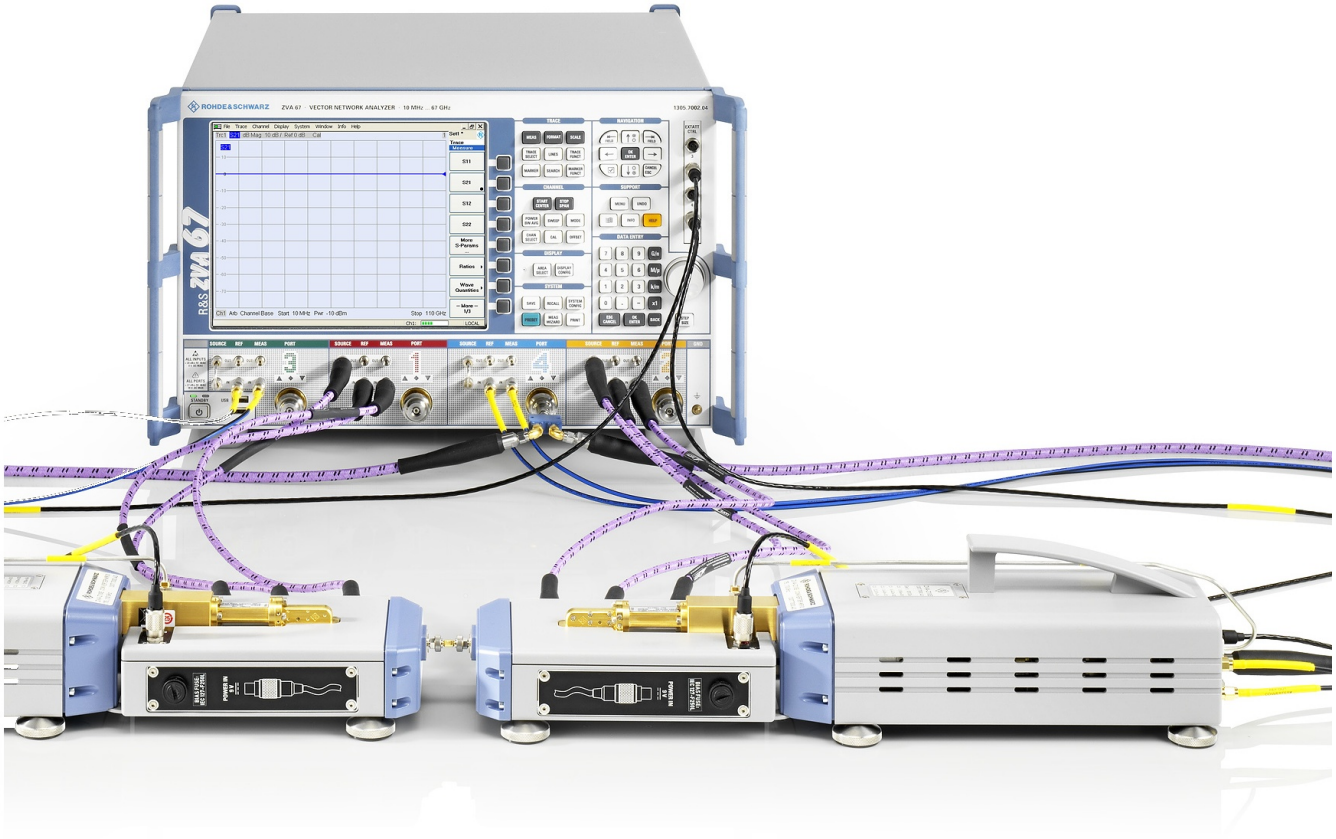
R&S®ZVA110
Broadband Measurements Using the 1 mm External Test Sets
Getting Started



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Getting Started

Version 03

ROHDE&SCHWARZ

This Getting Started guide describes the following network analyzer types:

- R&S® ZVA110 complete system based on R&S®ZVA67
  - regular power, stock number 1312.7004.03
  - regular power, without RF cables, stock number 1312.7004.05
  - high power, stock number 1312.7004.13
  - high power, without RF cables, stock number 1312.7004.15
- R&S® ZVA110 modular system
  - regular power, stock number 1312.7004.04
  - high power, stock number 1312.7004.14

It complements the Getting Started guide for all R&S®ZVA network analyzers, stock number 1145.1090.62 and the Getting Started guide for frequency converters with electronic attenuators R&S®ZVA-ZxxxE, stock number 1307.7197.62. It describes the operation of the R&S®ZVA110 with external test sets.

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1314.4502.62 | Version 03 | R&S®ZVA110

Throughout this document, R&S® is abbreviated as R&S.

Safety Instructions
Instrucciones de seguridad
Sicherheitshinweise
Consignes de sécurité

⚠ WARNING

Risk of injury and instrument damage

The instrument must be used in an appropriate manner to prevent electric shock, fire, personal injury or instrument damage.

- Do not open the instrument casing.
- Read and observe the "Basic Safety Instructions" delivered as printed brochure with the instrument.
- Read and observe the safety instructions in the following sections. Note that the data sheet may specify additional operating conditions.
- Keep the "Basic Safety Instructions" and the product documentation in a safe place and pass them on to the subsequent users.

⚠ ADVERTENCIA

Riesgo de lesiones y daños en el instrumento

El instrumento se debe usar de manera adecuada para prevenir descargas eléctricas, incendios, lesiones o daños materiales.

- No abrir la carcasa del instrumento.
- Lea y cumpla las "Instrucciones de seguridad elementales" suministradas con el instrumento como folleto impreso.
- Lea y cumpla las instrucciones de seguridad incluidas en las siguientes secciones. Se debe tener en cuenta que las especificaciones técnicas pueden contener condiciones adicionales para su uso.
- Guarde bien las instrucciones de seguridad elementales, así como la documentación del producto, y entréguelas a usuarios posteriores.

⚠ WARNUNG

Gefahr von Verletzungen und Schäden am Gerät

Betreiben Sie das Gerät immer ordnungsgemäß, um elektrischen Schlag, Brand, Verletzungen von Personen oder Geräteschäden zu verhindern.

- Öffnen Sie das Gerätegehäuse nicht.
- Lesen und beachten Sie die "Grundlegenden Sicherheitshinweise", die als gedruckte Broschüre dem Gerät beiliegen.
- Lesen und beachten Sie die Sicherheitshinweise in den folgenden Abschnitten; möglicherweise enthält das Datenblatt weitere Hinweise zu speziellen Betriebsbedingungen.
- Bewahren Sie die "Grundlegenden Sicherheitshinweise" und die Produktdokumentation gut auf und geben Sie diese an weitere Benutzer des Produkts weiter.

⚠ AVERTISSEMENT

Risque de blessures et d'endommagement de l'appareil

L'appareil doit être utilisé conformément aux prescriptions afin d'éviter les électrocutions, incendies, dommages corporels et matériels.

- N'ouvrez pas le boîtier de l'appareil.
- Lisez et respectez les "consignes de sécurité fondamentales" fournies avec l’appareil sous forme de brochure imprimée.
- Lisez et respectez les instructions de sécurité dans les sections suivantes. Il ne faut pas oublier que la fiche technique peut indiquer des conditions d’exploitation supplémentaires.
- Gardez les consignes de sécurité fondamentales et la documentation produit dans un lieu sûr et transmettez ces documents aux autres utilisateurs.

Contents

1 Safety Instructions

The vector network analyzer R&S ZVA110 has been designed and tested in accordance with the EC Certificate of Conformity. It has left the manufacturer's plant in a condition fully complying with safety standards.

