

R&S® SZU100A I/Q Upconverter 58.32-64.8 GHz Manual



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Version 05

ROHDE & SCHWARZ

Make ideas real



This document describes the R&S®SZU100A, order no. 1425.3003.02 and its options:

- R&S®SZU-B1066 (1425.3110.02)

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1425.3061.02 | Version 05 | R&S®SZU100A

The following abbreviations are used throughout this manual: R&S®SZU100A is abbreviated as R&S SZU, the vector signal generators R&S®SMW200A and R&S®SMM100A are abbreviated as R&S SMW and R&S SMM, or referred to as base unit. The R&S®ZCTW is abbreviated as R&S ZCTW.

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1 Safety and regulatory information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the following chapters.

Intended use

Together with an R&S SMW or R&S SMM vector signal generator, the R&S SZU I/Q upconverter generates accurate modulated signals in an extended frequency range. You can use the R&S SZU for Over-the-Air (OTA) beamforming verification in 5G, WLAN IEEE 802.11ad and also for conducted measurements like component test.

The R&S SZU is designed for use in production, R&D and calibration laboratories, and for installation and maintenance tasks. You can use it for setups in a measurement system like anechoic environments, RF shielded boxes or bench-top applications.

Observe the operating conditions and performance limits stated in the data sheet.

Target audience

The target audience is developers and technicians. The required skills and experience depend on the used operating concept.

Where do I find safety information?

Safety information is part of the product documentation. It warns you of potential dangers and gives instructions on how to prevent personal injury or damage caused by dangerous situations. Safety information is provided as follows:

- The multilingual printed "Safety Instructions" are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

1.1 Labels on R&S SZU

Labels on the casing inform about personal safety and product environment safety.

Where to find key documents on Rohde & Schwarz

Labels on the casing inform about:

- Product and environment safety, see [Table 1-1](#)
- Identification of the product

Table 1-1: Labels regarding product and environment safety

	Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its service life. For more information, see Chapter 10.3, "Disposal" , on page 51.
	Take care when handling electrostatic sensitive devices.

1.2 Warning messages in the documentation

A warning message points out a risk or danger that you need to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if you do not follow the safety precautions.

NOTICE

Potential risks of damage. Could result in damage to the supported product or to other property.

1.3 Where to find key documents on Rohde & Schwarz

Certificates issued to Rohde & Schwarz that are relevant for your country are provided at www.rohde-schwarz.com/key-documents, e.g. concerning:

- Quality management
- Environmental management
- Information security management
- Accreditations

1.4 Korea certification class B



이 기기는 가정용(B급) 전자파 적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

2 Documentation overview

This section provides an overview of the R&S SZU user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/szu100a

2.1 Manual

This manual introduces the R&S SZU and describes how to set up and work with the product. It also provides information on maintenance, storage and disposal. A printed version is delivered with the product.

For information on how to use the R&S SZU in setups with a vector signal generator, see the user manual of the generator.

2.2 Printed safety instructions

Provides safety information in many languages. The printed document is delivered with the product.

2.3 Data sheet and brochure

The data sheet contains the technical specifications of the R&S SZU. It also lists the options and their order numbers and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/szu100a.

Application notes, application cards, white papers, etc.

2.4 Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics, see www.rohde-schwarz.com/appnotes.

3 Welcome to the R&S SZU

The R&S SZU from Rohde & Schwarz is an I/Q upconverter for use with the Rohde & Schwarz vector signal generator R&S SMW or R&S SMM.

The I/Q upconverter extends the frequency range for vector modulation to the 60 GHz frequency band. These frequencies are used in modern high-performance wireless communication standards, e.g. IEEE802.11ad, or the application fields of 5G, supporting multiple radio frequency bands. Operating in the 60 GHz frequency band enables devices to communicate at multi-gigabit speed, with data transfer rates of several Gbit/s.



See the application note [1MA260](#) for information on the 802.11ad key parameters, and test setups for over-the-air (OTA) measurements.

Key features

The R&S SZU I/Q Upconverter features:

- Compact broadband upconverter providing 57 GHz to 66 GHz frequency
- Power output of at least 5 dBm for over the air (OTA) RF measurements and tests
- Adjustable output power in the range +5 dBm to -80 dBm, with integrated level detector
- RF output signal at the waveguide port
- Support of common mountable test port adapters
- High-level stability and harmonic suppression
- Compatible to all frequency options of the Rohde & Schwarz vector signal generator
- Support of the R&S SMW / R&S SMM output level user correction
- Fully calibrated at the waveguide port
- Control via user interface of the R&S SMW / R&S SMM
- Small size, easy usage, and operation in any position possible

About the R&S SZU I/Q upconverter

The R&S SZU receives the differential or single-ended baseband signals (I/Q), and an LO signal in the range of 1.944 GHz to 2.16 GHz from the R&S SMW /

R&S SMM. It generates a vector-modulated signal by converting the baseband signal to the output frequency range of 58.32 GHz to 64.8 GHz (center frequency).

The USB host interface is the communication port of the R&S SZU to the vector signal generator. As external instrument, the R&S SZU is configured in the "System Configuration" dialog of the generator, and indicated by a symbol in the GUI. Once connected, the generator reads the calibration data of the R&S SZU, and adjusts the frequency and level values to the output values of this downstream instrument. Thus the R&S SMW / R&S SMM almost completely controls the R&S SZU. You only need to select single-ended or differential mode for the baseband connection. We recommend that you work in differential mode due to better common mode noise suppression over the single-ended connection.

When you work with two R&S SZUs on one R&S SMW, i.e. an R&S SZU connected to each path, the R&S SMW only supports single-ended mode in both paths. The setting parameters in the R&S SMW remain the same.

4 Preparing for use

Here, you can find basic information about setting up the product for the first time.

For information on the equipment required for a basic test setup, see "[Required equipment](#)" on page 29.

4.1 Unpacking and checking

1. Unpack the product carefully.
2. Retain the original packing material. Use it when transporting or shipping the product later.
3. Using the delivery notes, check the equipment for completeness.
4. Check the equipment for damage.

If the delivery is incomplete or equipment is damaged, contact Rohde & Schwarz.

4.2 Choosing the operating site

Specific operating conditions ensure proper operation and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the data sheet.

Electromagnetic compatibility classes

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the product is given in the data sheet.

- Class B equipment is suitable for use in:
 - Residential environments
 - Environments that are directly connected to a low-voltage supply network that supplies residential buildings

Setting up the R&S SZU

- Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments. If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

4.3 Setting up the R&S SZU

The R&S SZU is used exclusively in test setups with the R&S SMW vector signal generators, see "[Intended use](#)" on page 5.

The R&S SZU I/Q upconverter is designed for use under laboratory conditions on a flat bench top or mounted on a wafer probe station. Four M8 threads are provided on all long sides of the converter to allow for mounting the converter on a flat surface. Some on-wafer measurement applications can require the converter to be tilted to bring the test port closer to the chuck. In these cases, an additional bent waveguide adapter can be necessary in front of the test port adapter to compensate for the tilt angle.

Typical test setups for OTA testing require short cabling distances between the R&S SZU and the antenna, see [Figure 6-1](#).

To mount the feet of the converter

The R&S SZU has four adjustable feet you can mount at each side of the converter.



1. Mount all four screwable feet on one of the long sides.
2. Place the R&S SZU horizontal stable position, see ["To place the R&S SZU on a bench top"](#) on page 14.

To place the R&S SZU on a bench top

1. Place the product on a stable, flat and level surface.
2. If necessary, adjust the screws of the feet to align the instrument parallel to the bench top.
3. The top surface is not designed for stacking. If you want to stack the R&S SZU together with other products:
 - a) Follow the instructions given for the other products.
 - b) Place the R&S SZU on top.
4. **NOTICE!** Overheating can damage the product.
Prevent overheating as follows:
 - Keep a minimum distance of 10 cm between the fan openings of the product and any object in the vicinity.
 - Do not place the product next to heat-generating equipment such as radiators or other products.

To mount a test port adapter

The waveguide port is at the [front panel](#).

1. Inspect the waveguide flange connector of the R&S SZU visually to check that it is clean, undamaged and mechanically compatible.
Thus, you prevent insertion loss and mismatch, and even premature wear of the connectors.

Note: If the visual inspection shows that the waveguide flange requires cleaning, see ["To clean a waveguide port"](#) on page 50.

2. Inspect the waveguide port of the test port adapter as described in [step 1](#).
3. Carefully align the holes of the test port adapter to the pins of the waveguide port of the R&S SZU until they match.
4. Insert the four included screws and screw them evenly to the waveguide port.

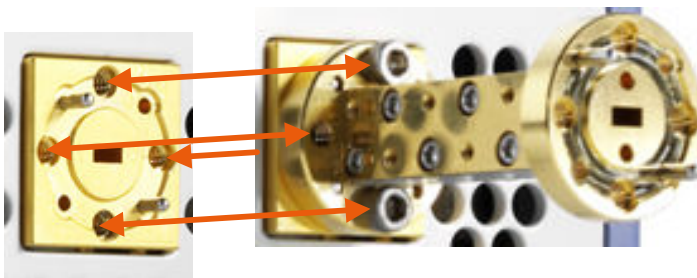


Figure 4-1: Example of mounting the waveguide-to-waveguide adapter to the R&S SZU

5. Tighten the screws with the torque wrench R&S ZCTW until the adapter is firmly connected, see [Table 5-1](#)



Figure 4-2: Recommended torque wrench R&S ZCTW

The R&S ZCTW-SW 3/32 with 0.58 Nm torque limit is especially designed for waveguide port mounting (order no. 1175.2014.02).

