

R&S® ZVA-Z75, -Z110, -Z140, -Z170, -Z220, -Z325, -Z500 Frequency Converters – Basic Operation Application Sheet



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The following abbreviations are used throughout this guide: R&S® ZVA-Z75 / -Z110 / -Z140 / -Z170 / -Z220 / -Z325 / -Z500 is abbreviated as R&S ZVA-Z75 / -Z110 / -Z140 / -Z170 / -Z220 / -Z325 / -Z500, R&S® ZV-WR02 / -WR03 / -WR06 / -WR08 / -WR10 / -WR12 as R&S ZVA-WR02 / -WR03 / -WR06 / -WR08 / -WR10 / -WR12, R&S® ZVA as R&S ZVA and R&S® ZVT as R&S ZVT.

1 Basic Operation

This application sheet describes the use of an R&S ZVA vector analyzer and two R&S ZVA-Z110 frequency converters for 2-port transmission measurements.

Measurements using other converter types are performed in an analogous way.

1.1 Required Equipment

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

- Vector network analyzer (NWA) R&S ZVA or R&S ZVT with an upper frequency limit of 20 GHz or higher (R&S ZVL 20, R&S ZVA 24, R&S ZVA 40 ...).
The required firmware version depends on the frequency converter model:
 - R&S ZVA-Z75: at least version V2.47
 - R&S ZVA-Z110: at least version V2.20
 - R&S ZVA-Z140: at least version V2.71
 - R&S ZVA-Z170: at least version V2.71
 - R&S ZVA-Z220: at least version V2.72
 - R&S ZVA-Z325: at least version V2.45
 - R&S ZVA-Z500: at least version V2.80
- Two NWA ports per frequency converter port.
Alternatively: One NWA port per frequency converter plus a common external generator for the LO signals. The R&S SMF100A signal generator with suitable options is recommended.
- N frequency converters for an N-port measurement
- Option R&S ZVA<n>-B16, "Direct Generator/Receiver Access" at each port
- Option R&S ZVA-K8, "Converter Control"
- a suitable set of calibration standards

1.2 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:

1. Selection of the converter and test setup, activation of the converter mode
2. Connection of the frequency converters

3. Calibration using a suitable waveguide calibration kit
4. Connection of the DUT and measurement

1.3 Activating the Frequency Converter Mode

To activate the converter mode for a setup without external generator,

1. Click "System > System Config ..." and open the "Frequency Converter" tab of the "System Configuration" dialog.
2. Select your converter "Type": R&S ZVA-Z75, R&S ZVA-Z110, R&S ZVA-Z140, R&S ZVA-Z170, R&S ZVA-Z220, R&S ZVA-Z325, or R&S ZVA-Z500.
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 ...").

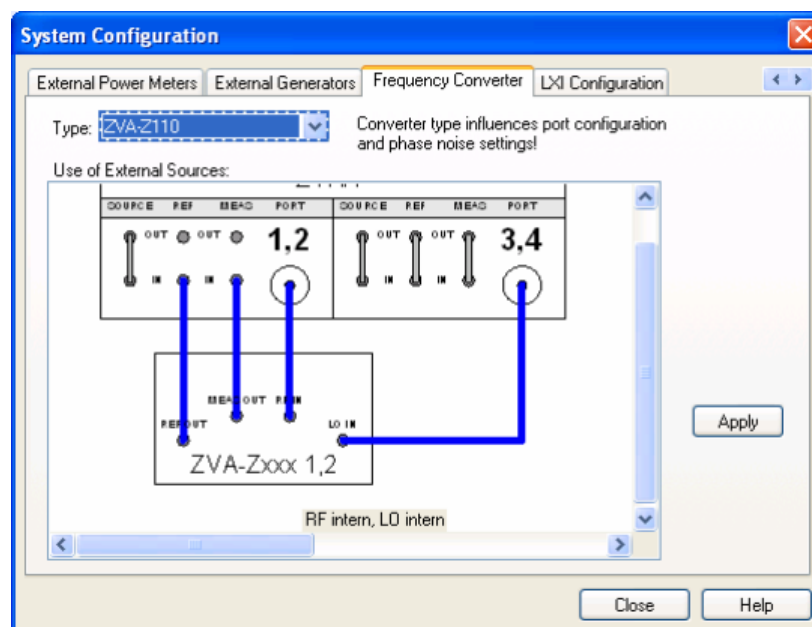


Fig. 1-1: Frequency Converter dialog (example: R&S ZVA-Z110)

1.4 Connecting the Frequency Converters

Each frequency converter must be connected to the analyzer, the power supply and the DUT.

- Analyzer ports: 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.
- Power supply: Connect the external DC power supply provided with the converter to the "9 V / 0.5 A" DC input.
- DUT (usually connected after calibration): Screw on the waveguide flange.

Refer to the Quick Start Guide of your converter for details.

