R&S®RT-ZVC Multi-Channel Power Probe

User Manual

1326213902

User Manual

Version 03

ROHDE&SCHWARZ

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)

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1326.2139.02 | Version 03 | R&S®RT-ZVC

The following abbreviations are used in this manual: R&S®RT-ZVC is abbreviated as R&S RT-ZVC. R&S®CMWrun is abbreviated as R&S CMWrun. R&S®RTO2000 and R&S®RTE are abbreviated as R&S RTx. R&S®RTO-B1E and R&S®RTE-B1E are abbreviated as R&S RTx-B1E.

Contents

1 Product Description

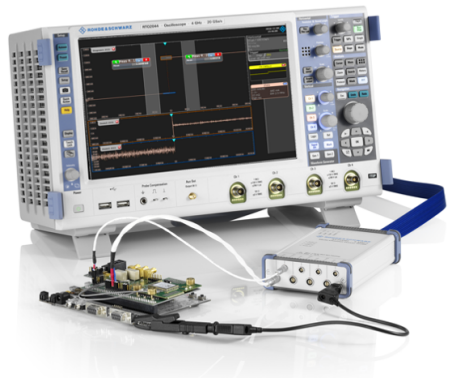
The R&S RT-ZVC is a multi-channel power probe with integrated 2- or 4-channel amperemeter and 2- or 4-channel voltmeter. It provides parallel measurements of analog or digital, voltage/current signals with excellent 18-bit resolution. Integrated post-processing logic calculates power and statistical 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 (wearables, smartphones)
- Power supply of integrated circuits
- Battery life-time measurements
- Power consumption measurements
- Energy-harvesting

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

Table 1-1: 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

1.1 Prerequisites

- **Operation with oscilloscope**
  - Oscilloscope of type R&S RTO2000 equipped with R&S RTO-B1E or
  - R&S RTE equipped with R&S RTE-B1E is required.

  Note, that old R&S RTx-B1 boards cannot run R&S RT-ZVC.
- **Operation with R&S CMWrun**
  - R&S CMWrun, version 1.8.8 and later. The option R&S CMW-KT051 of R&S CMWrun for general-purpose tests is required.
  - Windows supported operating system includes Windows 7 and Windows 10 (32-bit or 64-bit version).
  - A Rohde & Schwarz-specific driver is required to be installed at the run PC, to support 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.

1.2 Key Characteristics

The R&S RT-ZVC probe houses integrated voltmeter, amperemeter, and post-processing logic. The probe performs built-in A/D conversion and signal post-processing. Within integrated post-processing, 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.

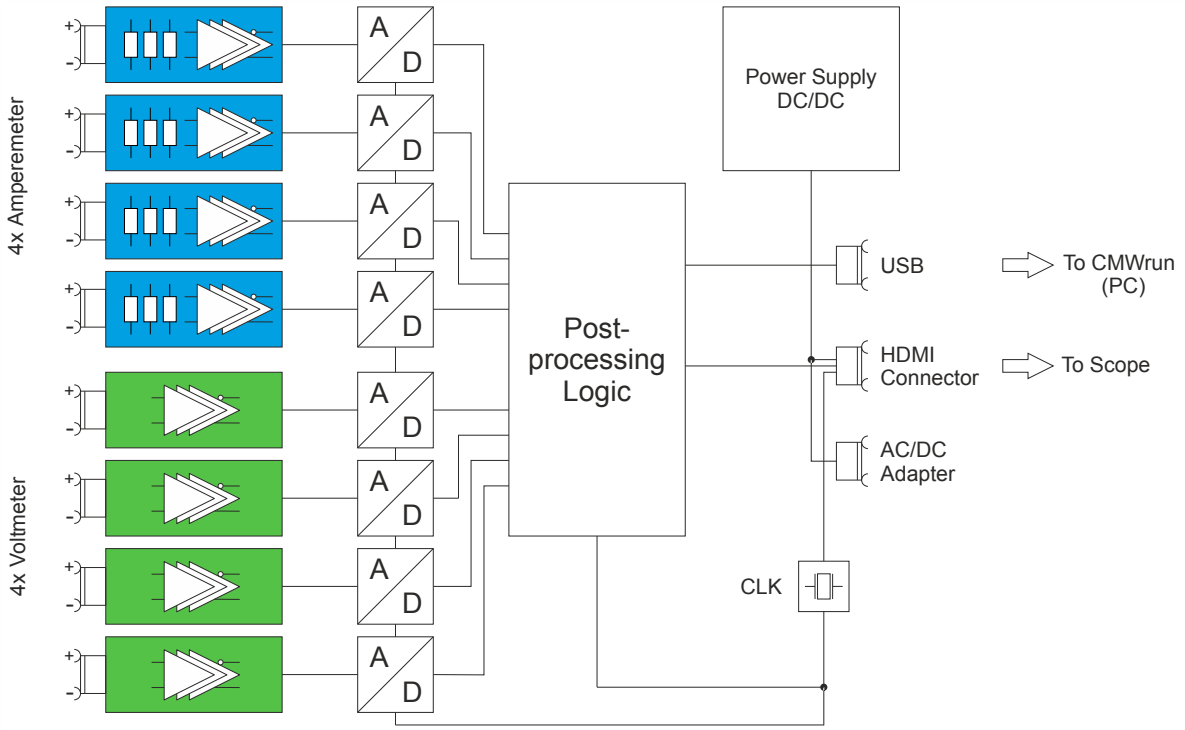


Figure 1-1: Electrical scheme

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 1-2: 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, consider the data sheet.

