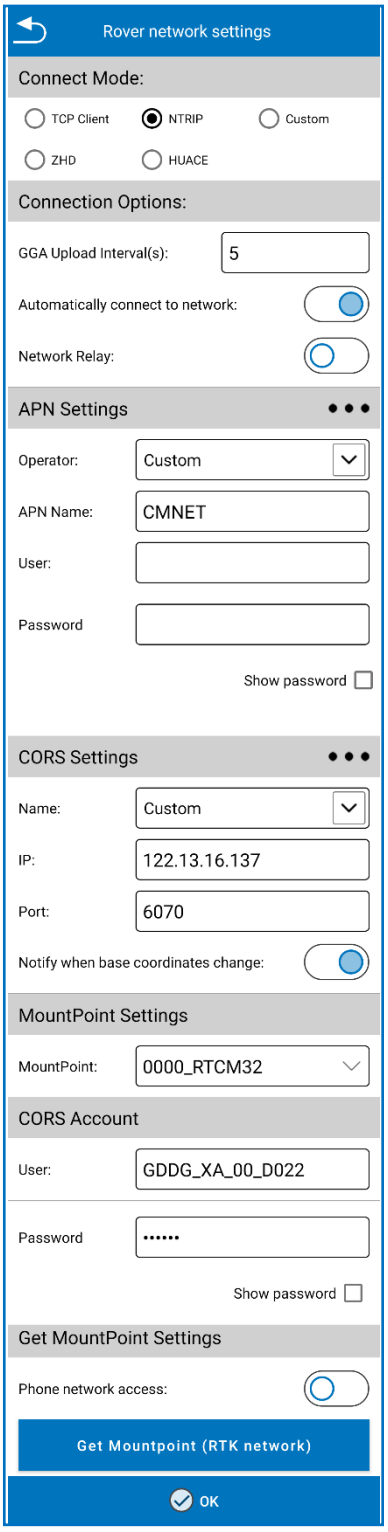
Dual

Simultaneous sending of data to a remote station via the internal network and via external radio.

4.9 Internal Network

Differential data is transmitted through the network, so it's necessary to insert a SIM card with internet connection available inside the receiver. In the following figures is shown the internal network settings for base (left) and rover (right).





The user has to set:

Connect Mode

- *TCP*: standard transmission control protocol, specific for network transmissions.
- *NTRIP*: standard protocol used to transmit differential data over the CORS network.
- *ZHD*: differential transmission mode of the HI-TARGET network.
- HUACE: differential transmission mode of the CHC network.
- *CUSTOM*: It is also possible to define a user-defined transmission protocol.

Connection options

- *GGA Upload Interval*: value of the GGA message sending interval (by default 5 sec).
- *Automatically connect to network*: the connection starts or re-starts automatically if enabled.
- *Network Relay*: data received via the network are relayed via internal radio to make them available for other rovers.

APN Settings

The user can search for a telephone operator by opening a dropdown menu or add a new one by clicking on the search button (icon with three dots) or use a custom operator by inserting parameters in the dedicated fields. The operator depends on the SIM card you use.

CORS Settings

- *Base CORS settings*: set the Caster IP address, it can be alphanumeric; set the Caster port; the base access point is fixed to the receiver serial number; set the Caster Password (it may not be requested).
- *Rover CORS settings*: search for a CORS network by opening dropdown menu or add a new one by clicking on the search button (icon with three dots) or use a custom CORS by inserting parameters in the dedicated fields.

It's possible to enable a warning message each time base coordinates are changed.

CORS Account

Set the user and password to access the CORS.

Get MountPoint Settings

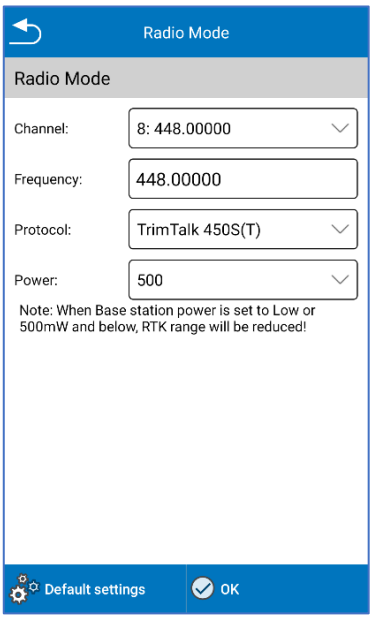
Get the entry points (mountpoint). Use the receiver's network or the device's telephone network for downloading them.

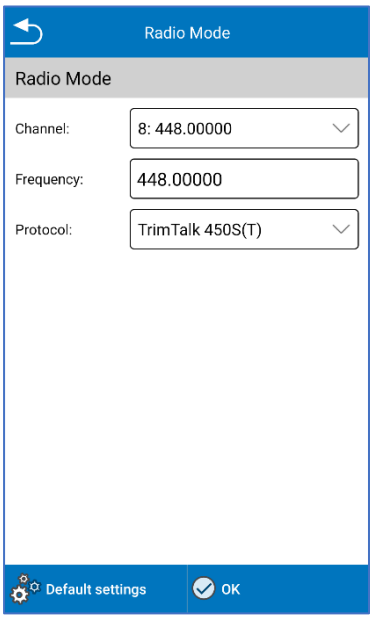
MountPoint Settings

Select the mountpoint from the dropdown menu once you have downloaded the list of mountpoint.

4.10 Internal Radio

Differential data is transmitted via GNSS internal radio. In the following figures is shown the internal network settings for base and rover.





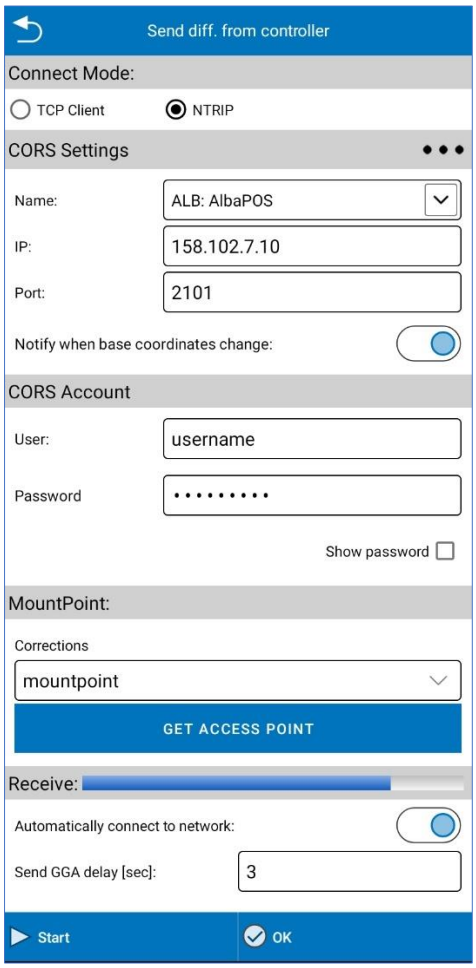
The list of available protocols depends on the connected GNSS receiver.

There are 8 channels. For each channel there is a preset frequency but if user chooses channel 8, he can change the frequency. Click *Default Radio Settings* below to change the frequency of the channels and select a different Radio Model.

The frequency and protocol of Base and Rover must be the same. In Basic mode, radio power affects the signal transmission distance. If the power is low, the energy consumption is also low, but the signal transmission distance is reduced; if instead the power is high, the energy consumption is high, but the signal transmission distance is extended.

4.11 Phone Network

Differential data is received through the controller network, so the use has to insert a SIM card with internet connection available inside the controller connected to GNSS or connect the controller to hotspot. This communication mode is only for rover.



Connect Mode

- *TCP*: standard transmission control protocol, specific for network transmissions.
- *NTRIP*: standard protocol used to transmit differential data over the CORS network.

CORS Settings

In Rover CORS settings the user can search for a CORS network by opening a dropdown menu or add a new one by clicking on the search button (icon with three dots) or use a custom CORS by inserting parameters in the dedicated fields.

It's possible to enable a warning message each time base coordinates changed.

CORS Account

Set the user and password to access the CORS network.

MountPoint

Click Get Access Point to download the list of mountpoints and select the mountpoint from dropdown menu.

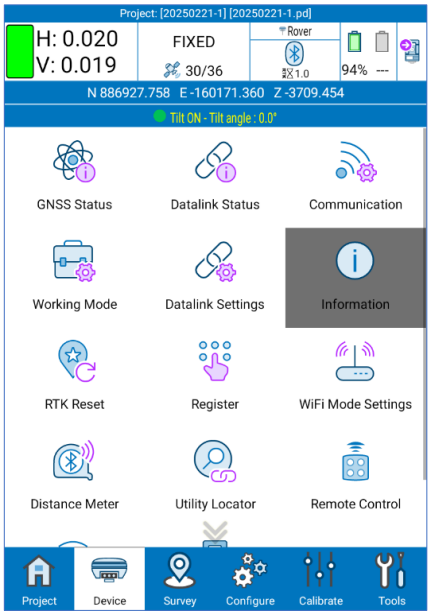
The user can also enable/disable some options:

- *Automatically connect to network*: the connection starts or re-starts automatically if enabled.
- *Send GGA delay*: interval (in seconds) to send position to NTRIP caster, to obtain the right corrections for that position.
- *Record diff. corrections*: only for debug, to record all corrections received (and to send them to us) for test.
- *Fake GGA coordinates*: send fake position to caster, only for test.
- *Forced GGA*: set fake position to force it if the previous option is enabled.

Click *Start* to start receiving differential corrections.

4.12 Information

This page contains all detailed hardware and firmware information about the GNSS receiver connected to the device.



4.13 RTK Reset

This function forces the GNSS board re-initialization. This will result in a complete recalculation of the location from new satellite signals.

4.14 Register

The user can see the expiration date of the GNSS receiver's user license (that is not the Cube-a license). It's also possible to insert a new GNSS receiver code (temporary or permanent).

Note. For this operation the GNSS must be connected to Cube-a.

4.15 WiFi Mode Settings

This function allows the user to set the Wi-Fi connection of the GNSS receiver.

- *MASTER*: the GNSS acting as hotspot, so other devices can connect to it (e.g., Cube-a can connect to the GNSS by WiFi instead of by Bluetooth).

- *CLIENT*: the GNSS is connected as client to a WiFi network (WiFi hotspot). The password is needed to access the selected WiFi unless it is not protected. When the GNSS is in CLIENT mode, its WiFi is not visible. To restore the MASTER mode, connect to the GNSS using Bluetooth.

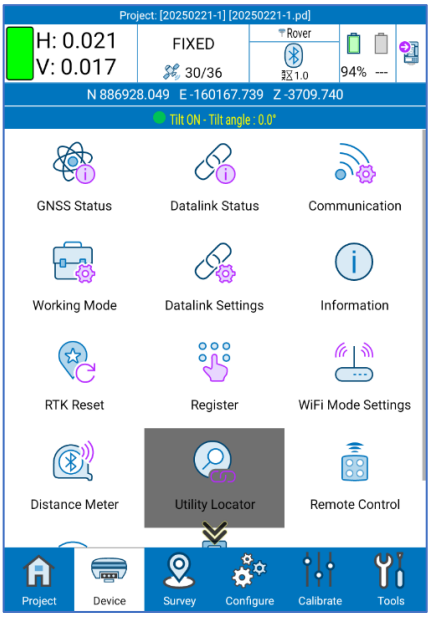
4.16 Distance Meter

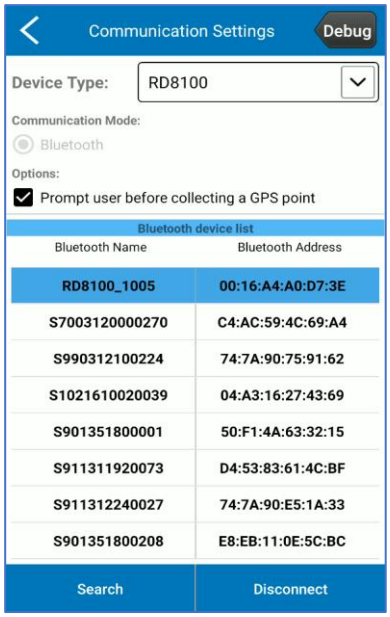
It's possible to connect a distance meter to Cube-a via bluetooth. The supported brands are Stonex and Leica. A screen will open where the user has to search and connect a Disto.

With the connected instrument it will be possible to measure directly from the Cube-a; the "Measure" command, which will start the measurement, in this case three measurements have been made. The "Clean up" button will be useful for deleting data and starting from scratch. The Disto command is available in all Cube-a functions that require measurement (but the command will only be visible if the distance meter has previously been connected).

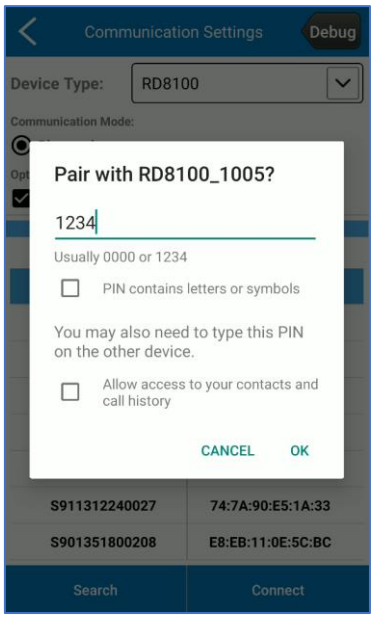
4.17 Utility Locator

The user can connect the controller and use Cube-a with RD1800 Pipe Locator or RD8200 Radio detection. This feature is available with the GIS module only. The page "Utility Locator" consists only in Bluetooth connection between the controller and the detector.



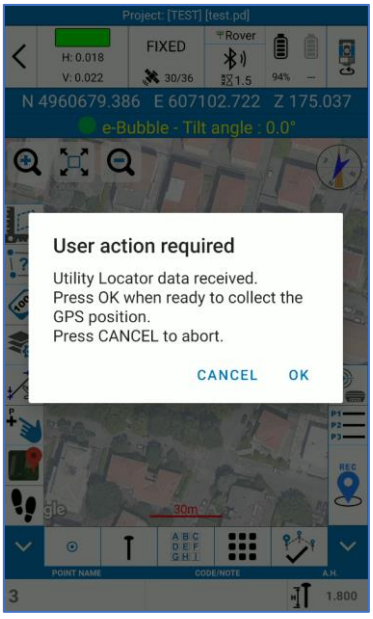


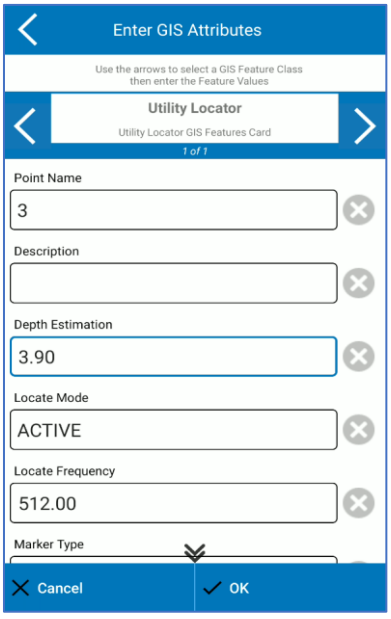
The first time you try to establish the connection, the pairing is required, and the password is 1234. Then, select the device and click *Connect*. See the detector user manual for more details on Bluetooth activation and locator settings.



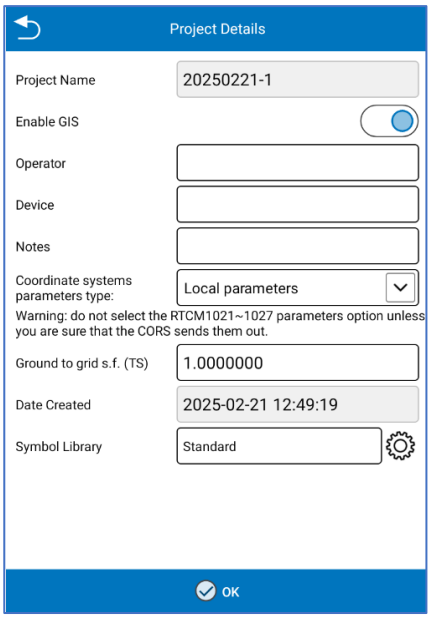
Once the connection is done, when pressing the measure button on the instrument to take measurement of the found pipes, the following message automatically appears in Cube-a. This way, move the GNSS on the point where the locator is to collect GPS position.

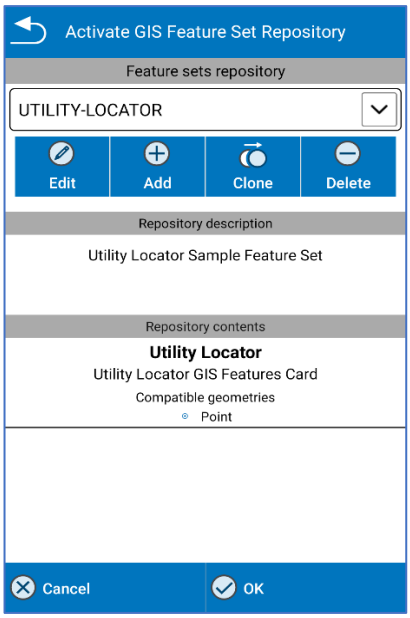
Note. If the user disables the option “Prompt user before collecting GPS point” in Bluetooth connection page, then the following alert does not appear and the GPS position is taken as soon as pressing the measure button on the detector.





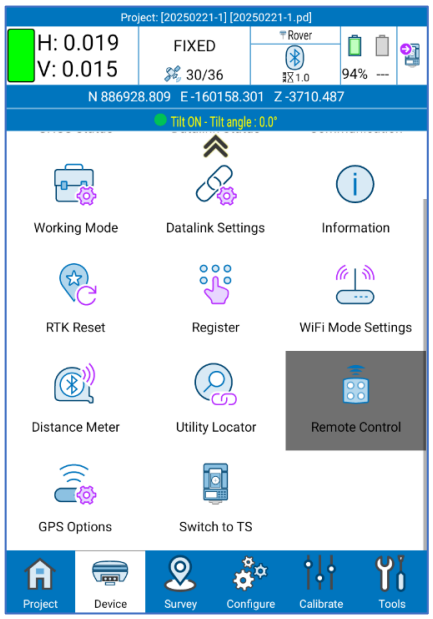
Remind to enable the GIS option and select Utility Locator GIS group of attributes to automatically save the detector measures as GIS attributes when saving the GPS point. Cube-a automatically take information from detector and insert them in the related GIS field, as in the figure above.

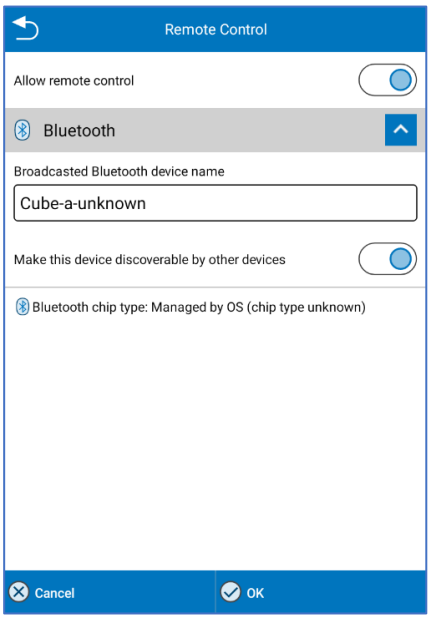




4.18 Remote Control

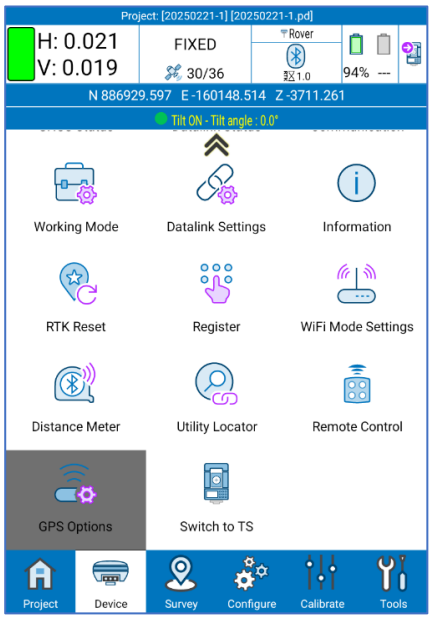
The remote-control function is used to transfer data between controllers or between controller and total station or total station to controller. To use this function, enable the "Allow remote control" option. It is possible to change the broadcast Bluetooth device name. Also see 3.1 Project Manager that allows to share Project file via Bluetooth from the page *Project -> Project Manager -> Share*.

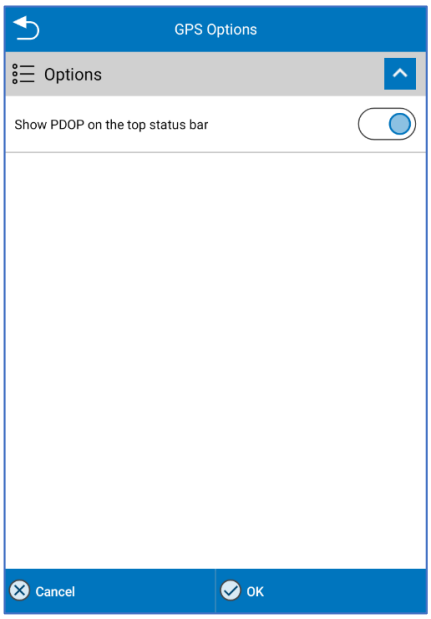




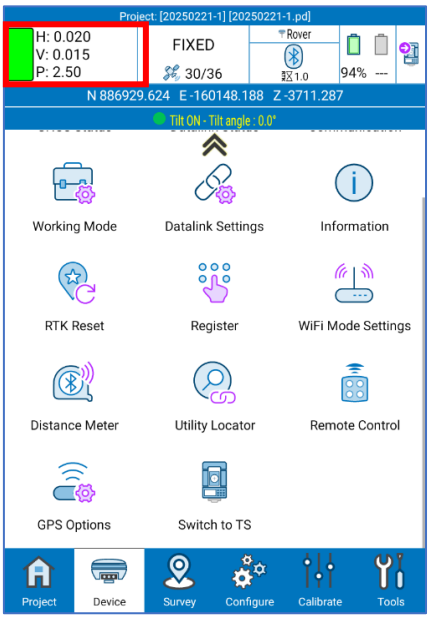
4.19 GPS Options

The GPS Option page allows to display PDOP information on the main screen, go to the GPS Option page and enable "*Show PDOP on the top status bar*" and click OK to display it in Cube-a upper bar.





On the main screen under HRMS and VRMS, it will be possible to see PDOP.

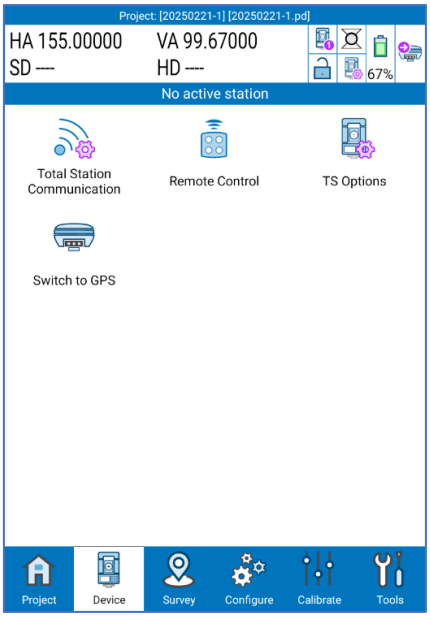


4.20 Switch to TS

Allows the user to switch to TS module's interface.

5. Device – TS Module

The Device menu contains all the functions concerning the communication and configuration of the GNSS receiver and the Total Station. It looks different depending on the GPS or TS module. This chapter will be dedicated to the description of the TS module interface (see 4 Device – GPS Module for GPS interface description).



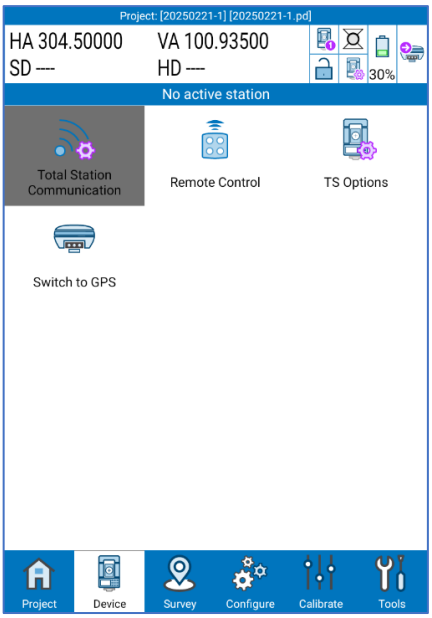
5.1 Total Station Communication

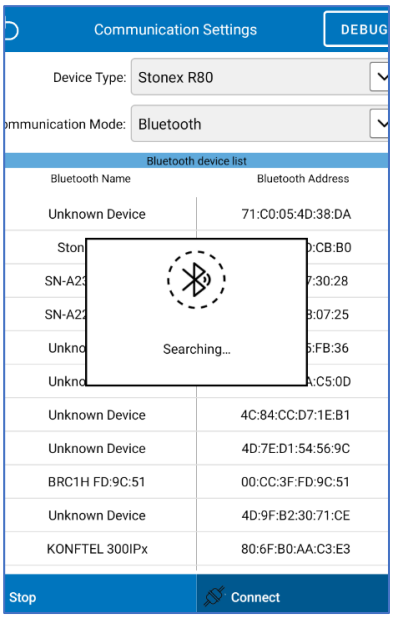
The supported total stations: Stonex R15, Stonex R25, Stonex R20, Stonex R35, Stonex R80, Stonex R120, Stonex R180. The demo mode works only if you select Stonex R80. In the *Communication* page, the user can establish the connection between the instrument and the controller.

Bluetooth

Here below the procedure for connecting a TS to Cube-a:

1. First, select the TS model from the dropdown menu.
2. Set the mode of communication Bluetooth. Click *Search* to search for nearby devices, select the device; the user can recognize its own device from Serial Number that will appear in the Bluetooth Name column.
3. Select the Serial Number corresponding to its own device and click on *Connect* to establish the connection.



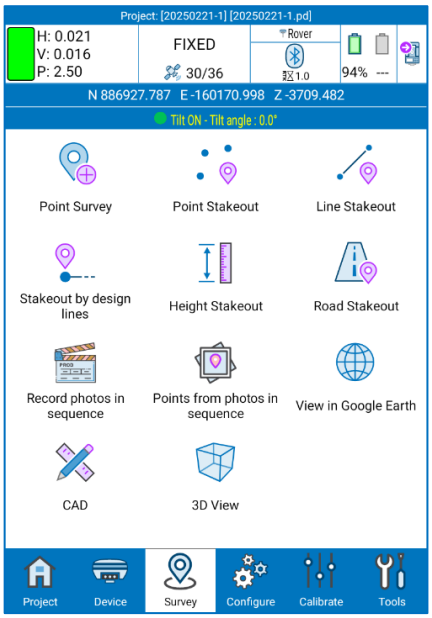


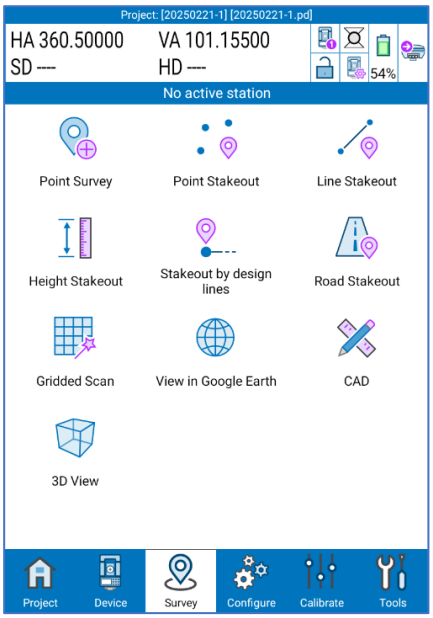
5.2 Total Station Communication

From this menu the user can configure the TS and Cube-a interface for the survey enabling confirmation prompts or options.

6. Survey

The *Survey* menu contains the survey area, the stakeout functions, record photos in sequence, point from photos in sequence, the CAD environment and 3D view. For robotic TS (R80 & R180), there is also the gridded scan function.



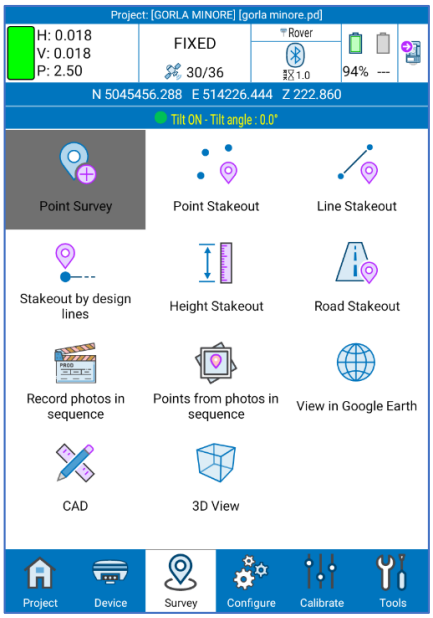


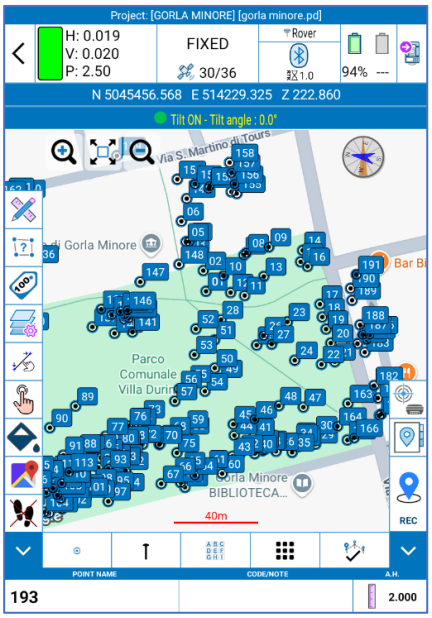
Click *Point Survey* to access the survey area. Here it's possible to save points, see them on the background Google Maps or DXF, draw while you are saving points, select points and CAD entities directly typing on them, change layer, perform geometric calculations and many other operations described in following.

The page looks different depending on module (GPS or TS). The common functions will be described in the following paragraph; see paragraphs 6.1.1 GPS Survey, 6.1.2 GIS Survey, 6.1.3 TS Survey, for specific functions in each mode.

6.1 Point Survey

Below there is the description of the icons in survey area common for GPS and TS mode.





Zoom in

Zoom all

Zoom out

Compass (same as the compass device on which Cube-a is installed)

Click to access to the CAD environment (see 6.9 CAD)

Calculate distances and area between points on the map. Click on the icon to enable it then it will turn yellow, and you can tap on the map to define the points. The distance between two segments is shown in green in the center of the segment, the progressive distances are shown in green on the points, and the area is in red in the center of the geometry.

Click to make visible or invisible the point labels. Hold down to access to 7.1 Display Settings.

Click to access to the 7.2 Layers.

Select line. Click on the icon to enable it then it will turn yellow, and you can click directly on the line in graphic to access the line staking out.

Select point. Click on the icon to enable it then it will turn yellow, and you can click directly on the point in graphic to access the point staking out.

Background map. Click to enable or change the map type. Hold down to access to the 7.3 Background Map page.

 map disabled

 road map

 satellite map

Background color. When the background map is off. It is possible to change the background color from white to black or vice versa. 7.1 Display Settings

Follow me function is enable: the map is always centered based on the position of the receiver. Click to disable then a red cross will appear.

Hide the side column.

Save only points. Click on the icon to choose the entity to draw while saving points or return to point capture only (see 7.4 Draw during the survey).

Click to change the current point type measure mode (see 7.5 Point type) (The options available can change between GNSS and TS module).

Save the point by clicking on the respective code. Hold down to quickly access to the code library.

Click to access to the 7.6 Survey Tools.

Click to end the entity you are drawing (see 7.4 Draw during the survey).

Set the fake GNSS position, available only in DEMO mode (see 4.3 Communication).

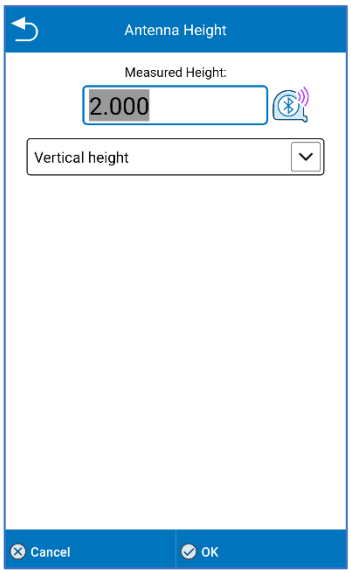
Click to open the 3.4 Point Library.

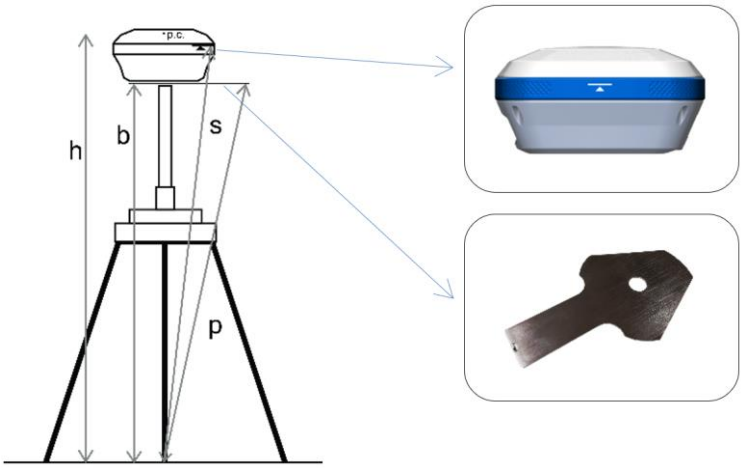
Click REC to record point

The bottom bar has the following fields:

POINT NAME	CODE/NOTE	A.H.
6	ADR	2.000

- The name of the next point. Click to change the name (if the user doesn't change the point name, Cube-a automatically incremented it).
- Code for next point. Click to change the code.
- Antenna height to set like described in the picture below.





