

1 Description

The RF Explorer Upconverter is a high-performance RF frequency mixer. It extends input frequency ranges from 100KHz to 250MHz in RF Explorer Spectrum Analyzer and other devices such as SDR and wideband radios.



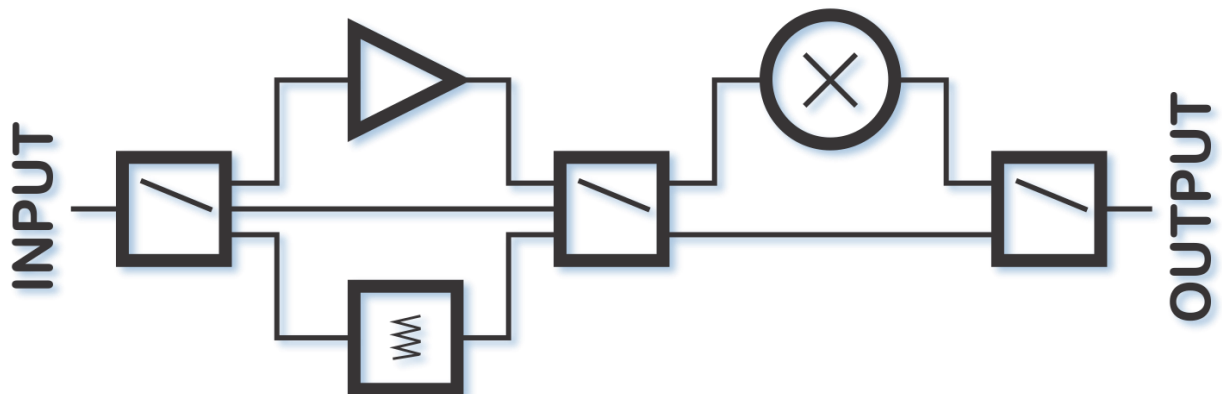
RF Explorer Upconverter is a multi-purpose device:

- Includes an Upconverter Mixer to enable frequencies 100Khz - 250MHz in your RF Explorer Spectrum Analyzer or other devices such as RTL-SDR and converts into 530.1-780MHz.
- Internal selectable Low Noise Amplifier with 25dB nominal gain; the LNA increase sensitivity of receivers, Spectrum Analyzers, Oscilloscopes and Near Field antennas in wideband frequencies 100KHz - 4GHz.
- Internal selectable Attenuator 30dB nominal adds support for large signal attenuation.

2 Features

- Internal LNA amplifier and selectable attenuator
- In Mixer mode convert frequencies from input 100KHz-250MHz up to 530.1-780MHz output
- In Bypass mode it can work in frequencies from 50KHz to 4GHz including LNA and Attenuator
- Compact size and light weight
- Solid aluminum metal case
- Mini USB port is used for powering the unit DC 5V, easy connection to a PC, wall wart or even portable power bank battery.
- Easy connection to RF Explorer with included RF adapter SNA Male-Male
- Ideal device to amplify weak signals using RF Explorer Near Field antennas

RF Upconverter Mixer Attenuator and LNA





3 Specification

- Input Frequency band: Mixer Mode 0.1 – 250MHz
- Input Frequency band: Bypass Mode 0 – 4GHz
- LNA Frequency band: 0 – 4GHz
- Attenuator Frequency band: 0 – 4GHz
- Internal selectable LNA 25dB gain
- Internal selectable Attenuator 30dB
- Standard SMA 50 ohms RF connectors
- Absolute Max input power Bypass and Attenuator mode: +30dBm
- Absolute Max input power LNA mode: +10dBm
- Mixer stability and accuracy (typical): +/-10ppm
- DC decoupled RF input and output connectors can support +16VDC.

4 Package contents

- RF Explorer Upconverter device
- SMA Male-Male adapter

5 Basic operation with Spectrum Analyzer

The Upconverter can be connected to any receiver device, such as RF Explorer or other brands Spectrum Analyzers.



The RF Output of the Upconverter must be connected to the RF Input of the Analyzer.

The included SMA Male-Male adapter is the ideal choice to connect to RF Explorer Spectrum Analyzer. Other options can be used to connect to the Analyzer, such as a RF cable if longer distance is required.

The RF Input of the Upconverter in this way becomes the actual input of the connected RF system, delivering mixed or direct RF signal based on simple push button selection.

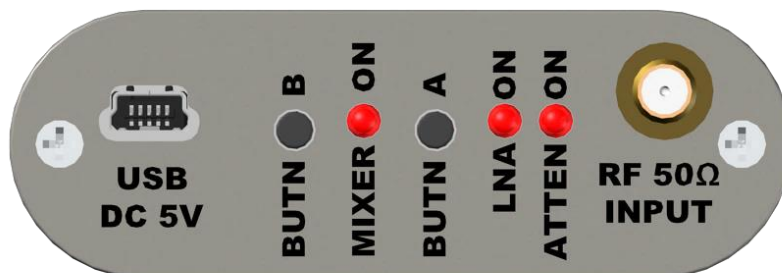
The Upconverter requires a standard 5V USB power source. It can be connected to a computer USB port, a wall wart charger or even a portable USB battery pack.

Note: The USB port is not capable of any control or data transfer, only DC power.

Future firmware upgrade in RF Explorer for Windows will include a simple selection of external Upconverter for visual frequency and amplitude adjustment. In current firmware version, or if using other brand Spectrum Analyzer, please note these operational details:

- Frequencies will be offset by exactly 530MHz. Detecting a signal of 5MHz as an example, will be displayed at 535MHz.
- Amplitude offset is about -5dB for Bypass mode, -35dB for Attenuator mode and +25dB for LNA mode. This can be adjusted in OffsetDB parameter in ATTENUATOR MENU of your RF Explorer.

5.1 Selecting operational mode



The RF Explorer Upconverter is easily operated with 2 push buttons on the front cover:

- **Button A** (BUTN A) can switch three possible states: Bypass, LNA and Attenuator. These three states are totally independent of the Mixer state.
- **Button B** (BUTN B) can switch two possible states: Mixer enabled, or Direct signal pass.

Three different LEDs conveniently labeled reports current state:

- **MIXER:** The LED lights when Mixer is enabled, being off if Mixer is disabled.
- **LNA:** The LED lights when LNA is enabled.
- **ATTEN:** The LED lights when the Attenuator is enabled.