1.3 Unpacking the Instrument

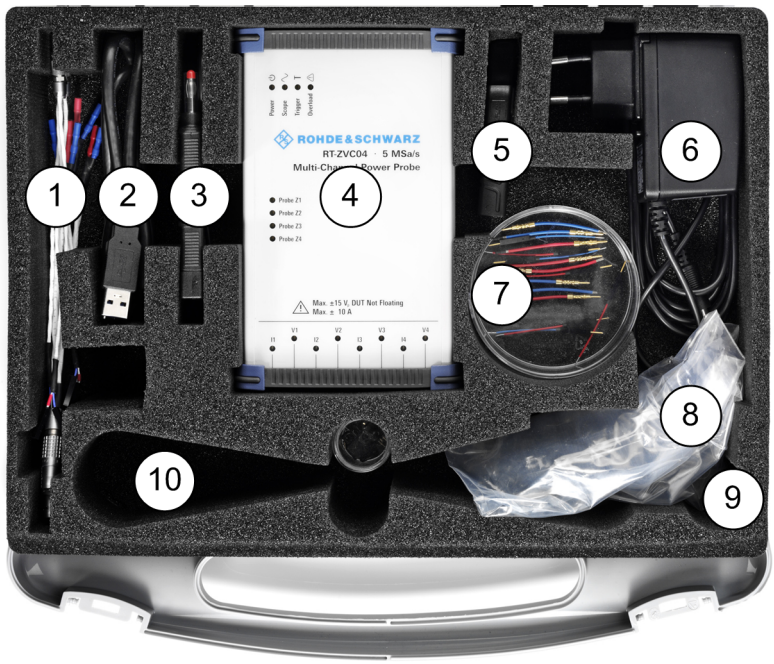


Figure 1-2: Carrying case (model for R&S CMWrun)

Inspecting the contents

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

Inspect the package for damage

Keep the package and the cushioning material until the contents have been checked for completeness and the device has been tested.

If the packaging material shows any signs of stress, notify the carrier and your Rohde & Schwarz service center. Keep the damaged package and cushioning material for inspection.

Inspect the product

If the content is incomplete, damaged, or defect or if the R&S RT-ZVC multi-channel power probe does not operate properly, notify your Rohde & Schwarz service center.

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.

1.4 Instrument Overview

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

- The probe box
- Leads and accessories for connection to the DUT. See also Chapter 2.3, "Connecting the Probe to the DUT", on page 22
- 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 2.2, "Test Setup with R&S CMWrun", on page 20

- Variant for operation with an oscilloscope:
  Blue flat oscilloscope interface cable, refer to Chapter 2.1, "Test Setup with Oscilloscope", on page 19

The next sections describe the main HW of the probe.

1.4.1 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.

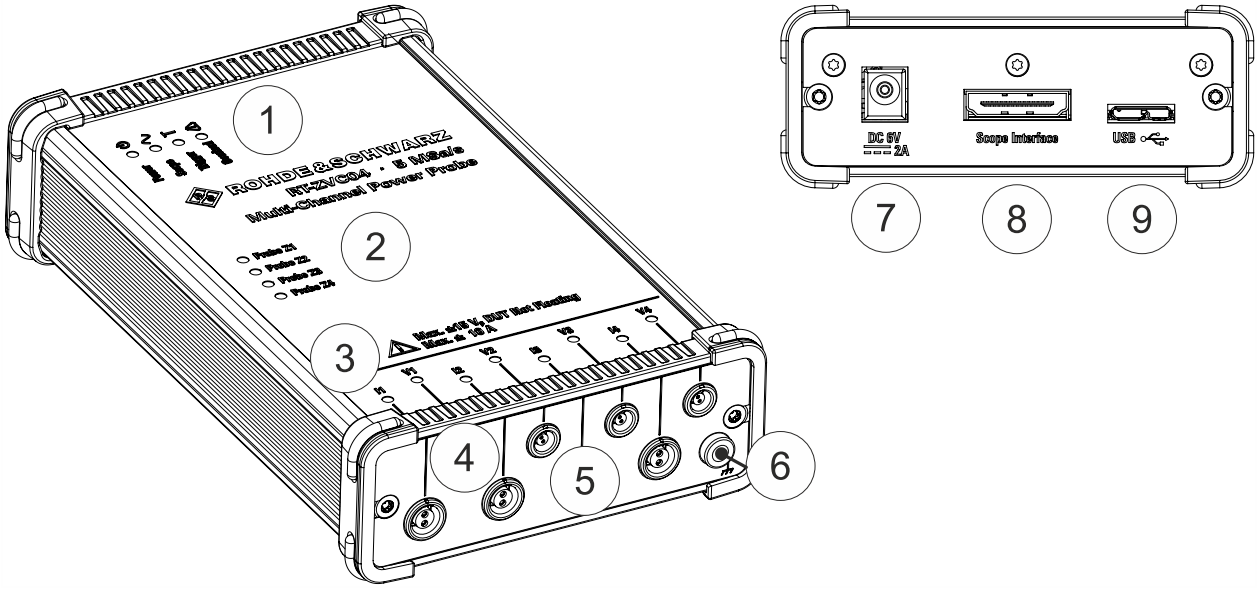


Figure 1-3: R&S RT-ZVC: upper, front, and rear view

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 oscilloscope.
- **Trigger**: Trigger signal is detected on R&S RTx interface.
- **Overload**: Red LED plus blinking affected channel indicate overload at 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. In case also the 10A 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. Red color at the socket marks the position of + wire. Number of sockets depends on the instrument model.
- 2 or 4 sockets (5) for current test leads AWG24. Red color at the socket marks the position of + wire. 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 3.2.1, "Ground Connection", on page 27.
- Socket (7) for 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.

