STONEX

STONEX S850A
GNSS Receiver
User Manual

May 2021 - Ver.1.0

www.stonex.it

Contents

Introduction

This document is a user guide for S850A and it is intended to introduce how to correctly use the receiver.

S850A GNSS receiver is a multiple-frequency receiver and designed for GNSS surveying applications. It is available as a base station, or as a standalone rover, which can be switched freely whenever and wherever, offering maximum versatility in the system configuration to meet your specific requirements. At the same time, S850A receiver can be upgraded easily to continually meet your new demand.

The integrated design of the receiver makes the S850A only 1.1 kg, which is light and portable. The internal antenna supports all the satellite systems: GPS, GLONASS, Galileo, Beidou, QZSS, IRNSS. And users no longer have to worry about upgrading RTK hardware to support other satellite systems.

S850A GNSS receiver has the new IMU System that allows tilted measurements (TILT). Thanks to it, difficult or inaccessible points are no longer a problem. The inertial Measurement Unit (IMU) is self-contained system that measures linear and angular motion usually with a triad of gyroscopes and accelerometers.

An important feature inside S850A is Atlas reception: Atlas is a differential corrections system broadcasted on L-Band, allowing real-time centimeter-level positions in areas not covered by conventional CORS working under NTRIP Technology (lack of reference stations, lack of GPRS signals, etc) or traditional RTK techniques. Atlas is broadcasted by satellite systems, so the reception is nearly ensured all over the world. Atlas uses similar technology compared to SBAS but providing a better positioning accuracy.

Another important feature is the new modem GSM. Worldwide LTE, UMTS/HSPA+ and GSM/GPRS/EDGE coverage. EG25-G is backward-compatible with existing EDGE and GSM/GPRS networks, ensuring that it can be connected even in remote areas devoid of 4G or 3G coverage.

This user manual provides basic information to help you get familiar with your GNSS receiver.

Key Features:

- Rugged housing
- Support full constellation satellites
- 4G LTE and Bluetooth / WLAN datalink support
- UHF datalink with internal 1 W radio module
- Atlas & aRTK support
- Easy configuration from Web UI and remote server.
- IMU System
- Intelligent connection
- IP67

1. Receiver appearance

1.1 Front view

Figure 1.1: Receiver front view

The following table contains the description of the receiver front view.

ITEM	DESCRIPTION
1. Satellite indicator	Flashing red: no satellites tracked Flashing green: satellites tracked. Solid green: the receiver tracks the satellites; it receives differential corrections and the quality of the solution is fixed. Flashing green and red alternately: GNSS board abnormal OFF: GNSS board abnormal
2. Datalink indicator	Solid green: datalink setting succeeded. Flashing green: receiving or transmitting differential corrections. Red solid: static mode Flashing red: in static mode, it blinks according to sampling rate. Flashing yellow and green: it records raw data in Base/rover working mode

3. Wi-Fi indicator	Green: Wi-Fi is enabled OFF: Wi-Fi is disabled
4. Bluetooth indicator	Blue: a device is connected to receiver's Bluetooth. Flashing blue: a device is connected to receiver's Bluetooth and receives differential corrections. OFF: No connection
5. Power button	Switch ON/OFF the receiver; short press to broadcast current operation mode and status. Green: The power supply is enough Flashing green (1s): power in 10%-20% Flashing red (1s): power＜10% Flashing red (3s): The device is charging

1.2 Bottom view

Figure 1.2: Receiver bottom view

The following table contains the description of the receiver bottom view.

ITEM	DESCRIPTION
1. UHF	TNC, external UHF antenna connector
2. SIM card slot	Nano SIM card interface
3. 5-pin LEMO	Connect the external power supply and external radio
4. Type-C	Power supply and data transfer

2. Basic operation

2.1 Power on receiver

Short-Press the power button, the power indicator will light on and you will hear one beep, then S850A will be powered on.

2.2 Power off receiver

Long press the power button, all indicators blink and the voice prompted "power off". Then short press the power button to confirm power off.

2.3 Model view and switch

Model view

When receiver is powered on, short press the power button and then it will voice broadcast the current working mode and data link.

Model switch

When the receiver is powered on, connect it with handheld or other instruments as to set up and switch the working mode of receiver.

2.4 Receiver self-check

Self-check functionality is to check whether every module works normally. When S850A receiver has indicators off or a module does not work normally, you can use self-check to inspect the receiver. S850A self-check consists of six parts, namely GNSS, radio, network, WIFI, Bluetooth, and sensor. The self-check results will be voice broadcasted in the process. Self-check operation and result broadcast are as followed:

When receiver is powered on, press power button and hold it until the receiver voice broadcasts "power off". Press it again until the receiver sounds

a beep and voice broadcasts “self-check”, which means the receiver starts to operate self-check. New receivers: it is recommended to operate self-check at least once.

In the process of self-check, each module inspection is followed by its inspection result. If the module inspection passes, it will voice broadcast “OK” and module led keeps on until the whole self-check finishes. If the module inspection fails, it will voice broadcast current module inspection fails, keep module led flashing and buzzer sounding until you restart the receiver. Self-check lasts for about 1 minute. If there is self-check failure, please contact local dealer.

If every module indicator is lit with no flashing, and voice broadcast says every module work normally (such as “GPS self-check. OK.”), it means all the modules work normally. Receiver starts to work after the whole self-check finishes.

2.5 Insert SIM card

If you need to use the SIM card, you should insert the SIM card before you power on the S850A; open the card cover first, then insert the SIM card as the notes in card cover.

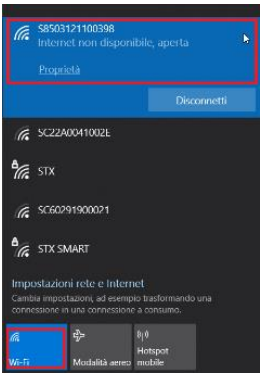
3. Web Interface

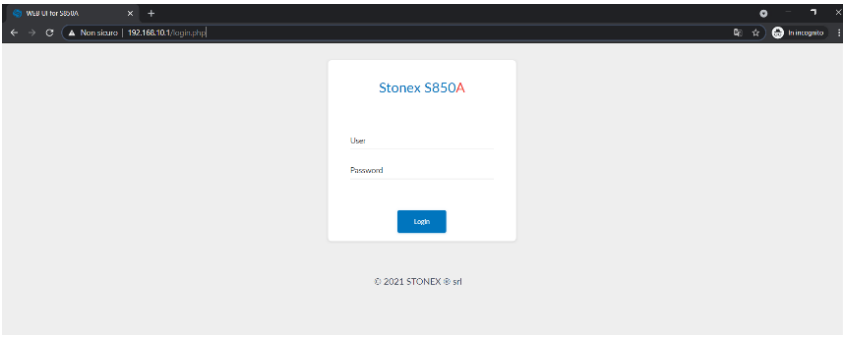
S850A receiver has Web UI functionality. By getting access to its internal hotspot, you can easily manage it on the Web UI. If you have a smart phone, PC or handheld with WIFI functionality, you can easily connect to the S850A receiver to view status, download data and configure the receiver.

S850A receiver is default to open WIFI automatically when it is powered on. Use smart phone/PC/handheld to search the receiver hotspot, whose name is its serial number, and connect to it. Receiver WIFI only supports getting access to Web UI to check status and set up mode, not for Internet connection.

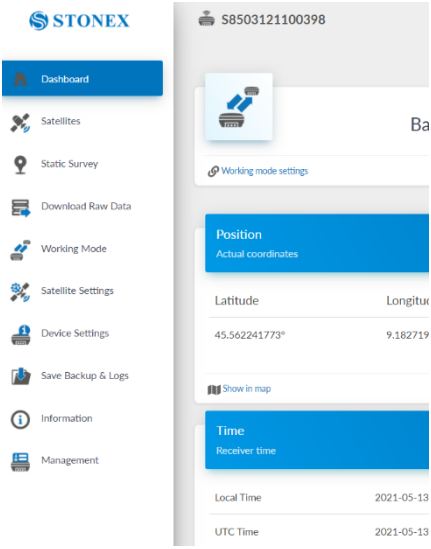
The WIFI hotspot name is the serial number of the receiver.

Enter the IP address: 192.168.10.1. A window will pop up when the user log in, which need to fill in the user, that is “admin”, and password that is “password”. The following pictures show the whole process:



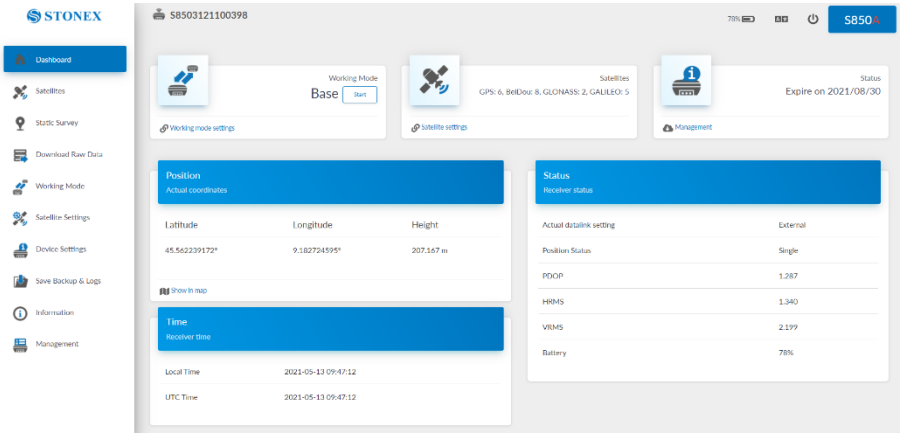


If the login is successful, the main page of the WebUI will be shown, this is Dashboard. By clicking on the left menu through the different options, it will be possible to get some important information and at the same time set up the receiver according to the requirements. When an option of the menu is selected, it will be highlighted with blue colour.



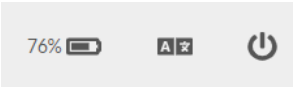
3.1 Dashboard

This is the main page of the Web UI. It gives an overview of the current configuration and status of the receiver.

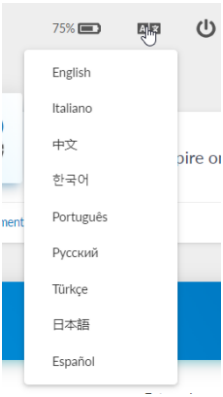


It is highlighted with blue colour on the left of the main menu as shown on the above picture. In addition to the main information, it allows to navigate directly through the most important configuration options and executes the main operations in an easy and quick way, e.g check the battery level, expiration time of the receiver, current position and datalink configuration, etc.

In the higher part of the page, the serial number of the receiver is shown and there are three small icons that allow some basic operations before starting to use the WebUI. The level of the battery as percentage and graphically:

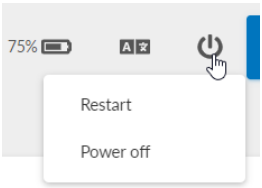


By clicking instead on the icon: there will be possible to change the language of the WebUI, choosing among those available:

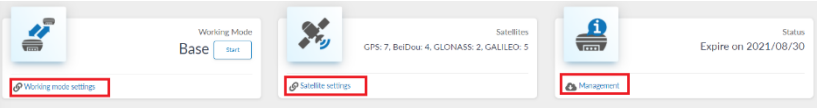


The language will be changed after selecting it and it is not required to restart the receiver.

