

R&S® ZVA-Z90E / -Z110E Frequency Converters – Basic Operation Application Sheet



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08/2009 – 02

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81671 Munich, Germany

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The following abbreviations are used throughout this document: R&S® ZVA-ZxxxE is abbreviated as R&S ZVA-ZxxxE. The vector network analyzer R&S® ZVA is abbreviated as R&S ZVA.

1 Basic Operation

This application sheet describes the use of an R&S ZVA vector analyzer and two R&S ZVA-Z110E 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:

- Network analyzer (NWA) R&S ZVA with an upper frequency limit of 20 GHz or higher (R&S ZVA 24, R&S ZVA40 ...).
The required firmware version depends on the frequency converter model:
 - R&S ZVA-Z110E: at least version V2.61
 - R&S ZVA-Z90E: at least version V2.70
- 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"
- Option R&S ZVA-B8 to establish the control connection between the NWA and the frequency converters
- 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. Entry of power coefficients (when a converter is used for the first time or assigned to a new analyzer port).
3. Connection of the frequency converters
4. Power and frequency settings

5. Power calibration using an appropriate external waveguide power meter
6. Calibration using a suitable waveguide calibration kit
7. 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 correct "Type": R&S ZVA-Z90E or R&S ZVA-Z110E.
3. If you use your frequency converter for the first time, click "Coefficients" to enter the power coefficients; see [chapter 1.4, "Entering Power Coefficients"](#), on page 5.
4. 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 ...").

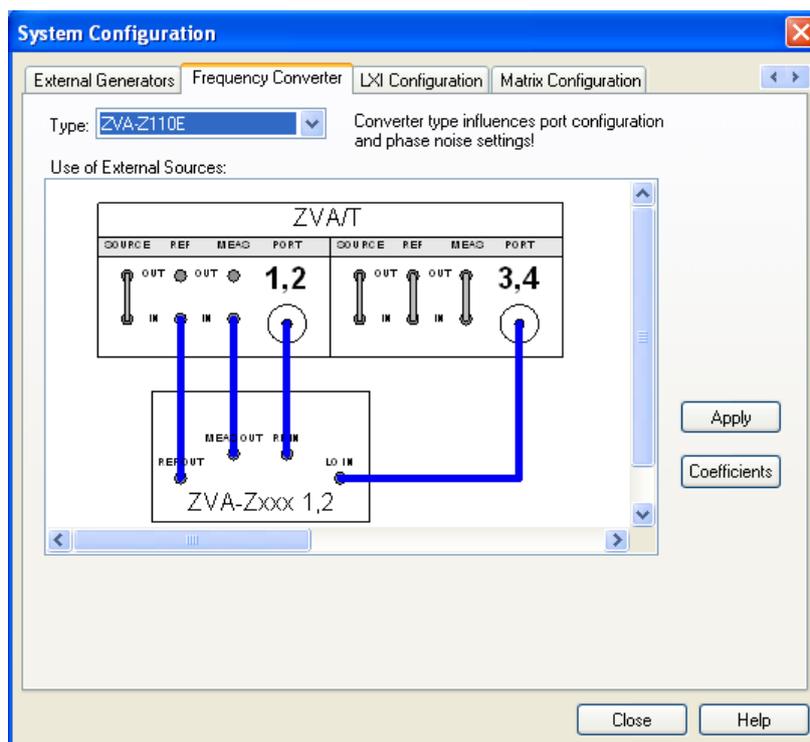


Fig. 1-1: Frequency Converter dialog (example: R&S ZVA-Z110E)

1.4 Entering Power Coefficients

For accurate control of the converter output power, the R&S ZVA analyzer must know the (non-linear) current-power characteristic of the converters. The characteristic is sufficiently described by a third-order polynomial. A label with the four polynomial coefficients c_0 , c_1 , c_2 , and c_3 is affixed to each converter.

The power coefficients must be adjusted whenever a new converter is connected to an analyzer port. To enter the coefficients, proceed as follows:

1. Activate the frequency converter mode following the first steps in [chapter 1.3, "Activating the Frequency Converter Mode"](#), on page 4.
2. In the "Frequency Converter" dialog, press "Coefficients".
3. In the "Power Coefficients" dialog opened, clear "Use default coefficients" and enter your coefficients into the appropriate table row.
The numbers of the table rows denote the analyzer port for the converter.
4. Repeat the last step for all frequency converters in the test setup.

