



RF EXPLORER® PRO AUDIO EDITION

User Manual

Updated to Firmware Version 3.06

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INTRODUCTION



RF Explorer Pro Audio Edition has been designed to be intuitive and easy to use. There is no need to read large user manuals to gain advantage of its advanced functionality.

Most of the complexity inherent to full sized Spectrum Analyzers is simplified with automatic functionality resolved by the firmware. For instance, you do not need to adjust Resolution Bandwidth (RBW) every time you select a different frequency span. Actually, you do not even need to know what RBW is. You can progress in your RF learning curve and come back to this manual and online tutorial anytime.

When used to setup, troubleshoot, or commission wireless microphone or in-ear monitor systems, the RF Explorer Pro Audio Edition can be a powerful tool. Use it to identify interference, check signal levels, position antennas for optimal performance, and more.

For questions or feedback, please visit rfvenue.com.

DESCRIPTION OF MAIN FEATURES

- ✓ Pocket-size and light weight with solid aluminum metal case
- ✓ 50 Ohm BNC Input for interfacing with wireless microphone and IEM systems and accessories
- ✓ Peak Max, Max Hold, Normal, Overwrite and Averaging modes
- ✓ High capacity Lithium Ion battery for up to 16 hours of continuous use, rechargeable by USB.
- ✓ Mac OSX Vantage software and Windows software applications available online
- ✓ USB Communication protocol is open for custom solutions and extensions.
- ✓ Free firmware upgrades available

CONNECTING THE RF EXPLORER PRO AUDIO EDITION



The RF Explorer Pro Audio Edition includes 9 functional buttons on the front side, including contextual HELP and preset handling with the SET button. The unit also includes one 50 ohm impedance BNC RF input connector.

The unit will automatically start running on USB power when a compatible mini-USB cable is connected.

Important: The internal battery power switch must be in the ON position for the battery to charge when the USB cable is connected. The internal battery will not charge when the power switch is in the OFF position.

SPECTRUM ANALYZER MODE - MAIN SCREEN

RF Explorer goes to Spectrum Analyzer mode automatically when powered on.



The X axis represents frequency in MHz and the Y axis displays received power in dBm or dBuV (selectable). In this example above, the frequency span goes from 2390 MHz to 2450 MHz (that is a 60MHz range), and the visual amplitude goes from -1 dBm to -110 dBm.

Configuration settings such as amplitude reference and frequency span are preserved between sessions, stored in the unit's internal FLASH memory.

The main screen automatically displays a small marker with a triangle shape. This indicates the peak amplitude found in the current frequency span, noted in the first text line in MHz and the second line in dBm at that particular point.

The main screen has a number of additional indicators:

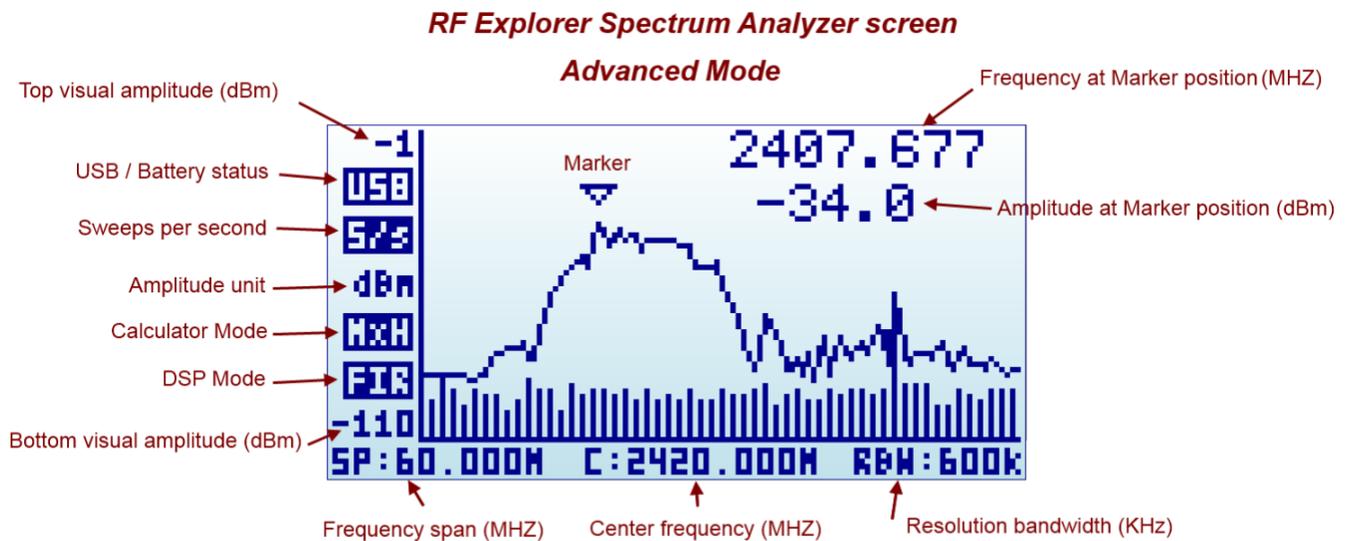
RF Explorer Spectrum Analyzer screen



The available indicators are:

- **USB / battery status:** this indicator will display USB¹ when a valid 5V USB connection is available. This will be true even if the connection is through a wall wart charger, meaning it does not indicate a data connection but rather a power bus connection. Alternatively, a battery icon with charge level indicator will display when the RF Explorer unit power switch is set to ON. If both connections are enabled, then USB and Battery will alternate and, in this case, the battery will be charging.
- **Sweeps per second:** this is an approximate value of the number of full screen sweeps happening every second. In the example above, there are 5 sweeps per second or, in equivalent terms, one sweep every 200ms.
- **Calculator mode:** this indicator may have different values as specified by the Calculator mode in the frequency menu. Please check the section Frequency Menu in page 10.
- **DSP mode:** this indicator shows the actual value being used by the Analyzer. The *DSP:Auto* is the recommended setting in the Frequency Menu (see page 10) so RF Explorer will select the best possible option as per below:
 - **FST:** Fast mode. This mode will configure the unit for fastest scanning.
 - **FIR:** Filter mode. This is the recommended mode for Pro Audio users, as it will increase accuracy using filtering.
- **Marker:** There are different operational modes for the marker, see Configuration Menu in page 16.

The analyzer screen can be turned into advanced mode using the [Return] key:

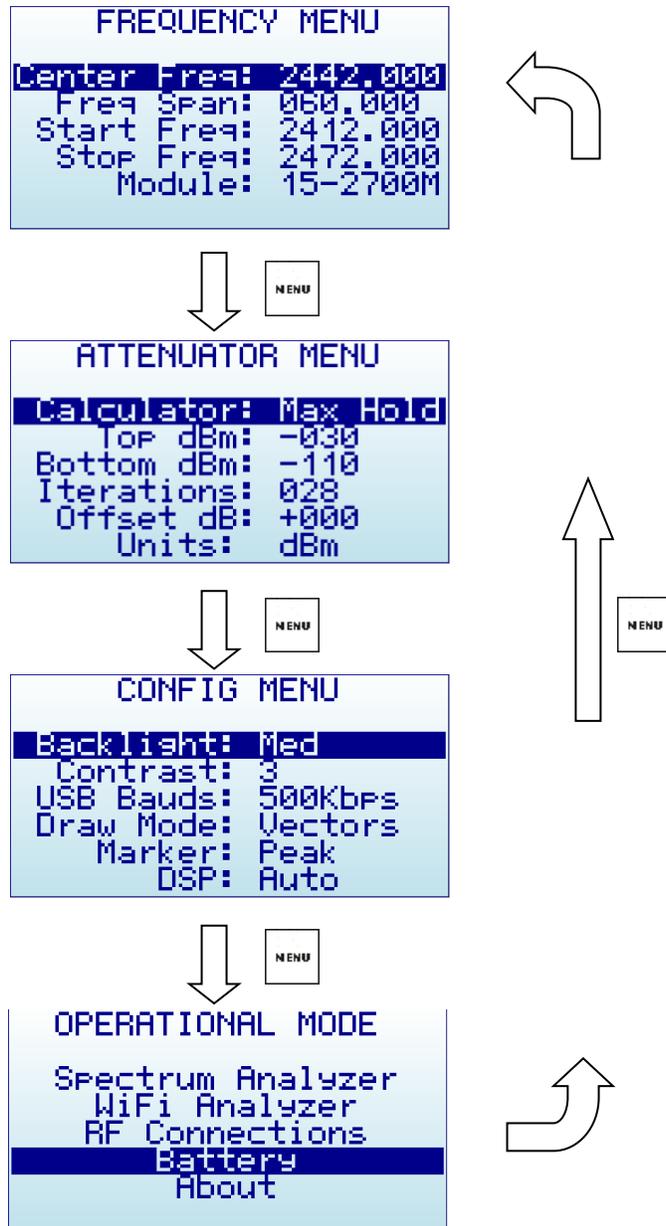


Note the frequency axis indicators changes at the bottom. More details about this screen mode in section *Analyzer screen* page 12.

¹ USB refers to Universal Serial Bus, the standard connectivity bus in all modern computers. Our fellow HAM users should not confuse this with Upper Side Band communication, even though uses the same mnemonic.

USING MENUS

There are several menus in RF Explorer. They are organized on different screens, which you can navigate through using the [Menu] key. If you click the [Menu] button multiple times, you will toggle through them:



You can also navigate screens using the [Left] and [Right] keys. You can exit from a menu anytime by using the [Return] key.

The first time you click on [Menu] button in a RF Explorer session, Frequency Menu will open. This may change as we will see later, so every time you click on [Menu] from Spectrum Analyzer main screen, you re-open the last menu you were working with. This saves time by not having to navigate through all the menus to go the same place you were before.

OPERATIONAL MODE MENU

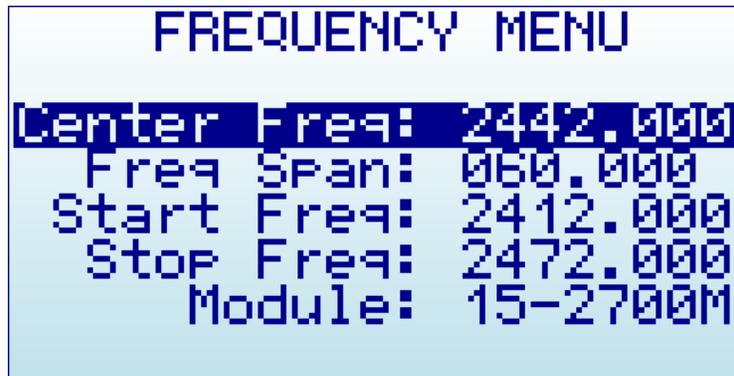
The menu display different functional modes available in your Analyzer.