By clicking on the icon there will be possible to restart or power off the receiver without pressing the buttons of the control panel.

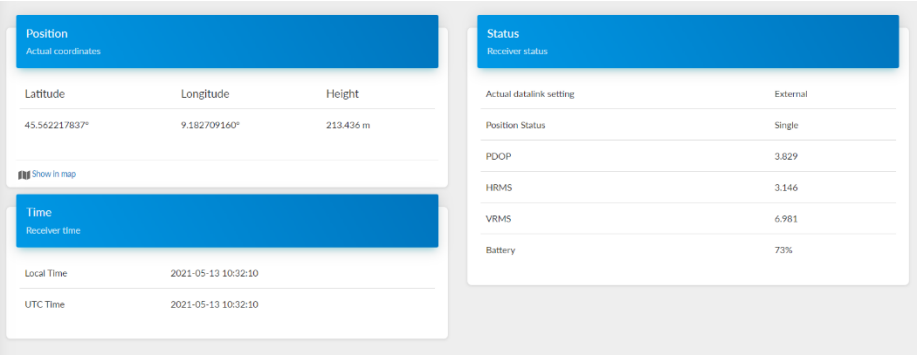


In the middle part of the receiver there is a summary of the main options of the menu of the WebUI, or those used frequently in a Job, these allow to get a preview of the configuration and at the same time access to the respectively option by clicking on the description icons as shown on the red squares:

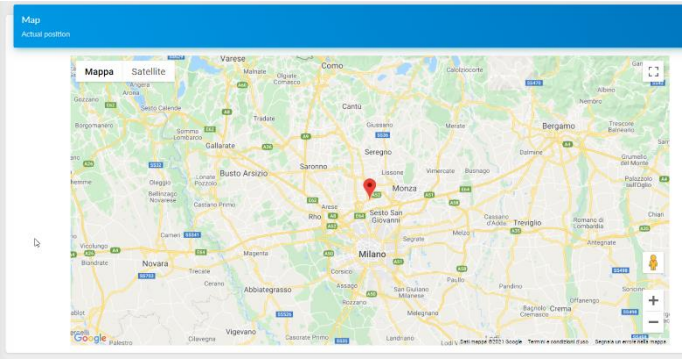


They are working mode settings, satellite settings and Management. These options will be described in the next paragraphs.

Finally, the Dashboard shows the current position, the GPS and local times and a summary of the configuration of the receiver:

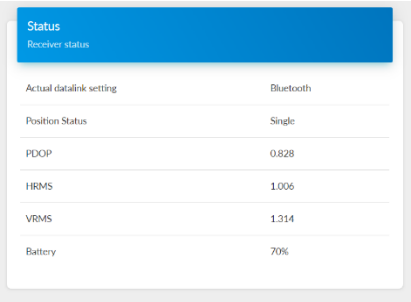


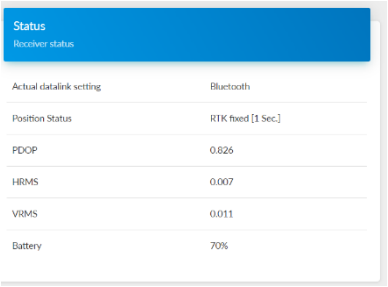
On the "Position" information the icon: Show in map allows to know and see graphically the current geographic position on a map:



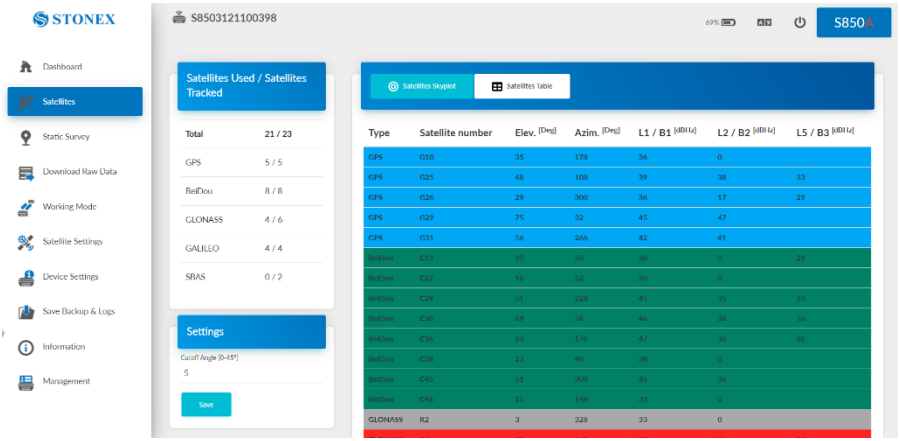
The information is available only if there is an internet connection on the device from which the connection to the WebUI is established.

On the "Status" information, the current datalink is shown and the quality of the position according to the differential corrections received, e.g., single when no differential corrections are received or RTK fixed when the receiver receives them:

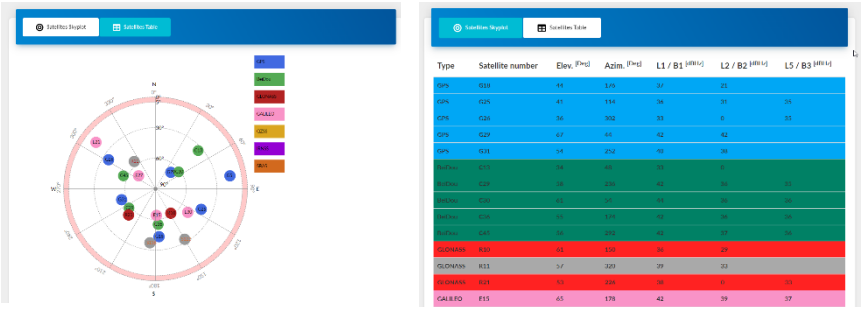




3.2 Satellites



Choosing this option, the main information about the satellites will be available. On the left, there is a summary by constellation and the ratio satellites used on tracked. The information of the satellites can be seen in two ways: as a Skyplot, where the position of every satellite is designed and as a table, where the main information of every satellite is provided:

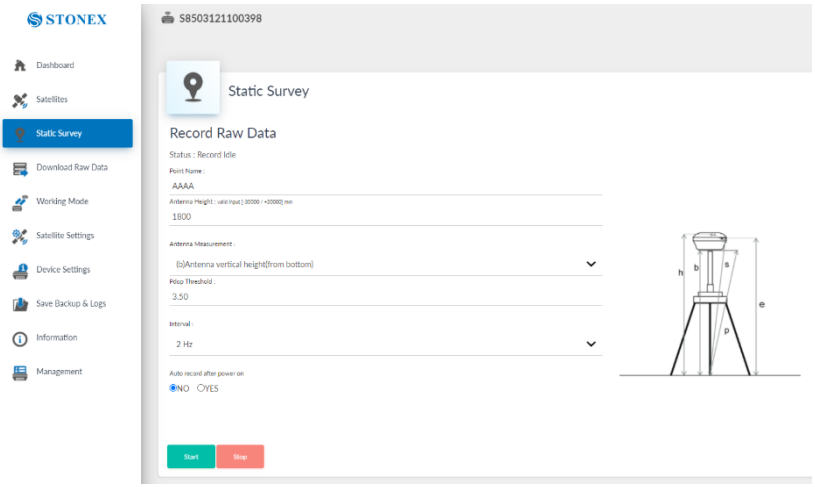


On the table, the satellites are ordered by constellation and highlighted with a different colour according to the constellation, e.g GPS are blue. The satellites highlighted with gray colour, are tracked but not used to calculate the current position, this can be due to a bad ratio signal/noise or because the kind of differential corrections used.

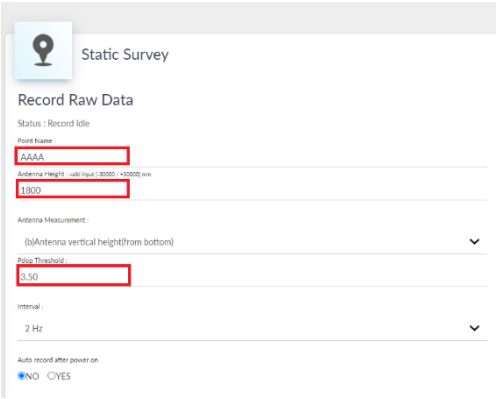
The only configuration that can be set on this option of the menu is the cut off angle, it is the minimum elevation below which the satellites are excluded to avoid a signal / noise ratio not suitable to calculate the position of the receiver.

3.3 Static Survey

By clicking on the next option of the menu, Static Survey, all the parameters to survey under this technique can be set. A static survey is one of the most common survey techniques that requires a post processing software to determine the position of the receiver with an accuracy according to many factors, for instance, the sampling frequency, the constellations used, the observation time, etc. in the case of limited theoretical knowledge on this topic it is advisable to refer to a specific bibliography before configuring the receiver.



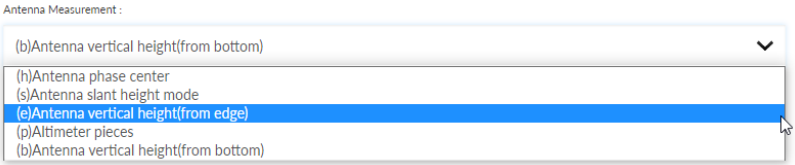
The main values that can be entered are the point name, antenna height and PDOP, indicated in the red squares of the below picture:



The limitation on the antenna height is indicated. About the way to measure it, on the right side of the page, there is a picture with all the options and how to measure them in the case the receiver is mounted on a tripod with tribrach.

There are mainly two references to which the height must be measured. The first one is the bottom of the receiver (e.g measure b). The second one is to the white line drawn on both sides of the receiver in the blue ribbon (e.g measure s).

The different options are available by clicking on the drop-down menu, as the following picture shows:



To calculate the antenna phase center height, can be taken the b value, so the measure to the bottom of the receiver and add then the phase center value indicated on the "information" page or on the label of the receiver.

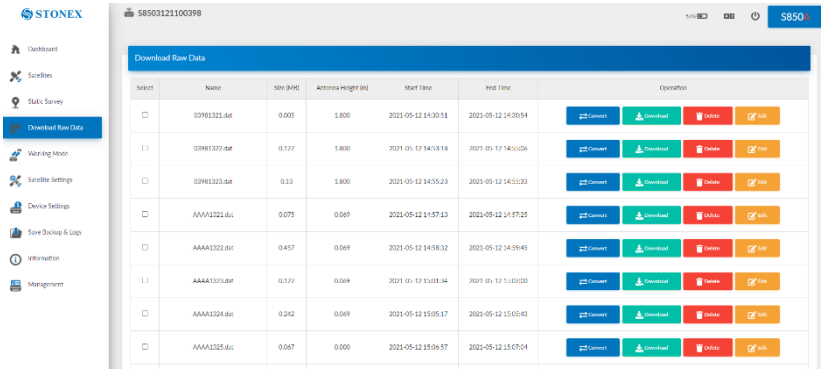
The last value that must be selected is the sampling rate. The minimum value, usually 60s and the maximum value that depends on the configuration available according to the technical features, it is usually 10Hz or 20Hz.

To conclude the configuration, the option "auto record after power on" can be set. This is a useful option that allows to start recording the raw data after turning on the receiver; different points can be surveyed without data controller or accessing to Web UI. The receiver can be placed on a point, turn it on, survey the point and turn the receiver off, move to next point and so on.