4.4 Considerations for test setup

Cable selection and electromagnetic interference (EMI)

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Only use the combined differential IQ/USB cable set delivered with the R&S SZU, as the product has been calibrated with these cables. Optionally, the combined differential IQ -Trigger-USB cable set R&S SZU-Z1 is available under order number 1425.4851.02. See also "Recommended Extras" in the data sheet.
- Use high-quality shielded cables, for example, double-shielded RF cables.
- Ensure that connected external devices comply with EMC regulations.

Protecting waveguide flanges

- Frequently connecting and disconnecting the RF output can wear and tear the waveguide port of the R&S SZU. We recommend that you use a test port adapter, as shown in "[Waveguide test port adapters](#)" on page 24.
- Protect the waveguide flanges of the I/Q upconverter against mechanical damage. Always use the torque wrench to tighten the screws of the waveguide flanges. See "[To mount a test port adapter](#)" on page 15.
- Shield the waveguide port from dust and moisture, and avoid scratching the contact surfaces. See [Chapter 10.1, "Cleaning"](#), on page 50 for information on how to clean the waveguide port, if necessary.
- When the I/Q upconverter is not in use, leave the test port adapter mounted and attach one of the included protective caps to the adapter.

Signal input and output levels

Information on signal levels is provided in the data sheet. Keep the signal levels within the specified ranges to avoid damage to the product and connected devices.

The R&S SZU works only with the R&S SMW / R&S SMM vector signal generators, which adjust the signal level for the LO input at any time to the optimum value for the R&S SZU.

Preventing electrostatic discharge (ESD)

Electrostatic discharge is most likely to occur when you connect or disconnect a DUT.

- ▶ **NOTICE!** Electrostatic discharge can damage the electronic components of the product and the device under test (DUT).

Ground yourself to prevent electrostatic discharge damage:

- a) Use a wrist strap and cord to connect yourself to ground.
- b) Use a conductive floor mat and heel strap combination.

4.5 Connecting to USB

The USB is a type B interface connector at the [rear panel](#) of the R&S SZU.

1. Only use the USB cable delivered with the R&S SZU.
See "[Cable selection and electromagnetic interference \(EMI\)](#)" on page 16.

2. Connect the USB cable to the USB connector of the R&S SZU.

Note: When connecting to the R&S SMW / R&S SMM, only use its USB port at the rear panel.

4.6 Connecting to I/Q

The I/Q input connectors are female SMA connectors at [rear panel](#) of the R&S SZU, see [Chapter 5.2.5, "I/Q input connectors"](#), on page 27. They are color coded to assign the connectors and the matching cables.

To connect the I/Q cables to the R&S SZU

1. Inspect the I/Q connectors of the R&S SZU visually to check that they are clean, undamaged and mechanically compatible.
Thus, you prevent insertion loss and mismatch, and even premature wear of the connectors.

Note: If the visual inspection shows that a connector requires cleaning, see the application note [1MA99](#). The application note provides information on the means you can use and how to clean the thread and the inside the connector.

2. Starting on the left with the BB I In connector, select the color matching differential I/Q cable from the differential IQ/USB cable set that was delivered with the R&S SZU.
3. Inspect the connector of the cable visually as described in [step 1](#).
4. Carefully align the connector of the cable and the connector of the R&S SZU along a common axis.
5. Mate the connectors along the common axis until the male pin of the cable connector engages with the female socket of the instrument connector.
6. Turn the nut of the outer cable connector until the connectors are coupled.
7. Tighten the nut as follows:
 - a) Use a calibrated torque wrench suitable for the type of connector.
 - b) Hold the opposite connector part stationary with a spanner.
 - c) Tighten the nut to the specified limit of 0.56 Nm.

Excessive tightening can damage the connectors. Too loose tightening can lead to inaccurate measurement results.

8. Repeat [step 2](#) to [step 7](#) to connect the other required I/Q cables.

4.7 Connecting to LO In/Out

The LO In is a female SMA connector at the [rear panel](#) of the R&S SZU, see [Chapter 5.2.3, "LO In/Out connectors"](#), on page 27.

To connect the LO In/Out cables to the R&S SZU

1. Use the cable was delivered with the R&S SZU.
See ["Cable selection and electromagnetic interference \(EMI\)"](#) on page 16.

Connecting to the DC supply

2. The LO In and I/Q connectors are of the same type.
To connect the LO In and LO Out cables, proceed the same way as described in [Connecting to I/Q, step 3 to step 7](#).

4.8 Connecting to Trigger

The Trigger input/output connector is a female SMA connector at the [rear panel](#) of the R&S SZU.

1. Use a high-quality cable that matches the connector type.
See "[Cable selection and electromagnetic interference \(EMI\)](#)" on page 16.
2. The Trigger connector and the I/Q connectors are of the same type.
To connect a cable for a trigger signal, proceed the same way as described in [Connecting to I/Q, step 3 to step 7](#).

4.9 Connecting to the DC supply

Use the external power supply and AC power cable delivered with the R&S SZU to supply the required voltage and current. Both values are stated on the casing above the DC power connector, see [Figure 5-4](#).

The input voltage and current must not exceed the maximum values. Using a power supply other than included can damage the R&S SZU.

To connect the R&S SZU to power

1. Plug the DC power cable of the external power supply delivered with the R&S SZU into the DC power connector on the [rear panel](#).
2. Plug the included AC power cable to the AC socket of the external power supply.
3. Plug the AC power cable of the external power supply into a power outlet with ground contact. The required ratings are listed in the data sheet.

The R&S SZU does not provide a separate power key. Once connected to the [Chapter 4.9, "Connecting to the DC supply"](#), on page 19, the R&S SZU is powered automatically.


To disconnect the R&S SZU from power

- ▶ Unplug the AC power cable of the external power supply from the power outlet.

On disconnecting, the R&S SZU is powered off.

4.10 Connecting to a DUT

The waveguide flange of the RF interface at the [front panel](#) enables you to connect the R&S SZU to the DUT directly, or to mount a test port adapter before connecting to the DUT. See "[Waveguide test port adapters](#)" on page 24 for the connecting options.

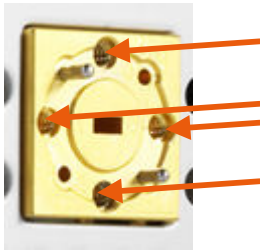
 To avoid possible wear due to frequent connection directly to the waveguide flange, we recommend that you use a test port adapter.

If an adapter shows any wear, you can exchange it. See "[Waveguide test port adapters](#)" on page 24 for order information on the available WR15 adapters.

For mounting the adapter to the R&S SZU, see "[To mount a test port adapter](#)" on page 15.

To connect the DUT to the R&S SZU directly

1. Inspect the waveguide flange connector of the R&S SZU visually to check that it is clean, undamaged and mechanically compatible.
Thus, you prevent insertion loss and mismatch, and even premature wear of the connectors.
Note: If the visual inspection shows that the waveguide flange requires cleaning, see [Chapter 10.1, "Cleaning"](#), on page 50.
2. Inspect the waveguide port of the DUT accordingly, see [step 1](#).
3. Carefully align the pins of the DUT to the holes of the waveguide port of the R&S SZU until they match.
4. Carefully fit the waveguide connectors into each other.
5. To tighten the waveguide connectors:



- a) Align the four included screws of the waveguide port to the screw threads of the opposite connector.
- b) Torque the screws to the specified limit of 0.58 Nm using the R&S ZCTW calibrated torque wrench. See [Figure 4-2](#).

Excessive tightening can damage the connectors. Too loose tightening can lead to inaccurate measurement results.

To connect the DUT to the waveguide-to-waveguide test port adapter

The precision waveguide flange of the waveguide-to-waveguide adapter provides two pins and two holes for aligning the DUT, see ["Waveguide-to-waveguide adapter"](#) on page 25.

1. Mount the test port adapter to the R&S SZU as described in ["To mount a test port adapter"](#) on page 15.
2. To connect the DUT to the test port adapter, proceed the same way as described in [To connect the DUT to the R&S SZU directly, step 1 to step 5](#).

To connect the DUT to the waveguide-to-V test port adapter

The precision waveguide flange of the waveguide-to-V adapter provides a 1.85 mm coaxial socket for connecting the DUT.

1. Inspect the coaxial connector of the test port adapter visually to check that it is clean, undamaged and mechanically compatible.
Thus, you prevent insertion loss and mismatch, and even premature wear of the connectors.

Note: If the visual inspection shows that the connector requires cleaning, see the application note [1MA99](#). The application note provides information on the means you can use and how to clean the thread and the inside of the connector.

2. Select a high-quality shielded RF cable that matches the connector type.
See ["Cable selection and electromagnetic interference \(EMI\)"](#) on page 16.

3. Inspect the connector of the cable visually as described in [step 1](#).
4. Carefully align the connector of the cable and the RF output connector of the test port adapter along a common axis.
5. Mate the connectors along the common axis until the male pin of the cable connector engages with the female socket of the instrument connector.
6. Turn the nut of the outer cable connector until the connectors are coupled.
7. Tighten the nut as follows:
 - a) Use a torque wrench suitable for the type of connector.
 - b) Hold the opposite connector part stationary with a spanner.
 - c) Tighten the nut to the specified limit of 0.9 Nm.

Excessive tightening can damage the connectors. Too loose tightening can lead to inaccurate measurement results.