NOTICE

Risk of instrument damage

To prevent instrument damage, make sure to read through and observe the following safety instructions.

ESD protective measures

Protect the vector network analyzer and the external test sets against damage due to electrostatic discharge (ESD). Use the wrist strap and grounding cord supplied with the analyzer and connect yourself to the GND connector at the front panel of the analyzer. For details, refer to the R&S ZVA Getting Started guide, stock no. 1145.1090.62.

Input powers RF IN and LO IN

The RF input power at the connectors RF IN and LO IN must not exceed the maximum values quoted in the data sheet. The maximum values are below the maximum RF source power of the network analyzer. The "ZVA110-BU" mode ensures compatible source powers.

Before you connect your external test set to the network analyzer, always activate the "ZVA110-BU" mode using the "Frequency Converter" dialog (see Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24).

Avoid heavy shocks

Heavy shocks can damage inner parts of the devices. Shockproof packing must be used for storing or dispatching the analyzer and the external test sets.

Opening the instrument

Do not open the frequency converter and diplexer elements of the external test sets. It can only be repaired at the manufacturer's servicing department.

Using frequency converters separately

The frequency converters can be dismounted from the external test sets and used separately (see Chapter 4, "Dismounting Frequency Converters", on page 31). The waveguide flanges of the dismounted converters and of the test port adapters must be protected against mechanical damage. Furthermore, the waveguides must be shielded from dust.

Protect the waveguide flange of the dismounted converter by leaving a test port adapter connected. When the converter is not in use, attach one of the included pro-

tective caps to the adapter. Avoid scratching the contact surfaces of the waveguide flanges.

2 Preparing the Analyzer for Use

The R&S ZVA110 vector network analyzer supports two different measurement modes:

- Measurements with internal test sets cover a frequency range between 10 MHz and approx. 67 GHz.
  The R&S ZVA110 is based on a four-port R&S ZVA67 vector network analyzer. The DUT can be connected to any of the four test ports of the R&S ZVA67. One- to four-port measurements are supported as described in the R&S ZVA Getting Started guide, stock number 1145.1090.62, and in the network analyzer's help system.
- Measurements with external test sets cover an extended frequency range between 10 MHz and 110 GHz. The DUT is connected to the 1 mm connectors at the front of the diplexers R&S ZVA-ZD110. This measurement mode is described in the present manual.

This chapter describes the external test sets and their connection to the DUT and to the R&S ZVA110 vector network analyzer. A typical measurement example is presented in Chapter 3, "Basic Operation", on page 24.

The measurement mode is selected in the "Frequency Converter" tab of the "System Configuration" dialog: "<NONE>" for measurements with internal test sets, "ZVA110-BU" for external test sets. See Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24.

2.1 Operation with External Test Sets

The external test sets enable a frequency range between 10 MHz and 110 GHz. The analyzer combines two different measurement methods to achieve this extended range.

- At frequencies below approx. 67 GHz (i.e. in "low frequency" mode), the frequency converter in the external test set is bypassed. The source signals of analyzer ports PORT 1 / 2 are directly fed to the 1 mm test port connectors of the diplexers. The network analyzer measures the a-waves and b-waves from the REF OUT and MEAS OUT on the diplexers, respectively. Analyzer ports PORT 3 / 4 and the RF connectors LO IN, RF IN, REF OUT, and MEAS OUT on the rear panel of the converters are not used.
- To achieve frequencies above approx. 67 GHz (i.e. to measure in "high frequency" mode), the frequency converter in the external test set is used. The source signals of analyzer ports PORT 1 / 2 are fed to the frequency converters, the converted signals are routed to the 1 mm test port connectors of the diplexers. The frequency converters use frequency multipliers to transform the source signal into a high-frequency stimulus signal. An additional Local Oscillator (LO) signal from PORT 4 of the analyzer is used for down-conversion of the reference and measurement channels. A power divider feeds the LO signal to both the left and the right converter. This test setup ensures a stable phase relationship between both LO signals.

The analyzer measures the a-waves from REF OUT and the b-waves from MEAS OUT on the converters. The RF connectors REF OUT, MEAS OUT on the rear panel of the diplexers are not used.

The network analyzer automatically switches between low frequency and high frequency mode, depending on the stimulus frequency; see Chapter 2.3.2, "H/L SWITCH Connector", on page 10. There is no need to change the test setup and cabling.

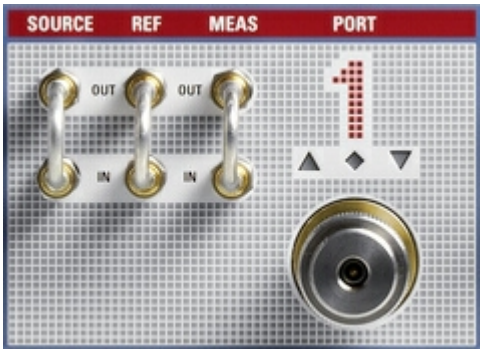
2.2 R&S ZVA110 Network Analyzer Connectors

The R&S ZVA110 is based on a four-port R&S ZVA67 vector network analyzer.

The front and rear panel controls and the connectors of the analyzer are described in the R&S ZVA Getting Started guide, stock number 1145.1090.62 and in the analyzer's help system. The following sections describe special aspects for measurements with external test sets.

2.2.1 Test Port Connectors

The R&S ZVA67 of the R&S ZVA110 is equipped with four complete test port connector groups. The PORT 1 to PORT 4 connector groups are similar. Each of them consists of a bidirectional, ruggedized 1.85 mm connector and 3 pairs of 1.85 mm (V) connectors for direct generator and receiver access.



The connectors are used alternatively:

- The ruggedized 1.85 mm connector serves as a test port connector for one- to four-port measurements with **internal** test set. In this operating mode, the three 1.85 mm connector pairs are not needed. However, they can provide an extended measurement functionality (see R&S ZVA Getting Started guide, stock number 1145.1090.62, and the network analyzer's help system). Unused OUT/IN loops must be jumpered as shown in the figure above.
- The SOURCE OUT connector provides the RF source signal for the **external** test set. SOURCE OUT is connected to the rear panel of the diplexer. In the low frequency range below approx. 67 GHz, REF IN and MEAS IN receive the reference waves and measured waves from the diplexer, respectively. The 1 mm connector of the diplexer serves as a test port connector; the ruggedized 1.85 mm connectors at PORT 1 / 2 are not needed.

See also Chapter 2.1, "Operation with External Test Sets", on page 7 and Chapter 2.5.6, "Connecting RF Cables", on page 17.

NOTICE

Maximum input levels

The maximum RF input levels at the ruggedized 1.85 mm connectors, and the SOURCE, REF, and MEAS inputs (according to the front panel labeling or the data sheet) must not be exceeded.

Furthermore, it is important that the signals fed in at the SOURCE, REF, and MEAS inputs contain no DC offset. A DC offset can impair the measurements and even damage the instrument.

2.3 Diplexer Connectors

The R&S ZVA110 is delivered with two fully assembled external test sets, each consisting of a diplexer R&S ZVA-ZD110 and a frequency converter R&S ZVA-Z110E.