NOTICE

Risk of instrument damage during operation

An unsuitable test setup can damage the instrument and connected devices. When operating the probe together with the oscilloscope, only oscilloscopes of type R&S RTE and R&S RTO2000 must be used.

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 3.3.3, "Internal Shunt Operation", on page 31
- Chapter 3.3.4, "External Shunt Operation", on page 32
- Data sheet

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 data sheet.

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

Within the integrated post-processing 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 chan-

nel. The statistical power results (min/max/avg/RMS) are calculated within 32-bit resolution.

For details, refer to:

- Chapter 1.2, "Key Characteristics", on page 6
- Chapter 3.3.2, "Signal Flow for R&S CMWrun Operation (USB IF Only)", on page 30

1.4.2 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 1.5, "Optional Accessories", on page 14.
  - 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.

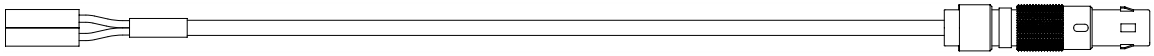


Figure 1-4: Basic lead for voltage measurements

  - 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.

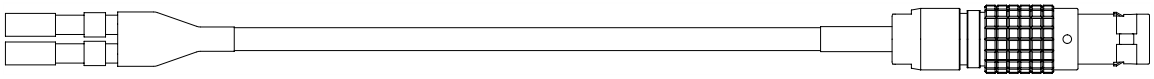


Figure 1-5: Basic lead for current measurements

- PCB cables and headers:

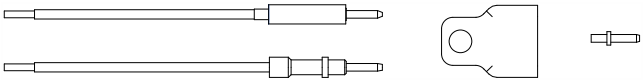


Figure 1-6: PCB cables, shorting link, header

– 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 provided within R&S RT-ZA36 (1333.1911.02), or Special OEM accessories for current sockets provided by manufacturer as with standard shipping.
Use the delivered shorting links to close unused measurement points at the DUT for current measurements.

1.5 Optional Accessories

If the included accessories do not meet individual customer requirements, different accessory sets are offered for sale.

Table 1-3: R&S RT-ZA30 (1333.1686.02)

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 1-4: R&S RT-ZA31 (1333.1692.02)

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 1-5: R&S RT-ZA32 (1333.1705.02)

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

Table 1-6: R&S RT-ZA33 (1333.1770.02)

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

Table 1-7: R&S RT-ZA34 (1333.1892.02)

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 1-8: R&S RT-ZA35 (1333.1905.02)

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 1-9: R&S RT-ZA36 (1333.1911.02)

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 1-10: R&S RT-ZA37 (1337.9130.02)

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 1-11: 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.

2 Putting into Operation

The R&S RT-ZVC multi-channel power probe has been designed to withstand a moderate amount of physical and electrical stress. Treat the probe with care. It can be damaged if excessive force is applied.

NOTICE

Risk of instrument damage due to mechanical shock

Exercise care to prevent the probe from receiving mechanical shock.

Always handle the probe by the probe cables or probe box.

Avoid putting excessive strain on the probe cable or exposing it to sharp bends.

Store the probe in a shock-resistant case such as the foam-lined shipping case that came with the probe.

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

NOTICE

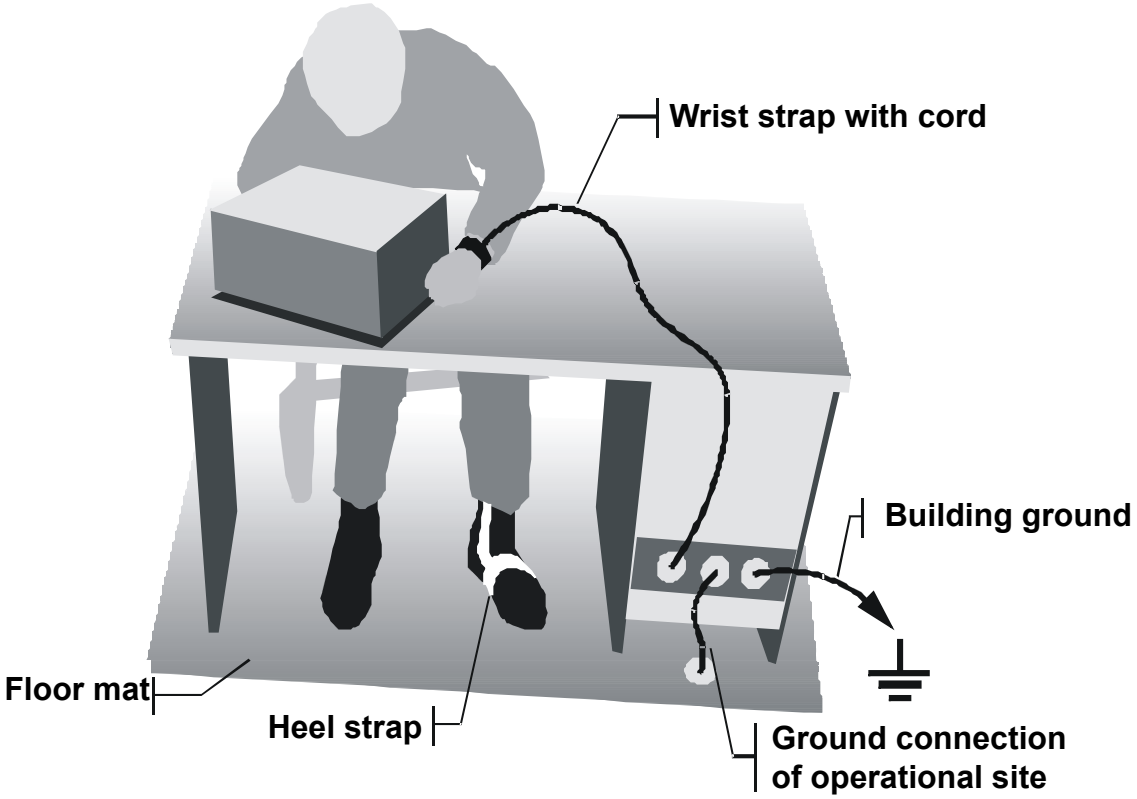
Risk of instrument damage due to excess power

Voltages or currents above the specified limits of the R&S RT-ZVC multi-channel power probe can damage the probe. Do not exceed the specified limits.

