R&S®RT-ZVC Multichannel Power Probe User Manual

1326213902
Version 04

ROHDE&SCHWARZ
Make ideas real

This user manual describes the following R&S®RT-ZVC models:

- R&S®RT-ZVC04 2x4 voltage/current channels for R&S®RTO2000/RTE (1326.0259.04)
- R&S®RT-ZVC02 2x2 voltage/current channels for R&S®RTO2000/RTE (1326.0259.02)
- R&S®RT-ZVC04 2x4 voltage/current channels for R&S®CMWrun (1326.0259.24)
- R&S®RT-ZVC02 2x2 voltage/current channels for R&S®CMWrun (1326.0259.22)
- R&S®RT-ZVC04A 2x4 voltage/current channels with autoranging for R&S®CMWrun (1326.0259.34)
- R&S®RT-ZVC02A 2x2 voltage/current channels with autoranging for R&S®CMWrun (1326.0259.32)

Muehldorfstr. 15, 81671 Muenchen, Germany
Phone: +49 89 41 29 - 0
Email: info@rohde-schwarz.com
Internet: www.rohde-schwarz.com

1326.2139.02 | Version 04 | R&S®RT-ZVC | COMPANY RESTRICTED

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol and without model numbers, e.g. R&S®RT-ZVC is indicated as R&S RT-ZVC.

Contents

1 Safety and regulatory information

The product documentation helps you to use the product safely and efficiently.

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:

- In Chapter 1.1, "Safety instructions", on page 5. The same information is provided in many languages in printed format. The 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.

Intended use

The product is intended for the development, production and verification of electronic components and devices in industrial, administrative, and laboratory environments. Use the product only for its designated purpose. Observe the operating conditions and performance limits stated in the specifications document.

Target audience

The target audience of this document includes developers and technicians, administrators and maintenance personnel using oscilloscopes and probes. The required skills and experience of the users depend on the test setup and application of the product.

1.1 Safety instructions

Products from the Rohde & Schwarz group of companies are manufactured according to the highest technical standards. To use the products safely, follow the instructions provided here and in the product documentation. Keep the product documentation nearby and offer it to other users.

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the specifications document, manuals and the printed "Safety Instructions" document. If

you are unsure about the appropriate use, contact Rohde & Schwarz customer support.

Using the product requires specialists or specially trained personnel. These users also need sound knowledge of at least one of the languages in which the user interfaces and the product documentation are available.

Reconfigure or adjust the product only as described in the product documentation or the specifications document. Any other modifications can affect safety and are not permitted.

Never open the casing of the product. Only service personnel authorized by Rohde & Schwarz are allowed to repair the product. If any part of the product is damaged or broken, stop using the product. Contact Rohde & Schwarz customer support at https://www.rohde-schwarz.com/support.

In these safety instructions, the term "product" covers instruments (oscilloscopes), probes and their accessories.

Choosing the operating site

Only use the product indoors. The product casing is not waterproof. Water that enters can electrically connect the casing with live parts, which can lead to electric shock, serious personal injury or death if you touch the casing. If Rohde & Schwarz provides accessories designed for outdoor use of your product, e.g. a protective cover, you can use the product outdoors.

Unless otherwise specified in the specifications document, you can operate the product up to an altitude of 2000 m above sea level.

The product is suitable for pollution degree 2 environments where nonconductive contamination can occur. For more information on environmental conditions such as ambient temperature and humidity, see the specifications document.

Connecting to power and grounding

The mains power supply input of the instrument complies with overvoltage category II. Connect the product to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Keep in mind that electrically powered products have risks, such as electric shock, fire, personal injury or even death.

Take the following measures for your safety:

- Do not use an isolating transformer to connect the instrument to the mains power supply.

- Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source. If the power adapter does not adjust automatically, set the correct value and check the rating of the fuse.
- If a product has an exchangeable fuse, its type and characteristics are indicated next to the fuse holder. Before changing the fuse, switch off the product and disconnect it from the power source. How to change the fuse is described in the product documentation.
- Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.
- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- If you connect the product to an external power supply, use the one delivered with the product or recommended in the product documentation. The external power supply must conform to the country-specific regulations.
- Ensure that you can disconnect the product from the power source at any time. Pull the power plug to disconnect the product. The power plug must be easily accessible. If the product is integrated into a system that does not meet these requirements, provide an easily accessible circuit breaker at the system level.
- Replace parts that are relevant to safety only by original parts, e.g. power cables or fuses.

Performing measurements

Take the following measures for your safety:

- To ascertain a voltage-free state, use an appropriate voltage tester. Any measurement setup including an oscilloscope is not suitable for this purpose.
- The maximum input voltage on channel inputs and the external trigger input must not exceed the value specified in the specifications document.
- Observe all voltage and current ratings of the instrument, the probes, and the accessories. Exceeding the allowed voltages can lead to an electric shock. Limits and ratings are marked on the products and listed in the specifications documents.
  Consider that the rated voltage depends on the frequency. The voltage limitation curves or values are provided in the specifications document.

- Never cause any short circuits when measuring sources with high output currents.
- Use only probes and accessories that comply with the measurement category (CAT) of your measurement task. If the product is rated for any measurement category, the permitted category is indicated on the product and in the specifications document. If you use other than Rohde & Schwarz accessories, make sure that they are suitable for the instrument and the measurement task.
- Set the correct attenuation factor on the instrument according to the probe being used. Otherwise, the measurement results do not reflect the actual voltage level, and you might misjudge the actual risk.
- Prevent the probe from receiving mechanical shock. Avoid putting excessive strain on the probe cable or exposing it to sharp bends. Touching a broken cable during measurements can cause injuries.
- Set up all probe connections to the instrument before applying power.

1.2 Labels on the product

Labels on the casing inform about:

- Personal safety
- Product and environment safety
- Identification of the product

Table 1-1: Meaning of safety labels

	Potential hazard Read the product documentation to avoid personal injury or product damage.

1.3 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.

WARNING

Potentially hazardous situation. Could result in death or serious injury if not avoided.

CAUTION

Potentially hazardous situation. Could result in minor or moderate injury if not avoided.

NOTICE

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

2 Product description

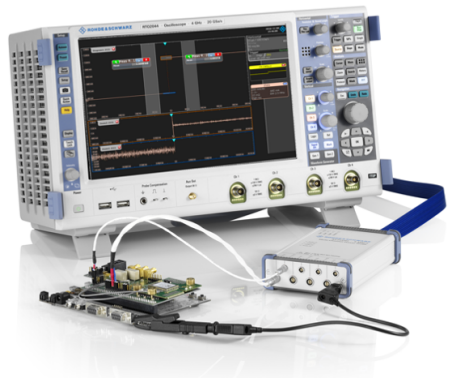
The R&S RT-ZVC is a multichannel power probe with integrated 2- or 4-channel amperemeter and 2- or 4-channel voltmeter. It provides parallel measurements of analog or digital, voltage/current signals with excellent 18-bit resolution. Integrated postprocessing logic calculates power and statistical results with high accuracy.

The R&S RT-ZVC is a useful measurement instrument for such applications as for example:

- Embedded electronics
- Battery-driven devices (wearable devices, smartphones)
- Power supply of integrated circuits
- Battery lifetime measurements
- Power consumption measurements
- Energy-harvesting

The multichannel power probe is developed for tests with R&S CMWrun and for operation with an oscilloscope.

Table 2-1: Variants of setup with R&S RT-ZVC

Operation with an oscilloscope	**Standalone device with R&S CMWrun**
	
Embedded electronics/circuit measurements, sophisticated processing • Data transferred via digital interface at full sample rate of 5 MSa/s • Probe powered by scope	System-level power measurements using R&S CMWrun, reduced sample rate via USB • Data transferred via USB to the R&S CMWrun controller PC • Externally powered

2.1 Prerequisites

- **Operation with oscilloscope**

  You can use one of the following oscilloscopes with R&S RT-ZVC:

  – R&S RTP equipped with R&S RTP-B1E
  – R&S RTO6 equipped with R&S RTO6-B1E
  – R&S RTO2000 equipped with R&S RTO-B1E
  – R&S RTE equipped with R&S RTE-B1E (discontinued product)

  Note, that R&S RTx-B1 boards cannot run R&S RT-ZVC.

- **Operation with R&S CMWrun**
  – R&S CMWrun, version 1.9.11 and later. The option R&S CMW-KT051 of R&S CMWrun for general-purpose tests is required.
  – Supported operating systems are: Windows 11 and Windows 10 (32-bit or 64-bit version), Windows 7.
  – A Rohde & Schwarz-specific driver is required to be installed at the run PC, to support the USB3.0 SuperSpeed (SS) interface.
  With the installed driver, no additional connection configuration is required.
  The probe acts as a plug-and-play device.
  The driver is delivered with the R&S CMWrun SW.