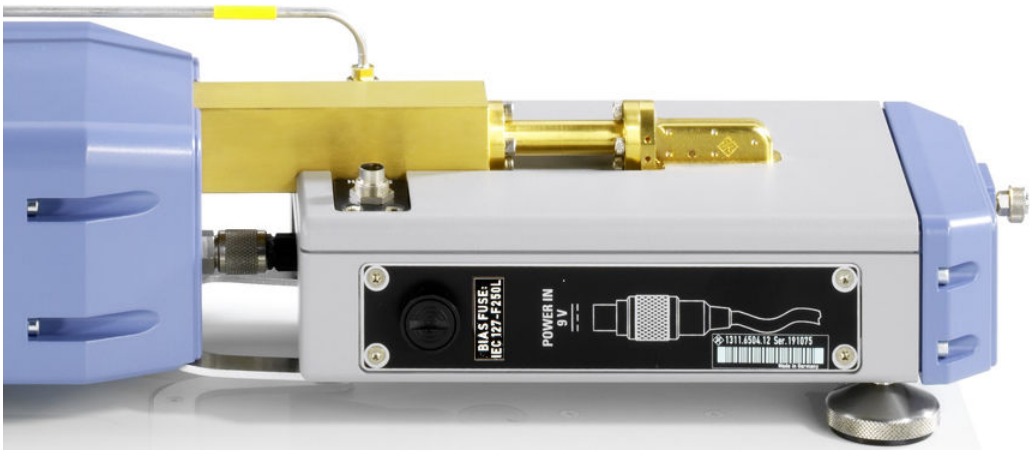


Figure 2-1: Connection between diplexer (right) and frequency converter (left)

The connection of the diplexer and the frequency converter includes conducting lines for waves and power supply:

- The RF HIGH OUT connector on the top side of the diplexer is connected to RF IN on the rear panel of the converter using a semi-rigid RF cable.
- The waveguide connector on the top side of the diplexer is connected to the waveguide flange of the converter.
- The connection underneath the waveguide flange ensures the power supply of the diplexer.

An additional metal clamp at the bottom ensures mechanical stability.

Dismounting the frequency converter

The connection shown above is suitable for all operating modes and measurements. Only dismount the frequency converter from the diplexer if you want to use it separately; see Chapter 4, "Dismounting Frequency Converters", on page 31.

2.3.1 Test Port

1 mm (m) connector, serves as an output for RF stimulus signals and as an input for the measured RF signals from the DUT (response signals).

- With a single external test set, you can generate a stimulus signal and measure the reflected response signal.
- With two external test sets, a full 2-port measurement is possible.

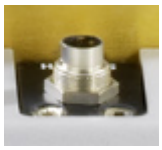
NOTICE

Maximum input level, mechanical damage

Do not exceed the maximum input level at the test port according to the data sheet, especially when using active DUTs or external amplifiers.

To avoid mechanical damage when connecting devices to the 1 mm connector, always use the torque wrench supplied with the R&S ZVA110.

2.3.2 H/L SWITCH Connector



The H/L SWITCH connectors on the top side of each diplexer are input connectors for the USER CONTROL signals from the R&S ZVA110 network analyzer unit; see Chapter 2.5.4, "Connecting the Control Cable", on page 17.

2.3.3 Rear Panel

The rear panel of the diplexer provides input and output connectors for RF signals and a DC input. Connectors labeled LOW are used in low frequency mode only; see Chapter 2.1, "Operation with External Test Sets", on page 7.

Figure 2-2: Rear panel of the diplexer

- MEAS OUT LOW is a 1.85 mm (V) female connector, which provides the measured signal (b-wave) in low frequency mode.
- RF IN LOW / HIGH is a 1.85 mm (V) female connector, which receives the RF source signal from the R&S ZVA110 network analyzer unit. This connector is used in low frequency and in high frequency mode.
- REF OUT LOW is a 1.85 mm (V) female connector, which provides the reference signal (a-wave) in low frequency mode.
- The tri-axial FORCE and SENSE connectors and the 4 mm GND socket implement the bias tee.
  Bias is applied via the FORCE input, which is protected by an exchangeable fuse (see Chapter 2.3.4, "Fuse Holder", on page 12).
  The SENSE output is connected to the bias tee via a 1 kΩ resistor, which allows measuring the bias voltage close to the DUT without the uncertainty caused by a voltage drop on a long bias line.

MEAS OUT, RF IN, and REF OUT are connected to the corresponding 1.85 mm connectors of PORT 1 / 2 at the R&S ZVA110 network analyzer unit. The complete RF connection of the external test set is described in Chapter 2.5.6, "Connecting RF Cables", on page 17.

NOTICE

Maximum input power at RF IN

The RF input power at the RF IN connector must not exceed the maximum value quoted in the data sheet. The maximum value is below the maximum RF source power of the network analyzer. The "ZVA110-BU" mode ensures compatible source powers.

Before you connect your external test set to the network analyzer, always activate the "ZVA110-BU" mode using the "Frequency Converter" dialog (see Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24).

NOTICE

Maximum input voltage at FORCE and EMI suppression

The maximum nominal input voltage and current for the FORCE bias input connector must not exceed the value quoted in the data sheet. Use a double-shielded cable and terminate open cable ends with 50 Ω to ensure successful control of electromagnetic radiation during operation.

The LED labeled ON lights when the diplexer is properly power-supplied. If the LED does not light, check the following:

- The power connection between the diplexer and the converter must be in place (see Figure 2-1).
- The converter must be power-supplied and switched on.
- The fuse at the converter must be intact.

2.3.4 Fuse Holder

A fuse of type IEC 127-F250L at the front protects the diplexer from excess input current at the FORCE connector. A fuse of different type protects the frequency converter (see Chapter 2.4.2.3, "Fuse Holder", on page 14).

For fuse replacement, refer to Chapter 2.5.10, "Replacing Fuses", on page 22.

2.4 Frequency Converter Connectors

The R&S ZVA110 is delivered with two fully assembled external test sets, as described in Chapter 2.3, "Diplexer Connectors", on page 9. The open connectors of the converter are described in the following sections.

2.4.1 Waveguide Flange

For normal operation, the waveguide adapter with the precision waveguide flange mounted on top is connected to the diplexer. If the frequency converter is used separately, a DUT can be connected to the waveguide flange. Refer to the Getting Started guide for frequency converters R&S ZVA-ZxxxE, stock no.1307.7197.62, for detailed information and safety instructions. This Getting Started guide is available on the Rohde&Schwarz internet site (see https://www.rohde-schwarz.com/manual/zvaz/).

See also Chapter 4, "Dismounting Frequency Converters", on page 31.

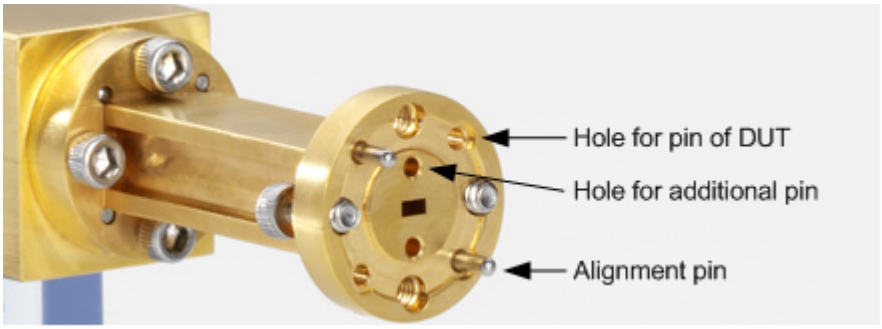


Figure 2-3: Test port adapter of the frequency converter

2.4.2 Rear Panel

The rear panel of the frequency converter provides the connectors and control elements shown below.

Figure 2-4: Rear view of the frequency converter

The connectors are described in the following sections.