5 Instrument tour

5.1 Front view

At the front, the R&S SZU covers the interface to the DUT that is the output of the RF signal. To connect the device under test (DUT), you can directly connect it to the waveguide flange, or use one of the available test port adapters.



Figure 5-1: Front view of the R&S SZU

1 = WR15 waveguide flange

Waveguide flange

The RF waveguide port of the R&S SZU is a standard WR15 waveguide flange that consists of an outer ring and an inner contacting surface with the waveguide. The outer ring provides four alignment fixtures, two cylindrical pins and two holes as counterparts of the DUT alignment pins.

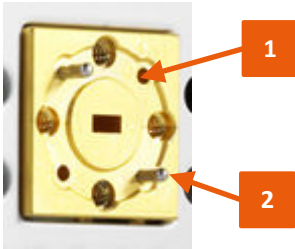


Figure 5-2: Assignment of the waveguide port

- 1 = Hole for pin of the DUT or test port adapter
- 2 = Alignment pin

See ["To connect the DUT to the R&S SZU directly"](#) on page 20.

Waveguide test port adapters

Rohde & Schwarz provides either a waveguide-to-waveguide adapter or a waveguide-coax-adapter. Refer to the data sheet for details on the type of waveguide adapters that match to the frequency band of the R&S SZU I/Q upconverter.

Table 5-1: R&S SZU I/Q upconverter front views

<p>R&S SZU with waveguide-to-waveguide adapter</p>	<p>R&S SZU with waveguide-to-V-connector adapter</p>

To mount a test port adapter to the waveguide flange of the R&S SZU, see ["To mount a test port adapter"](#) on page 15.

Waveguide-to-waveguide adapter

Designation: waveguide-to-waveguide adapter WR15, order number 1314.5780.00.

The precision waveguide flange of this test port adapter consists of an outer ring and a protruding inner contacting surface with the waveguide. On the outer ring there are four alignment fixtures, two cylindrical pins and two holes as counterparts of the DUT alignment pins. Two additional holes in the inner flange surface allow you to insert additional pins.



Figure 5-3: Assignment of the test port adapter

1 = Hole for pin of the DUT
2 = Alignment pin

See ["To connect the DUT to the waveguide-to-waveguide test port adapter"](#) on page 21

Waveguide-to-V-connector adapter

Designation: R&S WCA70 waveguide-coax adapter WR15-1.85 mm, order number 1314.5001.02.

The waveguide-to-V-adapter has an 1.85 mm coaxial output socket for connecting the DUT.

See ["To connect the DUT to the waveguide-to-V test port adapter"](#) on page 21

5.2 Rear view

The rear panel provides the connectors and control elements of the R&S SZU.

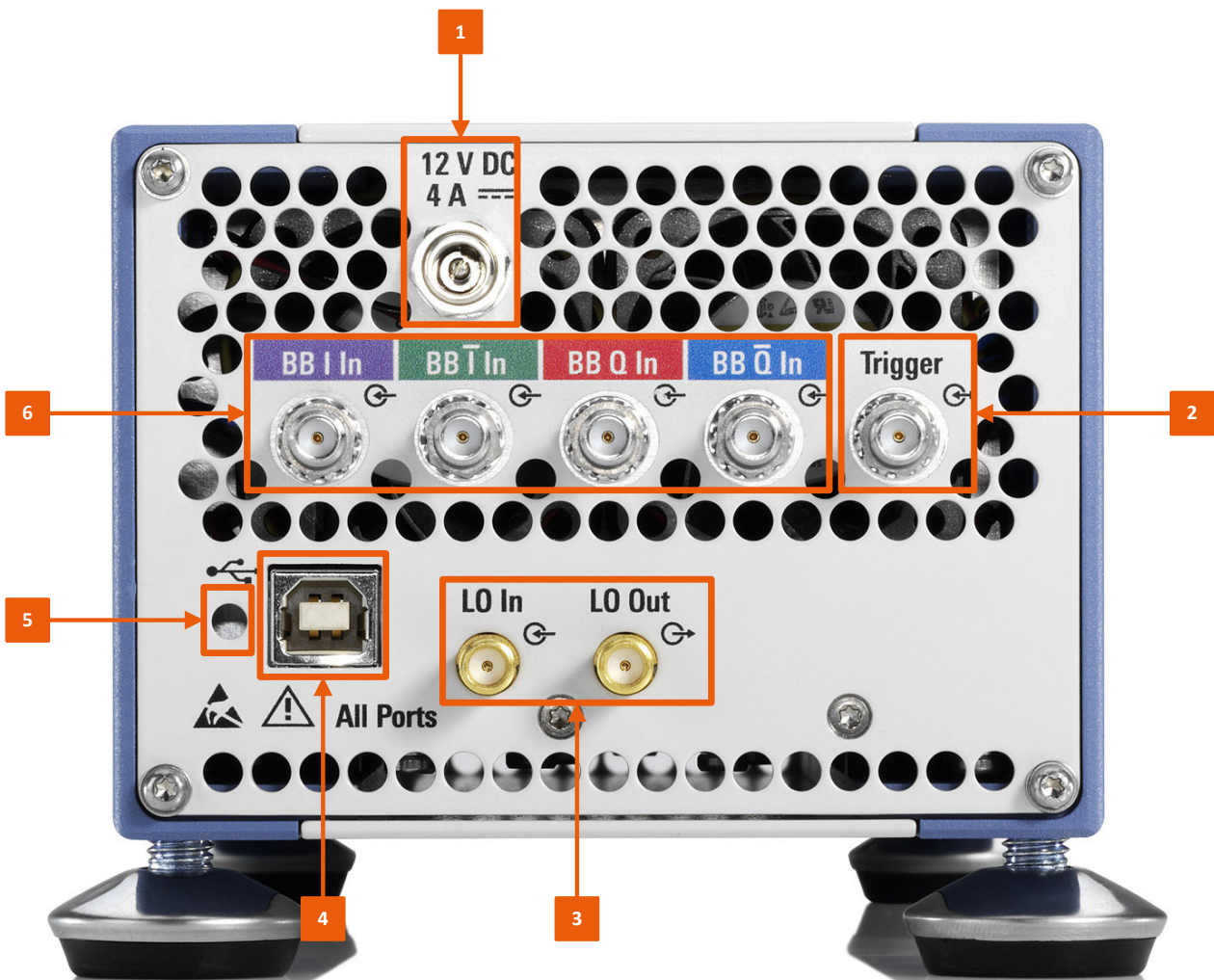


Figure 5-4: Rear view of the R&S SZU

- 1 = Power supply connector
- 2 = Trigger connector
- 3 = LO signal input and output
- 4 = USB interface
- 5 = Status LED
- 6 = I/Q input connectors

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5.2.1 Power supply connector

Connection for the DC power supply ([Figure 5-4](#), (1)).

The I/Q upconverter is supplied by an external DC power supply. It supports the AC input voltages between 100 V to 240 V and frequencies between 50 Hz to 60 Hz.

See [Chapter 4.9](#), "Connecting to the DC supply", on page 19.

5.2.2 Trigger input/output connector

Connector for an optional trigger signal ([Figure 5-4](#), (2)). The trigger connector is an SMA coaxial connector with 50 Ohm impedance.

See [Chapter 4.8](#), "Connecting to Trigger", on page 19

5.2.3 LO In/Out connectors

Connectors for RF signal input and output ([Figure 5-4](#), (3)). These connectors are SMA coaxial connectors with 50 Ohm impedance. LO In receives the LO signal from the R&S SMW / R&S SMM, and LO Out is intended for future use, e.g. to forward the LO signal when using multiple R&S SZU in a daisy chain.

See [Chapter 4.7](#), "Connecting to LO In/Out", on page 18

5.2.4 USB interface

Universal serial bus (USB) interface of type B ([Figure 5-4](#), (4)). This port is used to communicate with the host instrument, the R&S SMW / R&S SMM.

See [Chapter 4.5](#), "Connecting to USB", on page 17.

5.2.5 I/Q input connectors

Input connectors for the single-ended (I/Q) or differential (I/Q, I/Q BAR) baseband signal ([Figure 5-4](#), (6)). These connectors are SMA coaxial connectors with 50 Ohm impedance.

The I/Q input connectors receive the single-ended signal, or the positive signal components of the differential signal. The I/Q BAR connectors receive the negative signal components of the differential signal.

See [Chapter 4.6, "Connecting to I/Q"](#), on page 17.

5.2.6 Status LED

Indicates the instrument status ([Figure 5-4, \(5\)](#)).

Table 5-2: Status LED colors

LED	R&S SZU status	Description
● off	Off	R&S SZU is powerless.
● on	Standby	Controller is running, all analog circuitry are powered down.
● blinking (3 Hz)	Booting or busy	Controller is booting or USB transfer is running.
● on	RF Off	R&S SZU is ready for operation with RF deactivated.
● on	RF On	R&S SZU is ready for operation with RF signal activated.
● blinking once	Trigger received	LED switches off for 200 μ s when an external trigger event occurred.
● on	Internal error	E.g., over temperature, power failure, fan failure.
● blinking (6Hz)	External error	E.g., LO level out of range.

6 Basic operation

The following sections describe the prerequisites and main steps for setting up a measurement and operating the R&S SZU, using an R&S SMW vector signal generator. The proceeding for other Rohde & Schwarz vector signal generators that support the R&S SZU is analogous.

6.1 Setting up the measurement

This section describes the setup of a basic application with the R&S SZU I/Q Upconverter.