Finally, by clicking on "start" the receiver will start to record the raw data, then the survey will start. Differently on "stop" the registration will stopped.

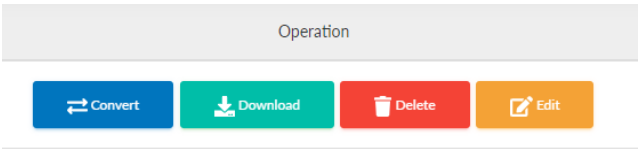
3.4 Download Raw Data

After performing a static survey and explained in the previous paragraph, to determine the position of the receiver with a specific accuracy, the post processing must be performed in a second time, using a suitable software.

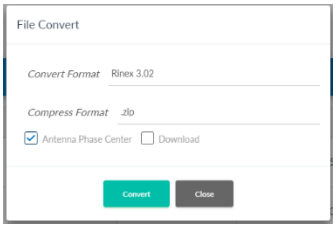


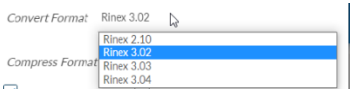
The main input is the raw data that can be downloaded in the "download raw data" menu option. On this page, all the files will be shown. The receiver records a proprietary file with .dat extension and can be converted into RINEX standard format, recognized by almost all the post processing software. The table of the previous picture shows the name of the file with .dat extension, the size, the antenna height defined in the survey and the starting and ending time of the registration. The table is useful to select the file needed, to delete the bigger ones, if they are not any more necessary, to download and convert the file required, etc.

The last column of the table allows the main operations for every file:



The “convert” option, as shown in the picture, is useful to convert a file into RINEX format with a specific standard and a specific compression format.

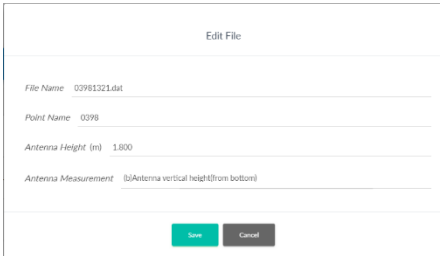




By selecting the option “Antenna Phase Center” the RINEX will take into consideration the measure of the antenna to the phase center (measure h as indicated in the previous paragraph) even though another option was selected. The “download” option instead, will download the converted file in the device used to get access to WebUI; if it is not selected, the file converted will be saved in the internal memory of the receiver accessible through Type C-USB cable connected to a PC.

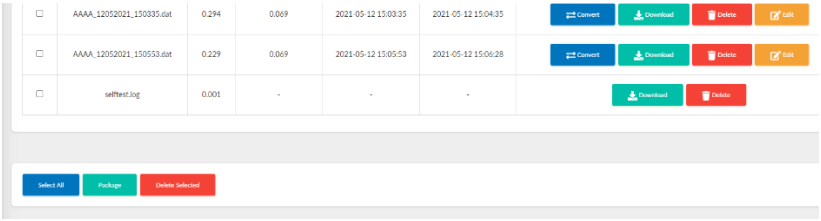
By clicking  the file selected can be removed permanently.

By clicking edit the following information can be changed: the name of the file, the point name, the antenna height and the antenna measurement mode. After clicking on “save” the changes will be applied.



After changing the previous parameters, it is necessary to convert again the file into RINEX format, in the case the file was converted before.

At the end of the page, there are some useful options to manage all the file at the same time:

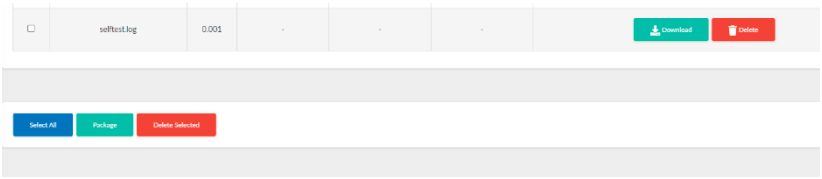


Select All this option allows to select all the file at the same time, without clicking on every single check box of the column select.

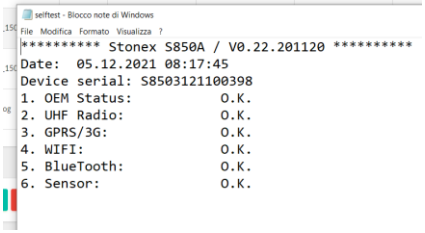
Package If some files are selected at the same time, by clink on this icon a single compressed file will be created with inside all the file selected.

Delete Selected The file selected will be deleted permanently.

If the self-check procedure has been performed as explained in the paragraph 2.4, the report can be downloaded from this table as the following picture shows:

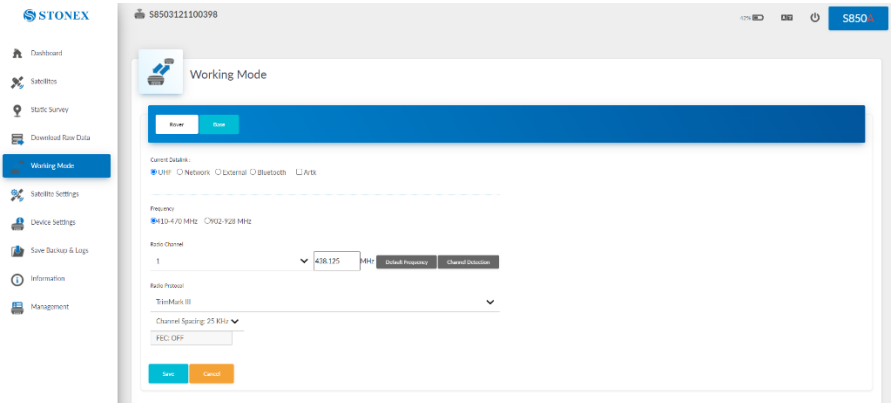


If there are no hardware problems a report like the following will be generated:



Instead, if there are some errors contact Stonex Technical Support.

3.5 Working Mode

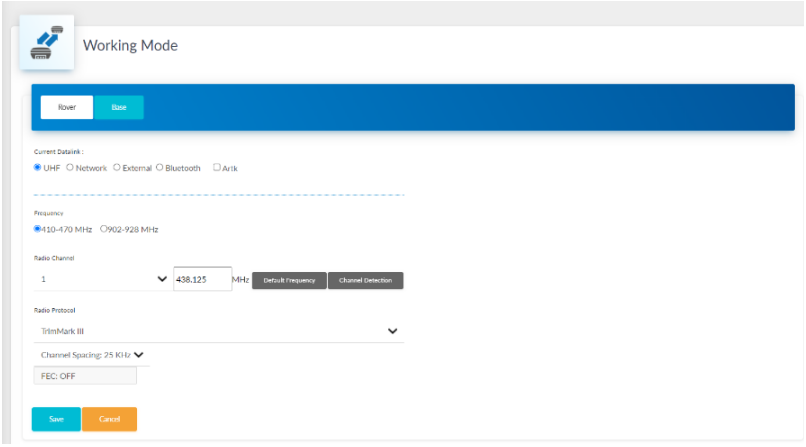


This is one of the most important menu options of the Web UI since the main configuration of the device can be defined. The principal working modes are Base and Rover, under these configurations a datalink can be associated.

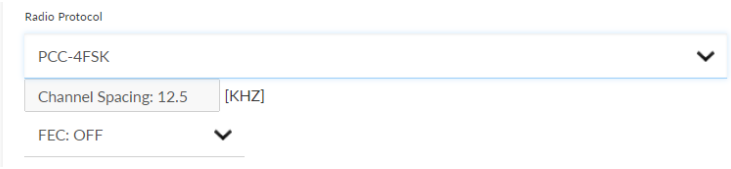
3.5.1 Rover – UHF

This configuration is used when there is available a base transmitting the differential corrections through an UHF radio. It is required to know the UHF parameters of the base radio to select the same on the rover configuration.

Both base and rover radio parameters must match to link them. These usually are defined by selecting UHF option; the following picture shows them:



The most common are frequency, channel and protocol; the channel spacing can be selected according to the protocol previously defined, some protocols have a default channel spacing, the option becomes grey out or not selectable, in this case, e.g PCC-4FSK, as the following picture shows



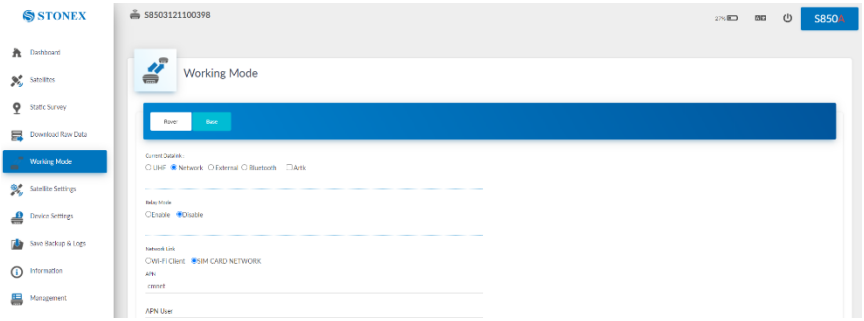
The value of the frequency can be changed but must be inside the interval defined by the technical specifications; moreover, it must be inside the UHF antenna frequencies interval (this can be checked in the label of the UHF antenna).

The receiver has a double frequency radio. By selecting the range 902-928 MHz, the frequency cannot be edited, select only the right channel.

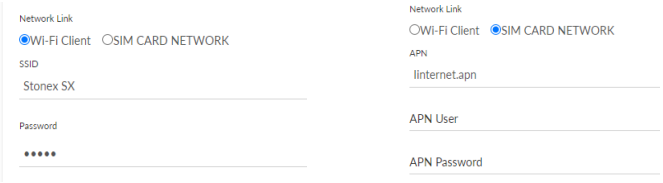
When all the parameters have been correctly defined, by clicking on “save” they will be saved.

3.5.2 Rover – Network

This is one of the most common configurations as rover. In this case the receiver will receive the differential corrections from a GNSS Network or single reference station through internet connection.



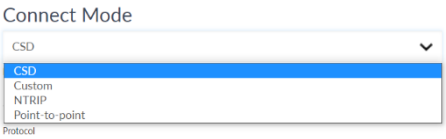
The internet connection can be established using a wi-fi network or the internal modem with a data SIM card.



The wi-fi option is only for advanced users, if this option is enabled the wi-fi communication to the Web UI will be interrupted since the wi-fi channel will become busy. In the case of SIM card, the APN (Access Point Name) must be entered, some networks operators require user and password to establish the internet connection. In both cases, the PIN to protect the SIM card must be removed.

The network type (Auto, GSM or CDMA1x) can also be selected. If there are not specific requirements for the network, with Auto option the modem we connect automatically according to the availability of the signal.

About the connection mode, it follows a brief description:



CSD: in this case the rover through a usual GSM call, will contact the base to receive the differential corrections, so the phone base number must be entered. Many GSM networks are being replaced by new technologies, so before using this kind of communication it is necessary to contact the provider to check the availability.

Custom: the connection is like NTRIP but the password to contact the server is not required.

NTRIP: the rover contacts a GNSS network provider through Networked Transport of RTCM via internet protocol (NTRIP), a protocol for streaming GNSS data over the internet.