NOTICE

Damage caused by electrostatic discharge

To avoid damage of electronic components, protect the operational site against electrostatic discharge (ESD).



To protect the operational site, use one or both of the following measures:

- Wrist strap with cord to ground connection
- Conductive floor mat and heel strap combination

The following topics are covered in the next sections:

2.1 Test Setup with Oscilloscope

A basic test setup with an oscilloscope does not include 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 oscilloscope.

CAUTION

Risk of injury

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

If grounding is *not* ensured by the mains system, ground the oscilloscope using the protective earth conductor on the front panel and an appropriate cable.

Do not use an isolating transformer to connect the oscilloscope to the AC power supply.

Supported oscilloscopes are listed in the R&S RT-ZVC data sheet.

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

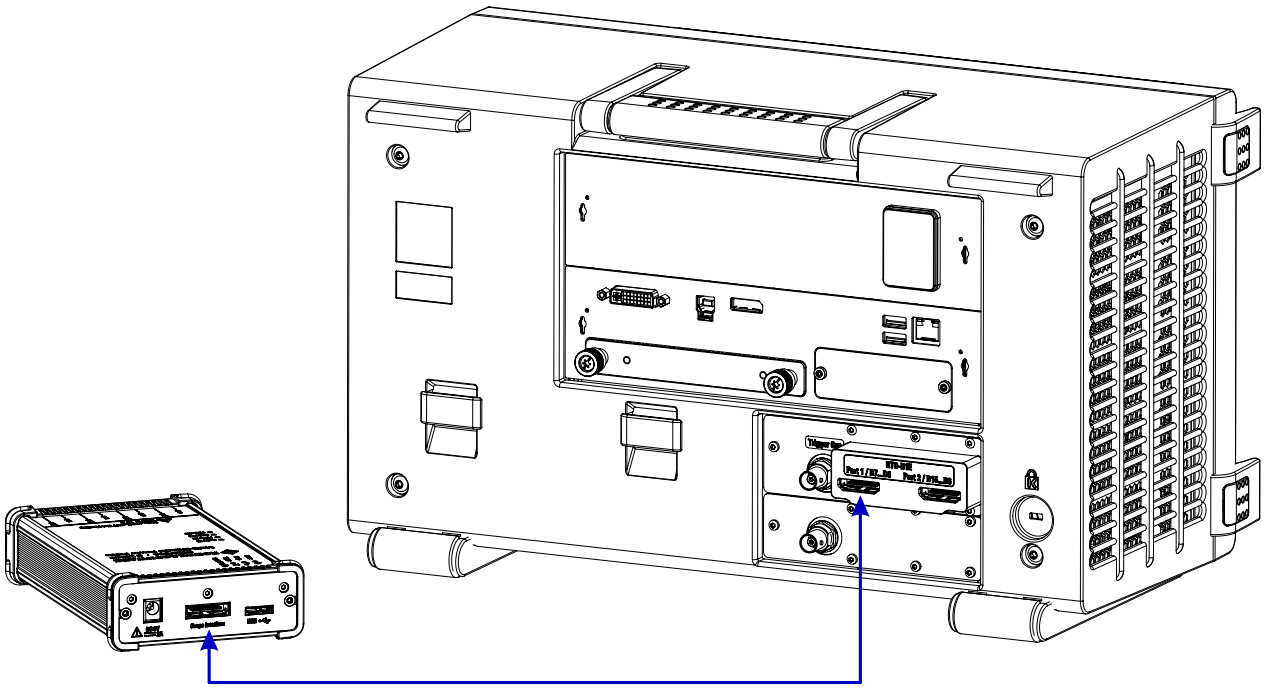


Figure 2-1: Connecting the probe to the oscilloscope

1. Connect the probe box via oscilloscope interface cable to the HDMI port of R&S RTx-B1E module at the rear side of oscilloscope. See Figure 2-1.

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

2. Configure the active channels and the desired ranges at the oscilloscope using the ZVC multi-channel power probe dialog under "Vertical".
   The procedure depends on the used instrument. For detailed description, refer to the oscilloscope's user manual.

NOTICE

Risk of instrument damage

To prevent wire damages, do not pull on the cord to disconnect the HDMI connector from the probe box or oscilloscope. Always grip and pull the connector to disconnect.

2.2 Test Setup with R&S CMWrun

Connect the R&S RT-ZVC multi-channel power probe with the R&S CMWrun as follows.