If both LNA and ATTEN are off, the bypass mode is active. LNA and ATTEN can never be enabled at the same time.

5.2 Signal amplitude levels

The LNA is a high-performance amplifier, useful to increase RF input signal amplitude. It works best when input signal is below -30dBm, avoiding distortion and potential overload.

The attenuator can support sustained input power of up to +30dBm and should be used to reduce amplitude of RF signals; typically for RF Explorer Spectrum Analyzer the Attenuator is a good choice for signals larger than -20dBm.

For best results and safe operation follow below indications:

Mixer	LNA	Attenuator	Recommended Max Input	Absolute Max Input
OFF	OFF	OFF	< +20dBm	+30dBm
OFF	OFF	ON	< +20dBm	+30dBm
OFF	ON	OFF	< -30dBm	+10dBm
ON	OFF	OFF	< -10dBm	+10dBm
ON	OFF	ON	< +20dBm	+30dBm
ON	ON	OFF	< -40dBm	-20dBm

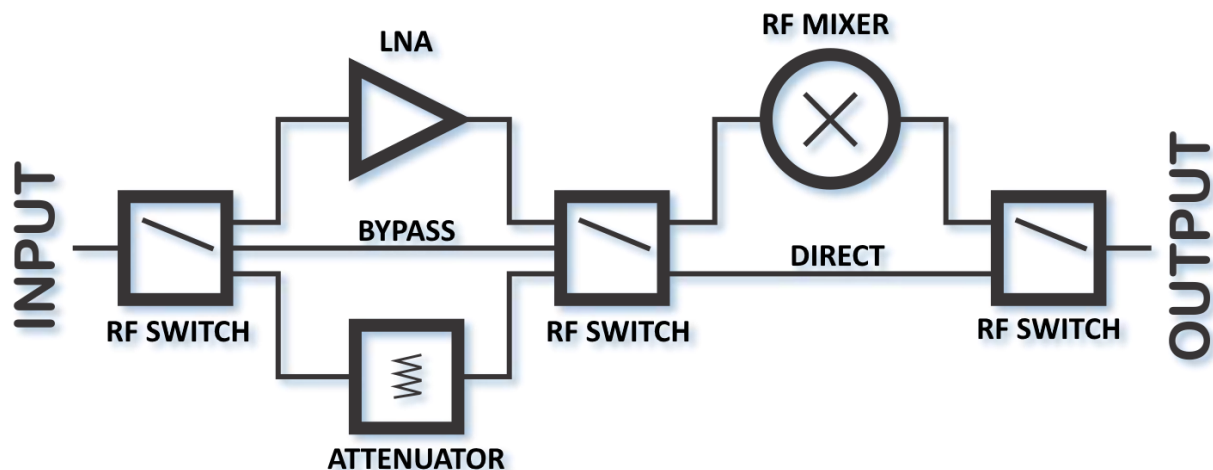
The Recommended Input is the maximum signal producing a linear output with minimal or no distortion. Signals higher than this level can be safe for the device, but may produce distortion and intermodulation.

The Absolute Max Input is the limit level, beyond that, the device may get permanent damage. It is not recommended to work at levels near the Absolute Max.

Note the safe input signal levels are low for the LNA and, therefore, it is not suggested activating the LNA when the input signal level is unknown. In such case, it is best practice to first enable Attenuator and, after signal level is known to be safe, use Bypass or LNA mode.

5.3 Basic Internal functionality

For simplicity, just basic functional RF modules are depicted. Other details such as RF filters or Local Oscillator are not included in this section. Check section 8 *Advanced operation* for more details.



The internal RF blocks are connected by high performance RF switches. These are operated indirectly by push buttons to select the RF signal path.