1.5 Calibration

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 appropriate external power meter, however, is possible and recommended for measurements concerning the wave quantities a and b. Waveguide power meters are configured in the ordinary way using the "System Configuration- External Power Meters" tab. Proceed as follows:

1. Ensure that the output power of the frequency converter is not attenuated (adjust the adjusting screw (knurled knob) at the top of the converter to 2 mm).
2. Connect the waveguide power meter to the converter's 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).

A receiver power calibration of the b-waves (without external power meter, using the "Receiver Power Calibration" dialog) is possible after completed power calibration of the a-wave.

After the power calibration procedure a system error correction is recommended. Due to the physical properties of the mm-waves and the waveguides, measurements with frequency converters require a special calibration kit for system error correction.

Rohde & Schwarz offers kits for this purpose:

- Calibration kit R&S ZV-WR15, for converter R&S ZVA-Z75
- Calibration kit R&S ZV-WR10, for converter R&S ZVA-Z110
- Calibration kit R&S ZV-WR08, for converter R&S ZVA-Z140
- Calibration kit R&S ZV-WR06, for converter R&S ZVA-Z170
- Calibration kit R&S ZV-WR05, for converter R&S ZVA-Z220
- Calibration kit R&S ZV-WR03, for converter R&S ZVA-Z325
- Calibration kit R&S ZV-WR02, for converter R&S ZVA-Z500

The standards in the calibration kit allow all one-port and two-port calibration types supported by the network analyzer except TNA. Refer to the documentation of the calibration kit or the help system of your network analyzer for details.

1.6 Measurement

After power calibration and system error correction, the mm-wave measurement can be performed like any other network analyzer measurement. The "Port Configuration" settings (together with 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 adjust the actual output power of the converters (e.g. for measuring wave quantities or testing compression effects), use the adjusting screw on top of the converters. Frequency converters R&S ZVA-Z500 do not provide an adjusting screw.

The following example shows the transmission and reflection coefficients of a bandpass filter in the frequency range between 75 GHz and 110 GHz, which is covered by the frequency converter R&S ZVA-Z110.

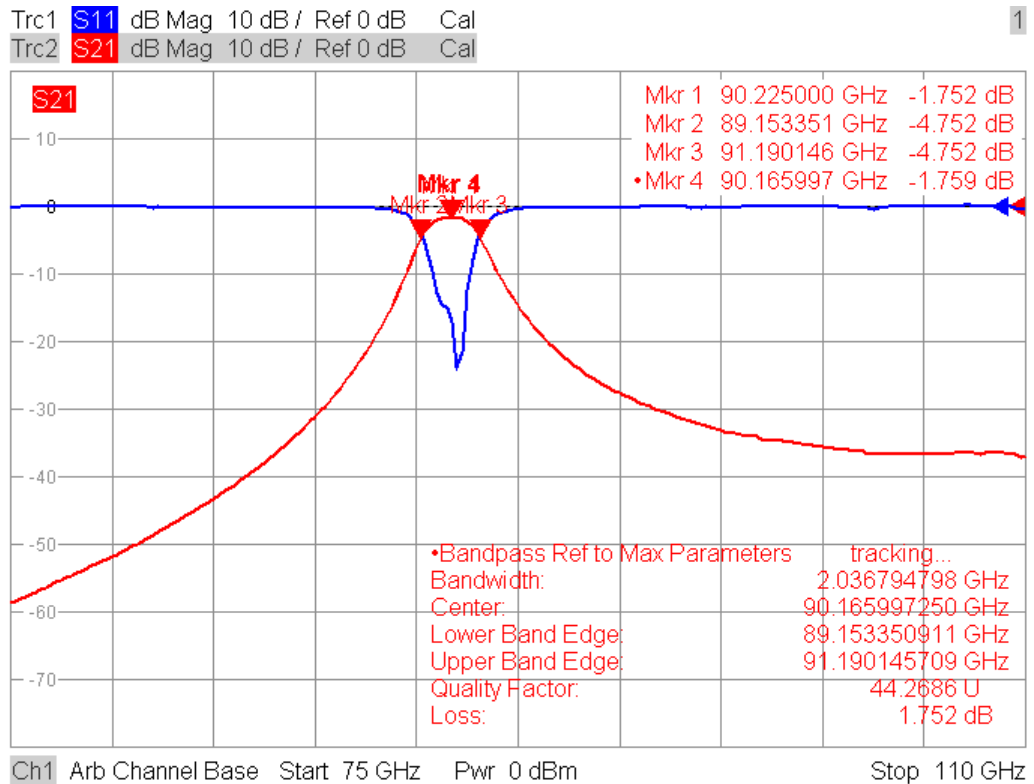


Fig. 1-2: Transmission and reflection of a bandpass filter measured with an R&S ZVA-Z110

1.7 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>.

For an description of the R&S ZVA-Z110 connectors and safety instructions refer to the R&S ZVA-Z110 Quick Start Guide.

Application notes related to the frequency converter are also available for download, see <http://www.rohde-schwarz.com/product/zva-z>.