Required equipment

To operate an R&S SZU I/Q upconverter, you need:

- An Rohde & Schwarz vector signal generator, e.g., an R&S SMW, which is used as an example in the following description.
The R&S SMW must be equipped with the corresponding options to meet the frequency range and the level of the R&S SZU. See the data sheet for the specification of the local oscillator signal.
- A test port adapter, recommended if applicable.
- Standard cabling, included:
 - Note:** Only use the cables delivered with the R&S SZU, as the product has been calibrated with these cables.
 - Four I/Q cables
 - USB cable
 - RF cable
- Trigger cable, optionally

Test setup

Signal source is the R&S SMW that supplies the analog I/Q signal, and optionally a trigger signal to the R&S SZU. For control, the R&S SMW uses the USB connection. The R&S SZU transmits the upconverted RF signal to the RF shield box (DUT).

Setting up the measurement

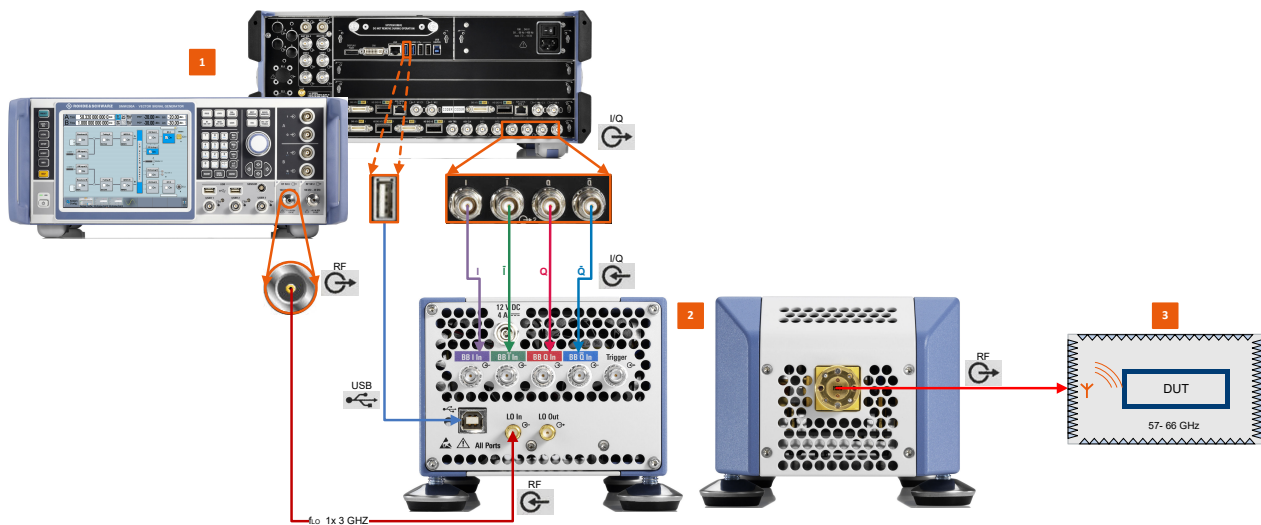


Figure 6-1: OTA RF measurement test setup

- 1 = Rohde & Schwarz vector signal generator, e.g., R&S SMW
- 2 = R&S SZU I/Q Upconverter
- 3 = RF shield box

To set up the measurement

Connecting the measurement setup and configuring the measurement includes the following steps:

1. Power up the R&S SMW.
2. Connect the I/Q outputs of the signal generator to I/Q connectors of the R&S SZU.
See [Chapter 4.7, "Connecting to LO In/Out"](#), on page 18.
3. **NOTICE!** Risk of instrument damage. High input power can damage the R&S SZU.
Switch off the RF output of the R&S SMW before connecting to LO In of the R&S SZU.
4. Connect the RF A output of the signal generator to LO In of the I/Q upconverter.
See [Chapter 4.7, "Connecting to LO In/Out"](#), on page 18.
5. Connect the USB cable plug B to the R&S SZU, and the USB cable plug A to the R&S SMW (rear panel).
See [Chapter 4.5, "Connecting to USB"](#), on page 17
6. Connect the R&S SZU I/Q Upconverter to the power supply.

Configuring the converter setup

See [Chapter 4.9, "Connecting to the DC supply"](#), on page 19

7. Keep the [Warm-up time](#).
8. Before connecting to the DUT, configure the R&S SZU in the R&S SMW. See [Configuring the converter setup](#).


With connecting USB, the R&S SMW recognizes the R&S SZU automatically. The R&S SMW reads all parameters for identification and the calibration table of the R&S SZU, and sets the optimum LO level.

At a reboot of the R&S SMW with a connected R&S SZU, RF can remain active. The base unit starts with the recently used settings.

6.2 Configuring the converter setup

After connecting the instruments, you need to configure the connection in the "System Configuration" dialog of the signal generator. The following instruction guides you through the first steps by the example of one connected I/Q Upconverter, assigned to path A of the R&S SMW.

Another example shows two R&S SZUs connected to the R&S SMW, i.e. one per path, see ["Two R&S SZU connected to the R&S SMW"](#) on page 37.

 For details to the setting parameters and to the corresponding remote control commands, refer to:

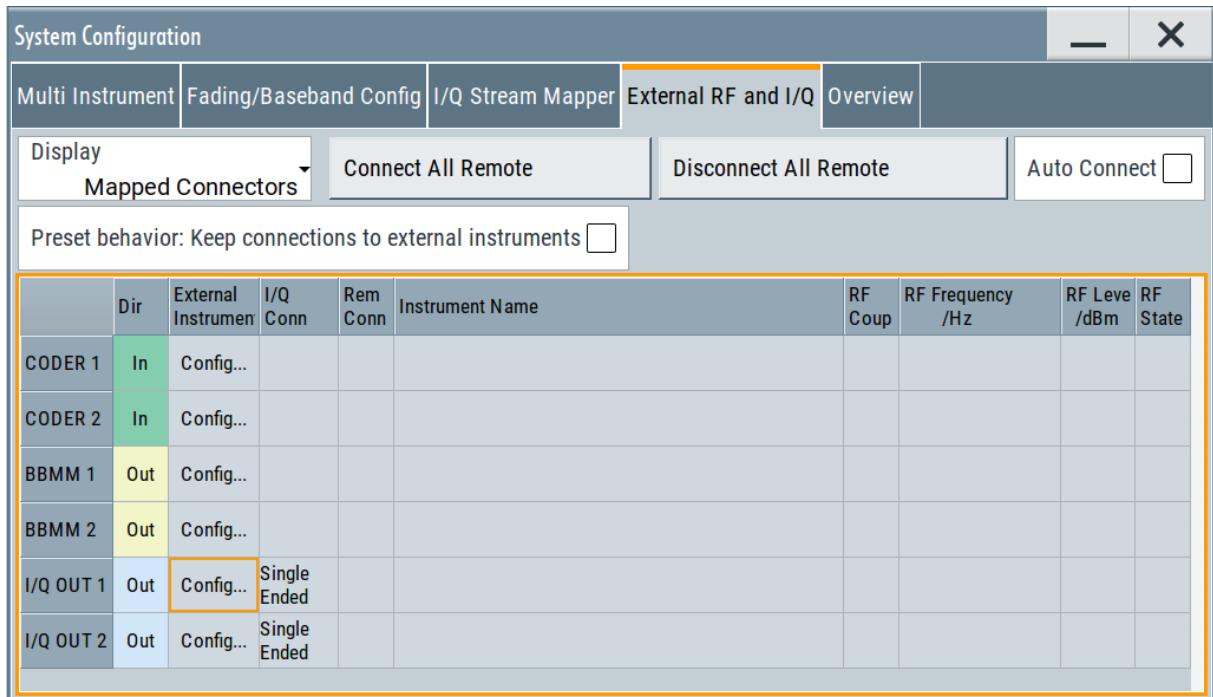
- The www.rohde-schwarz.com/product/SMW200A/User Manual, chapter "Signal routing and system configuration", sections "System configuration settings > External RF and I/Q settings", and section "System configuration settings > Overview".
- [Chapter 7, "Remote control of the R&S SZU"](#), on page 45, and the corresponding descriptions in the R&S SMW user manual.

To configure the R&S SZU in the R&S SMW

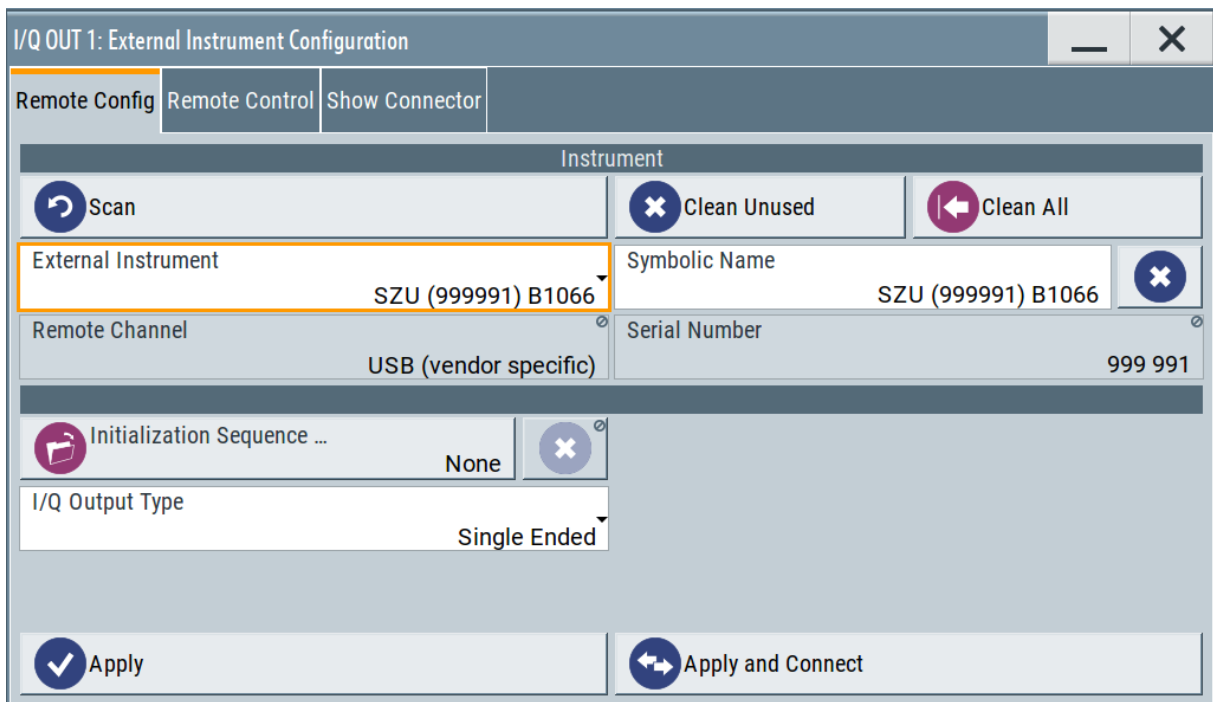
Access:

1. In the R&S SMW, select "Taskbar > System Config. > System Configuration > External RF and I/Q".

Configuring the converter setup



2. Select "I/Q OUT 1 > Config...".
3. Select "External Instrument > SZU (<Serial No> Bxxxx)".



4. Select "I/Q Output Type > Differential".

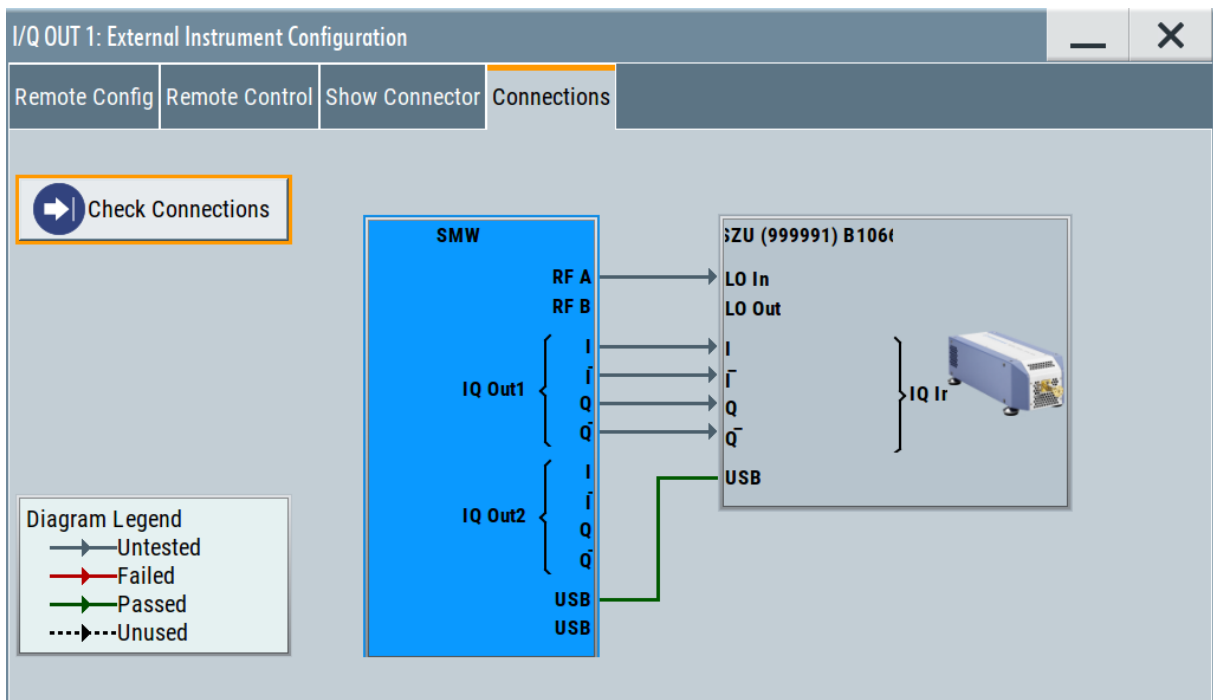
Note: If you are working with an R&S SZU in each path, the R&S SMW only supports the single-ended mode in both paths.

Configuring the converter setup

- Confirm with "Apply and Connect".

The R&S SMW establishes the connection to the R&S SZU and shows the "Connections" tab.

- Select "Check Connections".



The R&S SMW checks the connections at the corresponding RF and I/Q connectors and displays the results.

- Close the dialog.

Configuring the converter setup

	Dir	External Instrumen	I/Q Conn	Rem Conn	Instrument Name	RF Coup	RF Frequency /Hz	RF Leve /dBm	RF State
CODER 1	In	Config...							
CODER 2	In	Config...							
BBMM 1	Out	Config...							
BBMM 2	Out	Config...							
I/Q OUT 1	Out	Config...	Single Ended		SZU (999991) B1066	On		Δ: 0.00 Δ: 0.00	Off
I/Q OUT 2	Out	Config...	Single Ended						

1 = See [step 8](#)

2 = See [step 9](#)

8. In the "System Configuration" dialog, check "Auto Connect".

When enabled, the R&S SMW automatically (re)establishes the connection to the R&S SZU, e.g. after a restart or an instrument preset.

9. Select "Preset behavior: Keep connections to external instruments".

When enabled, the R&S SMW retains the connection to the R&S SZU at an instrument preset, see [Chapter 6.4, "Behavior of the R&S SMW when working with the R&S SZU"](#), on page 41.

10. Select the "Overview" tab.

Configuring the converter setup

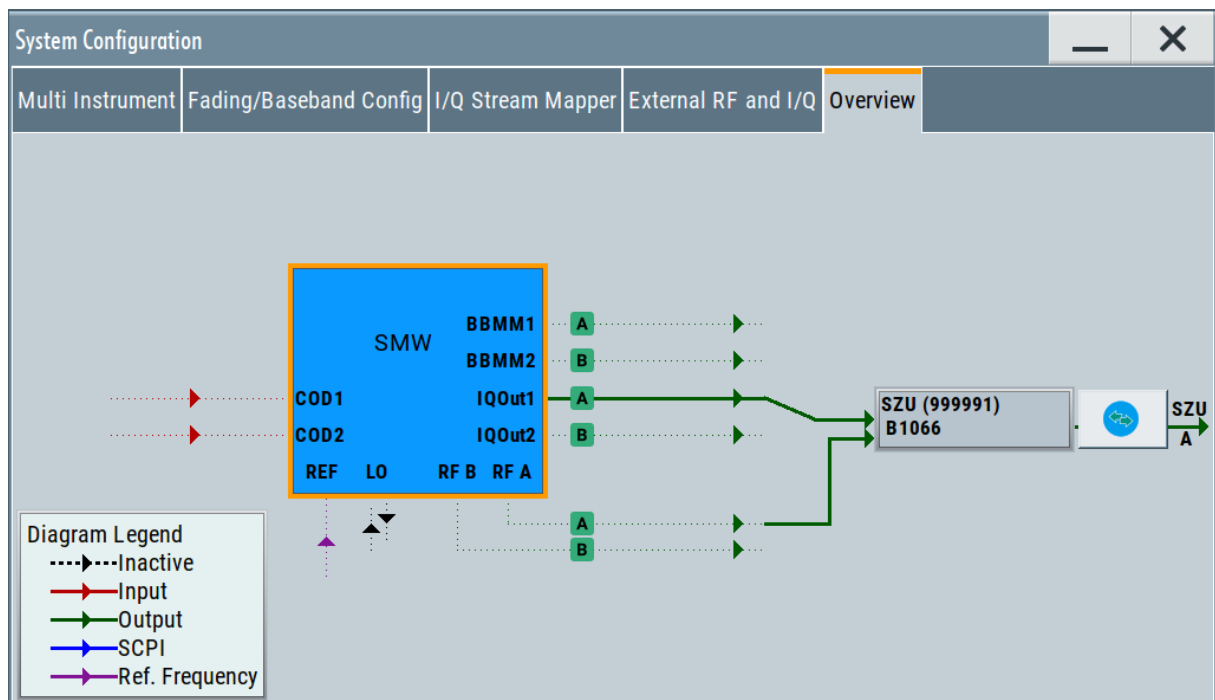


Figure 6-2: Display of one connected R&S SZU in the overview tab

The overview tab shows all external instruments connected, in this case one connected R&S SZU. For more, see the user manual of the R&S SMW, chapter "System configuration settings", section "Overview".

11. Close the dialog.
12. If necessary, perform an internal adjustment, before connecting the DUT and activating the measurement.
Proceed as described in [Chapter 6.3, "Running internal adjustments"](#), on page 39.

To activate the signal output

After the internal adjustments are completed, you can connect the DUT and start with your measurement.