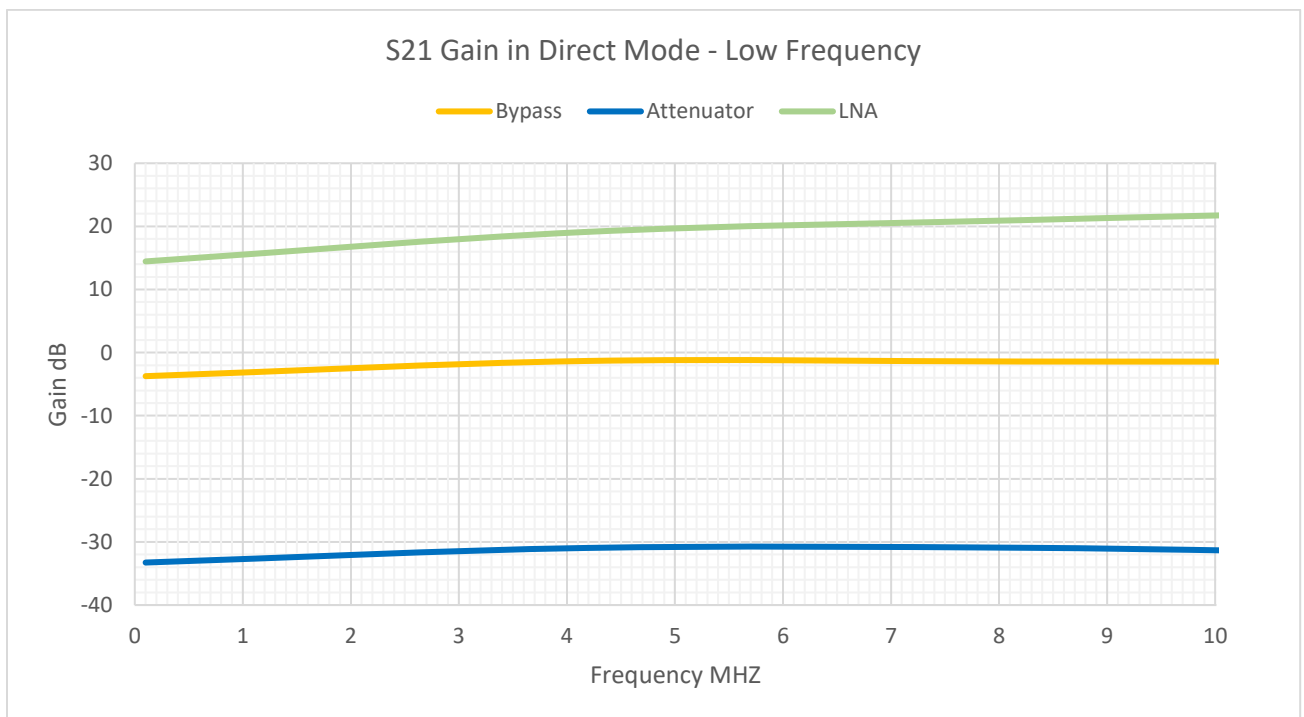
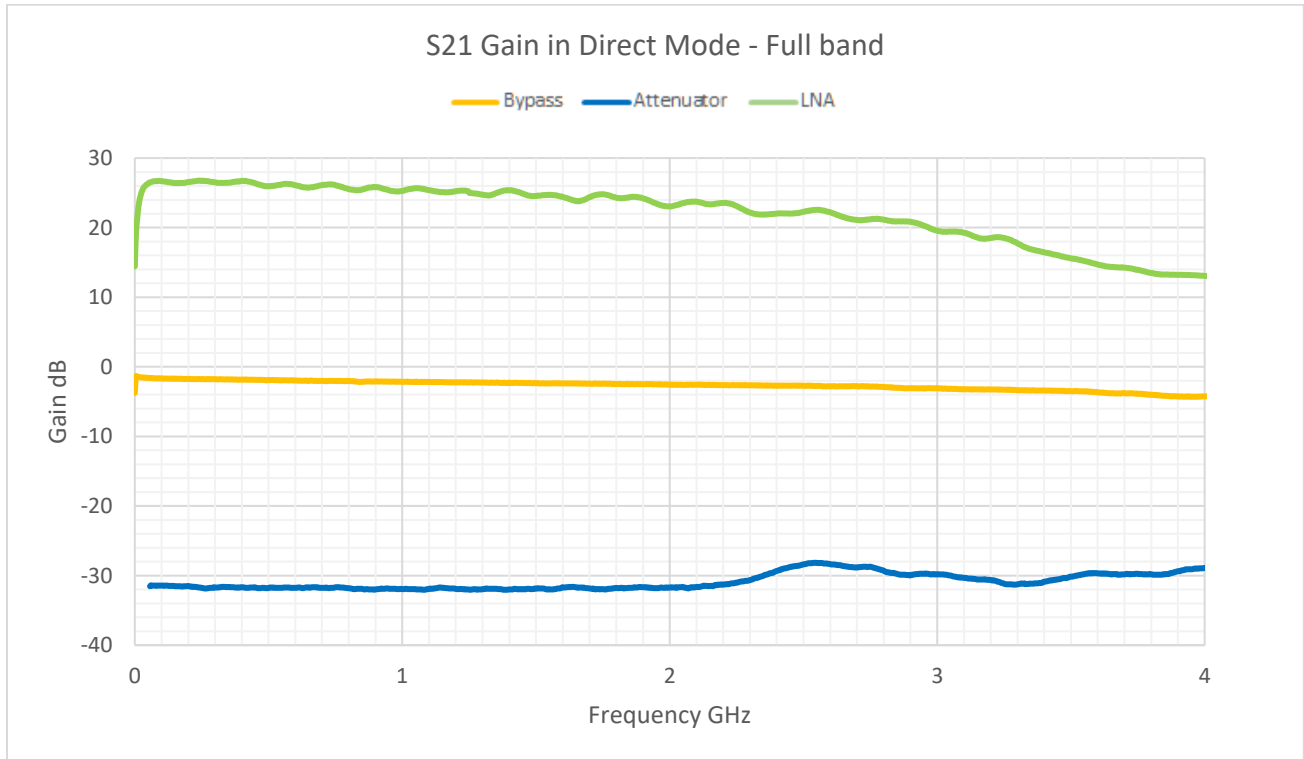
First stage: LNA, Attenuator or Bypass can be selected to adjust the input signal level.

Second stage: RF Mixer. If enabled frequency translation will be in place; if disabled then Direct signal low loss path is used.