2.4.2.1 Standby Switch

The standby toggle switch connects (ready state) or disconnects (standby state) the internal modules of the frequency converter from the power supply. In standby state also the output connector for the diplexer power supply (see Figure 2-1) is disconnected.

Figure 2-5: Standby switch and LEDs

A green light-emitting diode (LED) next to the switch indicates that the instrument is in ready state. An orange LED further to the right indicates that the instrument is in standby state. These LEDs are only lit when the converter is properly connected to the power supply and the fuse of the instrument is intact.

2.4.2.2 Power Supply Connector

To supply the frequency converter, connect the external DC power supply provided with the converter to the 9 V / 1.1 A DC input. For details, see Chapter 2.5.7, "Connecting the Converter to the DC Supply", on page 21.

Always switch the instrument to standby state before removing the power supply.

NOTICE

Risk of instrument damage

The input voltage and current must not exceed the maximum values according to the rear panel labeling or the data sheet.

Always use the DC power supply included in the delivery to power your frequency converter.

2.4.2.3 Fuse Holder

A fuse of type IEC60127 T1 L/H protects the frequency converter from excess input voltages at the power supply connector. A fuse of different type protects the diplexer (see Chapter 2.3.4, "Fuse Holder", on page 12).

For fuse replacement, see Chapter 2.5.10, "Replacing Fuses", on page 22.

2.4.2.4 RF Connectors – Input

Two 3.5 mm input connectors:

- RF IN receives the RF source signal from the diplexer. A semi-rigid cable connects RF IN to the RF HIGH OUT connector on the top side of the diplexer.
- LO IN receives the local oscillator signal from the R&S ZVA110 network analyzer unit.

Both input connectors are only used in high frequency mode. The complete RF connection of the external test set is described in Chapter 2.5.6, "Connecting RF Cables", on page 17.

NOTICE

Risk of instrument damage

The RF input power at the connectors RF IN and LO IN must not exceed the maximum values quoted in the data sheet. The maximum values are below the maximum RF source power of the network analyzer. The "ZVA110-BU" mode ensures compatible source powers.

Before you connect your external test set to the network analyzer, always activate the "ZVA110-BU" mode using the "Frequency Converter" dialog (see Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24).

2.4.2.5 IF Connectors – Output

Two SMA output connectors:

- MEAS OUT provides the measured signal (b-wave) for the R&S ZVA110 network analyzer unit.
- REF OUT provides the reference signal (a-wave) for the R&S ZVA110 network analyzer unit.

The output connectors are connected to the corresponding SMA connectors of PORT 3 / 4 at the R&S ZVA110 network analyzer unit. Both are only used in high frequency mode. The complete RF connection of the external test set is described in Chapter 2.5.6, "Connecting RF Cables", on page 17.

2.4.2.6 Power Control Connector

The three-pin power control connector receives the control signal for the source power of the vector network analyzer. The control signal is used in the high frequency range above approx. 67 GHz.

For correct connection read Chapter 2.5.4, "Connecting the Control Cable", on page 17.

2.5 Putting the Analyzer into Operation

The initial setup of the R&S ZVA110 is described in the R&S ZVA Getting Started guide, stock number 1145.1090.62 and in the network analyzer's help system. This section gives additional information related to operation with external test sets.

2.5.1 Unpacking and Checking the Instrument

The R&S ZVA110 network analyzer unit is shipped in a cardboard box; for unpacking instructions refer to the R&S ZVA Getting Started guide, stock number 1145.1090.62. Each of the two external test sets is shipped in a separate wooden case. The external test sets are fully mounted and accompanied by the necessary cables and additional equipment.

When you receive the shipment, please take the following steps:

1. Unpack the test sets and the other contents of the wooden case.
2. Check the contents of the cases against the list of accessories. Make sure that the delivery includes all listed items.
3. Remove the protective caps from the 1 mm test ports at the front of the diplexer elements. Carefully inspect the converters and diplexers. If you notice any damage, immediately notify the shipping company.

External test sets returned to Rohde & Schwarz or sent in for repair must be packed in the original wooden cases. It is also recommended to keep the cases for storing the test sets and accessories.

See also Chapter 2.7, "Storing and Packing", on page 22 and Chapter 4.1, "Service Re-Calibration", on page 32.

2.5.2 Positioning the Instrument

The R&S ZVA110 is designed for use under laboratory conditions on a bench top. The surface of the bench top must be flat. The external test sets must be used in horizontal position.

The general ambient conditions required at the operating site are as follows:

- The ambient temperature must be in the ranges specified for operation and for compliance with specifications (see data sheet).
- All ventilation openings must be unobstructed.

NOTICE

Risk of instrument and DUT damage

To avoid damage of electronic components of the DUT and the R&S ZVA110, the operating site must be protected against electrostatic discharge (ESD).

To prevent ESD damage, use the wrist strap and grounding cord supplied with the network analyzer and connect yourself to the GND connector at the front panel of the analyzer. For details, refer to the R&S ZVA Getting Started guide.

2.5.3 Adjusting the Feet of the Test Set

The frequency converter can be used with three or four feet attached to the bottom side. If possible, use three feet: two in front and one in the middle of the rear.

Figure 2-6: Setup with one rear foot (left) and two rear feet (right)

Two additional feet support the diplexer. Typically, the external test set can be aligned as follows:

1. Screw the diplexer feet and the front feet into the instrument as far as possible.
2. Use the rear foot to align the entire test set parallel to the surface of the bench top.
3. When you connect a DUT in-between two test sets (see Chapter 2.5.9, "Mounting a DUT", on page 22), use the diplexer feet for further alignment.

2.5.4 Connecting the Control Cable

Switchover between low frequency and high frequency mode is automatically controlled from the R&S ZVA110 network analyzer unit. Use the "H/L Switch" cable to connect the USER CONTROL connector on the rear panel of the analyzer to the H/L SWITCH connectors on the top side of the diplexers.

The "H/L Switch" cable is supplied with the R&S ZVA110. The cable end labeled H/L SWITCH PORT 1 is intended for the "left" diplexer (connected to the analyzer ports 1 and 3). The cable end labeled H/L SWITCH PORT 2 is for the "right" diplexer (connected to ports 2 and 4).

The H/L switch mechanism is controlled by the drive port bits no. 1 and 2 (pins no. 16 and 17) of the USER CONTROL connector. For a detailed description of the connector, refer to the help system of your network analyzer.

Low frequency mode

In low frequency mode, the control cable is not needed – even if the DUT is connected to the 1 mm test port connectors of the diplexers. Remove the control cable, if no frequencies above approx. 67 GHz are measured.

2.5.5 Connecting the Power Control Cable

The source power of the vector network analyzer is controlled from the R&S ZVA67 vector network analyzer. Connect the 3-pin control connector at the rear panel of the converter to the output connector of option R&S ZVA-B8 (EXTATT CTRL) at the top right of the R&S ZVA front panel. A suitable control cable is supplied with each converter.

The numbers below the EXTATT CTRL connectors denote the controlled analyzer ports. Control connector numbers and analyzer port numbers must always be the same.

2.5.6 Connecting RF Cables

The R&S ZVA110 is delivered with two fully assembled external test sets, each consisting of a diplexer R&S ZVA-ZD110 and a frequency converter WR10 R&S ZVA-Z110E.

The "internal" connection between the diplexers and frequency converters is described in Chapter 2.3, "Diplexer Connectors", on page 9. The left test set is intended for PORT 1 / PORT 3 of the R&S ZVA67 network analyzer; the right test set for PORT 2 / PORT 4. Connection of the two test sets is analogous.

