

Frequency Converters

This application sheet describes the use of an R&S ZVA vector analyzer and two frequency converters R&S ZV-Z110 for transmission measurements in the frequency range between 75 GHz and 110 GHz.

Measurement Principle

The frequency converters use frequency multipliers to transform the RF source signal from one of the network analyzer ports into a high-frequency stimulus signal. A second signal (Local Oscillator, LO) is used for down-conversion of the reference and measurement channels. The LO signal can be provided either by a second analyzer port or by an external generator.

The measurement involves the following steps:

- Selection of the converter and test setup, activation of the converter mode
- Connection of the frequency converters
- Calibration using a suitable waveguide calibration kits
- Connection of the DUT and measurement

Activating the Frequency Converter Mode

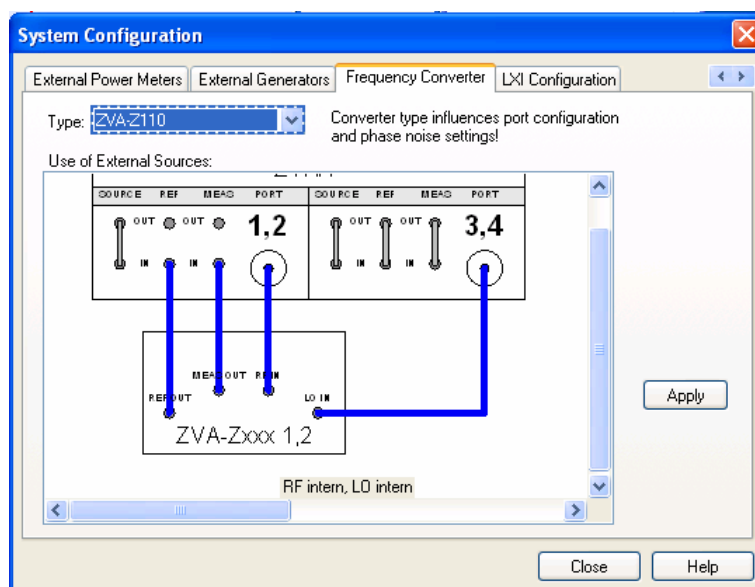
To activate the converter mode for a converter type R&S ZVA-Z110 and no external generator,

1. Click "System > System Config ..." and open the "Frequency Converter" tab of the "System Configuration" dialog.
2. Select "Type: ZVA-Z110".
3. Select a test setup with an analyzer port as external source, click "Apply" to activate the frequency converter mode and "Close".

Analyzer settings with active frequency converter



In frequency converter mode, the frequency and level settings of the network analyzer are automatically set to be compatible with the selected frequency converters. "Low Phase Noise" is enabled, Automatic Level Control (ALC) is disabled. The frequency and levels of all ports are displayed in the "Port Configuration" dialog ("Channel > Mode > Port Config...").



Connecting the Frequency Converters

Each frequency converter must be connected to the DUT, the analyzer ports, and the power supply. The DUT is screwed on the waveguide flange at the front of the converter. The remaining connectors are located on the rear panel of the converter.

NOTICE

General safety instructions

An excess input power or inappropriate analyzer configuration can cause damage to the frequency converters.

Please note the safety instructions in the quick start guide of the frequency converters before you connect and use them for the first time.

1. Connect each of the two frequency converters as shown in the "Frequency Converter" tab of the "System Configuration" dialog using the cables for the REF OUT and MEAS OUT signals supplied with the converters and two additional, high-quality coaxial cables.
2. To supply the frequency converter, connect the external DC power supply provided with the converter to the "9 V / 0.5 A" DC input.

The complete test setup for a 2-port transmission measurement is shown below.



Calibration

Due to the physical properties of the mm-waves and the waveguides, measurements with frequency converters require a special calibration kit. Rohde & Schwarz offers kits for this purpose, e.g. the calibration kit R&S ZV-WR10. The standards in the calibration kit allow all one-port and two-port calibration types supported by the R&S ZVA except TNA.

The output power of the frequency converter can be set manually (at the converter) only, therefore the standard source power calibration eliminating frequency response errors in the signal path between the source and the reference plane (external power meter) is not possible. A power calibration of the reference receiver (a-wave) using an external power meter, however, is possible and recommended for measurements concerning the wave quantities a and b. Proceed as follows:

1. Ensure that the output power of the frequency converter is not attenuated (adjust the knurled knob at the top of the converter to 2 mm).
2. Connect an appropriate external waveguide power meter to the waveguide flange and open the “Channel > Calibration > Start Power Cal > Source Power Cal” dialog.
3. Click “Modify Settings” and disable “Flatness Cal”, leaving “Reference Receiver Cal” checked.
4. Start the calibration sweep.