In GNSS mode, you can choose from the following options:

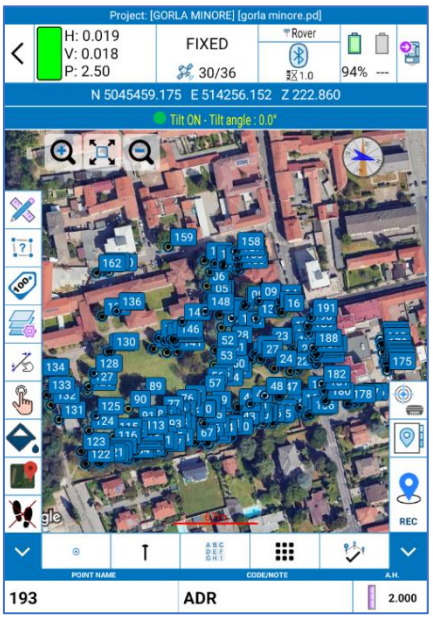
- *Vertical height*: insert **b**
- *Height to phase center*: insert **h**
- *Slant height to altimetry line*: insert **s**
- *Slant height to altimetry plate*: insert **p**

In Total Station mode, the values refer to the height of the pole.

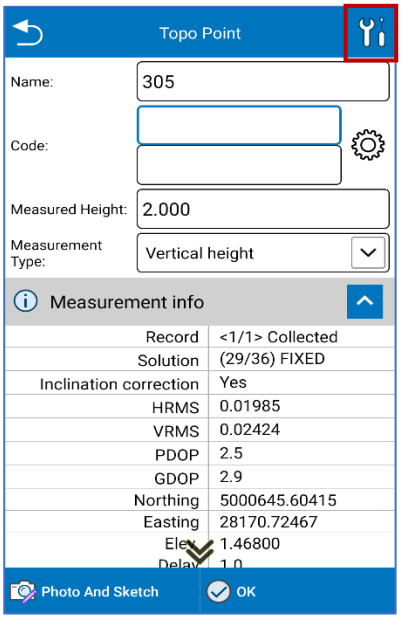
Note. Enter the height of the pole only if you have already considered the vertical offset of the prism in the prism setting (see 2.2.1 TS Control Panel).

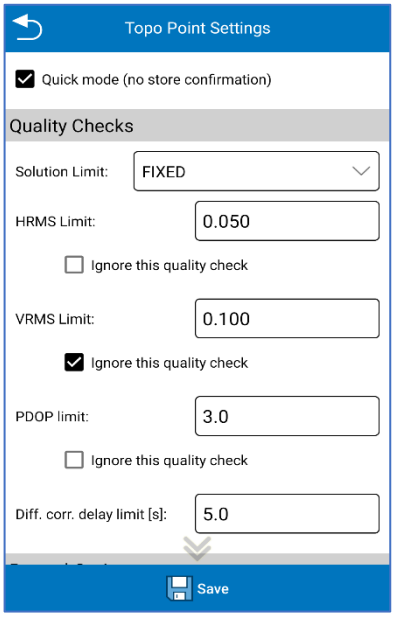
6.2 GPS Survey

In GPS mode, the survey area looks like the following figure.



After pressing REC to measure and record a point, the page visible in the left image below is displayed. In this summary page, the user can check the information about the point measured before saving it and change, if necessary, the name, pole height or code.

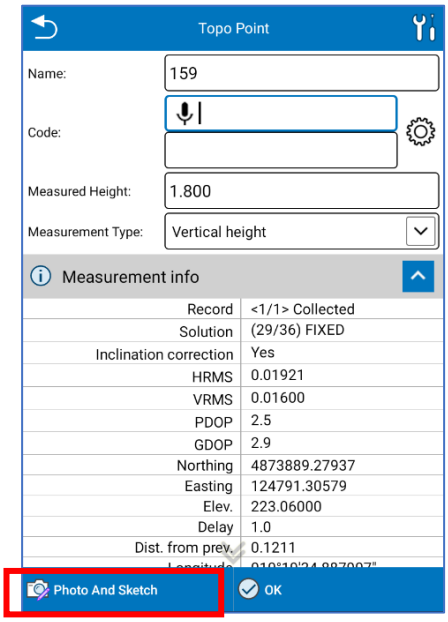




Pressing the Tool icon (squared in red in the left image above), the user can change the storing settings like visible in the right image above:

1. *Quick Mode* -> When enabling the Quick Mode, the summary page displayed after pressing REC is not shown and the point is immediately saved in the point library. With this option enabled after recording the point, Cube-a automatically increases the new point name.
2. *Set custom limits* -> The user can set some quality check for its measurements. If the quality of the measurement is over the tolerances set by the user, an alert message is displayed.
3. *Record Option* -> The user can choose how many times measure a point.

Photo and Sketch Option



The *Photos and Sketch* command allows the user to associate a photo with a point.

The photo will be taken using the built-in camera of the device and is saved as a .jpg file in the *Photos folder* of the project used. The name of the image will be the same as the point.

The user can also draw over the photo and add:

- Text notes.
- Point information (name, coordinates)
- Arrows
- Hand-drawn sketches.

Anything can be moved or rotated on the image.

Images can also be redone or deleted. With the help of *Share* button, it is possible to share the photo and the sketch data (XML file) by e-mail/other OS supported sharing provider.

Note. It's also possible to associate a Photo to a point also from the Point Library. After selecting the point in the Point Library click on Edit ->Photo And Sketch to take a picture and associate to a point. The point with a picture associated will be characterized by a P letter inside the Point Library "P" column.

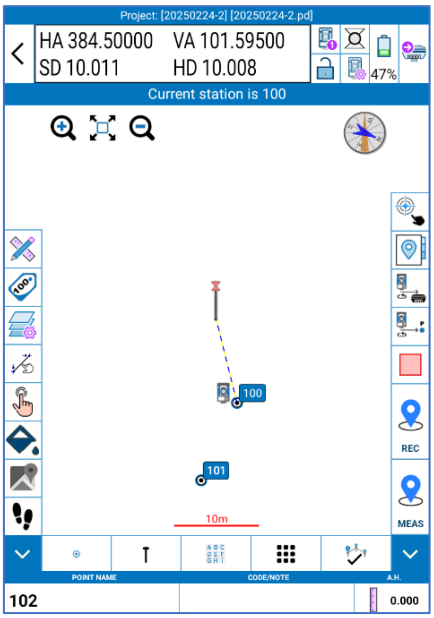
6.3 GIS Survey

If the GIS option is enabled for the current project, the *Enter GIS Attributes* window appears after saving a point or CAD entity. Here the user can choose the attribute class by clicking on the right or left arrow and enter the GIS attributes accordingly. Click *Cancel* to clear the inserted attributes or click *OK* to confirm.

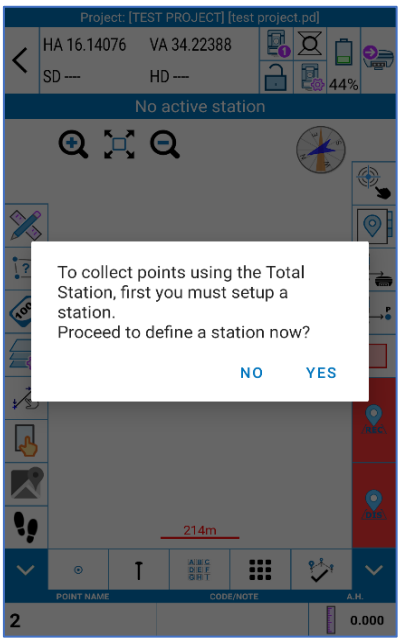
See chapter 3.2 GIS Project for the creation and management of the attribute tables.

6.4 TS Survey

In Total Station mode, the survey area looks like the following figure.



The *MEAS and* REC icons are red when the station has not yet been declared. Cube-a will not allow the user to survey points as long as the keys remain red, but pressing on one of them, you will have the following message that leads directly to the station definition page. Click *OK* to declare the station (see 10.1 Station on point and 10.2 Resection/Free Station).



In the survey area, in addition to the icons described in 6.1 Point Survey, in TS mode there are the following functions.

MEAS -> Only for measuring and display distance in Cube-a upper bar

REC -> Save points if a measure has already been made, otherwise measure, and save the point.

STOP -> In motorized TS, pressing the STOP button the station removes the prism lock. Pressing it two times to delete the measurement visible in Cube-a memory and Cube-a upper bar.

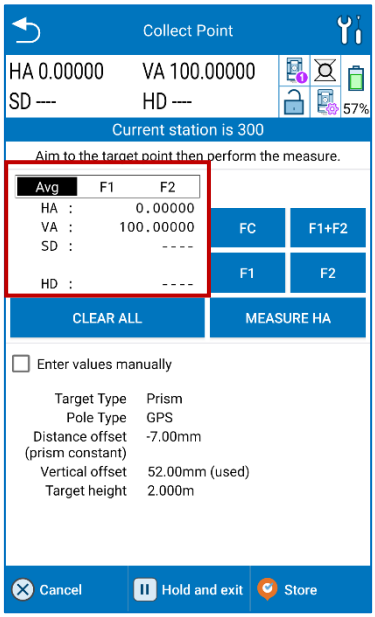
Rotate the telescope to a point-> In motorized TS, the user can rotate automatically the TS on a point already collected. This function can be used only after defining the station position and orientation (see 10.1 Station on point and 10.2 Resection/Free Station).

Rotate the telescope to the GPS location -> It can be used during surveying, after defining the station and its orientation. It is enabled if the user is working also with a GNSS connected to Cube-a and if the antenna is in a fixed solution.

Click on this icon to select the TS measure mode and configure the "*Topo Point*" mode (see chapter 7.5 Point type).

Offset Measurement -> Use this option for setting an offset when measuring with TS ((see chapter 7.5 Point type).

If the user taps and holds on the MEAS or REC button, the following page is displayed. Inside it, the user can manage the TS measurement manually choosing the best measure configuration. In this page the user can also have an overview of the TS settings before measuring and analysing the results before saving them.



In the left side of the screen (squared in red in the image above), the user can see the measurement data, moving from F1, F2 and AVG measurement (pressing on the black label).

Pressing on:

- *FC* -> Measure in the Current TS Face
- *F1* -> Measure in TS F1 like described above
- *F2* -> Measure in TS F2 like described above
- *F1+F2* -> Measure in F1+F2 configuration
- *Measure HA* -> Measure only HA angle
- *CLEAR ALL* -> delete the measurement in Cube-a background memory

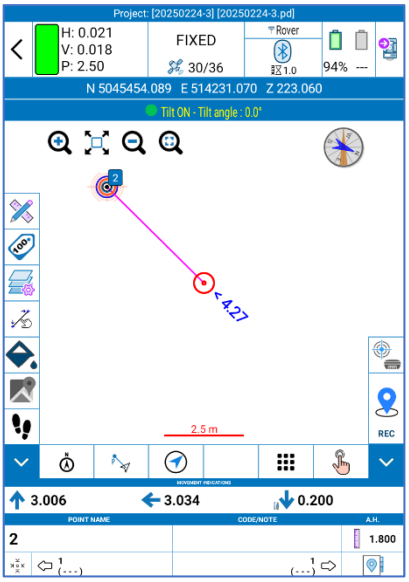
Click on "*Store*" to save the data inside the Point Library.

From this page the user can also manage out of center measurement, measuring on corners. To do this, it's necessary to combine a Distance measurement (FC, F1, F2, F1+F2) with an angle measurement. After measuring the distance and adjusting the horizontal angle, the user can press on "Measure HA" to save a point with the previous distance measured and the new HA measurement. When doing this operation, a message is displayed in Cube-a to alert the user about it. Click on "*Store*" to save the data inside the Point Library.

Press "Hold and exit" to come back in the survey page. After pressing it, Cube-a maintains in its background memory the measurement. In the survey page the user can choose if save it pressing REC, discard the measurement pressing on the STOP button or repeat the distance measurement pressing on MEAS.

6.5 Point Stakeout

The point stakeout interface is shown in the following figure and the second screen for virtual stakeout (if stakeout is performed using a GNSS receiver with camera (e.g. S880, S999).



In addition to the functions that are 6.1 Point Survey, there are also the following features.

Zoom in on your position and the point you want to stakeout.

Define the orientation. The indications to reach the point depend on this option.

- *North* -> rotate on yourself so that the North is in front of you.
- *South* -> rotate on yourself so that the South is in front of you.
- *Sun* -> rotate on yourself so that the Sun is in front of you.
- *Shadow* -> rotate on yourself so that the Sun is behind you.
- *Point* -> rotate on yourself so that the reference point is in front of you.
- *Line* -> rotate on yourself to have the same orientation of the defined alignment. To define the alignment points, use the point selection tool (blue pointing hand).
- *Stakeout by Polar + fwd/bck* -> select Stakeout by Polar + fwd/bck to stakeout point using angles and distance indications.
- *Station (2-man)* -> choose this option if there are two people at least in the field (only in TS mode). One stays at the total station and gives instructions to the second one who is close to prism.
- *Station (1-man)* -> choose this option if you are alone in the field. It must refer to the location of the station and move by supporting the prism. This mode is to be used if you are working with a motorized/robotic station.

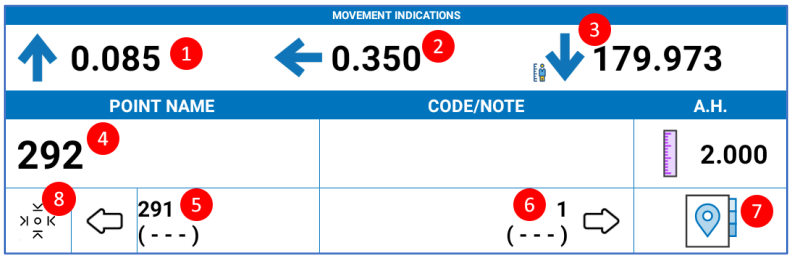
Shows the current location on the map, by representing a red arrow. The picket point is highlighted with a red and blue circle, and a purple line, which connects current position and point, shows the distance.

Shows the direction in which you are moving through a blue arrow and the distance between the current position and the point to stake out. To return to the map view press the  .

This option "*Augmented Reality*" is visible while performing survey with a GNSS Receiver. Long press to pass full screen. See 6.6 Augmented Reality (AR) Stakeout

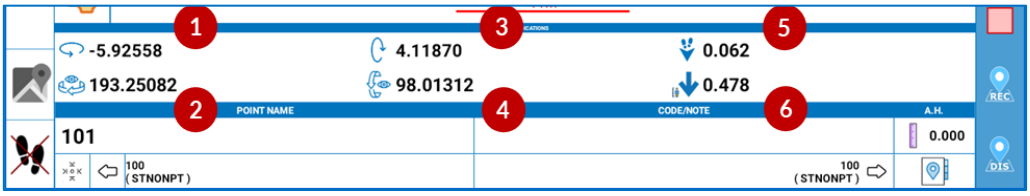
Stake out Indications

The following instructions refer to stake out methods: *North*, *South*, *Sun*, *Shadow*, *Point*, *Line*, *Station (2-man) and Station (1-man).*



1. Move back or forward to the distance shown to find the point: once the point is found, satisfying the declared tolerance, the arrow will turn green.
2. Move left or right for the distance shown to find the point: once the point is found, satisfying the declared tolerance, the arrow will turn green.
3. Shows the elevation of the stake out point: the point can be above or below, suggesting stretch or carry-over: once the point is found, satisfying the declared tolerance, the arrow will turn green.
4. ID of the point you are Setting out.
5. Picket the previous point.
6. Picket the next point.
7. Access the points library to select another point to stake out.
8. You can find nearest point modified to find first the "second nearest point", then if clicked again to find the "first nearest point". This allows to skip the just staked point.

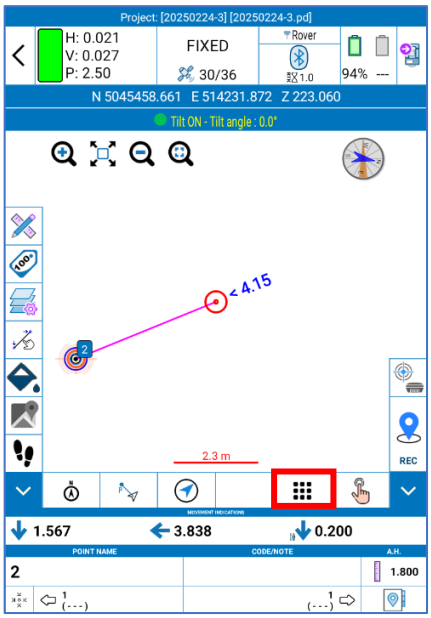
The following instructions refer to stake out method: *Stakeout by Polar + fwd/bck*

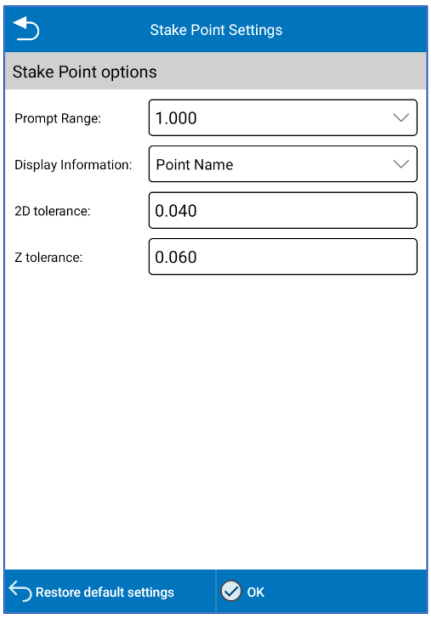


1. HA Offset. When HA offset is 0°00′00″, the stakeout direction is correct.
2. HA stakeout angle. HA Angle corresponding to the stakeout direction
3. VA Offset. When VA offset is 0°00′00″, the stakeout direction is correct.
4. VA stakeout angle. VA Angle corresponding to the stakeout direction.
5. Longitude distance. Move back (▼) or forwards (▲) from the station. It becomes green when reaching the stake out point.
6. Stakeout point elevation. Move the pole up and down, it becomes green when reaching the stake out point.

Click the icon to access the *Survey Tools*.

In addition to the functions described in 7.6 Survey Tools there are also the *Stake Point Settings*.





Here below the description of the option available in this page:

- *Prompt Range*: three concentric circles can be displayed on the screen around the point (the centre is the point to stake out). Define the maximum distance from the point for displaying circles.
- *Display Information*: Select what information you want to see on screen.
- *2D tolerance*: Insert staking out tolerance into floor plan.
- *Z tolerance*: Insert the tolerance for stacking out in elevation.

6.6 Augmented Reality (AR) Stakeout

This Augmented Reality option is visible when surveying with a GNSS receiver that has camera(s) (e.g. Stonex S880 and Stonex S999). These cameras can be used during stakeout. Cube-a helps the user to stake out the selected point with real time indications.

Visual Stakeout Prerequisites:

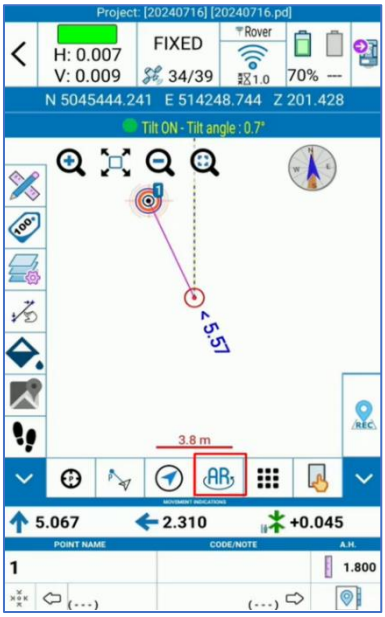
1. GNSS control panel must face the user so that the visual stakeout indications are congruent to the reality.
2. The connection with Cube-a is done using WIFI hotspot
3. The tilt corrections must be activated (IMU)
   (For the details see videos: S880 Stakeout with Camera, S999 Stakeout with Camera)

Enter the stakeout page from the page *Survey -> Point Stakeout* or from the survey area. Select point to stakeout. Click "*Stake point*" to continue and then click on the AR button to activate the camera for stakeout.

If the point is outside of the camera view, Cube-a will display a message to alert the user that "Point outside of the camera view. Turn around."

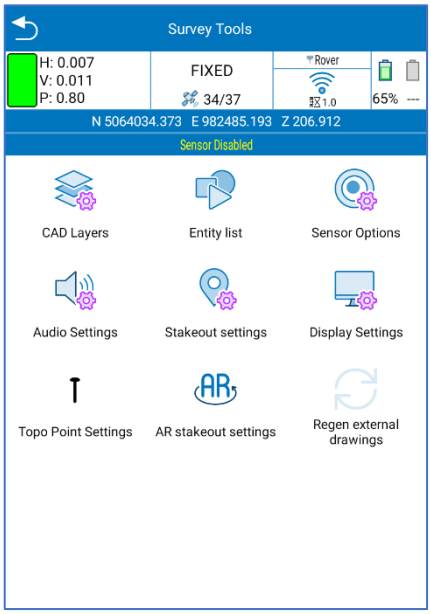
Dashed blue line defines that the point is not in the camera view. When the point will be visible in the camera view the line will turn into solid colour. When the tolerances are respected, the point will turn green colour.

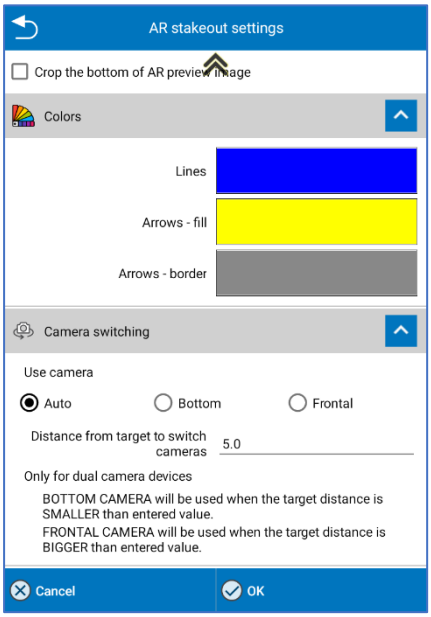
Click on REC to save the point.



If you long press on AR button, the camera view will be full screen. Press back to turn back to the normal screen.

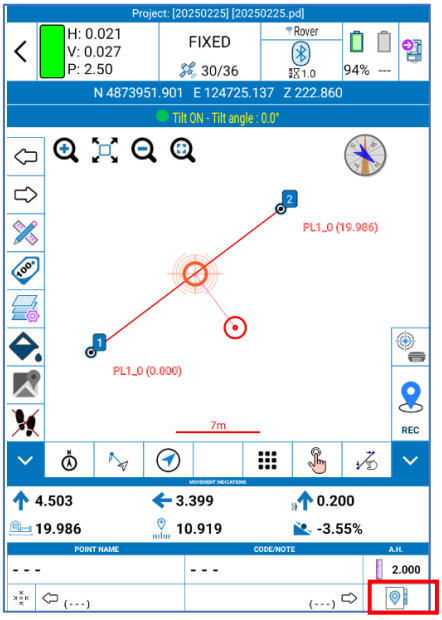
In the virtual stakeout interface, clicking on 'Survey tools' takes the user to the AR stakeout settings page. On this page, the user can customise the colours of the lines and arrows in the visual stakeout. It is also possible to set the distance at which the camera switches. If the staked-out element is closer than the set distance, the camera will switch from frontal to bottom view to provide a better view for the user.





6.7 Line Stakeout

The Line stakeout interface is shown in the following figure. The icons are the same described in the previous paragraph, see 6.2 Point Stakeout for more details on available options. The line the user is staking out is highlighted in red. The current position is shown with a red circle (if holding still) or arrow (if moving). The point the user is staking out is shown with an orange circle. The pink value is the chainage with respect to the first point of the line that is 0.000.

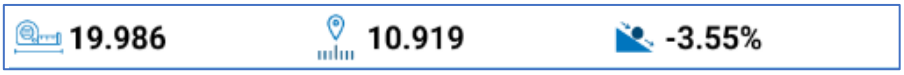


 Click on the Point Library icon to access the line library and select another line to stakeout.

If the user wants to stakeout a line from a DXF or DWG file, it's important to import it as external drawing. With this option then the lines and entities of the file will not be listed in the line library but can be selected from the map in the Survey Area (see 6.1 Point Survey).

If user wants to stakeout the circles and the arc imported from the page "External drawing", it's possible to select the entity directly by activating this option and clicking on the entity.

Below the description of the additional indications available in stake out line page:



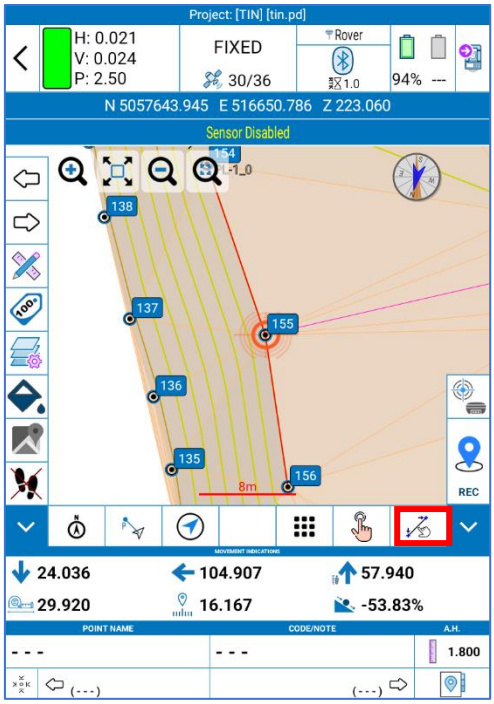
Line Length

Chainage

Slope

Note. This information is also visible in the Height Stakeout and Road Stakeout function.

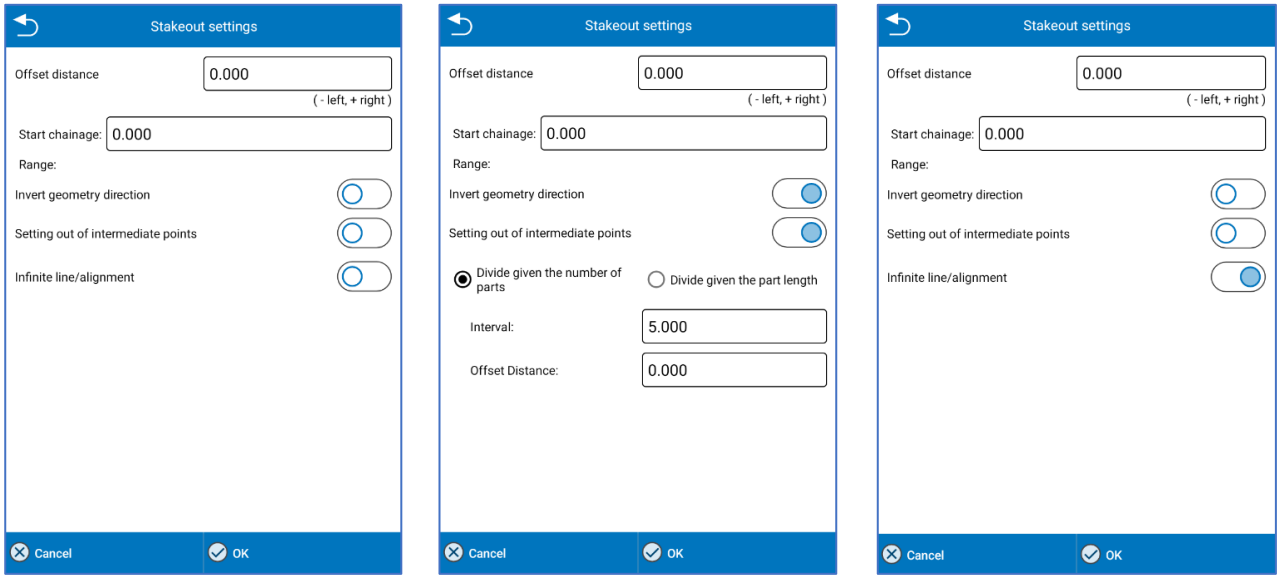
While staking out a line, it is possible to select another line to stake out by clicking the "Select Line" button and then selecting the desired line from the CAD view which is open in selection mode.



The user can use the arrows on the left-hand side of the screen to select the line closest to the one being staked out.

6.8 Line Stakeout Settings

The page *Stakeout settings* shown below appears as soon as you select a line to stakeout.

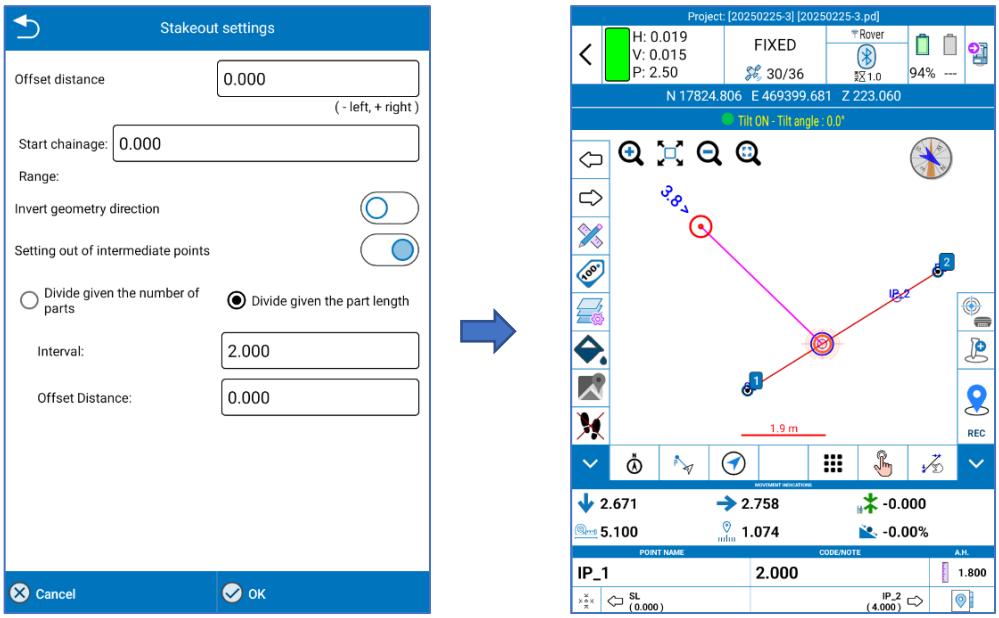


Here below the description of all options/functions available in this page:

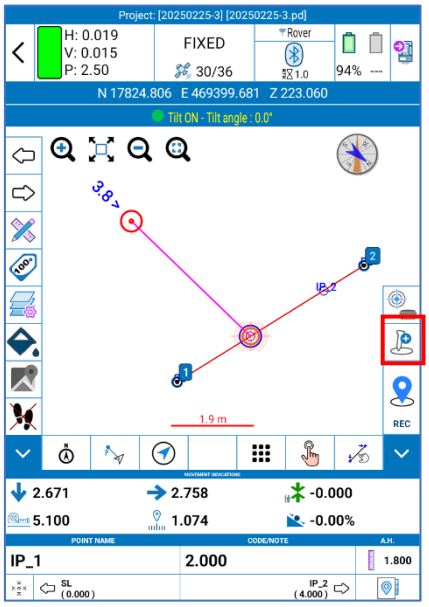
- **Offset distance ->** Stakeout the line selected shifted by value you insert.
- **Start chainage ->** It is possible to insert the start chainage.
- **Invert geometry direction ->** Enabled: The 'Invert Geometry Direction' option reverses the direction of the geometry.
- **Setting out of intermediate points**
  - Disabled: the indications are only for reaching the line or the extensions of the line.
  - Enabled: Two options appear, Divide given the number of parts and Divide given the part length.

  The user can define interval and offset distance.
- **Infinite line alignment ->** The indications are for reach specific points on the line, on the extensions of the line or on the shifted line.

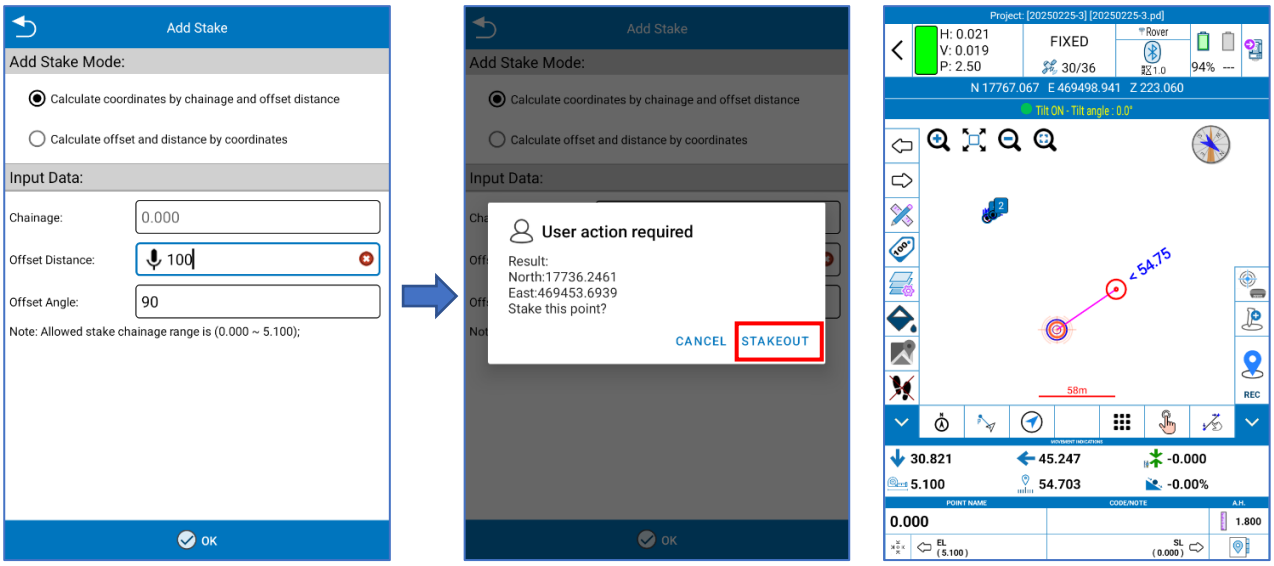
In the following example, setting out of intermediate points is enabled and the line has been divided in two (interval value) parts, so the indications are for reaching specific points that are the first, the middle and the end point of the line.