1. Connect the R&S SZU with the DUT.

Configuring the converter setup

2. In the block diagram, select the checkbox in the "RF" to activate RF signal output.

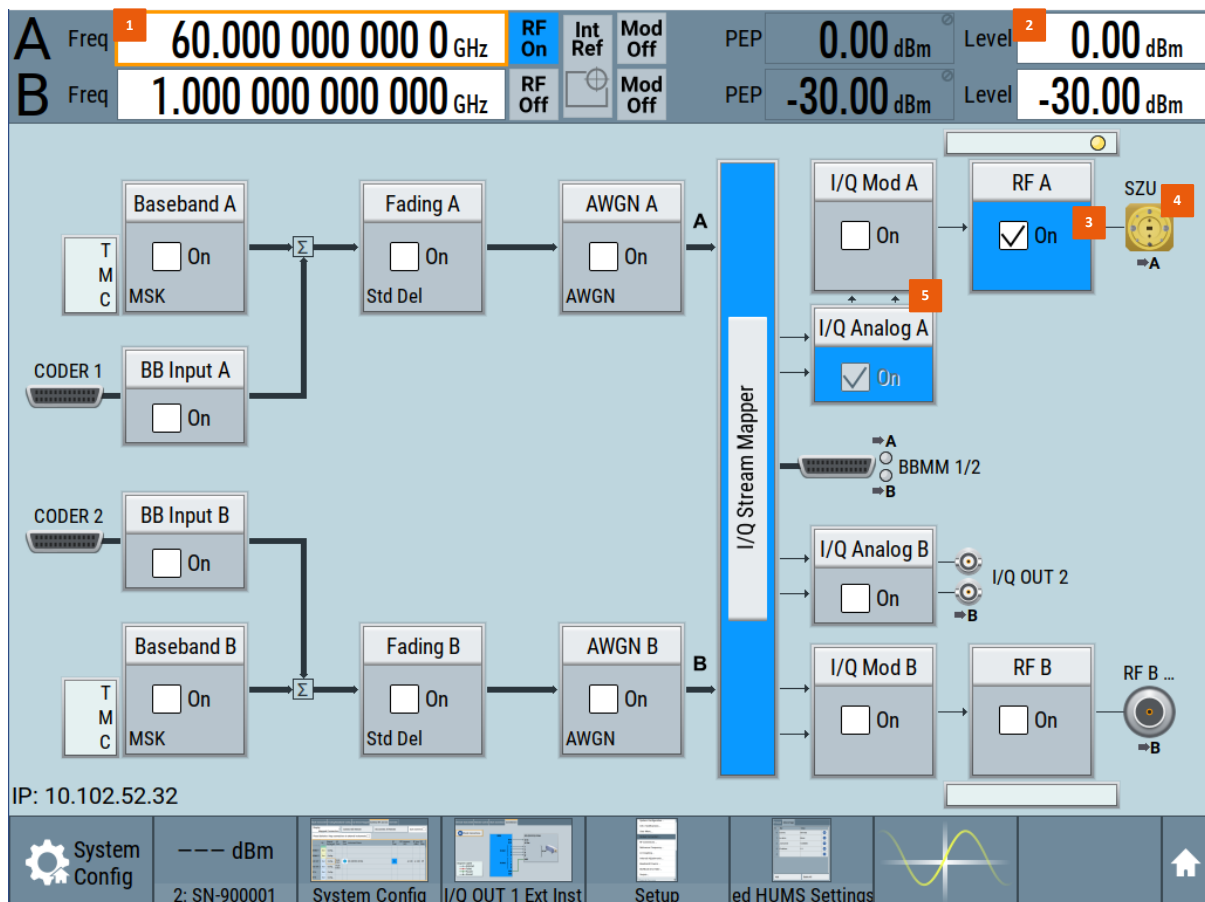


Figure 6-3: Display of one connected R&S SZU on the R&S SMW screen

- 1 = RF frequency of the R&S SZU RF output
- 2 = RF level, nominal level at the R&S SZU RF output (regulated level)
- 3 = RF_{LO} , CW signal for the LO input of the R&S SZU
- 4 = R&S SZU displayed by the waveguide port icon, the label and the serial number
- 5 = Active I/Q output with displayed connection lines

The R&S SMW performs the following:

- Reads all parameters for identification of the R&S SZU.
- Reads the R&S SZU calibration data.
- Indicates the connected R&S SZU at the RF output in the block diagram and displays the waveguide output icon.
- Sets the output signal level and frequency to the default values of the R&S SZU, and indicates these values in the status bar. You can set both parameters directly as usual.

Two R&S SZU connected to the R&S SMW

The R&S SMW supports one R&S SZU per path, i.e. you can connect another R&S SZU also to path B or vice versa.

For the I/Q and RF ports of the two paths, the R&S SMW allows the following combinations:

- The I/Q signal of the analog I/Q out 1 and the LO output of RF path A
- The I/Q signal of the analog I/Q out 2 and the LO output of RF path B

However, when you are working with two R&S SZU, you can process the IQ signals only in single-ended mode.

To configure two R&S SZU in one R&S SMW

The connection and configuration of a second R&S SZU in the R&S SMW are the same as described above.

- ▶ For the second instrument, proceed as described in ["To configure the R&S SZU in the R&S SMW"](#) on page 31. As an exception, consider [step 4](#). Select "I/Q Output Type > Single Ended" in both paths instead.

When completed, the R&S SMW indicates the two I/Q upconverters as shown in [Figure 6-4](#), and [Figure 6-5](#).

