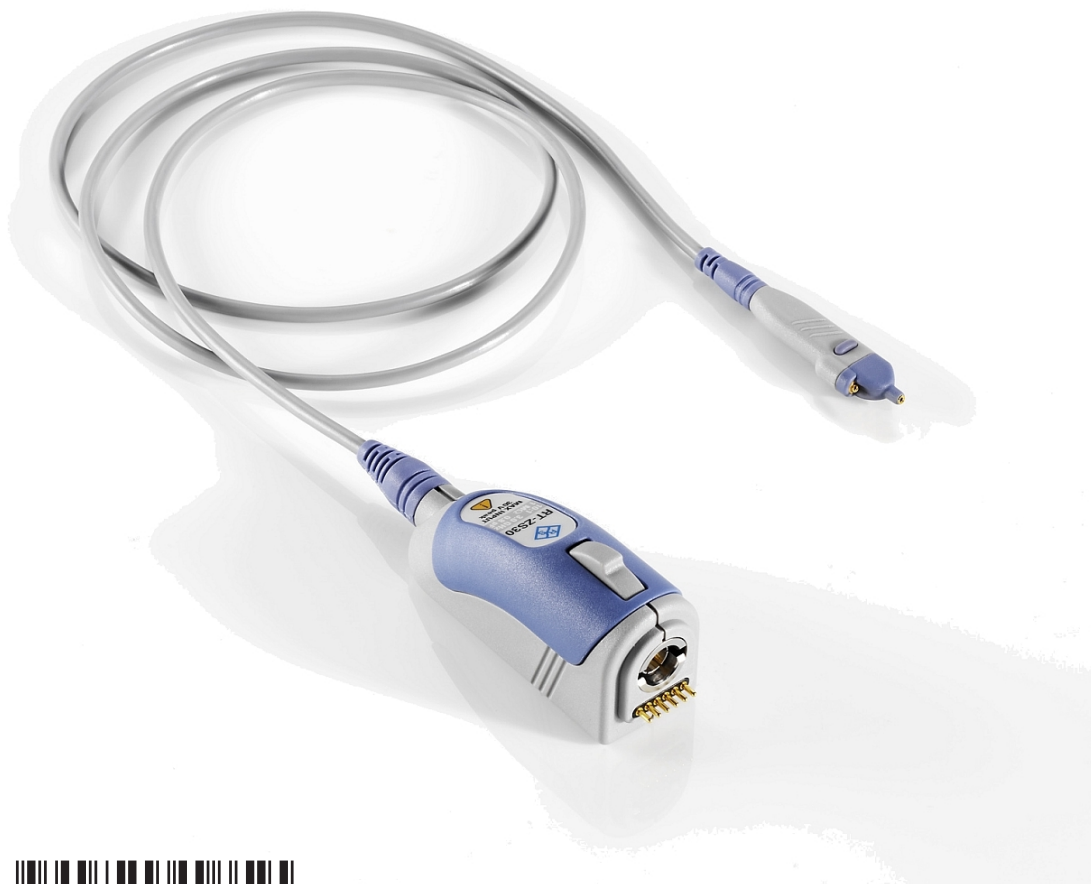


R&S[®] RT-ZS10E/10/20/30 Active Voltage Probe User Manual



1410353102



ROHDE & SCHWARZ

User Manual

Version 07

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 07 | R&S®RT-ZS10E/10/20/30

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.

Safety Instructions

Instrucciones de seguridad

⚠ WARNING**Risk of injury and instrument damage**

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

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

⚠ ADVERTENCIA**Riesgo de lesiones y daños en el instrumento**

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

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

Safety Instructions - Informaciones de seguridad

Safety Instructions for Active Voltage Probes

When handling active voltage probes, the following basic rules must be observed. Prior to using an active voltage probe, read the applicable manual including the safety instructions. Keep the safety instructions and the product documentation in a safe place and pass them on to other users. Use active voltage probes exclusively within the measurement ranges specified in the applicable data sheets. Rohde & Schwarz accepts no responsibility for misuse of the product. Use only the accessories supplied with the active voltage probe.

⚠ WARNING**Risk of electric shock**

Do not connect an active voltage probe to any voltage that exceeds the maximum permissible input voltage specified in the data sheet. Non-compliance with this instruction carries the risk of an electric shock.

Make sure not to cause any short circuits when performing measurements on sources with high output currents. Short circuits may cause injuries or burns.

⚠ CAUTION**Risk of injury caused by pointed object**

The pins of the active voltage probes are extremely pointed and can easily penetrate clothes and the skin.