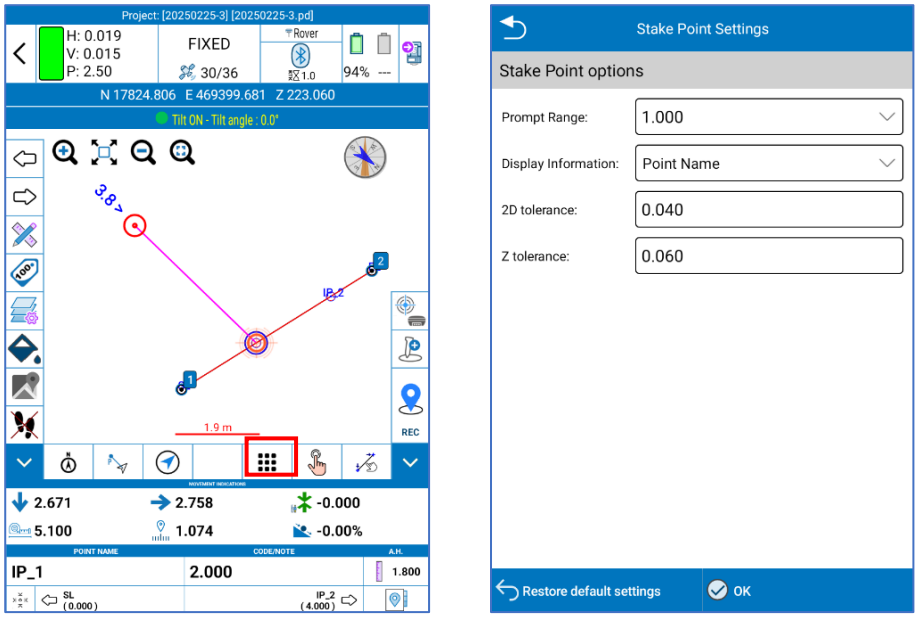
Click the icon in red in the figure below to stakeout specific points on the extensions of the line or on the shifted line.



In the following example, the indications are for reach the point at chainage 0, with an offset distance of 100 meters on the right with respect to the line.



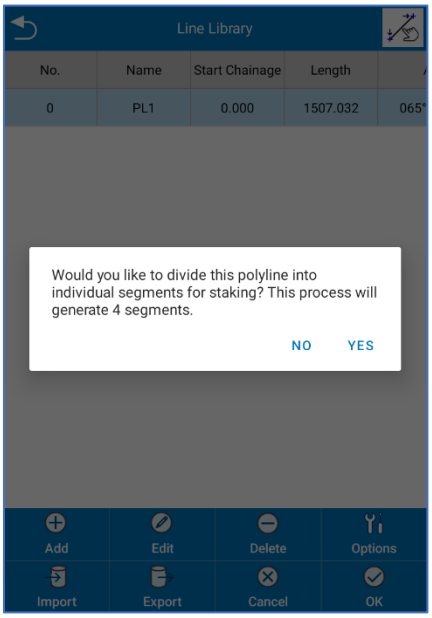
Click the icon in red in the figure below to access the *Survey Tools*. In addition to the functions described in [7.6 Survey Tools] there are also the *Stake Point Settings*.

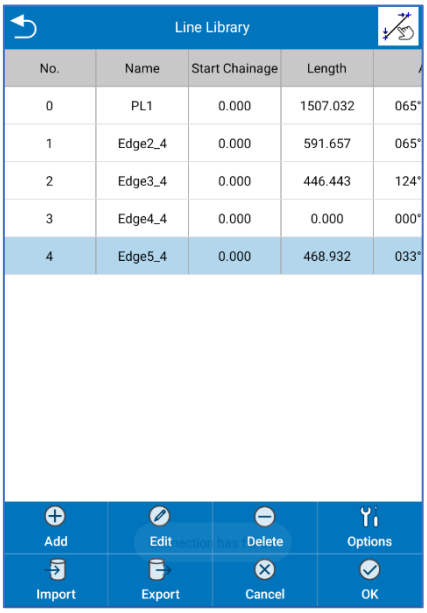


Here below the description of the option available in this page:

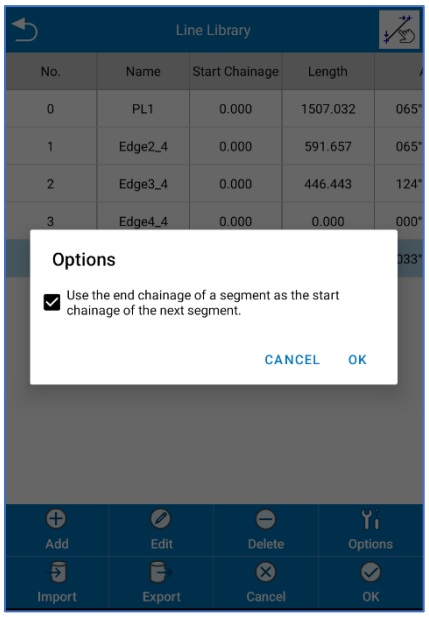
- *Prompt Range*: Defines the detection range for stake points.
- *Display Information*: Select what information you want to see on screen (No Display, Point Name, Point Code)
- *2D tolerance*: Acceptable error margin.
- *Z tolerance*: Acceptable error margin in Z-axis.

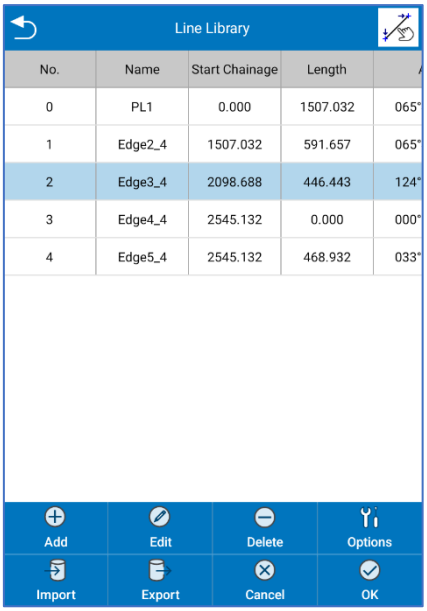
In Cube-a v7 it is possible to divide the polyline into individual segments. After the user selected the line to stakeout Cube-a asks the user to divide the polyline into individual segments for staking.





If the user clicks Options it is possible to enable “Use the end chainage of a segment as the start chainage of the next segment. To continue stakeout, select the edge or the polyline and click OK.

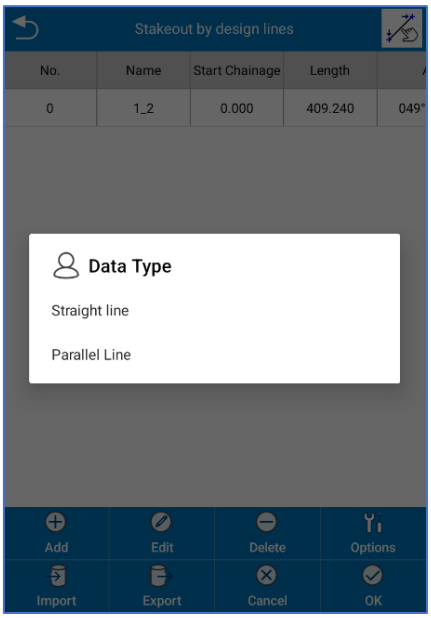




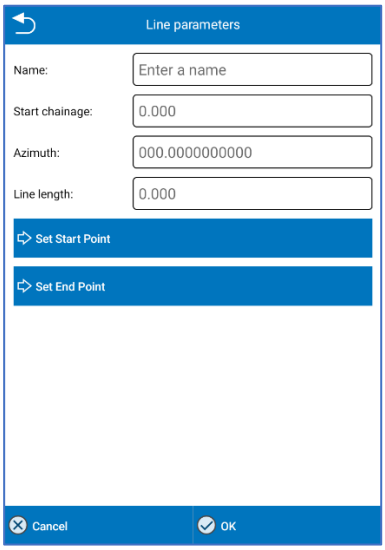
6.9 Stakeout by design lines

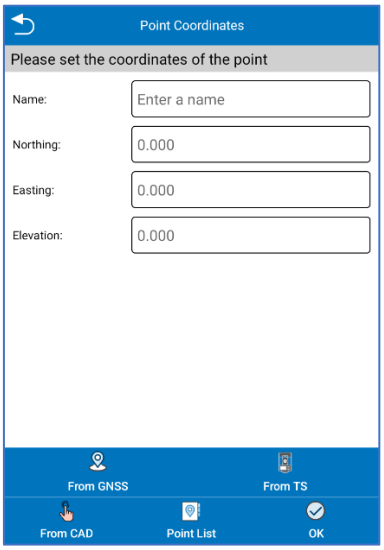
With this function, you can create parallel lines from one as a reference and stake out all lines.

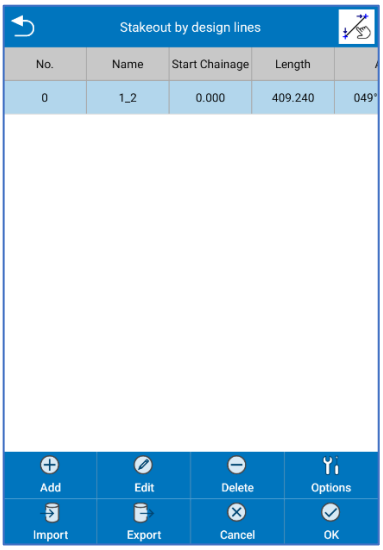
To do this, open the function and select *Add*. Then select *Straight Line to* set the reference line.



Set the start and end point and name of the line.

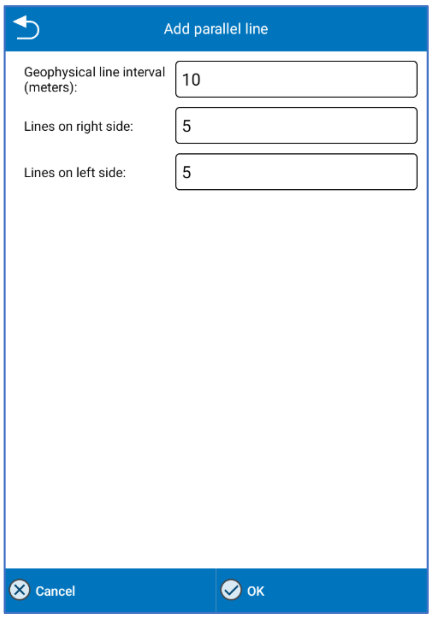


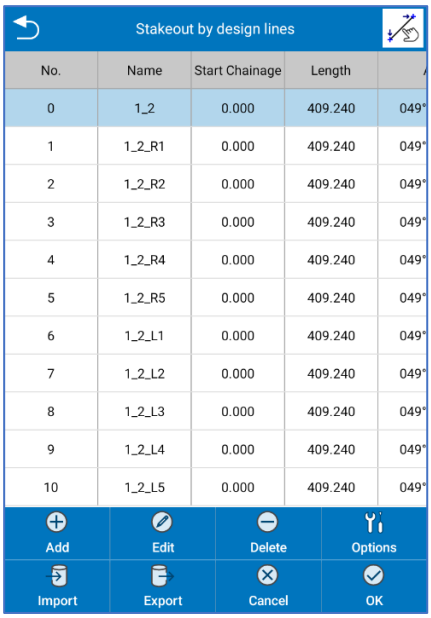




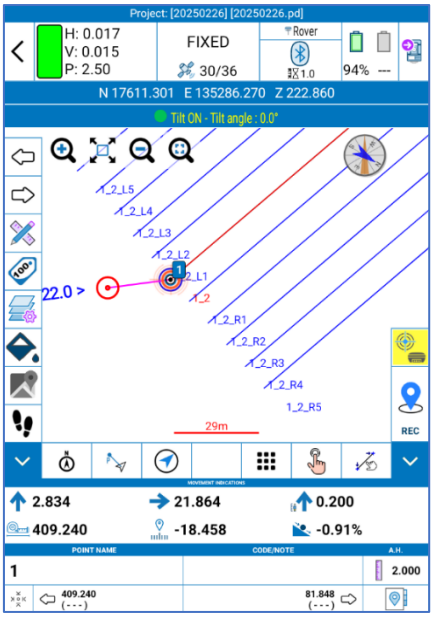
To create the parallel line, select the reference line and press *Add*. On the menu that appears, click *Parallel Line*. Then insert the Spacing (distance between the lines) and the number of parallels to the left and right.

After confirming, the user will have all the lines defined and ready for Staking out.





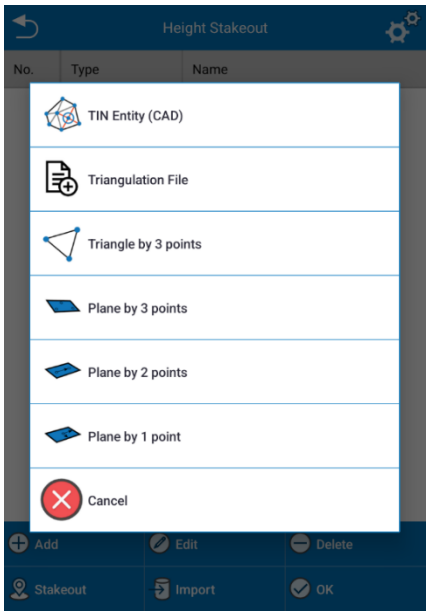
To start Staking out, select the line and press *OK*. Follow the same rules and instructions described in 6.7 Line Stakeout.



6.10 Height Stakeout

The Height Stakeout feature allows the user to "plot/stakeout in elevation".

First, it's necessary to select the entity to use as reference for the Height Stakeout. At the bottom, the "*Add*" command allows the user to create/import the file.



With the "*Add*" command, it's possible to add:

- Triangulated Irregular Network (TIN) file, in *format DXF, TTM, XML, DWG, OBJ, PLY. See 11.2 TIN List.
- Triangulation File, it is possible to import triangulation files in *format DXF, TTM, XML, DWG, OBJ, PLY
- Triangle by 3 points, the user can define three points by saving directly from or from point library (specifying the coordinates of the 3 vertices).
- Plane by 3 points, 2 points (a 3D point plus a 2D point plus the slope in the point-1 *direction towards* point-2) or define plane for 1 point (a 3D point plus the north and east slopes).

The "Import" command allows you to import a file with an extension *.CFG.

Stakeout of TIN models supports loading the model from DWG/DXF files.

This function displays the difference between the current GPS/Target height and the reference height.

If the height difference is positive, the program will show "CUT" followed by the absolute difference value: this means that to reach the reference height it is necessary to perform a "height cut", that is, dig the ground or simply lower the pole if it does not rest on the ground. If the height difference is negative, the program will show "FILL" followed by the difference value, which means that to reach the reference height you need to perform a "height fill", that is, add some ground or simply raise the pole if you are only noting the reference height level.

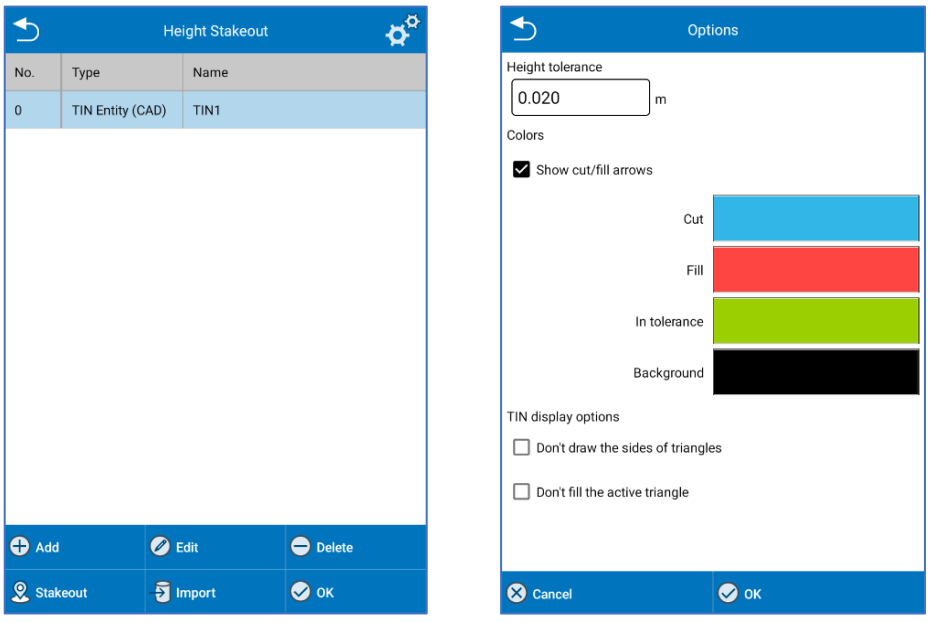
The user can follow the indications visible in Cube-a low bar or clicking on the icon squared in red to make this procedure simpler and display the Cut/Fill height

This value represents the height of the current position

This value represents the height of the triangulation

This value represents the cut/fill value

When importing the Height reference model, the user can access to the *Options* menu, clicking on the gears icon at the top right. Here it's possible to select the stakeout tolerance, display of cut/fill arrows, colour options and display options.

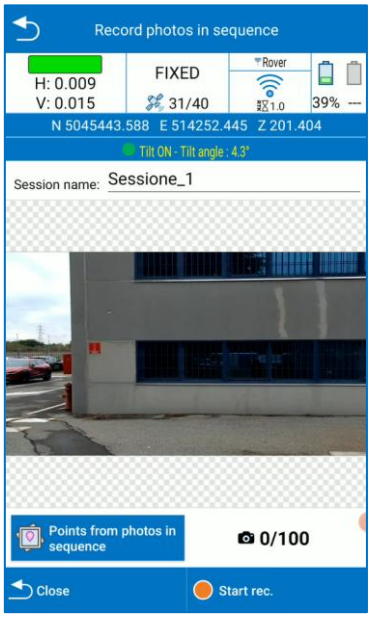


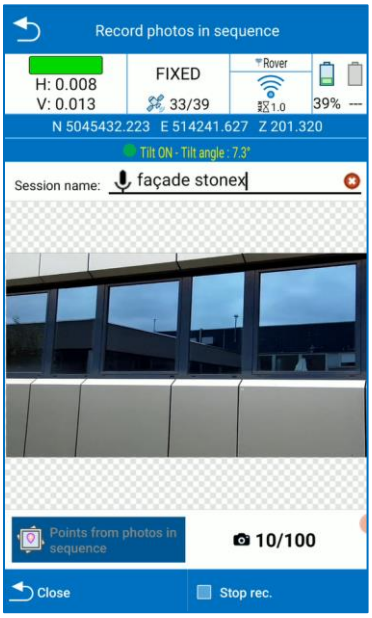
6.11 Road Stakeout

See Appendix B – Road Stakeout

6.12 Record Photos in Sequence

This function allows the collection of pictures using the frontal camera of Stonex S999 receivers, to be later used to calculate the coordinates of points using photogrammetry technology (6.8 Points from Photos in Sequence). Fixed status is required, tilt sensor must be enabled. It is possible to rename the session.





To start the operation, click on “Start rec.” Cube-a will begin recording images for the session. The number of photos is limited to 100 per session. To complete the session, click “Stop rec.” it will be visible in the Points from photos in sequence page.

The pictures are stored in the Cube-a project folder in the controller memory.

6.13 Points from Photos in Sequence

This page lists the sessions that have been recorded using the Record Photos in Sequence function. To open a session, select it and press “OK”.

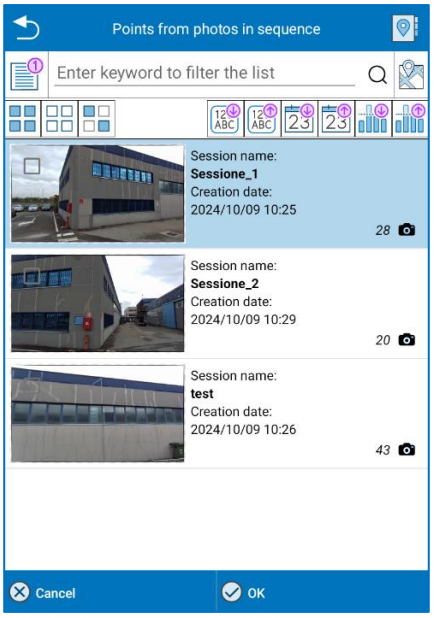
The screen shows the list of the pictures of the session, it can be navigated by sweeping to the left/right on the list. Tapping on an image will make it the current picture.

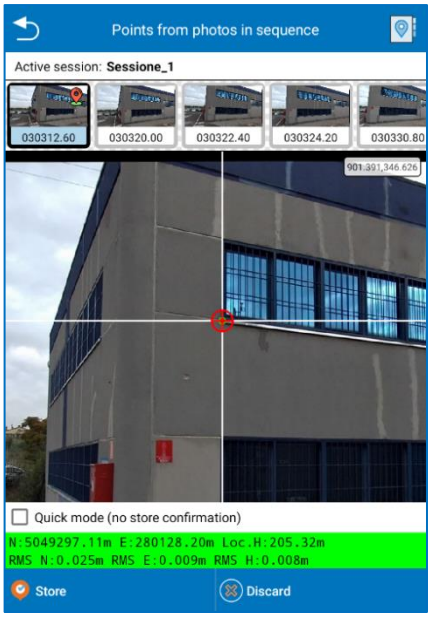
Aim a point using the crosshair then click “Select” to calculate its coordinates. A single tap moves the crosshair, a pinch gesture allows you to zoom in/out and the picture can be moved by dragging a finger on the screen.

North, East and Local Height with their respective accuracies will be visible in green at the bottom of the page, tapping on the coordinates shows Latitude, Longitude and Ellipsoidal Height. If the coordinates are not calculated, it’s necessary to select the same point from another picture and press “Solve”. If the point does not lay on the green line, the calculation will fail.

Once the coordinates are calculated, click on “Store” to save the point. Here you can change the name and assign a code to the point. If GIS attributes must be inserted, it can be done after pressing OK.

If the user saves the point, it will be visible in the point library.

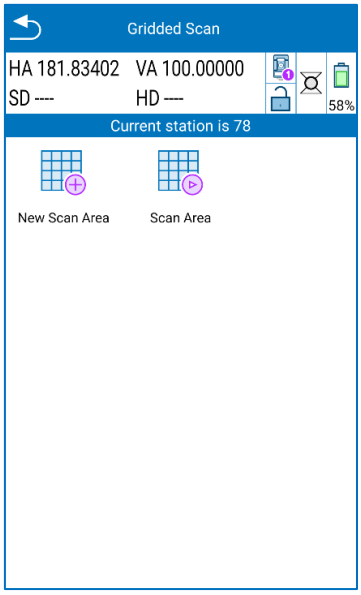




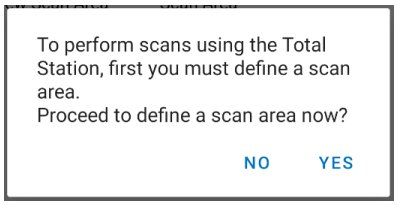
6.14 Gridded Scan

This tool is available with TS module R180 & R80 total station.

It allows the user to collect data within a defined area, following a regular grid.

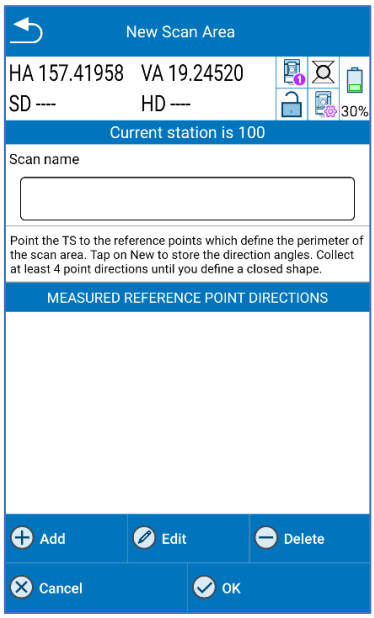


Before scanning, it is necessary to define the station position. By clicking on the Scan icons, the user will see the following pop-up:



Click *Yes* to proceed defining the station position following the instructions visible at chapter 10 Calibrate – TS Module.

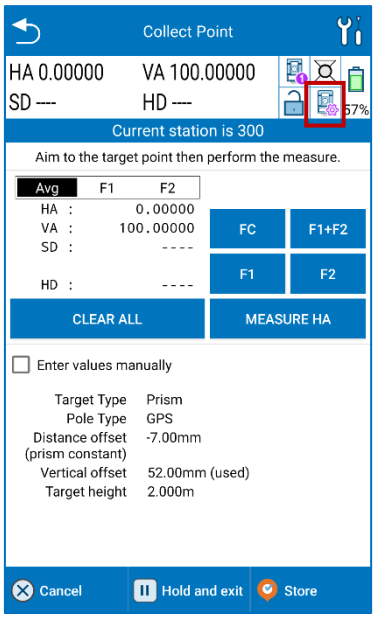
After defining the station, it's possible to start the scanning by clicking on *New Scan Area*.



In this page there are several options:

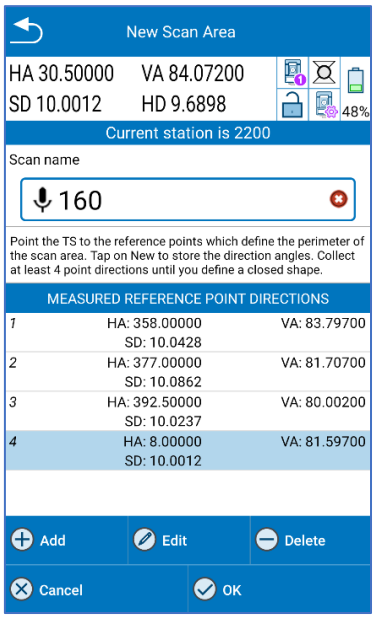
- *Add* -> to create a new point of the scan area. Before pressing it, insert a *Scan name*.
- *Edit* -> if the user has already defined points of the area and needs to modify it
- *Delete* to delete an existing point of the area.

Adding a new point, the following page is displayed:

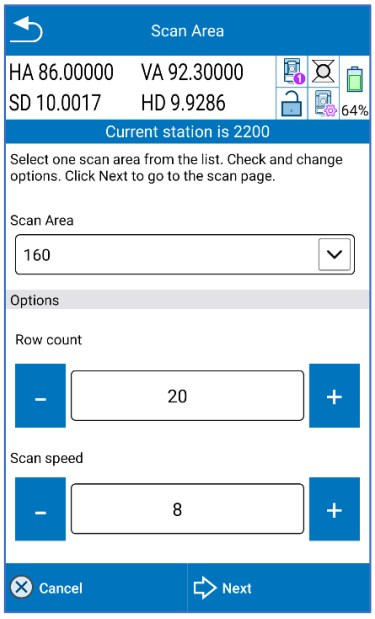


Clicking on the icon squared in red in the picture above, the user can enter in TS Control Panel (see 2.3 TS Control Panel). Measure the first point using the options available and click on “Store”.

Four points are at least needed for the definition of the scanning area.



After defining the scanning Area, press *Scan Area*:



From the drop-down menu it's possible to select the Scan Area defined in the previous step.

After choosing the "Row count" and the "Scan speed" (considering that higher is the speed fewer are the collected points), the user can "Next". On the next page press "Start Scanning" and the instrument will start collecting points.

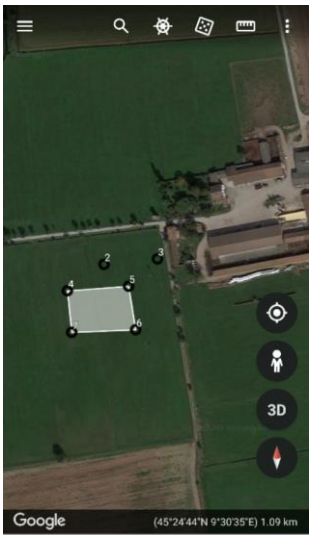
The screen shows the progression of the collection, indicating the number of points measured and the percentage of acquisition.

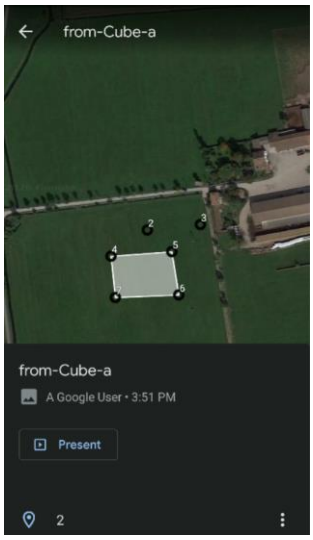
Press "Stop Scanning" to stop the acquisition. Data are automatically exported in the project's **TSScans** folder as a *.dxf.

6.15 View in Google Earth

This tool allows the user to view the active Survey using the Google Earth application, so it will also be possible to view in a 3D environment. To use this service, the Google Earth application must be installed on the device.

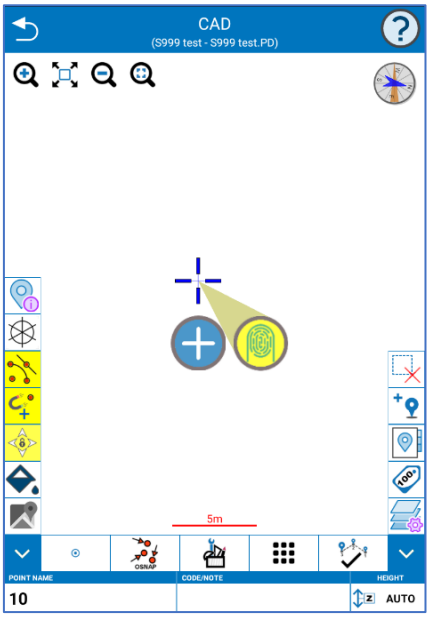
Note. CAD points and entities are "grounded", that is, heights are ignored, and all elements are placed on the ground.



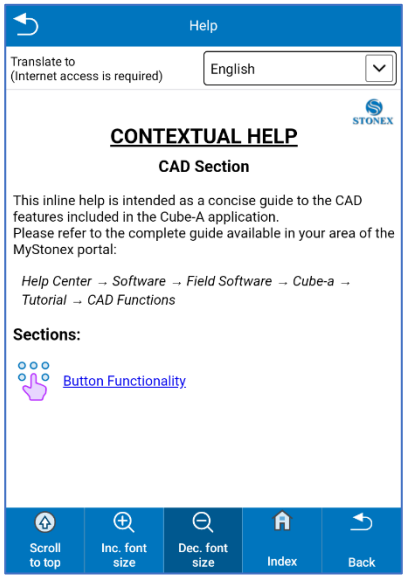


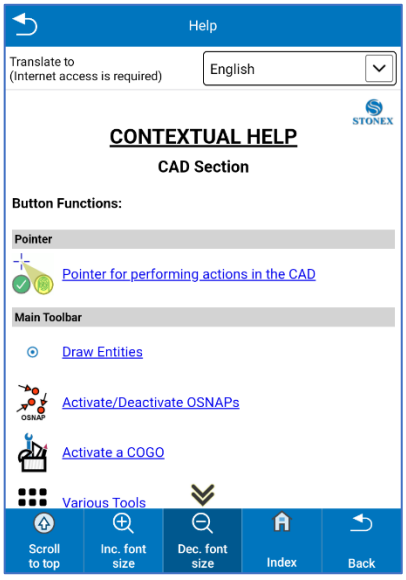
6.16 CAD

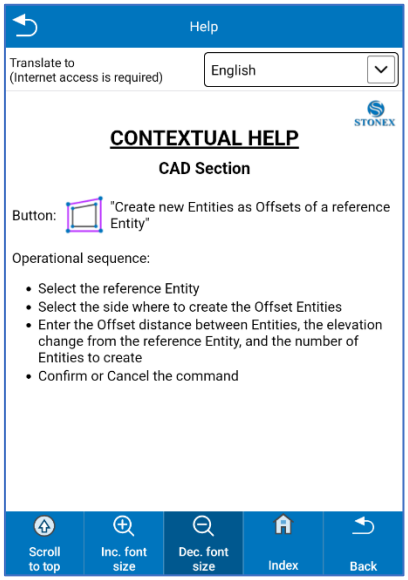
In the CAD environment the user can use various SNAPS to draw or edit existing entities. The main CAD functions are available: move, rotate, trim, scale, align, mirror and many other features described below.



In the upper right corner, there is an icon with a blue question mark: hold down it to start a contextual help that allows the user to remember, always, the meanings and instructions of the functions in the CAD area. Read the instructions that appear to use the help guide.







Zoom and compass icons at the top are described in 6.1 Point Survey.

The icons in the vertical bar on the left are described below. They turn yellow when enabled.

If enabled, displays the information for the selected entity.

If enabled, hides the points symbol.

If enabled, turn on all snaps you choose.

If enabled, the cursor is automatically snapped to.

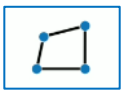
If enabled, snap the pointer to the map.

Change background color from white to black or vice versa.

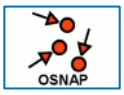
As in the survey area, enable a background map (e.g., Google).

The bottom fields for the point name and code are described in 6.1 Point Survey.

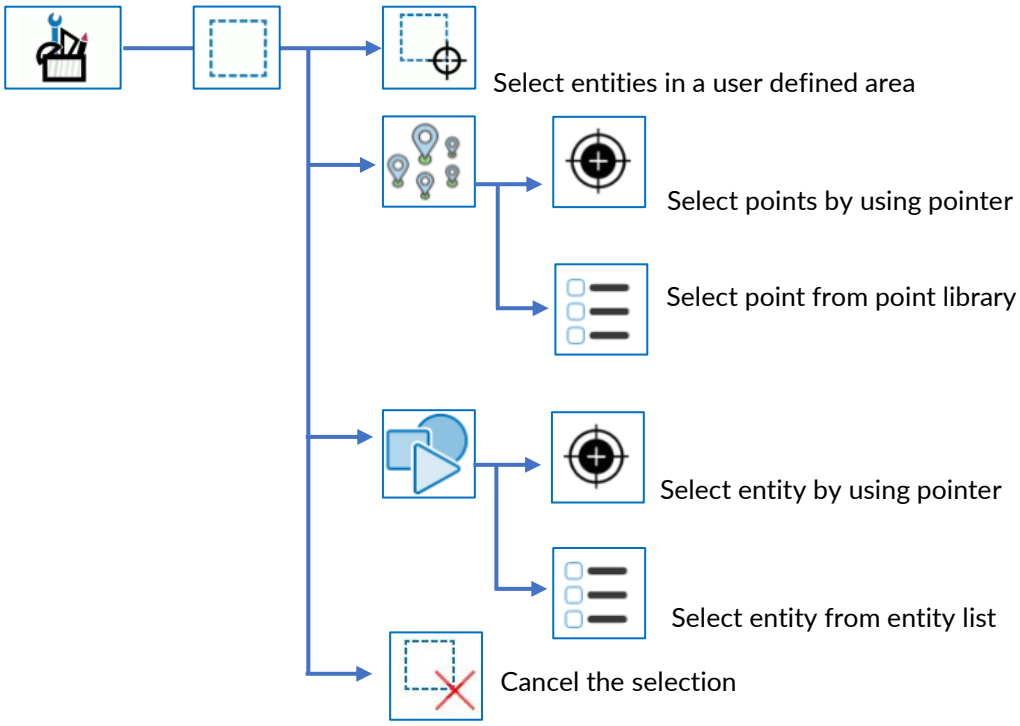
The icons in the horizontal bar are described below.