Point to point: the configuration is like a TCP connection, so only ip and port are required as parameters.

Following the most common NTRIP, to complete the configuration, the following parameters need to be entered, all of them provided by the GNSS Network provider and all of them mandatory.

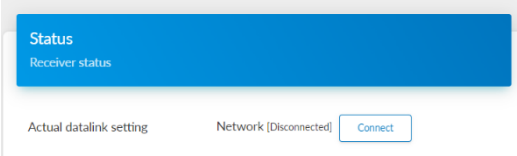
Caster Address or IP address: this can be numerical or alphanumerical.

Port: this is a numerical value, usually 2101.

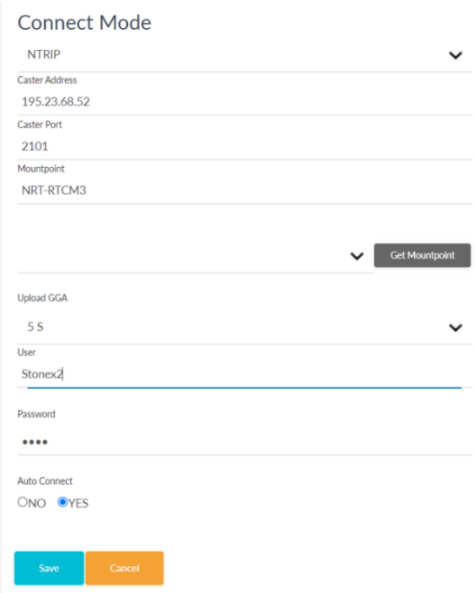
Mount point: this parameter represents the type of differential corrections and the kind of network solution, sometimes more meanings are added. For example: RTCM and Nearest solution can be defined as NRT-RTCM3 as mount point.

Upload GGA: it is the frequency of the current position that the rover will send to the GNSS Network.

Auto connect: flagging this option, when the receiver will power OFF and ON again, it will connect automatically to the GNSS Network provider automatically, it means without entering again all the parameters of the connection. If not selected, it will be necessary to access to the WebUI and on Dashboard page, click on connect.

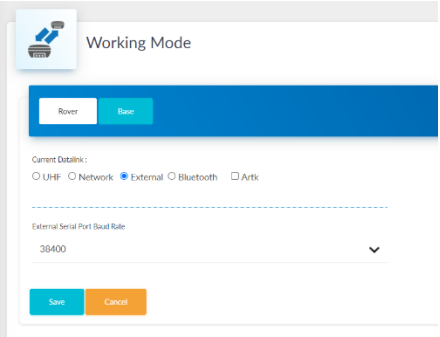


User and Password: they are the credentials that the GNSS Network provider will use to check if the user has accesses to the server.



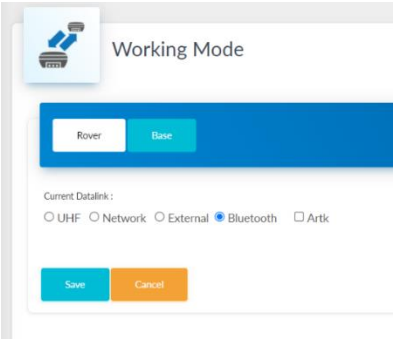
Once all the parameters have been defined, by clicking on "SAVE" they will be stored.

3.5.3 Rover – External



Under this configuration, the differential corrections will be managed through the 5-LEMO PIN connection using an external device, for example an external radio. The only parameter that needs to be chosen is the baud rate, so the speed of data transferring that must be the same of the output in the external device.

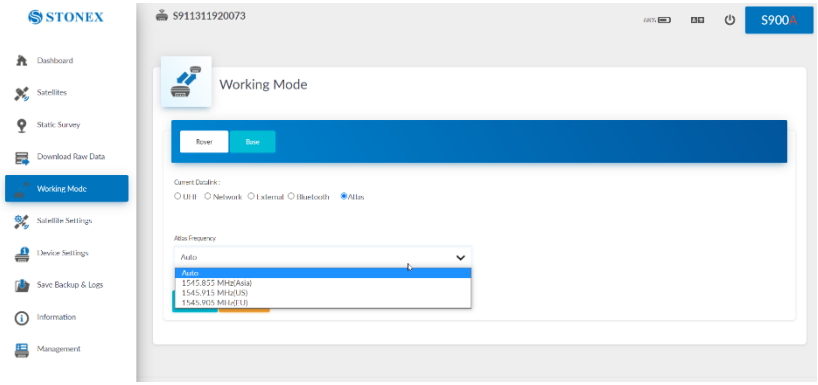
3.5.4 Rover – Bluetooth



This datalink usually is selected automatically from a data collector when the differential corrections are sent through the Bluetooth. By choosing this on the WebUI, an external device can be connected to the receiver through its Bluetooth module, for example a table or controller.

3.5.5 Rover – Atlas

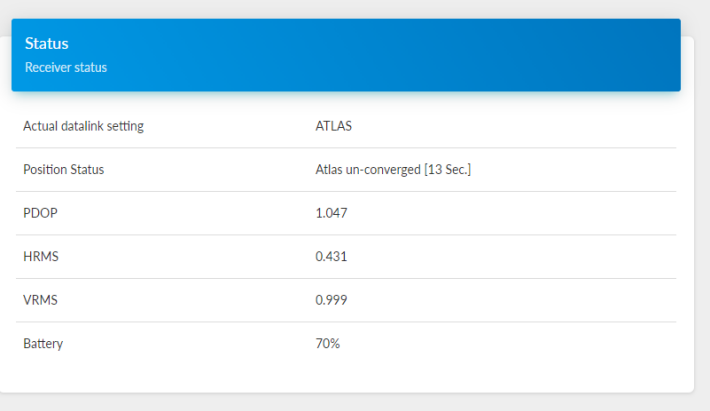
In the case the service is enabled, “Atlas” will appear on the datalink options.



This is a real-time differential corrections service provided through L-band satellite, it means that no RTK base stations or RTK networks are required to correct the position achieving centimetre accuracy.

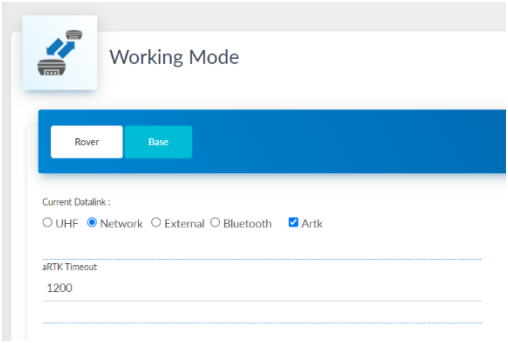
The frequency can be selected as Auto or chosen among the specific geographic area; in any case the system is able to recognize the geographic area.

The solution can be checked on the Status section of the Dashboard page, like the following picture shows:



3.5.6 aRTK option

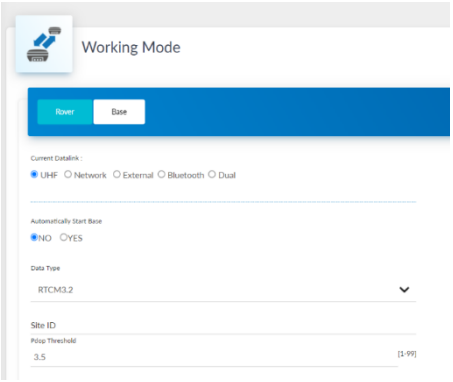
When using the receiver as ROVER, under any datalink is possible to select the option aRTK. As an option, it allows to maintain the centimetre accuracy in the case of the data source of the differential corrections be interrupted for any reason, for example in the communication BASE/ROVER, the base has stopped because of the battery. Choosing this option, it will appear automatically another menu to select the time in seconds, that need to be covered if this should happen.



In the above example, from the disconnection of the data correction source, the rover will have 20 minutes under centimetre accuracy, after that it will be necessary to get linked to a new or to the same source if a good accuracy is required. The maximum time is defined by technical specifications.

3.5.7 Base – UHF

Using the receiver as BASE, it will be able to broadcast the differential corrections through the different data link available. In the UHF communication, it will use the internal radio module.



The main parameters to be defined are:

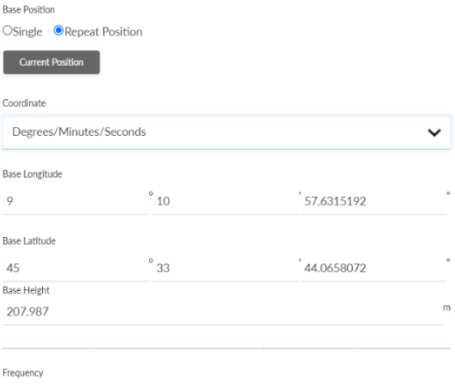
Automatically start Base: like the auto connection in the rover, every time the base turns OFF and ON, will start automatically broadcasting the differential corrections, otherwise it will be necessary to trigger on Dashboard.

Data type: this can be selected on the drop-down menu. The Formats available are defined by the technical specifications.

Site id: it is the name of the base.

PDOP Threshold: define the maximum value of PDOP for valid GNSS data in order to avoid bad satellite configuration in the sky (suggested values below 3.5)

Base position: the position of the BASE can be defined if the coordinates of the point above it is placed are known, it is repeat position:



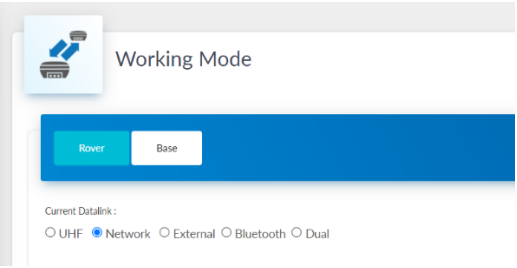
If they are unknown, then single position will calculate it automatically when the BASE starts transmitting data.

The UHF parameters were described in the paragraph Rover-UHF.

Finally, if the distance to be covered is longer or there are some physical interferences that can reduce the range, the higher power can be selected.

Clicking on “SAVE” the parameters will be stored.

3.5.8 Base – Network

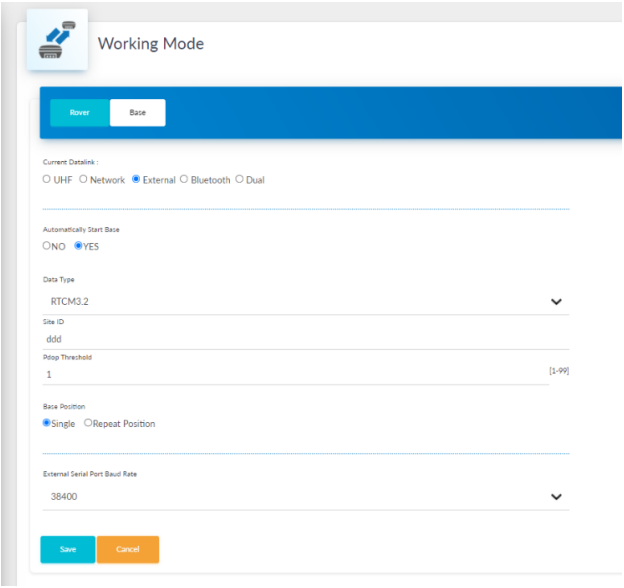


The configuration as network allows the base to send the corrections to a server that can be physical or virtual. Most of the parameters to be entered have been explained previously in the paragraph ROVER-Network. The main difference is the function they will execute, the server instead of broadcasting the differential corrections to the ROVER, will receive them from the receiver set up as BASE. The mount point then, will be defined by the user and will not be given by the GNSS Network.