Use [Up] and [Down] arrow keys to select the desired mode and click on [Enter] to activate it immediately.

- **Spectrum Analyzer** mode is the default mode, available in all RF Explorer models
- **WiFi Analyzer** is available in the Pro Audio Edition for analyzing 2.4 GHz spectrum in standard channel format.
- **RF Connections** displays the installed RF module
- **Battery** includes details on internal battery charge level, and assist you on charging the unit when connected to USB. For more details read section *Charging the internal battery* in page 20.
- **About** displays information about installed firmware and versioning. Use any key to get out of this screen.





- **Center Freq:** Center frequency in MHz
- **Freq Span:** Frequency span (or range) to display on screen in MHz
- **Start Freq:** Lower frequency range to display on screen in MHz
- **Stop Freq:** Higher frequency range to display on screen in MHz
- **Module:** Active selected RF module.

The selected frequency band to display can be specified in two different but complementary ways:

- **Center/Span:** This is the traditional Spectrum Analyzer format many engineers are used to. Select the Center frequency at which the band will be displayed, and then a Frequency Span.
- **Start/Stop:** This alternative mode is very useful to select frequency range between two frequencies of interest, with no need to manually calculate the Center or the Span.

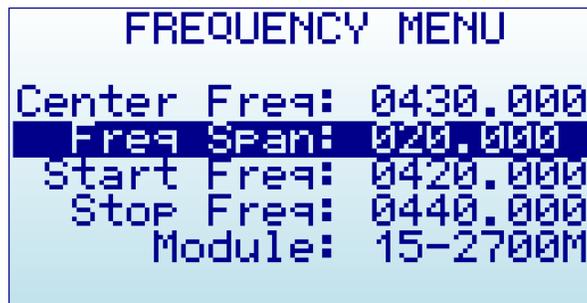
As you edit Center/Span or Start/Stop, the other values are updated accordingly, so feel free to use the method you prefer. In general, you will use Center/Span more frequently when you know the frequency you want to look at, and Start/Stop when you just want to look at a larger span to see what is happening in a specific range.

To navigate through the menu, just use [Up] and [Down] keys to go to the option you want, then click on [Enter] to edit that option, [Left] or [Right] to go to the digit you want to change, and [Enter] to confirm or [Return] to cancel.

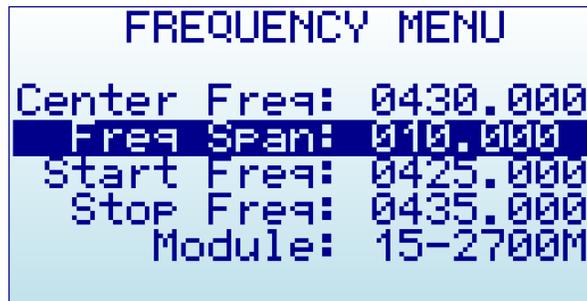
As an example, a center frequency of 430MHz with a 20MHz span:



A click on [Menu] button will open the Frequency Menu:



Selecting a span of 10MHz, the Start/Stop frequency changes accordingly:



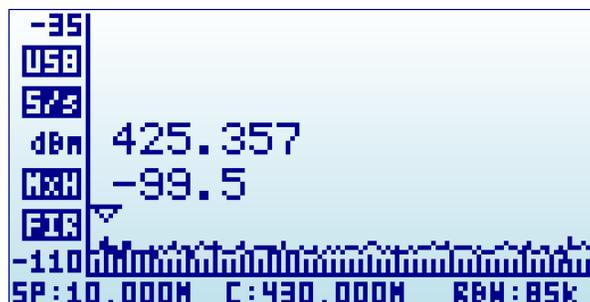
A click on [Return] button will close the menu and go back to Spectrum Analyzer main screen.



Note: While RF Explorer Spectrum Analyzer screen is enabled, the [Left] and [Right] buttons can be used to increase or decrease the Start/Stop frequency, moving the visible spectrum to the left or the right 25% on every key press. This is helpful in order to offset the visual range without need to specify a new numeric range.

ANALYZER SCREEN IN ADVANCED MODE

Alternatively, there is a simpler way to increase and decrease frequency span while keeping the center frequency. As this is a common workflow, the RF Explorer Spectrum Analyzer screen enables the [Return] key to switch between standard visualization mode and advanced mode.



In this screen above, the frequency reading at the bottom changed from Start/Center/Stop frequency to Span/Center/RBW. When this mode is enabled, a key press on [Left] or [Right] button will increase or decrease to double and half frequency span respectively.

As an example, to increase the span from 10MHz to 20MHz, a single click to the [Left] button is enough, no need to go back to the Frequency Menu.

ADVANCED: UNDERSTANDING RBW

The advanced mode displays the currently selected RBW (Resolution Band Width). This is an important concept for advanced users.

The RBW references the internal filter used to discriminate the bandwidth of each sweep step. In RF Explorer, each measurement dot represents a range of frequencies, and there are exactly 112 steps on each sweep. As an example, in a 10MHz span, each of the 112 measurement steps represents $10\text{MHz}/112=0.089\text{MHz}$ or, in other words, 89KHz².

