

R&S® RT-ZS10/10E/20/30 Active Voltage Probe User Manual



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Version 08

ROHDE & SCHWARZ

Make ideas real



This user manual describes the following R&S®RT-ZS models and options:

- R&S®RT-ZS10 (1410.4080.02)
- R&S®RT-ZS10E (1418.7007.02)
- R&S®RT-ZS20 (1410.3502.02)
- R&S®RT-ZS30 (1410.4309.02)

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1410.3531.02 | Version 08 | R&S®RT-ZS10/10E/20/30

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol, e.g. R&S®RT-ZS10/20/30 is indicated as R&S RT-ZS10/20/30, and R&S®ProbeMeter is indicated as R&S ProbeMeter.

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1 Safety and regulatory information

The product documentation helps you to use the product safely and efficiently. Follow the instructions provided here and throughout the manual.

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 data sheet.

The R&S RT-ZS10/20/30 active voltage probe is designed for measurements on circuits that are only indirectly connected to the mains or not connected at all. It is not rated for any measurement category.

The probe is designed for usage with oscilloscopes that have a Rohde & Schwarz probe interface. Supported Rohde & Schwarz oscilloscopes are listed in the probe's data sheet.

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 as printed "Safety Instructions". 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.

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 data

sheet, manuals and the printed "Safety Instructions for Oscilloscopes and Accessories" document. If you are unsure about the appropriate use, contact Rohde & Schwarz customer service.

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 data sheet. 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 service 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 data sheet, 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 data sheet.

Performing measurements

Take the following measures for your safety:

- To ascertain 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 data sheet.
- 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 data sheets.

Labels on the product

Consider that the rated voltage depends on the frequency. The voltage limitation curves or values are provided in the data sheet.

- 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 data sheet. 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.
- The probe pins are extremely pointed and can easily penetrate clothes and the skin. Handle the probe pins with great care. To exchange a probe pin, use tweezers or pliers to avoid injuries. When transporting the accessories, always use the box supplied with the probe.
- 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

	<p>Potential hazard Read the product documentation to avoid personal injury or product damage.</p>
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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

2.1 Key features and key characteristics

The R&S RT-ZS10/20/30 is a single-ended active voltage probe with high input impedance. It is used for ground-referenced voltage measurements from DC to 1.0 GHz, 1.5 GHz and 3 GHz, respectively.

The comprehensive accessory set allows this probe to be connected to a wide variety of devices under test (DUT). Provided with special features such as the R&S ProbeMeter and the micro button, the R&S RT-ZS10/20/30 is designed to meet tomorrow's challenges in probing.

The probe is equipped with the Rohde & Schwarz probe interface. It can be connected to any Rohde & Schwarz instrument that is compatible with this interface. When connected to the front panel, the probe is controlled by the oscilloscope's software. Supported oscilloscopes are listed in the data sheet.

Using a special adapter, the probe can also be connected to any other base unit (see [Chapter 2.4.2, "Optional accessories"](#), on page 16).

2.1.1 Key characteristics

The key characteristics of the probe are the following:

Bandwidth	DC to 1 GHz (R&S RT-ZS10) DC to 1.5 GHz (R&S RT-ZS20) DC to 3 GHz (R&S RT-ZS30)
Dynamic range	± 8 V with ± 12 V offset capability 16 V AC (V_{pp})
Maximum non-destructive input voltage	± 30 V
Input resistance	1 M Ω
Input capacitance	0.8 pF
R&S ProbeMeter, measurement error	<0.1 %
Extremely low zero and gain errors throughout the entire temperature range, no significant temperature drift	

Micro button
Rohde & Schwarz probe interface

2.1.2 Key features

Micro button

The micro button remotely controls important functions of the Rohde & Schwarz oscilloscope. The function is assigned at the oscilloscope.

For details, see [Chapter 4.3, "Micro button"](#), on page 29.

R&S ProbeMeter

The R&S ProbeMeter measures the DC voltage of the input signal directly at the probe tip. It provides a continuous high-precision DC voltage measurement that is independent of the settings of the oscilloscope and runs in parallel to the time domain measurement. If activated on the base unit, the measured value is displayed on the screen of the Rohde & Schwarz oscilloscope.

For details, see [Chapter 4.4, "R&S ProbeMeter"](#), on page 29.

Data memory

The probe has an integrated data memory, containing the individual probe correction parameters (e.g. gain, delay, offset). These parameters are read out and processed by the Rohde & Schwarz oscilloscope. As a result, the probe offers a high degree of accuracy, and additional calibration procedures are not required.

2.1.3 R&S RT-ZS10E

The R&S RT-ZS10E probe is a cost-efficient alternative to the R&S RT-ZS10 probe. The electrical specifications of both probes are identical. The two probes are of the same high quality, for example, in terms of frequency response, dynamic range, input resistance, input capacitance and zero and gain error. In contrast to the R&S RT-ZS10, the R&S RT-ZS10E has a limited range of accessories, and does not offer offset compensation, micro button and R&S ProbeMeter. The R&S RT-ZS10E is ideally suited for customers who value the high signal fidelity of Rohde & Schwarz probes, and who do not need a large set of accessories and additional functions.

Unpacking and checking

In the following, the R&S RT-ZS10E and the R&S RT-ZS10 are equivalent, with the following exceptions:

- The R&S RT-ZS10E does not come with a carrying case or its contents.
- The R&S RT-ZS10E does not offer the offset compensation, micro button and R&S ProbeMeter functions.
- The R&S RT-ZS10E has only a limited set of accessories.

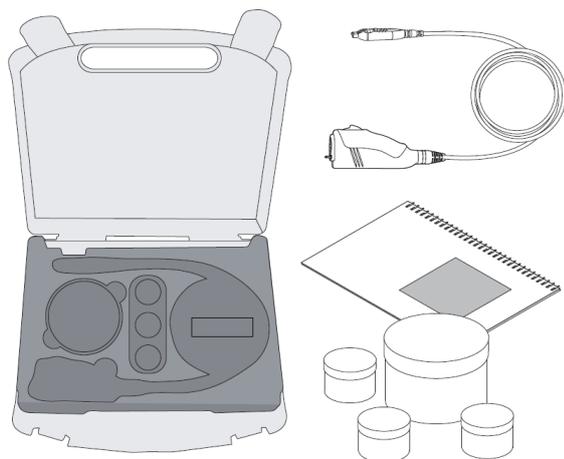
2.2 Unpacking and checking

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

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

Delivery notes

The delivery contains the following items:

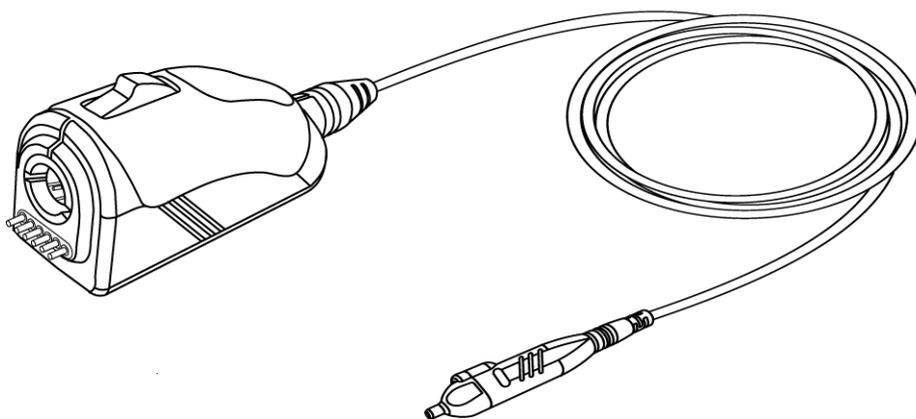


- R&S RT-ZS10/20/30 active voltage probe
- Carrying case
- Accessory boxes
- User manual
- Data sheet
- Calibration certificate
- Documentation of calibration values (if ordered)
- Safety instructions for oscilloscopes and accessories (multilingual)

Accessories supplied with the probe are listed in [Chapter 2.4.1, "Accessories supplied"](#), on page 15.

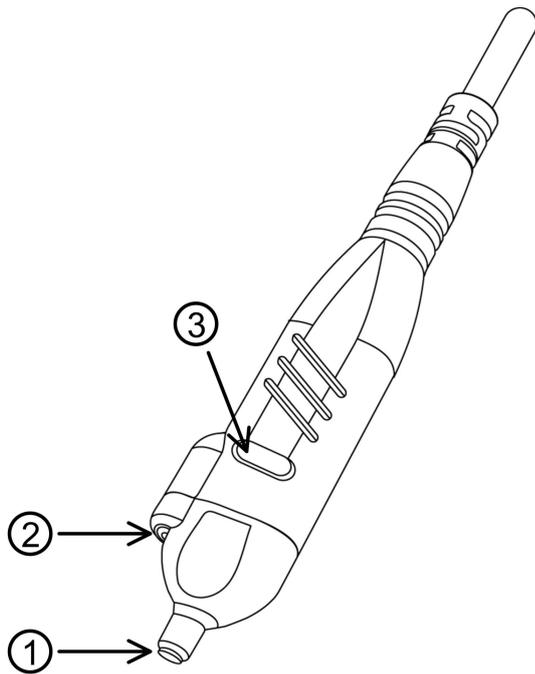
2.3 Description of the probe

The probe consists of the probe head for connection to the DUT, the probe box for connection to the oscilloscope, and the probe cable.



2.3.1 Probe head

The small and lightweight probe head is designed for easy handling and high-performance measurements. The probe head is used for connecting the probe and the DUT. Different accessories for the signal and ground sockets allow the probe head to be connected to a wide range of DUTs.



- (1) Signal socket
- (2) Ground socket
- (3) Micro button

The accessories supplied for the probe head sockets are listed in [Chapter 2.4.1, "Accessories supplied"](#), on page 15.

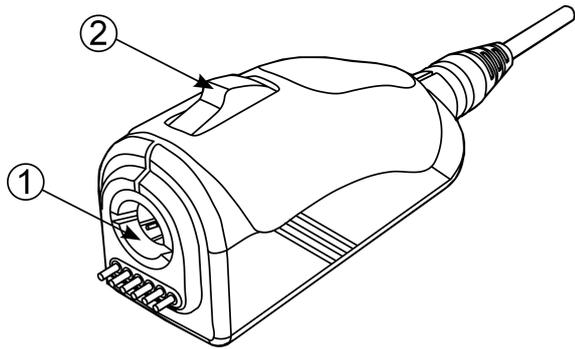
Signal and ground sockets are compatible with 0.64 mm (25 mil) square pins and 0.6 mm to 0.8 mm (24 mil to 35 mil) round pins.