The option to use a wi-fi network it is always to deal with carefully, since the connection to the WebUI will interrupt since the wi-fi channel will be busy.

3.5.9 Base – External

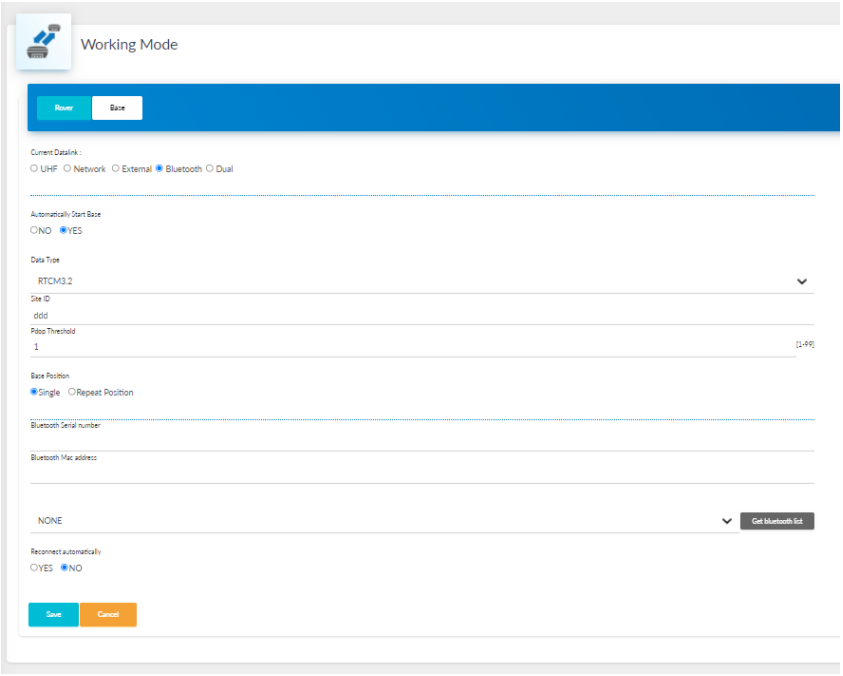
This option allows the receiver to send the corrections through an external device like an external radio. The configuration is almost the same as the previous but instead of the network parameters, the baud rate of the 5-LEMO pin connector must be selected.



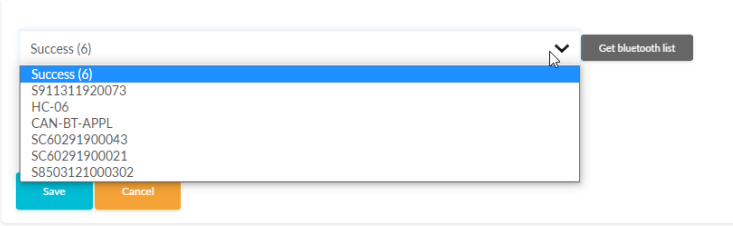
This function mainly sends the differential corrections to the 5-LEMO PIN connector, with the suitable cable then they can be transmitted to the external device. Some examples: an external radio, a PC to manage them in different applications etc.

3.5.10 Base – Bluetooth

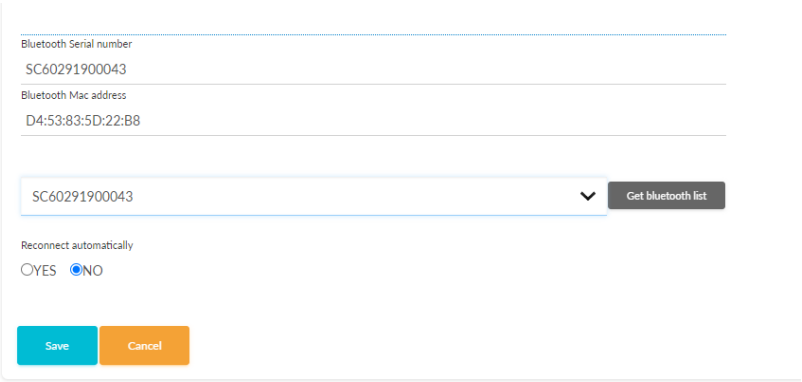
This is a useful option, like the configuration of the BASE as External, in this case the differential corrections can be sent to an external Bluetooth device like an external radio with Bluetooth capability. The connections established will be then wireless.



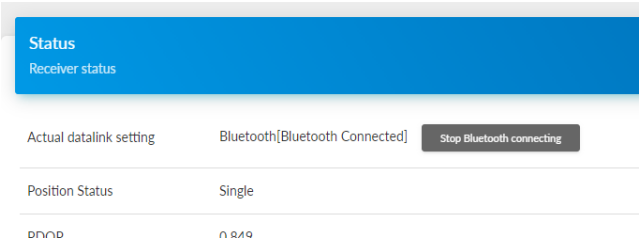
The main parameters set as base are the same. In addition, the Bluetooth connection must be defined; this is a simple operation: by clinking on "Get Bluetooth list" will appear all the devices near to the receiver among which it is possible to select one:



When it is selected, the fields Bluetooth serial number and Bluetooth Mac address will fill in automatically:

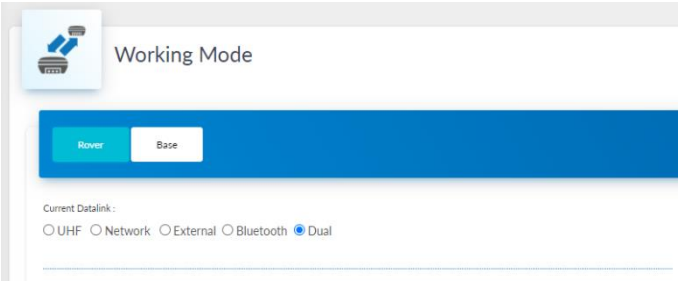


On the Dashboard the connection will be indicated as connected, if the base does not start:



Once the parameters have been defined, they can be saved.

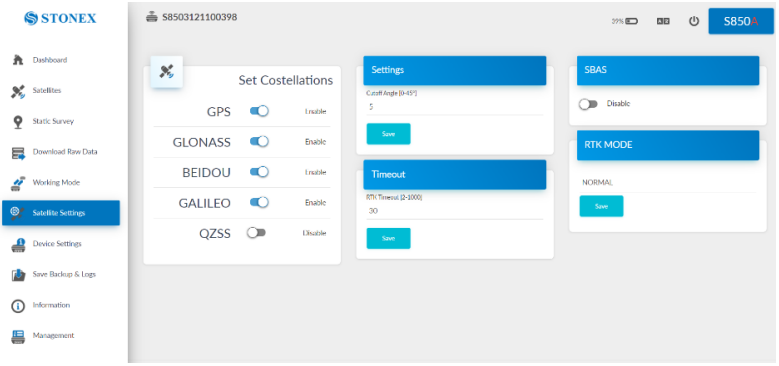
3.5.11 Base – Dual



As defined by its name, two datalinks can be set as the same time. The option is useful to send the corrections through two different channels and then cover more users or rovers at the same time, for example some of them connect through a NTRIP connection and some of the through UHF radio.

The configuration gathers the individual configuration explained previously, for example, in the case of NTRIP, the parameters of the server must be entered, in the case of UHF radio the protocol and channel must be selected. Once they are defined, they can be saved.

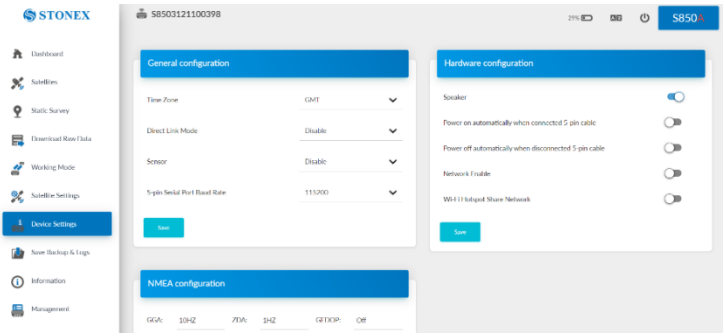
3.6 Satellite Settings



In this page, all the configuration options about the satellite system can be found. The constellation can be enabled/disabled by turning them ON/OFF.

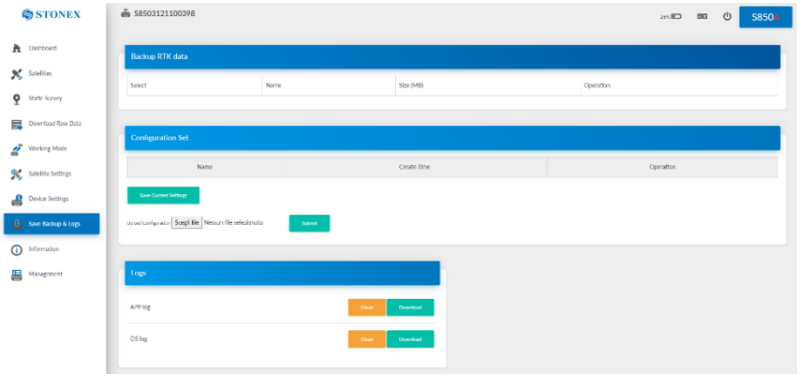
aRTK timeout as explained previously can be also set. If the geographic area has a geostationary navigation system, SBAS option can be enabled. Finally, RTK mode “Surefix” option performs statistical analysis to determine the true quality or the solution, ideal for users who use GNSS in harsh environments and want to ensure they do not suffer from incorrect fixes.

3.7 Device settings



The general configuration about the device can be found on the device settings page. Some useful options can be managed, like NMEA messages with the frequencies value or simply enable or disable the speaker.

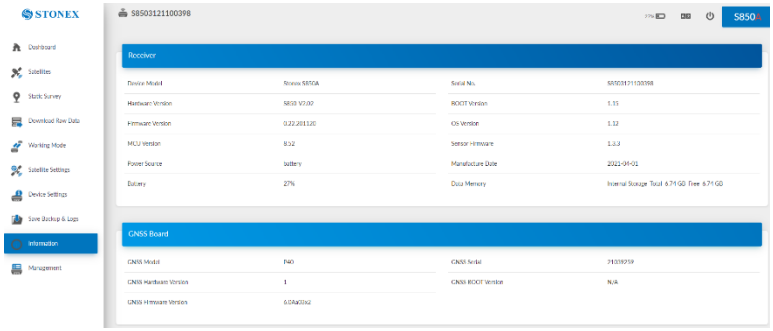
3.8 Save Backup & Logs



This page provides useful information about the receiver, especially when there are some problems or errors, the log of the system can be found or downloaded on APP and OS log.

Once the receiver has been set up, the configuration can be saved as a file to be downloaded in a second time; different configuration can be stored and used when it is required.

3.9 Information



This page provides the specific information, both hardware and firmware about the receiver. Through this page, it is possible to know the firmware version currently installed on the receiver, the hardware version of it or their modules. It also provides information about the Antenna like the phase center L1 and L2.