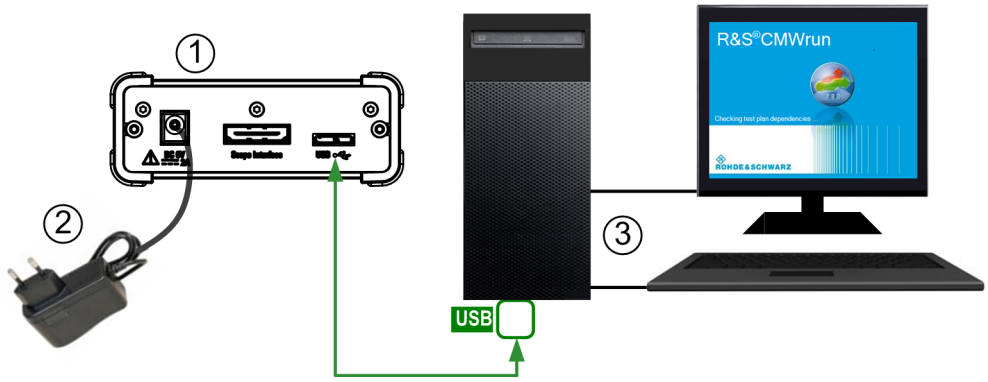


Figure 2-2: Test setup with R&S CMWrun

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

CAUTION

Risk of injury or damage

When operating on the 230V AC power supply, only the supplied AC/DC wall-mount power adapter of type Cincon TRG10R059-01-23E03 must be used. 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.

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. 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.

2.3 Connecting the Probe to the DUT

To achieve optimum RF performance, the connections have to be always as short as possible. If long connections cannot be avoided, they have to be preferably used for the ground socket.

The basic test setup enables up to 4 voltage and up to 4 current measurement points. The R&S CMWrun supports currently the measurement of only 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.

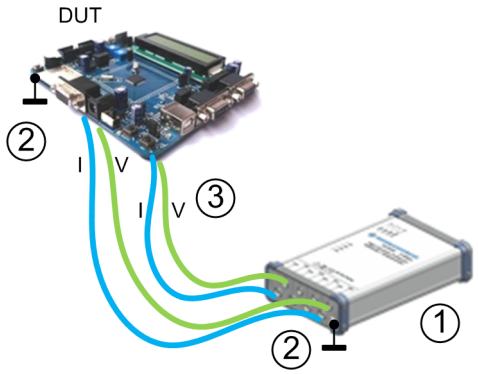


Figure 2-3: Test setup

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

It is forbidden to measure own power supply drain of the R&S RT-ZVC at the AC power supply adapter or at the HDMI connector.

Ground connection

Before starting measurements, establish a common ground between DUT and probe to keep common voltage within the common mode range of the amplifiers. Refer to Chapter 3.2.1, "Ground Connection", on page 27.

Ground socket is in the lower right corner of the front plane, refer to Figure 1-3. 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.

Measurement point connection

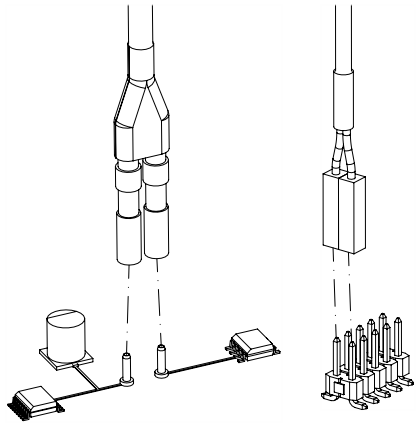
The voltage and current leads are connected with the DUT to tap off the measurement signal. Use delivered voltage and current cables. Their connectors fit into the voltage or current socket of probe box. Red color at the connector marks the position of + wire. Match the red marks of a connector and socket 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 1.4.2, "Cables and Accessories", on page 13.

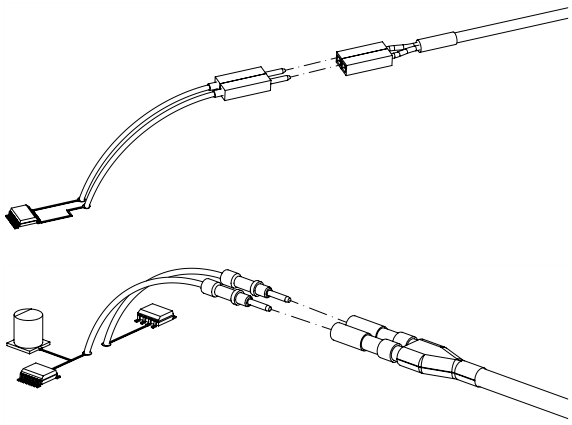
To connect the measurement points of the DUT, use solder-in connections. For details, see Chapter 3.1, "Solder-In Connection", on page 24.

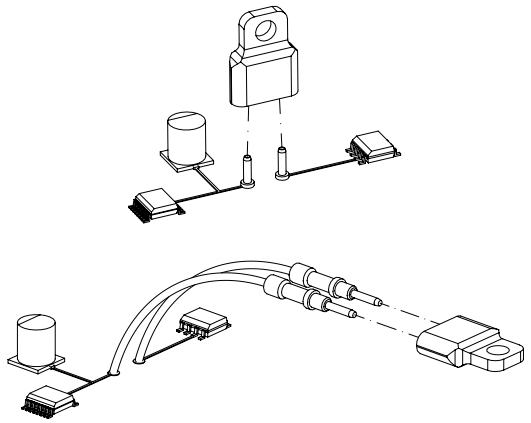
3 Measurement Principles

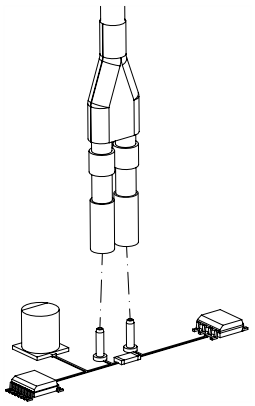
3.1 Solder-In Connection

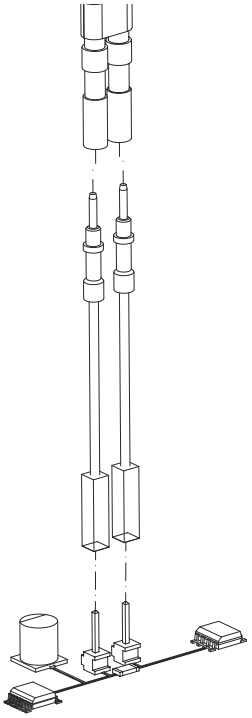
To prepare the DUT for measurements, solder the delivered headers or PCB cables to the DUT, to specify the measurement points.