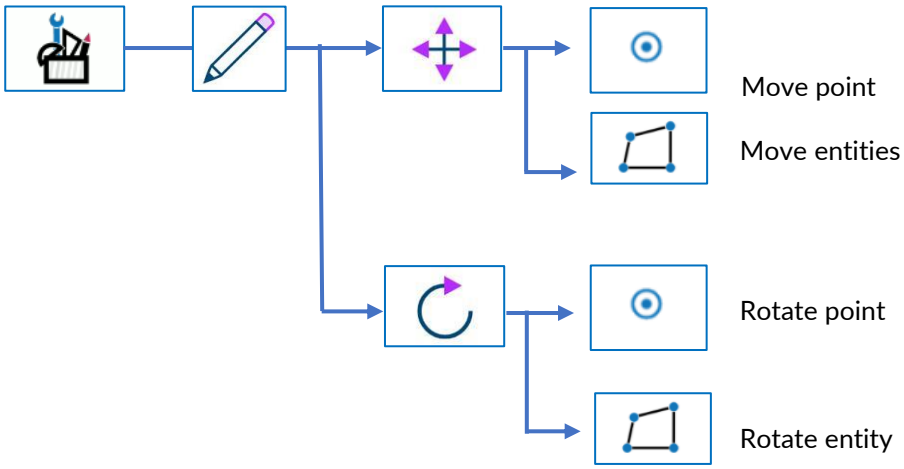
Choose the entity you want to draw (see 7.4 Draw during the survey).

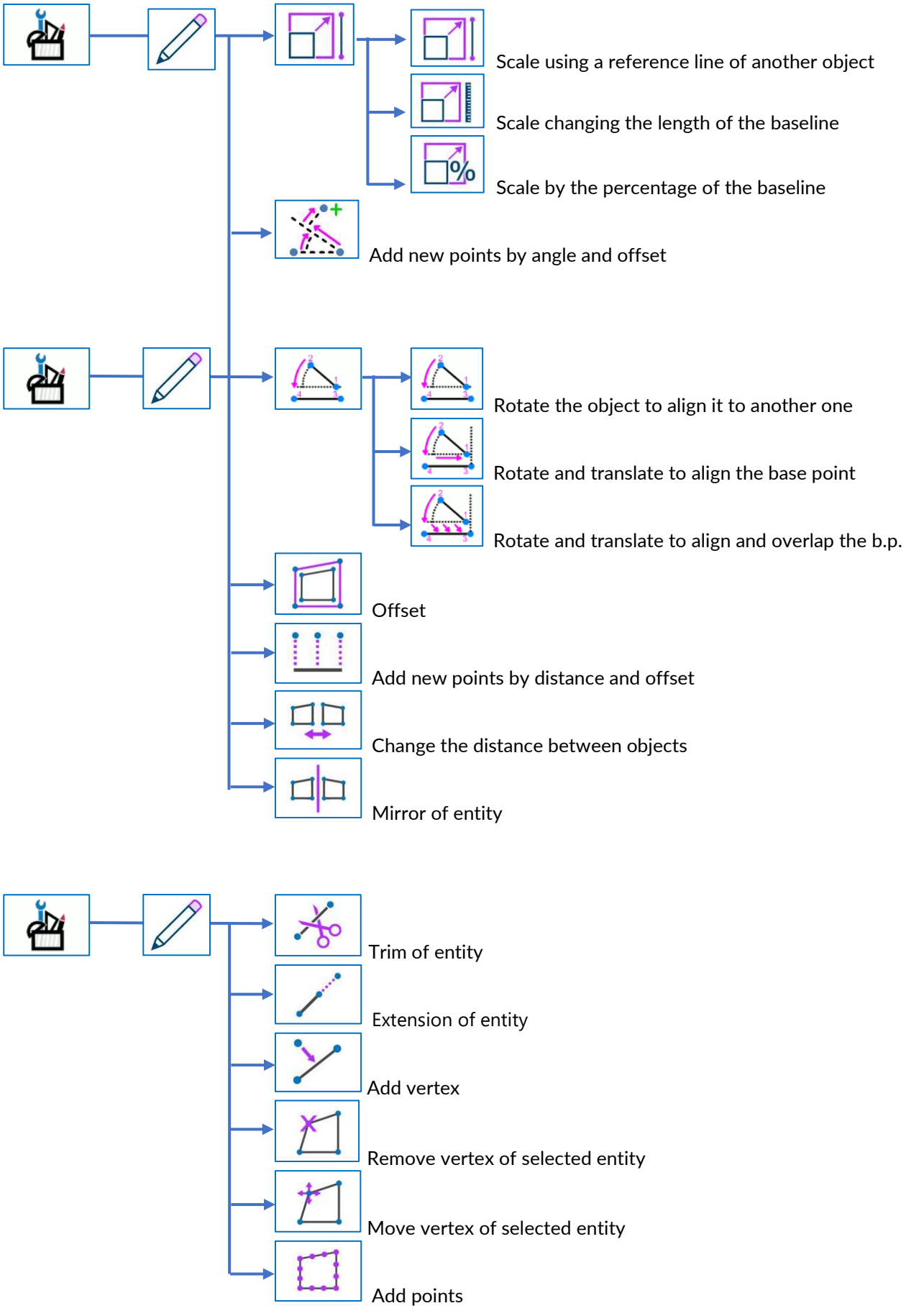


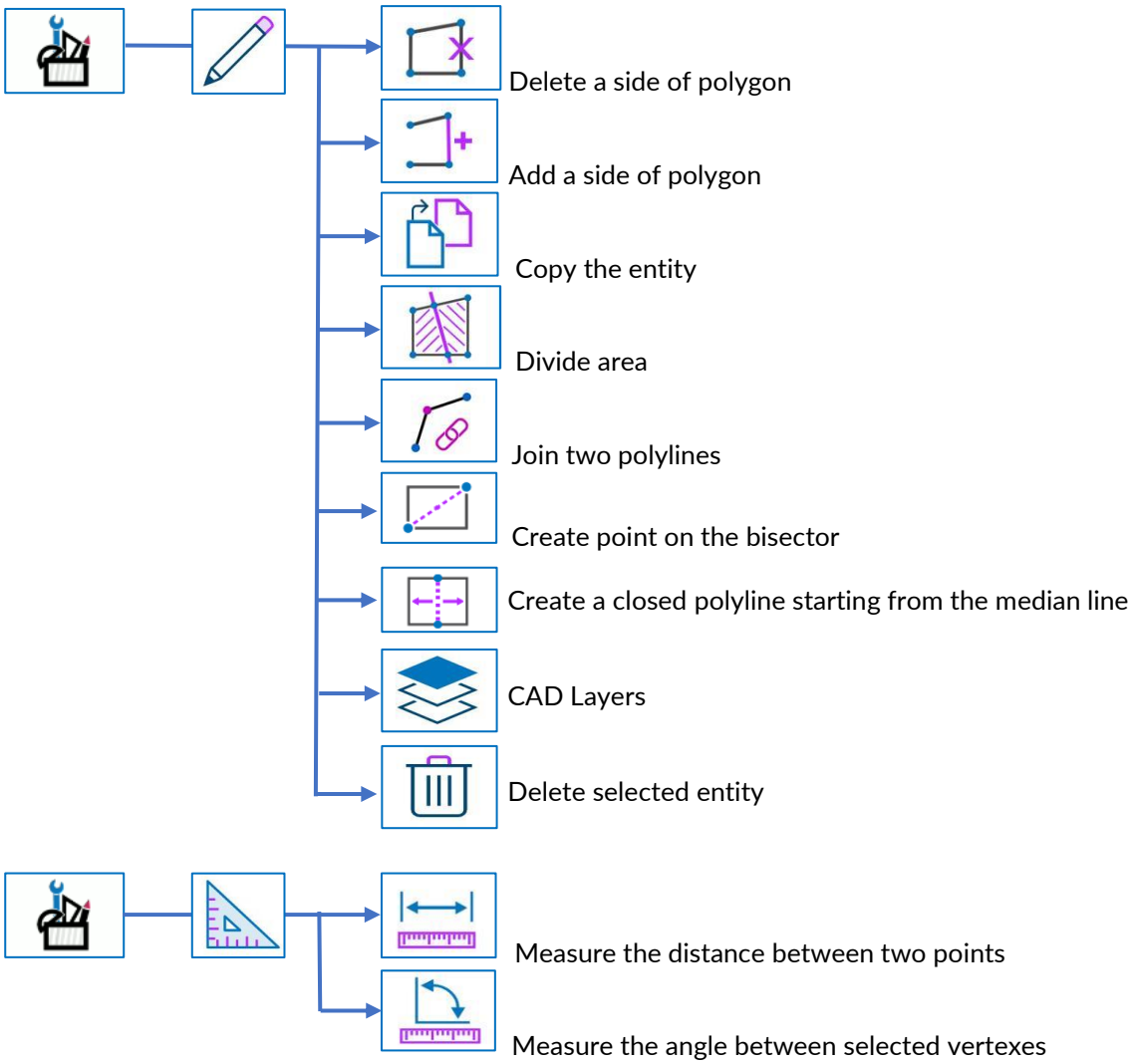
Choose which SNAPs to activate. Object snapping has been enhanced to support also DWG/DXF entities, point cloud points (3D module required), contour lines (3D module required), height interpolation from TIN triangles (3D module required).



Regarding the following functions, please read and follow the indications that appear in Cube-a when using the function, to select the right reference points or lines.




Scale using a reference line of another object
Scale changing the length of the baseline
Scale by the percentage of the baseline
Add new points by angle and offset
Rotate the object to align it to another one
Rotate and translate to align the base point
Rotate and translate to align and overlap the b.p.
Offset
Add new points by distance and offset
Change the distance between objects
Mirror of entity
Trim of entity
Extension of entity
Add vertex
Remove vertex of selected entity
Move vertex of selected entity
Add points



View additional CAD tools

End drawing (see 7.4 Draw during the survey).

Set point elevation

The icons in the vertical bar on the right are described below.

Clear selection

If enabled, when drawing an entity, the vertices become points in the library.

Opens point library

Click to make the point labels visible/invisible. Hold down to access to the 7.1 Display Settings.

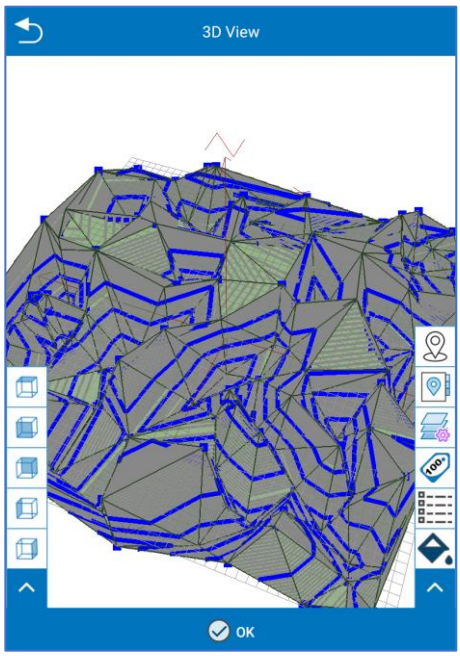
Click to access to the 7.2 Layers.

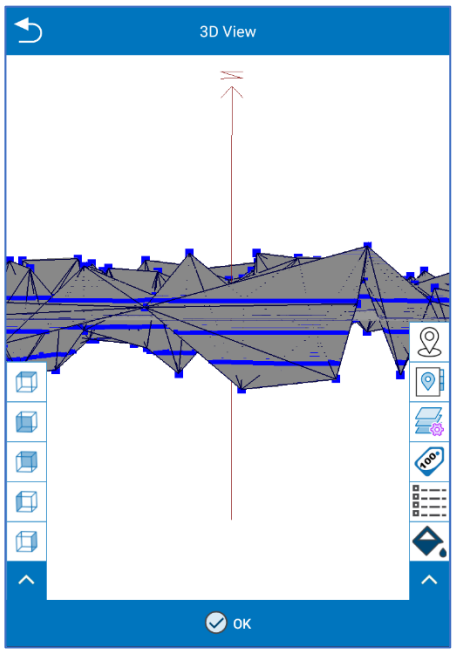
See 12 Appendix A – CAD Tools for details on operating sequence in each CAD command.

6.17 3D View

The 3D view option provides a wider perspective to view the project in the survey area. It is possible to select the view from the bar on the left.

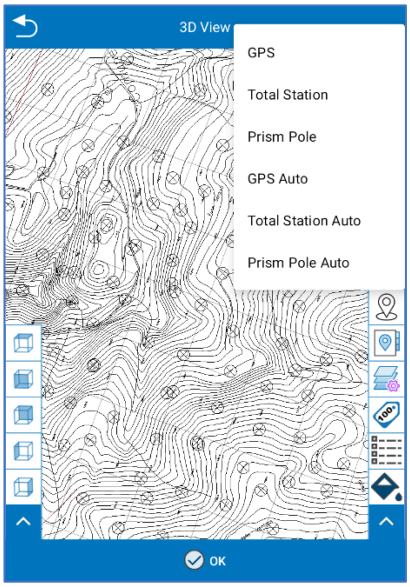
3D view function provides detailed DWG/DXF visualisation and almost real time LAS/LAZ/RCS/RCP point clouds and OBJ mesh visualisation

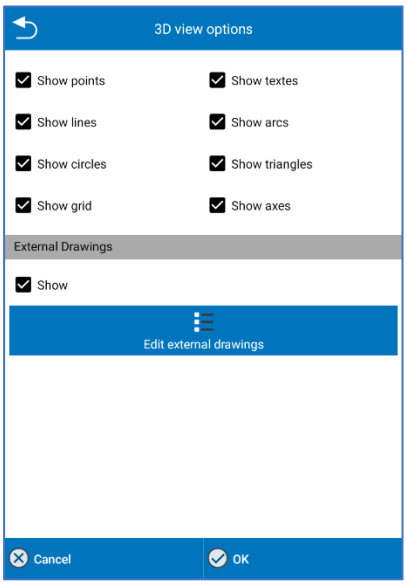




Point clouds are nor resampled unless the user requests to reduce the point density. However, resampling is performed in real time during visualisation.

It is possible to set background colour to white or black to better visualise the rendering.





Here below the description of the icons in the right bar:

It is for enabling the display of GPS/TS instruments (as 3D objects). The user can choose GPS, Total Station. Prism Pole, GPS Auto, Total Station Auto, Prism Pole Auto

To reach the point library

CAD layer

Display settings/Labels

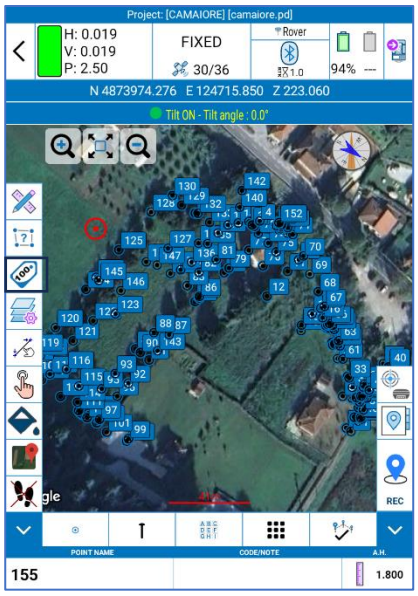
3D View Options

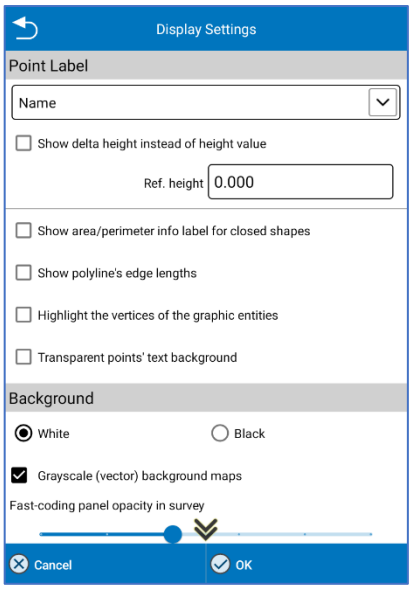
Set the background color to white or black to better visualize the rendering

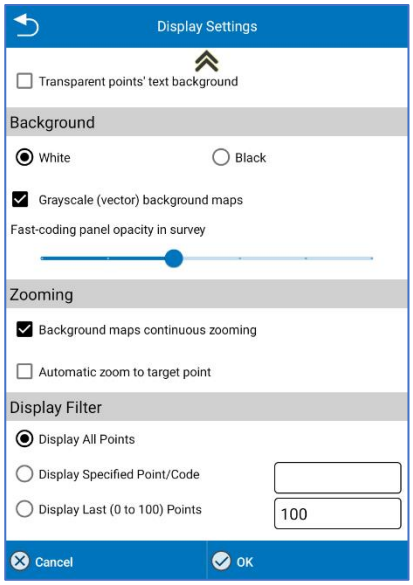
7. Survey Options

7.1 Display Settings

Hold down the “Point labels” button on survey area to access to the “Display Settings” page shown below.







Here below the description of the several options available in this page:

Point Label

- In this page the user can choose the information he wants to see in the point label from the drop-down menu.
- Option to show delta height instead of height value with a reference height input.
- Options to show area/perimeter info label
- Polyline’s edge lengths
- Highlight the vertices of the graphic entities
- Transparent points’ text background

Background

- Background color can be set white or black
- Option to set grayscale (vector) background maps
- Adjust opacity for the fast-coding panel in surveys

Zooming

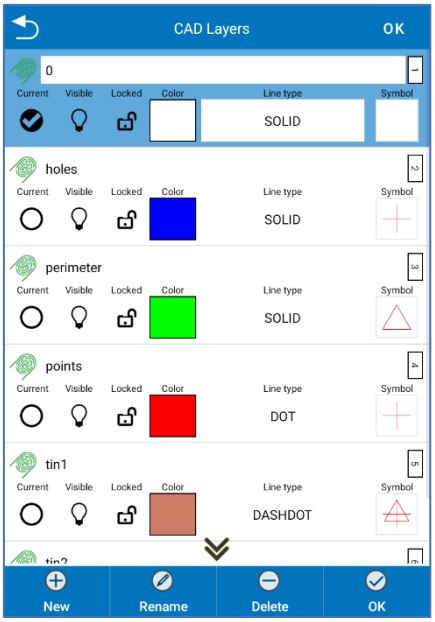
- Option background maps continuous zooming
- Automatic zoom to target point

Display Filter

- Display all points
- Allows the user to display specified point/code, show only specific points
- Display last (0 to 100) points, limit displayed points to the most recent ones.

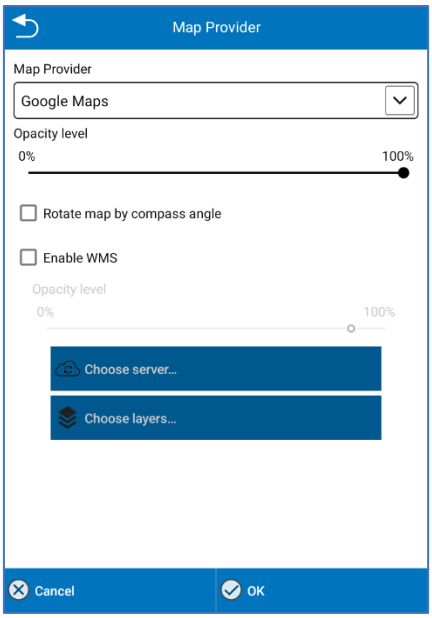
7.2 Layers

In the page “CAD Layers”, the user can change the current layer (click on current), make invisible a layer (click on the lamp), lock a layer (click on padlock), change the color, line type and symbol associated. The user can even create a new layer (click *New*) and rename or delete the layer selected. The default layer is layer 0 and it cannot be deleted. Use this function for saving the points/entities on different layers.



7.3 Background Map

Hold down the map icon in the survey area to access the Map Provider page.



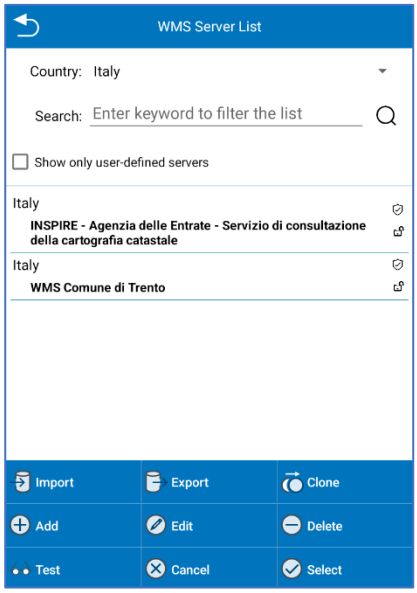
Here it’s possible to choose the background map between Google Maps, OpenStreetMap and Bing Maps.

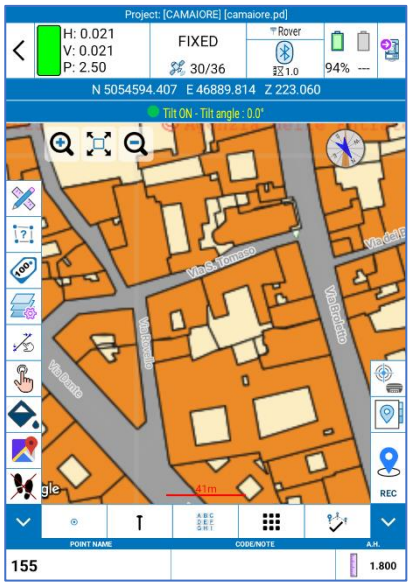
Internet connection is mandatory. It is also possible to change the opacity level of the map and to rotate it using the compass angle; by activating this option, the map will always be oriented in the same direction as the user's movement, instead of being oriented in a fixed manner towards geographic north

WMS

It is possible to activate the WMS (web map service) which is a standard protocol for serving georeferenced map images over the internet. It allows users to access and overlay map data from different servers real time.

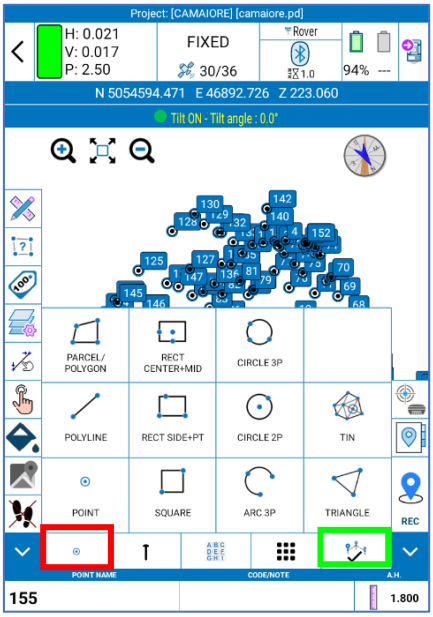
Click “Choose server” to open the menu to select a WMS server providing map data. “Choose Layer” allows the users to select specific map layers to display from the chosen WMS server.





7.4 Draw during the survey

CAD entities can be drawn during the points capturing. Click the icon highlighted in red below to choose the entity. Blue points are the points needed for drawing. The user can stop the drawing by clicking on another entity or by clicking “Complete the Entity” button highlighted in green below.



Point capturing. No CAD entities will be created during the point capturing. The user can even draw after points capturing with CAD functions (see 6.16 CAD).

Polyline. Requires 2 points at least. While this function is active, Cube-a joins the points you are surveying in a polyline. If there are more than one edges, when clicking the "Complete the Entity" button, the program asks if the user wants to connect the first and last vertices.

Polygon. Requires 3 points at least. While this function is active, Cube-a joins the points you are surveying in a polyline. When clicking the "Complete the Entity" button, the first and last vertices are automatically connected to draw the polygon.

Square. Requires 2 points only. Take the vertices of the square's diagonal to draw the square. The acquisition ends automatically as soon as the second point has been measured.

Rectangle. Requires 3 points only. Take 2 vertices to define two edges and a third point that determines the distance of the opposite parallel side so the remaining two edges. The acquisition ends automatically as soon as the third point has been measured.

Rectangle. Requires 3 points only. The first point defines the center of the rectangle, the second defines the middle of one side and the third the middle of the orthogonal side to the previous one. The acquisition ends automatically as soon as the third point has been measured.

Arc. Requires 3 points only. Take the starting point of the arc, a point of tie for which the arc passes and the endpoint. The acquisition ends automatically as soon as the third point has been measured. The three points must not stay along the same line.

Circle. Requires 2 points only. The first defines the center of the circle, the second defines the radius of the circle. The acquisition ends automatically as soon as the second point has been measured. The input of radius can be inserted automatically.

Circle. Requires 3 points only. Take 3 points along the circle. The acquisition ends automatically as soon as the third point has been measured. The three points must not stay along the same line.

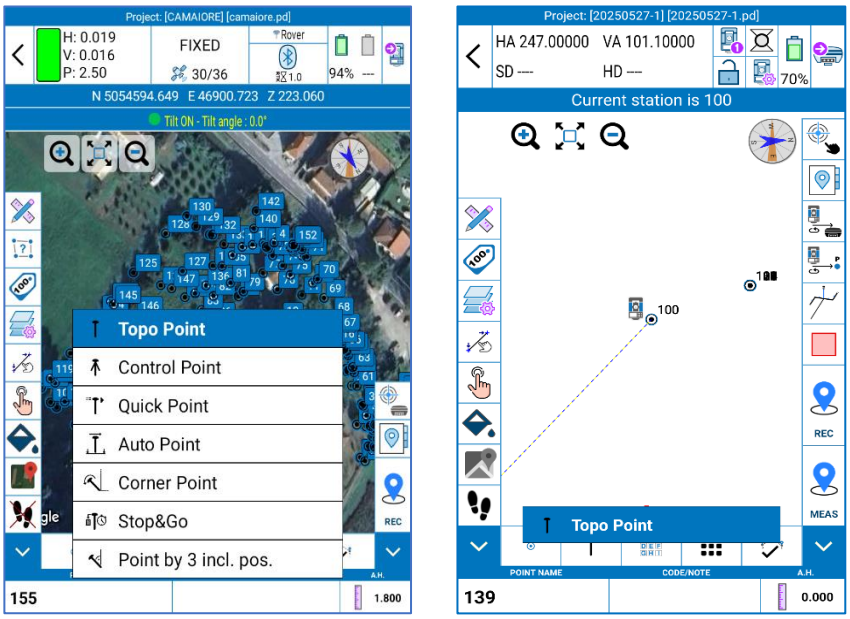
Triangle. Requires 3 points only. Take the 3 vertices of the triangle. The acquisition ends automatically as soon as the third point has been measured.

TIN. Requires 3 points at least. Draw a TIN in the current layer with the points you are capturing.

End the entity. The action performed by this button depends on the type of active drawing function and how many points/vertices have been saved.

7.5 Point type

In the survey area there is the shortcut button for the point type. This page is different from GNSS (left image below) and TS Module (right image below).



This function allows the user to quickly choose the point type according to its needs, so the user does not need to change the parameters to save different types of point each time. Example: during the survey, the user wants to save boundary points with the best possible accuracy (which means staying a few more seconds on the point). The user should change the point parameters to make the checks more stringent and, once saved these types of points, the user should reset the starting parameters, otherwise it would mean staying more time on all the other points as well. Thanks to this function it is enough to change the point type and choose the one with the parameters already inserted that meets user needs.

The following types of point have default parameters, but the user can always change them.

GNSS Module

- **Topo Point:** "classic" point. It is possible to set the following control parameters: minimum solution, maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age, readings to mediate and interval (interval between readings).

- **Control Point:** point with stricter controls, recommended when the user wants to obtain the maximum reliability possible at the cost of stationing extra time on the point. It is possible to set the following control parameters: maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age, planimetric and altimetric limit, readings to mediate, average GPS range, number of readings repetition and interval. Example: if the number of readings is 10, the average GPS range is 2, the number of repetitions is 2, and the interval is 15s, then Cube-a performs 10 readings every 15s, the averages to 2 at a time and repeats the whole thing 2 times. When the saving is complete, the user will see the "report of generated control point."

- **Quick Point**: quick points acquisition since the controls are fewer and, by default, less binding. It is possible to set the following control parameters: minimum solution, maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age.

- **Auto Point**: this function allows to automatically save points, so it's not needed to click the REC button. It is possible to set the following control parameters: minimum solution, maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age. It is obviously necessary to choose the criteria for auto-saving; the user can record according to step or time. If step is selected, it is related to meter or foot as per units' settings in Cube-a and the points are saved automatically depending on distance or height difference.

- **Corner Point**: this function allows the user to save a corner point (without resorting to geometric calculation by intersection) even if the user does not have a GNSS receiver with tilt sensor. It is possible to set the following control parameters: maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age, readings to mediate. The acquisition consists in moving the pole drawing arcs around the edge holding the tip on the corner point; Cube-a makes average between these readings.

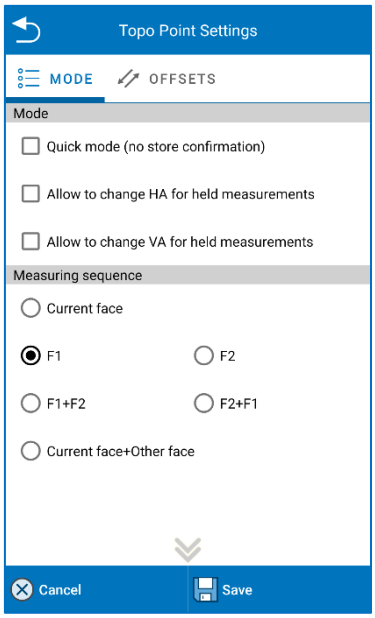
- **Stop&Go:** point with no controls, to allow the user to save points even without differential corrections. You can enable the recording of raw data and set the number of epochs. This function is suitable for saving points in bad condition to perform the post-processing in the office.

- **Point by 3 inclined pos.:** this function allows to save a corner point (without resorting to geometric calculation by intersection) even if the user does not have a GNSS receiver with tilt sensor. Attention, you need a GNSS receiver with electronic bubble. It is possible to set the following control parameters: maximum horizontal and vertical root mean square, PDOP limit, maximum differential correction age, readings to mediate and interval (interval between readings). The acquisition consists of making three readings with the pole tilted in three different directions; Cube-a intersects the three spheres resulting from these three readings.

In some types of point it's possible to enable quick mode. If the user doesn't enable this option, after clicking on REC, a window appears, which allows you to associate a photo to the point, change the code or height of the pole (it's possible also to do these operations later from points library), check much information about the point and cancel the record. If the "Quick Mode" is enabled, the point is saved immediately, as soon as clicking REC.

TS Module

Clicking on "Topo Point" the following page is displayed.



In this page the user can set:

- *Quick Mode* -> enabling/disabling the Quick Mode. When enabling the summary page displayed after pressing REC is not shown and the point is immediately saved in the point library. With this option enabled after recording the point, Cube-a automatically increases the new point name.

- *Allow to change HA for held measurement* -> if enabled Cube-a is able to save HA angle and distance separately inside the survey page (use this option for eccentric measurements inside the Survey Page).

- *Allow to change VA for held measurement* -> if enabled Cube-a is able to save VA angle and distance separately inside the survey page (use this option for eccentric measurements inside the Survey Page).

From the "*Measure Mode Option*" menu, the user can choose between several measurement methods:

- ***FC*** *-> Current Face*
  For robotic TS, the station measures in the Face where its located.

- ***F1*** *-> Station measure in F1*
  For robotic TS, the station automatically rotates in F1 and measure. If the station is already in F1, it measures the target.

- ***F2*** *-> Station measure in F2*
  For robotic TS, the station automatically rotates in F2 and measure. If the station is already in F2, it measures the target.

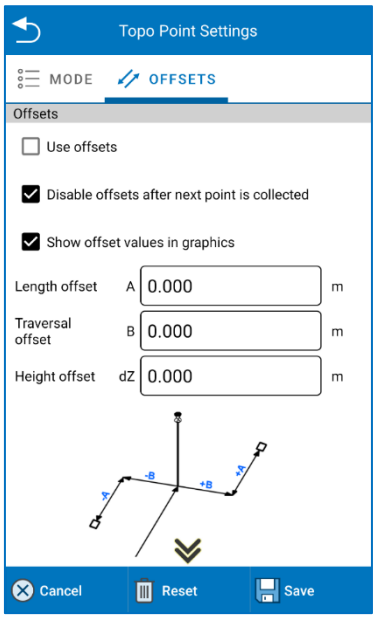
- ***F1/F2*** *-> Station measure in F1/F2*
  For robotic TS, the TS rotates in F1 and measure the target; then automatically it rotates in F2 and measures the same target. When using this option both measurements are saved in the fieldbook. The data used for coordinates calculation are the average value between F1 and F2 measurements.

- ***F2/F1*** *-> Station measure in F2/F1*
  For robotic TS, the TS rotates in F2 and measure the target; then automatically it rotates in F1 and measures the same target. When using this option both measurements are saved in the fieldbook. The data used for coordinates calculation are the average value between F1 and F2 measurements.

- ***Current face + Other Face***
  For robotic TS, the TS measures the target; then automatically it rotates in the Other Face and it measures the same target. When using this option both measurements are saved in the fieldbook. The data used for coordinates calculation are the average value between F1 and F2 measurements.

  Note. For robotics, If the target type is Prism and the APC/LOCK are activated. The station searches and centers the prism before measuring.

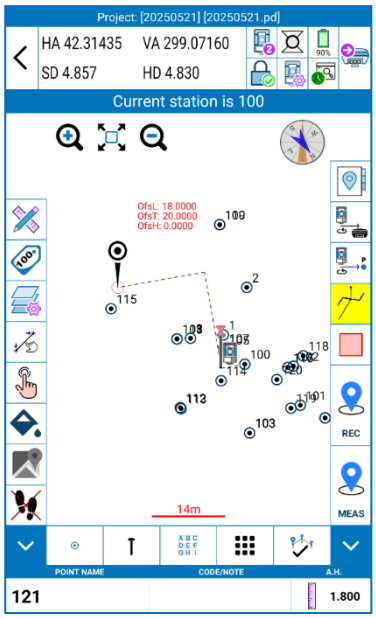
From the "*Offset*" menu, it's possible to set a length, traversal or height offset to the measurement, following the indications visible in the scheme included in the picture below.

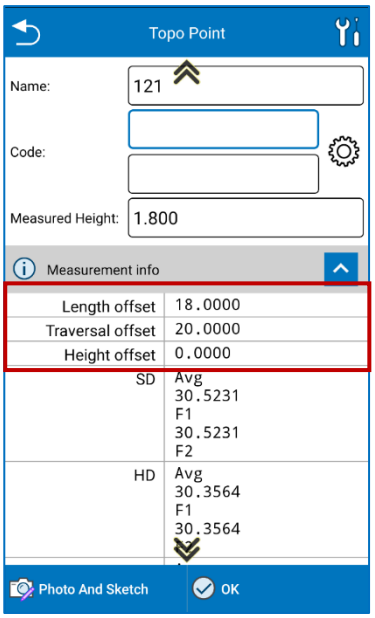


If the user selects the option:

- "Use Offset" -> Cube-a will apply the offset values set to the new measurement.
- "Disable offset after next point is collected" -> Cube-a will apply the offset values to the new measurement and then disable it.
- "Show offset value in graphics" -> Cube-a display the offset values in the survey page.