Configuring the converter setup

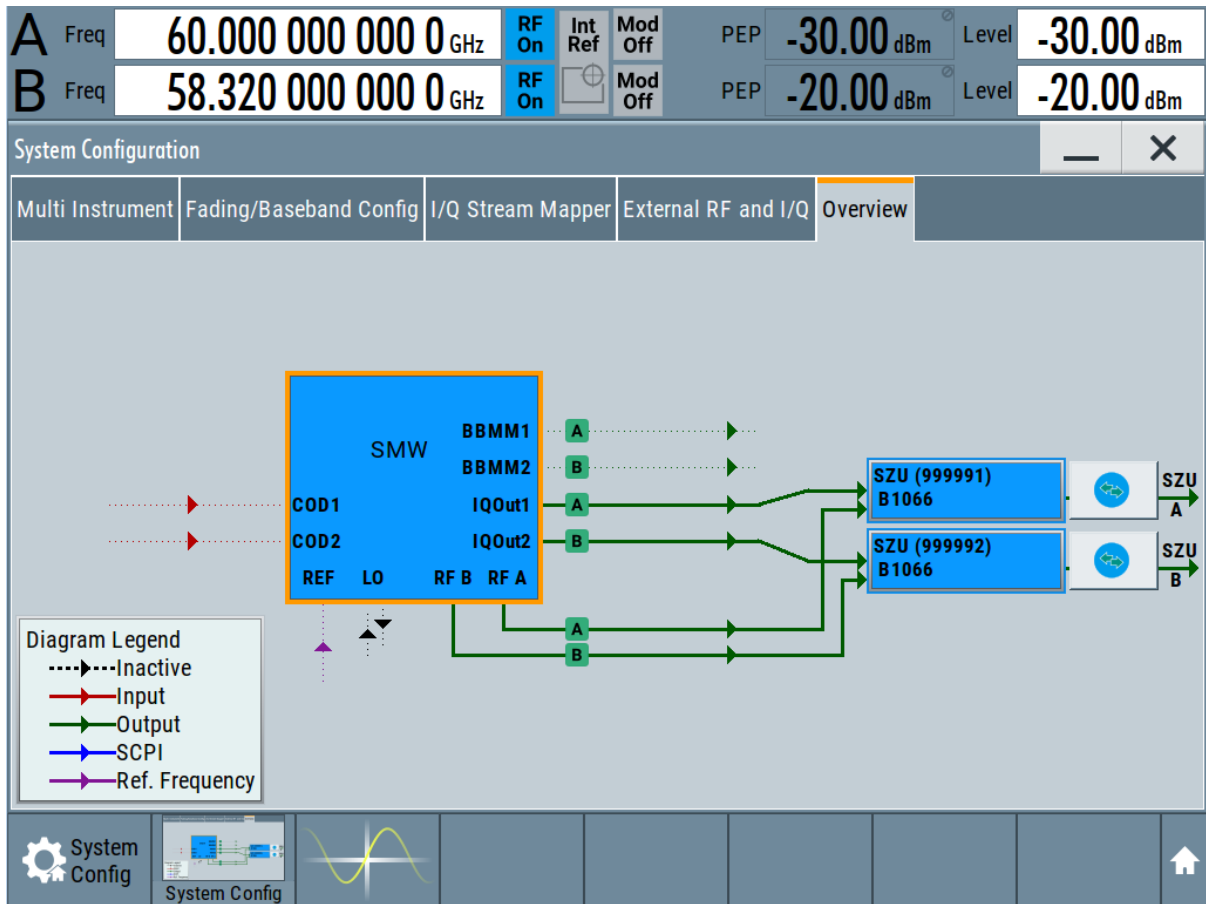


Figure 6-4: Overview tab with two connected R&S SZUs

Running internal adjustments

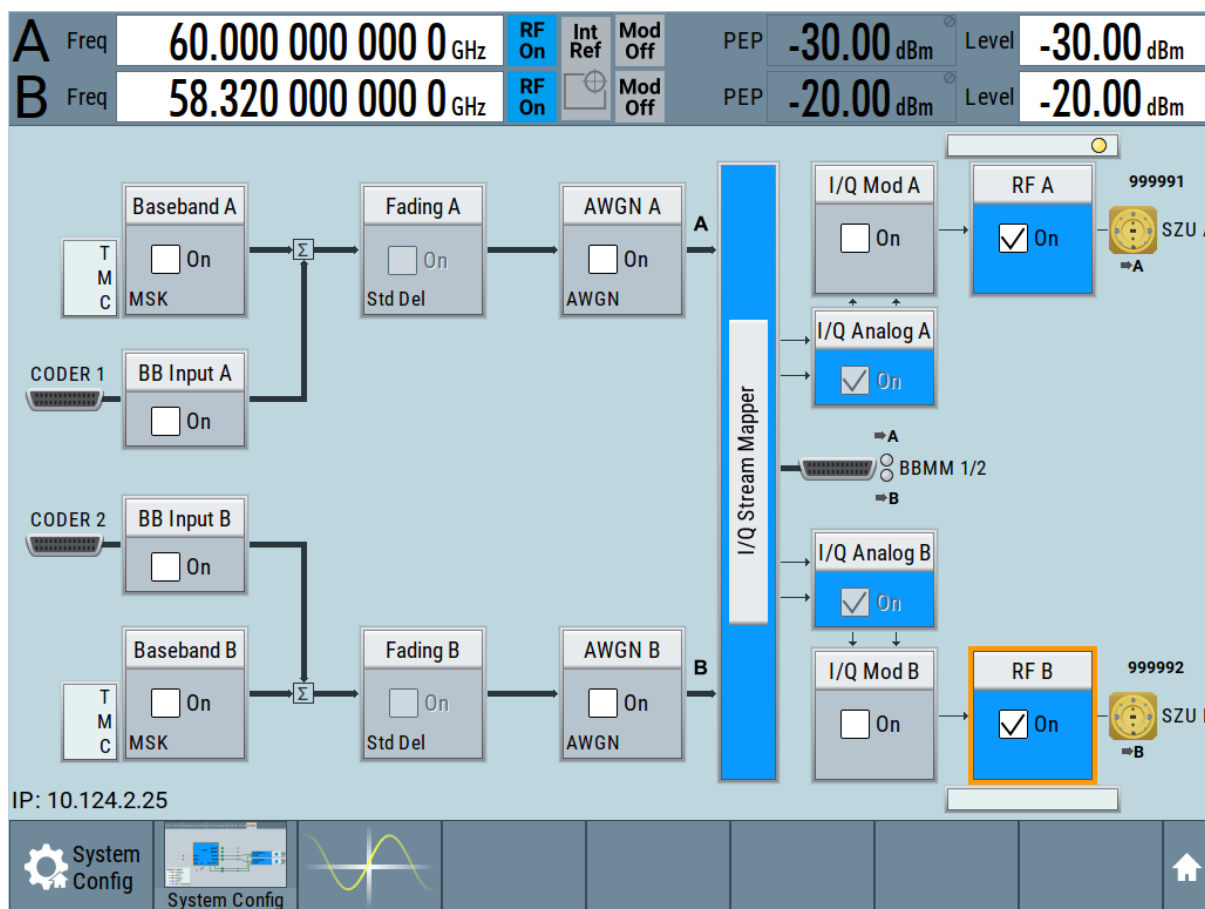


Figure 6-5: R&S SMW screen with an R&S SZU in both paths


6.3 Running internal adjustments

To optimize the accuracy for the application with the R&S SZU, you can execute calibration routines directly in the R&S SMW.

When to perform the internal adjustments?

We recommend that you perform the internal adjustment:

- When setting up an application the first time.
 - When changing the I/Q output type of an already set measurement.
- When you have calibrated the R&S SZU with a different I/Q output type (single-ended / differential), the R&S SMW issues the notification:

(A)SZU settings conflict: At least one adjustment is done in another mode than the SZU is curr ...  Info

Running internal adjustments

"SZU settings conflict: At least one adjustment has been done in another mode than the SZU is currently set to (single-ended / differential). Accuracy may be affected!"

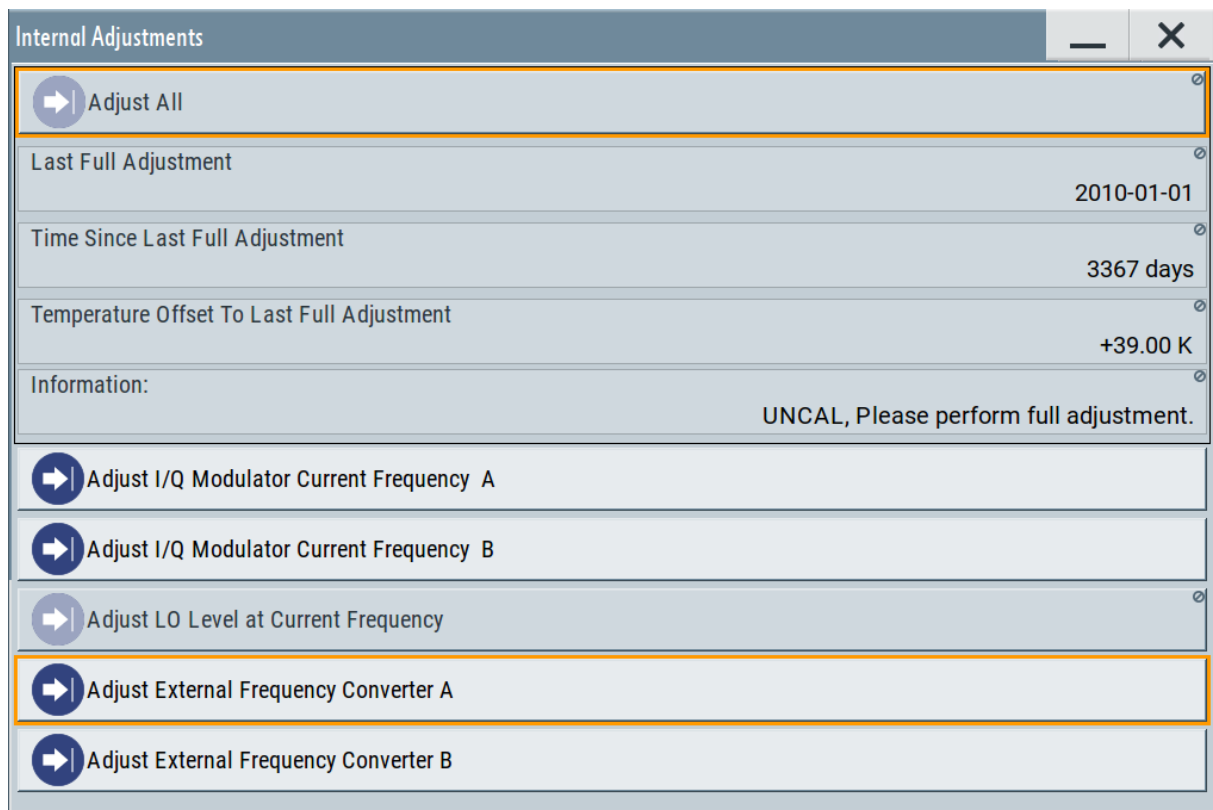
To validate the setup before starting the adjustment

1. Make sure that the serial number of the R&S SZU and the cable set match.
The R&S SZU is calibrated with the supplied cables. Other cables lead to deviations from the specified values and thus affect the adjustment accuracy.
2. Connect the R&S SZU to the R&S SMW as described in [Chapter 6.1, "Setting up the measurement"](#), on page 29.
3. Remove the protective cap from the waveguide port, if plugged.
The protective cap plugged on the waveguide port can cause undefined reflections, and thus impact the internal adjustments.
4. Make sure that you have terminated the waveguide port with 50 Ohms.
5. Make sure that no power is fed into the waveguide output during the internal adjustment process.
It can be caused, e.g. by a connected spectrum analyzer which emits LO power when operating in receiving mode.

To adjust the R&S SZU

1. In the R&S SMW, configure the R&S SZU.
See ["To configure the R&S SZU in the R&S SMW"](#) on page 31.
2. Make sure, that you have selected the correct I/Q output type (single-ended or differential).
3. Check the connection with the connection test in the R&S SMW.
See [To configure the R&S SZU in the R&S SMW > step 6](#).
4. In the R&S SMW, select "System Config > Setup > General > Internal Adjustments".
In this dialog you can perform the internal calibration routine for the R&S SZU, when connected.

Behavior of the R&S SMW when working with the R&S SZU



The R&S SMW adjusts the internal calibration routines to the R&S SZU. "Adjust All" is disabled, i.e. in this configuration, you cannot execute adjustment routines for the R&S SMW.

5. Select "Adjust External Frequency Converter A/B" for all R&S SZU.

The R&S SMW automatically calibrates the parameters of the externally connected R&S SZU.

6. When completed, check that no errors occurred.

If the internal adjustments detect any errors, see User Manual of R&S SMW, chapter Internal Adjustment Settings for further information on how to proceed.

6.4 Behavior of the R&S SMW when working with the R&S SZU

At startup, the R&S SMW firmware almost completely controls the R&S SZU. You can only select the analog I/Q connection (differential or single-ended), provided you are working with only one R&S SZU.

Behavior of the R&S SMW when working with the R&S SZU

The R&S SZU considers the converter like an internal assembly. The following section describes the actions and behavior of the R&S SMW according to the operating states.

At startup or repeated plugging

- The R&S SMW adds a connected R&S SZU to the list of external instruments. Vice versa, the R&S SMW removes an R&S SZU from the list, when it is disconnected.
- If "Auto connect" is enabled, the R&S SMW establishes the connection automatically, provided the R&S SZU is assigned to an I/Q output.
- The R&S SMW adopts the related minimum and maximum values of the R&S SZU.

Furthermore, it obtains the calibration data of the R&S SZU. If these calibration data confirm a wider frequency range as given in the data sheet, you can enable the frequency overrange in the "RF Frequency" setting dialog of the R&S SMW.