2.2 Key characteristics

The R&S RT-ZVC probe houses an integrated voltmeter, amperemeter, and post-processing logic. The probe performs built-in A/D conversion and signal postprocessing. Within integrated postprocessing, the R&S RT-ZVC calculates power and statistical results (min/max/avg/RMS). It measures the differential and common mode AC and DC signals simultaneously.

The following figure illustrates the scheme of a probe with four voltage and four current channels.

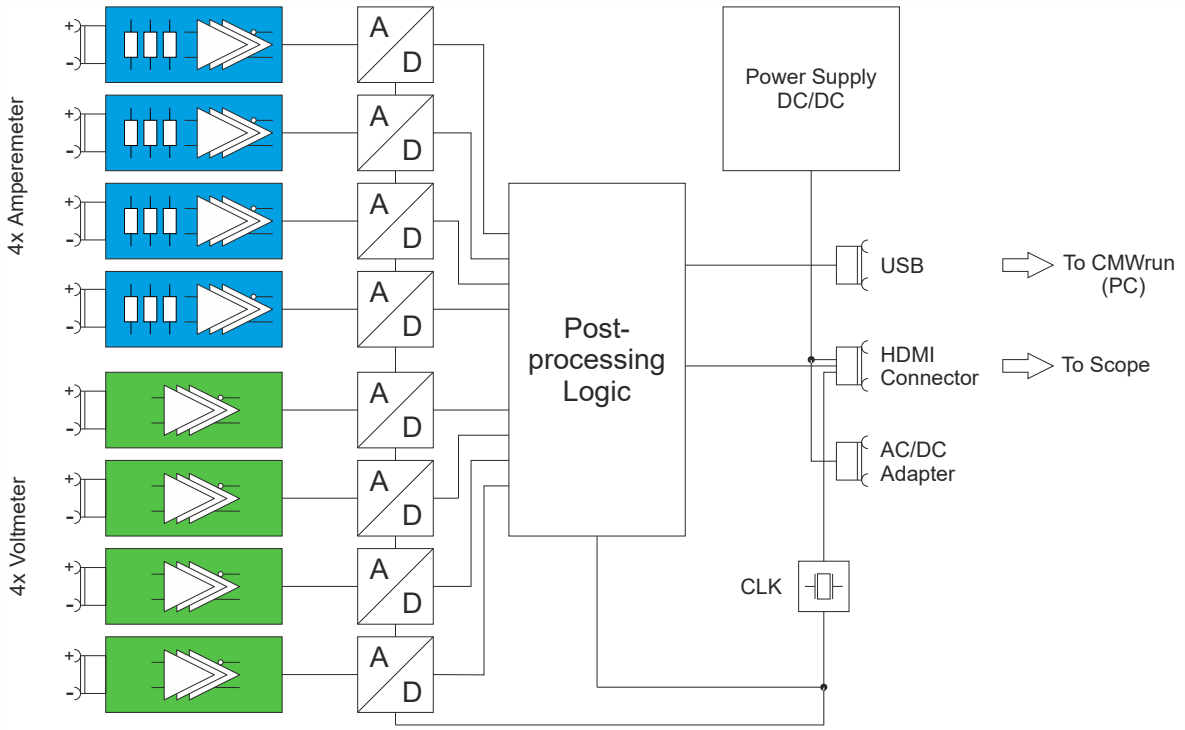


Figure 2-1: Electrical scheme

There are separate A/D converters for each channel that allow for parallel and fully synchronous data acquisition.

The key characteristics of the probe are the following:

Table 2-2: Technical data

	Voltmeter (V)	**Amperemeter (I)**	**Power (internal multiplier)**
No. of channels	2 or 4	2 or 4	2 or 4
Measurement resolution	18 bit	18 bit	32 bit
Sampling rate with R&S RTx	5 MSa/s per channel	5 MSa/s per channel	5 MSa/s per channel
Sampling rate with R&S CMWrun	50 kSa/s per channel	50 kSa/s per channel	50 kSa/s per channel (synchronous multiplication of V and I)

For detailed specification and derating information, see the specifications document.

2.3 Unpacking and checking

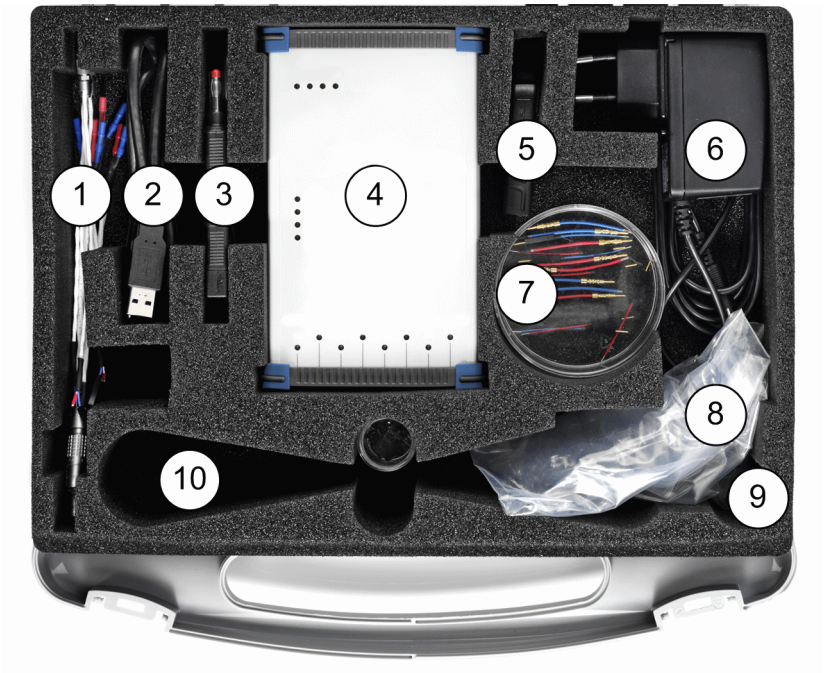


Figure 2-2: Carrying case (model for R&S CMWrun)

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.

Deliveries

The carrying case contains the following items:

- Basic voltage and current leads (1), length 16 cm, one lead per each instrument channel
- USB 3.0 cable (2) (only for R&S CMWrun)
- Ground cable (3) with 4 mm plugs
- R&S RT-ZVC probe box (4)

- Ground clip (5) for connection to the DUT
- AC power adapter (6) (only for R&S CMWrun)
- PCB solder-in cables (7):
  – Blue and red round 1.02 mm, length 5 cm, one pair per each current channel
  – Blue and red square 0.64 mm, length 5 cm, one pair per each voltage channel
- Exchangeable clips for AC power plugs (8) for UK, US, Australian and European standard
- Solder-in contacts (9):
  – 8x round headers 1.02 mm
  – 4x shorting links, round 1.02 mm, spacing 5.08 mm
- Blue flat oscilloscope interface cable (10) (only for R&S RTx)
- User manual

Calibration certificate

The calibration certificate is not included in the standard shipping. The document is available for download at https://gloris.rohde-schwarz.com/calcert.

2.4 Description of the probe

The probe R&S RT-ZVC consists of the following parts:

- Probe box
- Leads and accessories for connection to the DUT. See also Chapter 3.4, "Connecting the probe to the DUT", on page 24
- Variant for operation with R&S CMWrun:
  AC power adapter and USB 3.0 cable for connection to the PC with R&S CMWrun application, refer to Chapter 3.3, "Test setup with R&S CMWrun", on page 23
- Variant for operation with an oscilloscope:
  Blue flat oscilloscope interface cable, refer to Chapter 3.2, "Test setup with oscilloscope", on page 22

The next sections describe the main parts of the probe.

2.4.1 Probe box

The following section provides an overview of the control elements and sockets of the probe box and explains how to connect external devices.