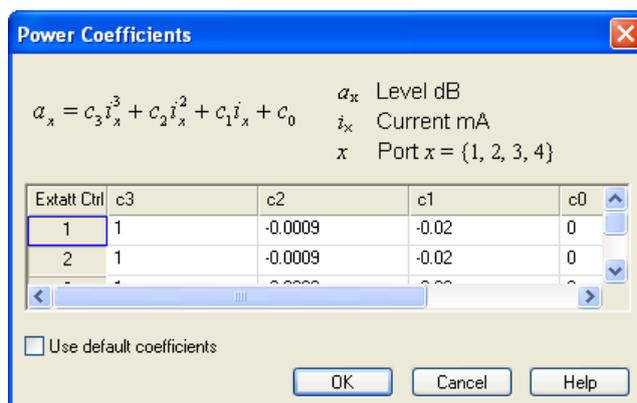


Fig. 1-2: Entry of power coefficients for analyzer port 1

1.5 Connecting the Frequency Converters

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

- Control connection: Connect the 3-pin control connector at the rear panel of the converter to the output connector of option R&S ZVA-B8 (EXT ATT CTRL) at the top right of the R&S ZVA front panel using the control cable supplied with the converter.
- 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.

1.6 Power and Frequency Settings

While the frequency converter mode is active, the "Channel > Stimulus" settings of the network analyzer control the frequency and power range of the converters. In addition the "Channel > Mode > Port Configuration" dialog shows an additional row for each converter. The "Frequency" and "Power" settings in the "Source" section of the dialog serve different purposes:

- The output power for each converter can be selected in the "Power" column. A source power calibration of the converter port ensures that the analyzer will generate the selected source power; see [chapter 1.7, "Calibration"](#), on page 7.

- The source frequency at the converter ports is essentially determined by the port frequency of the analyzer. The converter frequency settings in the "Port Configuration" dialog define the frequency axes for the source power calibrations, however, they do not actually affect the converter output frequencies. For best accuracy, ensure that the correct converter frequencies are set, especially if the test setup contains additional frequency-converting components.

Example:

In the example below, the frequency at the NWA "Port 1" has been increased by a 50 MHz offset. The converter source frequency six times the NWA source frequency, therefore a 300 MHz offset has been entered for "Converter Port 1". This ensures a correct frequency axis during the power calibration.

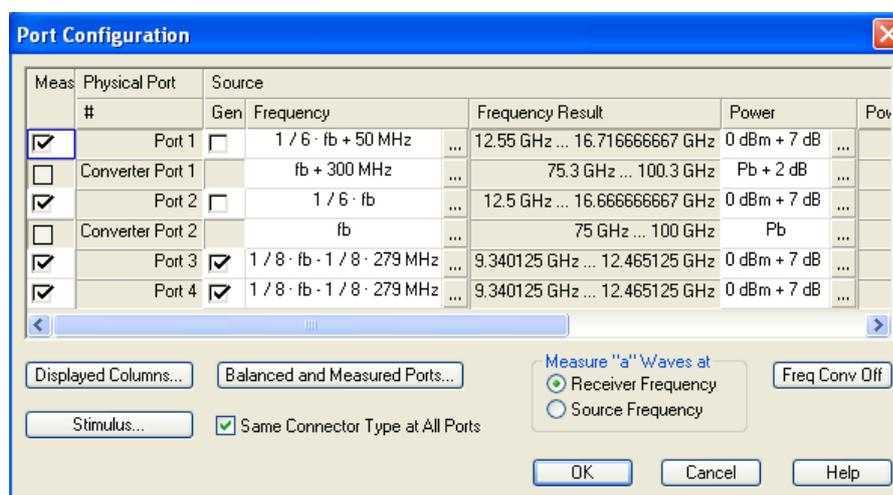


Fig. 1-3: Converter frequency and power settings (example: R&S ZVA-Z110E)

1.7 Calibration

A source power calibration for a frequency converter requires an appropriate external power meter, to be connected to the converter's waveguide flange. Waveguide power meters are configured in the ordinary way using the "System Configuration > External Power Meters" tab.