NOTICE

Risk of instrument damage

The RF input power at the RF IN and LO IN connectors must not exceed the maximum value quoted in the data sheet. The maximum value is below the maximum RF source power of the network analyzer. The "ZVA110-BU" mode ensures compatible source powers.

Before you connect your external test set to the network analyzer, always activate the "ZVA110-BU" mode using the "Frequency Converter" dialog (see Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24).

NOTICE

Connecting cables, risk of damage

A full set of connecting cables including the necessary adapters (for instrument types 03 and 04) is supplied with the R&S ZVA110. It is strictly recommended to use these high-quality cables for the RF connection. For accurate measurement results, RF cables must have a low attenuation and an excellent phase stability.

Tightening the cable connectors too much can cause damage. Loose connections can result in inaccurate measurement results. For these reasons always use appropriate torque wrenches, suitable for the different connectors types. A torque wrench for the delicate 1 mm connector is supplied with the R&S ZVA110.

Some of the RF connections are only used while the network analyzer operates in the low frequency range (below approx. 67 GHz) or in the high frequency range (above approx. 67 GHz). However, to ensure full flexibility and maximum accuracy, it is recommended to establish all RF connections.

1. Ensure that the converter is in standby state or disconnected from the power supply (see Chapter 2.4.2.1, "Standby Switch", on page 13).
2. Make sure the "ZVA110-BU" mode is active (see Chapter 3, "Basic Operation", on page 24).
3. Connect the RF input and output connectors of the diplexers and the frequency converters as shown below.

The following figure shows the cabling of the left test set to the R&S ZVA67 network analyzer. Notice that the test port connector PORT 4 provides the LO IN signal for both the left and the right converters. An appropriate RF power divider R&S ZV-Z1227 is supplied with the R&S ZVA110.

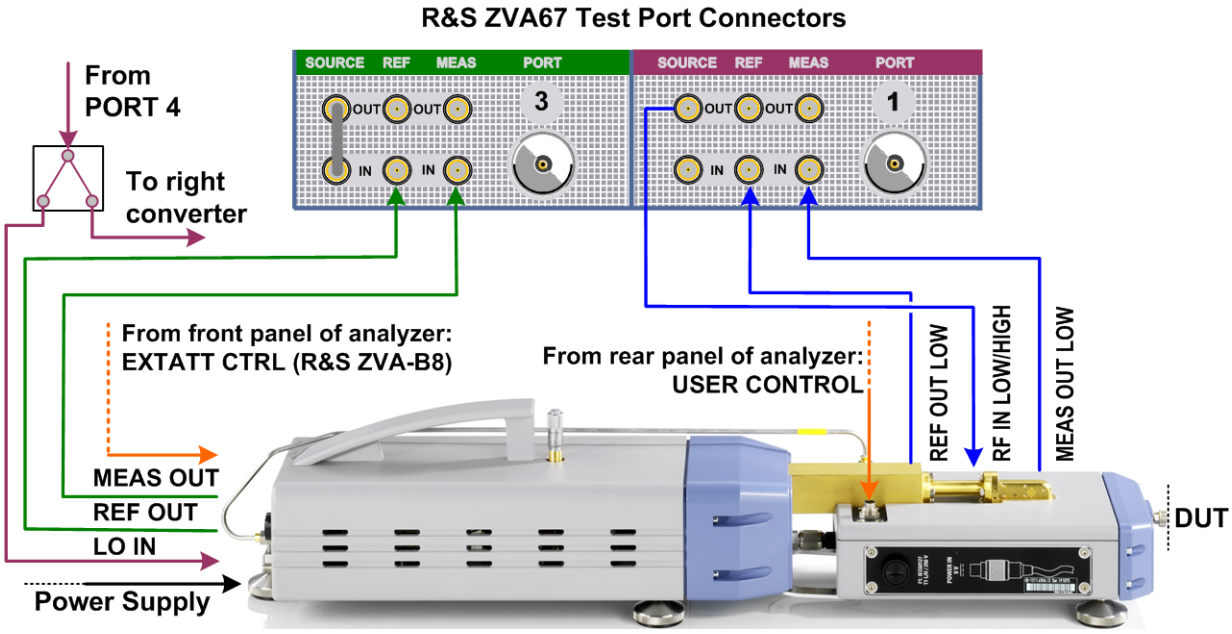


Figure 2-7: Connection of left test set

Table 2-1: RF connection for left external test set

R&S ZVA67 connector	Ext. test set connector	Cable	Used at frequencies
PORT 1 – SOURCE OUT	Diplexer – RF IN	R&S ZV-Z196 67 GHz, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW / HIGH
PORT 1 – REF IN	Diplexer – REF OUT	R&S ZV-Z196 67 GHz, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW
PORT 1 – MEAS IN	Diplexer – MEAS OUT	R&S ZV-Z196 67GHz, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW
PORT 3 – SOURCE OUT must be connected to PORT 3 – SOURCE IN[1)]	–	–	–
PORT 3 – REF IN	Converter – REF OUT	CABLE MEAS, 1.55 m	HIGH
PORT 3 – MEAS IN	Converter – MEAS OUT	CABLE REF, 1.55 m	HIGH

1) The output signal at the ruggedized test port PORT 3 can be used as an auxiliary signal, e.g. an LO signal for a mixer under test.

Table 2-2: RF connection for right external test set

R&S ZVA67 connector	Ext. test set connector	Cable	Used at frequencies
PORT 2 – SOURCE OUT	Diplexer – RF IN	R&S ZV-Z196, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW / HIGH
PORT 2 – REF IN	Diplexer – REF OUT	R&S ZV-Z196, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW
PORT 2 – MEAS IN	Diplexer – MEAS OUT	R&S ZV-Z196, 1.85 mm (M) – 1.85 mm (M), 0.6 m	LOW

R&S ZVA67 connector	Ext. test set connector	Cable	Used at frequencies
PORT 4 – ruggedized connector	Power divider to both converter – LO IN connectors	R&S ZV-Z193, 3.5 mm (M) – 3.5 mm (M), 1.5 m R&S ZV-Z1227, POWER DIVIDER	HIGH
PORT 3 – SOURCE OUT must be connected to PORT 3 – SOURCE IN	–	–	–
PORT 4 – REF IN	Converter – REF OUT	CABLE MEAS, 1.55 m	HIGH
PORT 4 – MEAS IN	Converter – MEAS OUT	CABLE REF, 1.55 m	HIGH