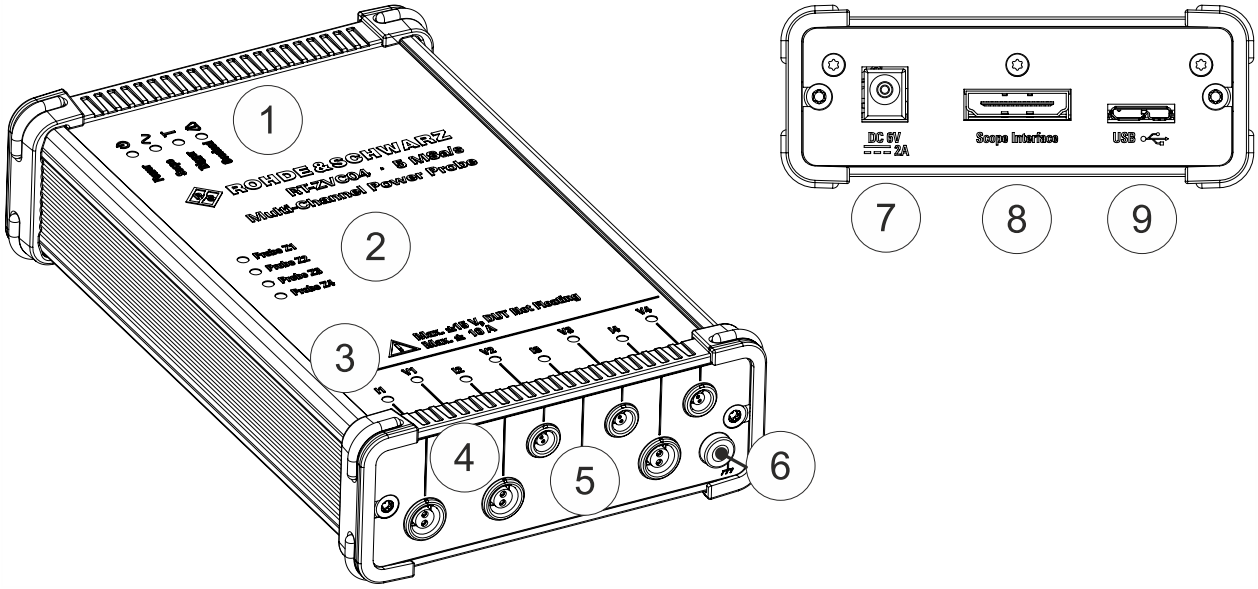


Figure 2-3: R&S RT-ZVC: upper, front, and rear view

1 = Status LEDs
2 = ID LEDs
3 = Channel LEDs
4 = Voltmeter sockets
5 = Amperemeter sockets
6 = Ground socket
7 = Socket for AC power adapter
8 = HDMI interface
9 = USB 3.0, micro B socket

LEDs

The status LEDs (1) of the probe box are located in the upper left corner of the upper plate. They light to indicate the following detections:

- **Power**: Probe is on (connected to power supply or R&S RTx).
- **Scope**: Probe is connected with an oscilloscope.
- **Trigger**: Trigger signal is detected on R&S RTx interface.
- **Overload**: A red LED plus blinking affected channel indicate overload at a particular voltage or current channel. The overload indication can be reset via a control dialog.

During an overload at a current channel, the R&S RT-ZVC switches automatically to the next higher range. If also the 10 A range is exceeded, the amperemeter switches to external shunt mode to protect the probe against permanent damage. Thus, the current flow through the DUT is interrupted.
In external shunt mode, there is no automated range switching. The user must take care that the external shunt resistor is not damaged.
Furthermore, there is no automated range switching at voltmeter channels for overload conditions.

The ID LEDs (2) are located in the middle left part of the upper plate.

- **Probe Z1 to probe Z4**: Indicates on which port of the digital extension board R&S RTx-B1E the probe is attached to.

Channel LEDs (3) are located in the bottom-left corner of the upper plate.

- **I1 to I4**: Blue LEDs for up to four current channels. LEDs indicate which channel is enabled in the GUI.
  A light-dark flashing indicates active auto-ranging for the corresponding channel (only relevant for variants R&S RT-ZVC04A and R&S RT-ZVC02A).
- **V1 to V4**: Green LEDs for up to four voltage channels. LEDs indicate which channel is enabled in the GUI.

Interfaces

- 2 or 4 sockets (4) for voltage test leads AWG28. The red color at the socket marks the position of + wire. The number of sockets depends on the instrument model.
- 2 or 4 sockets (5) for current test leads AWG24. The red color at the socket marks the position of + wire. The number of sockets depends on the instrument model.
  The voltage and current sockets at the probe box are of different type, to avoid the mixing of voltage and current leads. In addition, current cables have 1.02 mm round pins that allow for currents up to 10 A.
- Ground socket (6) - to establish common ground with the DUT. For detailed information on ground connection, refer to Chapter 4.1.1, "Ground connection", on page 28.
- Socket (7) for the AC power adapter is used together with the USB interface.
- USB 3.0 interface with micro B socket (9) for connection to R&S CMWrun.
- HDMI socket (8) for blue oscilloscope interface cable to the digital extension board R&S RTx-B1E of an oscilloscope.

Amperemeter

The current measurement is performed with a shunt-amperemeter, i.e. the current measurement is reduced to a measurement of a voltage drop on a resistor where the current is flowing through. It has digitally adjustable gain. There are three built-in shunts that can be switched in series to the circuit under test. For using internal shunts, the circuit under test needs to be interrupted so that the current can flow through the probe.

In addition to internal shunts, the amperemeter can work as a sensitive voltmeter to measure voltage drops on external shunts mounted directly in the circuit under test (external shunt mode). The maximum input voltage range is 450 mV to GND.

For details, refer to:

- Chapter 4.2.3, "Internal shunt operation", on page 32
- Chapter 4.2.4, "External shunt operation", on page 33
- specifications document

Voltmeter

The voltmeter measures both differential and common mode, not floating signals. The input voltage range is ±15 V to GND. The signal can be attenuated or amplified depending on the selected range. Refer to the specifications document.

Power multiplier (only via USB for R&S CMWrun)

Within the integrated postprocessing of R&S RT-ZVC, the internal multiplier uses the measured values of the voltmeter and amperemeter and provides high precise statistical results. The minimal, maximal, average and RMS current and voltage values are internally calculated with the sampling rate of 5 MSa/s per channel. The statistical power results (min/max/avg/RMS) are calculated within 32-bit resolution.

For details, refer to:

- Chapter 2.2, "Key characteristics", on page 11
- Chapter 4.2.2, "Signal flow for R&S CMWrun operation (USB IF only)", on page 31

2.4.2 Cables and accessories

The R&S RT-ZVC delivery contains the following cables:

- Oscilloscope interface cable (only variants for oscilloscopes): blue flat Samtec Twinax cable
- USB 3.0 cable with AC power adapter (only variants for R&S CMWrun). USB cable connects the probe box and the R&S CMWrun controller PC.
  AC power supply is required for operation with USB 3.0 interface. Use only the delivered power adapter.
- Voltage and current leads for connecting the probe box and the DUT.
  Shielded twisted-pair cables are used for the leads. Different accessories for the signal sockets allow the leads to be connected to a wide range of DUTs, see Chapter 2.5, "Optional accessories", on page 19.
  - The leads with 2.54 mm square sockets are used for voltage measurements at the DUT. The signal sockets are based on standard 0.64 mm (25 mil) square pins.

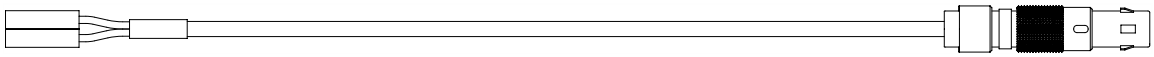


Figure 2-4: Basic lead for voltage measurements

  - The leads with 1.02 mm round sockets are used for current measurements. They have a special design to ensure optimal performance for higher currents. The signal sockets are *not* compatible to standard accessories based on 0.8 mm (35 mil) round pins.

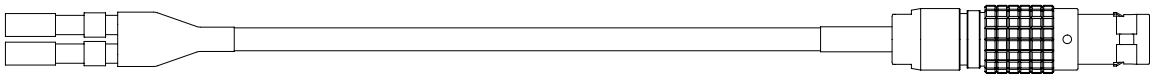


Figure 2-5: Basic lead for current measurements

- PCB cables and headers:

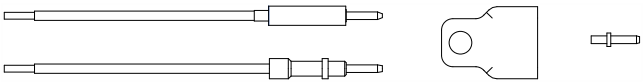


Figure 2-6: PCB cables, shorting link, header

  - The voltage PCB cables are based on standard 0.64 mm (25 mil) square pins. They are compatible with 2.54 mm square sockets.
  - The current 1.02 mm round headers and PCB cables have a special design optimized for higher currents. Use only either the accessories provi-

ded within R&S RT-ZA36, or Special OEM accessories for current sockets provided by the manufacturer as with standard shipping.
Use the delivered shorting links to close unused measurement points at the DUT for current measurements.

2.5 Optional accessories

If the delivered accessories do not meet individual customer requirements, Rohde & Schwarz offers different accessory sets for sale. The order numbers are provided in the specifications document.