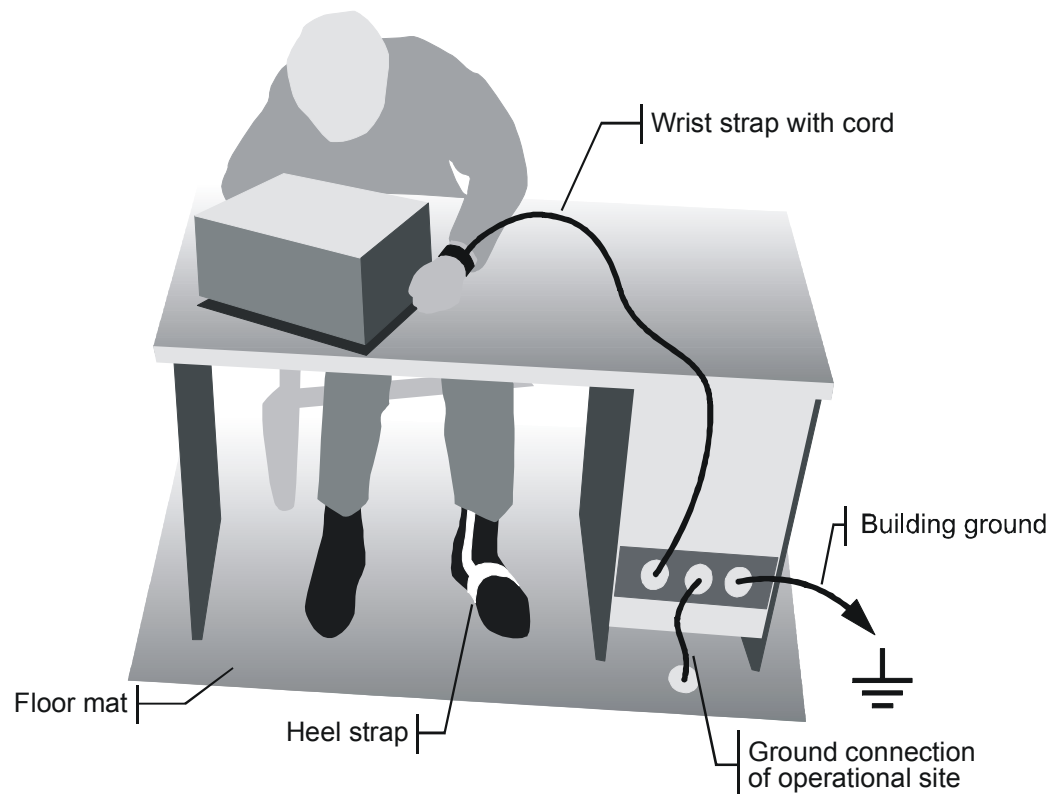
Therefore, handle the probe pins with great care. When transporting an active voltage probe, e.g. when carrying it in a pocket or tool bag, always use the box supplied with the probe. To exchange a probe pin, use tweezers or pliers to avoid injuries.

Instructions for Electrostatic Discharge Protection

NOTICE

Risk of damaging electronic components

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



The following two methods of ESD protection may be used together or separately:

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

Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish. We will take care that you will get the right information.

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1 Product Description

1.1 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.

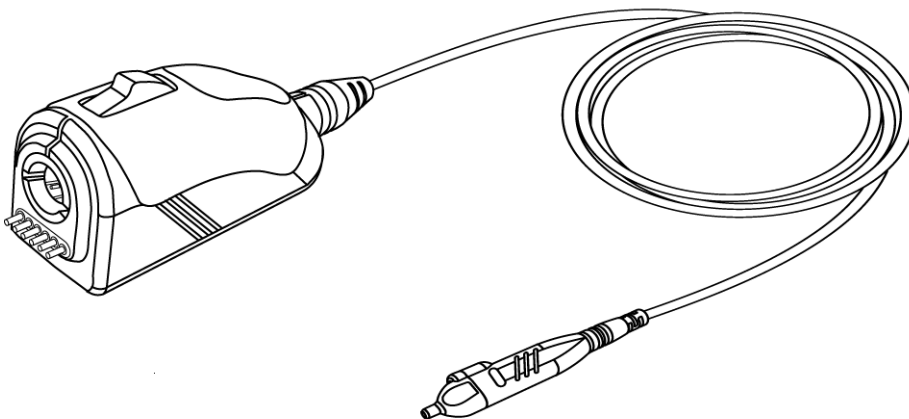
The comprehensive accessory set allows this probe to be connected to a wide variety of devices under test (DUT). Provided with special features such as the R&S ProbeMeter and the micro button, the R&S RT-ZS10/20/30 is designed to meet tomorrow's challenges in probing.

Since the probe is equipped with Rohde & Schwarz probe interface, it can be connected to any Rohde & Schwarz base unit that is compatible with this interface. When connected to the front panel of an R&S oscilloscope, the probe is controlled via the software menus of the oscilloscope.

Using a specially developed adapter (see [Chapter 1.4.2, "Optional Accessories"](#), on page 12), the probe can be connected to any other base unit.

1.1.1 Key Characteristics

The key characteristics of the probe are the following:



Key Features and Key Characteristics

| | |
|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 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 MΩ |
| 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 | |

1.1.2 Key Features

Micro button

The micro button at the probe head can remotely control different functions on the base unit. The assigned function is configured via the base unit.

For details, see [Chapter 2.3.2, "Micro Button"](#), on page 18.

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 2.3.4, "R&S ProbeMeter"](#), on page 19.

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.