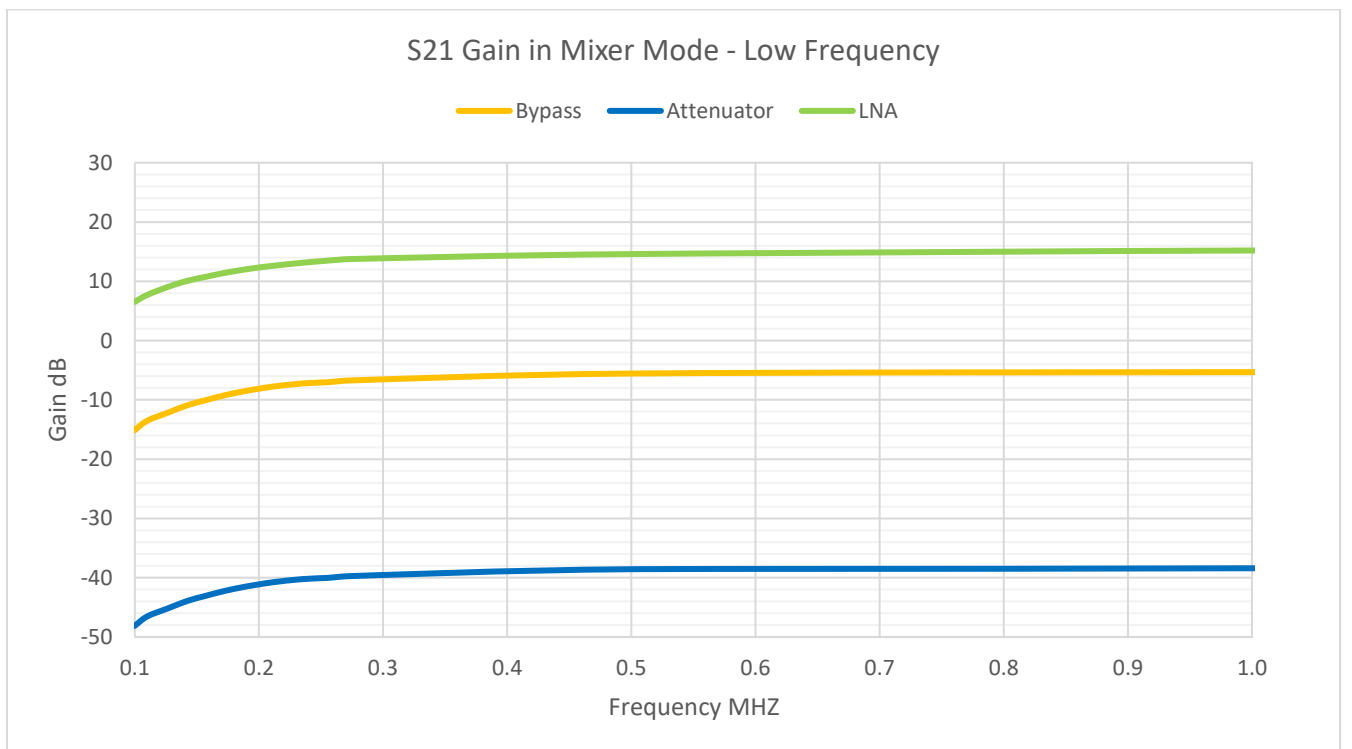
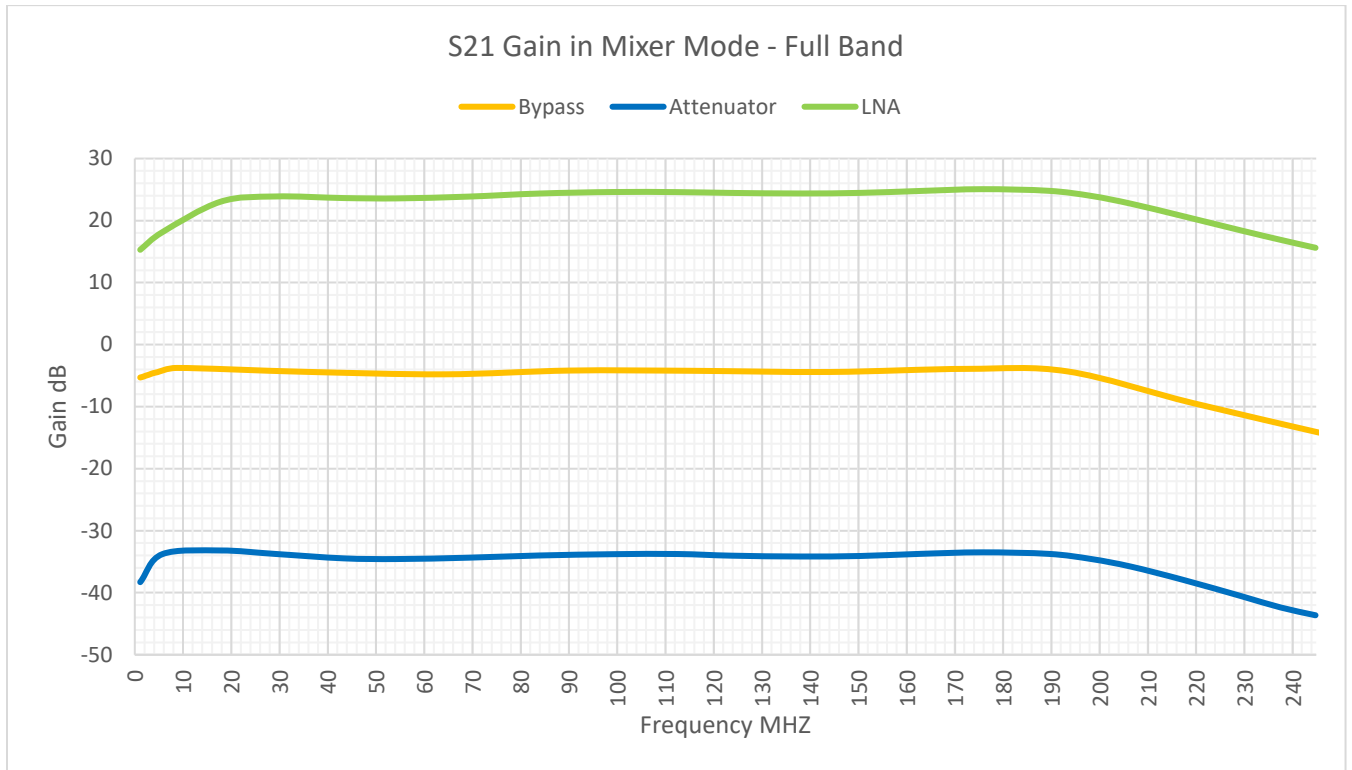
The Mixer is tuned with a Local Oscillator at exactly 530.000MHz with a 10ppm crystal. Input frequencies are supported in range 100KHz to 240MHz with translated output in 530.100MHz to 770MHz. If some attenuation is acceptable, the mixer can be used up to 250MHz input and beyond, with corresponding output at 780MHz and beyond.