When the user enables the offset values, the survey page appears like in the image below. After recording a point with offset, the offset values are displayed in the summary page like visible below.





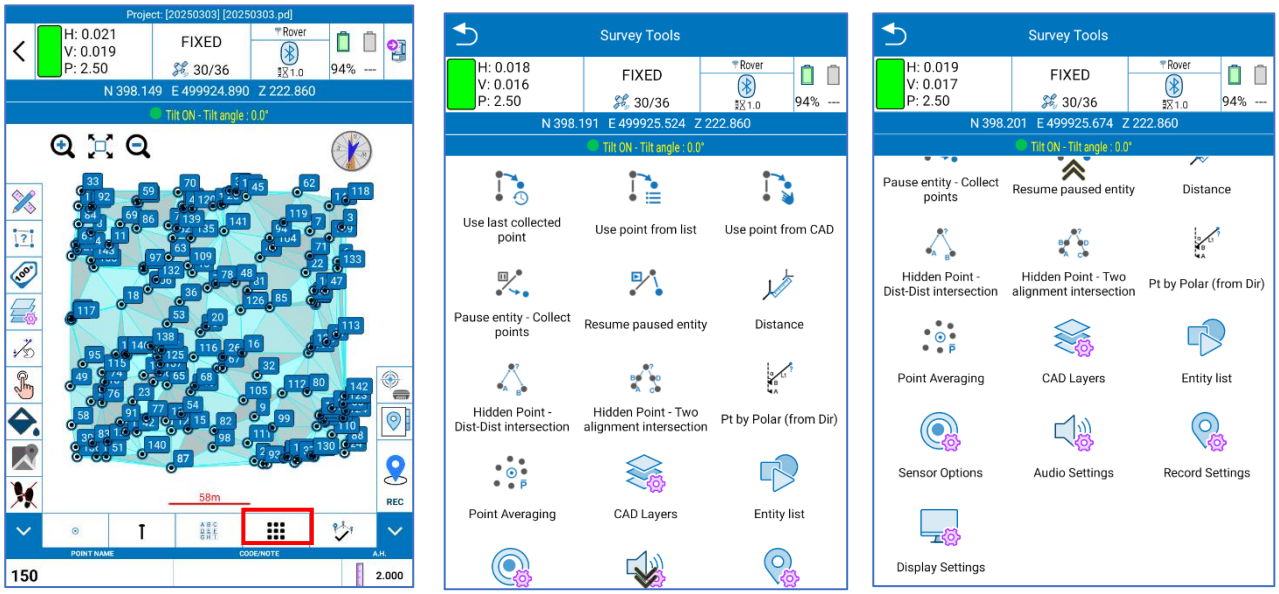
Note 1. The user can enter in the offset page clicking on the offset icon inside the survey page (yellow in the image above). The “offset icon” blinks when the offsets are enabled.

Note 2. The data saved in the fieldbook in this configuration, take care of the offset values set. Angles and distance are recalculated according to the offset values by the user.

Note 3. The offset options can be used in Survey and Stake out pages.

7.6 Survey Tools

Click on the icon with nine squares in the survey area to access to the *Survey Tools* page shown below.



The survey tools functions are described below:

- **Use last collected point** -> Click to use the last collected point as first point of the entity you are going to drawing, then you will be back on the survey area.
- **Use point from list** -> Click to use a point from library as point of the entity you are drawing, then the point library will open to let you choose the point.
- **Use point from CAD** -> Click to select a point from CAD area to use it as point of the entity you are drawing.
- **Pause entity – Collect points** -> Pause the entity you are drawing, so you can take some point that is not a vertex of that CAD entity.
- **Resume paused entity** -> Resume the last paused entity to continue to draw it.
- **Distance** -> Calculate the distance between two given points.
  Points setting options available:

Typing coordinates


Select point from survey area

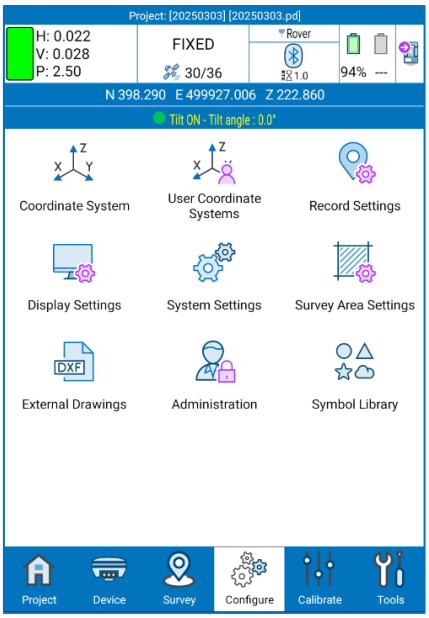

Take current coordinates from GPS


Select from point library

- **Hidden Point – Dist-Dist** -> Calculate the hidden point by two given points and the distances between the two points and the unknown point. Within the command, at the top, there is a brief description of what you must insert to perform the calculation and what the result is.
- **Hidden Point – Two alignment** -> Calculate the hidden point by four given points. Within the command, at the top, there is a brief description of what you must insert to perform the calculation and what the result is.
- **Pt by Polar** -> Calculate the hidden point by two given points, the angle and the length. Within the command, at the top, there is a brief description of what you must insert to perform the calculation and what the result is.
- **Point Averaging** -> Calculate the average point. Click *Start* to start taking coordinates then click *Save* to save the point obtained by average of taken coordinates
- **CAD Layers** -> See 7.2 Layers
- **Entity List** -> See 11.1 Entity List
- **Sensor Options** -> See 9.5 Sensor Options
- **Audio Settings** -> See 8.5 System Settings
- **Record Settings** -> See 7.5 Point type
- **Display Settings** -> See 7.1 Display Settings

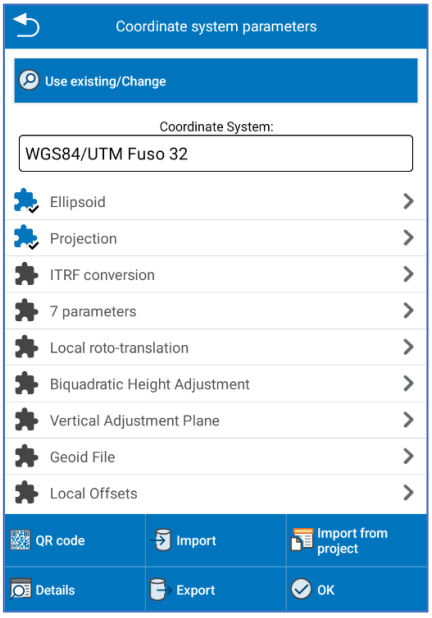
8. Configure

This menu contains all the functions useful for configuring the Cube-a program, configuring some parameters of the current project, such as the reference system, and importing external drawings such as layers.



8.1 Coordinate System

By clicking on The Coordinate System, in the Configure menu, opens the Reference System Parameters page, where the user can check the reference system currently in use and modify it. It is not necessary to modify the parameters listed below (Ellipsoid, Projection, ...), except for specific needs that require the customization of these parameters, since the program defaults to the main reference systems in use worldwide. Click “Existing Use/Change” and then on “Default Systems” to access this list; you can search for the reference system by filtering by country or by word. By clicking on “Details”, the user can read the parameters of the selected reference system. To choose and set up a reference system from the list of default systems, select it and click “OK”.



By clicking on "Import", the user can import a reference system saved on the device (files are supported*.SP, *.JXL and *.RMGEO); by clicking instead on "QR code" you can scan the QR code and acquire the parameters of the coordinate system in this way.

The following are the parameters of your reference system listed on the Reference System Parameters page.

- **Ellipsoid**: This command opens a page where it's possible to choose the name of the ellipsoid that supports parameters that have already been defined or choose a customizable ellipsoid. In the latter case, the user must choose "Custom" at the bottom of the "Ellipsoid Name" drop-down menu; the user can then set semi-major axis and flattening ratio 1/f.

- **Projection**: This command opens a page where it's possible to choose the projection. Using Gauss Krüger projection, for example, you need to set the central meridian; this is automatically entered by the program if you are already connected to the GNSS receiver, using the position transmitted by it, otherwise it can be entered manually or, after connecting the GNSS receiver, the central meridian can be inserted by the program by clicking on the drop icon (icon to the right of the Central Meridian drop menu).

- **ITRF Conversion**: This command opens a page where it's possible to enable conversion between International Terrestrial Reference Frames (ITRF) with different reference eras. To enable ITRF conversion, the user must choose the type of conversion, enter the reference era, and enable or disable speed entry; If enabling speed, the user must insert the speed components along the axes. X, Y, Z. Attention, this conversion is applied to all points in the current project, and not just from the moment you enable it.

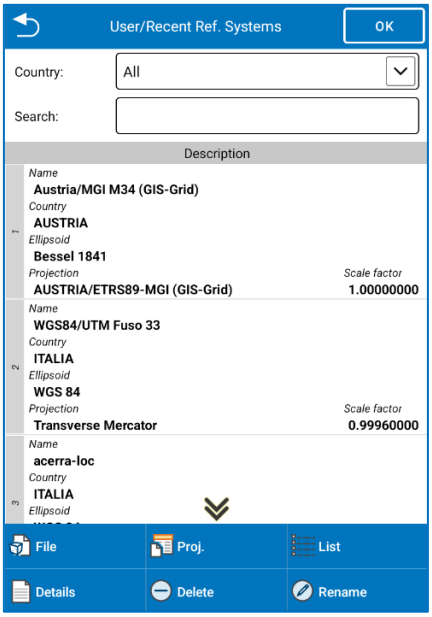
- The **7 parameters**, **Local Rototranslation, Biquadratic Height Adjustment, Vertical Adjustment Plane, Local Offsets** commands contain translation, rotation, and scale factor values when expected from your localization.

- **Geoid files**: This command opens a page where you can enable the use of the geoid. By clicking Open on the "Geoid Files" page leads to the list of preloaded geoids in the program. To add a geoid that is not in this list, copy the file to stonexcube -> Geoid; Cube-a supports all major standard geoid formats (*. GSF, *. GGF, *. UGF, *. BIN, ...).

Click "OK" to apply the chosen reference system. Click "Save" and choose "Local Disk" to save the system data to a file whose name and location you have defined. The user can also encrypt the file by setting an Expiration Date, General Password (data cannot be displayed before expiration date), and Advanced Password (data can be displayed before expiration date). Click "Save" and choose "QR Code" to share the parameters of the current coordinate system via QR Code.

8.2 User Coordinate Systems

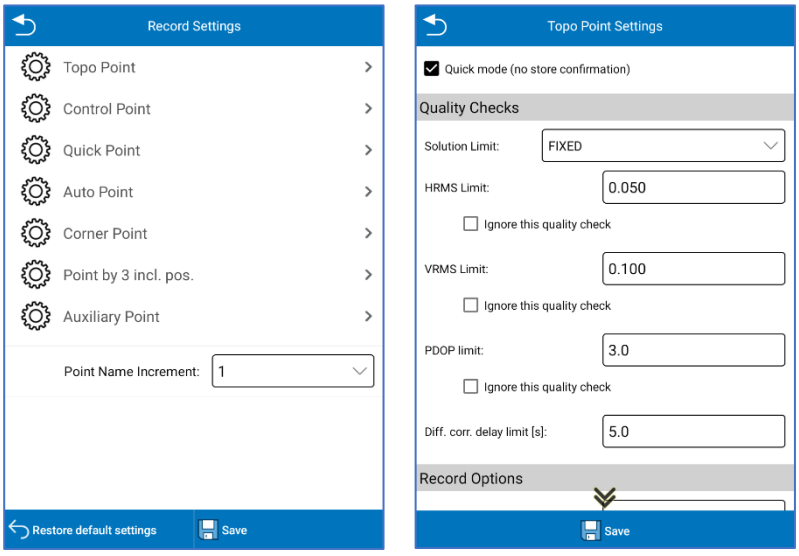
In the sub-menu User Coordinate Systems there are all the systems created by the users or chosen from predefined and recently used ones.



8.3 Record Settings

Click on *Configure -> Record Settings*, to open the page, where the user can set the parameters for saving the various point types.

In “Point Name Increment”, the user can change the Auto-naming rule for saved points. For example, if you choose 2 in the drop-down menu, the point names will be auto incremented by two units, each time you save the point.

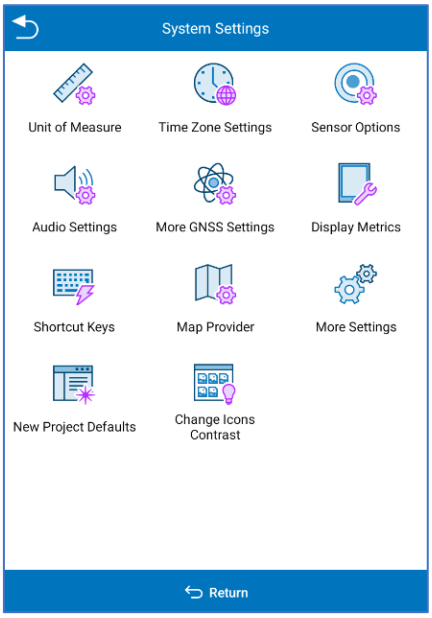


8.4 Display Settings

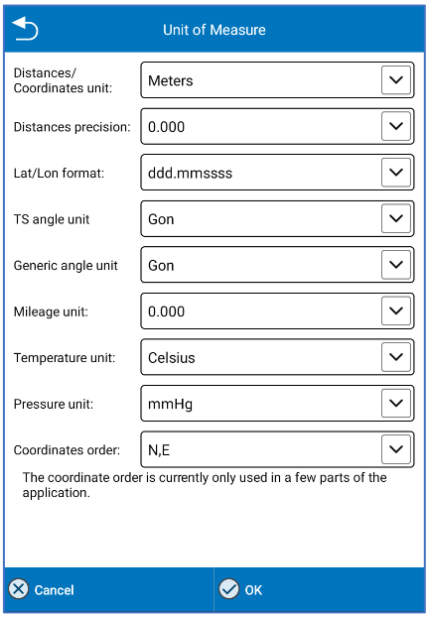
See 7.1 Display Settings

8.5 System Settings

The following figure shows the system settings. Below the description of the functions on it included:



- **Units Settings**
  In this section you can define the units of measurement to be used in Cube-a. From this page it is also possible to change the order of the coordinates visible in the top bar from N, E to E, N and vice versa.



- **Time Zone Settings**
  In this page the user can set a time zone through the appropriate drop-down menu. The time zone is used to bring GPS time back to local time. if not set differently Cube-a uses the system time zone.

- **Sensor Options**
  This command accesses the same page as described in section 9.5 Sensor Options

- **Audio Settings**
  This command enables/disables voice alerts and sounds expected in the program, as well as receiver's alerts. Option to enable Voice Recognition in editable fields

- **More GNSS settings**
  The user can choose to work in *Normal or Strict Mode*. The strict mode consists of a more accurate search for the FIXED solution, but at the expense of speed. The maximum achievable accuracy will be the same, but the solution will be much more reliable.
  With the function called L-band Zone the user can set the reception zone of L-band frequencies, normally receivers select the zone automatically (available only for GNSS receivers with Hemisphere card).

  From this screen the user can also activate the Wi-Fi of the receiver and disable high -speed GPS stakeout.

  From this screen, the user can choose to connect to the last GPS device used (Yes, No, Ask).

- **Display Metrics**
  The user can choose the display orientation (Auto, Portrait, Landscape).

- **Shortcut Keys**
  Shortcuts can be set for some Survey and Stake out functions. The possible settings can be: "Not Set", if you do not want to associate any shortcut key, "Vol UP" or "Vol DOWN" to associate the Volume button, "Custom" allows the user to associate a button of your choice, the first one you press, after selecting the item "Custom".

- **Map Provider**
  See paragraph 7.3 Background Map

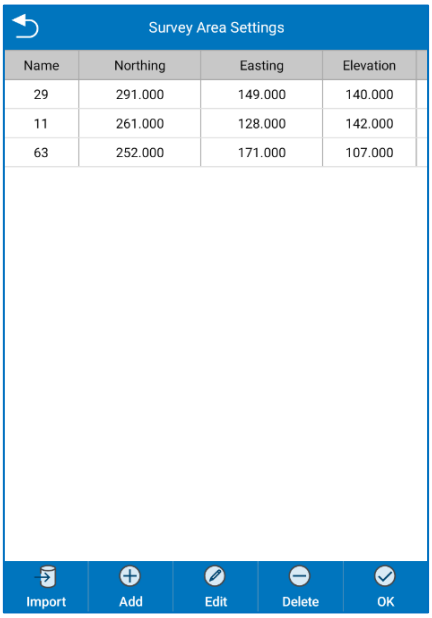
- **More settings**
  The command allows you to enable fictitious locations, i.e. the location of the device (and all the applications present that use its data) will follow the coordinates of the connected GNSS receiver (and not those of the internal GPS). You can change the forced language/translation from this page and you can enable "Use new RTCM decoder for 1021-1026 messages" option.

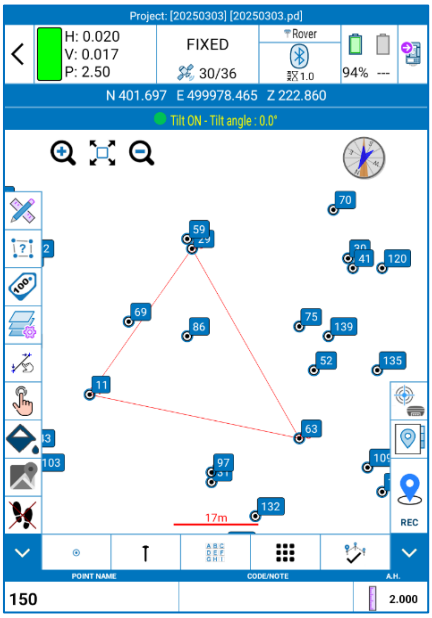
- **New Project Defaults**
  Allows the user to select configuration and default symbol library.

- **Change Icons Contrast**
  The user can choose the icons contrast from standard (color icons) to maximum (black and white icons)

8.6 Survey Area Settings

Click "Add" to set the coordinates of the point or search for coordinates in the points library or use the current GPS coordinates. Generally, the area of investigation needs at least three points. Points can be chosen, edited, or deleted. Click "Import" to import coordinate files (*.dat, * .txt, * .csv). The survey area, after setting, is visible as a figure with red lines, so you can visibly check if the current point is in the set area.



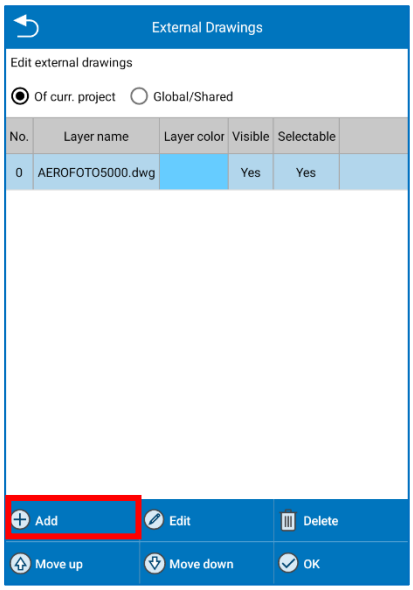


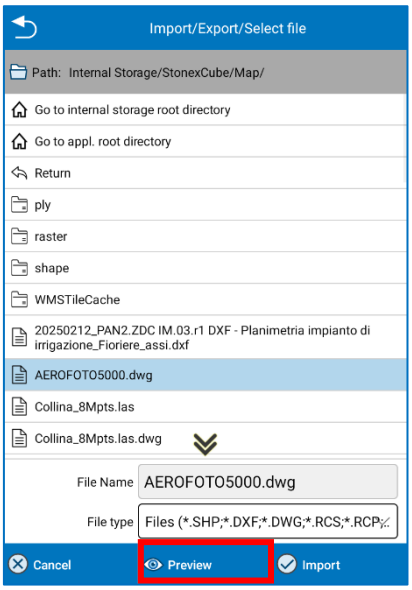
8.7 External Drawings

This command allows the user to import:

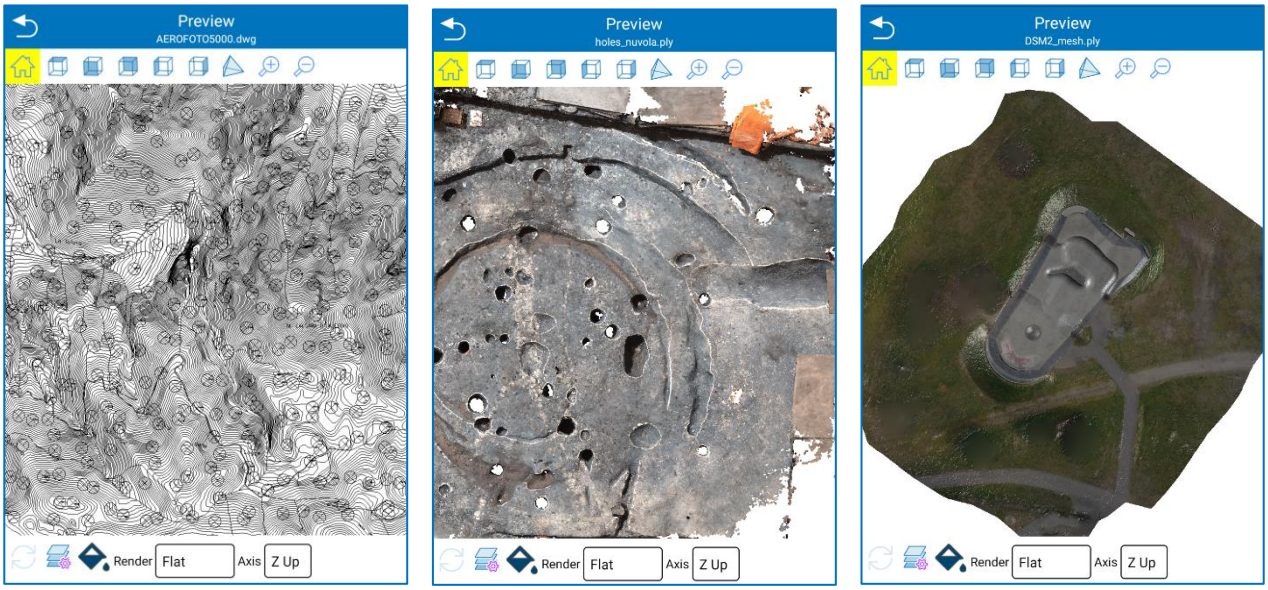
*SHP shapefile, *DXF, *DWG, *RCS, *RCP, *LAS, *LAZ, *XYX, *OBJ, *PLY files into the program in the form of layers. As a result, points will not be imported into the library, only in graphics.

The user can select points and entities from the graphics and use them for stakeout. Click "Add" to select the file to import.





In this page the user can preview the file. This allows the user to select the correct file based on visual recognition of the actual file contents rather than just the file name.



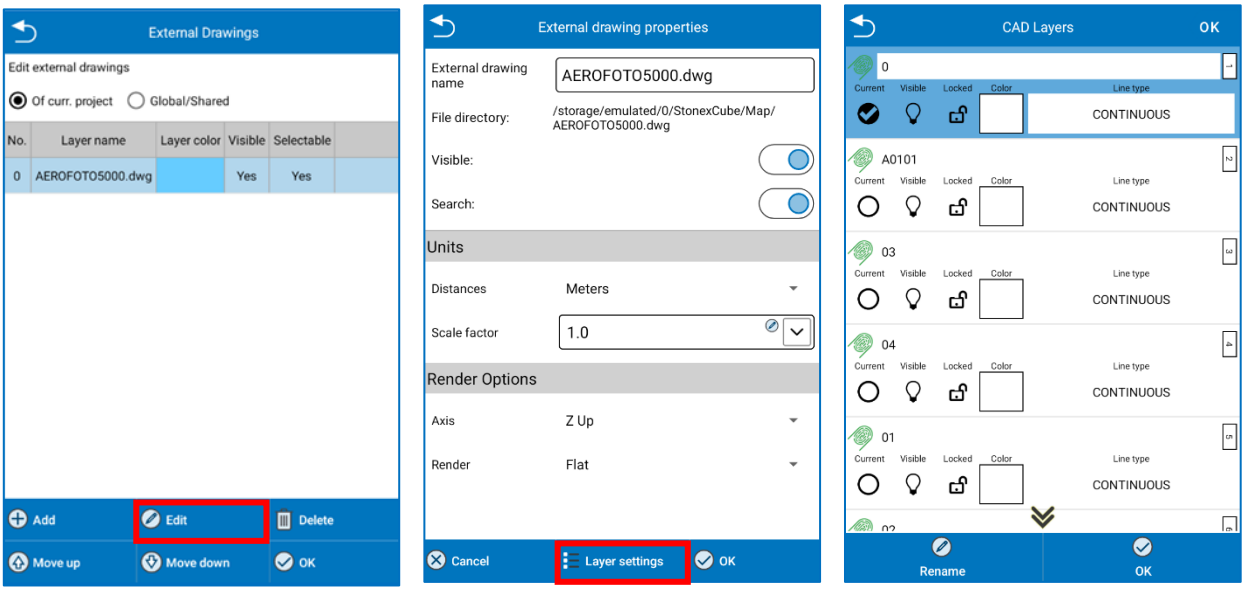
At the top bar of the “Preview” page, it’s possible to select the view, zoom in or zoom out. At the bottom bar the user can see the layers, change the background colour, select Render type and Axis.

Preview is supported for

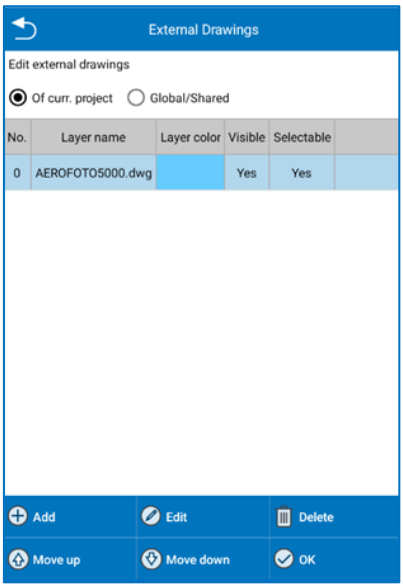
- DWG/DXF drawings
- RCS/RCP point clouds
- OBJ mesh files

The "Edit" command allows the user to change/read the name of the imported external drawing, read the location of the file in the data store, enable/disable visibility, enable/disable the selection of items in the layer, such as lines and points ("Find" command), set the unit of measure and scale factor and set the render options such as axis (Z up, Y up, -Z up, -Y up) and render (wireframe, flat, shaded).

In the Layer Settings page, the user can view and organize the layers in the file. Layer visibility can be controlled for each DWG/DXF file.



Note If the file is imported from the "Of curr. project" page, it will only be visible for the current project, while if it is imported to the "Global/Shared" page, it will be visible for all projects until you delete it or make it invisible.



Note. The program does not place limits on the size of imported files, however, there are limits that do not depend on the program but on the state of the system, the version of Android, the size of the RAM and the RAM actually free and usable by the program. It is therefore advisable to limit the size of the files by including only the data necessary to carry out the work in the field.

Examples:

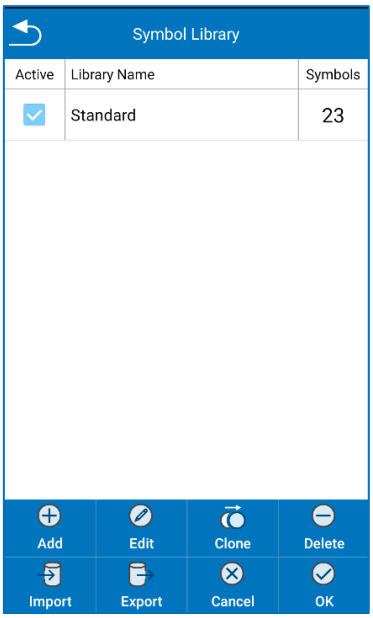
- DWG/DXF: delete all embellishment elements (screens, blocks and texts) that can make the drawing heavier.
- Point clouds: delete non-essential parts of the cloud.

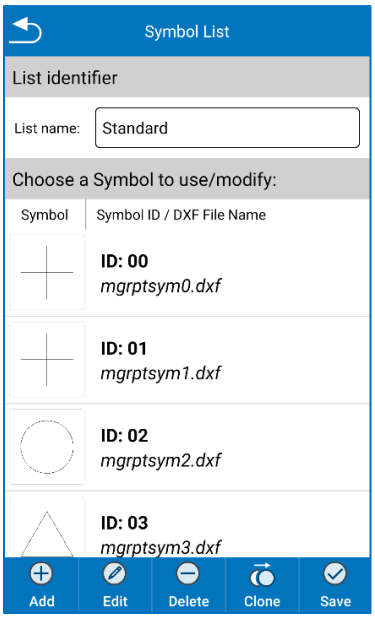
8.8 Administration

On this page, the user can change the password visibility settings in Cube-a (such as those for your CORS account). It's also possible to protect this screen so that visibility settings are protected themselves and accessible only by a password administrator. The last field at the bottom, if left blank, from free access to the function, if a password is entered, to access this function again the user will need to enter the password.

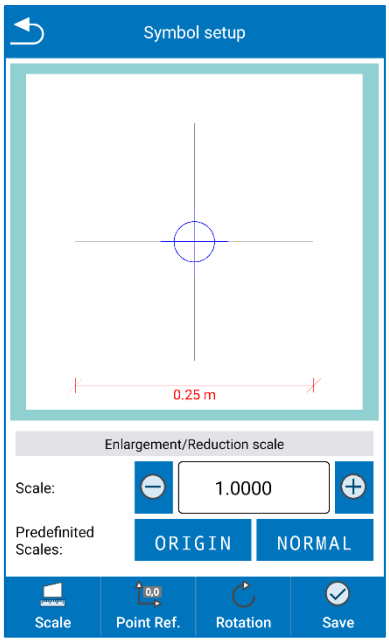
8.9 DXF Symbol Library

On this page, the user can import or create a symbol library so that it's possible to associate them with layers, and then points with different symbols in the survey area. The program defaults to a standard library containing 23. Within the selected library, the user can preview the available symbols.



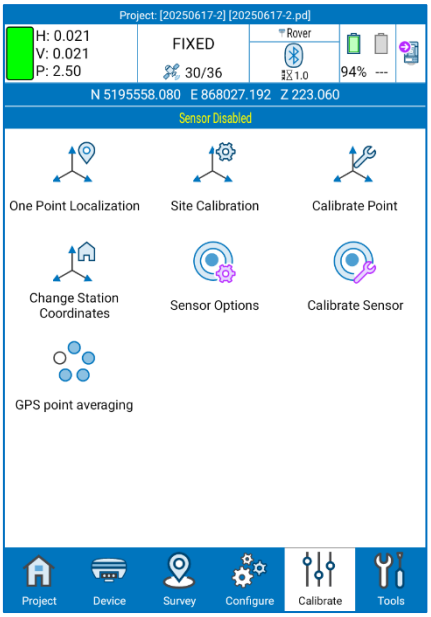


The user can select a symbol and edit it, changing scale, rotation, color, and shape.



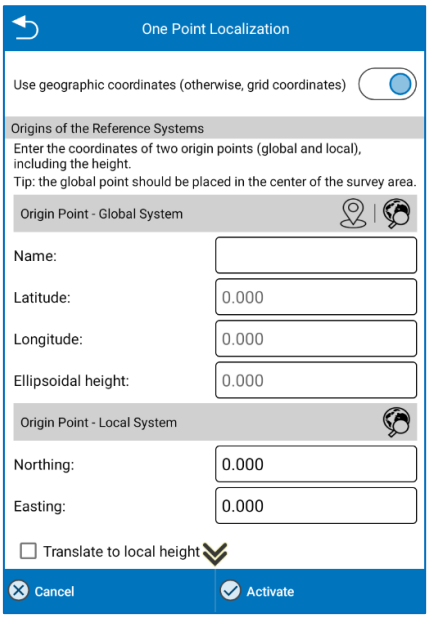
9. Calibrate – GPS Module

The “Calibrate” menu, in the GPS mode, contains useful functions for calibrating the survey or the instrument.



9.1 One Point Localization

The function one point localization is useful when the user wants to obtain the real distances between points, therefore not affected by the deformation of the projection of the GPS reference system. This function is necessary when the user wants to compare the GPS survey with a total station survey.



The function consists in assigning to a point, preferably central to the survey, the local coordinates that will represent the origin of the new local system.

By default, the program asks for geographical coordinates in the global system of the origin point; if the user wants to enter map coordinates (North, East) then disable the option at the top “Use geographical Coordinates”. In the global system section, it’s possible to manually enter the origin point or detect it in real time from the GNSS receiver (click on record point) or select it from the point library (click on search). In the local system section, the user can manually enter the coordinates of the origin point or select them from the point library (click on search).

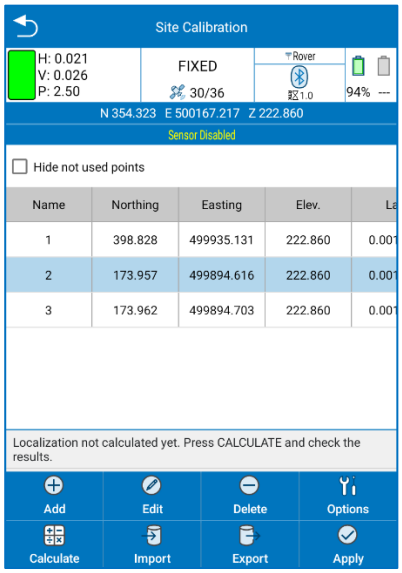
It is also possible to define a point for the orientation of the new local system (as you are used to working with the total station); this is not mandatory, and If ignoring this section then the local system will be oriented towards geographic north.

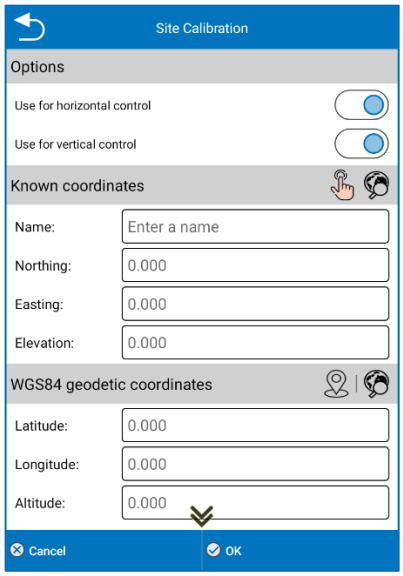
Click “Activate” at the bottom to create the new local system.