1.1.3 R&S RT-ZS10E

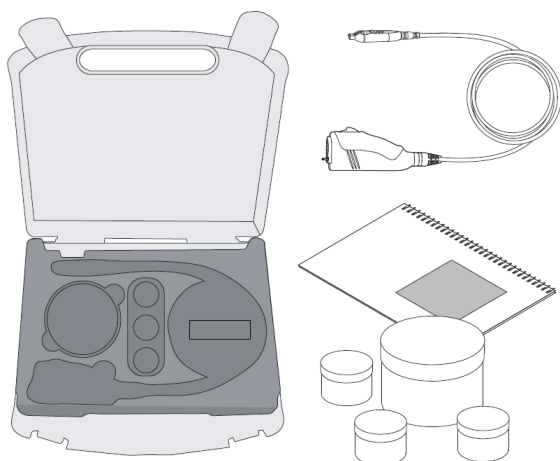
The R&S RT-ZS10E probe is a cost-efficient alternative to the R&S RT-ZS10 probe. The electrical specifications of both probes are identical. The two probes are of the same high quality, for example, in terms of frequency response, dynamic range, input resistance, input capacitance and zero and gain error. 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.

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.

1.2 Unpacking

The carrying case contains the following items:



- R&S RT-ZS10/20/30 active voltage probe
- Carrying case
- Accessory boxes
- User manual
- R&S RT-ZS10/20/30 data sheet
- Calibration certificate
- Documentation of calibration values (if ordered)

1.2.1 Inspecting the Contents

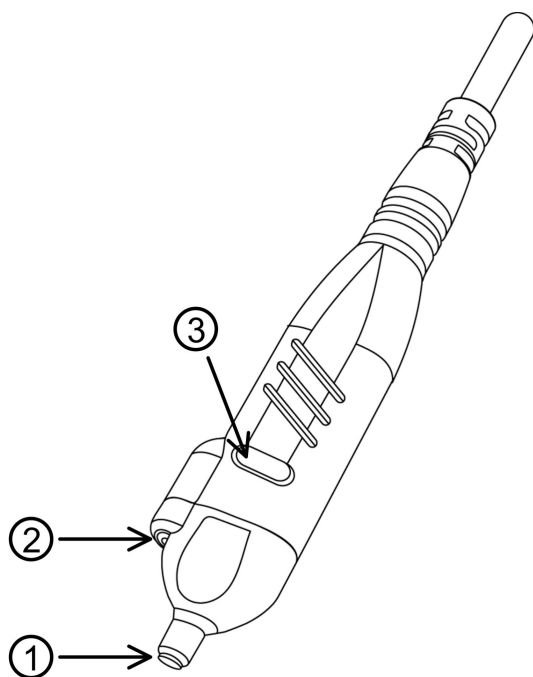
- Inspect the package for damage.
Keep the package and the cushioning material until the contents have been checked for completeness and the device has been tested.
If the packaging material shows any signs of stress, notify the carrier and your Rohde & Schwarz service center. Keep the package and cushioning material for inspection.
- Inspect the probe.
If there is any damage or defect, or if the R&S RT-ZS10/20/30 active voltage probe does not operate properly, notify your Rohde & Schwarz service center.
- Inspect the accessories.
If the contents are incomplete or damaged, notify your Rohde & Schwarz service center.
Accessories supplied with the device are listed in [Chapter 1.4.1, "Accessories Supplied"](#), on page 10.

1.3 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.

1.3.1 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.



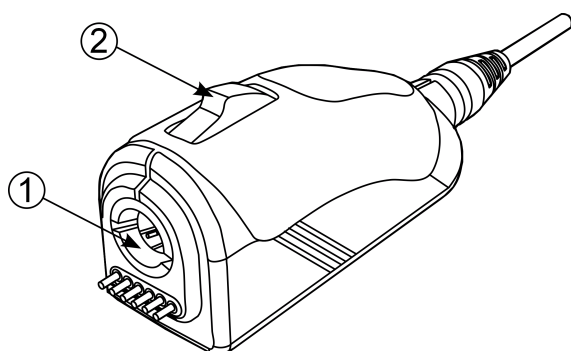
- (1) Signal socket
- (2) Ground socket
- (3) Micro button

The accessories supplied for the probe head sockets are listed in [Chapter 1.4.1, "Accessories Supplied"](#), on page 10.

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.

1.3.2 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. This approach ensures that it will be possible to operate future probes on any base unit that features a Rohde & Schwarz probe interface.