Table 2-3: R&S RT-ZA30

Item	Quantity	Description
Current lead basic AWG20 (L 32 cm)	2	Extended cable set PCB (length 32 cm) for R&S RT-ZVC
Voltage lead basic AWG28 (L 32 cm)	2	

Table 2-4: R&S RT-ZA31

Item	Quantity	Description
Current lead 4 mm plug AWG20 (L 32 cm)	2	Extended cable set 4 mm (length 32 cm) for R&S RT-ZVC
Voltage lead 4 mm plug AWG28 (L 32 cm)	2	

Table 2-5: R&S RT-ZA32

Item	Quantity	Description
TRG10R059 AC/DC adapter 10W 6V clips	1	Power adapter for R&S RT-ZVC

Table 2-6: R&S RT-ZA33

Item	Quantity	Description
Samtec Twinax flat cable	1	Blue oscilloscope interface cable

Table 2-7: R&S RT-ZA34

Item	Quantity	Description
Current lead 4 mm plug AWG20 (L 100 cm)	2	Extended cable set 4 mm (length 100 cm) for R&S RT-ZVC
Voltage lead 4 mm plug AWG28 (L 100 cm)	2	

Table 2-8: R&S RT-ZA35

Item	Quantity	Description
Current lead basic AWG20 (L 100 cm)	2	Extended cable set PCB (length 100 cm) for R&S RT-ZVC
Voltage lead basic AWG28 (L 100 cm)	2	

Table 2-9: R&S RT-ZA36

Item	Quantity	Description
Adapter cable current to 2.54 mm blue and red*	2x 4	Solder-in cable set for R&S RT-ZVC
Current PCB cable AWG20 (L 50 mm) blue and red	2x 4	
Voltage PCB cable AWG26 (L 50 mm) blue and red	2x 4	
Solder-in header round 1.02 mm	8	
Shorting links 2.54 mm	4	
* note the limitations to 3 A for current adapter cable to 2.54 mm		

Table 2-10: R&S RT-ZA37

Item	Quantity	Description
Current lead BNC female AWG24 (L 160 mm)	1	BNC cable set (length 160 mm) for R&S RT-ZVC
Voltage lead BNC female AWG28 (L 160 mm)	1	

To prepare multiple measurement points on your DUT for connecting the R&S RT-ZVC probe, the following current connectors are recommended:

Table 2-11: Special OEM accessories for current sockets

Item	Manufacturer ordering description
Cambion round headers 1.02 mm *	460-3233-02-03-00
Cambion shorting link round 1.02 mm with 5.08 mm spacing *	450-3775-01-06-XX XX standing for color code
* as with standard shipping	

Additional current connector pins (1.02 mm diameter) are available from Cambion Electronics Ltd.

3 Putting into operation

The following topics are covered in the next sections:

3.1 Handling the probe

The R&S RT-ZVC can withstand a moderate amount of physical and electrical stress. To avoid damage, treat the probe with care:

- Handle the probe by the probe box.
- Prevent the probe from receiving mechanical shock.
- Avoid strain on the probe cable and route it carefully.
- Always grip and pull the HDMI connector to disconnect from the probe box or oscilloscope. Never pull the cord to disconnect.
- Do not spill liquids on the probe.

During operation, the probe slightly heats up. This behavior is normal and not a sign of malfunction.

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.

Discharge cables and leads before you connect them.

3.2 Test setup with oscilloscope

A basic test setup with an oscilloscope does not include an external power adapter or USB cable. The connection is realized via the delivered blue flat oscilloscope interface cable. The R&S RT-ZVC is powered by an oscilloscope.

Supported oscilloscopes are listed in the R&S RT-ZVC specifications document.

The multichannel power probe variants R&S RT-ZVC04A and R&S RT-ZVC02A with autoranging are not supported in operation with oscilloscopes.

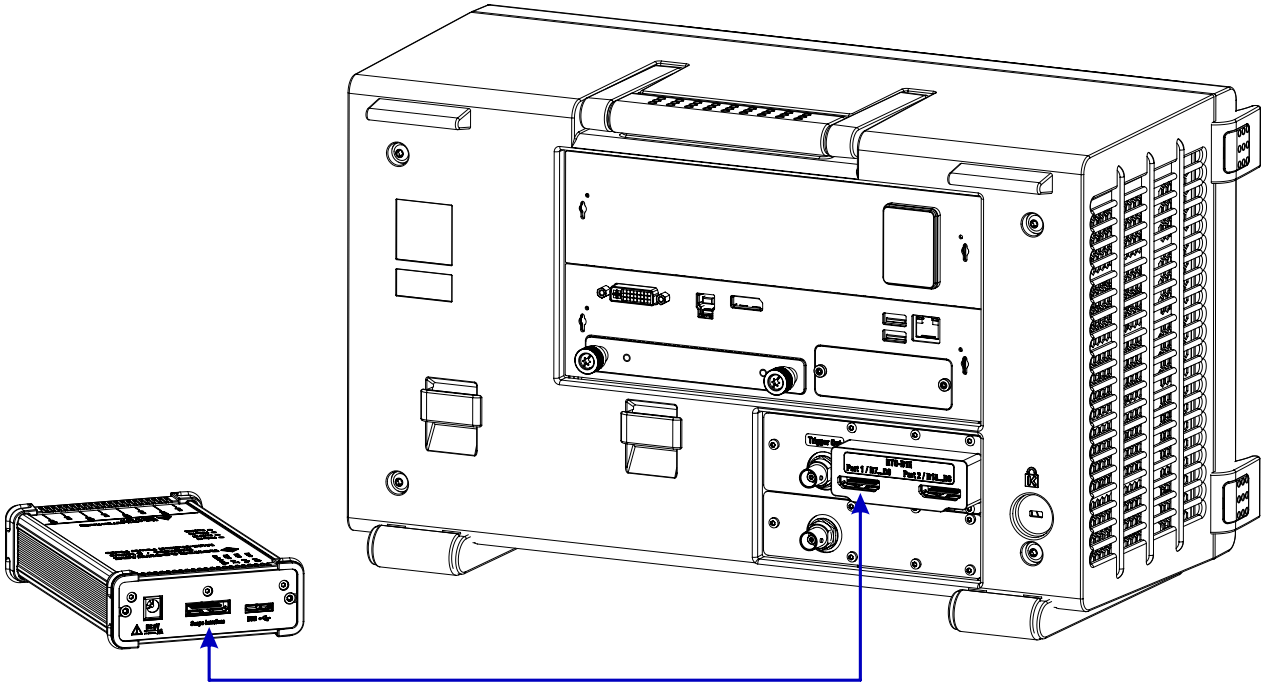


Figure 3-1: Connecting the probe to the oscilloscope

1. **CAUTION!** Risk of injury. Make sure that the oscilloscope is properly grounded. For safety information, see "Connecting to power and grounding" on page 6.

   Connect the oscilloscope to an outlet that has a ground contact.

2. Using the oscilloscope interface cable, connect the probe box to the HDMI connector of R&S RTx-B1E module at the rear side of oscilloscope. See Figure 3-1. At R&S RTP oscilloscopes, the connectors are at the front side.

   When the probe is connected to the oscilloscope, the oscilloscope recognizes the probe and reads out the probe-specific parameters.

3. Configure the active channels and the desired ranges at the oscilloscope using the ZVC multichannel probe dialog. The procedure depends on the instrument used. For detailed description, refer to the oscilloscope's user manual.

3.3 Test setup with R&S CMWrun

Connect the R&S RT-ZVCmultichannel power probe with the R&S CMWrun as follows.

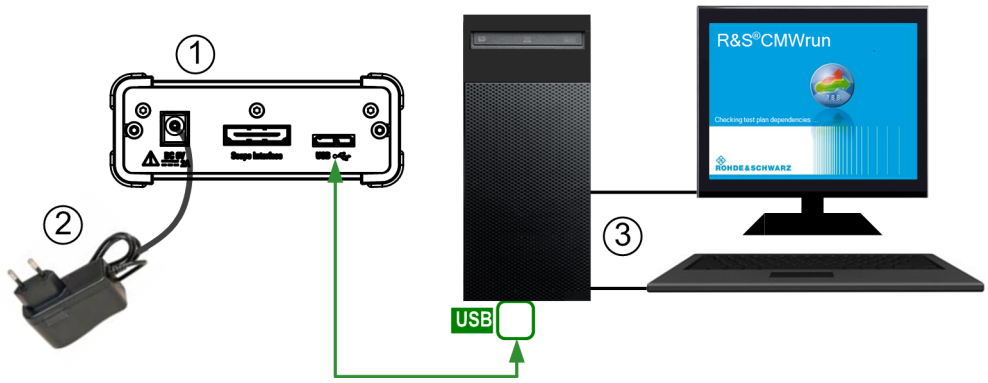


Figure 3-2: Test setup with R&S CMWrun

1 = probe box
2 = power adapter
3 = controller computer with R&S CMWrun

To start the measurement, proceed as follows:

1. If not yet done, install the USB driver delivered with R&S CMWrun SW at the controller PC of R&S CMWrun.

   The driver enables the R&S CMWrun application to detect the connected probe automatically. No additional configuration of probe connection is necessary.