9.2 Site Calibration

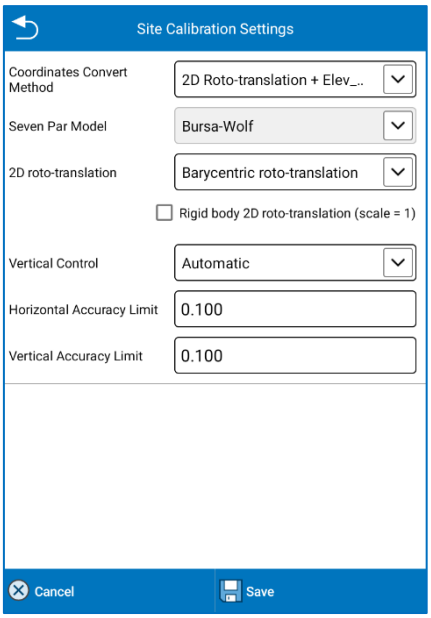
Cube-a offers the possibility to localize, i.e., convert outbound coordinates from the GNSS receiver into an unconventional reference system. The screen for this feature is shown in the Figure below. At the top are the points that will be used to calculate localization, the points can be added to the table by pressing the "Add" command at the bottom. The screen to add is the one shown in Figure below. Here it’s possible to enter the known (local) coordinates, on which the user wants to locate, these can be entered by hand or by selecting a point in memory with the selection commands  . The conversion's target coordinates are below and can be collected from the current GNSS location or selected from a point in memory  . The options below the coordinates provide the ability to enable planimetric and/or altimetric localization.

The localization points added can be changed with the "Edit" command, at the bottom.





After added the point (or points) for localization, it’s possible to perform the conversion. There are three methods of converting coordinates: Inclined plane + Delta dimension (Roto-translation), 7 parameters + Inclined plane + Delta quota, 7 parameters, click the "*Options*" command in Figure, to access the reference screen in Figure.



In the figure above, the user can set one of the expected conversion methods. In case of 7-parameter conversion calculation, it's possible to set the Helmert or Bursa-Wolf model, for the management of the sign of the roto-translations parameters. For the 4-parameter model, the user can set up a barycentric or non-barycentric roto-translation. And finally, it's possible to set the quota control and a horizontal and vertical accuracy limit. By clicking the "Save" command at the bottom, the options will be saved for calculation.

Below is a brief description of the calculation methods 4 parameters and 7 parameters.

4 parameters: At least two Control Point related to an arbitrary coordinate system must be known. It is the coordinate transformation mode used to perform a conversion between different coordinate systems within the same ellipsoid. Parameters include four values (north translation, east translation, rotation, and scale), the scale must be infinitely close to 1.

In general, the distribution of control points directly determines the quote difference and the four parameters to be controlled. The use of four parameters for the RTK measurement method, can be used in a reduced area (20-30 square kilometers). Measure a point in flat coordinates and operate in the precision of a control network with dimensions of known points. The more known points you will have, the higher the accuracy (2 or more than 2). But in a very large point distribution (e.g., tens of kilometers), the 4 transformation parameters often do not help, in this case to have an increase in precision both in the planimetric coordinates and on the altitude should use the 7-parameter transformation.

First, you need to perform a static survey in the area where the cornerstones are present, and then select a cornerstone A as a static reference station (in WGS84), which will be used to correct the point network. Use a static receiver to measure a single fixed point for more than 24 hours (this step, in test zones you can perform in less time and in case of low precision required this step can also be omitted) and then import into the software, as a single point all the captured data, the average of the readings will be the actual coordinates of point A in WGS84 coordinates. Absolute accuracy should be below 2 meters, so regarding adjusting the three-dimensional control network, you need to take point A WGS84 as the cornerstone to calculate the 3D coordinates of other points. The 4-parameter model, used to perform a 2D transformation, can achieve a barycentric roto-translation (around the midpoint of the source coordinates, called "Vertical Translation") or a non-barycentric roto-translation (around the origin of the axes, called the "Inclined Plane").

When the 4-parameter model is used, vertical correction will be automatically enabled.

The actual vertical correction parameters used depend on the number of points used. If less than 3 points are used, the heights are adjusted using the average corrections on the 3 points indicated.

If 3 to 6 topographic points are used, an inclined plane is calculated. If more than 7 points are used, a paraboloid surface is used.

7 parameters: At least three cornerstones, relating to an arbitrary coordinate system, must be known. It is the coordinate transformation mode used to perform a rectangular transformation of spatial coordinates between different ellipsoids. The parameters include seven values: 3 translations, 3 rotations and the scale factor (ΔX, ΔY, ΔZ, Δα, Δβ, Δγ, scale).

How to calculate conversion parameters?

Generally, use 3 known points (A, B, and C) to calculate parameters, so first you need to know the WGS84 coordinates and local coordinates of the 3 known points (A, B, and C). There are 2 methods to get the WGS84 coordinates of points A, B, C. The first method is to set the static control network and then obtain WGS84 coordinates from the GPD capture of the post-processing software. Second method, the GPS Rover records the original WGS84 coordinates in a fixed solution when the correction parameters are not active.

After entering all the points for localization, click " Calculate "to perform the operation and a report will appear containing the calculated GPS parameters. Click "Back " to return to the previous interface, then click "Close" to exit from localization. A message will appear before you exit asking if you want to use the calculated parameters for the current project. You can confirm or exit without saving the calculation. When a localization is saved, Cube-a asks you to set a name for the new reference system, and the " Reference System " command has an alert, which reminds you that localization is active in the current project.

After you apply the conversion parameters, the original coordinates in WGS 84 in the points library of the current project will be converted to the coordinate system based on the calculated conversion parameters. To verify that the results are accurate and precise, you can perform a check by logging in from another known point.

Click "Import" to import files *.cot or *.loc, (extension import coordinates).

Click "Export "to export and save coordinates localized, in a file with a *.COT. The coordinates can then be used in the future, without having to reinsert them.

9.3 Calibrate Point

Click "calibrate" then "Calibrate Point", to access the interface shown in the figure. The program has two methods to calibrate the station: "*Base point Calibration*" and "*Marker point calibration*":

Base Point Calibration:

Enter the coordinates of the known point (i.e., known coordinates before conversion); can be entered from the points library or manually. Then click the command alongside the "Current Base Coordinates" ▪▪▪, to set the antenna parameters. Proceed to the calculation by pressing "Calculate" (a pop-up window with the mart displacement deltas will be displayed).

Note. Station calibration should be done in fixed solution.

The "Base Information" command below gives you access to location functions, already illustrated in the paragraph on the infobar.

Marker Point Calibration:

Place the coordinates of the known point (manual or library in memory) and coordinates in WGS84 (as the current location of the GNSS or from the library in memory). Click "*OK*" to perform the operation and view the result with the displacement deltas.

Click "View Local Offsets ", to see the current deviation.

Calibration of a station should be done based on the transformation parameters already calculated.

Below are the cases where the calibration of the station must be performed.

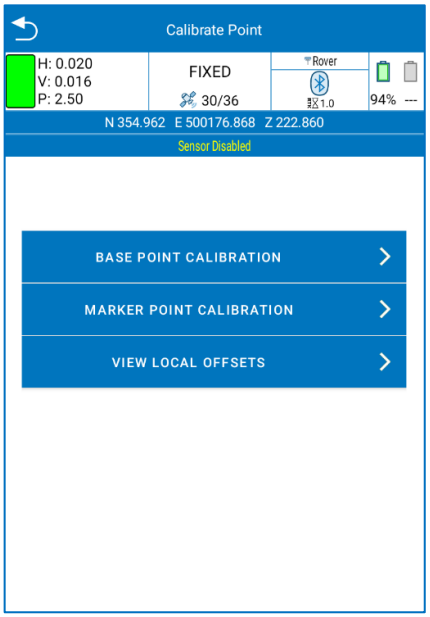
If the " Use Current Coordinates "option is selected in the start parameters of a base, the Rover should calibrate the station if the base has been restarted or the location has been changed.

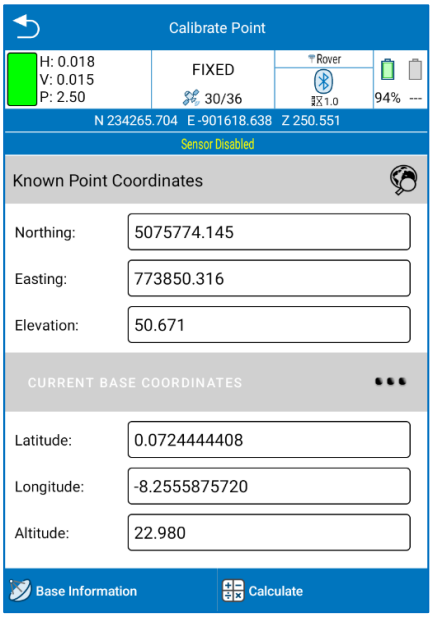
When the user knows the workspace conversion parameters, the base can be calibrated to any location. However, the conversion parameters must be entered, and the Rover will then calibrate the station.

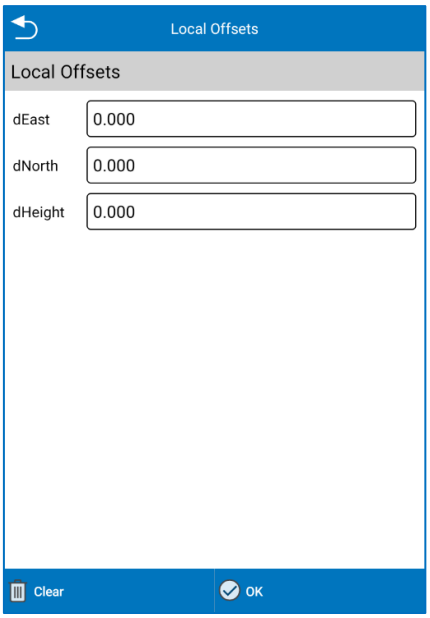
If "Input Base Coordinates" is selected at base startup and the base has been moved, then the Rover should calibrate the station.

If the entry " Input Base Coordinates " is selected when starting the base, and if the base is in the same position, then it should be enough to turn the device back on, without the need to calibrate the station.

Station calibration parameters do not update the current point coordinates in the library. When the current coordinates are shown, the calibration parameters of the station will also be shown, the next coordinate measure will be corrected according to the calibration parameters of the station. The transformation parameters obtained from calculating parameters from the library will update the coordinates of the current point. The WGS84 coordinates of the measured point are converted to local coordinates, using conversion parameters.







9.4 Change Station Coordinates

This feature is useful in Basic-Rover RTK working mode. When you save a point with the rover, Cube-a always saves the coordinates of the point base. So, if the user needs to move the base to a different place, it's possible to use this function to calculate the coordinates of the saved points to keep the same length as the baselines.

Warning: The function is in BETA PREVIEW. It is not recommended to use it in real survey to avoid possible data loss.

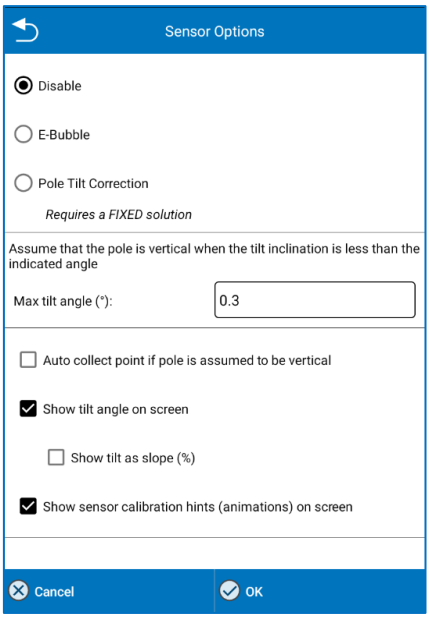
9.5 Sensor Options

The user can enable/disable the use of the electronic bubble/IMU following the configurations available on his receiver. To enable the electronic bubble/pole tilt correction, simply select the option and confirm. In the menu it's possible also to define the maximum limit angle within which to consider the vertical pole. So, this value will be the tolerance for the verticality of the pole during Survey.

The user can also set the automatic collection of points if the pole is assumed vertically with respect to the set limit.

It's possible to show the angle of the receiver inclinometer live during the Survey.

If the user prefers, there is an opportunity to show animations for IMU sensor initialization every time they lose calibration during the survey. Once the user is practical with the sensor, he can disable the option for the help of calibration.



9.6 Calibrate Sensor

The Sensor Calibrate page depends on the connected GNSS receiver.

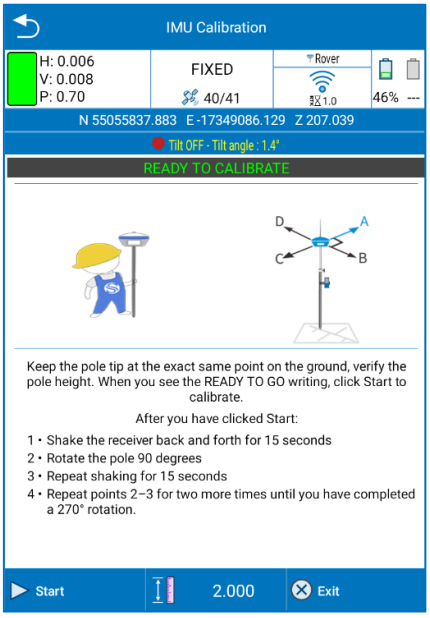
Stonex receivers equipped with new IMU technology

Follow the instructions shown to perform the calibration.

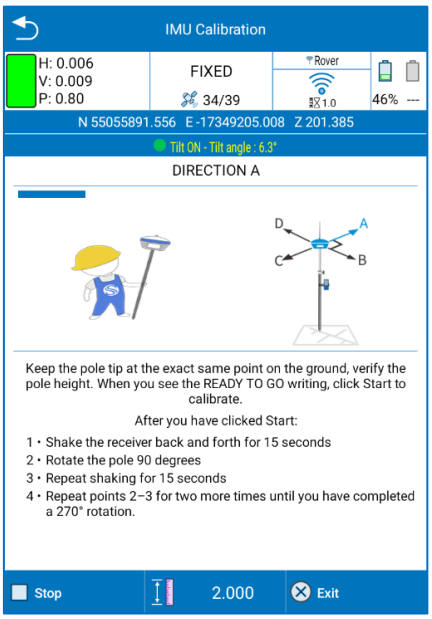
A fixed GNSS solution is mandatory for calibration.

Check the antenna height: an incorrect antenna height will make the calibration inaccurate.

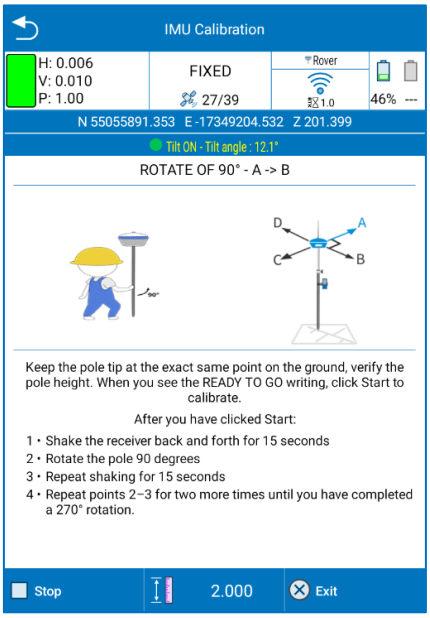
Once checked the parameters described above, select the Calibrate Sensor option. A screen like the one in the figure will open, then wait for the message “Ready to Calibrate”, start the calibration by clicking “Start”.



As shown in the following image, to calibrate the sensor correctly, the user must first choose an arbitrary direction as a reference (direction A), then start moving the receiver back and forth along that direction until a message appears asking you to change direction.

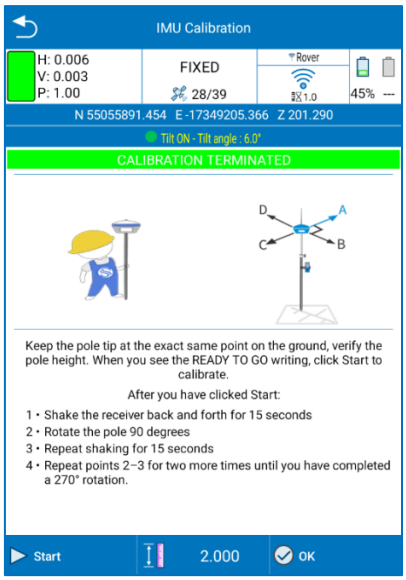


Then turn the receiver 90 degrees clockwise, reaching the direction A+90° = B, and continue moving back and forth in the device.



This operation must be repeated three times, then every 90 degrees up to a total of 270° clockwise.

After moving the device back and forth along the D direction, the message Calibration completed will be displayed.If calibration fails, an error message will be displayed. In this case check the conditions and repeat the calibration procedure.

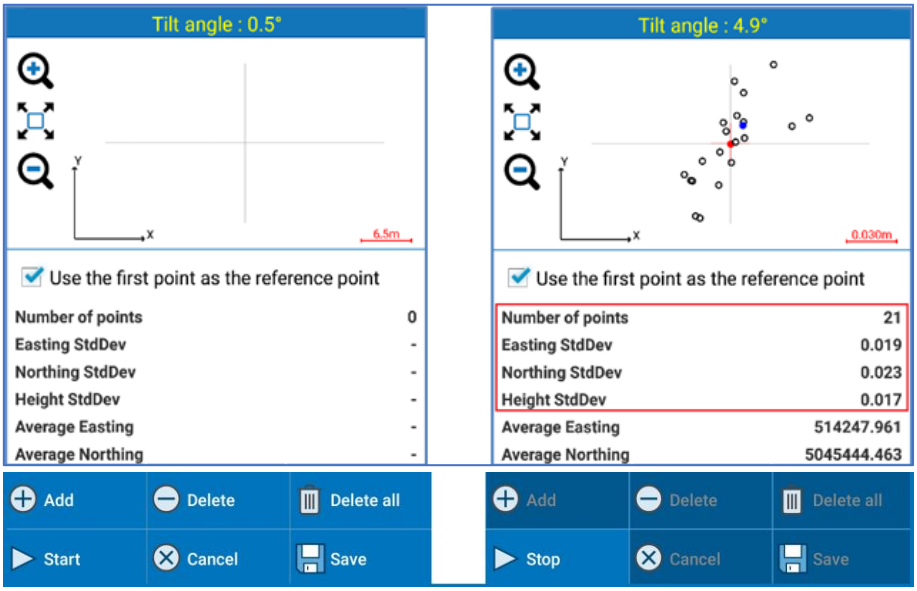


9.7 GPS Point Averaging

The user can check the accuracy of the inclinometer compensation by verifying the standard deviation. If the accuracy is good, it's possible to continue to work, otherwise calibrate the sensor through the Calibrate Sensor function. The Standard Deviation Test carries out the study of the quality/precision of repeated measurements (keeping the tip of the pole in the exact same position on the ground).

For using it, open the function and click "Start" to start the measurement collection.

The application collects points with an average frequency of 1Hz. The collected positions will be mediated, and the standard deviation will be calculated. At this point, the operator can choose to procedure with calibration or continue the survey.

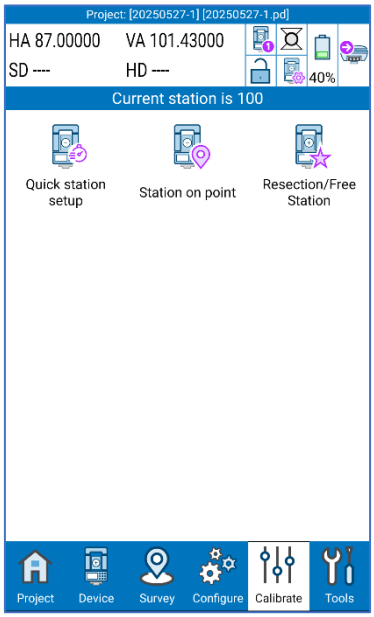


The user has control over the number of locations used in the calculation, and when he decides to end the control, he can press "Stop" to stop the automatic capture. As mentioned, if the evaluation leads to unsatisfactory values, procedures with sensor calibration are invited.

This is also suggested when changing the height or type of pole (it could be a change in the straightness of the pole).

10. Calibrate – TS Module

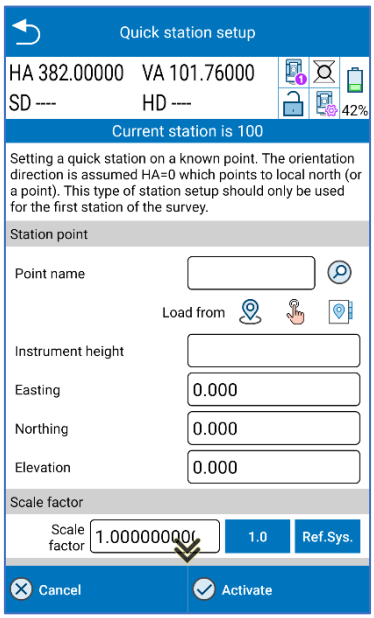
The *Calibrate* menu, in the TS mode, contains the function to define the base station on a point or as free station.



10.1 Quick station setup

Click Calibrate -> Quick Station Setup: the screen in the figure below will be shown.

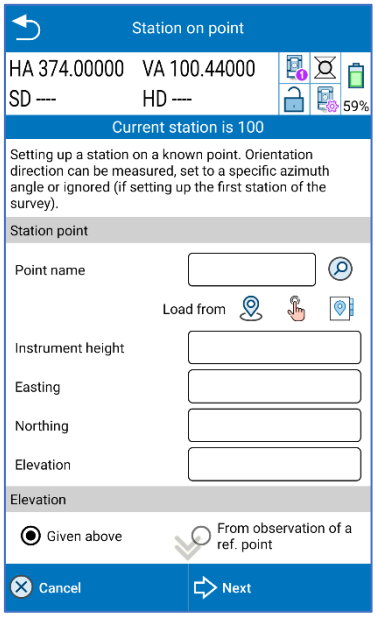
In this page the user can define the station position and its orientation. With this method the orientation direction is assumed HA = 0 which points to local north (or a point). See chapter 10.2 Station on point for a complete description of the options included in this page.



Note. This type of station setup should only be used for the first station of the survey.

10.2 Station on point

“Station on Point” function has to be used to define station position and orientation. Clicking Calibrate -> Station on Point: the screen in the figure below is shown.



In the first page the user has to insert the TS station position coordinates. Station point coordinates can be entered manually by filling in the *Est Nord* and *Elevation* boxes, or by using the following keys:

Measure with GNSS antenna (if available). By clicking on it, Cube-a collects GPS coordinates directly using topographic point mode.

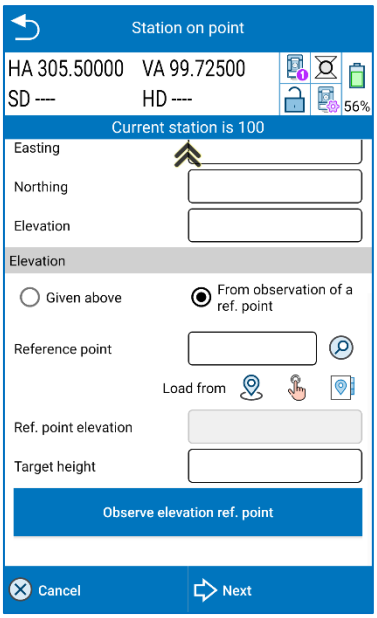
Select from the map including CAD entities

Select from the points list

Write the point name and click on it to search the point by name inside the Point library

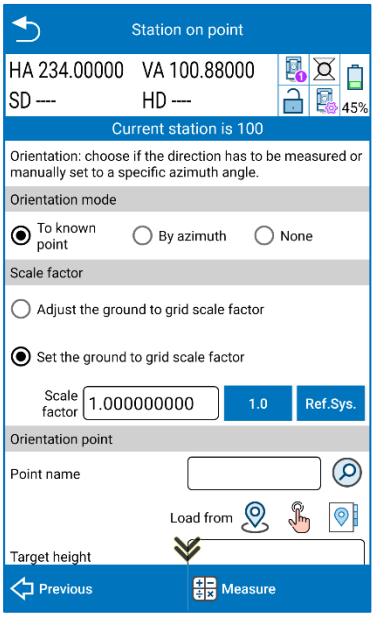
Use the left box next to the icons to change the station point name and enter the Instrument Height (Total Station Height).

The elevation can also be inserted as a measure to a reference point. Define the reference point in the same way as it was done for the station point and insert the height of the target, then measure it.



After inserting the coordinates of the TS, click on “Next”. On the next page, define which orientation mode you want to use:

- *To a known* point -> to orient the station to a point whose coordinates are known. Enter the coordinates of a point or measure or select it from the project (in the same way as defining the station point) and enter the height of the target.
- *By azimuth* -> allows the input of an orientation azimuth. Enter the reference angle with respect to North of the local system (not to be confused with the horizontal angle/azimuth read by the instrument).
- *None* -> do not consider the orientation. By default, Cube-a uses the horizontal angle of the station, without zeroing it or setting it to a certain value.

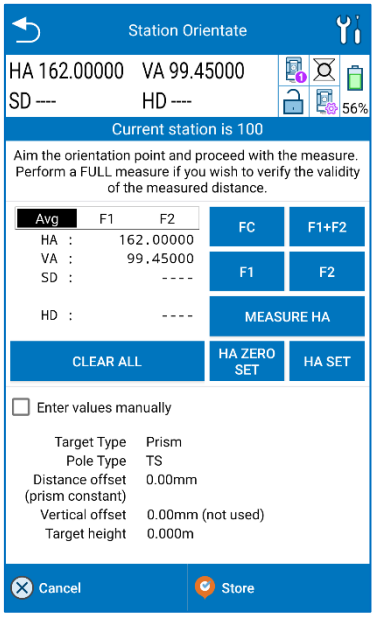


After selecting the orientation mode, the user has to define the scale factor of its reference system choosing between several options:

- *Button "1"* -> Set the scale factor equal to 1 to work in a local reference system with real distances (Cube-a sets it equal to 1 by default).
- *"Adjust the ground to grid scale factor" option* -> Flag this option to calculate the TS scale factor using scaled data (like GNSS data for example). Enable this option to be able to compare TS measurements with scaled data. (***Note***. This option is available only by selecting "To Known Point" as Orientation Mode).
- *Button "Ref. Sys."* -> Use this option to set the TS scale factor equal to the one of the project reference system. Enable this option to be able to compare TS measurements with scaled data.
- *Manual Insert* -> Set the TS scale factor manually. Enable this option to be able to compare TS measurements with scaled data.

If the user selects "None", click directly on Activate to complete the Station-by-Point procedure. Otherwise, in the other two cases, it's necessary to click Measure and collect the measurement of the orientation point. Click on "Measure" to measure the orientation point/direction.

- *HA=0 Set* -> sets the horizontal angle to 0 (the vertical angle will be automatically forced to 100 gon).
- *Set HA* -> sets the horizontal angle to a manually inserted value.
- Measure Button -> use FC, F1, F2, F1+F2 or MEASURE HA for measuring the point as described in 6.4 TS Survey



Click "OK", after measuring.

After the procedure, Cube-a asks for confirmation before activating the station on the defined point. Click on the "YES" to proceed.

Note. If the customer uses Orientation "to known point", after measuring the point, Cube-a display the difference between measured and theorical distance to give the possibility to the user to check it's orientation quality.

Station Position Changing

If the user needs to change the station position and orientate it on the previous one, he has to use “Station on Point” function, recalling the new station point as new station position and the old station point as orientation point.

10.3 Resection/Free Station

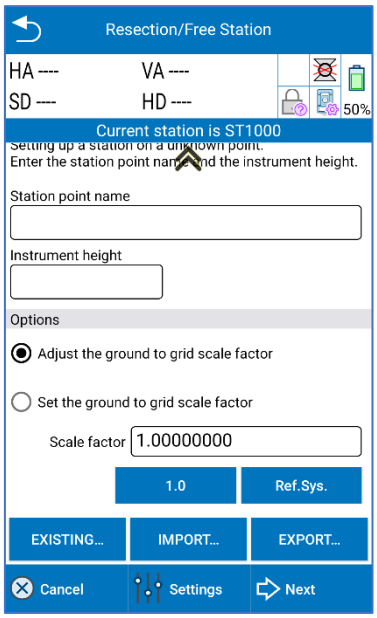
Resection/Free Station function can be used to calculate the position of a station on an unknown coordinate point.

Please note that the orientation/reference points should cover and be all around the stationing site. The location of the reference points limits the area where subsequent measures should be carried out, using the stationing. Point capture and/or stake out should never be performed outside this area. If measurements occur towards points outside the area, orientation errors will be extrapolated (maximized) rather than interpolated (reduced).

Click “Calibrate-> Free Station”: the screen in the figure below will be shown.

In this page the user has to set manually:

- Station Point Name
- instrument height
- Scale Factor. The user can set the scale factor in several ways, according to the user needs and the survey conditions:
    - Set the scale factor equal to 1 if you are using real-distances data for free station calculation.
    - Flag the option “Adjust the ground to grid scale factor” to calculate the TS scale factor when using scaled data (like GNSS data for example) for free station calculation. Enable this option to be able to compare TS measurements with scaled data.
    - Use the “Ref.Sys” option to set the TS scale factor equal to the one of the project reference system, when using scaled data (like GNSS data for example) for free station calculation. Enable this option to be able to compare TS measurements with scaled data.
    - Set the TS scale factor manually, when using scaled data (like GNSS data for example) for free station calculation. Enable this option to be able to compare TS measurements with scaled data.

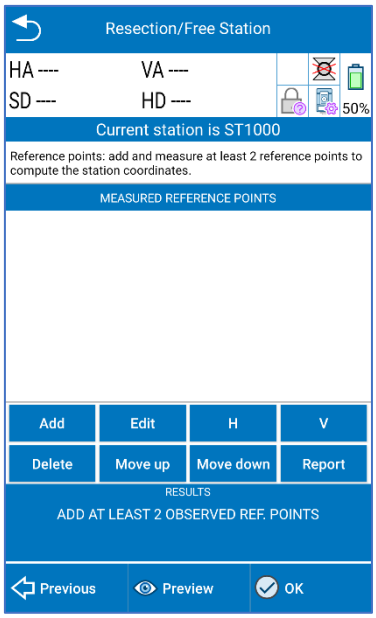


The “Import” and “Export” commands work with *.cr files, which store all stationing calculation, with the chosen points, station name, and each option entered performing this function. Click on “Existing” for review your free station calculation. Click on “Settings” to change the parameters of the free station calculation (use this option only if you are an expert user).

Click “Next” to enter and measure the points for the least squares calculation. Cube-a requires you to satisfy one of the following cases:

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

Insert the points to use for the free station calculation.



The coordinates of the point can be entered manually, either by filling in the East, Nord and Elevation box or by using the following keys:

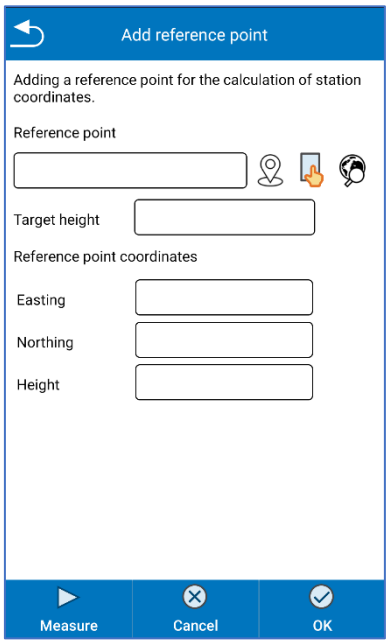
to measure with GNSS antenna (if available). By clicking on it, Cube-a collects GPS coordinates directly using topographic point mode.

to select from the map, including CAD entities

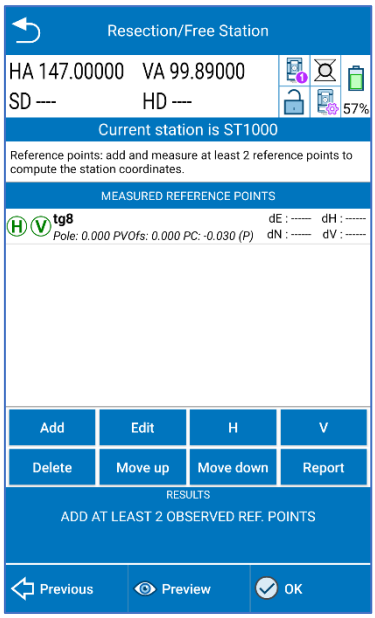
to select from the points list.

To change the name of the point, change the box to the left of the icons.

Insert the Prism Height (pole height) and click “Measure”.



In this page, the user has to aim the point previously inserted and measure it with the total station (see chapter 6.4 TS Survey for the description of the options available). After pressing “OK” the first observation is displayed in the list like in the image below.

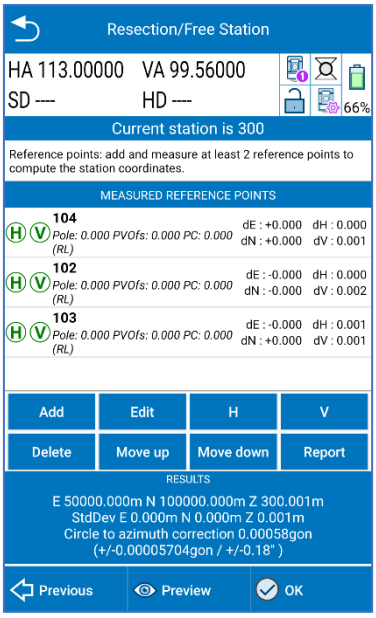


Continue with the addition of the next point(s), proceed in the same way.

Note 1. The free station calculation requires at least two points. With two points free station is important to order the points in the list in clockwise direction; if the points are listed in counterclockwise direction, the errors on the distance will be very high. In this condition the user has to click on “Move Up” or “Move Down” button to change their order and find the right solution.

Note 2. The order of the points in the list is not important when using more than 2 points.

Here below an example of free station results:



Before confirming the calculation, the user can see and check its results, analyzing different information:

- Points Measurement Quality Check
  - dE -> Residual (Measured-Known) on East coordinate
  - dN -> Residual (Measured-Known) on North coordinate
  - dH -> Residual (Measured-Known) on 2D distance
  - dV -> Residual (Measured-Known) on Height

- Free Station Quality Check
  - New Station Coordinates.
  - Standard Deviation on Free Station Calculation -> the estimation of the possible error on coordinates. They can be negative or positive values.
  - Circle to Azimuth Correction.
  - Scale Factor set or calculated.
  - Preview (for have as graphical preview of the free station calculation).