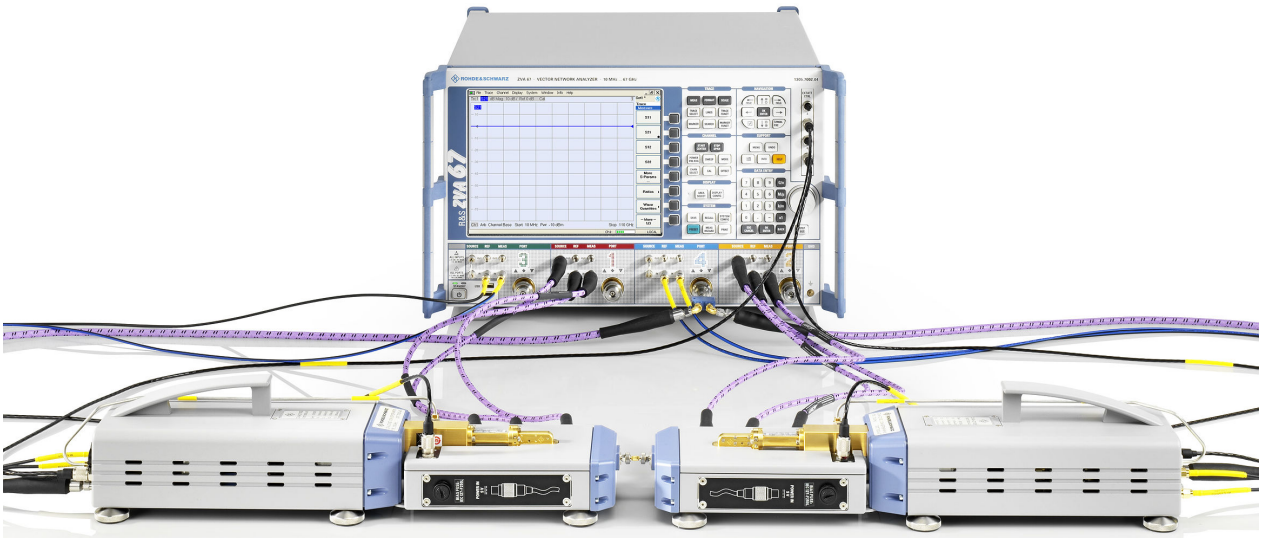


Figure 2-8: Complete test setup for 2-port transmission measurement

Right and left diplexers and converters

A label on the rear panel of the network analyzer shows the two diplexer and converter units with their position. The label contains the following information.

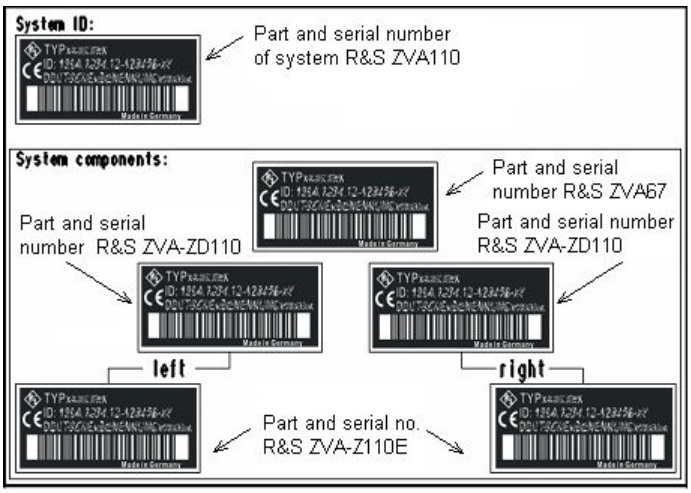


Figure 2-9: System component information

Compliance with rated specifications

The "left" external test set (consisting of one diplexer R&S ZVA-ZD110 plus one converter R&S ZVA-Z110E) is connected to analyzer ports 1 and 3. The "right" external test set is connected to analyzer ports 2 and 4. Compliance with the rated specifications requires a system setup according to the rear panel labeling. Never interchange the left and right diplexer and converter units, and never interchange diplexers and converters from different R&S ZVA110 systems.

2.5.7 Connecting the Converter to the DC Supply

An external DC power supply and several plug adapters are provided with each of the external test sets. Select the appropriate adapter and attach it to the power supply. To remove a mounted adapter, press the small button next to the adapter and push the adapter away from the button.

Connect the power supply to the 9 V / 1.1 A DC input at the rear panel of the frequency converter (see Chapter 2.4.2.2, " Power Supply Connector", on page 13) and to a power outlet. The power supply supports input AC voltages between 100 V and 240 V and frequencies between 47 Hz and 63 Hz.

A lit LED next to the standby switch indicates that the power supply operates appropriately. If neither of the two LEDs is lit, check the fuse of the instrument (see Chapter 2.5.10, "Replacing Fuses", on page 22).

2.5.8 Switching On the External Test Set

The standby toggle switch is located at the rear panel (see Chapter 2.4.2.1, "Standby Switch", on page 13). To switch the external test set to ready state, press the key. The green LED next to the switch must be lit now.

After switching the external test set to the ready state, a warm-up time of one hour is required to ensure accurate measurements. The instrument is only warmed-up in ready state, not in standby state.

2.5.9 Mounting a DUT

The DUT must be screwed to the 1 mm test port connector at the front of the diplexer. A tight connection is essential to ensure precise calibration and measurement results. Depending on the connectors of the DUT, possibly additional adapters are required.

For two-port measurements, two external test sets must be connected to one DUT. Use the adjustable feet of the test sets to align the DUT accurately.

2.5.10 Replacing Fuses

The frequency converter is protected by a fuse of type IEC60127 T1 L/H, the diplexer by a fuse of type IEC127-F250L. To replace a fuse, open the fuse holder by slightly turning the lid counter-clockwise, preferably using a small coin. Replacement fuses are provided with the instrument.

2.6 Maintenance

The external test sets do not require any special maintenance. Make sure that the air vents of the frequency converters are not obstructed. The outside can be cleaned using a soft, line-free dust cloth.

NOTICE

Risk of damage

Cleaning agents contain substances that can damage the external test set, e.g. the front panel labeling or plastic parts.

Never use cleaning agents such as solvents (thinners, acetone etc.), acids, bases or other substances.

For our support center address and a list of useful R&S contact addresses, refer to the pages at the beginning of this guide.

2.7 Storing and Packing

The R&S ZVA110 network analyzer unit and the external test sets can be stored in the temperature range quoted in the data sheet. When stored for a longer period of time, the devices must be protected against dust.

Transport and store the external test sets in their original wooden cases. The 1 mm test port of the diplexer must be protected by its cap; see also Chapter 2.5.1, "Unpacking and Checking the Instrument", on page 15.

The waveguide flanges of dismounted frequency converters must be protected against mechanical damage and shielded from dust; see Chapter 4, "Dismounting Frequency Converters", on page 31.

3 Basic Operation

This chapter describes the use of an R&S ZVA110 vector network analyzer with two external test sets for 2-port transmission measurements.

One-port reflection measurements can be performed in a similar way using a single external test set.

3.1 Required Equipment

The R&S ZVA110 system is delivered with all measurement equipment needed. An additional 1 mm calibration kit is required for system error correction (calibration).

3.2 Measurement Principle

The principle of the measurement with external test sets is described at the beginning of this guide; refer to Chapter 2.1, "Operation with External Test Sets", on page 7.

The measurement involves the following steps:

1. Activation of the "ZVA110-BU" mode for measurements with external test set
2. Entry of power coefficients (when using an external test set for the first time).
3. Connection of the external test sets
4. Power and frequency settings
5. Power calibration using an appropriate external power meter
6. System error correction (calibration) using a suitable calibration kit
7. Connection of the DUT and measurement

3.3 Activating the ZVA110-BU Measurement Mode

After a factory preset, the R&S ZVA67 is configured for measurements using the internal test sets. Activate the "ZVA110-BU" mode explicitly before you connect the external test sets.

To activate the "ZVA110-BU" mode:

1. Click "System" > "System Config ..." to open the "System Configuration" dialog.
2. Activate the "Frequency Converter" tab.
3. Select "Type" : "ZVA110-BU".

4. Click "Apply" to activate the mode.
5. If you use your vector network analyzer for the first time, click "Coefficients" to enter the power coefficients; see Chapter 3.4, "Entering Power Coefficients", on page 25.
6. "Close" the "System Configuration" dialog.

Analyzer settings with active "ZVA110-BU" mode

In "ZVA110-BU" mode, the frequency and level settings of the network analyzer are automatically set to be compatible with the external test sets. "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 …").