2. **CAUTION!** Risk of injury when operating the 230V AC power supply. Use only the supplied AC/DC wall-mount power adapter of type Cincon TRG10R059-01-23E03. To reduce the risk of electric shock, damage of the probe, or unreliable measurement results, do not plug any other type of power adapter into this product.

   Connect the probe box via power adapter to the power supply.

3. Connect the probe box via USB cable to the R&S CMWrun controller PC. Use USB 3.0 port at your PC.

   The PC detects the probe as a USB device.

4. For the connection to the DUT, use delivered voltage and current leads and PCB cables. Refer to Connecting the probe to the DUT.

5. In the test module "Power Consumption Measurement", specify measurement-specific parameters and input signal characteristics.
   The option R&S CMW-KT051 of R&S CMWrun provides the test module within general-purpose tests.

   The characteristics of amperemeter and voltmeter channels must be specified according to the measured ranges.

6. Start the measurement. Measure current and voltage at the measurement points of the DUT.

7. Evaluate results within the R&S CMWrun application.

3.4 Connecting the probe to the DUT

This chapter describes the different ways of connecting the probe to the DUT. In addition, the usage of the supplied accessories is explained.

- The maximum non-destructive input voltage is 18 V. A higher input voltage can destroy the probe and the accessories.
- Never measure own power supply drain of the R&S RT-ZVC at the AC power supply adapter or at the HDMI connector.
- Always keep the connections as short as possible for best performance and signal integrity. If long connections cannot be avoided, they have to be preferably used for the ground socket.
- When transporting the accessories, use the boxes supplied with the probe.

The basic test setup with an oscilloscope enables up to 4 voltage and up to 4 current measurement points. The R&S CMWrun supports the measurement of one voltage and one current channel simultaneously at the same time. The following figure shows a test setup with two voltage and two current channels.

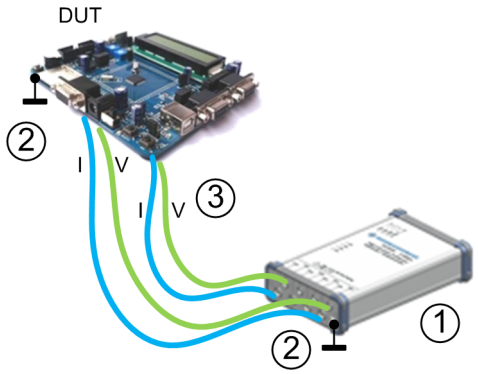


Figure 3-3: Test setup

1 = probe box
2 = ground connection
3 = current (I) and voltage (V) leads

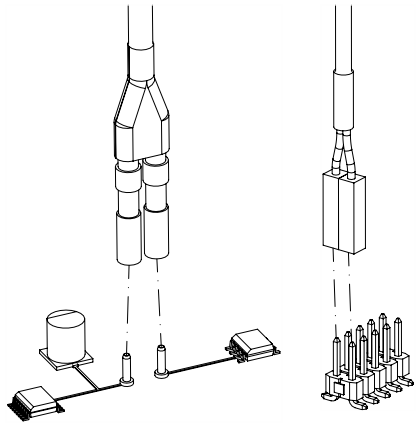
1. Establish a common ground between DUT and probe to keep common voltage within the common mode range of the amplifiers. Refer to Chapter 4.1.1, "Ground connection", on page 28.
   Ground socket is in the lower right corner of the front plane, refer to Figure 2-3. You can also clamp the delivered ground clip to your DUT. The clip fits to the ground socket of the probe using the delivered 4 mm ground cable.
2. **NOTICE!** Do not exchange the current and voltage connections at the probe box. Wrong connection can damage the instrument. Use only delivered voltage and current cables.

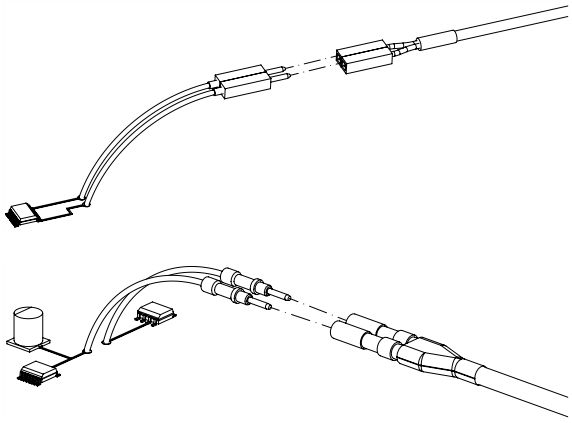
   Connect the leads to the voltage or current socket of probe box. Red color at the connector marks the position of + wire. Match the red marks of a connector and socket when plugging a signal lead into the probe box. The correct connector orientation is with the red mark upward. For details on cables, refer to Chapter 2.4.2, "Cables and accessories", on page 18.
3. Connect the voltage and current leads to the DUT. Use solder-in connections.

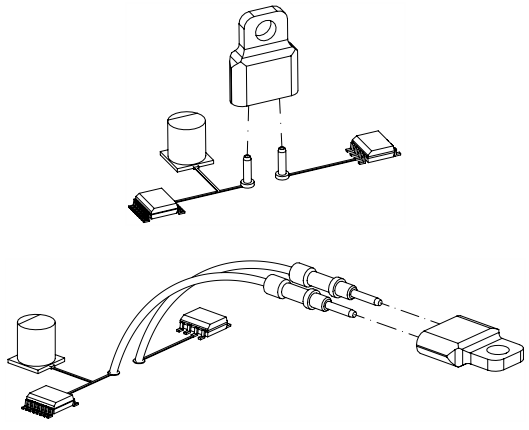
Considerations for soldering

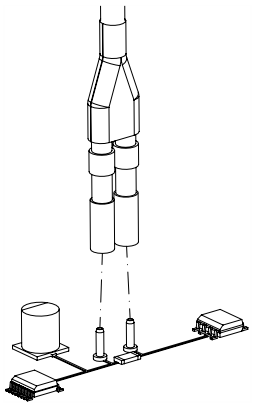
- Do not leave the soldering iron in contact with the probe tip for more than a few seconds at a time. Excess heat can damage the probe.
- Some solder-in accessories are very fine and sensitive. Stabilize the probe using appropriate means (e.g. adhesive pads, probe positioner) to protect the solder joint from excessive mechanical stress.

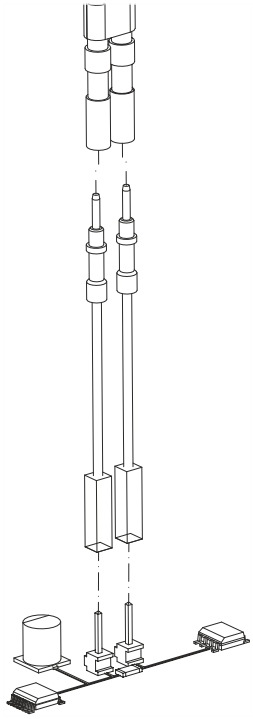
To prepare the DUT for measurements, solder the delivered headers or PCB cables to the DUT to specify the measurement points.

Headers	
	The headers soldered to the DUT provide firm contact with the measurement point during the whole measurements. The signal lead is plugged onto soldered-in headers on the DUT. The figure shows headers for current (on the left) and voltage measurements (on the right).

Standard PCB cables	
	The PCB cables provide a flexible connection to the DUT. They are soldered onto the DUT and connected with the signal lead. The figure shows PCB cables for voltage (top) and current measurements (bottom).

Shorting links	
	If the current measurement points are temporary not connected to the probe box, close the circuit at the DUT via delivered shorting links. The figure shows shorting links connected to soldered-in headers (top) and PCB cables (bottom).

External shunt	
	To reduce burden voltage, use the external shunt for the measurements of higher current drains. The figure shows the solder-in connection of external shunt.

Adapter PCB current cable to 2.54 mm	
	To use the standard square headers also for current measurements, you can use adapter cables to 2.54 mm delivered within the option R&S RT-ZA36, see Table 2-9. The PCB adapters are designed for current measurements of only up to 3 A. These adapter cables are recommended for external shunt measurements. With these adapters, the design of sockets cannot distinguish between the current and voltage measurement points. Be aware, that connecting the measurement point of the DUT to the false probe channel can damage the DUT.