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

1.4 Accessories and Items

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

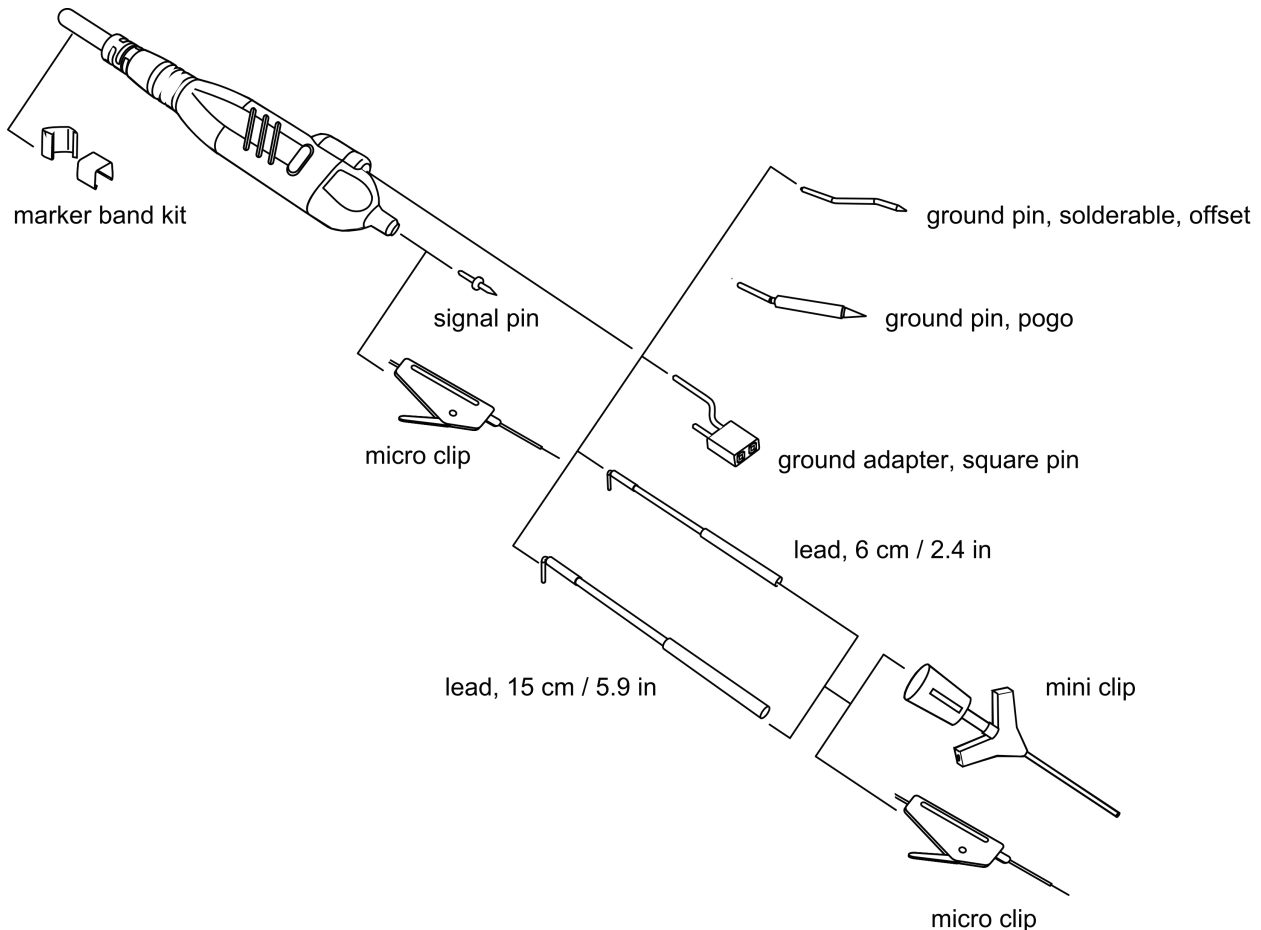
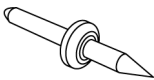


Figure 1-1: Available accessories

1.4.1 Accessories Supplied

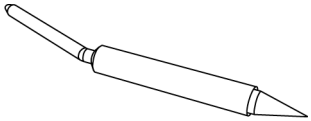
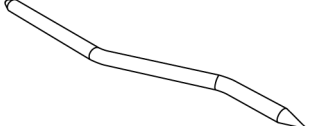
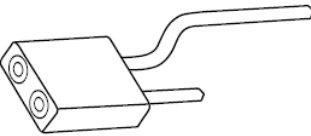
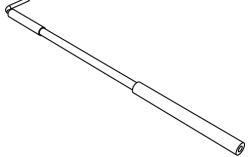
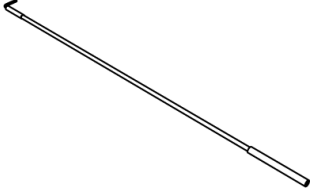
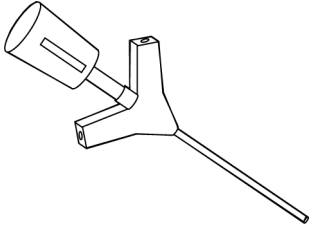
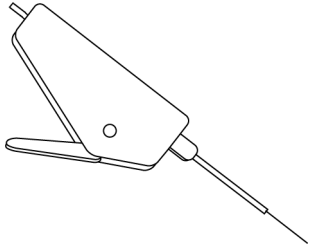
The following table shows the accessories supplied with the R&S RT-ZS10/20/30 active voltage probe.

Table 1-1: Accessories supplied

| Item | Quantity | | Description |
|-------------------------------------------------------------------------------------|------------|-------|-------------|
| | ZS10/20/30 | ZS10E | |
|  | 10 | 5 | Signal pin |

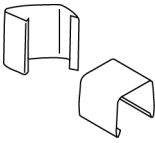
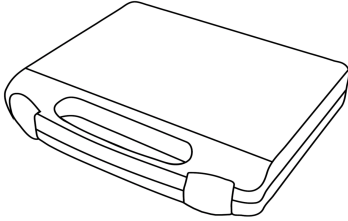
R&S®RT-ZS10E/10/20/30**Product Description**

Accessories and Items

| Item | Quantity | | Description |
|-------------------------------------------------------------------------------------|----------|---|--------------------------------|
|  | 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 |
|  | 2 | - | Micro clip |

R&S®RT-ZS10E/10/20/30**Product Description**

Accessories and Items

| Item | Quantity | | Description |
|-----------------------------------------------------------------------------------|----------|---|-------------------------------|
| | | | |
|  | 1 | 1 | Marker band kit |
|  | 1 | - | Carrying case with foam inlay |

For a list of spare parts, see [Chapter 5.6, "Spare Parts"](#), on page 38.