6 Characterized Frequency Response

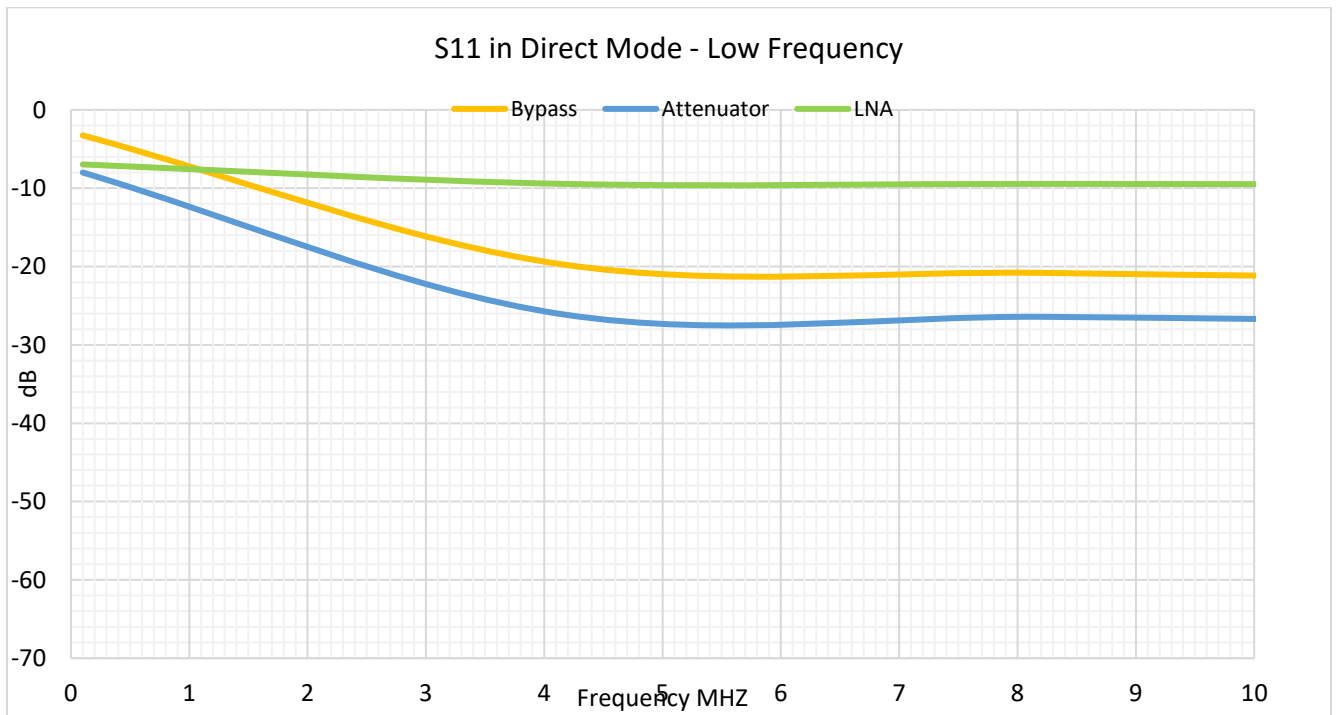
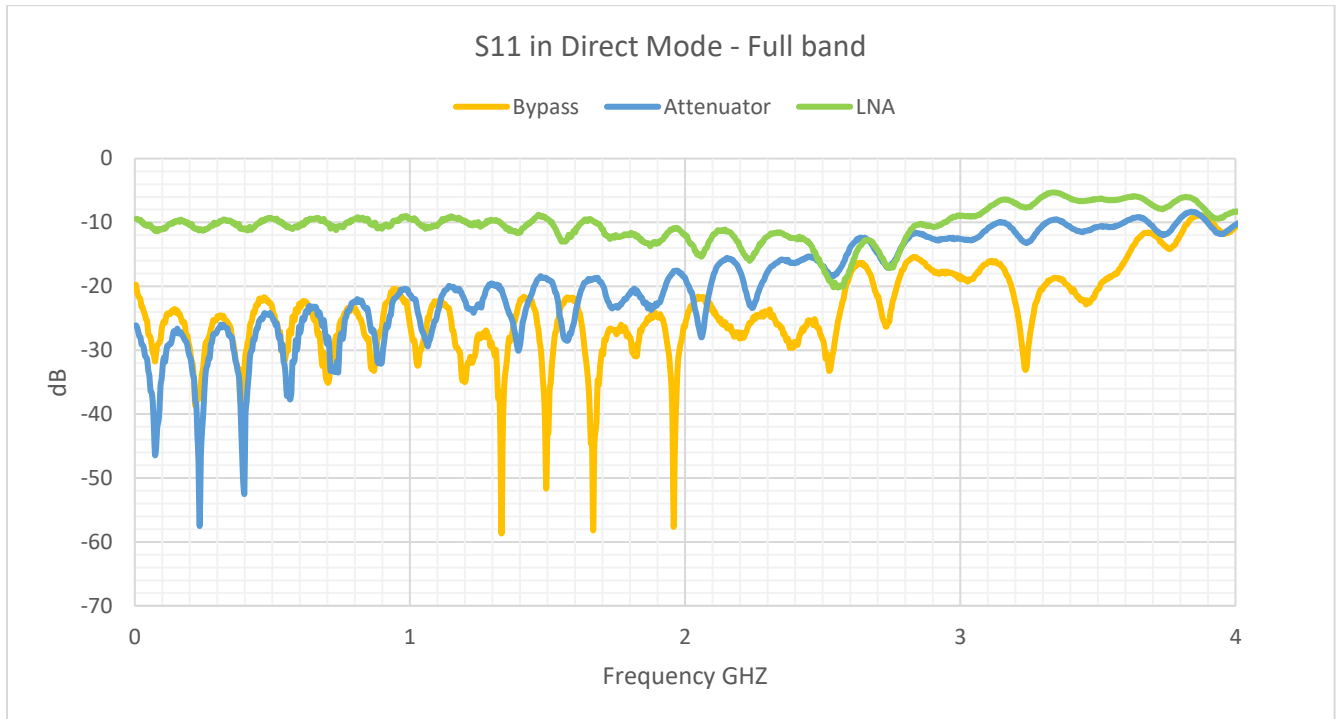
6.1 S21 Gain in Direct Mode