2.3.2 Probe box

The probe box connects the probe and the oscilloscope via the Rohde & Schwarz probe interface. The Rohde & Schwarz probe interface contains a male precision 7 mm (276 mil) BNC connector and six pogo pin connectors. This interface provides the required supply voltage and is also used to transmit analog signals and digital data simultaneously. All the analog voltages required by the probe are generated in the probe box.

The BNC connector is a precision component designed to reach a much higher frequency limit when connected to an instrument with Rohde & Schwarz probe interface.

Connect the probe only to an instrument with Rohde & Schwarz probe interface. Never connect it to a usual BNC jack, because this can damage the probe interface.



- (1) Rohde & Schwarz probe interface with 7 mm (276 mil) coaxial connector and 6 pogo pins
- (2) Release knob

2.4 Accessories and items

The figure below shows all accessories that are available for the R&S RT-ZS10/20/30 active voltage probe.

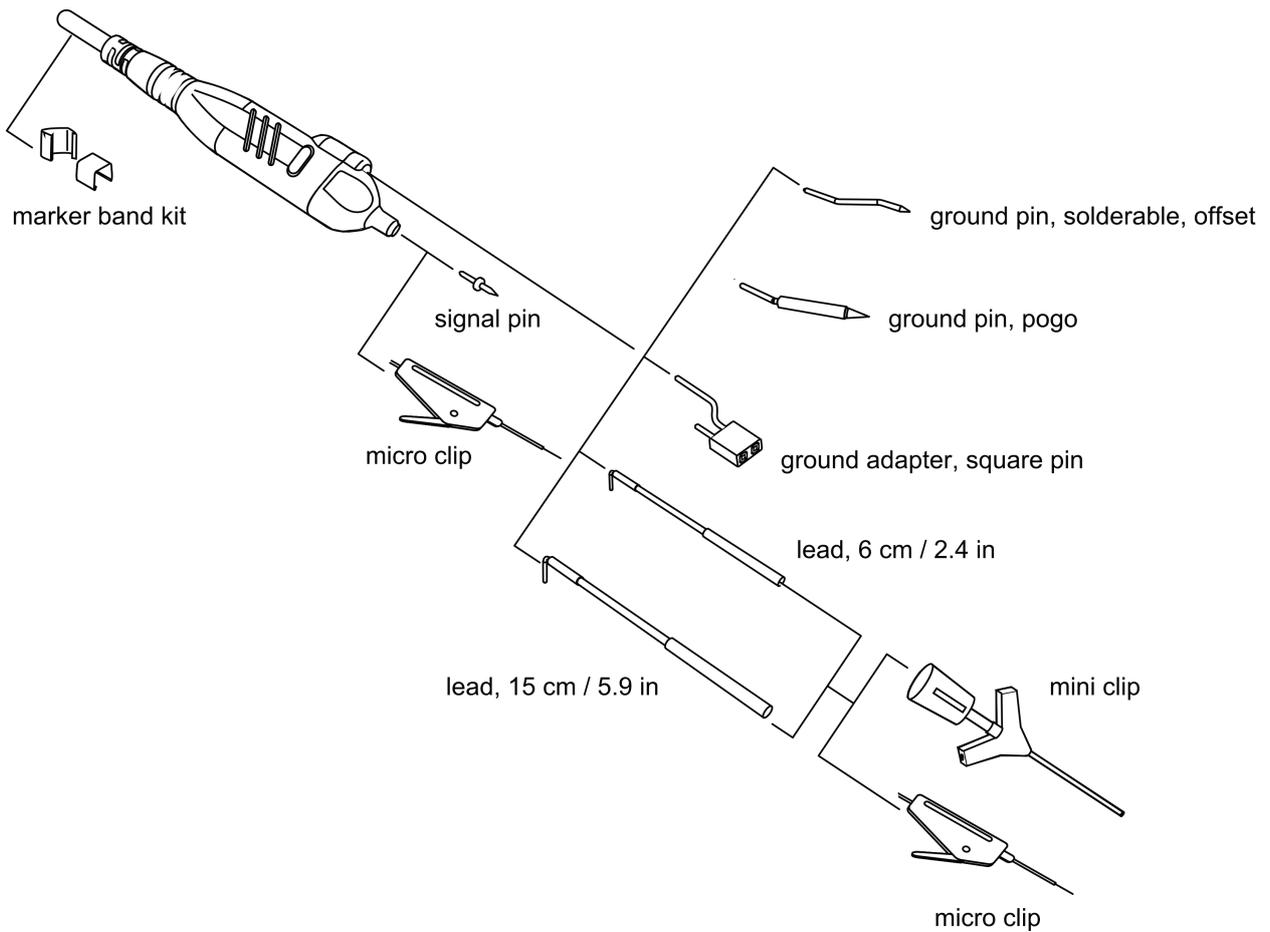
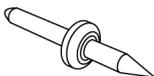
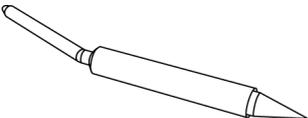
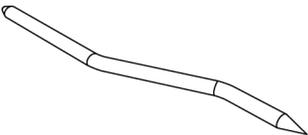
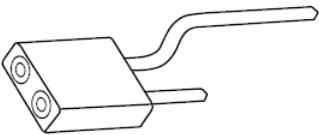
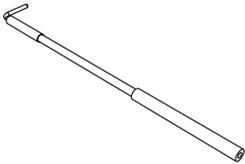
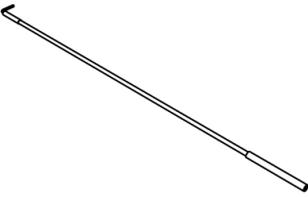
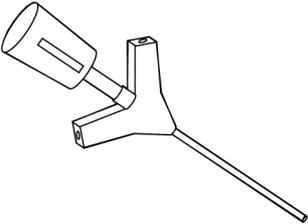


Figure 2-1: Available accessories

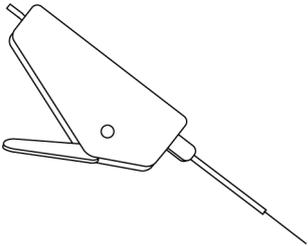
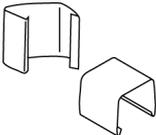
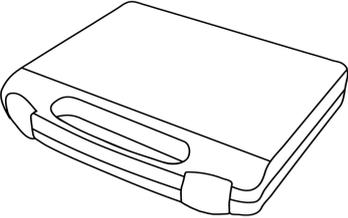
2.4.1 Accessories supplied

The following table shows the accessories supplied with the R&S RT-ZS10/20/30 active voltage probe.

Table 2-1: Accessories supplied

Item	Quantity		Description
	ZS10/20/30	ZS10E	
	10	5	Signal pin
	5	2	Ground pin, pogo
	10	2	Ground pin, solderable, offset
	2	-	Ground adapter, square pin
	2	-	Lead, 6 cm / 2.4 in
	2	1	Lead, 15 cm / 5.9 in
	2	1	Mini clip

Accessories and items

Item	Quantity		Description
	2	-	Micro clip
	1	1	Marker band kit
	1	-	Carrying case with foam inlay

For a list of spare parts, see [Chapter 5.7, "Spare parts"](#), on page 44.

2.4.2 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 data sheet.

Table 2-2: Optional accessories

Accessories	Items	Quantity
R&S RT-ZA2 spare accessory set Contains all accessories that are supplied with the R&S RT-ZS10/20/30.	Signal pin	10
	Ground pin, pogo	5
	Ground pin, solderable, offset	10
	Ground adapter, square pin	2
	Marker band kit	1
	Mini clip	2
	Micro clip	2
	Lead, 6 cm / 2.4 in	2
	Lead, 15 cm / 5.9 in	2
	Accessory box and vials	1
	Carrying case with foam inlay	1
	R&S RT-ZS10/20/30 User Manual	1
	R&S RT-ZA3 pin set	Signal pin
Ground pin, pogo		5
Ground pin, solderable, offset		20
Ground adapter, square pin		2
Marker band kit		1

Table 2-3: Optional clips and leads

Accessories	Items	Quantity
R&S RT-ZA4 mini clips	Mini clip	10
R&S RT-ZA5 micro clips	Micro clip	4
R&S RT-ZA6 lead set	Lead, 6 cm / 2.4 in	5
	Lead, 15 cm / 5.9 in	5

Table 2-4: Optional adapters

Accessories	Items	Quantity
	<p>R&S RT-ZA9 probe box to N / USB adapter</p> <p>The adapter connects the R&S RT-ZS10/20/30 active voltage probe to any other oscilloscope or any other measurement instrument (e.g. a network or spectrum analyzer).</p> <p>Using the USB interface of the adapter, the probe can be powered and controlled from any conventional PC. However, full software functionality is only provided by the supported oscilloscopes (see data sheet).</p>	1
	<p>R&S RT-ZA50 probe interface extender</p> <p>The adapter is a breakout box that leads out the R&S probe interface to the following standard connectors: USB-C for power and control, SMA for signal and DC jack for auxiliary supply.</p> <p>Together with the R&S RT-ZA51 probe to 3.5 mm adapter, it moves the R&S probe interface closer to your test setup.</p>	1
	<p>R&S RT-ZA51 probe to 3.5 mm adapter</p> <p>The probe adapter has an R&S probe interface and standard connectors USB-C, 3.5 mm and DC jack. Using this adapter, you can power and control your Rohde & Schwarz probe without an appropriate Rohde & Schwarz oscilloscope.</p> <p>Together with the R&S RT-ZA50 probe to 3.5 mm adapter, it moves the R&S probe interface closer to your test setup.</p>	1

2.4.3 Service accessories

To order accessories for servicing the probe, contact your Rohde & Schwarz service center. The following accessories are available:

Table 2-5: Service accessories

Item	Description
R&S RT-ZK1	The service kit is used to calibrate the probe, to do performance tests, and for servicing. The service kit includes all adapters and accessories to connect the probe to the required measuring instruments.
R&S RT-ZS10/20/30 Service Manual	The service manual contains a detailed description of the performance test to verify the specifications, and other important service procedures.