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 1-9. 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.

NOTICE

Risk of instrument damage

Do not exchange the current and voltage connections at the probe box. Be aware of possible instrument damage.

3.2 Signal Integrity

The R&S RT-ZVC multi-channel power probe transfers the voltage and current of the electrical signal tapped off the DUT to the post-processing 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.

3.2.1 Ground Connection

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

NOTICE

Risk of instrument damage and unreliable measurement results

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

Always establish common ground connection and fixed common mode relation even for non-floating DUTs.

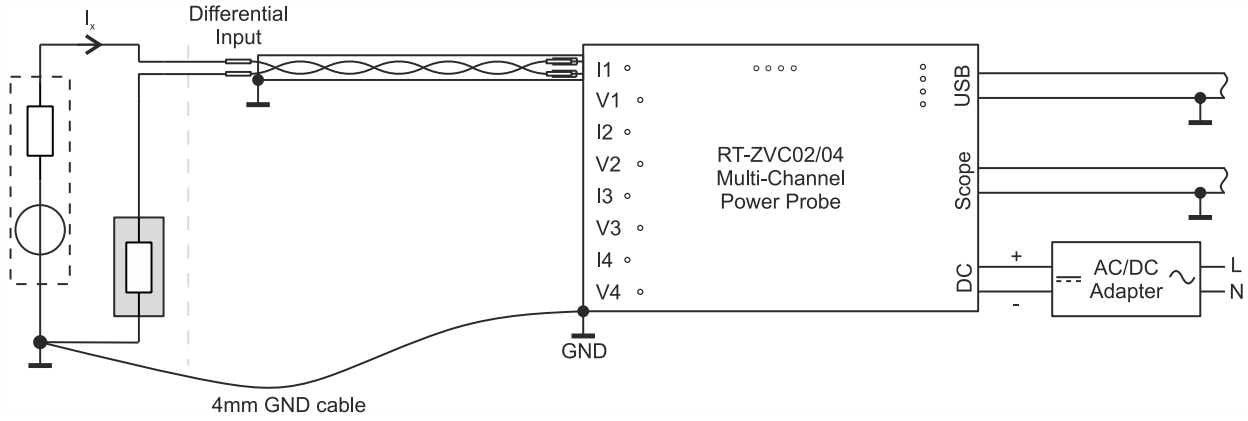


Figure 3-1: Ground connection

3.2.2 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.

3.2.3 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 % (0.1 dB) of its amplitude. For details, consider the data sheet.

3.2.4 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 specific 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.

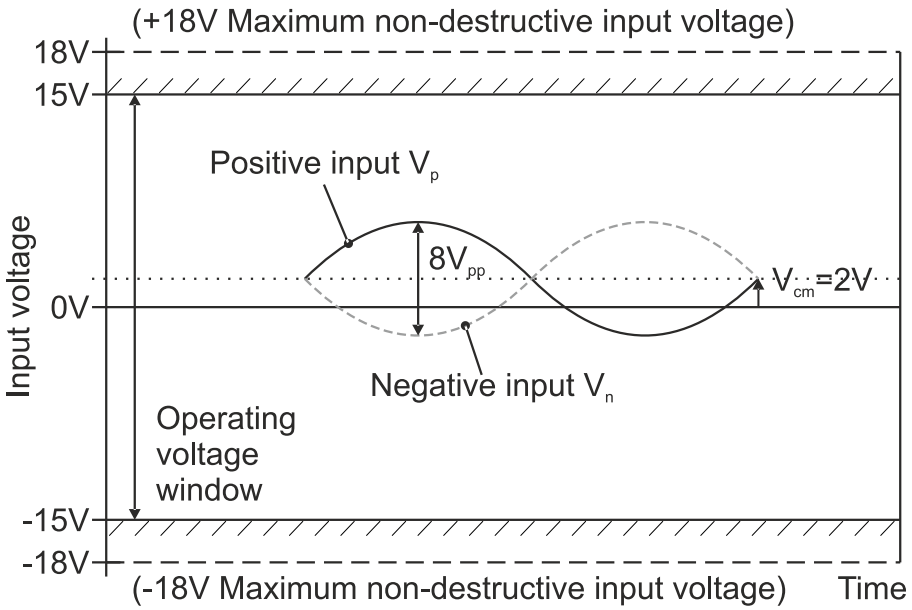


Figure 3-2: Voltage operating window

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.

NOTICE

Signal clipping

Only differential input signals are detected by the probe and displayed. Common mode signals are suppressed by the probe. Therefore, you possibly do not initially recognize that the operating voltage window is exceeded owing to inadmissible common mode voltages. 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 owing to excess DC common mode voltages.

3.3 Probing Philosophy

3.3.1 Signal Flow for Oscilloscope Operation

After the measuring of 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 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.