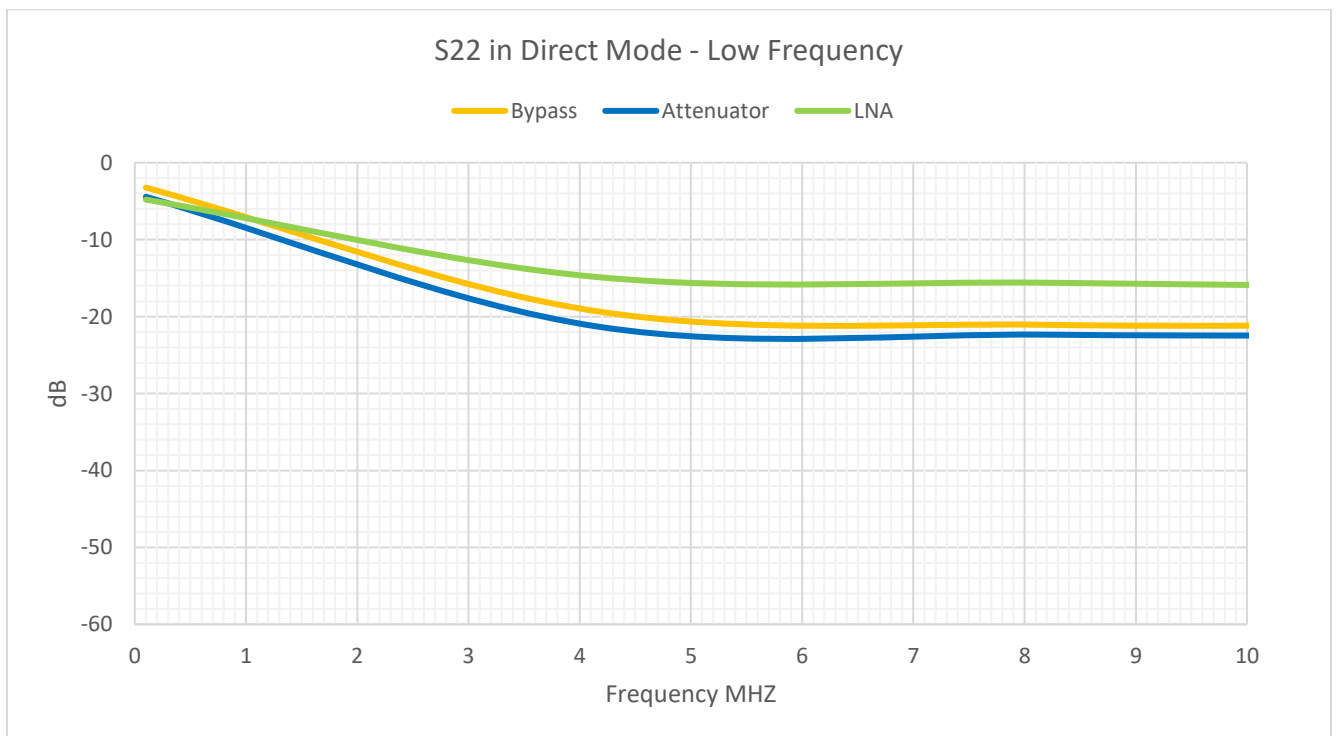
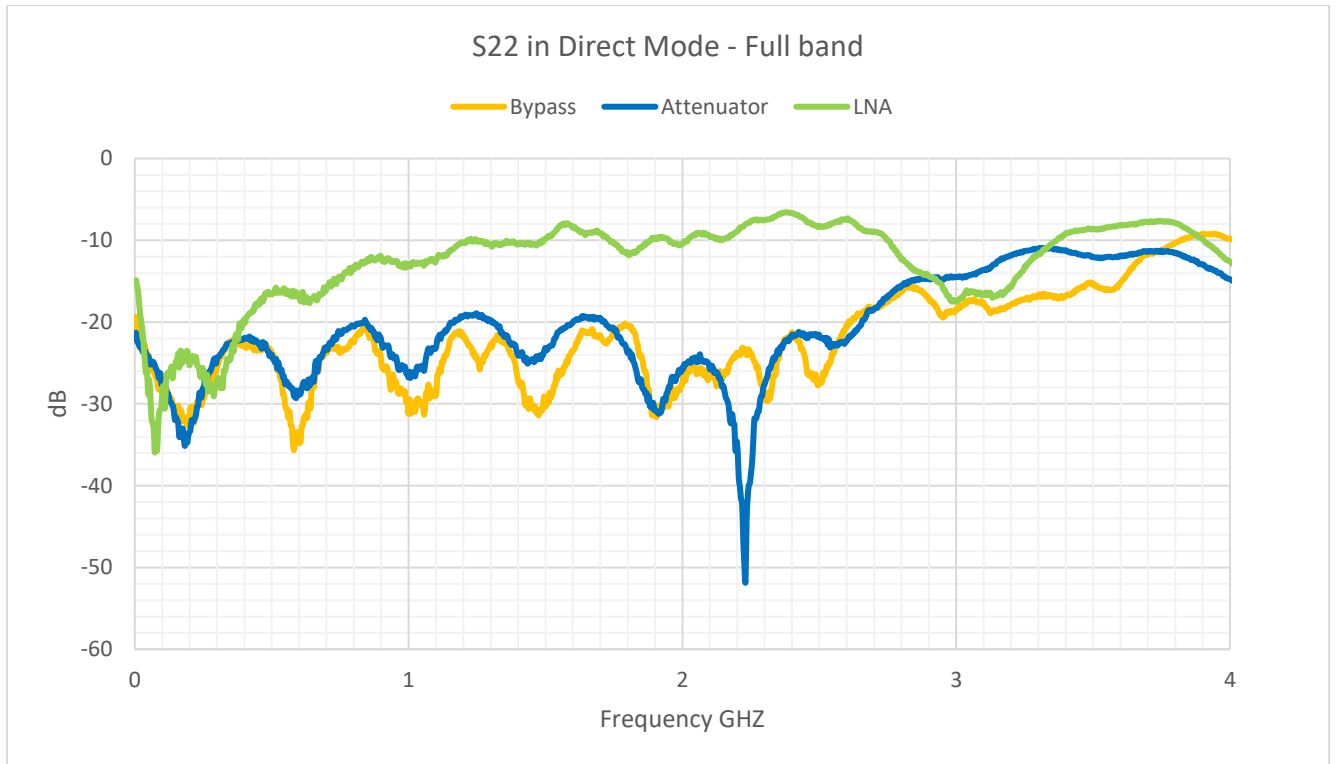
6.2 S21 Gain in Mixer Mode