The range of frequencies represented on each sweep step is a level of uncertainty; screen resolution is limited to that RBW. With a resolution of 89KHz on screen (for a 10MHz span), the best accuracy expected is exactly that value. In other words, a frequency reading of 430.100MHz on screen may mean a range of $\pm 44.5\text{KHz}$ each side, as the filter will not discriminate further than that for a 10MHz span.

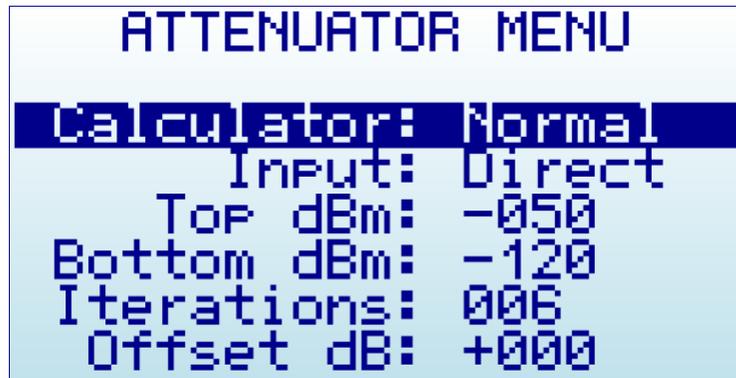
In addition to that, RBW has an important impact on the sensitivity of the Spectrum Analyzer. The wider the filter bandwidth, the higher the spectral noise and therefore the lower the sensitivity. This is visible by an increasing noise floor as the RBW is larger, and lower noise floor as the RBW is narrower. Based on this, the narrowest RBW would look like the better choice for all measurements but as you get a narrower RBW you also decrease the scan speed notably, due to the slower nature of a narrow filter as well as the need to measure more sweep points to cover the full span.

² Note the actual value used by the device may differ from the value calculated, due to finite tabulated choices.

Selecting the best combination of RBW, scan speed and sensitivity requires significant experience. In most Spectrum Analyzers, the operator needs to fully understand and select RBW for each measurement, one of the most challenging aspects of proper Spectrum Analyzer usage.

Fortunately, this is not the case with RF Explorer: The design of the internal DSP includes sophisticated internal tables and algorithms to make the best possible choice at all times automatically. No user intervention is required to get the best compromise between scan speed, noise floor and sensitivity every time.

The internal RBW setting can be checked anytime in advanced screen mode [Return Key in Spectrum Analyzer View].



- **Calculator:** internal DSP calculator mode
- **Input:** select input stage to enable LNA or Attenuator
- **Top dBm:** Visual max amplitude on screen.
- **Bottom dBm:** Visual min amplitude on screen.
- **Iterations:** Internal DSP calculator iterations.
- **Offset dB:** external dB attenuation or gain value to compensate for external devices, such as attenuators or amplifiers.
- **Units:** dBm or dBuV. *Note you may need to navigate all the way to the bottom for the menu to show this last option on screen.*

The selected Top and Bottom dBm are visual limits, not real internal limits.

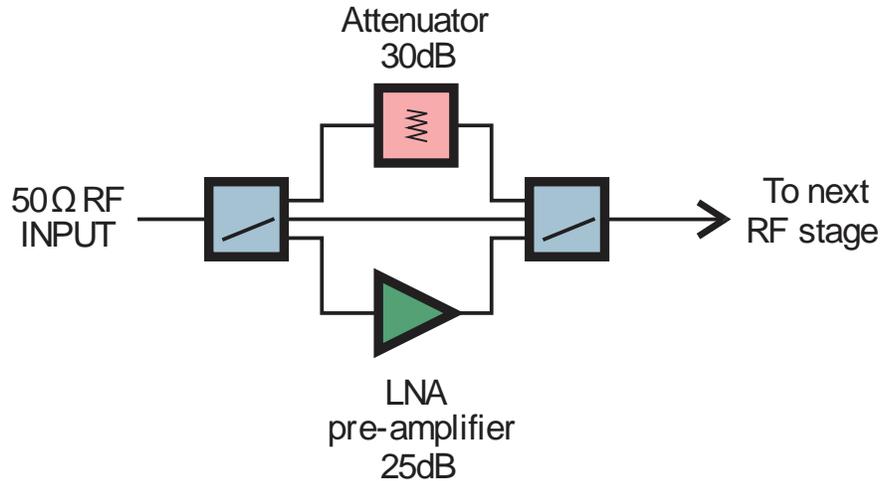
The internal DSP optionally performs advanced calculations in order to configure the analyzer for the required measurement:

- **Calculator** offers multiple modes to display data, to change mode click on [Enter] key:
 - **Max:** Peak values are used from the last sweep Iterations (see menu option at the bottom). This is the standard mode you will want to use to detect rapidly changing DSS signals or find for worst case channel occupancy.
 - **Max Hold:** Capture all activity in the band including the Max signal envelope mode with vector graphics and real-time activity with vertical bars. Use this mode anytime you want to detect activity for a long period of time. It is a very powerful mode to detect activity in busy bands such as 2.4 GHz. As this is a cumulative mode, **while on Spectrum Analyzer screen you can clear the spectrum anytime with the RETURN button.**
 - **Average:** Average is calculated over the last sweep Iterations. This is the best possible choice to remove unwanted noise, particularly useful in constant wave (CW) and channel signals display.
 - **Normal:** No calculation is done, just raw data as a result of the real-time sweep.
 - **Overwrite:** Useful to track unlimited activity in the band. Darker areas will point to high activity signal. You can clear the spectrum anytime with the RETURN button.
- **Iterations:** The number of sweep data iterations to perform calculations on. It goes from 1 to 16. As an example, a value of 5 with Calculator: Average means the DSP will use 5 complete accumulated sweeps to average data.