1.4.2 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 1-2: R&S RT-ZA2 spare accessory set

| Item | Quantity | Description |
|--------------------------------|----------|------------------------------------------------------------------------|
| Signal pin | 10 | Contains all accessories that are supplied with the R&S RT-ZS10/20/30. |
| 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-ZS10E/10/20/30**Product Description**

Accessories and Items

Table 1-3: R&S RT-ZA3 pin set

| Item | Quantity | Description |
|--------------------------------|----------|--------------------------------------------------------|
| Signal pin | 20 | Contains the pins available for the R&S RT-ZS10/20/30. |
| Ground pin, pogo | 5 | |
| Ground pin, solderable, offset | 20 | |
| Ground adapter, square pin | 2 | |
| Marker band kit | 1 | |

Table 1-4: R&S RT-ZA4 mini clips

| Item | Quantity | Description |
|-----------|----------|----------------------|
| Mini clip | 10 | Contains mini clips. |

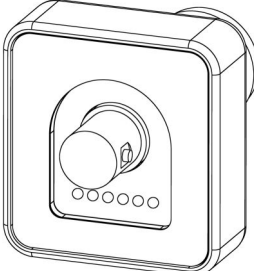
Table 1-5: R&S RT-ZA5 micro clips

| Item | Quantity | Description |
|------------|----------|-----------------------|
| Micro clip | 4 | Contains micro clips. |

Table 1-6: R&S RT-ZA6 lead set

| Item | Quantity | Description |
|----------------------|----------|--------------------------------|
| Lead, 6 cm / 2.4 in | 5 | Contains short and long leads. |
| Lead, 15 cm / 5.9 in | 5 | |

Table 1-7: R&S RT-ZA9 probe box to N / USB adapter

| | |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>The adapter can be used to connect 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.</p> |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1.4.3 Service Accessories

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

Table 1-8: 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. |

2 Putting into Operation

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.

Read and observe the "Basic Safety Instructions" that are delivered with the probe as a printed brochure. Also, read and observe the safety instructions of the oscilloscope the probe is connected to.

NOTICE

Maximum non-destructive input voltage

The maximum non-destructive input voltage is ± 30 V. A higher input voltage can destroy the probe.

The maximum input voltage is derated for higher frequencies. Refer to the data sheet for further information.

NOTICE

Risk of device damage

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:

- Do not exceed the specified voltage limits.
 - Connect the R&S RT-ZS10/20/30 only to an instrument with Rohde & Schwarz probe interface. Never connect it to a usual BNC jack. Although the 7 mm coaxial connector looks like a standard BNC connector, it is constructed differently and does not fit to the standard BNC jack. The interface of the R&S RT-ZS10/20/30 can withstand a higher frequency limit.
 - Avoid excessive strain on the probe cable, and kinking.
 - Prevent the adapter from receiving mechanical shock.
 - Do not spill liquids on the probe.
 - Store the probe in a shock-resistant case, e.g. in the foam-lined shipping case.
-

Connecting the Probe to the Oscilloscope

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

NOTICE**Damage caused by electrostatic discharge**

Electrostatic discharge (ESD) can damage the electronic components of the probe and the instrument, and also the device under test (DUT). Electrostatic discharge is most likely to occur when you connect or disconnect a DUT or test fixture to the probe and to the instrument's test ports. To prevent electrostatic discharge, use a wrist strap and cord and connect yourself to the ground, or use a conductive floor mat and heel strap combination. Discharge cables and probe tips before you connect them.

2.1 Connecting the Probe to the Oscilloscope

- 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.