4 Measurement principles

4.1 Signal integrity

The R&S RT-ZVCmultichannel power probe transfers the voltage and current of the electrical signal tapped off the DUT to the postprocessing logic. With an ideal probe, the signal that is post-processed is identical to the input signal at the measurement point of the DUT. The following sections explain how to minimize signal alterations.

4.1.1 Ground connection

Connection to the ground is established either through USB or scope interface. The AC/DC wall adapter has no protective ground connector.

In the case of battery operation, the ground of the DUT is floating. High static potentials between the DUT ground and the probe ground can exceed the operating voltage window of the probe. Therefore it is necessary to connect the ground socket of the probe to the ground of the DUT. The ground connection also improves problems with unwanted common mode signals.

1. **NOTICE!** Unsufficient ground connection can damage the internal shunt, cause unreliable measurement results or unexpected high offsets.

   Always establish a common ground connection and fixed common mode relation, also for non-floating DUTs.

2. If the DUT is floating, connect the ground socket of the probe to the ground of the DUT.

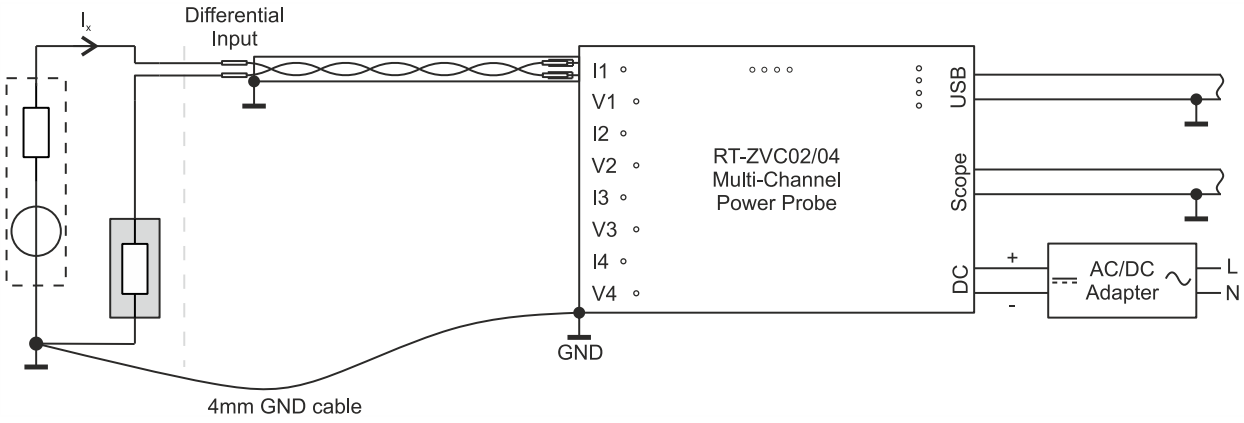


Figure 4-1: Ground connection

4.1.2 Electromagnetic interference

Although shielded twisted-pair cables are used for the leads, the measurement is highly sensitive to electromagnetic interference effects near the sockets for PCB cables. Therefore, consider additional shielding methods, such as shield boxes for the DUT, to avoid interference.

4.1.3 Accuracy

The accuracy of power measurements depends on the accuracy of the amperemeter and the accuracy of the voltmeter.

The bandwidth specifies the maximum frequency at which a purely sinusoidal signal is still transferred at 89 % (1 dB) of its amplitude. For details, see the specifications document.

4.1.4 Dynamic range and operating window

Two separate specifications are necessary to characterize the permissible input voltage range of a differential voltage probe:

- The dynamic range (or "differential-mode range") designates the maximum differential voltage that can occur between the positive and negative signal pin.
- At the same time, the two voltage values at each of the two pins - the positive and negative pin, referenced to the common ground must not exceed a spe-

cific limit. This limitation is referred to as the operating voltage window (some manufacturers also use the term "common mode range" for the same parameter).

If one of these ranges is exceeded, an unwanted signal clipping can occur.

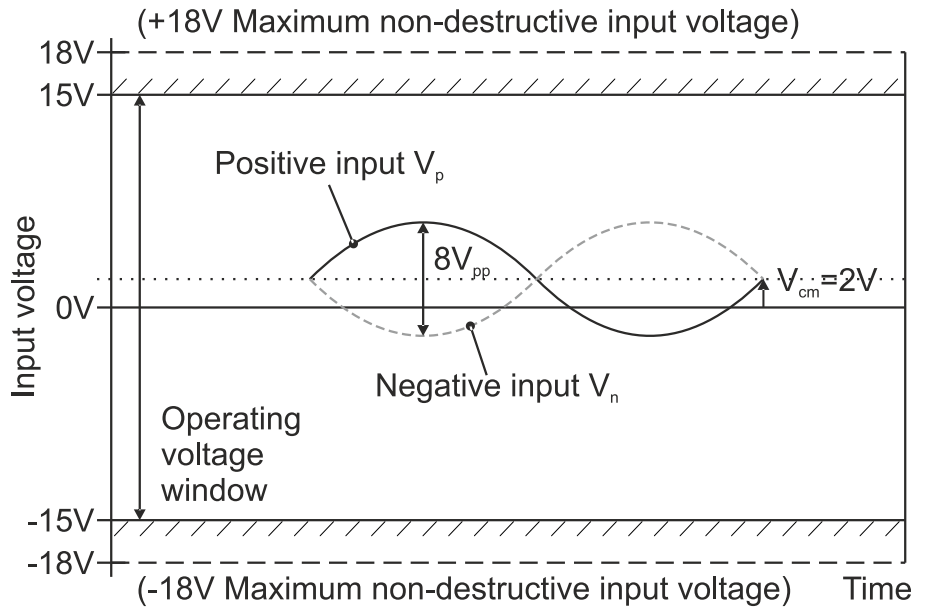


Figure 4-2: Voltage operating window

The dynamic range between the positive and negative signal pins depends on the gain or attenuation. The operating voltage window between each of the signal pins and common ground is not affected by the gain or attenuation.

Signal clipping

Only differential input signals are detected by the probe and displayed. Common mode signals are suppressed by the probe. Therefore, the common-mode offset compensation is not directly visible on the oscilloscope screen. An incorrect common-mode offset compensation can lead to unwanted clipping effects. If unexpected clipping occurs, check the positive or negative input voltage relative to ground. In addition, measuring the common mode input voltage is a convenient way to detect breaches of the operating voltage window.

4.2 Probing philosophy

4.2.1 Signal flow for oscilloscope operation

After the measuring of the signal, the R&S RT-ZVC offers the following functions:

- **Deskew**: Each signal can be delayed by using the deskew function.
- **Lowpass**: To resolve very low voltages and currents, a built-in lowpass module can be activated. The bandwidth reduction affects all channels simultaneously.
- **Decimation**: Three different decimation modes can be chosen to reduce the sample rate to less than 5 MSa/s: "Sample", "Peak detect", and "High Res Decimation".
- **Trigger**: It is possible to set an edge trigger on every voltage or current signal. The trigger event is transferred to the oscilloscope together with the digitized data.
- The measurement results are transferred via digital interface at maximal sample rate of 5 MSa/s to the oscilloscope for postprocessing.

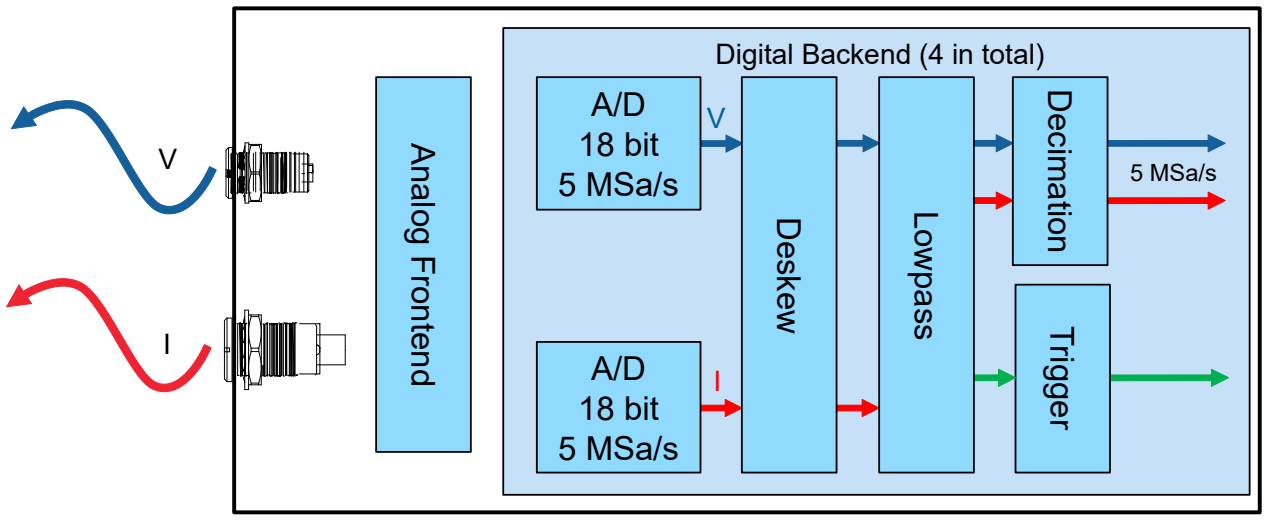


Figure 4-3: Signal flow with an oscilloscope

4.2.2 Signal flow for R&S CMWrun operation (USB IF only)

The R&S RT-ZVCmultichannel power probe with integrated postprocessing provides high precise statistical results. The minimal, maximal, average and RMS

current and voltage values are internally calculated for 5 MSa/s per channel. The high measurement resolution is suitable for high accuracy measurements of instantaneous values.