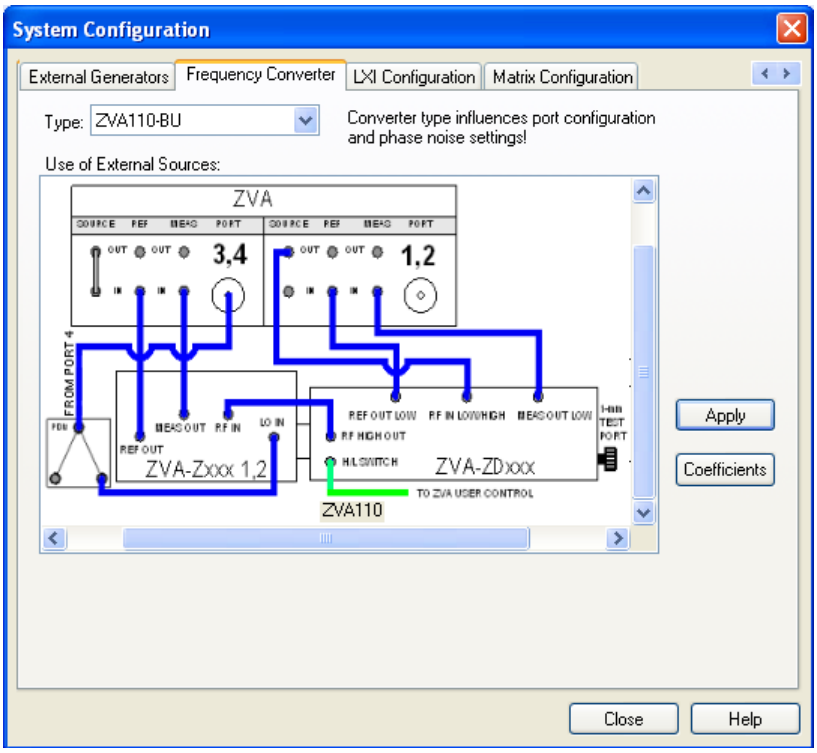


Figure 3-1: Frequency Converter dialog

3.4 Entering Power Coefficients

For accurate control of the converter output power, the R&S ZVA67 analyzer must know the (non-linear) current-power characteristic of the frequency 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.

When the R&S ZVA110 is used for the first time, it is recommended to check whether the power coefficients on the converter labels correspond to the entries in the analyzer dialog. Proceed as follows:

1. Activate the "ZVA110-BU" mode following the first steps in Chapter 3.3, "Activating the ZVA110-BU Measurement Mode", on page 24.
2. In the "Frequency Converter" dialog, press "Coefficients".
3. In the "Power Coefficients" dialog opened, clear "Use default coefficients". Adjust the coefficients in the dialog to the converter coefficients, if necessary.

   The numbers of the table rows in the dialog denote the analyzer ports for the converters.
4. Repeat the last step for both frequency converters/external test sets.

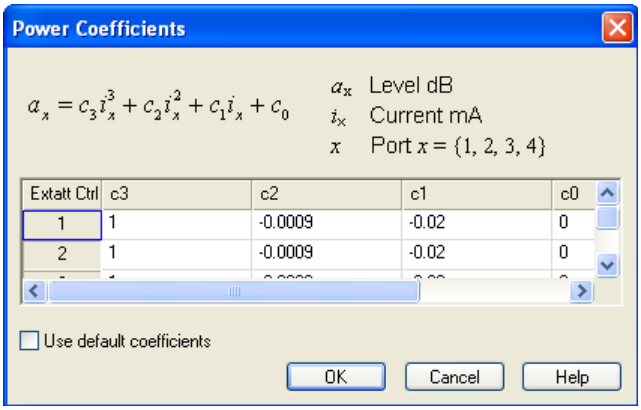


Figure 3-2: Entry of power coefficients for analyzer port 1

3.5 Connecting the External Test Sets

Each of the external test sets must be connected to the R&S ZVA110 base unit, the power supply and the DUT. Please refer to the following sections for details.

- Power control connection: See Chapter 2.5.5, "Connecting the Power Control Cable", on page 17
- H/L SWITCH (control connection): Chapter 2.5.4, "Connecting the Control Cable", on page 17
- RF connection: See Chapter 2.5.6, "Connecting RF Cables", on page 17
- Power supply: See Chapter 2.5.7, "Connecting the Converter to the DC Supply", on page 21
- DUT (usually connected after calibration): See Chapter 2.5.9, "Mounting a DUT", on page 22

3.6 Power and Frequency Settings

While the "ZVA110-BU" mode is active, the "Channel" > "Stimulus" settings of the network analyzer control the frequency and power range of the converters. The "Channel" > "Mode " > "Port Configuration" dialog shows an additional row for each converter. The "Power" and "Frequency" settings in the "Source" section of the dialog serve different purposes:

- The "Power" setting defines the output power for each external test set. After a source power calibration of the converter ports, the analyzer will generate the selected source powers at the 1 mm test port connectors of the external test sets; see Chapter 3.7, "Calibration", on page 28.
  Port 4 provides the local oscillator signal for the converters. The default source power setting ensures a suitable input level of approx. 7 dBm at the LO IN connectors.
- The source frequencies at the 1 mm test ports are determined by the port frequencies of the analyzer: The "Port 1" and "Port 2" source frequencies define the source frequencies of the left and right external test sets, respectively.
  The "Converter Port 1" and "Converter Port 2" frequency settings in the "Port Configuration" dialog define the frequency axes for the source power calibrations. They do not affect the source frequencies at the 1 mm test ports. 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 1 GHz offset. The same offset has been entered for "Converter Port 1". This setting ensures a correct frequency axis during the power calibration.

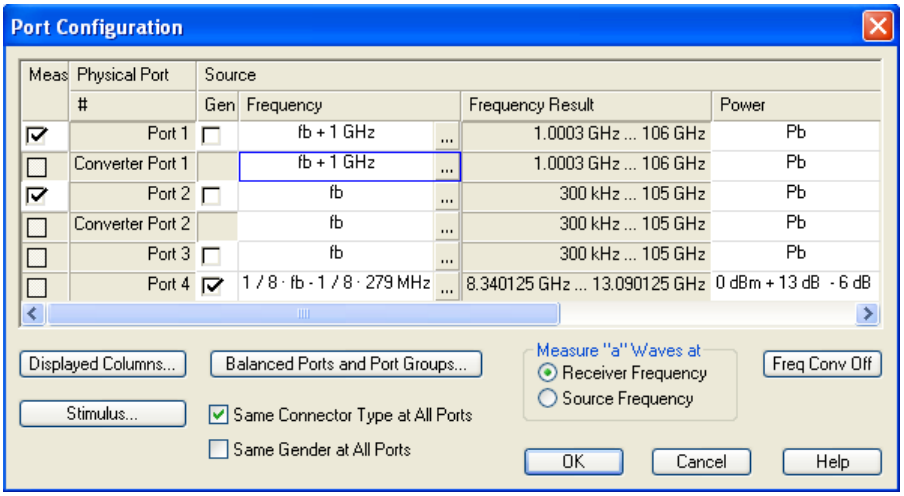


Figure 3-3: Converter frequency and power settings

3.7 Calibration

A source power calibration for an external test set requires an appropriate external power meter, to be connected to the converter's 1 mm test port connector. The power meter is 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 power meter and open the "Channel" > "Calibration" > "Start Power Cal" > "Source Power Cal" dialog.
2. Select the converter source port to calibrate from the "Source" pull-down list (e.g. "Port 1" for the left external test set connected to Port 1 and Port 3).
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 3.7, "Calibration", on page 28.