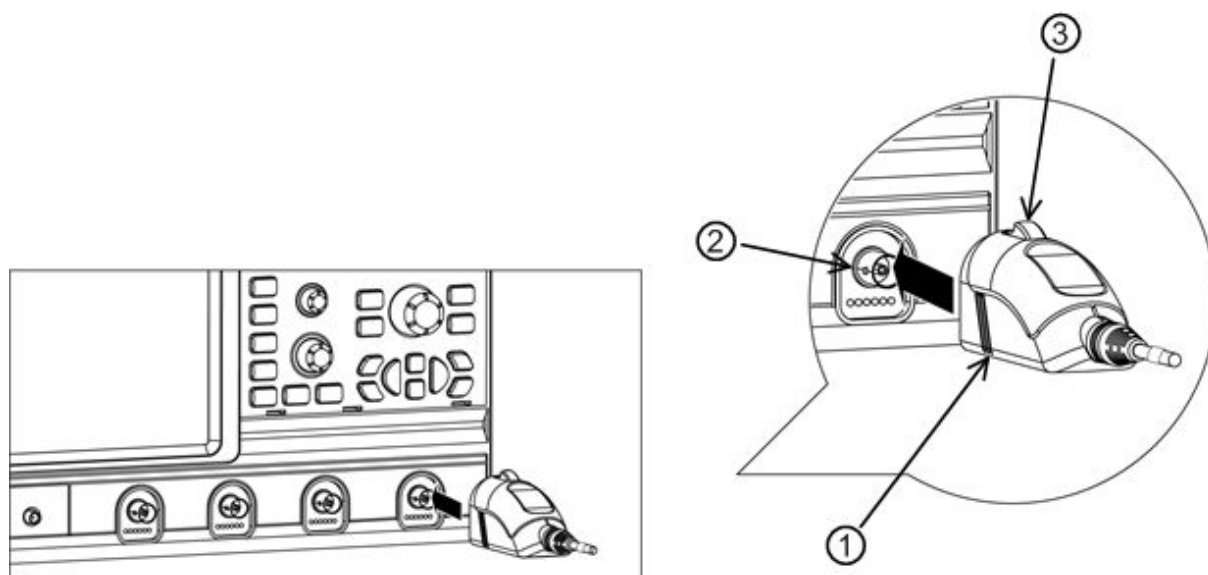


Figure 2-1: Connecting the probe to the Rohde & Schwarz oscilloscope

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

2.2 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.

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

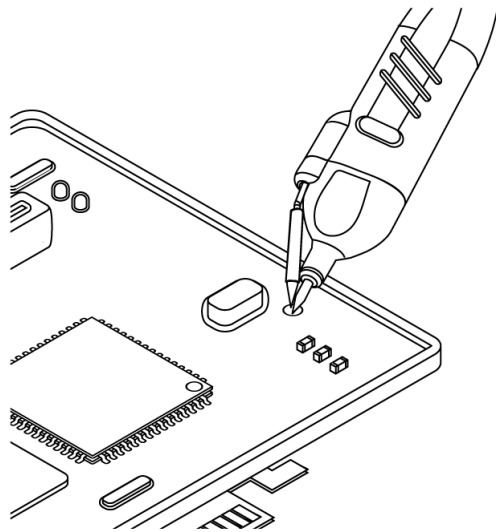
2.3 Using the Probe

2.3.1 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 Rohde & Schwarz 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.



4. 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.

2.3.2 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, "Continuous Run" or "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.

2.3.3 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.

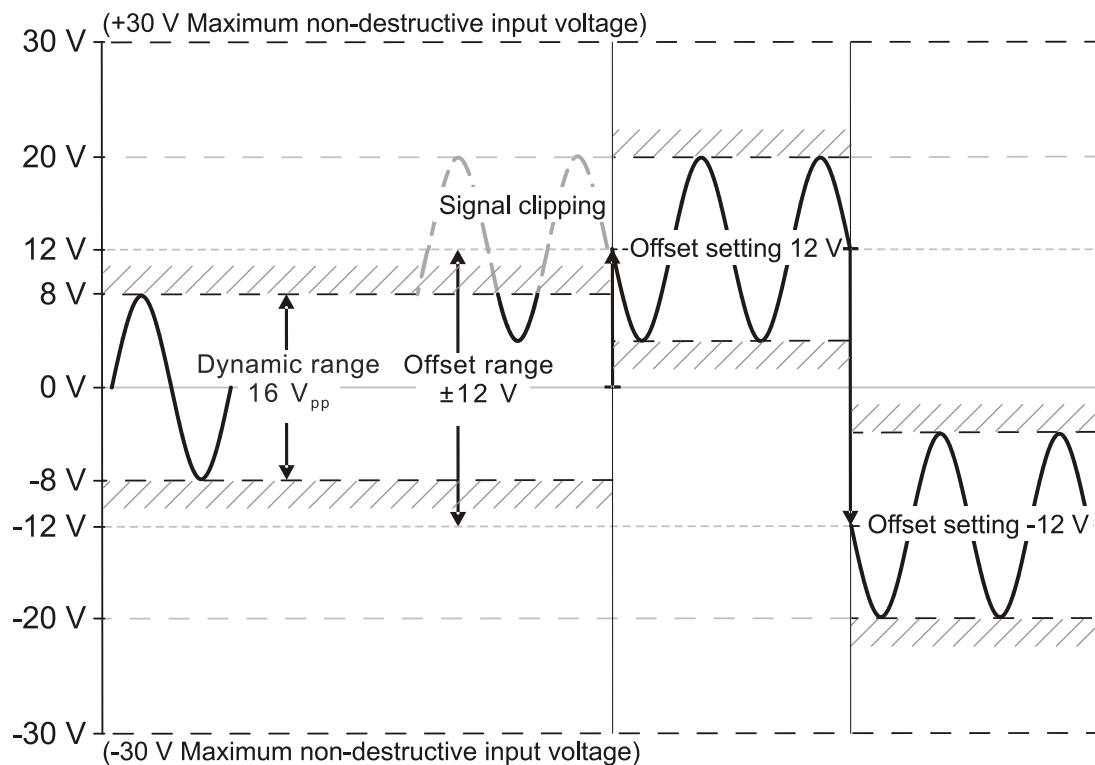


Figure 2-2: Offset compensation voltage and dynamic range

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 R&S RTx.
- Use the micro button to measure input signals with different DC offsets: assign "Set offset to mean" to the micro button. See also [Chapter 2.3.2, "Micro Button"](#), on page 18.

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

2.3.4 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 measurement is performed continuously and in parallel to the time domain measurement of the oscilloscope.