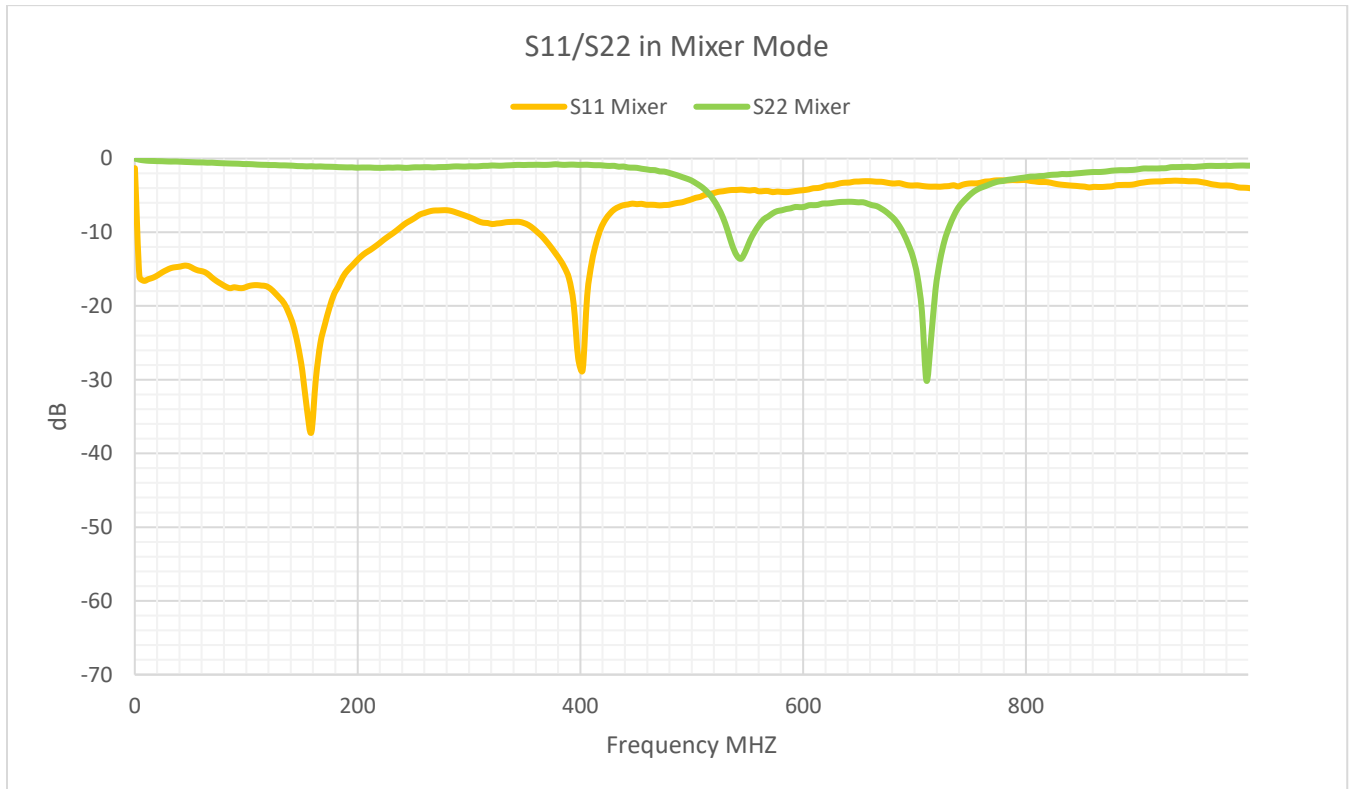
6.3 S11 in Direct Mode



6.4 S22 in Direct Mode



6.5 S11 / S22 in Mixer Mode

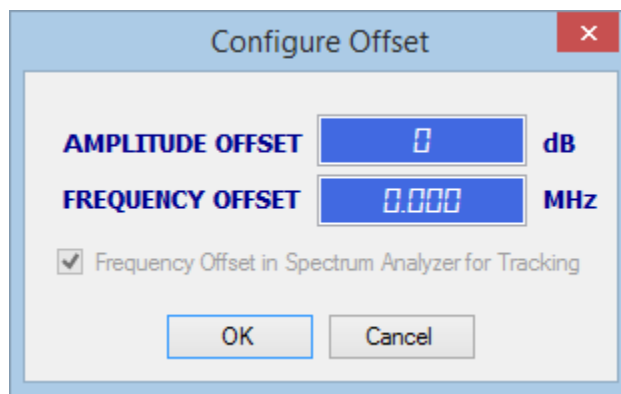


7 Using the Upconverter with RF Explorer for Windows

One important advantage of using a characterized mixer is the automatic adjustment available in RF Explorer for Windows application.

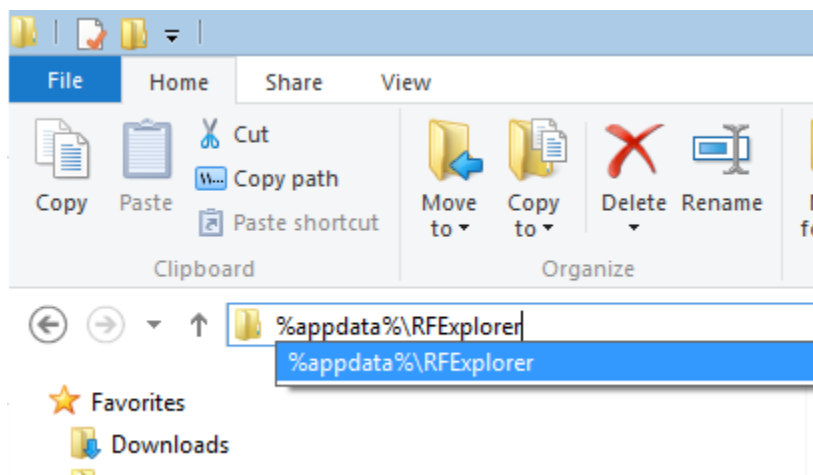
Using this feature and calibration files provided, the application will automatically display the real signal power level and frequency.

For configurations where the Mixer is enabled, the visual frequency offset correction is defined in the menu Device->Offset and defining the value as -530MHz. If the Mixer is not enabled, frequency offset should be set to zero.



Calibration files are available for download and are very easy to use:

- Download files from www.rf-explorer.com/downloads
- Decompress file contents and store all *.RFA files in a folder of your choice. The recommended path is the folder directly pointed by %appdata%\RFExplorer – this is the same folder used by other calibration files.



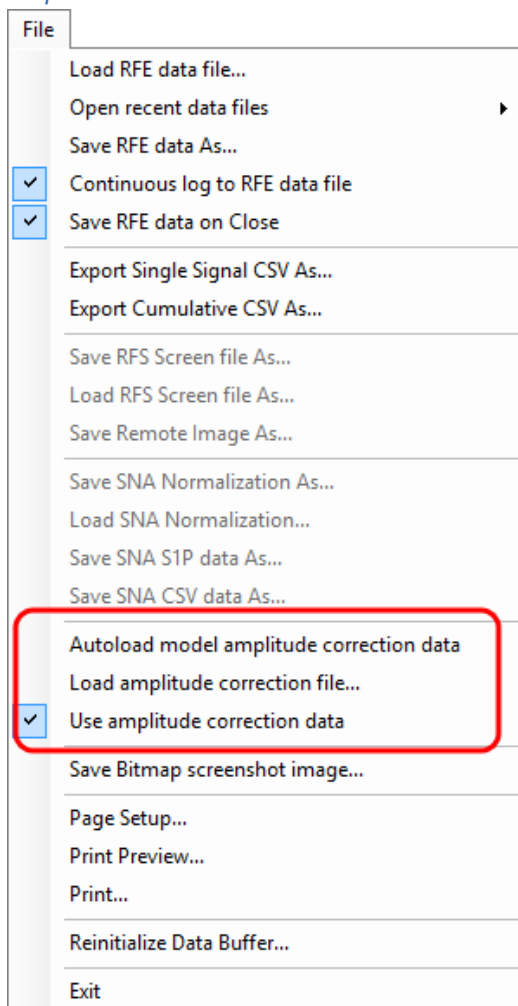
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- To enable calibration of a specific Upconverter configuration in RF Explorer for Windows, open menu [File -> Load amplitude correction file...](#) and select it. The table below includes all suggested configurations for the different options available in the RF Explorer Upconverter.