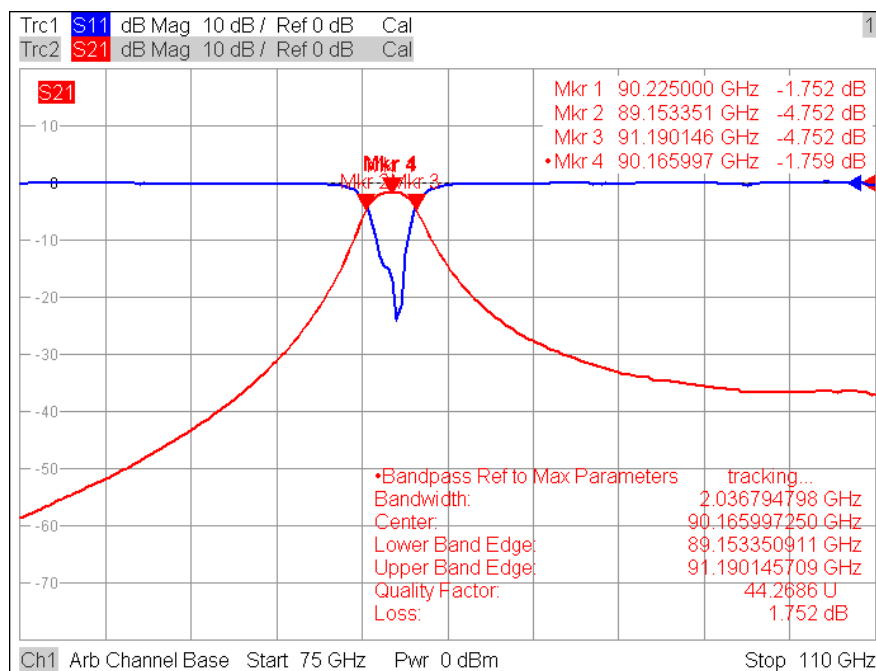
This power calibration procedure ensures a reasonable accuracy of the reference power readings over a wide range of converter output powers (i.e. even if the adjusting screw is used to reduce the powers).

Measurement

After system error correction and – possibly – power calibration, the mm-wave measurement can be performed like any other network analyzer measurement. The *Stimulus* settings determine the sweep range of the converted signals (i.e the input and output frequencies at the DUT ports). All measured quantities (S-parameters, wave quantities, ratios etc.) and other trace settings are available. The following restrictions hold for measurements with external frequency converters:

- The measurement is performed at fixed RF source and LO power. No power sweep is possible.
- To reduce the actual output power of the converters (e.g. for measuring wave quantities or testing compression effects), turn the adjusting knob on top of the converters clockwise. You will see an effect on the output power within the last 2 mm of the adjustable range.

The following example shows the transmission and reflection coefficients of a bandpass filter in the frequency range between 75 GHz and 110 GHz.



Possible Extensions

The analyzer provides an alternative frequency converter mode where the LO signal is provided by an external generator which is synchronized to the analyzer. Possible measurements depend on the number of analyzer ports available:

- With a single frequency converter and two analyzer ports (or one analyzer port plus an external generator) you can perform one-port reflection measurements.

- With n frequency converters and $2 \cdot n$ analyzer ports you can perform a full n -port S-parameter measurement. You can always replace one analyzer port by an external generator.

Related Measurements and Products

Option R&S ZVA-K4, "Arbitrary Generator and Receiver Frequencies", provides frequency-converting measurements within the operating frequency range of the vector network analyzer including harmonics and mixer measurements. R&S ZVA-K4 is included in option R&S ZVA-K8.

Equipment Required

Measurements using the converters can be carried out with the following equipment:

- Vector network analyzer R&S ZVA or R&S ZVT supporting a frequency range up to 20 GHz or higher.
- One or more frequency converters, depending on the test setup.
- Option R&S ZVA-K8, "Converter Control".
- Option R&S ZVA< n >-B16, "Direct Generator/Receiver Access"
- A suitable set of calibration standards.

Additional Information

For a comprehensive description of the frequency converter mode including remote control refer to the R&S ZVA/ZVT online help system or to the printable operating manual, which is available for download at <http://www.rohde-schwarz.com/product/zva>.

The text book "Fundamentals of Vector Network Analysis" by Michael Hiebel is an ideal complement for the information given in the user documentation. The book combines theoretical background and practical measurements on an R&S ZVA network analyzer. In case of interest please contact your local R&S office.