3 Connecting the probe

3.1 Handling the probe

The R&S RT-ZS10/20/30 can withstand a moderate amount of physical and electrical stress. To avoid damage, treat the probe with care:

- Handle the probe by the probe head.
- Prevent the probe from receiving mechanical shock.
- Avoid strain on the probe cable and route it carefully.
- Do not spill liquids on the probe.

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 probe clips before you connect them.

3.2 Connecting the probe to the oscilloscope

The probe is designed for usage with oscilloscopes that have a Rohde & Schwarz probe interface. Supported Rohde & Schwarz oscilloscopes are listed in the probe's data sheet.

- ▶ **NOTICE!** Risk of damaging the probe.
Connect the probe only to an instrument with Rohde & Schwarz probe interface. Never connect it to a usual BNC jack, because this can damage the probe interface.

Identification of the probe

Connect the probe box (1) to the Rohde & Schwarz probe interface of the oscilloscope (2).

The probe snaps in when connected properly to the port.

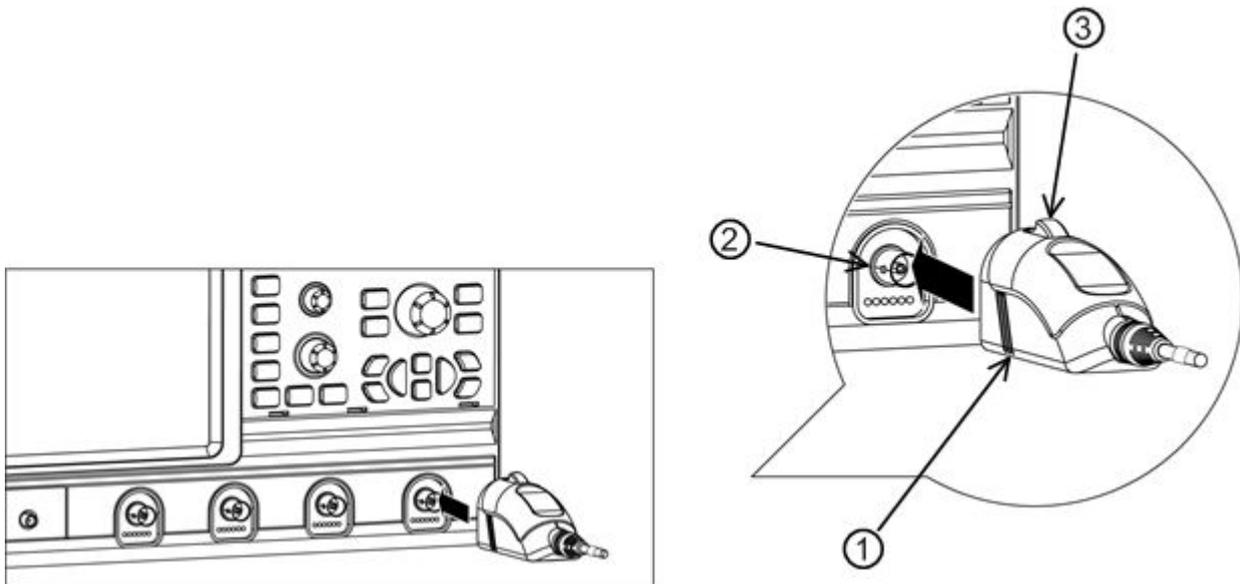


Figure 3-1: Connecting the probe to the Rohde & Schwarz oscilloscope

- ▶ To disconnect the probe:
 - a) Press and hold the release button (3).
 - b) Pull the probe box away from the oscilloscope.

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

3.3 Identification of the probe

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

The oscilloscope settings for attenuation and offset are automatically adjusted. After the probe is connected to the oscilloscope and the settings are adjusted, the waveform is shown for the channel to which the probe is connected.

Connecting the probe to the DUT

The complete probe information is shown in the probe settings dialog. For more information, refer to the user manual of your oscilloscope.

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.

Handling the accessories

- The maximum non-destructive input voltage is ± 30 V. A higher input voltage can destroy the probe and the accessories.
- The probe pins are extremely pointed and can easily penetrate clothes and the skin. Handle the probe pins with great care. To exchange a probe pin, use tweezers or pliers to avoid injuries.
- Always keep the connections as short as possible for best performance and signal integrity.
- When transporting the accessories, use the boxes supplied with the probe.

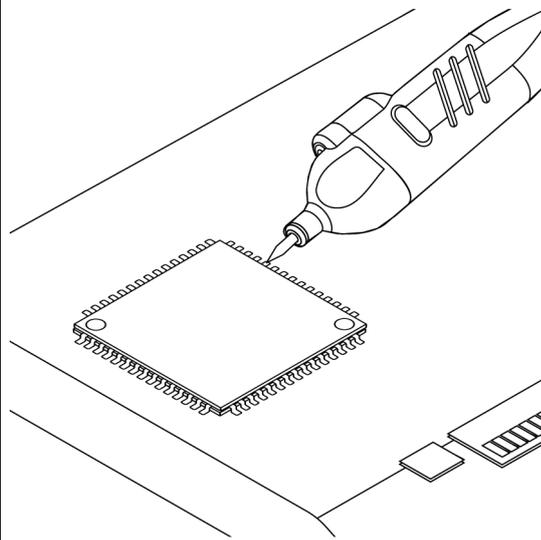
Considerations for soldering

- 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.

Connecting the probe to the DUT

Pins

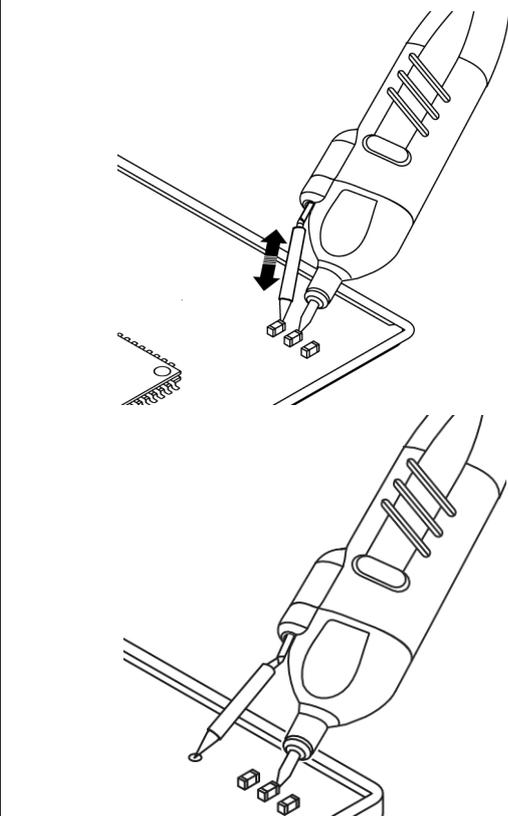
Signal pin



The signal pin is held to the DUT to tap off the measurement signal. It fits into the signal socket and is designed for various applications, e.g. measurements on SMT resistors, IC pins, conductors or vias.

If necessary, the signal pin can also be soldered to the DUT.

Ground pin, pogo



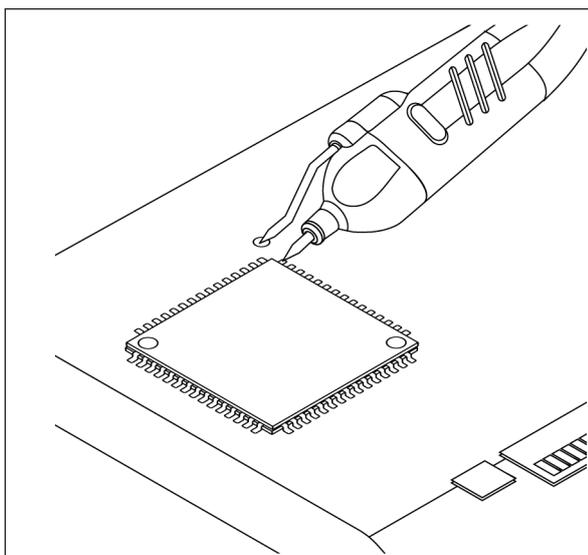
The spring-loaded ground pin allows handheld probing. Because this ground pin compensates for minor unevenness and movements, it can establish a firm contact with the test point. It fits into the ground socket of the probe head.

The distance to the signal pin can be varied by turning the ground pin.

Distance range: 0 mm to 10 mm (0 mil to 400 mil)

Ground pin, solderable, offset

Connecting the probe to the DUT



The rigid ground pin is soldered to a test point on the DUT and provides a reliable and permanent connection to the DUT.

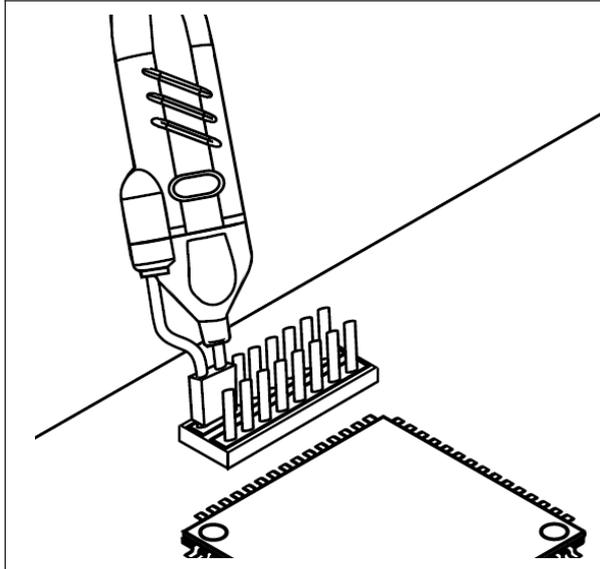
To protect the solder joint from excessive mechanical stress, stabilize the soldered probe, for example, with adhesive tape or probe positioner.

The distance to the signal pin can be varied by turning the ground pin.

Distance range:

2.54 mm to 8 mm (100 mil to 315 mil)

Ground adapter, square pin



The ground adapter is used for plugging the probe onto pin strips with 0.64 mm square pins (typical pitch 2.54 mm, 100 mil).