Note: *Selecting a higher or lower Top dBm value is a very frequent workflow, as you typically want to zoom in or out based on signal power being measured. RF Explorer Spectrum Analyzer main screen offers two keyboard shortcuts: [Up] and*

[Down] arrow keys can be used to increase or decrease Top dBm respectively by 5dBm each time. This shortcut, together with [Left] and [Right] for moving Center Frequency or Span as described before, are very convenient to make configuration changes in real-time without navigating to the Menu settings.

Included in RF Explorer Pro Audio Edition is a selectable input stage with three possible signal paths:



- **Direct:** low loss signal path to standard sensitivity, use for linear measurements up to -25dBm
- **Attenuator:** 30dB nominal wideband attenuator, use for linear measurement up to 0dBm
- **LNA:** low noise wideband preamplifier, use for linear measurements up to -40dBm. Note this option requires more battery power than other modes. When using LNA and an antenna, it is recommended using band pass filters to limit the wideband noise detected, otherwise degraded signal/noise reception may limit or even cancel the benefit of the amplifier.

The selection is defined by using the *Input* option in the *Attenuator Menu*. High performance RF switches drive the signal path into the selected option instantly.



- **Backlight:** Several levels of display backlight. RF Explorer has good visibility indoors and outdoors, including direct sunlight. The level of backlight should be set for operating conditions, and you may want to limit backlight brightness to preserve battery capacity.
- **Contrast:** There are 10 different display contrast levels to choose from.
- **USB Bauds:** Default is 500Kbps, which is also the recommended setting.
- **Draw mode:** Vectors is the standard mode, and Fill can be specified if additional contrast is required by filling the area behind the signal.
- **Marker:** There are three different modes available for the Marker on the Spectrum Analyzer screen:
 - **Peak:** The marker will automatically detect the peak value on screen.
 - **Manual:** The marker can be manually moved anywhere on the screen by using [Left] and [Right] buttons. When this mode is selected, the standard functions to move Center Frequency or Span are disabled.
 - **None:** The marker is not displayed.
- **DSP:** The DSP (Digital Signal Processor) can be configured in different ways in order to select the best possible choice of noise reduction, image rejection and scan speed.
 - **Filter: This mode is recommended for all Pro Audio applications such as wireless microphones and IEM scanning.** When Filter mode is enabled, the DSP will scan the spectrum several times in order to reject unwanted spurs and image frequency out of the screen. As result of that, the scan speed is slower than compared with Fast mode.
 - **Auto:** When Auto mode is enabled, the internal configuration tables will select the best possible algorithm. The Spectrum Analyzer screen will display a FIR (Filter) or FST (Fast) mode to indicate the actual DSP mode being used.
 - **Fast:** This mode is recommended for advanced users only. When it is selected on the 15-2700MHz or Plus module, the DSP will not process spurs and therefore unwanted signals could display on screen.



The Preset section is a convenient way to store multiple configurations which can be easily recovered.

- **Identifier:** Numerical index of the preset valid from 1-100 (Plus model) or 1-30 (Combo models)
- **Description:** Descriptive text up to 12 characters long. An asterisk at the end is automatically added when the preset has actually some data stored. This field is editable and can be changed.
- **Load:** Action option to load stored preset values into current configuration, the menu screen is automatically closed once the preset is loaded
- **Save:** Action option to save current configuration into the selected preset – this option cannot be undone, care should be taken to not overwrite another valid preset
- **Reset:** Action option to remove all values from selected preset and reset to unused state - this option cannot be undone, care should be taken to not reset a valid preset
- **Frequency range:** when an active preset with data stored is selected, the last line of the screen shows the Start/Stop frequency range of the preset, to help on determining the specific preset configuration before engaging it. This line will be blank when an empty preset is selected.

Easy Preset restore:

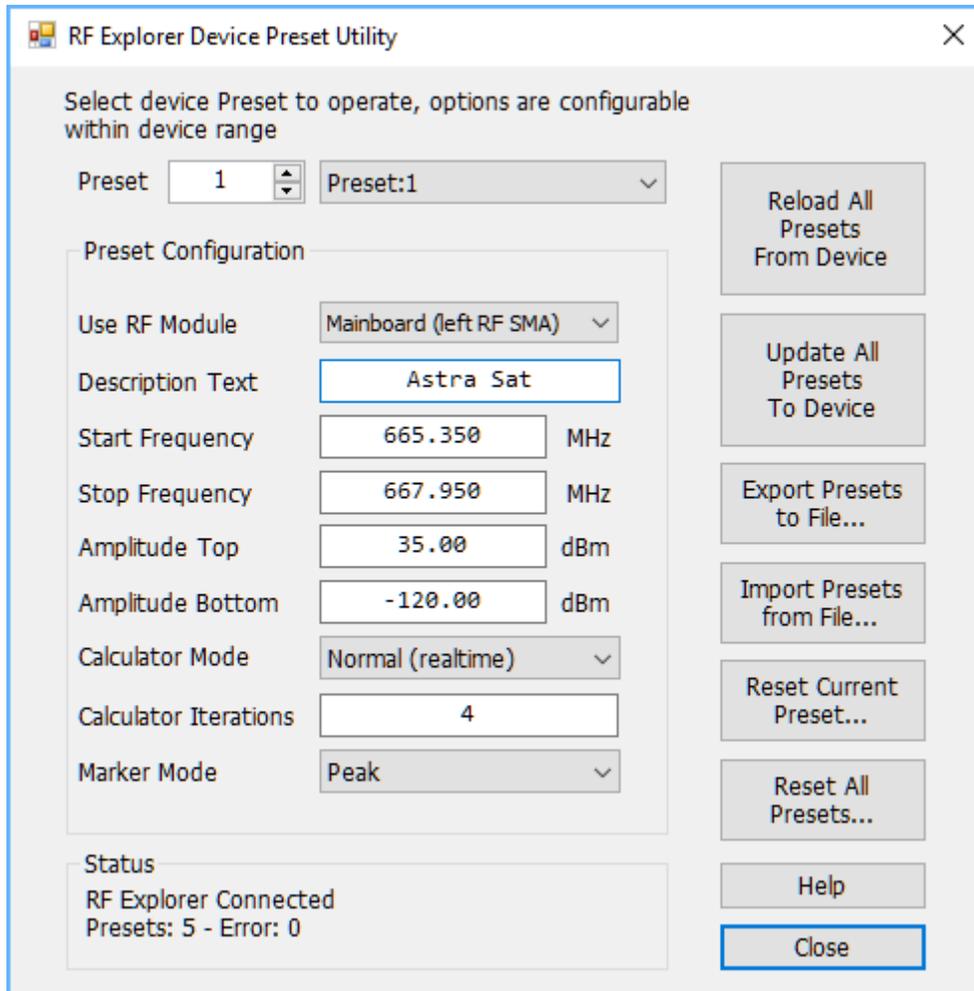
This menu has a very convenient shortcut for easy selection and restore of any pre-defined preset:

- Press SET button from any *Analyzer* mode screen. By pressing SET button, this menu becomes active and the cursor is preselected in *Load* action option. Pressing the SET button inside this menu will iterate through all predefined Presets with valid data one by one. This shortcut is faster than manually changing *Identifier* numbers one by one when you are looking to load a preset.

USING RF EXPLORER PRESET MANAGER

This is an included convenient tool to easily create and edit Presets from a Windows, Linux or Mac computer. It also includes the ability to define custom Description text for each preset.

Presets can be uploaded to / downloaded from the RF Explorer device using USB standard connection, and presets definitions can be imported / exported to share definition among devices easily.

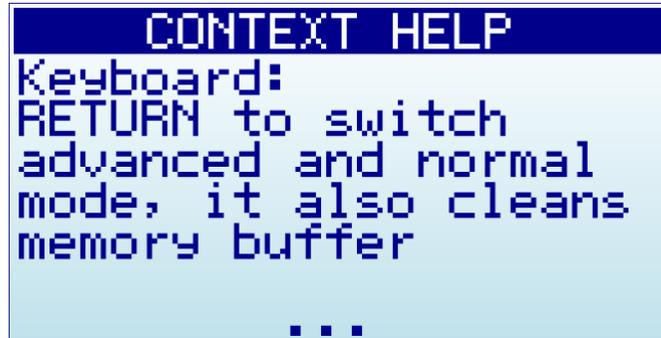


For more details please visit online help: <http://www.rf-explorer.com/preset>

HELP BUTTON

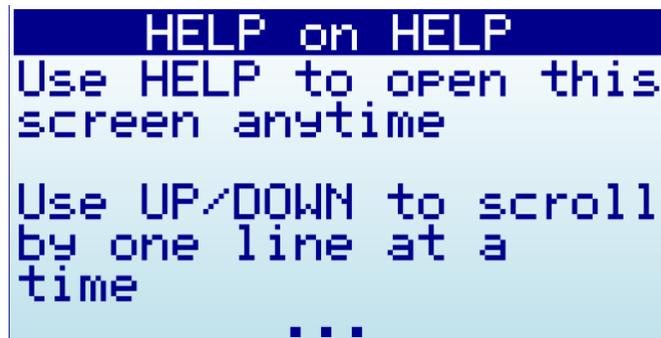
RF Explorer Pro Audio Edition includes HELP button for easy, intuitive context-sensitive help.

The HELP text can be displayed in all functional screens, effectively complementing this User Manual with handy information, always available with a simple click.



Use the following keys to interact with Help screen:

- **Scroll text up and down:** The bottom of screen shows “...” when additional text is available for scroll. Use UP and DOWN arrow key buttons to scroll text one line at a time, or LEFT and RIGHT arrow key buttons to scroll text full page at a time.
- **Help on Help:** This special screen offers description of how to interact with Help screen itself. Use HELP button within a Help screen to activate *Help on Help*.



- **Close help screen:** use RETURN or ENTER key, both will close the help screen and return to previous device state.