Mixer	LNA	Attenuator	Frequency Offset (MHz)	Recommended Correction file
OFF	OFF	OFF	0	Upconverter_Bypass_Direct.RFA
OFF	OFF	ON	0	Upconverter_Attenuator_Direct.RFA
OFF	ON	OFF	0	Upconverter_LNA_Direct.RFA
ON	OFF	OFF	-530	Upconverter_Bypass_Mixer.RFA
ON	OFF	ON	-530	Upconverter_Attenuator_Mixer.RFA
ON	ON	OFF	-530	Upconverter_LNA_Mixer.RFA

- Make sure the [Autoload model amplitude correction data](#) option is **unchecked**, and [Use amplitude correction data](#) is **checked**.

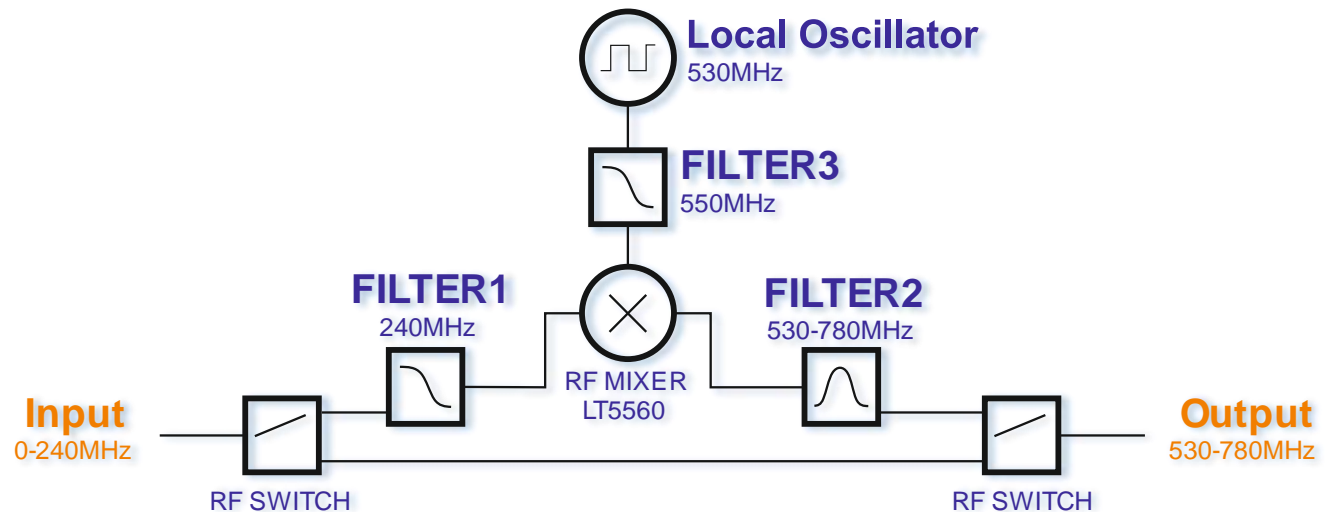


8 Advanced operation

This section is useful if extra details are required; It may help to get all possible juice from the RF Explorer Upconverter in non-conventional scenarios.

8.1 Internal Mixer details

In certain scenarios it may be useful to understand how the internal mixer works. Previous knowledge of basic heterodyne topology is required.



The high performance double balanced active Mixer LT5560 is at the core of the design. This component offers excellent response for low level signals.

Input low pass FILTER1 with 240MHz cut reduce unwanted signals, while band pass FILTER2 at the output removes unwanted sub-products and image frequency efficiently from the output.

The Local Oscillator is driven by a 10ppm crystal, and can be adjusted manually for fine tune 530.000Mhz output. A low pass FILTER3 removes harmonics and high frequency noise.

The 530MHz LO signal is fairly attenuated but still available at the output with about -45dBm power level; LO cannot be completely eliminated in a heterodyne system. Fortunately, this signal can be used to tune the output system to easily reference the relative “zero frequency” on the receiver system, such as an SDR.



8.2 Fine tuning the LO frequency

The LO frequency is calibrated at factory, for a relative error of only 1ppm typical at 25C temperature.

If working at completely different temperature or some aging effect drift LO frequency to a value that is not good enough, it can be manually calibrated by following this procedure:

1. Connect a 50ohm dummy load at the RF input of the RF Explorer Upconverter
2. Connect a Spectrum Analyzer or a sensitive RF frequency counter at the RF output of the RF Explorer Upconverter.
3. Configure the Upconverter to have LNA and Attenuator disabled, and Mixer enabled.
4. Connect USB DC power while pressing buttons A and B simultaneously for 5 seconds. This will enable the special Frequency Calibration mode.
5. Press button A or B to increase/decrease LO frequency about 500Hz each time.
6. When correct frequency is adjusted, unplug the USB DC power.
7. RF Explorer will remember and use this new configuration from this point on.



RF Explorer Upconverter Advanced Mixer datasheet

9 Revision History

Version	Date	Comments
1.0	2017-11-12	First Version assuming Spectrum Analyzer firmware v1.23



RF Explorer Upconverter Advanced Mixer datasheet

Table of Contents

1	Description	1
2	Features	2
3	Specification	3
4	Package contents	3
5	Basic operation with Spectrum Analyzer	4
5.1	Selecting operational mode	5
5.2	Signal amplitude levels	5
5.3	Basic Internal functionality	6
6	Characterized Frequency Response	7
6.1	S21 Gain in Direct Mode	7
6.2	S21 Gain in Mixer Mode	8
6.3	S11 in Direct Mode	9
6.4	S22 in Direct Mode	10
6.5	S11 / S22 in Mixer Mode	11
7	Using the Upconverter with RF Explorer for Windows	12
8	Advanced operation	14
8.1	Internal Mixer details	14
8.2	Fine tuning the LO	15
9	Revision History	16