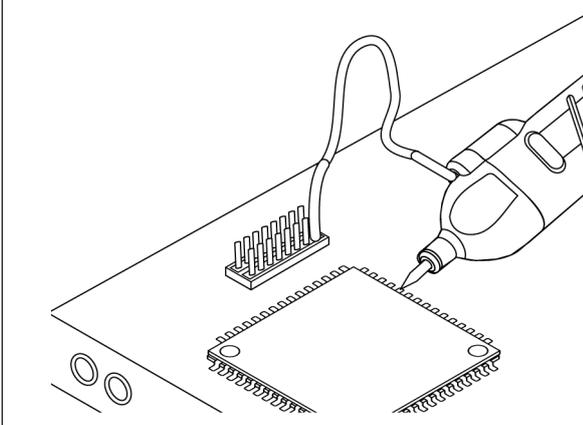
The adapter is plugged onto the ground and signal socket of the probe.

Distance: 2.54 mm (100 mil)

Connecting the probe to the DUT

Leads

Short and long lead



The lead provides a flexible connection to the DUT. It is plugged onto a pin on the DUT and can be used to connect either the signal socket or the ground socket. In addition, it allows micro and mini clips to be connected to the probe.

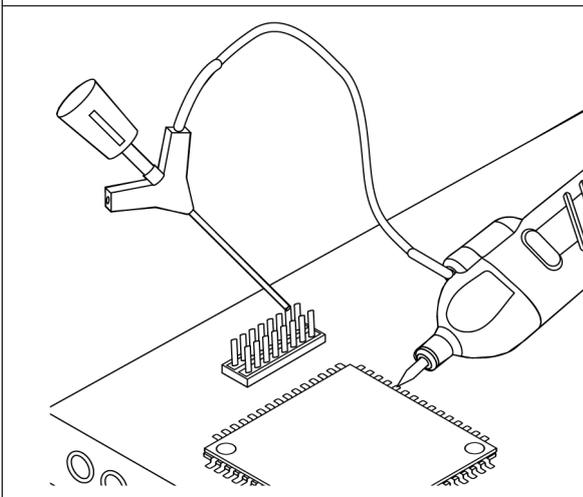
Length:

Short lead: 6 mm (236 mil)

Long lead: 15 mm (591 mil)

Clips

Mini clip

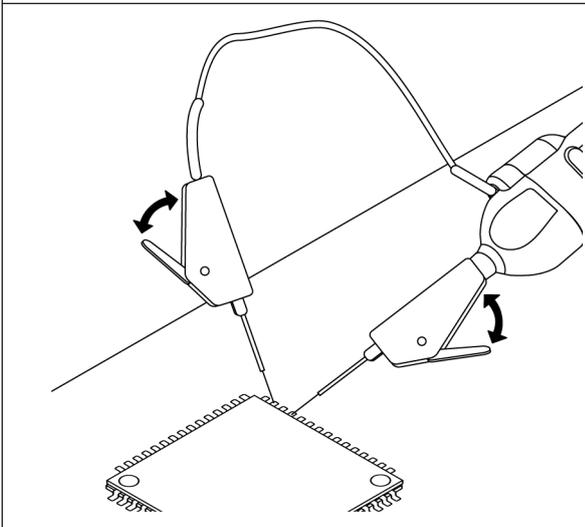


The mini clip is designed for probing large IC pins, wires and through-hole components.

For probing, clamp the mini clip to a pin and connect it to the signal socket or the ground socket using a lead.

Connecting the probe to the DUT

Micro clip



The micro clip is designed for probing IC pins and thin wires in fine-pitch applications.

The micro clip fits directly into the signal socket or the ground socket using a lead.

4 Features and characteristics of active voltage probes

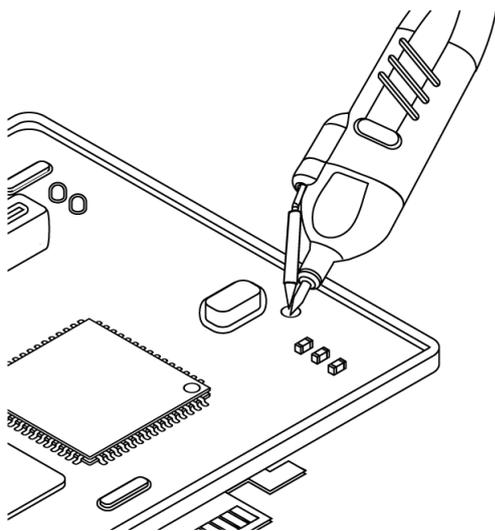
4.1 Zero adjustment

The zero error can impair the measurement results, therefore, correct the zero error if necessary. The zero error of the probe itself is very small.

However, differences in DUT and oscilloscope ground levels can cause larger zero errors visible on the oscilloscope's screen. If the DUT is not floating but ground-referenced, a zero adjustment improves the measurement results.

The zero error is corrected at the oscilloscope. Depending on the type of the used oscilloscope, correction is done automatically using the AutoZero function, or manually ("Zero Adjust" or similar setting). Refer to the oscilloscope's user manual for available functionality and its usage.

1. Connect the probe to the oscilloscope.
2. Set the oscilloscope to the smallest vertical scale.
3. Short the signal pin and the ground pin together and connect them to the ground of the DUT.



- Adjust the zero position of the waveform using the appropriate function of the oscilloscope ("AutoZero", "Zero Adjust" or similar).

The waveform is set to 0 V on the horizontal centerline of the oscilloscope.

4.2 Offset compensation

The offset compensation function can compensate a DC component of the input signal, even in front of the active amplifier in the probe tip. As a result, the entire dynamic range of the probe is maintained. This function is useful when measuring AC signals with high superimposed DC component.

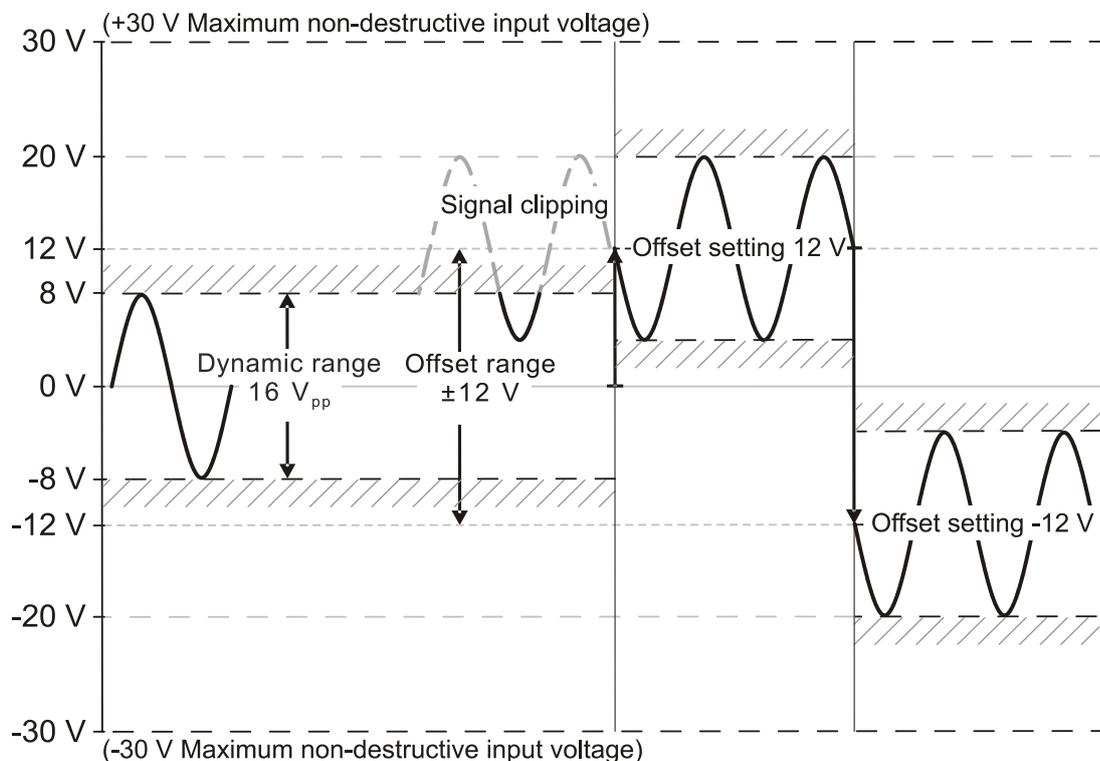


Figure 4-1: Offset compensation voltage and dynamic range

There are several ways to set the offset compensation:

- Use the vertical knob at the oscilloscope if its function is set to offset.
- Enter the offset value in the channel settings or probe settings on the Rohde & Schwarz oscilloscope.

- Use the micro button to measure input signals with different DC offsets: assign "Offset to mean" to the micro button. See also [Chapter 4.3, "Micro button"](#), on page 29.

For more details, see the oscilloscope's user manual.

4.3 Micro button

The micro button provides easy and quick access to important functions of the Rohde & Schwarz oscilloscope. After a function has been assigned, pressing the micro button remotely controls this specific function on the base unit. For example, "Run continuous" or "Run single" are often assigned to the micro button.

The configuration of the micro button is part of the probe settings of the channel to which the probe is connected. For more details, see the oscilloscope's user manual.

4.4 R&S ProbeMeter

The R&S ProbeMeter is an integrated voltmeter that measures DC voltages with higher precision compared to the oscilloscope's DC accuracy. The DC voltage is measured continuously and runs parallel to the time domain measurement of the oscilloscope.

High-precision measurements are achieved by immediate digitization of the measured DC voltage at the probe tip.

When the R&S ProbeMeter is active, the measured values are displayed on the oscilloscope. The R&S ProbeMeter state is part of the probe settings of the channel to which the probe is connected. For details, refer to the user manual of the Rohde & Schwarz oscilloscope.

Advantages of the R&S ProbeMeter:

- Measures DC voltages of different levels, no need to adjust the measurement range of the oscilloscope.
- True DC measurement (integration time > 100 ms), not mathematical average of displayed waveform.
- High measurement accuracy and low temperature sensitivity.