RF EXPLORER INTERNAL BATTERY

The internal battery is a high capacity 1000 mAh Lithium-ion polymer type. This is the same battery technology used in cell phones and modern laptops and tablet computers.

The power switch is a *true hard switch* connecting the battery in ON position, fully isolating the battery in the OFF position. As the battery is fully disconnected in the OFF position, you can keep your RF Explorer stored for months and the battery will keep the charge intact, as opposed to cell phones or laptops which typically implement a *soft switch* which slowly discharge the battery by drawing a microamperes continuously from it. This doesn't happen in your RF Explorer.

IMPORTANT

Never charge your device unattended or in any place where there is a risk of fire.

Never store RF Explorer in a place where temperature may go beyond 50°C (122°F). A car can heat up incredibly quickly in the **SUN**, especially in the summer, and damage or reduce the lifetime of your battery if stored in such an environment.

If you manipulate RF Explorer to assemble an Expansion Module, always proceed very carefully with the Lithium Ion battery and make sure it is not punctured, damaged or inflated in any way. A healthy battery is a flat rectangle with no signs of any deformation. If you have any doubt, please take a picture of your unit and send it to us for further help.

If your battery doesn't seem to hold a charge or work properly, or if the unit gets hot when charging, switch the power button OFF immediately and review and/or replace your battery.

Never use RF Explorer with a damaged battery or with a Lithium Ion battery different than the one officially supplied by technical service, which includes a protection circuit for safety.

Contact QC@SeedStudio.com if you have any question on any matter related with your battery or if you need a replacement.

CHARGING THE INTERNAL BATTERY

To charge the internal battery, plug it in to a powered USB port or USB wall-wart charger via the USB mini socket. For the internal charger to access the battery, you must set the power switch to ON position, otherwise the device will be running from USB but will not use or charge the internal battery.

RF Explorer may draw up to 500mA according to USB standard, and may take up to 3hs max to charge a fully discharged battery in normal conditions. We recommend first charging for up to 8hs.

It is ok to keep the battery connected to the USB port, the internal charger will stop and start the charge when needed.

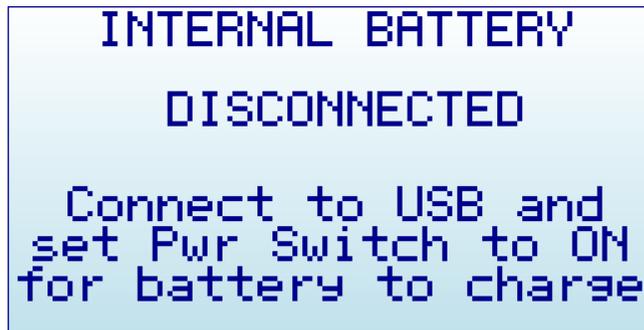
If your USB port is unpowered it may not be capable of delivering more than 100mA; the battery may not be charged at all. If you have no other option available than a 100mA USB port, set the LCD backlight to OFF in the OPTIONS MENU and keep charging for as long as needed (it may take up to 24hs in these conditions so you should use a powered USB port whenever possible).

USING THE BATTERY SCREEN

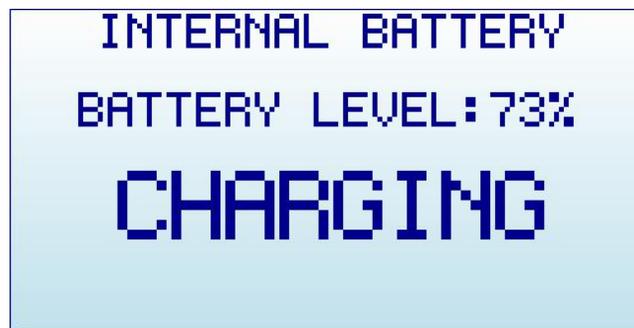
In latest firmware version, you can use the Battery menu option for battery charge control. Note: As long as the USB is connected and the power switch is in the ON position, the battery will charge. However, you can get additional information when using the Battery specific menu.



Inside this INTERNAL BATTERY charger screen, it is easy to check battery level and confirm if the battery is being charged. In this case below, it indicates the power switch is not in the ON position and, therefore, battery is not being charged.

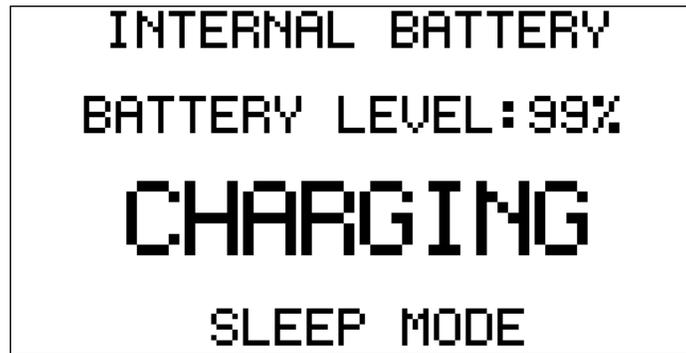


As soon as the power switch is set to the correct position, the screen will display correct charging status.