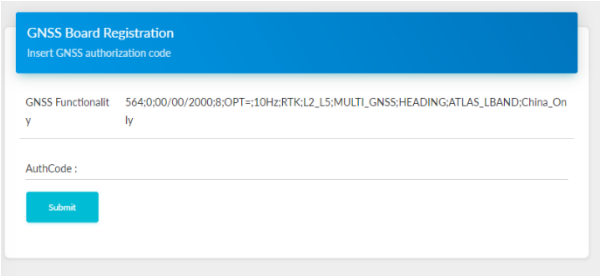
3.10 Management

As its definition, this page allows to manage the receiver from the system and configuration point of view.

On the section firmware

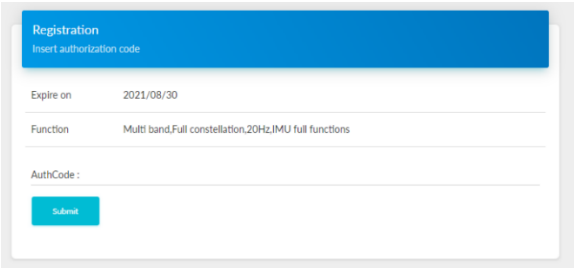
A new firmware version can be uploaded. It is only necessary to search for the file and click on submit to confirm. The receiver will complete the process automatically, it sometimes will power ON/OFF to correctly install it.

On GNNS board registration



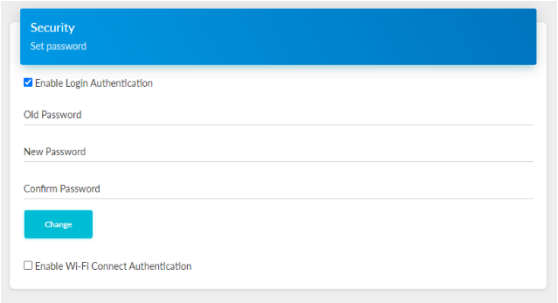
Some alphanumerical codes upon request can be entered, for example Atlas subscription or higher positioning codes to increase the speed of the positioning.

In the section Registration, the registration of the receiver can be changed, it means the time for which it can work. The current expiration date is shown, in the case this is over, the receiver will not be able to work, it will start beeping continuously until a new alphanumeric code be entered.



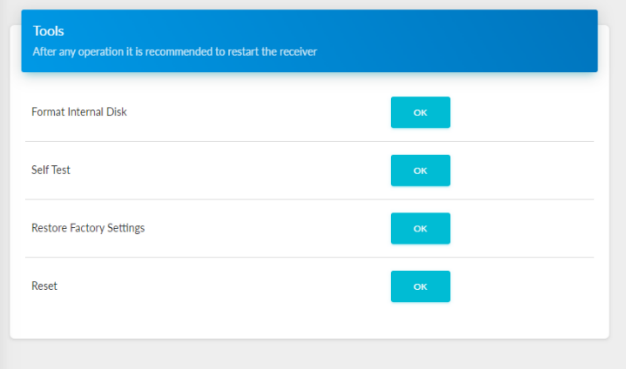
If the code instead has no expiration, the word “never expires” will appear instead of the date.

The wi-fi parameters can be changed on the section Security:



The default credentials can be replaced as the user prefers. It is also possible disable the authentication to access to the WebUI.

In the section Tools, the following simple operations ca be executed:



Format Internal Disk, self-test to check automatically if there are hardware problems. Restore Factory settings, to delete any kind of configuration and Reset to turn the receiver ON/OFF.

4. New IMU Technology

The receiver is equipped with the new IMU[1] System that allows tilted measurement (TILT).

It has the following advantages:

- The initialization process is easier compared to other similar systems.

  Stonex Cube-a field software can be used to calibrate the sensor; Cube-a will ask to initialize the IMU when needed and it will show how to do it. The process is very fast, usually a few seconds for IMU initialization.

- The receiver with integrated inertial navigation module ensures the real-time interference-free tilt compensation.

  It is not affected by any geomagnetic and external metal structures and other environmental influences. It adopts "satellite and inertial navigation" dual inspection.

- Fast and precise survey.

  It is possible survey and store points with just one measure with slant pole up to 60° (2 cm accuracy up to 30°, 5 cm accuracy up to 60°).

1.Optional activation

4.1 IMU with Stonex Cube-a

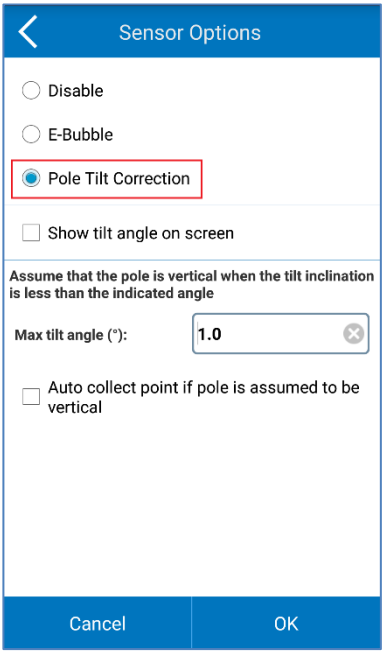
4.1.1 Sensor Activation and Configuration

Before using the receiver to collect points with the slanted pole, check if the pole tilt correction functionality has been enabled.

With Stonex Cube-a, follow this path to find the configuration menu:

Configure → System Settings → Sensor Options.

There, enable the **Pole Tilt Correction**.



In the same screen, it is possible to select the option "show tilt angle on screen" the angle of the tilt (in decimal degrees, 0° = true vertical) will be shown in the Survey window.

To show this information, mark the relative check inside the Sensor Option menu.

The user can also define the verticality tolerance of the instrument.

That is, the maximum value of the (sensor) tilt angle that the software shall accept when checking for the pole verticality.

The value is in decimal degrees.

Example: 0.3 means +/- 0.3° from true (local) verticality.

Finally, there is also the possibility of automatically starting the measurement of the point when the pole is considered vertical.

4.1.2 Initialization

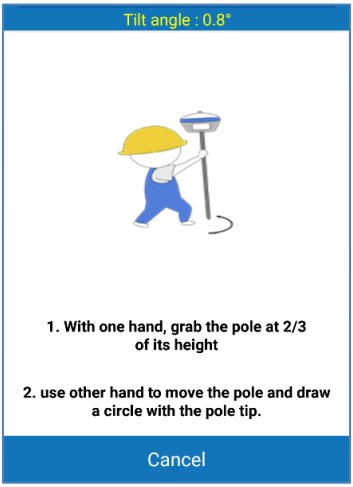
After the activation of the sensor, go in Survey window.

If the sensor is not ready to work yet, Cube-a will show which operations are necessary to perform its initialization.

There is a necessary pre-requisite to use the IMU: the status of the GNSS solution must be **Fixed** (Fixed, aRTK Fixed, Surefix or ExtraSafe Fixed).

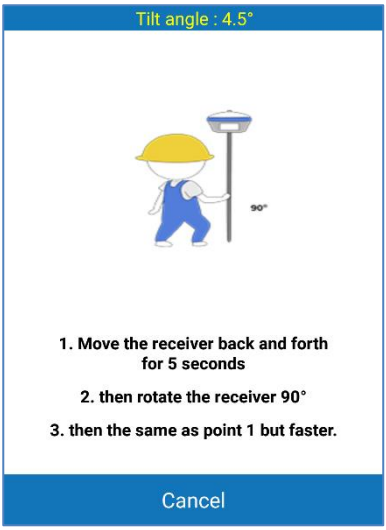
When, and only when, the receiver is in Fixed, and ***if the sensor needs to be initialized***, two different popup screens will show up.

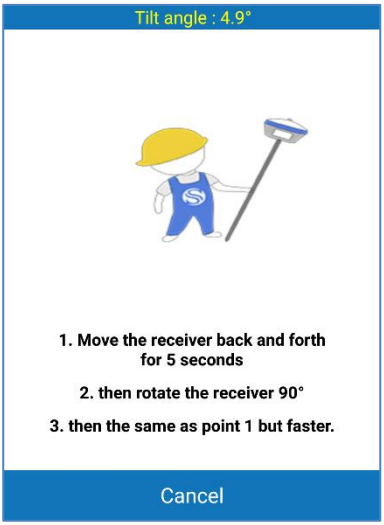
The first screen shows up seldomly: it lets the sensor adjust for the local magnetic field. Just rotate the pole with the device as shown in the picture below.



The second screen lets the sensor adjust the calibration parameters based on the local GNSS position and accuracy.

Move the receiver back and forth for a few seconds in a direction. Then rotate the system about 90 degrees and repeat the movements, in the same direction as before, as shown in the picture below.





If the screen does not disappear, try changing position to get lower RMS values and then repeat the two steps.

It could happen that during the survey, the screen shows up: this means that the IMU accuracy has degraded and it is necessary to adjust it: shake the receiver for a few seconds and it will be ready to continue working.

4.1.3 RMS Study and Sensor Calibration

You can check the accuracy of the tilt compensation through the RMS quality check.

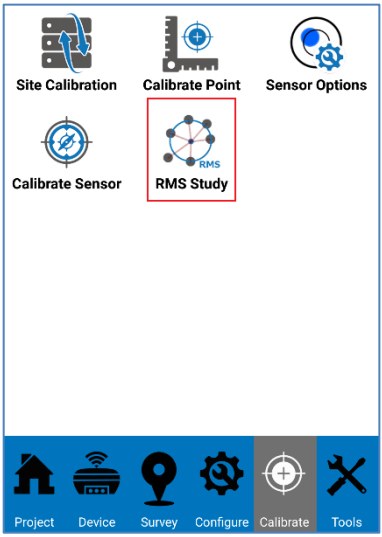
If the accuracy (RMS) is good, then you can continue working. If the accuracy (RMS) is not good, then calibrate the sensor using the Calibrate Sensor tool.

The RMS Study performs the study of the quality/accuracy of repeated measures (keep the pole tip at the same exact position on the ground).

How to use it?

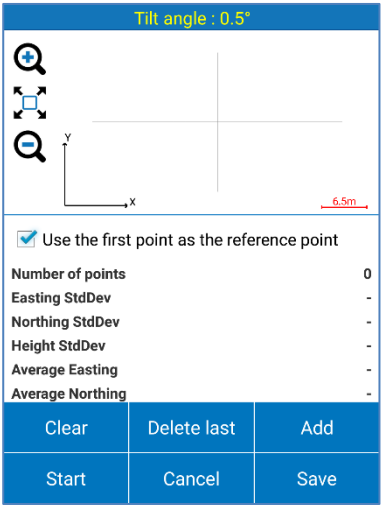
Open the **Calibrate** menu, then select the **RMS Study** command.

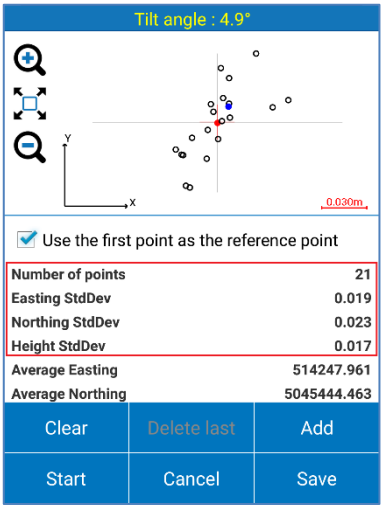
When inside the RMS Study screen, click **Start** to collect the measures.



The application will collect measures/positions at an average frequency of 1Hz. Collected positions will be averaged and RMS values will be computed.