- Simple means of setting the oscilloscope's trigger level and vertical scaling if a waveform is not visible.
- Independent of oscilloscope settings for position, vertical scale, horizontal scale, and trigger.
- Measurement range $\pm 8\text{ V}$ + offset compensation setting. Maximum measurement accuracy is achieved when offset compensation is switched off.

The R&S ProbeMeter enables the ground-referenced measurement of voltages. A difference in the ground levels of oscilloscope and DUT can cause an unwanted zero error. In this case, correct the zero error, see [Chapter 4.1, "Zero adjustment"](#), on page 27.

4.5 Measurement principles

The R&S RT-ZS10/20/30 active voltage probe provides an electrical connection between the DUT and the oscilloscope. The probe transfers the voltage of the electrical signal tapped off the DUT to the oscilloscope, where it is displayed graphically. Although a probe has a wide variety of specifications, these specifications can be grouped into two classes of basic requirements:

- High signal integrity of the transferred signal:
With an ideal probe, the output signal that is transferred to the base unit is identical to the input signal between the probe tips, and signal integrity is extremely high. Every real probe, however, transfers the input signal in altered form. A good probe causes only minimum alterations.
How the probe can fulfill this requirement is mainly determined by its bandwidth.
- Low loading of the input signal:
Every probe is a load for the signal to be measured. The signal to be measured changes when the probe is connected. A good probe causes only a minimum change to the signal, so that the function of the DUT is not adversely affected.
How the probe can fulfill this requirement is mainly determined by its input impedance.

The parameters of a probe are usually specified for a minimally short connection between the probe and the DUT. With longer connections, the connection inductance has a significant effect on the measurement.

The high-frequency behavior of active probes is typically characterized in a 50 Ω measurement environment. The probe is connected to a 50 Ω line that is fed by a source with 50 Ω internal impedance and that is terminated into 50 Ω .

The [Figure 4-2](#) shows the equivalent circuit model of a probe that is connected to the DUT.

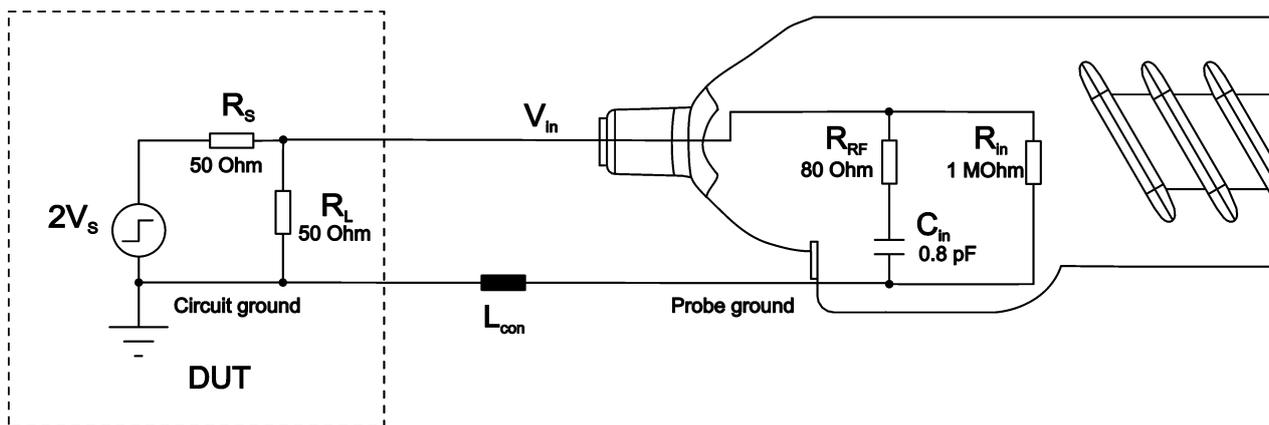


Figure 4-2: Equivalent circuit model of the R&S RT-ZS10/20/30 probe

Table 4-1: Designations

Abbreviation	Description
V_s	Voltage at the test point without probe connected
V_{in}	Voltage at the test point with probe connected, corresponds to the input voltage of the probe
R_s	Source resistance of the DUT
R_L	Load resistance of the DUT
R_{in}	DC input resistance
C_{in}	Input capacitance of the probe
R_{RF}	RF input resistance of the probe
L_{con}	Parasitic inductance of the ground connection

In a 50 Ω system, the output resistance of the source, the load resistance and the characteristic impedance of all lines equal exactly 50 Ω . However, the behavior of the probe in the circuit is determined by the effective source impedance which is the impedance present in the DUT between the probe tip and ground.

Effective source impedance:

$$R'_S = R_S \parallel R_L = 25\Omega$$

4.5.1 Signal integrity of the transferred signal

The following sections describe the effect that bandwidth and connection inductance have on signal integrity.

4.5.1.1 Bandwidth

The bandwidth BW of a probe is one of its specific parameters. The bandwidth of the probe and the bandwidth of the base unit together form the system bandwidth. The following explanations refer to the probe itself, but can also be applied to the entire system.

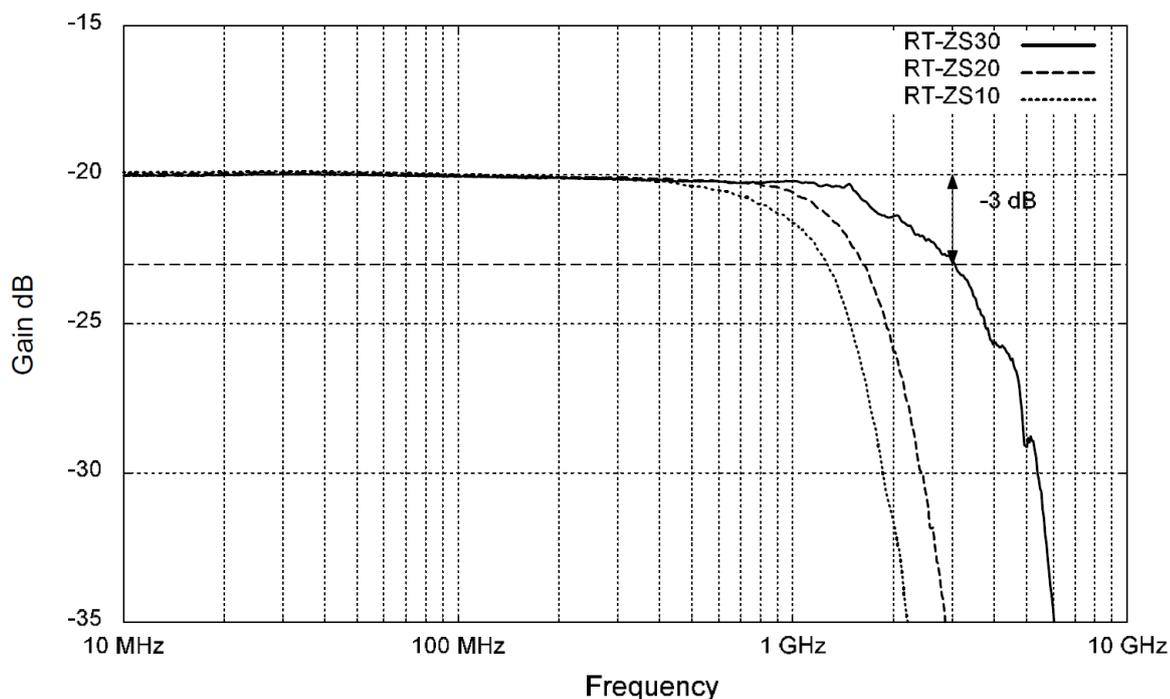


Figure 4-3: Amplitude/frequency response of the R&S RT-ZS10/20/30

The bandwidth:

- Specifies the maximum frequency at which a purely sinusoidal signal is still transferred at 70 % (–3 dB) of its amplitude.

- Specifies the transferable spectrum for other waveforms. E.g., with square wave signals, the fifth harmonic should still be within the bandwidth for a high signal integrity.
- Determines the minimum measurable signal rise time. The rise time t_{rise} of the probe is inversely proportional to its bandwidth. The following approximation applies:

$$t_{rise} \approx \frac{0.4}{BW}$$

In addition to bandwidth, a constant amplitude/frequency response of the probe is decisive for high signal integrity. The [Figure 4-3](#) shows the typical amplitude/frequency response of an R&S RT-ZS10/20/30 active voltage probe. All frequency components are transferred with the same gain so that the input signal is displayed without distortion.

The [Figure 4-4](#) shows a typical step response of an R&S RT-ZS10/20/30 active voltage probe.