RF Frequency/Phase A	
RF Frequency	Phase
Frequency	60.000 000 000 0 GHz
Offset	0.0 Hz
Multiplier	1.000
Frequency Overage	
Frequency Overage Active	<input checked="" type="checkbox"/>
Minimal Frequency	56.940 000 000 0 GHz
Maximal Frequency	66.180 000 000 0 GHz
User Variation	
Variation Active	<input type="checkbox"/>
Variation Step	1.000 000 0 MHz

- The R&S SMW adjusts the resulting frequency range also in the status bar.

Channel	Frequency	Min	Max
A	60.000 000 000 0 GHz	-	-
B	60.000 000 000 0 GHz	56.94 GHz	66.18 GHz
Frequency A	60.000 000 000 0 GHz	58.32 GHz	64.80 GHz

Behavior of the R&S SMW when working with the R&S SZU

- 1 = Frequency range with overrange enabled
- 2 = Frequency range with overrange disabled

Note: The performance in the extended range can deviate from the specified values given in the data sheet.

- You can connect and configure two R&S SZU only in the predetermined paths, see ["Two R&S SZU connected to the R&S SMW"](#) on page 37
The R&S SMW issues a notification, if the connection and the assigned ports do not match, or, e.g., the connection is interrupted.
- When disconnected in the "External RF and I/Q" dialog (or by remote control), the R&S SMW retains the R&S SZU in the list of instruments and at the assigned output. It presets the R&S SZU and the parameters of the "I/Q Analog Outputs", the "I/Q Modulator" and the "RF" path, and turns off the RF output. Not affected settings remain.

During operation

- In the status bar, the indicated frequency and level values correspond to the RF signal at the output of the R&S SZU.
Settings like, e.g. level offset or level limit also affect the RF output of the R&S SZU.
- The firmware of the R&S SMW controls the affected I/Q output parameters automatically, i.e. except for the "I/Q Output Type", the settings are read only.
- The R&S SMW disables list mode, analog modulations and LO coupling.

At preset

- If "Preset behavior: Keep connections to external instruments" is enabled, the R&S SZU remains connected to the R&S SMW, if the USB and I/Q connections still exist physically.
The R&S SMW presets the RF parameters to the R&S SZUs default values ("RF Off", "RF Freq = 60 GHz", "RF Level = 30 dBm").
The "Frequency Overage" setting is not affected. It is reset only by factory preset.
- If "Preset behavior: Keep connections to external instruments" is disabled, the R&S SMW presets the R&S SZU, cuts the connection and presets to its default values.
It also resets the "Frequency Overage".
- If no R&S SZU is connected, the R&S SMW presets to its default values ("RF Off", "RF Freq = 1 GHz", "RF Level = 30 dBm").

Behavior of the R&S SMW when working with the R&S SZU

At reboot

- If "Auto connect" is enabled, the R&S SMW establishes the connection automatically, provided the USB connection exists and the R&S SZU is assigned to an I/Q output
- If "Auto connect" is disabled, the state remains disconnected, the entry in the list of external instruments still exists.

At recall

Applies the settings from a saved configuration.



For a proper configuration, load saved configurations that fit to the current setup.

Do not load a saved configuration of a connected R&S SZU and R&S SMW in a standalone R&S SMW and vice versa.

Mismatch between the setup and the loaded configuration leads to wrong frequency indication in the status bar. The output frequency is correct and corresponds to the current setup.

In setups with R&S SZU and R&S SMW, always establish the connection between the two instruments and load a saved configuration with a connected setup.

7 Remote control of the R&S SZU

For description of the remote control commands required to connect and configure the connection between the R&S SZU in the R&S SMW / R&S SMM. See the user manual of the R&S SMW / R&S SMM, chapter "Remote Control Commands > SCONfiguration subsystem", available on the manual page of the corresponding Rohde & Schwarz vector signal generator.

When connected to the R&S SMW / R&S SMM, the R&S SZU is remotely controlled with the same commands as the generator.

The following remote control commands apply also to the R&S SZU:

- "SOURce:FREQUency subsystem"
`[:SOURce<hw>] :FREQUency [:CW | FIXed]`
 Value range of command: 58.32 GHz to 64.8 GHz
- "SOURce:PHASe subsystem"
- "SOURce:POWer subsystem"
`[:SOURce<hw>] :POWer [:LEVel] [:IMMediate] [:AMPLitude]`
 Value range of command: -80 dBm to 12 dBm
`[:SOURce<hw>] :POWer:ATTenuation`
 Value range of the command: 0 dB to 50 dB
 The ALC remote control commands are queries only.
- "SOURce:OUTPut subsystem"
- "SOURce:CORRection subsystem"
- "SENSe, READ, INITiate and SLISt subsystems"
- "SOURce:IQ:OUTPut:ANALog subsystem"
`[:SOURce<hw>] :IQ:OUTPut [:ANALog] :TYPE`
 All other commands in the "SOURce:IQ:OUTPut:ANALog subsystem" are queries only.
- "SOURce:BB:IMPairment subsystem"
`[:SOURce<hw>] :BB:IMPairment:OPTimization:MODE`
 Analog impairments (`[:SOURce<hw>] :IQ:IMPairment:...`)
 Digital impairments (`[:SOURce] :BB:IMPairment:IQOutput<ch>:...`)
- `[:SOURce<hw>] :IQ:STATe`
 All other commands in the "SOURce:IQ subsystem" are queries only.
- The commands of the "SOURce:IQ:DPD subsystem"

When the R&S SZU is connected to the R&S SMW, the following remote control commands for the particular RF output are disabled also for the R&S SMW:

- "Analog modulation subsystems"
- "SOURce:LIST subsystem"
- "SOURce:SWEEp subsystem"
- The commands of the "SOURce:IQ:OUTPut:ENVELOpe subsystem"

8 Troubleshooting

The R&S SZU works only with a vector signal generator from Rohde & Schwarz. The vector signal generator controls the converter, and displays notifications, if deviations or malfunctions occur.

If hardware problems occur in the R&S SZU, the status LED lights up red, see [Chapter 5.2.6, "Status LED"](#), on page 28.

To solve problems when the status LED lights red

Both, the permanently lighting red and the red blinking "Status" LED indicate hardware problems that result in a malfunction of the R&S SZU.

Proceed as follows:

1. Permanently red lighting status LED indicates an internal error, e.g., overheating of the R&S SZU:
 - a) Make sure that the fan openings are free, and the minimum distance of 10 cm to a nearby object is kept.
 - b) Check if you can feel the ventilation.
If the ventilation works properly, continue with step 4.
2. Blinking red status LED indicates an external error:
 - a) Make sure that you have connected all cables.
 - b) Check that the plugs are firmly connected.
If you cannot detect any error in the connections, continue with step 5.
3. Set up the measurement again.
 - a) Disconnect the R&S SZU from the vector signal generator.
 - b) Preset the signal generator.
 - c) Reconnect the R&S SZU as described in ["To set up the measurement"](#) on page 30.
4. If problems still exist:
 - a) Switch off the vector signal generator.
 - b) Switch off the R&S SZU by disconnecting from the DC supply.
 - c) Wait until the instruments have cooled down.
 - d) Switch on both instruments and start the measurement again.

If hardware problems persist, contact the Rohde & Schwarz [customer support](#).

8.1 Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



Figure 8-1: QR code to the Rohde & Schwarz support page

9 Transporting

Packing

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection.

Securing

When moving the product in a vehicle or using transporting equipment, make sure that the product is properly secured. Only use items intended for securing objects.

Transport altitude

The maximum transport altitude without pressure compensation is specified in the data sheet.

10 Maintenance, storage and disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable to check the nominal data from time to time.

10.1 Cleaning

If visual inspection shows that the R&S SZU or the test port adapters require cleaning, consider the following instructions.

To clean the R&S SZU

Cleaning agents, solvents, acids and bases can damage the labeling or plastic parts of the product. Do not use any liquids for cleaning.

- ▶ Clean the outside of the R&S SZU I/Q upconverter using a lint-free cloth. You can dampen the cloth with water but keep in mind that the casing is not waterproof.

To clean a waveguide port

- ▶ **NOTICE!** Liquids and in particular compressed air damage the circuits inside the waveguide.

Use a dry, lint-free cloth to clean the test port flange surface.

To clean the waveguide-to-V test port adapter

- ▶ Proceed as described in the application note [1MA99](#). The application note provides information on the means you can use and how to clean the thread and the inside of the connector.

10.2 Storage

Protect the product against dust. Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the data sheet.

10.3 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

Disposing electrical and electronic equipment

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its service life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.



Figure 10-1: Labeling in line with EU directive WEEE

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

Glossary: Abbreviations and definitions

D

DUT: Device Under Test

G

Glossary: List of the often used terms and abbreviations

GUI: Graphical User Interface

O

OS: Operating System

OTA: Over The Air

P

PC: Personal Computer, desktop or laptop PC

R

RF: Radio Frequency

S

Serial number: Unique device identification, provided at the rear panel of the R&S SZU I/Q upconverter and required to build the Computer name.

The serial number are the last 6 digits in the string <stock no.>-<serial number>, e.g. 1425.8563.02-**100099**

T

Trigger: Internally generated or externally supplied signal which starts signal generation at a particular point in time.

Trigger event: A trigger event is caused by the received trigger signal or executed manual trigger.

U

USB: Universal Serial Bus. A standard type of connection for many different kinds of devices.

W

Warm-up time: Minimum time the device needs to reach operating temperature and to adjust to the ambient temperature. The R&S SZU requires at least 30 minutes.

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