Use icons Ⓗ and Ⓥ to turn off Horizontal and/or Vertical reading and check if the quality of the result increases. The same command is carried out by H and V in the blue icons.

Click on “Edit” to modify a point and re-measure it or “Delete” to remove it.

Free Station with OnePole Solution

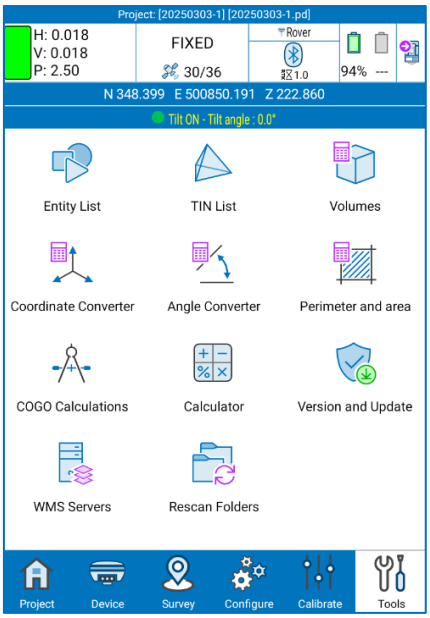
When working in OnePole Solution configuration, it’s necessary to set the GNSS and TS pole height properly. In OnePole configuration the GNSS is located above the prism.

When inserting the GNSS pole height, the user has to sum the pole height (visible on the pole graduated scale) to the prism height. For TS pole height refers to chapter 2.3 TS Control Panel.

After setting the pole height properly, the user can follow the same free station procedure described above.

11. Tools

The *Tools* menu contains many useful functions such as volume and COGO calculations and information about the version and personal license of the Cube-a software.

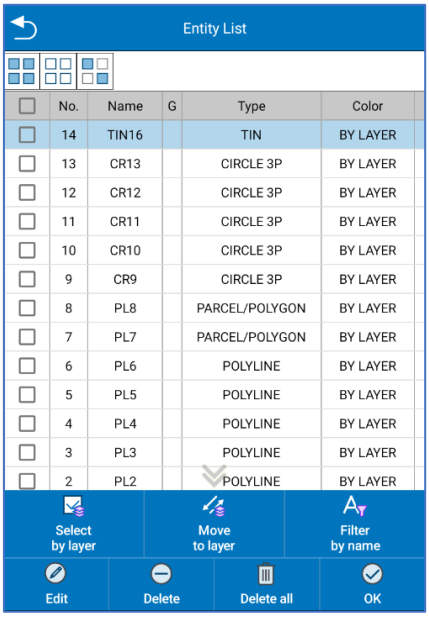


The *Calculator* submenu directly invokes the calculator within Cube-a software.

11.1 Entity List

The *Entity List* submenu contains the list of the CAD entities imported or created in Cube-a.

As visible in the following figure, the TIN are also CAD entity.



In this page the user can use different options:

- ***Select by layer***

  Select entities based on their layer

- ***Move to layer***

  Move selected entities to a different layer

- ***Filter by name***

  Filter entities based on their name (searches in layer name, code id or code name)

Select the entity and click “Edit” to edit one or more of the following properties:

- Name
- Code
- Layer
- Color
- Line type
- Make it closed or open (if you select a polygon)
- GIS data
- TIN properties (see 11.2 TIN List)

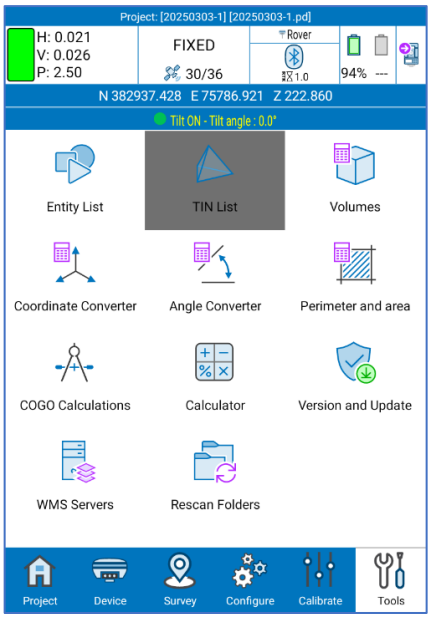
Select the entity and click “Delete” to delete definitively the entity selected or “Delete All” to delete all entities in the list.

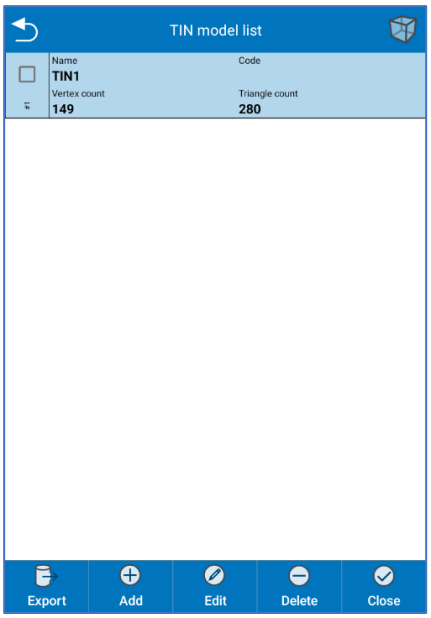
Click “OK” to exit the menu.

11.2 TIN List

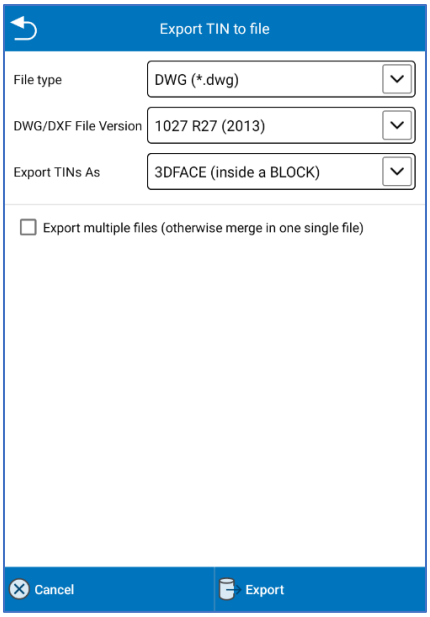
This page contains the list of the TIN (Triangulated Irregular Network). This feature is available with the module 3D only. Each TIN model in *TIN model list* corresponds to a TIN entity, that it’s visible in the survey area (***Note***. if the user deletes the TIN entity he deletes the TIN model also). In the TIN model list page click top right corner to switch 3D View  .

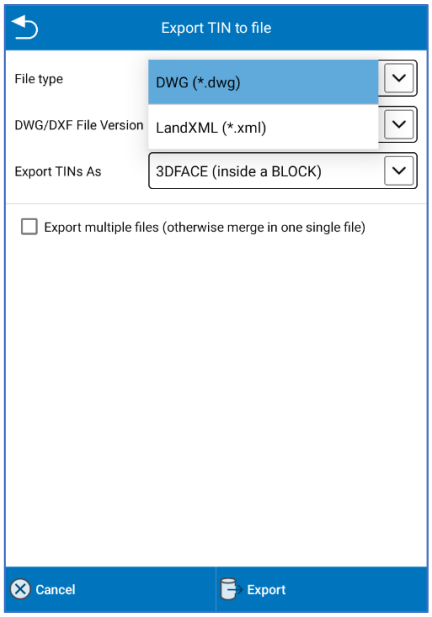
By the help of real-time calculation when a dynamic TIN is recomputed (in response to some change of the points/breaklines), the contour lines are also recomputed.

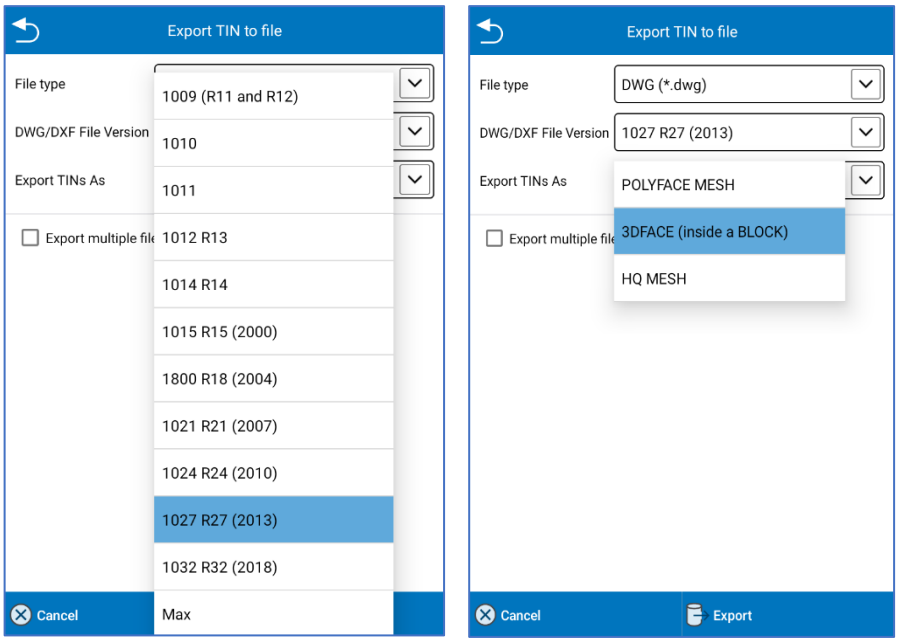




From the *TIN Model List* page, the user can export the TIN in .dwg or LandXML .xml file format. You must define the path and give the export a name.

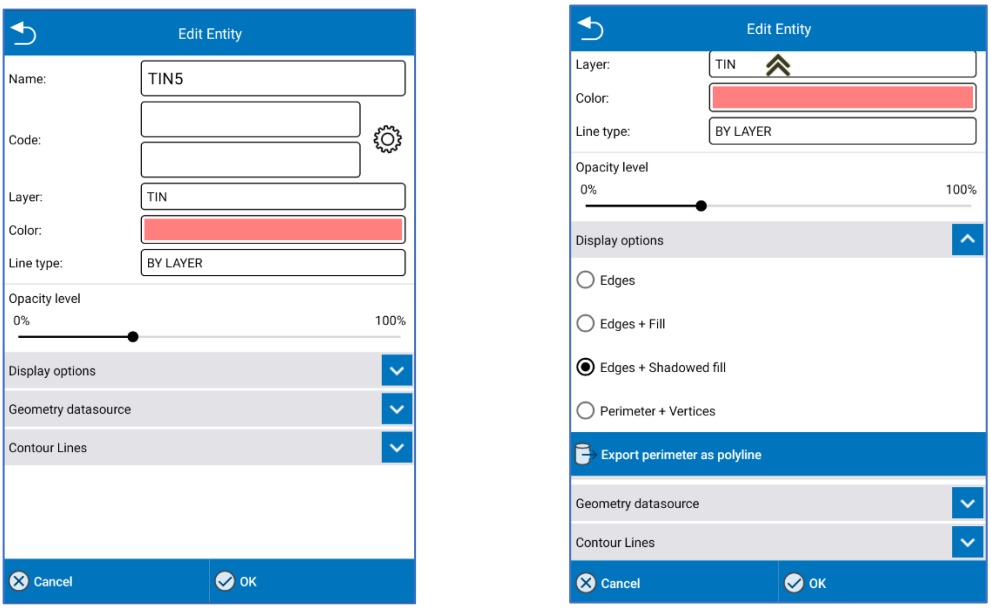






Select an existing TIN to edit its properties or to delete it.

Click “Add” to add a new TIN model; the following page appears.



In this page at the top, the user will see the section dedicated to name, code, layer, color and line type of the TIN. It is possible to select the opacity level between 0-100.

Display Options

In the “*Display Options*” section it is possible to select the display option as;

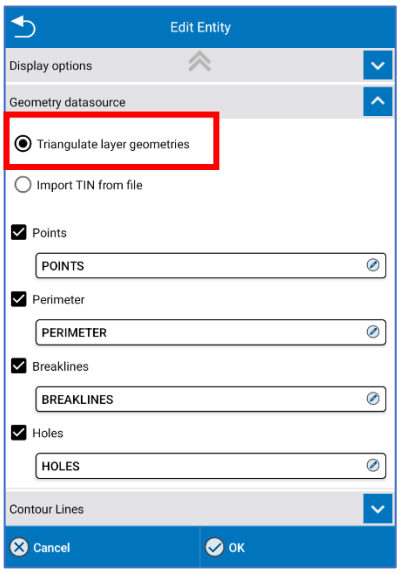
- Edges,
- Edges + Fill,
- Edges +Shadowed fill

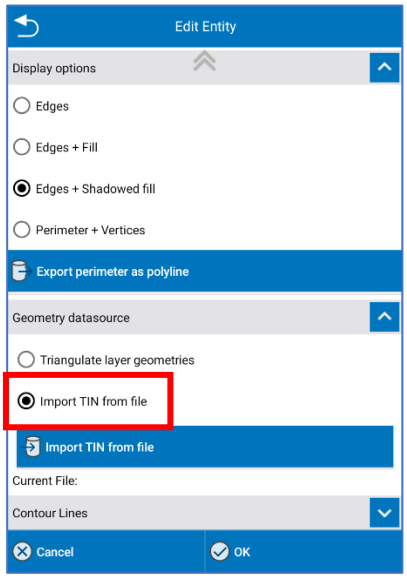
- Perimeter + Vertices

It is also possible to export perimeter as polyline.

Geometry Data Source

In the Geometry Data source section, the user has to define the source of this TIN file.





Option 1: Triangulating layer geometries

- Use this option to associate layers with the entities.

  All points in the layer *POINTS* will be automatically triangulated with TIN during the survey.

  All closed entities in the layer *PERIMETER* will be automatically used as perimeter for TIN during the survey.

  All lines in the layer *BREAKLINES* will be automatically used as break lines for TIN during the survey.

  All closed entities in the layer *HOLES* will be automatically used as exclusions for TIN during the survey.

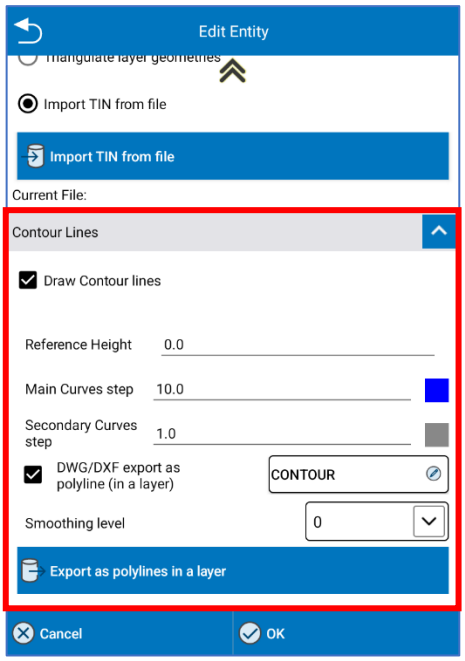
Option 2: Import TIN from file

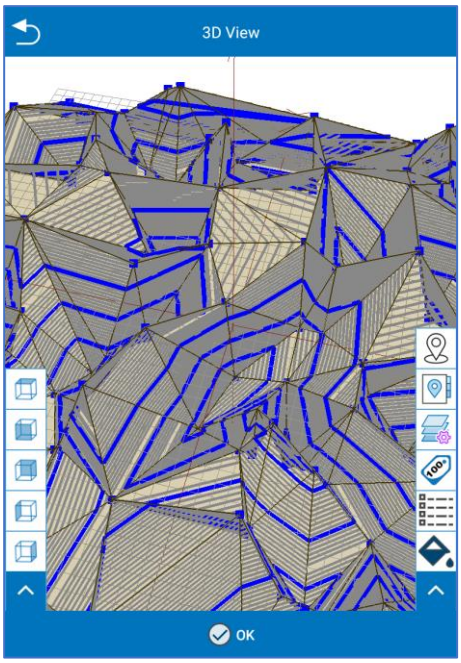
- Use this option to import the TIN file directly from file. The file format can be *.DXF, *.TTM, *.XML, *.DWG, *.OBJ, *.PLY.

Contour Lines

In the Contour Lines section, the user can draw the contour lines enabling the option “Draw Contour Lines”, define the Reference Height, Main Curves Step and Secondary Curves Step

Enable DWG/DXF export as polyline (in a layer) to export the contour lines. It is possible to define the layer and the smoothing level (between 0-4).



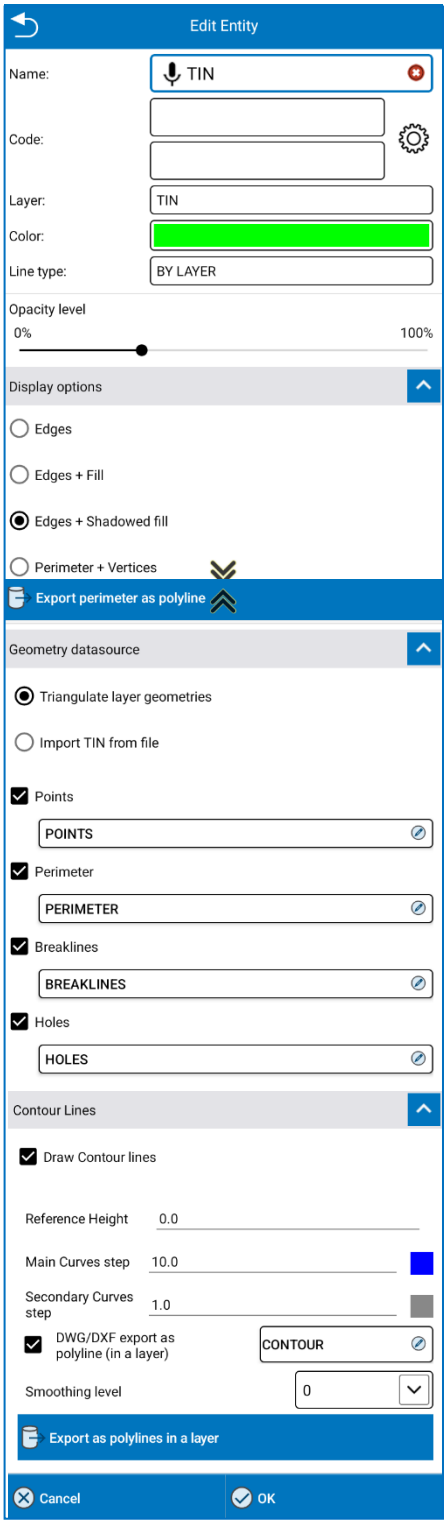


Contour lines can be optionally converted to real drawing entities and stored into a selectable CAD layer. If the user selects export as polylines in a layer, after defining the layer to export the polylines will be visible in the entity list.

Note. It's possible to edit all the properties, even for already existing TIN. They are dynamic so the user will see in the survey area the changes in real time.

In "Geometry data source", it's possible to choose layer for points, perimeter, break lines and holes to triangulate automatically.

It's possible even leave all these options off. In this case, the TIN will only be drawn when selecting the TIN entity in the Survey area. See the examples below.

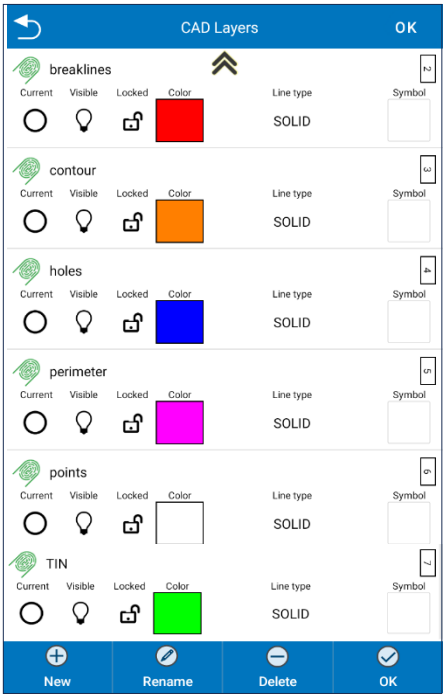


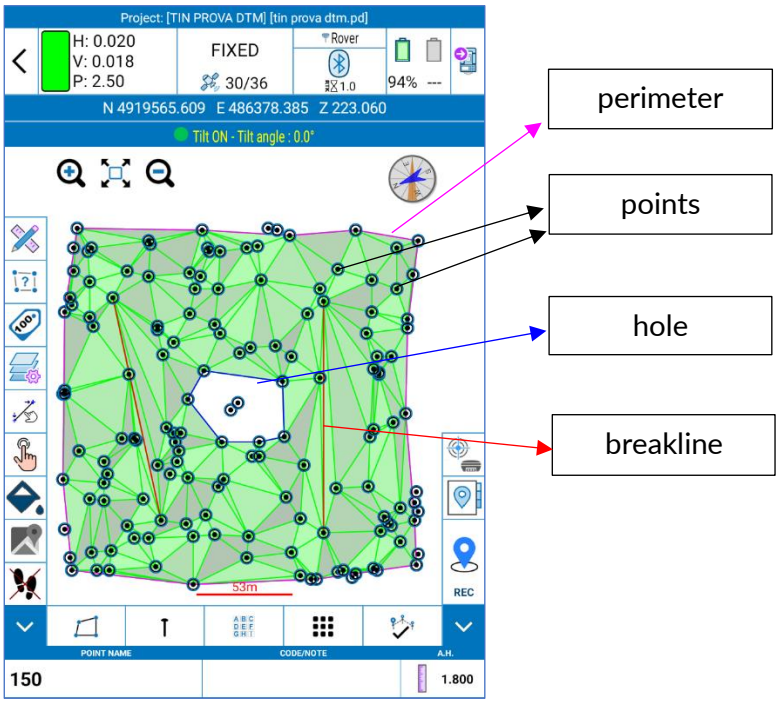
Example 1

The TIN1 will be drawing in the layer tin1, green.

- All points in the layer POINTS1 will be automatically triangulated with TIN1 during the survey.
- All closed entities in the layer PERIMETER1 will be automatically used as perimeter for TIN1 during the survey.
- All lines in the layer BREAKLINES will be automatically used as breaklines for TIN1 during the survey.
- All closed entities in the layer HOLES1 will be automatically used as exclusions for TIN1 during the survey.

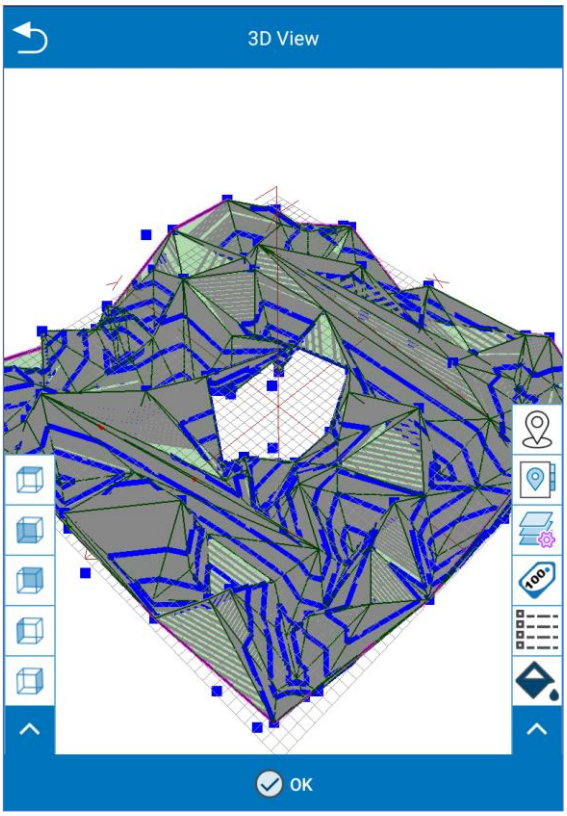
Below the layers settings and the TIN entity.

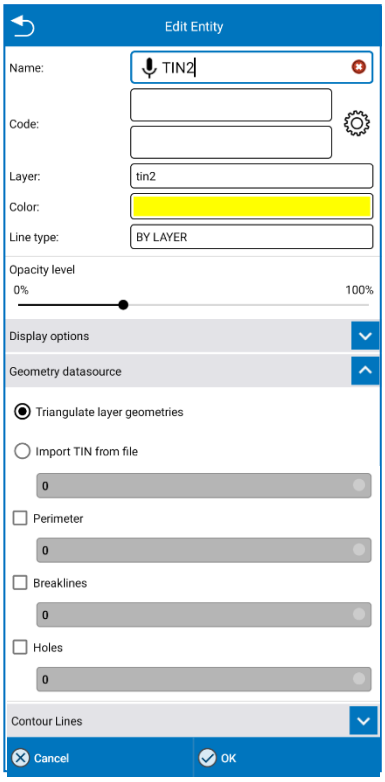




You can collect points or entities, and the software automatically creates the TIN when the points or entities belong to the layers you have chosen in *Geometry data source*.

If we enable "Draw Contour Lines" on the Edit TIN page, this Tin will be visible in the 3D View page like this:





Example 2

The TIN2 will be drawing in the layer tin2, yellow.

The TIN2 will not be automatically drawing during the survey because there are not layers to triangulate enabled, in the *Layers to triangulate* section.

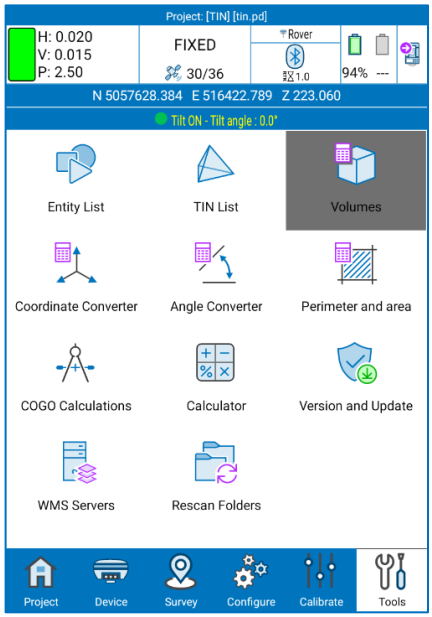
To draw the TIN2 you must select TIN entity in the Survey area. Only if the TIN entity drawing is enabled, the collected point will be triangulated.

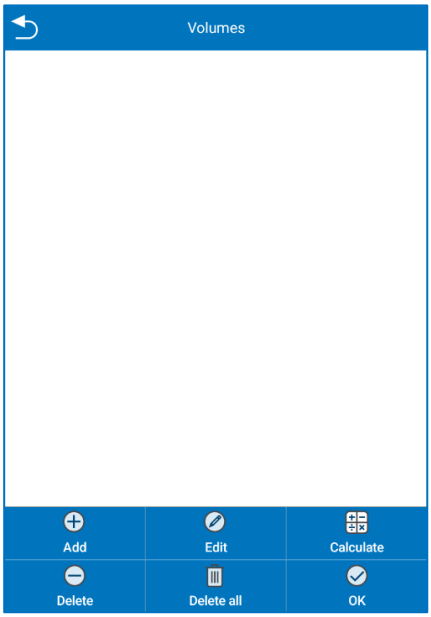
Below are shown
- TIN entity function enabled
- TIN2 with edges + shadowed fill
- TIN2 with only edges

11.3 Volumes

This page contains the list of the volumes defined by the user. He can see the cut and fill volume and the 2D and 3D area for each volume, updated in real time. The user can perform the volume calculation TIN vs TIN or TIN vs inclined plane. This feature is available with the module 3D only.

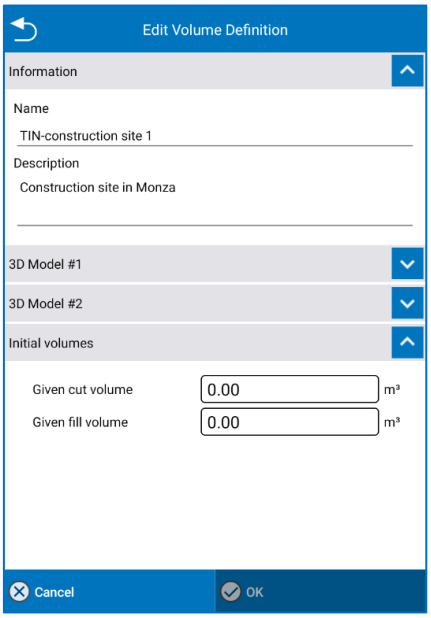
- The various 3D faces (triangles) are compared two by two, intersected to create smaller triangles.
- The volumes between those small triangles are calculated.
- The calculated volumes are added to the cut/removal or fill/addition volume accumulators based on the relative heights of the base faces of the corresponding prismoid solid



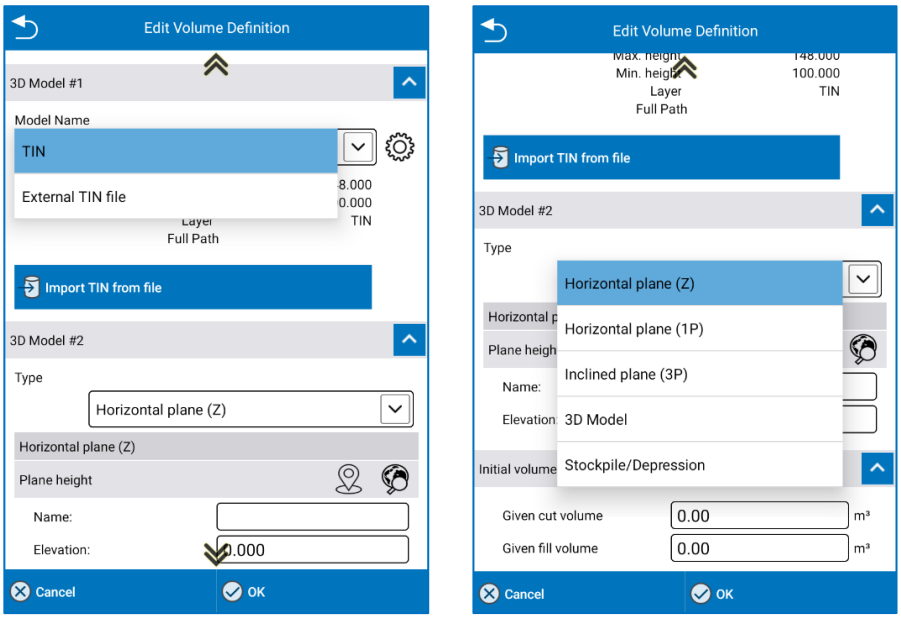


In the *Volumes* page, you can select an existing Volume to edit its properties or to delete it.

Click *Add* to add a new Volume; the following page appears.



The user has to insert a name for the volume that is going to define, and can insert a description (e.g., to remind the reason of the volume calculation).



In the *Edit Volume Definition* page, Cube-a asks the user to define:

3D Model #1

It can be an existing TIN model in Cube-a or imported as an external TIN in *.DXF, *.TTM, *.XML, *.DWG, *.OBJ, *.PLY file formats. While importing the external TIN, the user can preview the file.

3D Model #2 can be

- Horizontal plane (z):
  Define the horizontal plane by Z value. Insert the Z value in the *Elevation* field or take from current GPS coordinates by clicking on REC button or take from a point in the library by clicking on search button.

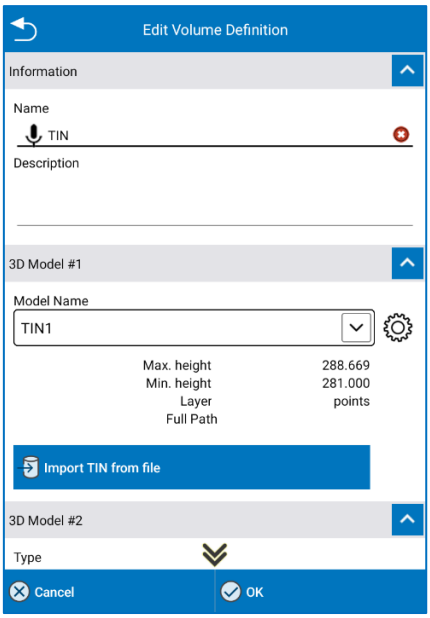
- Horizontal plane (1P):
  Define the horizontal plane by one point. Same as the previous option, but the application will also store the other 2 coordinates (Easting, Northing) for reference.
  Insert the point coordinates or take from current GPS coordinates by clicking on REC button or take from a point in the library by clicking on searching button

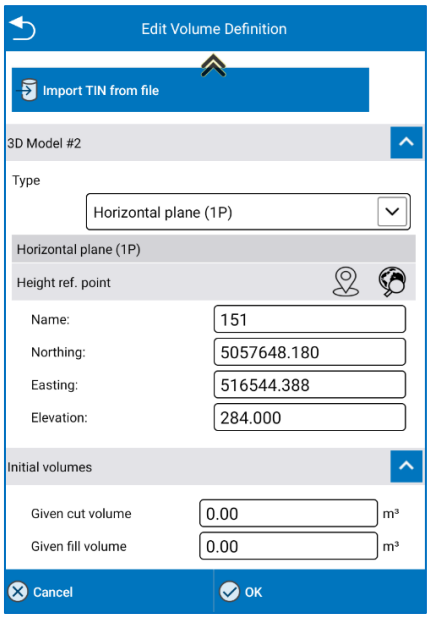
- Inclined plane (3Points): Define reference point 1, 2 and 3 to have an inclined plane
  Define the inclined plane by 3 points. Insert the points coordinates or take from current GPS coordinates by clicking on REC button or take from a point in the library by clicking on search button.

- 3D Model: Import TIN in Cube-a from an external file or use existing TIN.

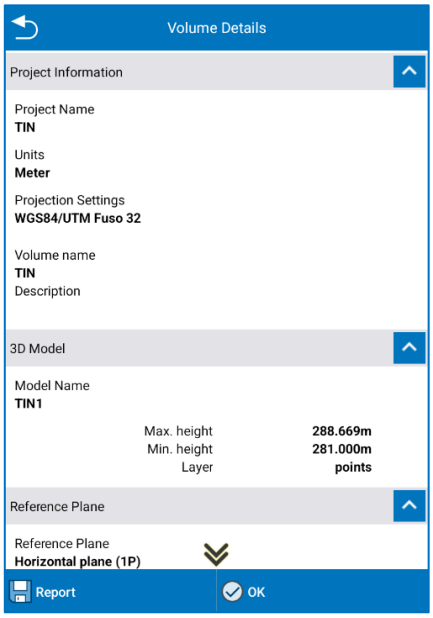
- Stockpile/Depression: Insert Given Cut volume/Given fill volume.