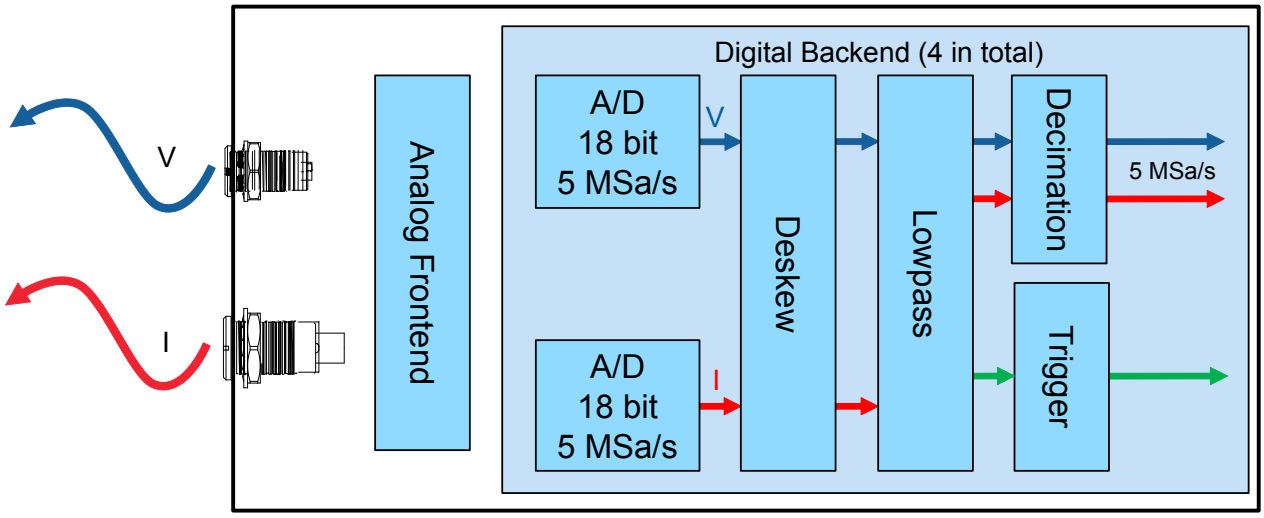


Figure 3-3: Signal flow with oscilloscope

3.3.2 Signal Flow for R&S CMWrun Operation (USB IF Only)

The R&S RT-ZVC multi-channel power probe with integrated post-processing 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 post-processing. In the GUI of R&S CMWrun, specify the decimation level of up to 50 kSa/s for each active channel.

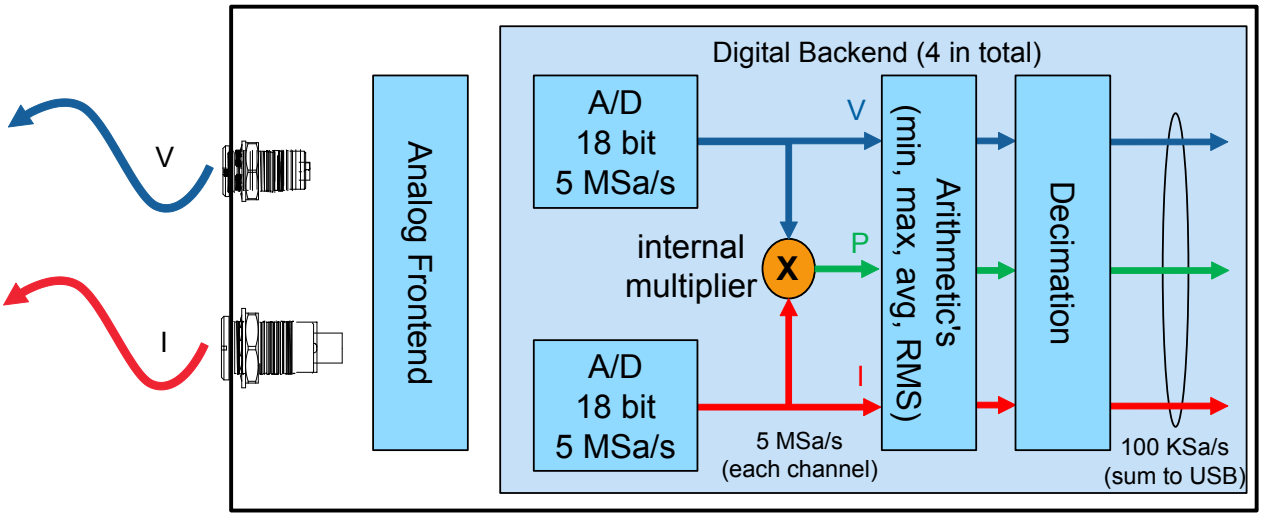


Figure 3-4: Signal flow with R&S CMWrun

3.3.3 Internal Shunt Operation

Before measurements, 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.

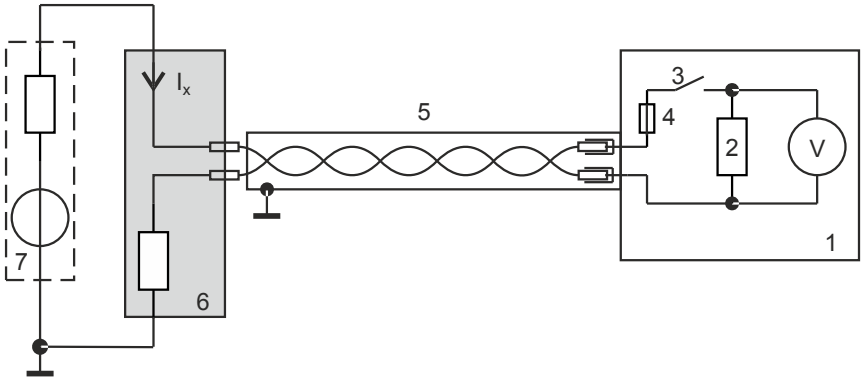


Figure 3-5: Scheme of the shunt-amperemeter with internal shunt

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, consider the data sheet. For instance, the total resistance for the basic current leads AWG24 (5) contained in the standard shipping is 128 mΩ nominal.

3.3.4 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 front-end 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.