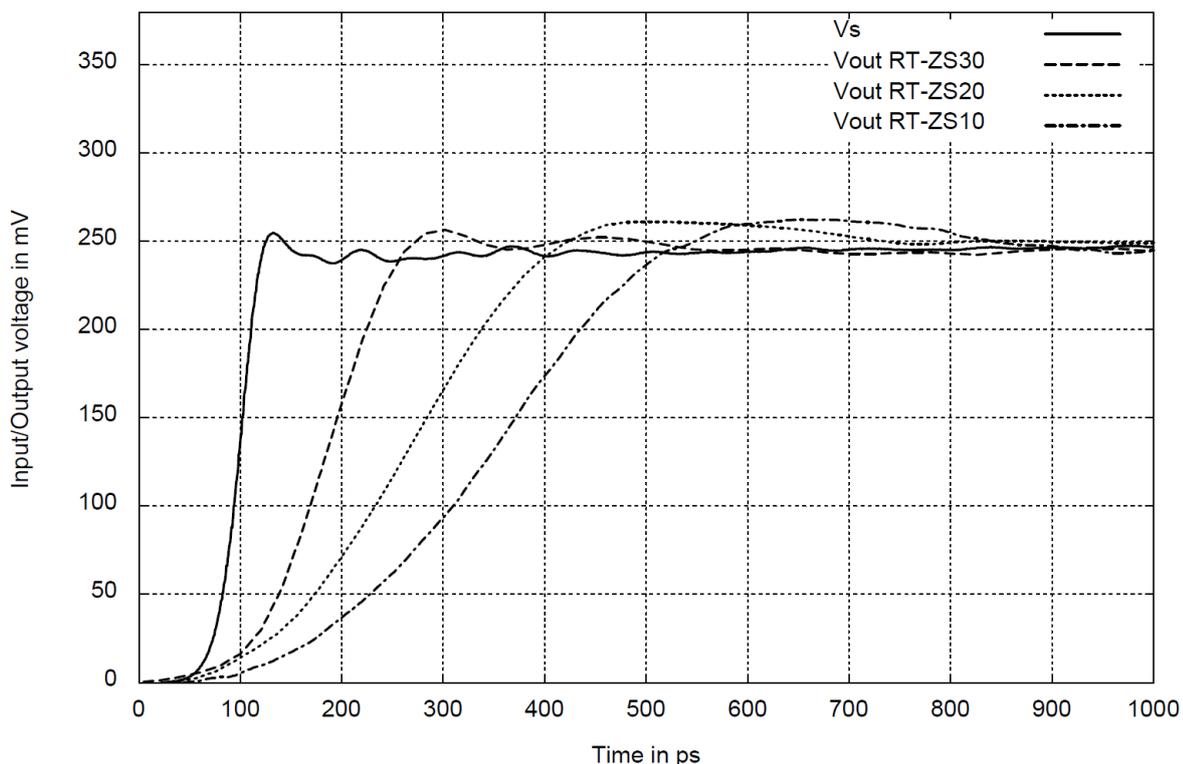


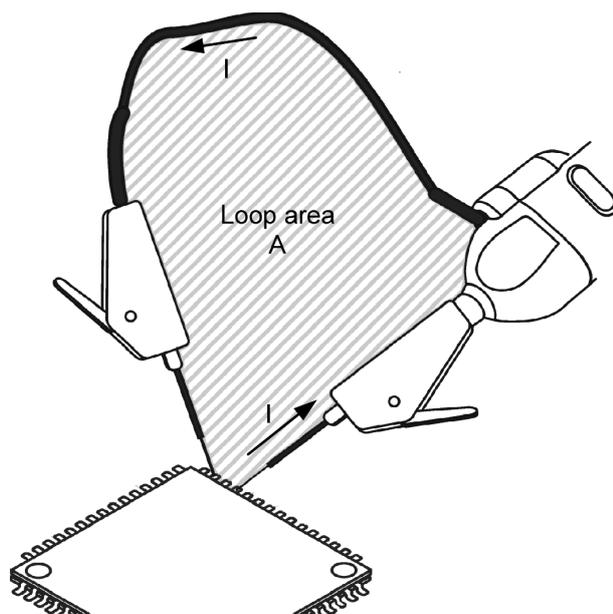
Figure 4-4: Step response of the R&S RT-ZS10/20/30

4.5.1.2 Connection inductance

The connection inductance L_{con} is caused by connecting the probe to the DUT. In contrast to the probe-specific bandwidth, the connection inductance mainly depends on the selected type.

The connection inductance:

- Increases with the length of the connection and the size of the resulting loop area A .
See [Figure 4-5](#).
- Reduces the usable bandwidth and causes ringing with signals having a short rise time, due to a series resonance with the input capacitance.
- Must be as small as possible (short lead length) to maintain high signal integrity.
- Long leads on the signal input are especially problematic.



$$L_{con} \text{ proportional to } A$$

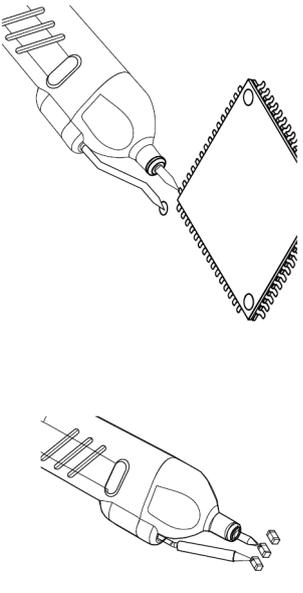
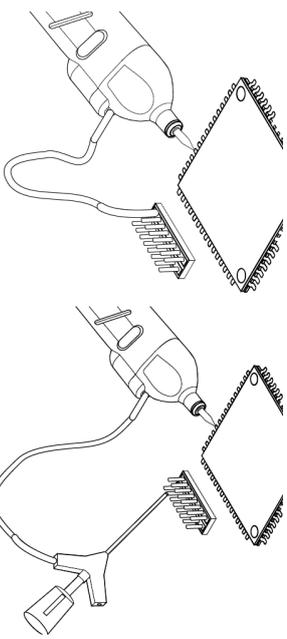
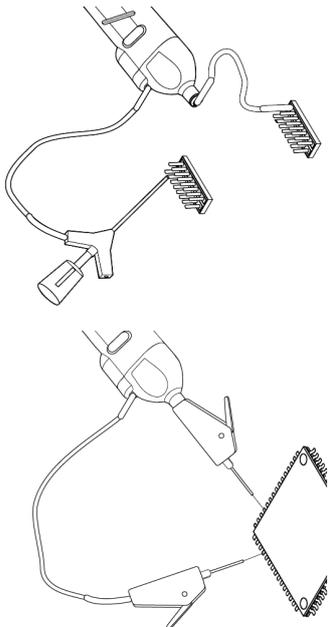
$$f_{resonance} \approx \frac{1}{2\pi\sqrt{L_{con} \cdot C_{in}}}$$

$$BW \text{ proportional to } \frac{1}{\sqrt{L_{con}}}$$

Figure 4-5: Ground connection and connection inductance

The following [Table 4-2](#) shows different types of connection between probe and DUT as well as the associated connection inductance L_{con} and the step responses.

Table 4-2: Connection inductance L_{con} and resulting bandwidth with different types of connection

No	Type of connection	Connection		Connection inductance L_{con}	Resulting bandwidth	Rise time
		Signal socket	Ground socket			
1.		Signal pin	Ground pin	~4 nH	RT-ZS10: 1.0 GHz RT-ZS20: 1.5 GHz RT-ZS30: 3.0 GHz	RT-ZS10: < 350 ps RT-ZS20: < 250 ps RT-ZS30: < 135 ps
2.		Signal pin	Ground lead	~20 nH	RT-ZS10: 1.0 GHz RT-ZS20: 1.2 GHz RT-ZS30: 1.3 GHz	RT-ZS10: < 400 ps RT-ZS20: < 300 ps RT-ZS30: < 270 ps
3.		Clip / Lead	Ground lead	~60 nH	700 MHz	> 1 ns