The RMS values let the user to verify if the accuracy of the device falls within some required accuracy upper limit. If the RMS values are not satisfactory then the user can, and it is suggested, perform the calibration.

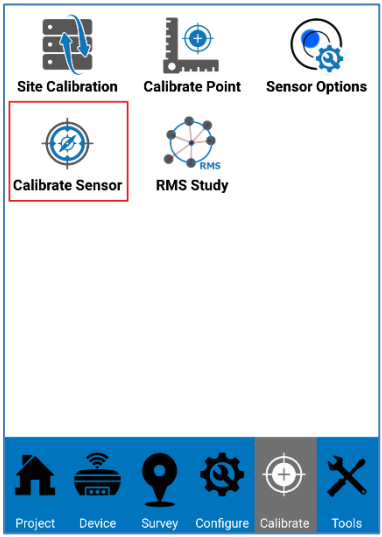




The user has the control of the number of sample positions used in the RMS calculation. When the user decides to complete the check, by tapping **Stop** the automatic position acquisition will be stopped.

The RMS values let the user to verify if the accuracy of the device falls within some required accuracy upper limit. If the RMS values are not satisfactory then the user can, and it is suggested, perform the calibration. This operation is also suggested when the user changes the pole height and/or the pole type (there could be a change in the straightness of the pole).

To calibrate the sensor, select the **Calibrate** menu and then click on the **Calibrate Sensor** option**.**

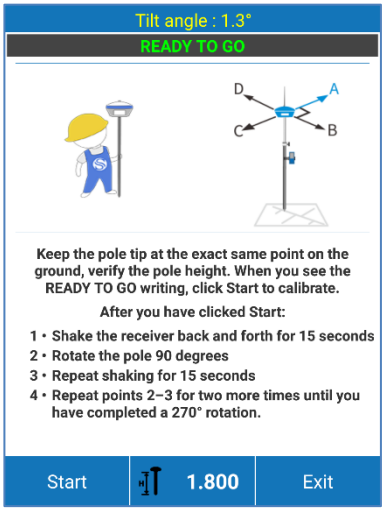


Follow the instructions indicated to perform the calibration.

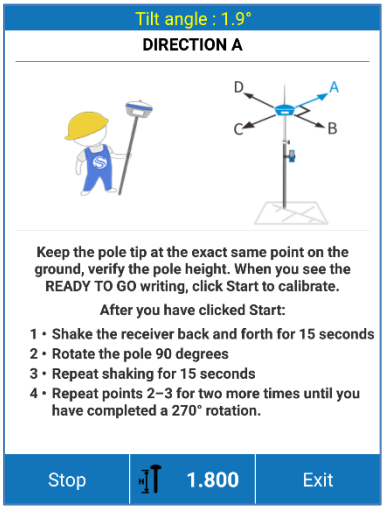
A **Fixed** GNSS solution is mandatory.

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

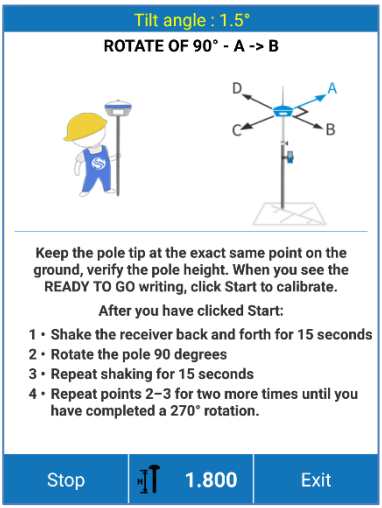
Wait for the message **Ready To Go**, start the calibration by clicking on the **Start** button**.**



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



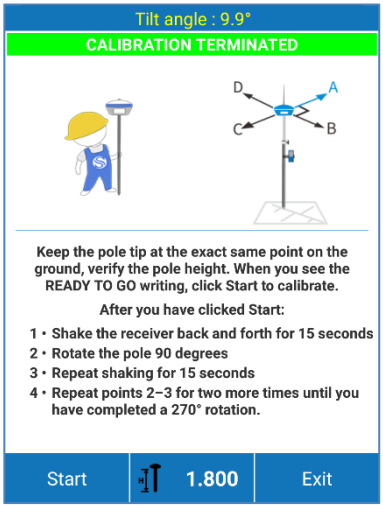
Rotate the receiver 90 degrees clockwise, reaching the direction A+90° = B, and continue to move back and forth the device.



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

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

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


Tilt angle : 9.9°
CALIBRATION TERMINATED
D
A
C
B
Keep the pole tip at the exact same point on the ground, verify the pole height. When you see the READY TO GO writing, click Start to calibrate.
After you have clicked Start:
1 • Shake the receiver back and forth for 15 seconds
2 • Rotate the pole 90 degrees
3 • Repeat shaking for 15 seconds
4 • Repeat points 2–3 for two more times until you have completed a 270° rotation.
Start
1.800
Exit

5. Accessories

5.1 Carrying case

The external appearance of the transport container is shown in the Figure 5.1.

Figure 5.1: External appearance

5.2 Standard accessories

Adaptor

Power adaptor (model: KSA-45P-45W) with 4 plugs (US, UK, AU and EU).

Charging cable

Type C -Type C charging cable (model: CTMM-1.5) 1.5 meter long.

Data cable

Type C -USB cable (model: CUTM-1.5) 1.5 meter long.

6. Technical specifications

RECEIVER	
Satellite signals tracked	GPS: L1 C/A, L1C, L1P, L2C, L2P, L5
	GLONASS: L1 C/A, L1P, L2 C/A, L2P, L3
	BEIDOU: B1, B2, B3, ACEBOC
	GALILEO: E1, E5a, E5b, ALTBOC, E6
	QZSS: L1 C/A, L1C, L2C, L5, L6
	IRNSS: L5
	SBAS: L1, L5
L-Band	Atlas H10 / H30 / Basic (optional)[5]
Bridging of RTK outages	aRTK - Works up to 20 minutes
Channels	800
Position Rate	10Hz (optional 20Hz)[5]
Signal Reacquisition	< 1 sec
RTK Signal Initialization	Typically < 10 s
Hot Start	Typically < 15 s
Initialization Reliability	> 99.9 %
Internal Memory	8 GB
Tilt Sensor	IMU[5]

POSITIONING[1]	
HIGH PRECISION STATIC SURVEYING	
Horizontal	2.5 mm + 1 ppm RMS
Vertical	5.0 mm + 1 ppm RMS
CODE DIFFERENTIAL POSITIONING	
Horizontal	<0.5 m RMS
Vertical	<1.0 m RMS
SBAS POSITIONING	
Horizontal	<0.6 m RMS[2]
Vertical	<1.2 m RMS[2]
REAL TIME KINEMATIC (< 30 Km) – NETWORK RTK[3]	
Fixed RTK Horizontal	8 mm + 1 ppm RMS
Fixed RTK Vertical	15 mm + 1 ppm RMS

INTEGRATED GNSS ANTENNA

High accuracy four constellation micro-strip antenna, zero phase center, with internal multipath suppressive board

INTERNAL RADIO (optional)[5]

Type	Tx - Rx
Frequency Range	410 - 470 MHz 902.4 – 928 MHz
Channel Spacing	12.5 KHz / 25 KHz
Maximum Range	3-4 Km in urban environment Up to 10 Km with optimal conditions[4]

INTERNAL MODEM

Band	LTE FDD: B1/B2/B3/B4/B5/B7/B8/B12/ B13/B18/B19/B20/B25/B26/B28 LTE TDD: B38/B39/B40/B41 UMTS: B1/B2/B4/B5/B6/B8/B19 GSM: B2/B3/B5/B8 Nano SIM card

COMMUNICATION

I/O Connectors	5 pins Lemo, connect the external power supply and external radio Type-C, for receiver power supply and data transfer
Bluetooth	V2.1 + EDR /4.0 LE
Wi-Fi	802.11 b/g
Web UI	To upgrade the software, manage the status and settings, data download, etc. via smartphone, tablet or other electronic device with Wi-Fi capability
Reference outputs	RTCM 2.3, 3.2 CMR, CMR+, ROX
Navigation outputs	NMEA 0183

POWER SUPPLY

Battery	Internal rechargeable 7.2 V - 6.900 mAh
Voltage	9 to 28 V DC external power input with over-voltage protection (5 pins Lemo)
Working Time	Up to 10 hours
Charge Time	Typically 4 hours

PHYSICAL SPECIFICATION

Dimensions	140 mm x 140 mm x 71 mm
Weight	1.10 Kg
Operating Temperature	-30°C to 65°C (-22°F to 149°F)
Storage Temperature	-40°C to 80°C (-40°F to 176°F)
Waterproof/Dustproof	IP67
Shock Resistance	Designed to endure to a 2 m pole drop on concrete floor with no damage
Vibration	Vibration resistant

Specifications are subject to change without notice.

1. Accuracy and reliability are generally subject to satellite geometry (DOPs), multipath, atmospheric conditions and obstructions. In static mode they are subject even to occupation times: the longer is the Baseline, the longer must be the occupation time.
2. Depends on SBAS system performance.
3. Network RTK precision depends on the network performances and are referenced to the closest physical base station.
4. Varies with the operating environment and with electromagnetic pollution.
5. Optional, it can be activated via firmware.

Appendix 1: Default radio configuration

The internal radio TRM121 can transmit on the 410-470MHz and 902.4-928 MHz band; users can choose radio channel and radio protocol through the handheld software or WEB interface. The default frequency of each channel is in the following table.

Channel	Frequency
1	438.125 MHz
2	440.125 MHz
3	441.125 MHz
4	442.125 MHz
5	443.125 MHz
6	444.125 MHz
7	446.125 MHz
8	447.125 MHz

Main features and general performance of the internal radio are summarized below.

General performance	
Frequency range	Fixed frequency: 410-470 MHz
	Hopping frequency: 410-470 MHz and 902.4-928 MHz
Band width	Fixed frequency: 12.5 KHz, 25 KHz
	Hopping frequency: 280 KHz
Modulation scheme	Hopping frequency: GMSK
	Fixed Frequency: GMSK, 4FSK
Transmitter	
RF output power	High power (1.0 W)
Modem	
Rate	Fixed frequency: 9600bp, 19200bps
	Hopping frequency: 115200bps
Modulation	GMSK

Appendix 2: Copyrights, warranty and environmental recycling

Copyrights and trademarks

STONEX®, the STONEX® logo, and S850A GNSS receiver are trademarks of STONEX® Limited.

STONEX® Cube-a, *STONEX® Cube Connector* are trademarks of STONEX® Limited.

Bluetooth is a trademark owned by Bluetooth SIG, Inc. and licensed to Trimble Navigation Limited. All other trademarks are the property of their respective owners.

Release Notice

This is May 2021 release of the STONEX® S850A GNSS new model receiver user guide.

The following limited warranties give you specific legal rights. You may have others, which vary from state/jurisdiction to state/jurisdiction.

Standard Limited Warranty

Version 2021

The terms and conditions of this Limited Warranty constitute the complete and exclusive warranty agreement between The Customer or Dealer and STONEX® for the Product and supersedes any prior agreement or representation made in any STONEX® sales document or advice that may be provided to Customer by any STONEX® representative in connection with Customer's purchase of the Product. No change to the conditions of this Limited Warranty is valid unless it is made in written form and signed by an authorized STONEX® supervisor.