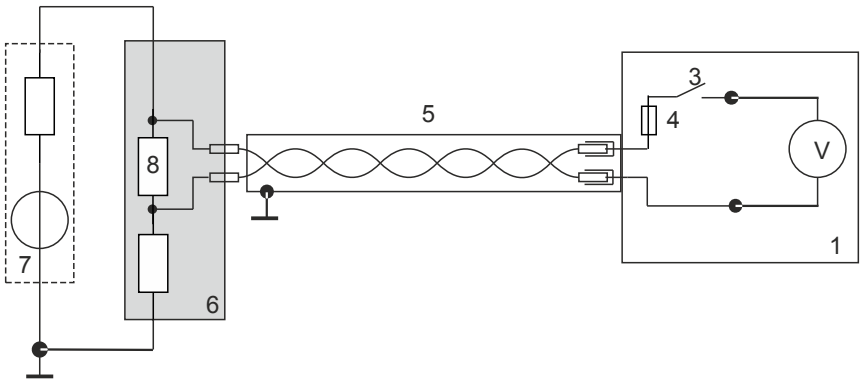


Figure 3-6: Scheme of the shunt-amperemeter with external shunt

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 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 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.

3.3.5 Autoranging Mode

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

Auto-Ranging 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 auto-ranging mode allows seamless current measurements of up to 50 ksample/s.

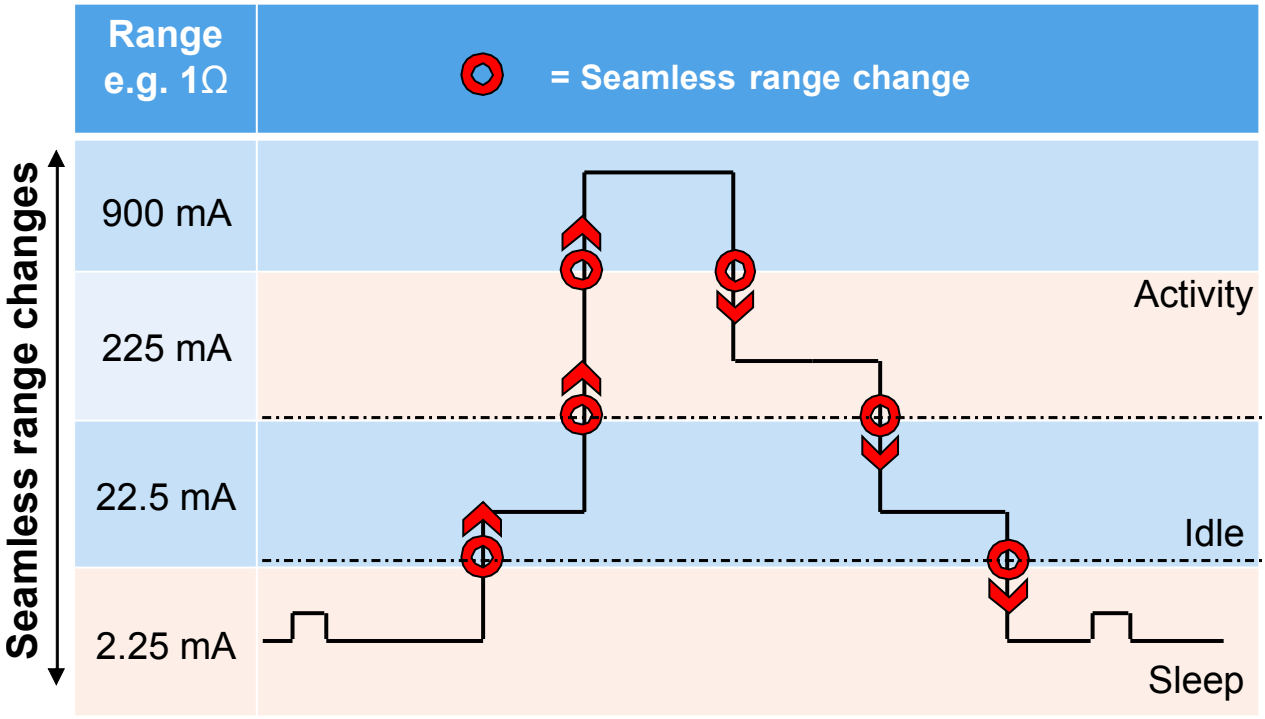


Figure 3-7: Seamless ranging

4 Maintenance and Service

4.1 Service Strategy

Like all Rohde & Schwarz devices, Rohde & Schwarz probes are of high quality and require only minimum service and repair. However, if the probe needs to be serviced, contact your Rohde & Schwarz service center. Return a defective probe to the Rohde & Schwarz service center for diagnosis and exchange.

You can return the R&S RT-ZVC multi-channel power probe for calibration. The service personnel performs the required tests.

4.2 Returning the Probe for Servicing

Use the original packaging to return your Rohde & Schwarz probe to your Rohde & Schwarz service center.

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

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

4.3 Cleaning

To clean the exterior of the probe, use a soft cloth moistened with either distilled water or isopropyl alcohol. Before using the probe again, make sure to dry it completely.

NOTICE

Device damage caused by cleaning agents

Cleaning agents contain substances that can damage the device; for example, solvent can damage the labeling or plastic parts.

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

NOTICE

Device damage caused by static electricity

Before cleaning the facing surfaces of the sensor head, discharge any static electricity at your hands. Thus you ensure that a high voltage caused by static electricity is not applied to the device. Application of a high voltage to the device can damage the internal Hall elements or circuitry. Static electricity at your hands can have built up by touching a nearby metal object.

4.4 Calibration Interval

The recommended calibration interval for R&S RT-ZVC multi-channel 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 4.2, "Returning the Probe for Servicing", on page 35).

4.5 Discarding the Probe

Handle and dispose the probe in accordance with local regulations.

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