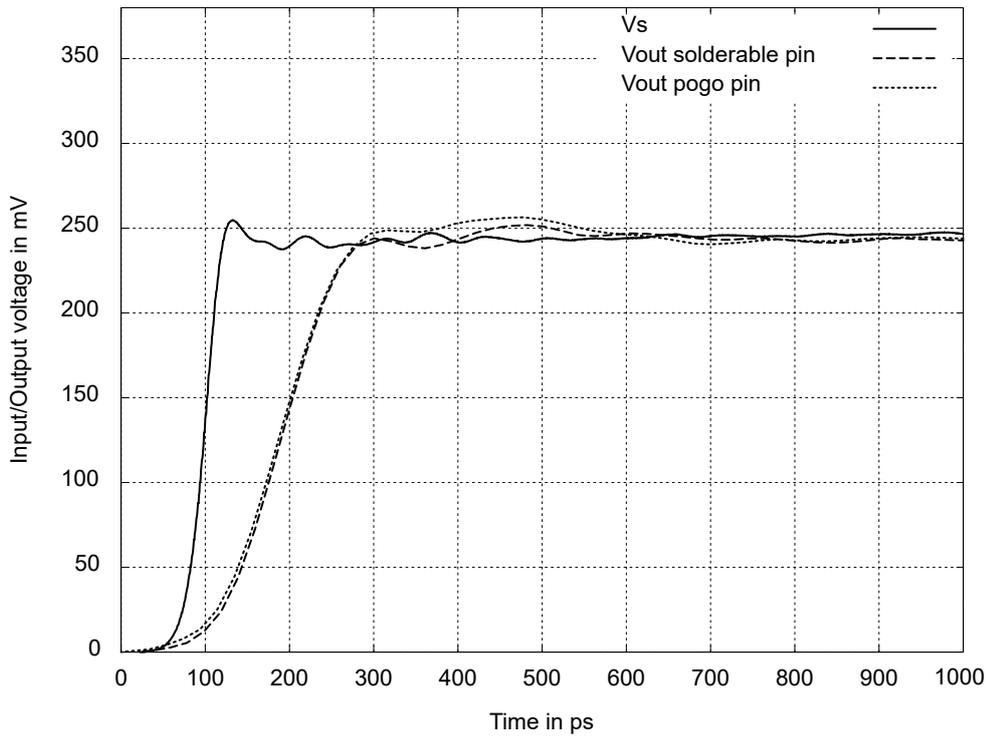


Figure 4-6: Step response of the R&S RT-ZS30 with a type 1 connection

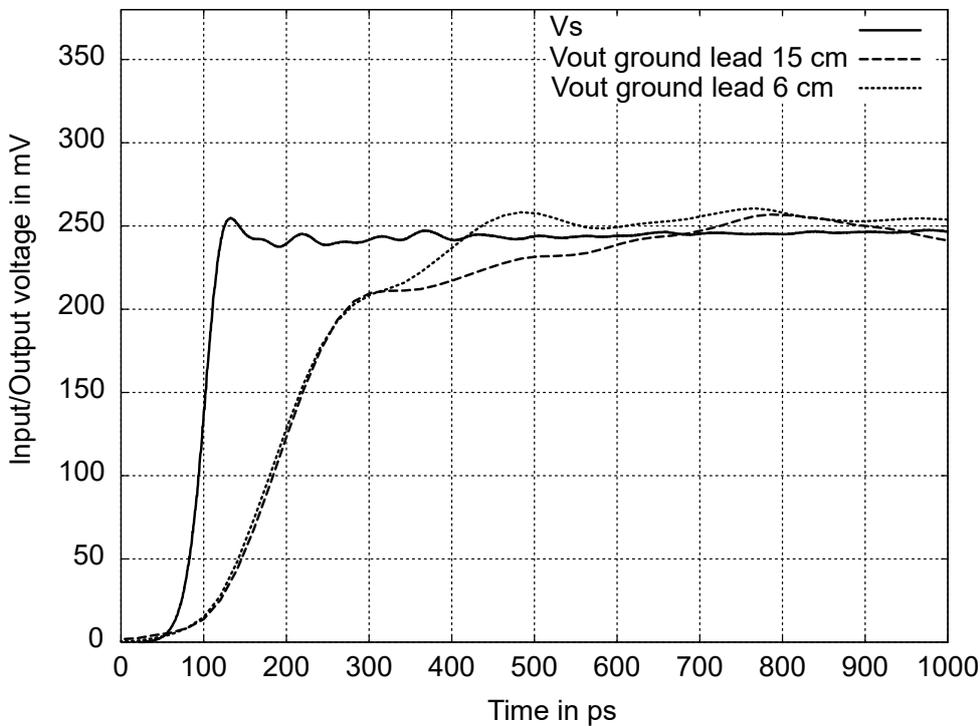


Figure 4-7: Step response of the R&S RT-ZS30 with a type 2 connection

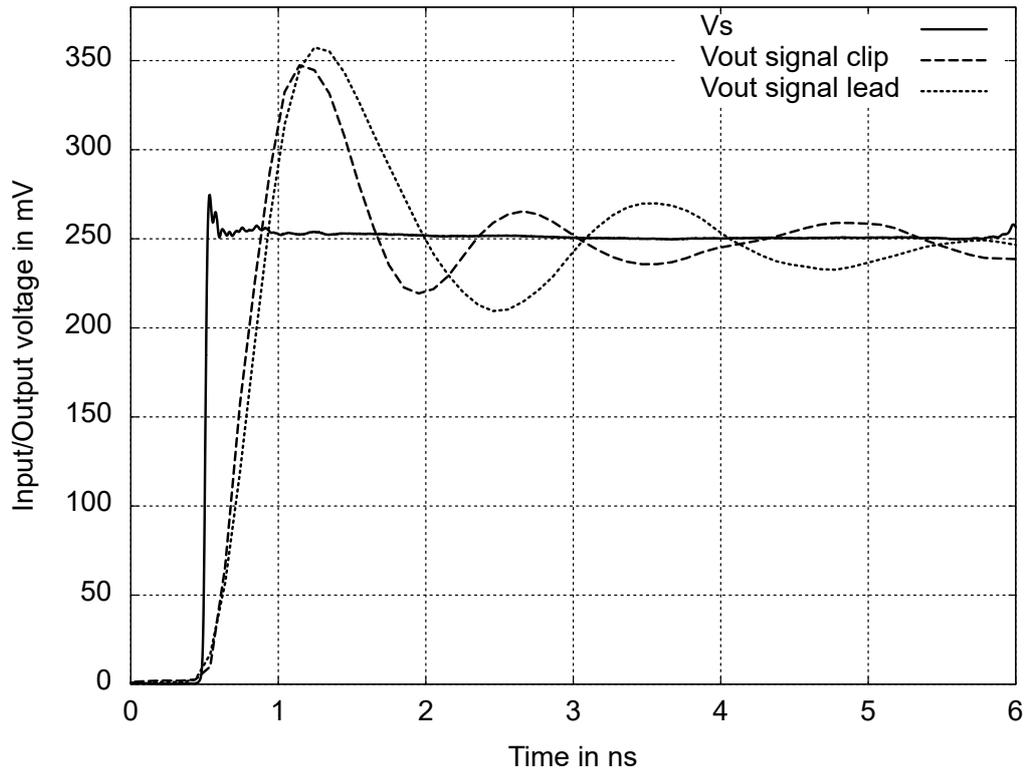


Figure 4-8: Step response of the R&S RT-ZS30 with a type 3 connection

4.5.2 Signal loading of the input signal

The previous section dealt with the transfer function and step response of the probe. This section describes how the probe influences the input signal.

4.5.2.1 Input impedance

The input signal loading caused by the probe is determined by its input impedance Z_{in} . The [Figure 4-2](#) presents an equivalent circuit model.

Z_{in} consists of the following probe-specific parameters.

- Input resistance R_{in}
- Input capacitance C_{in}
- RF resistance R_{RF}

The resulting input impedance versus frequency is indicated in [Figure 4-9](#). The trace shows three characteristic areas that can be assigned to R_{in} , C_{in} and R_{RF} .

The resulting loading of a step signal at the input of the probe is given in [Figure 4-10](#).

The connection inductance L_{con} has only a minor effect on the signal loading and is therefore not considered in the following.

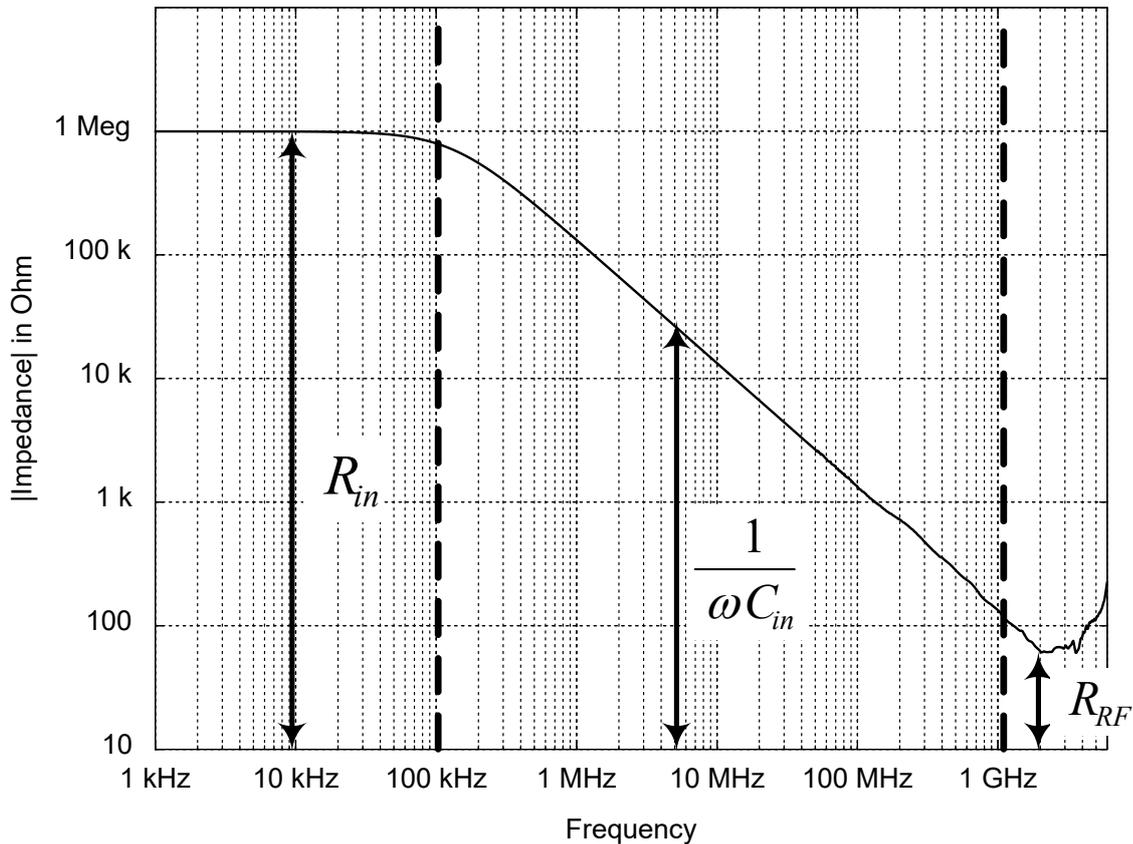


Figure 4-9: Magnitude of the input impedance of the R&S RT-ZS10/20/30 probe as a function of frequency

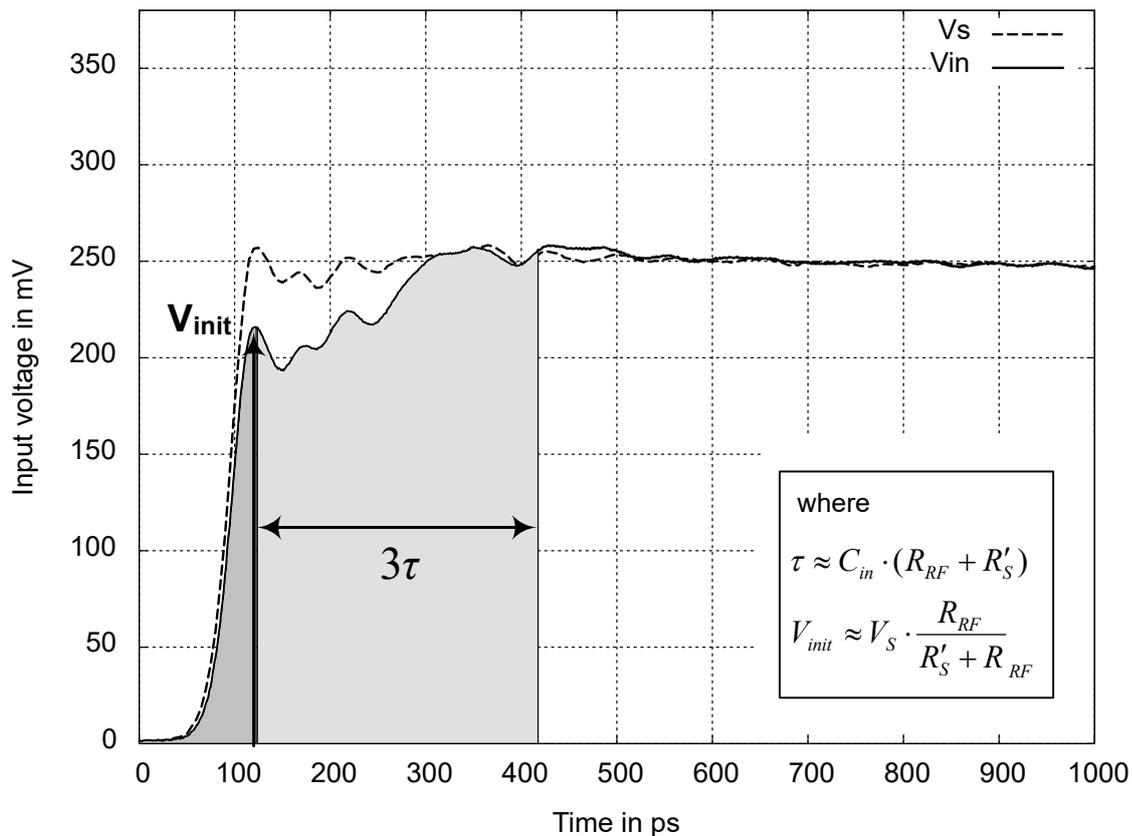


Figure 4-10: Signal loading caused by the R&S RT-ZS10/20/30 probe at an effective source impedance of 25 Ω

Input resistance

The input resistance R_{in} determines the loading of the DUT at DC and low frequencies (< 100 kHz). A low input resistance can potentially disturb measurements of high-frequency signals as it influences the DC operating point of active components. This effect is negligible for most applications involving the R&S RT-ZS10/20/30 probe due to the high input resistance of the probe (1 MΩ).