In contrary, the R&S CMWrun focuses on the long-time battery-life measurements. Therefore, for USB interface, the R&S RT-ZVC performs decimation of average and peak values provided by postprocessing. In the GUI of R&S CMWrun, specify the decimation level of up to 50 kSa/s for each active channel.

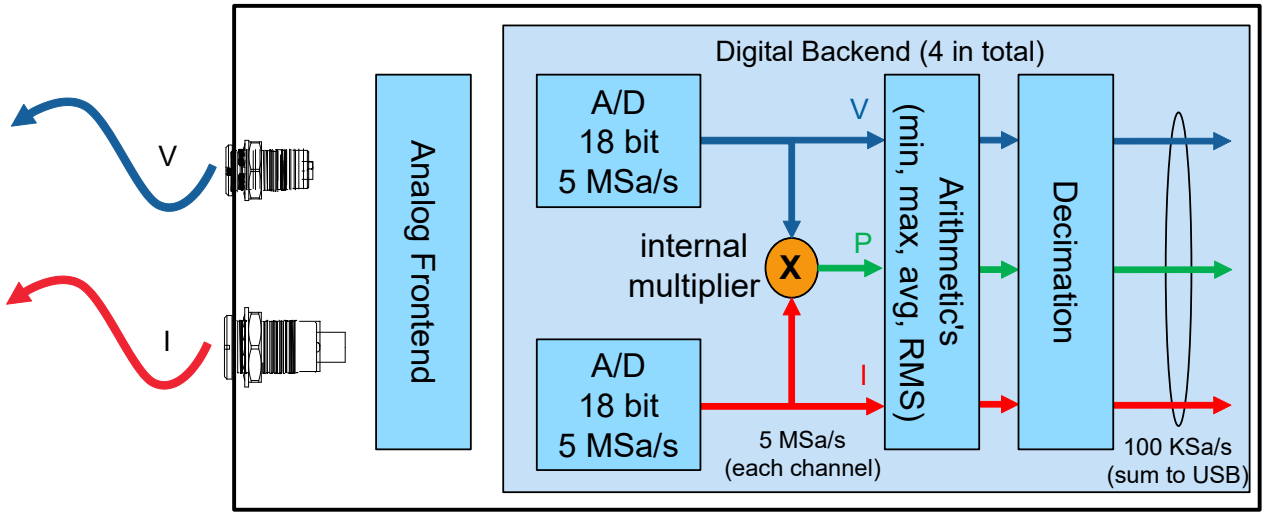


Figure 4-4: Signal flow with R&S CMWrun

4.2.3 Internal shunt operation

Before measurement, the correct measurement range has to be specified in the settings. Therefore, the amperemeter provides internal shunts (2) of 10 kΩ, 10 Ω, and 10 mΩ to be selected as a reference resistor.

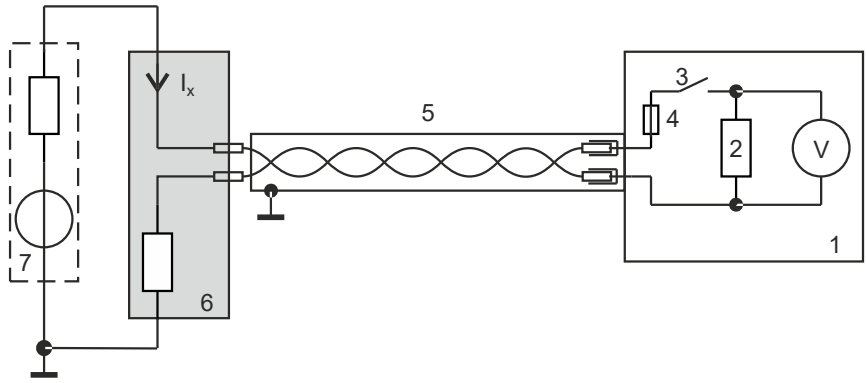


Figure 4-5: Scheme of the shunt-amperemeter with internal shunt

1 = R&S RT-ZVC probe, channel x
2 = selectable internal shunts
3 = switch for shunt selection
4 = fuse, 15 A (non-resettable)
5 = current leads - shielded twisted pair
6 = DUT
7 = DUT's power supply

With the internal shunt selection, the operating range of the amperemeter is specified. At the same time, the burden voltage at the amperemeter input can be estimated.

The burden voltage is the DUT circuit loading caused by leads, connectors and the amperemeter circuit. For values of the total round-trip resistance that can be seen at the test lead ends, see the specifications document. For instance, the total resistance for the basic current leads AWG24 (5) contained in the standard shipping is 128 mΩ nominal.

4.2.4 External shunt operation

The burden voltage depends on the operating range of amperemeter. Regarding the shunt selection, i.e. the burden voltage level, there is a trade-off between the burden of the circuit under test and the SNR at the frontend input. From the DUT perspective, the burden voltage has to be kept low not to distort the device operation. In contrast, from the probe's view the voltage has to be as large as possible to obtain a good SNR. For that reason, the external shunt can be applied to get the best compromise of both for a specific measurement range.

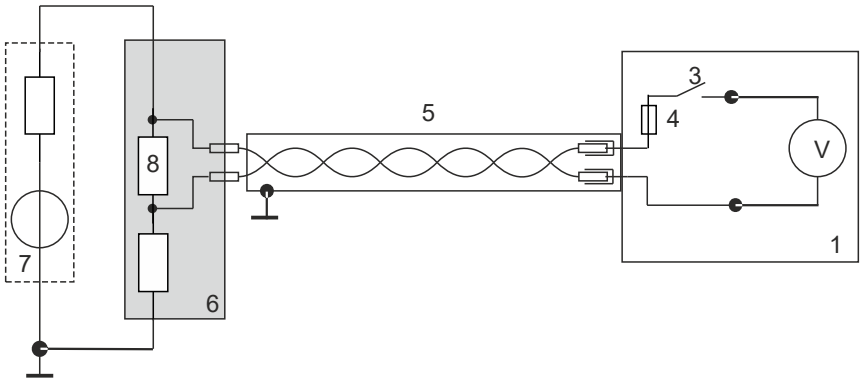


Figure 4-6: Scheme of the shunt-amperemeter with external shunt

1 = R&S RT-ZVC probe, channel x
4 = fuse, 15 A (non-resettable)
5 = current leads - shielded twisted pair
6 = DUT
7 = DUT's power supply
8 = external shunt to reduce burden voltage

For higher current values, a significant burden voltage appears at the amperemeter connectors. For current values above approximately 3 A, an external shunt (8) is recommended. Consider also the maximal tolerable voltage drop of the DUT. By selecting an external shunt, the amperemeter becomes a sensitive voltmeter and allows you to measure the current over a voltage drop.

Requirements of external shunt

For high-current measurements, the use of external shunts directly mounted in the circuit under test is preferred regarding the burden voltage issue.

There are different requirements the low-value (for example ≤10 mΩ) shunt resistor has to fulfill:

- High-power rating of ≥1 W (depending on actual current and resistor value)
- High precision (low-resistance tolerance) of ±0.5% or lower
- Low temperature coefficient, ≤25 ppm/°C
- Four terminals (Kelvin connections) for precise and accurate measurements

To fulfill these requirements, precise metal strip resistors are recommended, such as the Vishay CSM series. The 10 mΩ shunt in the probe is of type CSM3637 (Vishay Y14880R01000B9R). The smallest shunt available in this series is 1 mΩ.

4.2.5 Autoranging mode

For the multichannel power probe variants R&S RT-ZVC04A or R&S RT-ZVC02A, autoranging mode can be enabled on request either on internal or external shunts.