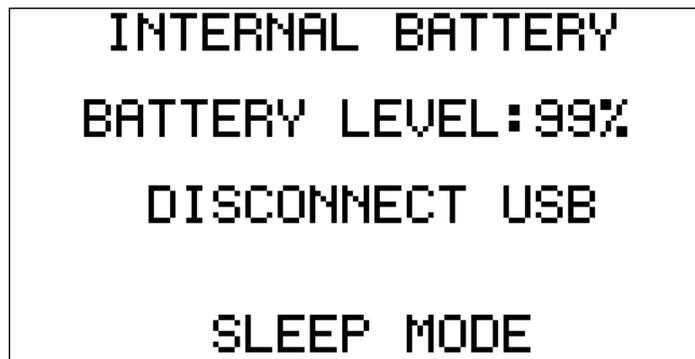


At this point you can close this screen pressing ENTER or RETURN. If you keep it active for more than 15 seconds, it automatically sets the device in SLEEP MODE - all internal circuits and LCD backlight go off, except for charging and minimal

CPU monitoring - **This is the recommended procedure to charge the device overnight.** Note: for the sake of clarity, below black/white screen images are depicted when LCD backlight is OFF.



In this mode you can stop charging whenever the device reaches 99% or 100%, which may take up to 2 or 3 hours under normal condition and depending on initial battery charge level. When the charging algorithm detects the battery fully charged and a minimum of 2hs connected, it will suggest disconnecting the USB cable.



Calibrating the battery capacity

The INTERNAL BATTERY screen, at this point, can re-calibrate the available battery power level. This is a useful feature to adjust what reference voltage the internal charger considers 100% capacity. This reference is subject to change over time as the internal battery reduces total capacity over many charge cycles. As a reference, 500 charge cycles will typically reduce the total battery capacity about 30% - in order for this new capacity to be consistent with the battery icon on screen, you can easily recalibrate after the charge process completed.

In the previous example screen, if the battery charge remains at 99% (or any other level) after the internal charger timer completes 3hs charge process, it will keep asking to DISCONNECT USB.

By doing so, the firmware adjust for a few seconds the new charge level and save in internal ROM for future use.



After the device recalibrates the internal battery charge reference level, it will automatically restart and you should see the Battery icon (on Spectrum Analyzer screen) showing full charge.

CHARGING A FULLY DEPLETED BATTERY

The firmware includes a protection mechanism to shutdown if the battery goes too low, in the range of 3.3V or less. However, this state will still keep drawing about 1mA from the battery. If you keep the power switch to ON forever the battery will be depleted but limited to a safe 3V level where the battery protection circuitry will reduce the leakage to about 50uA.

In any case, the internal battery charger will take care of the battery conditions once it gets power back from the USB and will charge the battery using an internal efficient algorithm. For that to work properly when the battery was fully depleted, you should use the Battery menu option as described above.

AUTOMATIC IDLE MODE WITH BATTERY CHARGE

As described in the previous section, you should enable the Battery screen and keep it charging for the device to automatically set internal circuits to Sleep for overnight charge.

SUPPLIED UHF ANTENNA



The supplied UHF whip antenna is the ideal choice for Pro Audio and Video professionals. The UHF antenna is a high performance, robust rubber duck model for the 400-900MHz range. It covers all TV and Digital TV Broadcast (DTVB) and the range used for all UHF Wireless Microphones from major brands.

PROTECTING YOUR INSTRUMENT FROM DAMAGE

The RF Explorer Pro Audio Edition is a very sensitive device. It can detect signals as low as -120dBm , which is $10\text{E-}12\text{mW}$ or 9nA over a 50ohm load.

This extreme sensitivity comes at the price of some fragility; your device needs care handling and protection in order to run for many years without problems.

Most RF technicians know the RF instruments have to be protected in order to survive the high Electro Magnetic (EM) fields that may be in the environment.

Expensive instruments like \$50,000 full sized Spectrum Analyzers and Signal Analyzers come with a long list of handling procedures the operator must observe in order to limit any chance of damage.

The first and most obvious precaution is to make sure the input RF power is not beyond the acceptable levels of the instrument. Below are listed max tolerable input power levels, beyond these values the instrument may get permanent damage or decreased sensitivity.

Max power input (BNC)
+30dBm using internal attenuator
+10dBm direct mode
-20dBm LNA mode

RF Explorer Pro Audio Edition is well-protected up to $+30\text{dBm}$ (1 Watt) input power, which is plenty to operate safely in pretty much any environment. Typically, no extra protection is needed for this model.

For best results, be sure to always use the internal attenuator function when connecting to any transmit sources like in-ear monitors or in-ear monitor combiner systems.

CONNECTING RF EXPLORER TO A COMPUTER



RF Explorer Pro Audio Edition can be connected to a computer via USB for additional capabilities, including higher resolution screen, additional features and control.

For RF Explorer for Windows, please check this link: www.rf-explorer.com/windows

For Mac OSX, a free trial of RF Venue's Vantage software is available at www.rfvenue.com/vantage

FCC AND CE REGULATIONS

RF Explorer is a Test and Measurement device, and therefore compatible with US FCC regulation 47 CFR Part 15.103(c).

LICENSE

RF Explorer embedded firmware is copyrighted © by RF Explorer Technologies SL, 2010-2018

RF Explorer for Windows is Open Source software released under GPL v3, so you are free to modify, distribute and use it based on GPL terms.

RF Explorer is a registered trademark in USA, China, Australia, Canada, Japan and all EU Countries.