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. Measurements with external test sets require a 1 mm calibration kit for system error correction.

3.8 Measurement

After power calibration and system error correction, the millimeter wave measurement can be performed like any other network analyzer measurement. The analyzer can perform frequency and power sweeps. 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 a transmission measurement on a through connection in the frequency range between 10 MHz and 110 GHz.

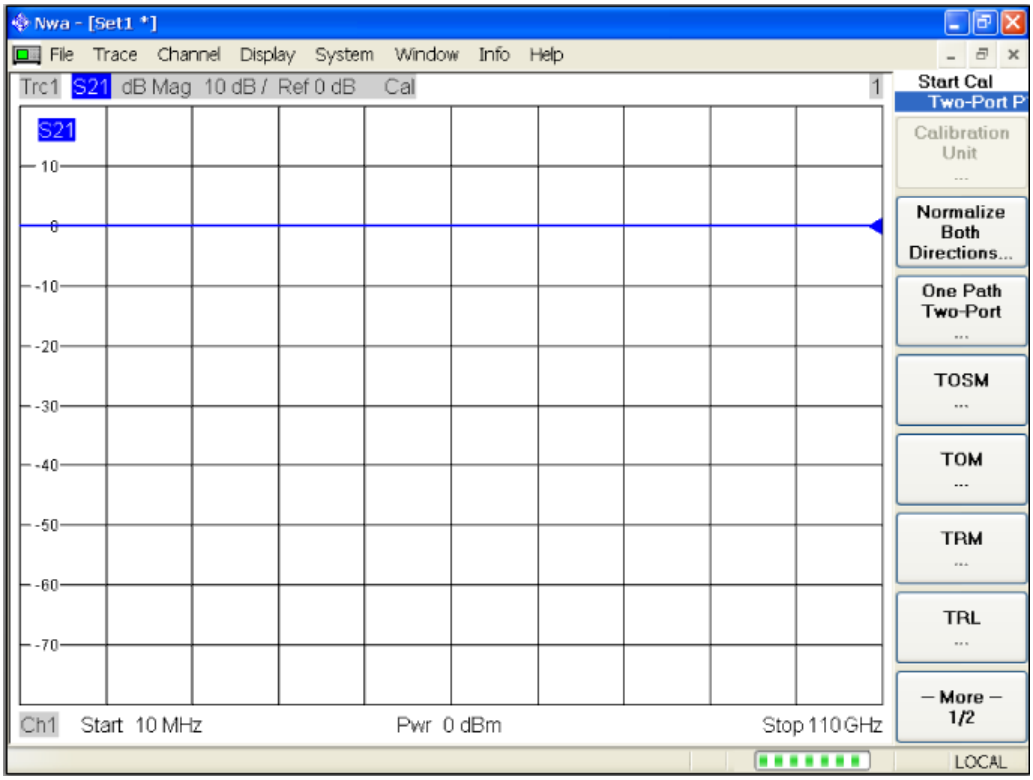


Figure 3-4: Transmission measurement with an R&S ZVA110

For best measurement accuracy, observe the following rules:

- Enter the correct power coefficients of all frequency converters; see Chapter 3.4, "Entering Power Coefficients", on page 25.
- Perform a source power calibration; see Chapter 3.7, "Calibration", on page 28. Using output powers at the 1 mm connectors 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 calibration kit.

3.9 Troubleshooting

The table below lists possible errors and remedies.

Error	Possible cause	Remedy
No output signal, LED next to the mains switch on the rear of the converter panel off.	Converter not power-supplied	Check power supply and fuse (see Chapter 2.5.8, "Switching On the External Test Set", on page 21).
Switchover between low frequency and high frequency mode fails	Control connection not established or Port 1 and Port 2 connectors interchanged	Check connecting "H/L Switch" cable (see Chapter 2.5.4, "Connecting the Control Cable", on page 17).
Inconclusive measurement results	REF and MEAS cables at the diplexer or at the converter are interchanged	See Figure 2-7.
Measurement shows noise only	No supply power at the diplexer unit	See Chapter 2.3, "Diplexer Connectors", on page 9.
Power control fails, external test sets operate at maximum output power.	Power control connection not established	Check connecting cables and port assignment of control connectors.
Inaccurate source levels at the 1 mm ports	Insufficient settling time, especially for fast sweep and strong power variations	Increase sweep time ("Channel" > "Sweep " > "Sweep Time").
Inaccurate source levels, even at reduced speed	Power coefficients entered and converters do not match, e.g. the coefficients of port 1 and port 2 are interchanged	Make sure that all coefficients are correct and assigned to the right analyzer ports (see Chapter 3.4, "Entering Power Coefficients", on page 25).

3.10 Additional Information

For a comprehensive description of R&S ZVA analyzers, including frequency conversion and remote control, refer to the R&S ZVA help system or to the printable operating manual. The latter is available for download at http://www.rohde-schwarz.com/product/zva.

Application notes related to frequency converters are also available for download, see http://www.rohde-schwarz.com/application/zvaz.

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 R&S ZVA network analyzers. If you are interested, please contact your local R&S office.

4 Dismounting Frequency Converters

The frequency converters can be dismounted from the external test sets and used separately. They can be used in combination with any network analyzer R&S ZVA with an upper frequency limit of 20 GHz or higher (R&S ZVA24, R&S ZVA40 ...). Option R&S ZVA-B8 is required to establish the power control connection between the analyzer and the converters.

The frequency converters provide:

- A frequency range between 75 GHz and 110 GHz
- Direct connection of DUTs with waveguide flanges
- System error correction using waveguide calibration kits (e.g. R&S ZV-WR10)

For detailed information about measurements with external frequency converters, refer to the Getting Started guide R&S ZVA-Z90E / -Z110E, and to your network analyzer's operating manual (see https://www.rohde-schwarz.com/manual/zvaz/).

Dismounting the converter

To detach the frequency converter from the diplexer:

1. Unscrew the semi-rigid RF cable between the RF HIGH OUT connector on the top side of the diplexer and the RF IN connector on the rear panel of the converter.
2. Turn the external test set by 90° so that the diplexer connectors point in upward direction.
3. Open the corrugated union screw of the power supply cable between the converter and the diplexer manually, leaving the cable attached to the diplexer.
4. Open two screws at the U-shaped metal clamp, leaving the clamp attached to either the converter or the diplexer.
5. Put the external test set back on its feet.
6. Use the hexball driver supplied with the R&S ZVA110 to open all screws at the waveguide flange, leaving the adapter attached to the converter.
7. Carefully detach the two devices in horizontal direction.

NOTICE

Risk of damaging waveguide flanges

The waveguide flanges of the dismounted converter and of the test port adapters must be protected against mechanical damage. Furthermore, the waveguides must be shielded from dust.

Protect the waveguide flange of the dismounted converter by leaving a test port adapter connected. When the converter is not in use, attach one of the included protective caps to the adapter. Avoid scratching the contact surfaces of the waveguide flanges.

Remounting the converter

To remount the converter, perform the steps described above in reverse order. Use a torque wrench to tighten the semi-rigid RF cable to the SMA connectors and notice that the RF cables of the left and right test sets are not identical.

4.1 Service Re-Calibration

For accurate measurements, the R&S ZVA110 must be recalibrated by Rohde & Schwarz after the calibration interval in the data sheet has elapsed. Calibration involves all components of the test system, including the R&S ZVA67 network analyzer and both external test sets.

To help us carry out your order as quickly as possible, please always return the complete test system. Observe the label on the rear panel of the network analyzer to ensure that all components belong together.

Index