Autoranging is performed by gain-switching according to the measured values, as illustrated in the following figure. Thus, switching times are kept low and the burden voltage seen by the DUT is not affected. Only if there is an overload, the R&S RT-ZVC switches automatically to the next smaller shunt (or external shunt mode) to protect the probe against permanent damage.

The autoranging mode allows seamless current measurements of up to 50 ksample/s.

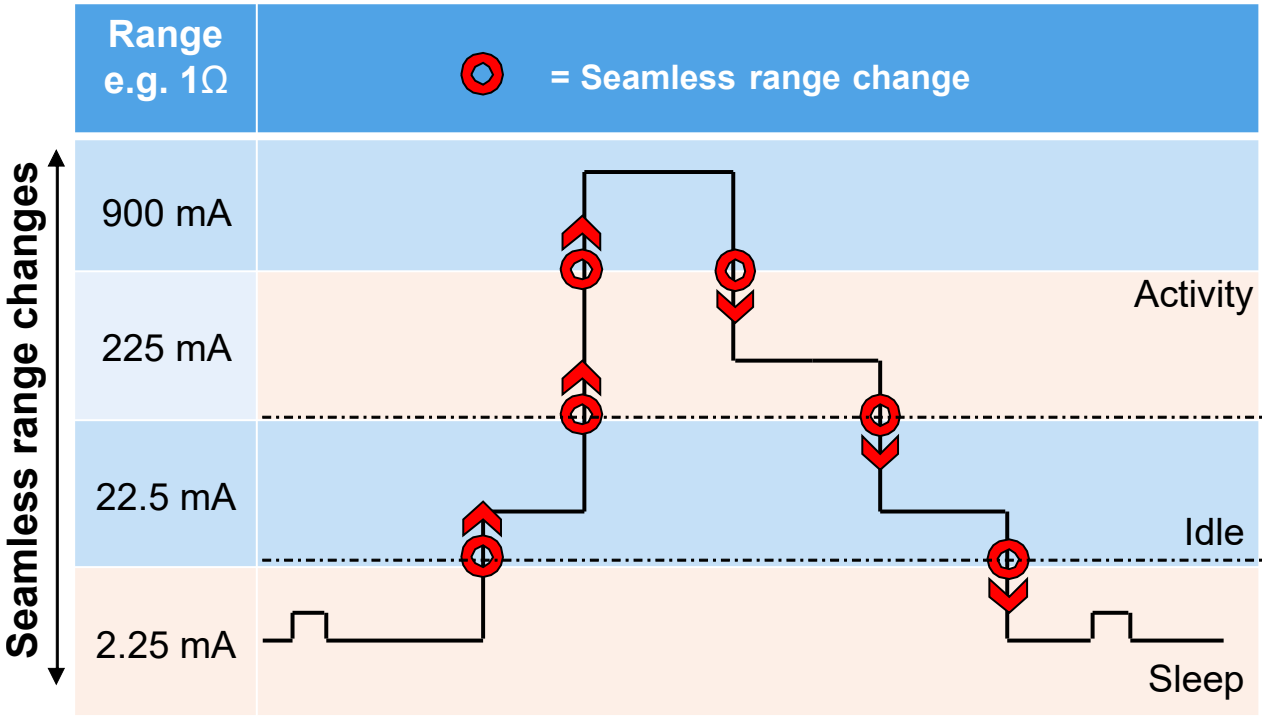


Figure 4-7: Seamless ranging

5 Maintenance and service

Like all Rohde & Schwarz products, Rohde & Schwarz probes and adapters are of high quality and require only minimum service and repair. However, if service or calibration is needed, contact your Rohde & Schwarz service center. Return a defective product to the Rohde & Schwarz service center for diagnosis and exchange.

5.1 Cleaning

1. Discharge any static electricity at your hands before cleaning the facing surfaces.

   Thus, you ensure that no high voltage caused by static electricity is applied to the product. Application of a high voltage can damage the internal Hall elements or circuitry. You can attract static electricity to your hands by touching a nearby metal object.

2. Clean the outside of the product using a soft cloth moistened with either distilled water or isopropyl alcohol. Keep in mind that the casing is not waterproof.

   Note: Do not use cleaning agents. Solvents (thinners, acetone), acids and bases can damage the labeling or plastic parts.

3. Dry the product completely before using it.

5.2 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 5-1: QR code to the Rohde & Schwarz support page

5.3 Returning for servicing

Use the original packaging to return your R&S RT-ZVC to your Rohde & Schwarz-service center. A list of all service centers is available on:

www.services.rohde-schwarz.com

If you cannot use the original packaging, consider the following:

1. Use a sufficiently sized box.
2. Protect the product from damage and moisture (e.g. with bubble wrap).
3. Use some kind of protective material (e.g. crumpled newspaper) to stabilize the product inside the box.
4. Seal the box with tape.
5. Address the package to your nearest Rohde & Schwarz service center.

5.4 Calibration Interval

The recommended calibration interval for R&S RT-ZVC multichannel power probe is one year for highest accuracy and two years for general test and measurement applications. For servicing, send the probe to your nearest Rohde & Schwarz service center (see Chapter 5.3, "Returning for servicing", on page 37).

5.5 Storage and transport

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

Store the product in a shock-resistant case, e.g. in the shipping case.

Unless otherwise specified in the specifications document, the maximum transport altitude without pressure compensation is 4500 m above sea level.

5.6 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 of 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 life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

Figure 5-2: 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.

5.7 Spare parts

You can order the following accessories from the Rohde & Schwarz service center. Use the order numbers provided in the following table.

Probe spare parts

Item	Designation	Part No.	Recommended spare part
20	AC/DC power supply	3625.3308.00	x
30	TWINAX cable	1316.0662.00	
40	USB 3.0 cable A to micro B 1.5M SW	3625.2818.00	
50	4 mm ground lead, black	1333.1786.02	
200	RT-ZVC housing	1326.0265.00	
202	RT-ZVC04 label set	1326.2174.00	
204	RT-ZVC02 label set	1326.0888.00	
206	RT-ZVC04A label set VAR 34	1326.4483.00	
208	RT-ZVC02A label set VAR 32	1326.4490.00	
210	Analog board VAR 04 24	1320.7345.04	x
215	Analog board VAR 34	1326.3864.04	x
220	Analog board VAR 02 22	1320.7345.02	x
225	Analog board VAR 32	1326.3864.02	x
230	Current socket 2XAWG20 L50	1333.1457.00	
240	Voltage socket 2XAWG28 L50	1333.1534.00	
250	Spacer	3625.5200.00	x
260	Digital board	1320.7322.04	x
270	Digital board	1320.7322.02	x
280	LED board	1320.7368.02	x
290	SMD-FUSE 2.5A FF 0402	3590.2701.00	x
300	SMD-FUSE 15A FF	2081.7103.00	
310	Shunt 0R01 0.1%	3590.7132.00	
320	Shunt 10R 0.1%	0009.9546.00	
330	Shunt 10K 0.1%	3590.7226.00	
340	Shunt resistor 0R05 0.1%	3629.6824.00	
350	Shunt resistor 0R2 +-0.1%	3629.6876.00	
360	Shunt resistor 1R0 +-0.1%	3629.6882.00	

Accessories spare parts

Item	Designation	Part No.	Recommended spare part
60	Alligator clip 4 mm SW	3626.3576.00	
70	Voltage lead basic 2XAWG28	1333.1863.02	
80	Current lead basic 2XAWG24	1333.1840.02	
90	PCB cable AWG20 L50 BL	1333.1834.03	
100	PCB cable AWG20 L50 RD	1333.1834.02	
110	Voltage PCB cable AWG26 L50 RD/BL	1333.1792.03	
120	Voltage PCB cable AWG26 L50 RD/BL	1333.1792.02	
130	Solder-in contact	3625.2776.00	x
140	Short contact 1X2.54	3625.2782.00	x
500	Current lead basic 2XAWG20	1333.1840.03	
510	Voltage lead basic 2XAWG28	1333.1863.03	
600	Current lead 4 mm plug 2XAWG20	1333.1857.02	
610	Voltage lead 4 mm plug 2XAWG28	1333.1870.02	
700	Current lead 4 mm plug 2XAWG20	1333.1857.03	
710	Voltage lead 4 mm plug 2XAWG28	1333.1870.03	
800	Current lead basic 2XAWG20	1333.1840.04	
810	Voltage lead basic 2XAWG28	1333.1863.04	
900	Adapter cable current to 2.54 RD/BL	1333.1805.02	
910	Adapter cable current to 2.54 RD/BL	1333.1805.03	