STONEX® warrants that its Products:

(1) are free from defects in materials or workmanship for generally 1 year (accessories or specific parts for which different limited warranty period shall apply).

(2) have been tested/calibrated in proper working status prior to shipment.

The warranty period starts from date of first sale of the instruments. At its sole discretion, under the warranty period, STONEX® will repair the product or send parts for replacement at its expense. STONEX® agrees to repair or replace the defected instrument within thirty (30) days only if STONEX® Europe recognizes that the defects of the instrument are not caused by human factors or no obvious damage to its surface is visible. STONEX® warrants any new replaced parts or products are warranted to be free from defects in materials and workmanship for thirty (30) days or for the remainder of the Limited Warranty Period of the Product in which they are installed, whichever is longer. Faulty Parts or Products replaced under this Limited Warranty shall become property of STONEX®. All products that have to be repaired have to be returned to our technical representative office location via any delivery company the customer prefers, nevertheless STONEX® is not accountable for the unlikely event that the Products gets lost in transit. Any damage inflicted by the customer or by third party after the products has been delivered to the customer is excluded from the limited warranty as well any damage arising from an improper use, from any action or use not provided for in the enclosed user guides and/or manuals.

Shipping policy

The Customer or the dealer is required to pay for the charges for shipping of fault parts or instruments to STONEX® representative office and STONEX® is providing the shipping for return. Dealers need to follow STONEX® repair/service procedure to achieve a better and prompt service result.

Return policy Dead On Arrival instruments

All returned products have to be shipped to STONEX® representative office.

The original Purchaser has a period of seven (7) days starting from date of purchasing to signal the existence of a defect in the instrument for a full refund (less shipping and handling), provided the merchandise is in new, resalable condition and returned in the original, undamaged packaging.

Customer has to pay for both the return and the original freight fees, regardless of the original freight paid by the Company. All warranty books, instruction manuals, parts and accessories must be included as well as the original box in which the item was shipped. We recommend placing the original carton inside another box, to avoid any additional damage to the carton itself. In some cases, returns of special items will require a re-stock fee. Acceptance of returned merchandise is final only after inspection by STONEX®.

Above terms and policies shall apply as for hardware. Dealers need to follow STONEX® repair/service procedure to achieve a better and prompt service result.

Firmware/Software warranty

Stonex does not warrant that operation of Firmware/Software on any instruments will be uninterrupted or error-free, or that functions contained in Firmware/Software will operate to meet your requirements.

Stonex will forward the Software/Firmware Fix to the dealer or customer. Firmware/software Fix means an error correction or other update created to fix a previous firmware version that substantially doesn't conform to the instrument's specification.

Over Warranty repair(s) policy

Customer shall pay the standard repair fees for any service (whether part replacement or repairs) and performed by STONEX® under request and explicit authorization of the customer itself. In this case the customer is charged for return shipment's fees as well.

Disclaimer and Limitation of Remedy

All other express and implied warranties for this product, including the implied warranties of merchantability and fitness for a particular purpose and/or non-infringement of any third party's rights, are hereby disclaimed. Stonex® expressly disclaims all warranties not stated in this limited warranty. Any implied warranties that may be imposed by law are limited in duration to the term of this limited warranty. Some jurisdictions do not allow the

exclusion of implied warranties or limitations on how long an implied warranty lasts, so the above exclusions or limitations may not apply to customer. Customer must read and follow all set-up and usage instructions in the applicable user guides and/or manuals enclosed. If customer fails to do so, this product may not function properly and may be damaged. Customer may lose data or sustain personal injuries. Stonex®, its affiliates and suppliers do not warrant that operation of this product will be uninterrupted or error free; as do all electronics at times. If this product fails to work as warranted above, customer's sole and exclusive remedy shall be repair or replacement. In no event will Stonex®, its affiliates or suppliers be liable to customer or any third party for any damage in excess of the purchase price of the product. This limitation applies to damages of any kind whatsoever including (1) damage to, or loss or corruption of, customer's records, programs, data or removable storage media, or (2) any direct or indirect damages, lost profits, lost savings or other special, incidental, exemplary or consequential damages, whether for breach of warranty, contract, tort or otherwise, or whether arising out of the use of or inability to use the product and/or the enclosed user guides and/or manuals, even if Stonex, or an authorized Stonex® representative, authorized service provider or reseller has been advised of the possibility of such damages or of any claim by any other party. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages for some products, so the exclusions or limitations may not apply to customer. This limited warranty gives customer specific legal rights, and customer may also have other rights which vary from country/state/jurisdiction to country/state.

Instruments

2 years on STONEX® S850A GNSS.

Accessories

Accessories and specific parts warranty

For accessories provided by Stonex with the instruments S850A GNSS the following general warranty time is for reference:

Power Adaptor, cables: 1 year.

Environmental recycling

The cardboard box, the plastic in the package and the various parts of this product have to be recycled and disposed of in accordance with the current legislation of your Country.

For countries in the European Union (EU)

The disposal of electric and electronic device as solid urban waste is strictly prohibited: they must be collected separately.

Contact Local Authorities to obtain practical information about correct handling of the waste, location and times of waste collection centre. When you buy a new device of ours, you can give back to our dealer a used similar device.

The dumping of these devices at unequipped or unauthorized places may have hazardous effects on health and environment.

The crossed dustbin symbol means that the device must be taken to authorize collection centres and must be handled separately from solid urban waste.

For countries outside European Union (EU)

The treatment, recycling, collection and disposal of electric and electronic devices may vary in accordance with the laws in force in the Country in question.

Appendix 3: Safety Recommendations

Warnings and Cautions

An absence of specific alerts does not mean that there are no safety risks involved in the use of this equipment.

Always follow the instructions that accompany a Warning or Caution, reported in this.

This information is intended to minimize the risk of personal injury and/or damage to propriety. In particular, observe safety instructions that are presented in the following form:

WARNING - A Warning alerts about risk for health and/or damage to the propriety. A warning identifies the nature of the risk and the extent the possible injury and/or damage. It also describes how to protect yourself and/or the equipment from this risk.

CAUTION - A Caution alerts about a possible risk of damage to the equipment and/or loss of data, but no risk for human safety.

Wireless Module Approval

The receivers use internal wireless modules or can be connected to an external data communications UHF radio. Regulations regarding the use of the radio-modems vary greatly from country to country. In some countries, the unit can be used without obtaining an approval license. Other countries require specific approval or auto certification by the set maker.

Before using this instrument, check if authorization to operate the receiver is required in your country. It is the responsibility of the importer to verify if it is necessary a certification or license for the equipment in the country of use.

Instrument Approval

Covers technical features of the equipment relatives to electromagnetic emissions that can cause interference and disturbances to other instruments (note like emc compatibility) or generate not correct functionalities of the instrument itself. Approval is granted by the manufacturer of the equipment. Some countries have unique technical requirements for operation in particular frequency bands. To comply with those requirements, Stonex srl may modified the equipment to be subjected to grant.

Unauthorized modification of the units voids already got approvals, the warranty time and the operational licenses of the instrument.

UHF 410-470 MHz / 902.4-928 MHz Data transceiver

General Antenna Installation Warning

1. All antenna installation and servicing are to be performed by qualified technical personnel only. When servicing the antenna, or working at distances closer than those listed below, ensure the transmitter has been disabled.

2. Typically, the antenna connected to the transmitter is a directional (high gain) antenna, fixed-mounted on the side or top of a building, or on a tower. Depending upon the application and the gain of the antenna, the total composite power could exceed 90 watts ERP. The antenna location should be such that only qualified technical personnel can access it, and that under normal operating conditions no other person can touch the antenna or approach within 0.6 meters of the antenna.

You can see below a table showing the Antenna Gain versus Recommended Safety Distance:

	Antenna Gain		
	0-5 dBi	5-10 dBi	10-16.5 dBi
Minimum RF safety distance	0.6 meters	1.06 meters	2.3 meters

For USA

The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy. Proper use of this radio modem results in exposure below government limits. The following precautions are recommended:

DO NOT operate the transmitter when someone is located less than 20 cm (7.8 inches) of the antenna.

DO NOT collocate (place within 20 cm) the radio antenna with any other transmitting instruments.

DO NOT operate the transmitter unless all RF connectors are secure, and any open connectors are properly terminated.

DO NOT operate the equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly used according to the installation instructions for safe operation.

All equipment should be repaired and calibrated only by a qualified technician.

For Europe

The European Community provides some Directives for the electronic equipments introduced on the market.

All the relevant information's are available on the European Community website:

http://ec.europa.eu/enterprise/sectors/rtte/documents/

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://ec.europa.eu/enterprise/sectors/electrical

For USA

For your own safety, and in terms of the RF Exposure requirements of the FCC always observe the precautions listed here.

Maintain a minimum separation distance of 20 cm (7.8 inches) between yourself and the radiating antenna.

Do not collocate (place within 20 cm) the radio antenna with any other transmitting device.

Bluetooth/Wi-Fi radio Module

The radiated output power of the internal Bluetooth module of this equipment is far below the FCC and EU radio frequency exposure limits. In any case, be sure to use the equipment with the radio far at least 20 cm from the human body. The Bluetooth module match the guidelines found in radio frequency "safety standards and recommendations "published by Scientific organizations.

Stonex srl therefore believes the internal wireless radio is safe for use by end users. The level of energy emitted is far less than the electromagnetic energy emitted by wireless devices such as UMTS phones. However, the use of Bluetooth/Wi-Fi may be restricted in some special situations or place, like aircraft , hospital ,etc. If you are unsure of existence of restrictions, you should ask for authorization before switching on the Bluetooth radio.

Recommendation for installing antennas for internal radios.

An absence of specific alerts does not mean that there are no safety risks involved in the use of this equipment.

Always follow the instructions that accompany a Warning or Caution, reported in this. This information is intended to minimize the risk of personal injury and/or damage to propriety. In particular, observe safety instructions that are presented in the following form:

CAUTION

For your own safety, and to match the RF Exposure requirements of the FCC, always observe these precautions:

Always maintain a minimum separation distance of 20 cm (7.8 inches) between yourself and the radiating antenna.

Do not collocate (place within 20cm) the radio antenna with any other transmitting device.

Do not switch on the GSM or UHF module without the antenna mounted to the external connector.

UHF Antennas having a gain greater than 5 dBi, are strictly prohibited for use with this device. The required antenna impedance must be 50 ohms.

Rechargeable Lithium-ion batteries

These receivers use a rechargeable Lithium-ion battery.

WARNING

- Do not creates damage at the rechargeable Lithium-ion battery.

A damaged battery can cause an explosion, with risk or fire, and can result in personal injury and/or property damage.

To prevent injury or damage:

– Do not use or charge the battery if it appears to be damaged. Signs of damage are discoloration, warping, leaks of liquids.

– Do not expose the battery to fire, high temperature, or direct strong sunlight.

– Do not introduce the battery in water or liquid substance, in general.

– Do not use or store the battery in very hot ambient.

– Do not drop or puncture the battery.

– Do not open the battery and do not put in short-circuit its electrical contacts.

WARNING

- Avoid direct contact with the rechargeable Lithium-ion battery if it appears damage. Battery liquids are corrosive and, contact with it can result in personal injury or damage to proprieties.

To prevent injury or damage:

– If the battery leaks, avoid contact with the battery fluid.

– If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!

– If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.

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