Input capacitance

The input capacitance C_{in} causes the input impedance to decrease in the medium-frequency range (100 kHz to 1.0 GHz). Thus, the measurement result depends on the source impedance of the DUT. The input capacitance affects the settling time 3τ of the input voltage for fast transients, see [Figure 4-10](#).

RF resistance

The RF resistance R_{RF} determines the minimum input impedance and thus the maximum loading at high frequencies above 1.0 GHz. Thus, the measurement result depends on the source impedance of the DUT. The RF resistance prevents the input voltage from rising immediately to its final value for fast transients.

The initial voltage V_{init} depends on R_{RF} , see [Figure 4-10](#).

4.5.3 Probing philosophy

The previous sections explained that probes exert a load on the signal to be measured and change its characteristic. The signal at the test point where the probe makes contact (V_{in}) is therefore different from the signal that was present before the probe was connected (V_S). This effect cannot be avoided and occurs with all real probes – independent of type and manufacturer.

As a result, there are different opinions which signal is the better output of the probe:

- The initial signal that is not loaded by the probe (V_S), and that corresponds to the signal at the test point without the probe being connected.
- The input signal that is loaded with the input impedance of the probe (V_{in}) and that is present between the probe tips.

Both approaches are physically correct and have their individual advantages and disadvantages. In theory, it is even possible to convert mathematically the two measurement results into each other, but conversion is a complex transformation to and from the frequency domain. Probe manufacturers use one or the other of these two approaches.

Rohde & Schwarz has decided in favor of the user-friendly approach. In our opinion, most users want to know the signal present in the DUT before it was altered by the influence of the probe. Their goal is to characterize the DUTs, not the probe.

If measurements are carried out in a 50 Ω environment, the signal displayed on the oscilloscope is always a direct representation of the unloaded signal V_S , see [Figure 4-11](#).

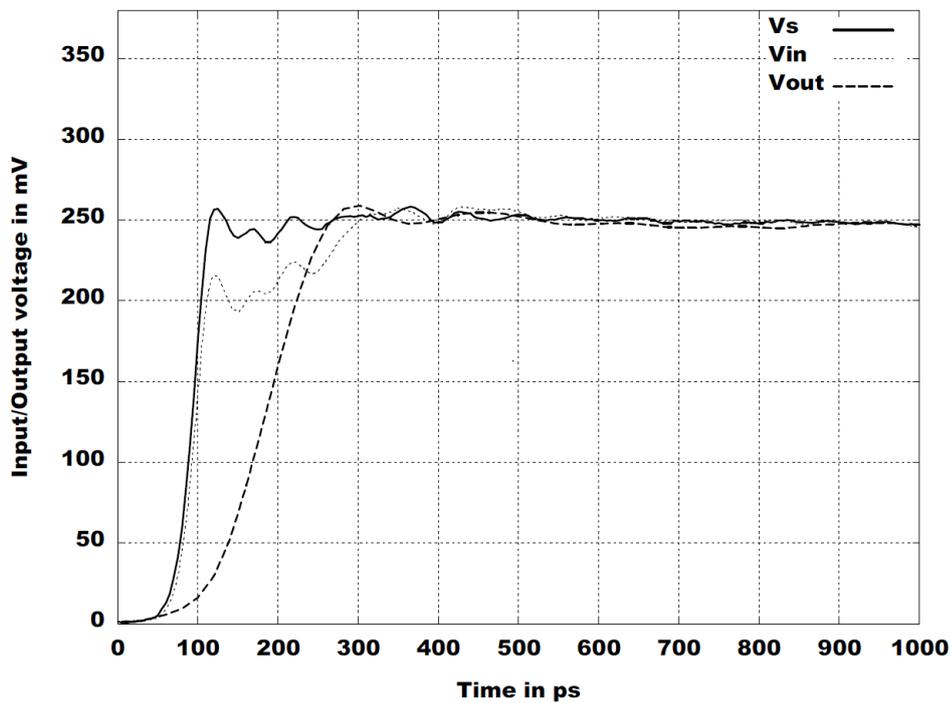


Figure 4-11: Unloaded and loaded input signal and step response (for RT-ZS30)

5 Maintenance and service

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. 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.
2. 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-ZS10/20/30 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-ZS10/20/30 active voltage probe is two years. For servicing, send the probe to your nearest Rohde & Schwarz service center (see [Chapter 5.3, "Returning for servicing"](#), on page 43).

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 data sheet.

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

Unless otherwise specified in the data sheet, 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 electrical and electronic equipment

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



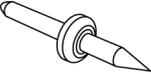
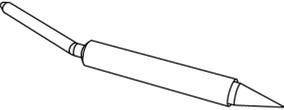
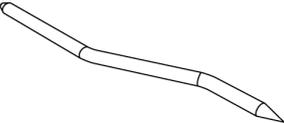
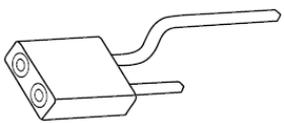
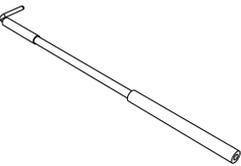
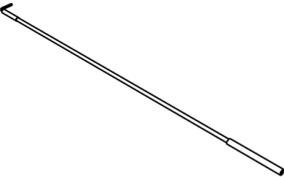
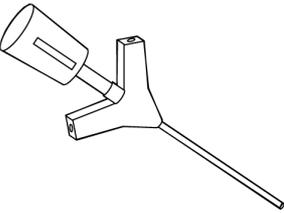
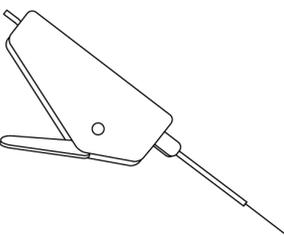
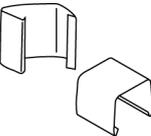
Figure 5-2: Labeling in line with EU directive WEEE

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.

Table 5-1: Accessories spare parts

Pos.	Item	Description	Material number
1		Signal pin	1416.0005.00
2		Ground pin, pogo	1416.0034.00
3		Ground pin, solderable, offset	1416.0040.00
4		Ground adapter, square pin	1416.0063.00
5		Lead, 6 cm / 2.4 in	1416.0128.00
6		Lead, 15 cm / 5.9 in	1416.0134.00
7		Mini clip	1416.0105.00
8		Micro clip	1416.0111.00
9		Marker band kit	1416.0205.00

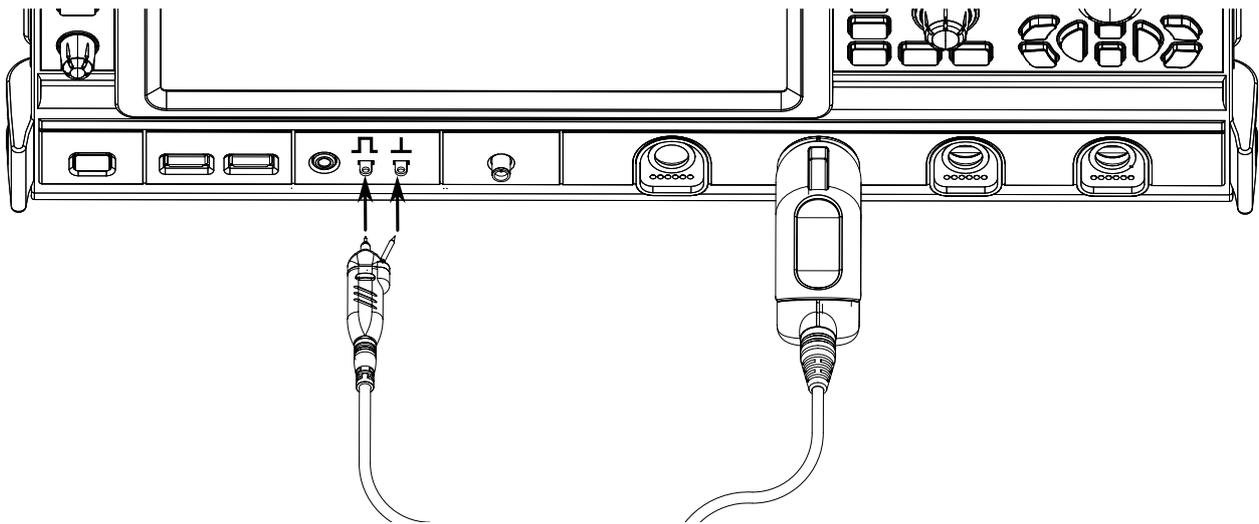
Pos.	Item	Description	Material number
10	Pogo pin	Pogo pin connector, 6 pins	3584.6396.00
11	R&S RT-ZK1	R&S RT-ZK1 service kit	1410.5157.02

Table 5-2: Parts for ESD prevention

Pos.	Item	Material number
1	ESD wrist strap	0008.9959.00
2	ESD grounding cable	1043.4962.00

6 Functional check

The functional check confirms the basic operation of the R&S RT-ZS10/20/30 active voltage probe. The functional check is not suitable for verifying compliance with the probe specifications.



1. Connect the R&S RT-ZS10/20/30 probe to a Rohde & Schwarz oscilloscope as described in [Chapter 3.2, "Connecting the probe to the oscilloscope"](#), on page 20.
2. Connect the signal pin to the square wave output \square of the oscilloscope.
3. Connect the ground pin to the probe ground connector \perp of the oscilloscope.
4. Press the [Preset] key and then the [Autoset] key on the oscilloscope.

A square wave is shown on the display. The voltage values depend on the oscilloscope model, they are listed in the oscilloscope's data sheet.

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