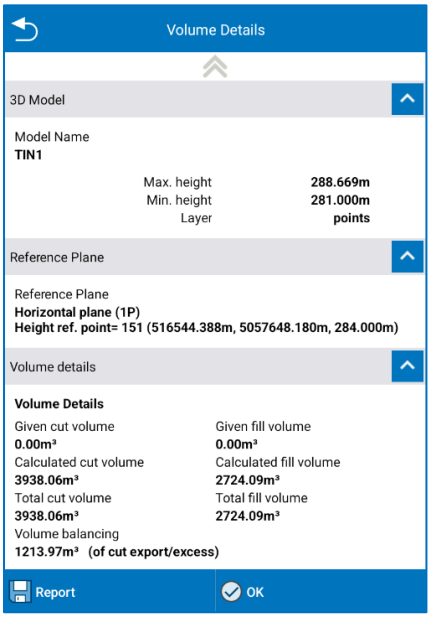
See 11.2 TIN List





Click “OK” and then on “Calculate” to calculate the Volume.

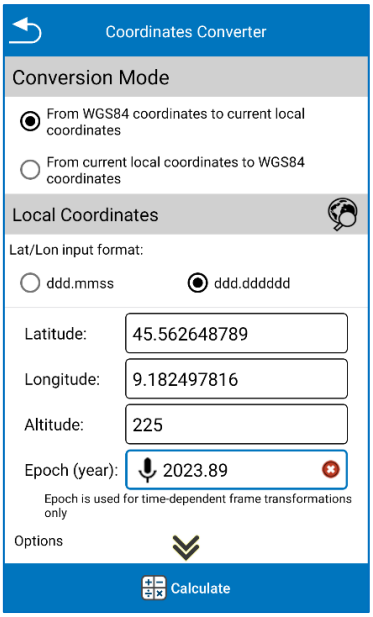


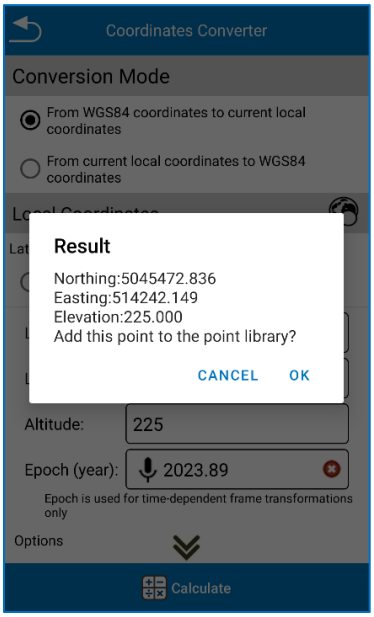


Click on “Report” to export the report in *.TXT format.

11.4 Coordinate Converter

The user can convert local coordinates to WGS84 geodetic coordinates and vice versa. Choose the conversion mode at the top and insert the coordinates in the section below in the format chosen. The section below depends on the conversion mode selected. It is possible to insert the coordinates manually, or to choose the point from the library by clicking the search icon (globe with lens) on the right. Once converted coordinates, there is the possibility to save the point in the points library.





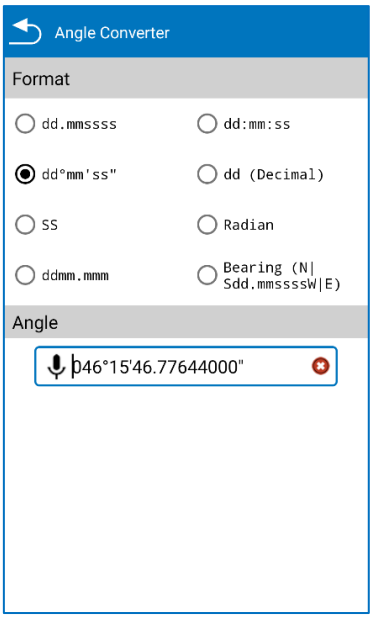
11.5 Angle Converter

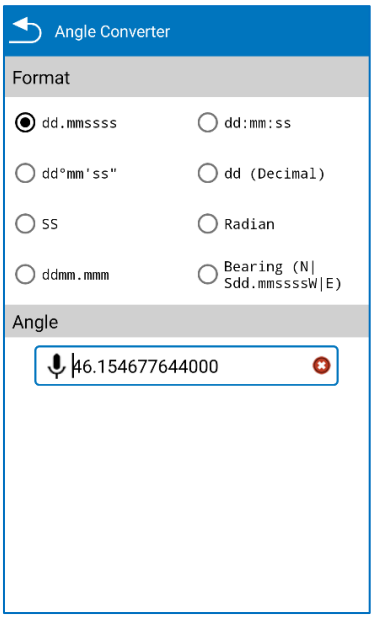
There is the possibility to perform a conversion between different angle formats. Below, the procedure:

a) Select the angle input format.
b) Insert the angle value.
c) Select the format in which you want to convert.

The value entered will be automatically replaced by the angle value in the new format chosen.

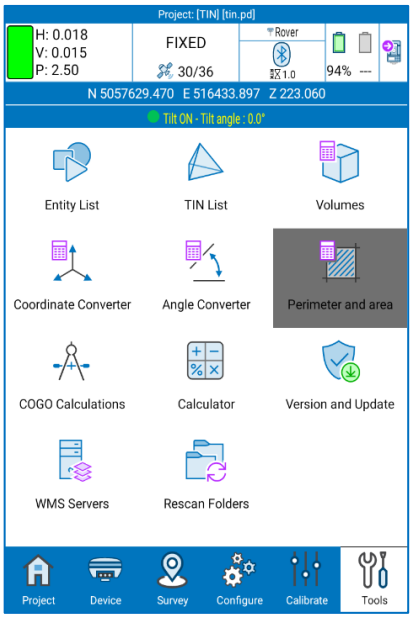
In the example, the angle inserted is 45°33’45.449604” in dd°mm’ss”, the result converted to dd.mmssss is shown in the figure on the right.

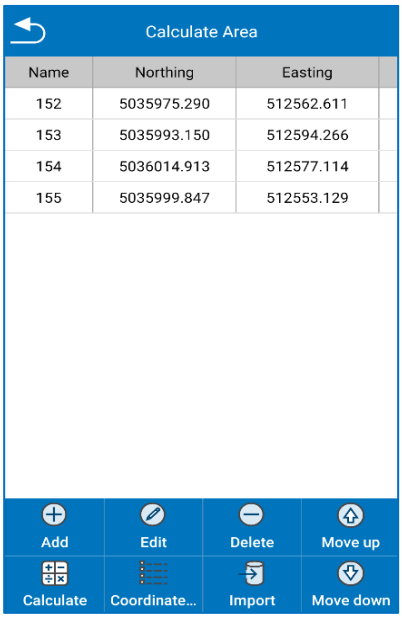




11.6 Perimeter and Area

It is possible to calculate the area and perimeter of entities obtained with certain points.





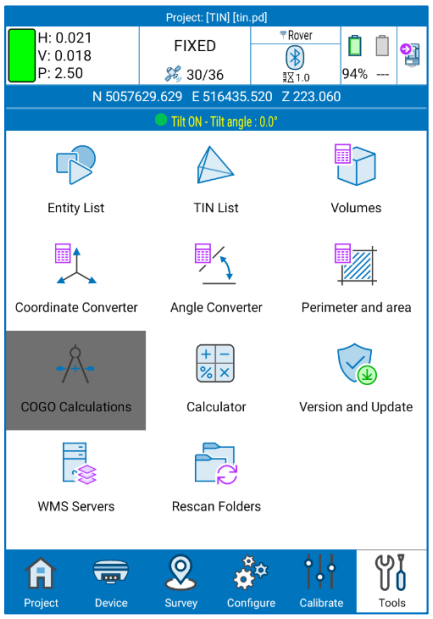
Define the entity vertices and click “Coordinate list” to access to the existing point list. Click “Add” to insert manually the coordinates, to select the points from survey area (“Hand” icon), to take the coordinates from GNSS receiver (REC icon) or select the points from the point library (“Search” icon). Click “Import” to take coordinates from an external file (*.csv, *.dat, *.txt).

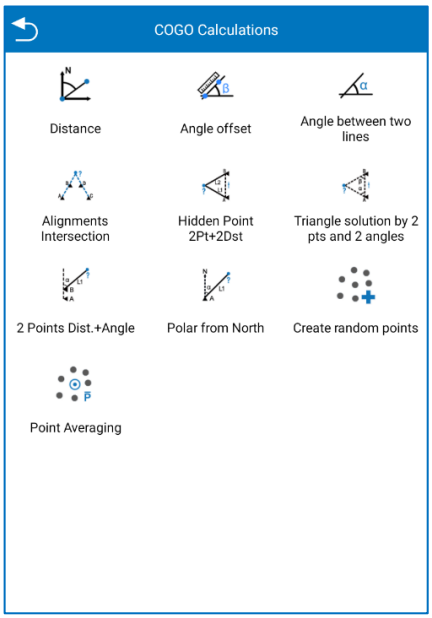
Once the points are added, the user can see them in the “Calculate Area” window and also change the order of the vertices with the commands “Move Up” and “Move Down”.

Click “Calculate” to perform the calculation; is not possible to save the results.

11.7 COGO Calculations

In the COGO Calculations page, the user can find various geometric calculations. Within each command, at the top, there is a brief description of what to insert to perform the calculation and what is the result.





Distance

Given 2 points (a and B), calculates the distance between the points.

Angle offset

Three known coordinates A, B and C. Calculates offset of A and B based on C.

Angle between two lines

Calculates the angle between two straight lines passing through the points A-B and C-D.

Alignments Intersection

Given the coordinates of points A, B, C and D, calculates the coordinates of the intersection point of the lines A-B and C-D.

Hidden Point 2Pt+2Dst

Given the coordinates of points A and B, distances L1 and L2: calculates the coordinates of the unknown vertex of the resulting triangle.

Triangle solution by 2 pts and 2 angles

Given the coordinates of points A and B, two angles α, β. Calculates points coordinates in chart.

2 Points Dist.+Angle

Given the coordinates of points A and B, angle α, length L1. Calculates point coordinates in chart.

Polar from North

Given the coordinates of point A, angle α, length L1. Calculates point coordinates in chart.

Create random points

Create randomly distributed points in various ways.

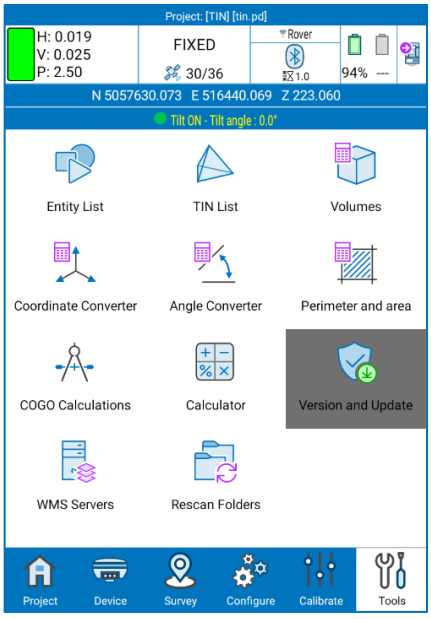
Point Averaging

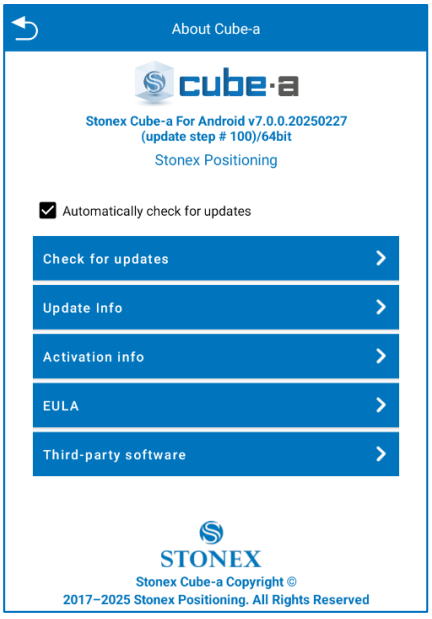
Performs point averaging

11.8 Version and Update

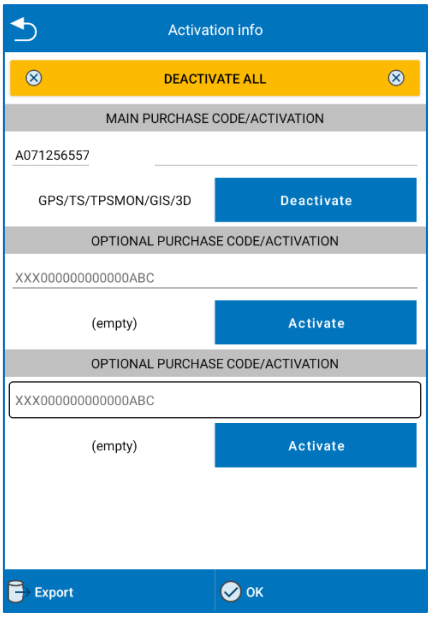
In this page you can read at the top the current version of the Cube-a installed on the device. Below, there are four keys.

- *Check for updates*: search for updates (internet connection is required); if a new version is available, a window will suggest downloading and installing the latest version if you click *Info*, you can see the update log before installing the update.
- *Update info*: history of all releases with their respective bug fixes and implementations. Click *Search* to search by key word.
- *Activation info:* information about your personal license.
- *EULA*: End User License Agreement.





By clicking *Activation info*, the user can enter the following page. Here he can read its own Cube-a license and the active modules (GPS/TS/GIS/3D).



Click “Export” below on the left to save your license in a txt file.

Click “Deactivate” to cancel the license. Export or copy the license before deactivation.

Warning: the user can deactivate and register the purchased license on different hardware at most three times. he cannot deactivate and register a demo license on a different hardware.

11.9 WMS Server

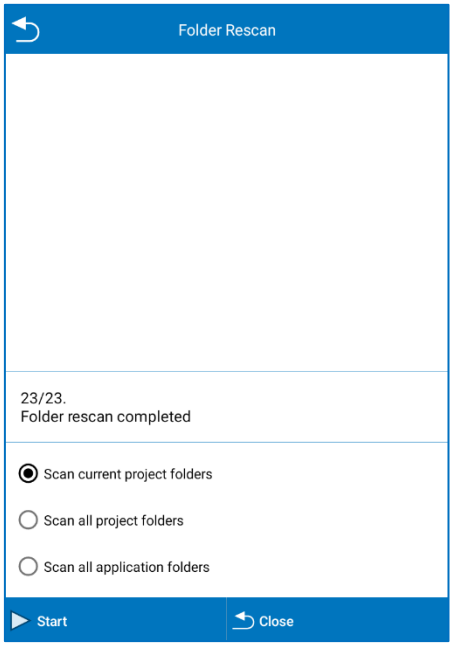
From Cube-a, using the function WMS Servers (World Map Service Servers), it is possible to select one of the available WMS by filtering as a country or by searching a keyword. It is possible to select the layers to be visualized in the survey area.

If desired, the user can also import the WMS file in .xml format by clicking Import. See also Background map

7.3 Background Map

11.10 Rescan Folders

If you have problems viewing (to your PC) the Cube-a folders or files, or a particular project, you can force a scan of the current project folders, of all projects folders or of all Cube-a folders. Click *Start* to start the process.

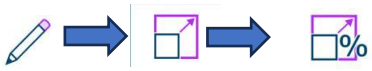


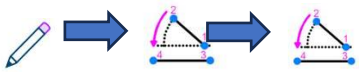
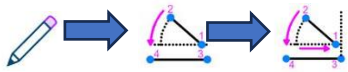
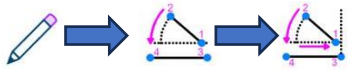
12. Appendix A – CAD Tools

Function	Icons	Operating sequence
Multi selection from area		Move the cursor over a vertex of the Entity bounding box and press [v]. "Move the cursor to the opposite vertex of the Entity bounding box and press [v]. If the second Vertex is to the right of the first Vertex (blue box), the Entities included entirely in the selection pane will be selected. If the second Vertex is to the left of the first Vertex (green box), the Entities included even partially in the selection pane will be selected." Then the MultiSelEach command (soon below) is automatically activated to allow you to add or remove individual Entities from the current selection. To end the selection command, move the cursor to an empty area and press [v].
Multi selection from entities selection		Move the cursor over each Entity to select and press [+] to add it or [-] to remove it. To end the selection command, move the cursor to an empty area and press [v].
Multi selection from list		The list of Entities in the current Project is displayed. Indicate the Entity to select and press the OK button
Cancel selection		Selecting this command will remove each selection.
Move points		Move the cursor to each Point you want to move and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the first reference point and press [v] or [+].

		Move the cursor to the second reference point and press [v] or [+]. In the following dialog, confirm/change the Offset of Moving Points and press [v] to accept or [x] to cancel the command. Finally you can see the Moved Points. Press [v] to end the command.
Move entities		Move the cursor over each Entity you want to rotate and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the first reference point and press [v] or [+]. Move the cursor to the second reference point and press [v] or [+]. In the following dialog, confirm/change the dot displacement offset and press [v] to accept or [x] to cancel the command. Finally you can see the Moved Points. Press [v] to end the command.
Points rotate		Move the cursor to each Point you want to move and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the center point of rotation (corner vertex) and press [v] or [+]. Move the cursor to another point on the initial witness line for rotation (first side of the corner) and press [v] or [+]. Move the cursor to another point on the final witness line for rotation (second side of the corner) and press [v] or [+]. In the following dialog, confirm/change the angle of rotation of the Points and press [v] to accept or [x] to cancel the command. Finally you can see the Moved Points. Press [v] to end the command.

Entities rotate		Move the cursor over each Entity you want to move and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the center point of rotation (corner vertex) and press [v] or [+]. Move the cursor to another point on the initial witness line for rotation (first side of the corner) and press [v] or [+]. Move the cursor to another point on the final witness line for rotation (second side of the corner) and press [v] or [+]. In the following dialog, confirm/change the angle of rotation of the Entities and press [v] to accept or [x] to cancel the command. Finally you can see the Moved Entities. Press [v] to end the command.
Entities cut		Move the cursor and indicate a first point of the cutting line and press [v] or [+]. Move the cursor and point to a second point in the cutting line and press [v] or [+]. Move the cursor over each Entity to be dissected and press [+] (to renew it press [-]). Move the cursor to an empty area and press [v] to end the selection. Finally, you can see the result of the operation and the number of New Entities created. Press [v] to end the command.
Scale entities using a reference line of another object		Move the cursor over each Entity you want to scale and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to finish the selection. Move the cursor to one of the Vertices of the Entities to be scaled to select a reference segment and press [v]. Move the cursor to a second Vertex of the Entities to be scaled to finish selecting the reference segment and press [v].

		Move the cursor to a segment vertex that represents the new length of the reference segment above and press [v]. Move the cursor to the second vertex of the segment that represents the new length of the reference segment previously indicated and press [v]. Finally you can see the result of the Scala operation. Press [v] to end the command.
Scale entities changing the length of the baseline		Move the cursor over each Entity you want to scale and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to one of the Vertices of the Entities to be scaled to select a reference segment and press [v]. Move the cursor to a second Vertex of the Entities to be scaled to finish selecting the reference segment and press [v]. In the following dialog, enter the new distance to be taken by the previously selected segment and press OK. Finally you can see the result of the Scala operation. Press [v] to end the command.
Scale entities by the percentage of the baseline		Move the cursor over each Entity you want to scale and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the Point that will be the Reference Base Point to scale the selected Entities and press [v]. In the following dialog, enter the new scale for the selected Entities and press OK. Finally you can see the result of the Scala operation. Press [v] to end the command.

Align entities		Move the cursor over each Entity you want to align and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the Point that will be the Reference Base Point for the rotation of the selected Entities and press [v]. Move the cursor to a second Point to indicate the segment to be made parallel to the witness line that will be selected later and press [v]. Move the cursor to a first point on the witness line to which to align the selected Entities and press [v]. Move the cursor to a second point on the witness line to which to align the selected Entities and press [v]. Infine è possibile vedere il risultato dell'operazione di Allineamento. Premere [v] per terminare il comando.
Align entities and base point		Move the cursor over each Entity you want to align and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the Point that will be the Reference Base Point for the rotation of the selected Entities and press [v]. Move the cursor to a second Point to indicate the segment to be made parallel to the witness line that will be selected later and press [v]. Move the cursor to a first point on the witness line to which to align the selected Entities and press [v]. Move the cursor to a second point on the witness line to which to align the selected Entities and press [v]. Finally, you can see the result of the Alignment operation. Press [v] to end the command.
Align and overlap entities		Move the cursor over each Entity you want to align and press [+] to select it. Press [-] to deselect it.

		Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the Point that will be the Reference Base Point for the rotation of the selected Entities and press [v]. Move the cursor to a second Point to indicate the segment to be made parallel to the witness line that will be selected later and press [v]. Move the cursor to a first point on the witness line to which to align the selected Entities and press [v]. Move the cursor to a second point on the witness line to which to align the selected Entities and press [v]. Finally, you can see the result of the Alignment operation. Press [v] to end the command.
Entity offset		Move the cursor over the Reference Entity from which to create the Offsets and press [v]. Move the cursor to the side where you want to create the new Offset Entities and to the distance that will indicate the step between the new Entities and press [v]. In the following dialog, confirm/modify respectively the distance between the new Entities, the Δ dimension and the number of new Entities to be created and press [v]. Finally, you can see the result of the Offset operation. Press [v] to end the command.
New points along a parallel line, from offset and step		Move the cursor to indicate the first point on the witness line and press [v] or [+]. Move the cursor to indicate the second point on the witness line and press [v] or [+]. Move the cursor to indicate the location of the first point in the series to be created and press [v] or [+]. In the following dialog, confirm/modify the Square and Distance values of the first point to be created and press [v]. Move the cursor to indicate direction and pitch of the new Points to be created and press [v].

		In the following dialog, confirm/edit Step, Δ Quota and Number of new Points to create and press [v]. Finally, you can see the result of the Point Offset operation along a parallel. Press [v] to end the command.
New points from angle and offset		Move the cursor to indicate the first point on the witness line and press [v] or [+]. Move the cursor to indicate the second point on the witness line and press [v] or [+]. In the following dialog, enter Angle, Distance, Square, and Δ Dimension of the new Point and press [v]. Finally you can see the result of the Operation of Offset Point from Angle-Distance-Square. Press [v] to end the command.
Entity spacing		Move the cursor over each Entity you want to Translate and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the first reference point to calculate the new distance and press [v] or [+]. Move the cursor to the second reference point to calculate the new distance and press [v] or [+]. In the following dialog, confirm/modify the new distance between the 2 points to translate the selected Entities along the indicated direction and press [v]. Finally you can see the result of the Translation operation. Press [v] to end the command.
Entities mirror		Move the cursor over each Entity from Mirror and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. Move the cursor to the first Reference Point of the mirror line and press [v] or [+]. Move the cursor to the second Reference Point of the mirror line and press [v] or [+].

		Finally you can see the result of the Mirror operation. Press [v] to end the command.
Extend entities		Move the cursor over the Line that identifies the extension limit of the ends of the selected Entities and press [v]. Move the cursor over each Entity whose ends you want to extend and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to finish selecting Entities and execute the command. Finally you can see the result of the Extension operation. Press [v] to end the command.
Insert vertex		Move the cursor to the side of the Polyline where you want to add the new Vertex and press [v]. Move the cursor to the point where you want to insert the new Vertex and press [v] or [+]. In the following dialog, confirm/change the coordinates of the new Vertex and press [v]. Finally, you can see the result of the Vertex Insertion operation. Press [v] to end the command.
Delete vertex		Move the cursor to the Vertex of the Polyline to be deleted and press [-]. Finally you can see the result of the Summit Erase operation. Press [v] to end the command.
Move vertex		Move the cursor to the Vertex of the Polyline you want to move and press [v]. Move the cursor to the new position where you want to move the Vertex and press [v] or [+]. In the following dialog, confirm/change the new summit coordinates and press [v]. Finally, you can see the result of the Vertex Shift operation. Press [v] to end the command.
Copy entities		Move the cursor over each Entity you want to copy and press [+] to select it. Move the cursor to an empty area and press [v] to end the selection.

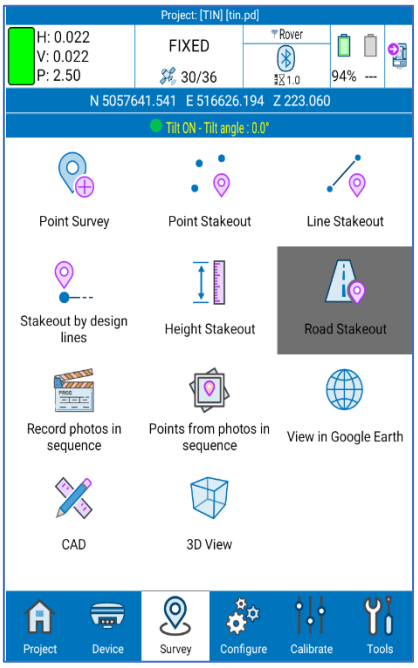
		Move the cursor to the first reference point and press [v] or [+]. Move the cursor to the second reference point and press [v] or [+]. In the following dialog, confirm/modify the placement offset of the newly copied Entities and press [v] to accept or [x] to cancel the command. Finally you can see the copied Entities. Press [v] to end the command.
Move entities on a different layer		Move the cursor over each Entity you want to Move and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. In the following dialog, indicate the new Layer where to move the selected Entities and press [OK]. Finally you can see the Moved Entities. Press [v] to end the command.
Delete entities		Move the cursor over each Entity you want to Erase and press [+] to select it. Press [-] to deselect it. Move the cursor to an empty area and press [v] to end the selection. The following dialog prompts you to confirm the deletion operation of the selected Entities by pressing [v] to confirm or [x] to cancel. Finally you can see the result. Press [v] to end the command.
Measure distance		Move the cursor to indicate the first point of the segment to be measured and press [v] or [+]. Move the cursor to indicate the second point of the segment to be measured and press [v] or [+]. Finally you can see on the status bar the size of the Segment. Press [v] to end the command.
Measure angle		Move the cursor to indicate the vertex of the Angle to be measured and press [v] or [+].

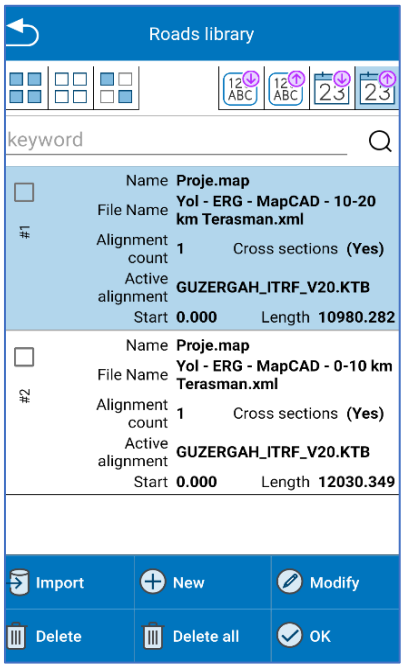
		Move the cursor to indicate a point on the first side of the Angle to be measured and press [v] or [+]. Move the cursor to indicate a point on the second side of the Angle to be measured and press [v] or [+]. Finally you can see on the status bar the size of the Angle. Press [v] to end the command.

For the details, please go CAD Section- Contextual Help See 6.16 CAD.

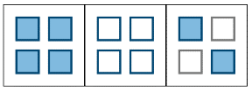
13. Appendix B – Road Stakeout

It's possible to stakeout roads and, in general, geometries composed of straights, arches, clothoids and parables, from Cube-a version 6.1. Click *Road Stakeout* to access the road library. If you have already selected a file from road library, then the road stakeout page will open as soon as you click Road Stakeout submenu; in this case, click  to access the road library.

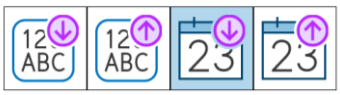




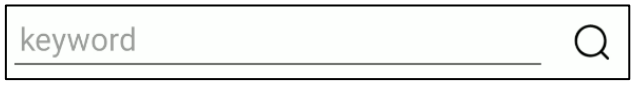
You can select or clear multiple roads at the same time and reverse selections using the selection icon in the upper left.



All roads can be sorted by name or acquisition date using the following icons in the upper right.



You can search the road by keyword.



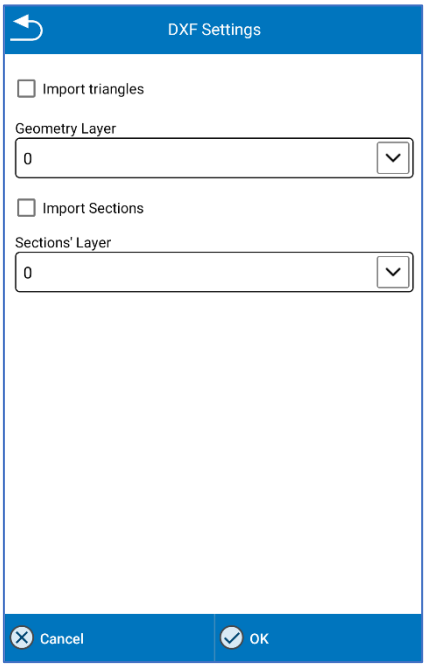
Click *Import* to import the road or road geometry to stakeout. The compatible formats are *.XML, *.DXF, *.CSV.

LandXML Import

The most complete format is LandXML, it can contain the planimetric track, the cross sections, and the elevation profile and 3D models by TIN.

DXF Import

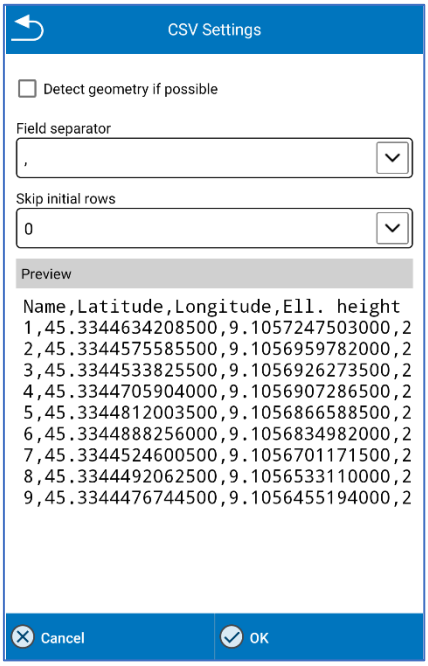
The DXF format allows to import tracks and cross sections by polyline or LWpolyline so lines and arches and 3D models by TIN. When you import a DXF file the following window appears.



You can choose the destination layer for track and sections and if you want to also import the TIN or not.

CSV Import

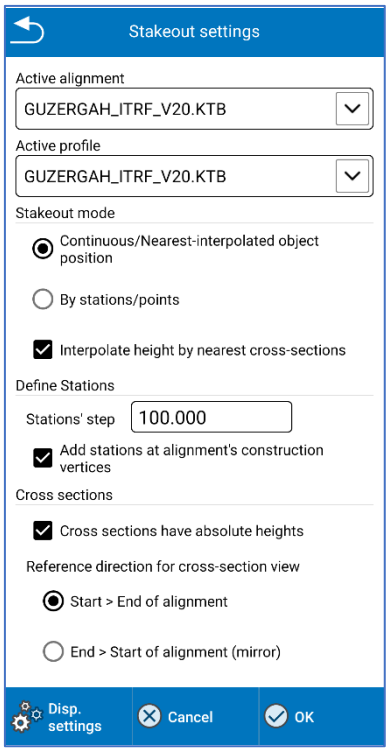
The CSV format allows to import just one geometry as sequence of points in axis. When you import a CSV file the following window appears.



It shows a preview, the first lines of the file to remind what's the field separator and if there is a header to correctly set the number of initial lines to skip. Enable the option "Detect geometry if possible" to recognize straights and arches; this function works properly if the points come from discretization of a complex geometry.

Stakeout settings

Select the road from list and click OK to stakeout.



- Active alignment

  Which alignment will be used for stakeout between the available ones.

- Active profile

  Which elevation profile will be used.

- Stakeout mode: Continuous/nearest interpolated object position

  The current gps position will be projected on the track to reach the nearest point.

- Stakeout mode: By stations/points

  Reach the defined stations/points along the track.

- Interpolate height by nearest cross-sections

  Calculate height by interpolation between the previous and next cross-sections.

- Stations step

  Set the distance between each station along the track.

- Add stations at alignment's construction vertices

  Add stations also on feature points of the track, like start and end of each junction of the track.

- Cross sections have absolute heights

  If enabled, cross sections heights are absolute; if disabled cross sections heights are relative to the elevation profile so it's important, in this case, select the right profile.

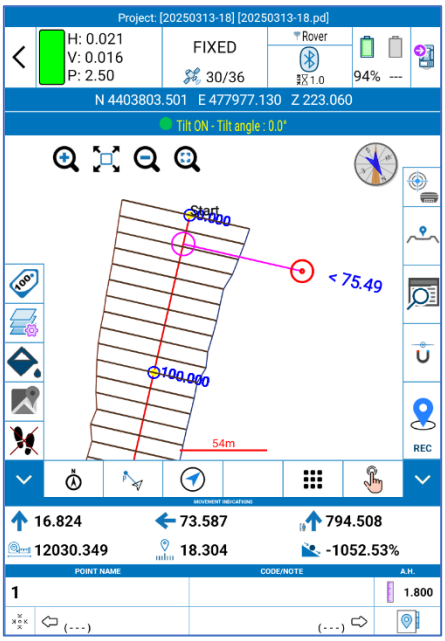
- Reference direction for cross-section view

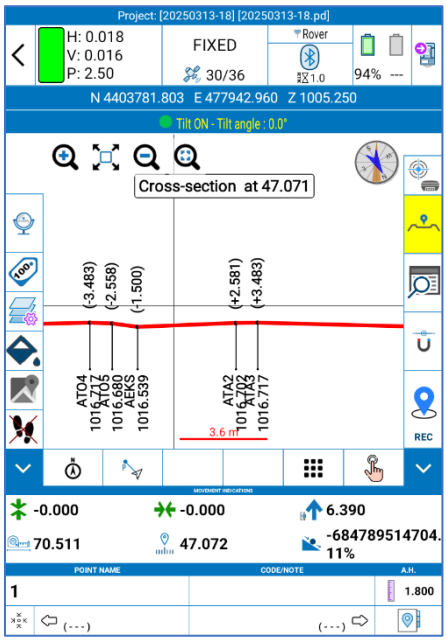
  Mirror the section if the walking direction it's not the same of the road project direction (start->end)

Road Stakeout Interface

If you have already selected a file from road library, then the road stakeout page will open as soon as you click Road Stakeout submenu, otherwise, select the file and click OK to start the stakeout.

The interface is like the standard stakeout interface (see 6.5Point Stakeout).





In the indication bar, in addition, there are the length and the chainage that is calculated from the projection of the current measure, and the following icons.

	Enable SNAP on the closest station point
	Go to section view (the closest available section) or back to profile view

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