To perform the source power calibration, proceed as follows:

1. Connect the waveguide power meter and open the "Channel > Calibration > Start Power Cal > Source Power Cal" dialog.
2. Select your converter and source port from the "Source" pull-down list (e.g. "Conv 1" for a frequency converter connected to NWA port 1).
3. Click "Modify Settings" and ensure that both "Flatness Cal" and "Reference Receiver Cal" are checked.
4. If your test setup causes strong nonlinear effects, you can choose a "Convergence Factor" different from one.

5. Start the calibration sweep.



To ensure an accurate source power calibration and quick convergence, use the correct power coefficients; see [chapter 1.7, "Calibration"](#), on page 7.

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

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, e.g. the calibration kits R&S ZV-WR10 and R&S ZV-WR12. 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.

1.8 Measurement

After power calibration and system error correction, the mm-wave measurement can be performed like any other network analyzer measurement. The analyzer may perform a frequency or power sweep. The "Port Configuration" settings (together with the "Stimulus" settings), determine the sweep range of the converted signals (for a frequency sweep, 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 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-Z110E.

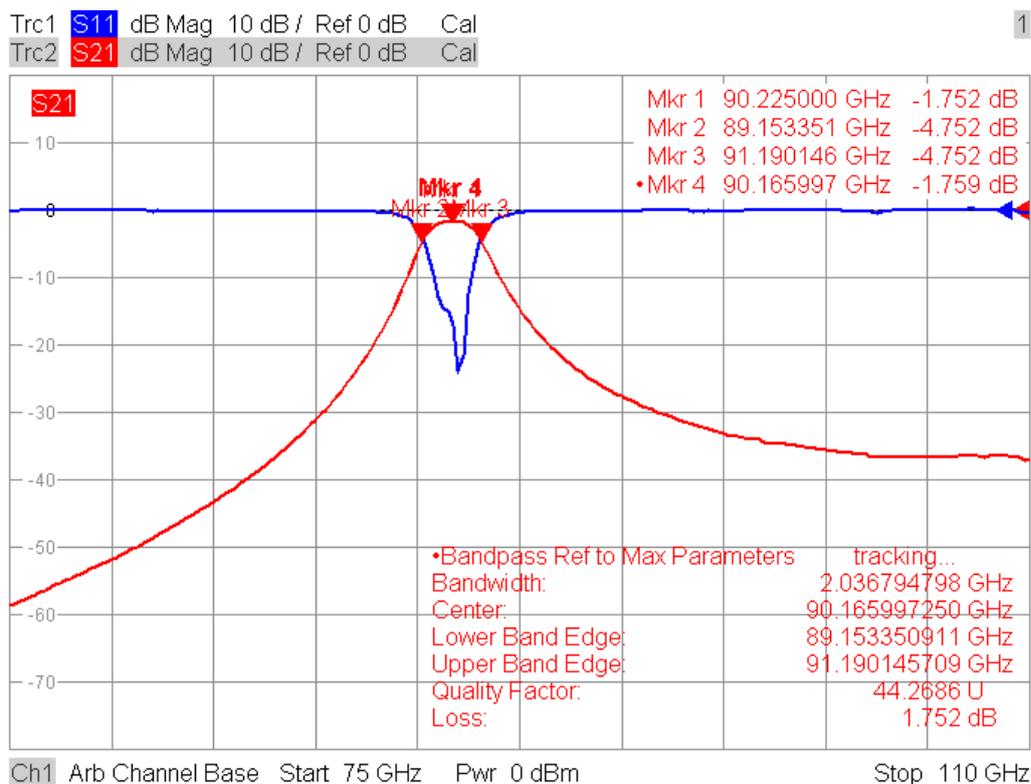


Fig. 1-4: Transmission and reflection of a bandpass filter measured with an R&S ZVA-Z110E



For best measurement accuracy, observe the following rules:

- Enter the correct power coefficients of all frequency converters; see [chapter 1.4, "Entering Power Coefficients"](#), on page 5.
- Perform a source power calibration; see [chapter 1.7, "Calibration"](#), on page 7. Using converter output powers outside the calibrated range generally impairs the measurement accuracy. The effect is enhanced if the power coefficients are not correct.
- Perform a system error correction for the power-calibrated test setup using an appropriate test setup.

1.9 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-Z110E connectors and safety instructions refer to the R&S ZVA-Z110E Quick Start Guide.

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