High-precision measurements are achieved through 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 offset, position, vertical scale, horizontal scale, and trigger.
- Independent of probe settings for measurement mode and gain.
- Measurement range ± 8 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 2.3.1, "Zero Adjustment"](#), on page 17.

3 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.

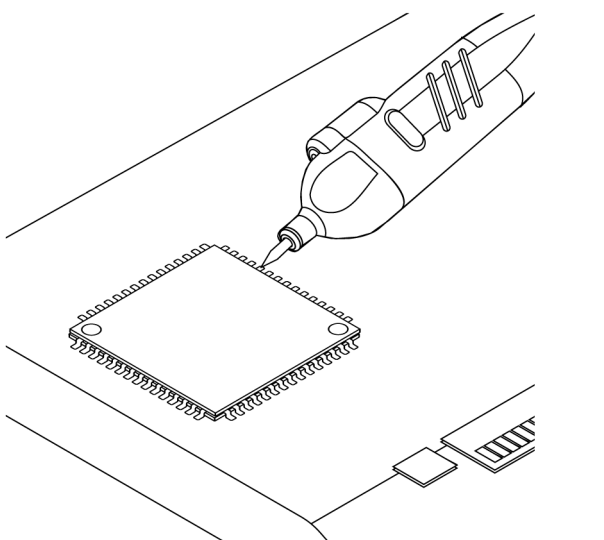
To achieve optimum RF performance, the connections must be as short as possible. If long connections cannot be avoided, they have to be preferably used for the ground socket.

⚠ CAUTION

Risk of injuries

The included probe pins are exceptionally sharp and must be handled with extreme care. To prevent injuries, always use tweezers when inserting or removing pins.

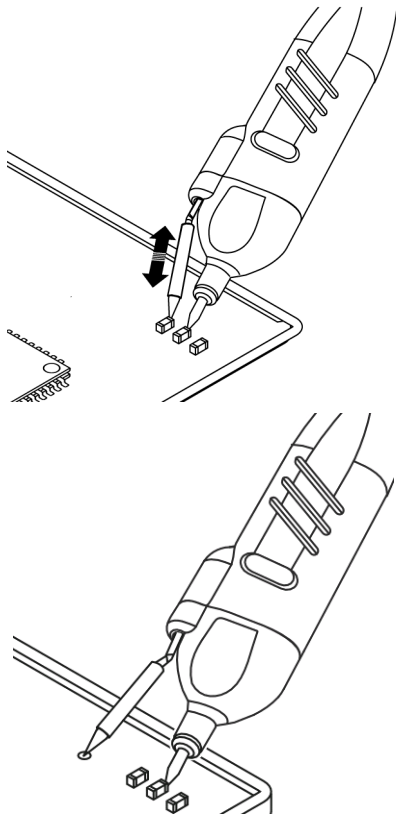
Pins

| Signal pin | |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>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.</p> <p>If necessary, the signal pin can also be soldered to the DUT.</p> |

R&S®RT-ZS10E/10/20/30

Connecting the Probe to the DUT

Ground pin, pogo

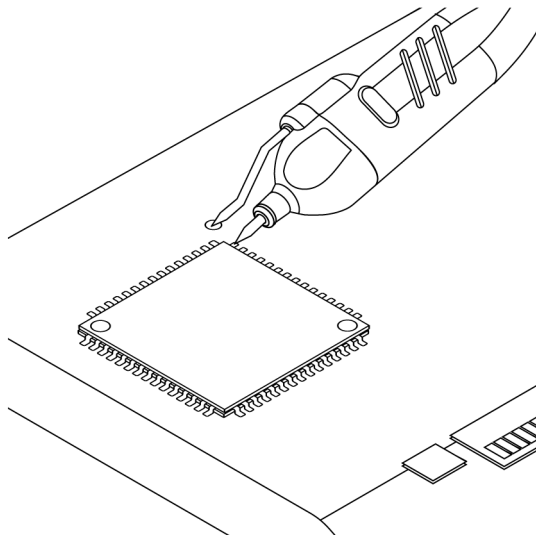


The spring-loaded ground pin allows handheld probing. Because this ground pin compensates for minor unevenness and movements, it can establish a firm contact with the test point. It fits into the ground socket of the probe head.

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



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.

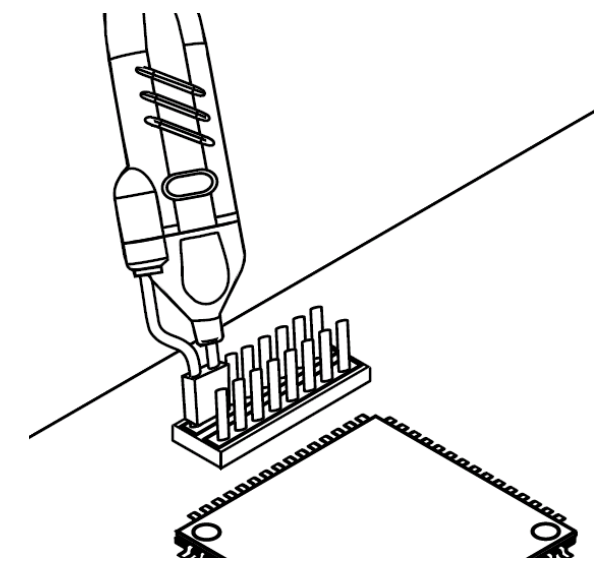
Distance range:

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

R&S®RT-ZS10E/10/20/30

Connecting the Probe to the DUT

Ground adapter, square pin



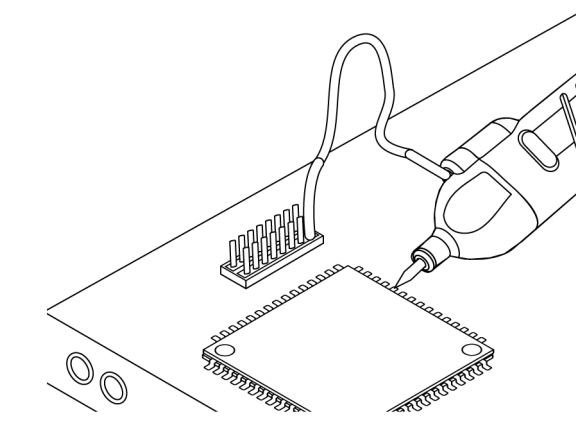
The ground adapter is used for plugging the probe onto pin strips with 0.64 mm square pins (typical pitch 2.54 mm, 100 mil).

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

Distance: 2.54 mm (100 mil)

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.

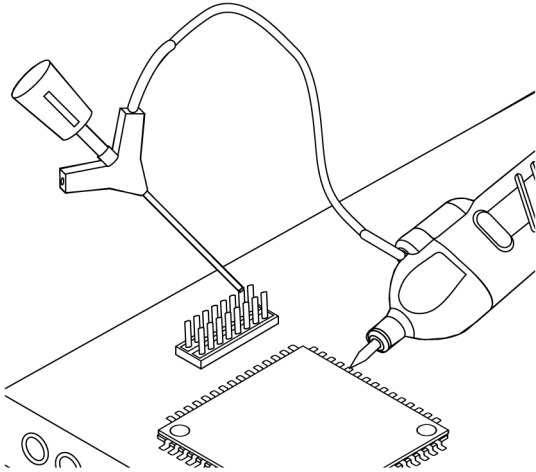
Length:

Short lead: 6 mm (236 mil)

Long lead: 15 mm (591 mil)

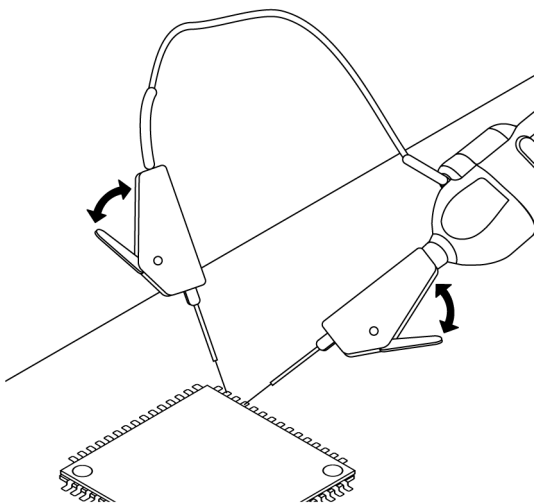
Clips

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.

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 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 4-1](#) shows the equivalent circuit model of a probe that is connected to the DUT.

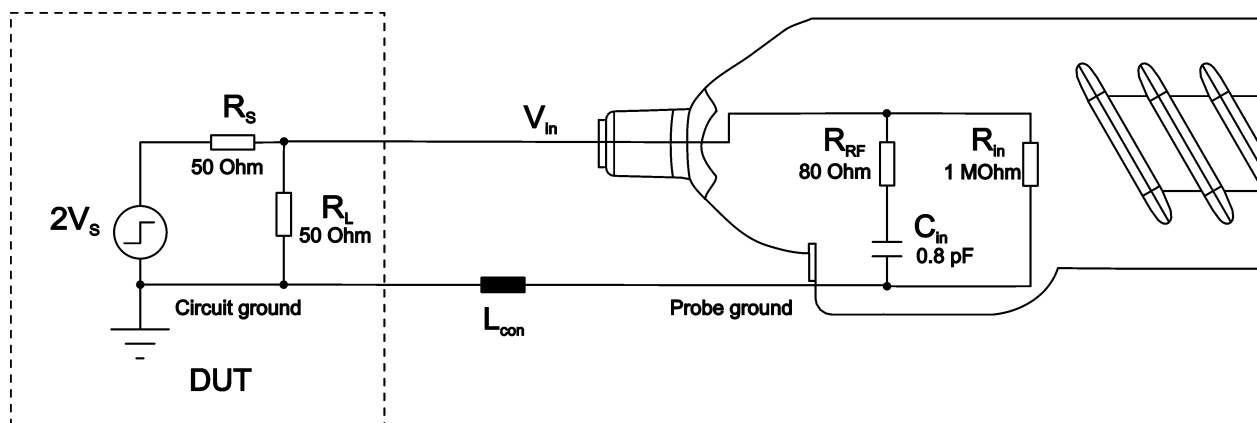


Figure 4-1: Equivalent circuit model of the R&S RT-ZS10/20/30 probe

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:

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

4.1 Signal Integrity of the Transferred Signal

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

4.1.1 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.

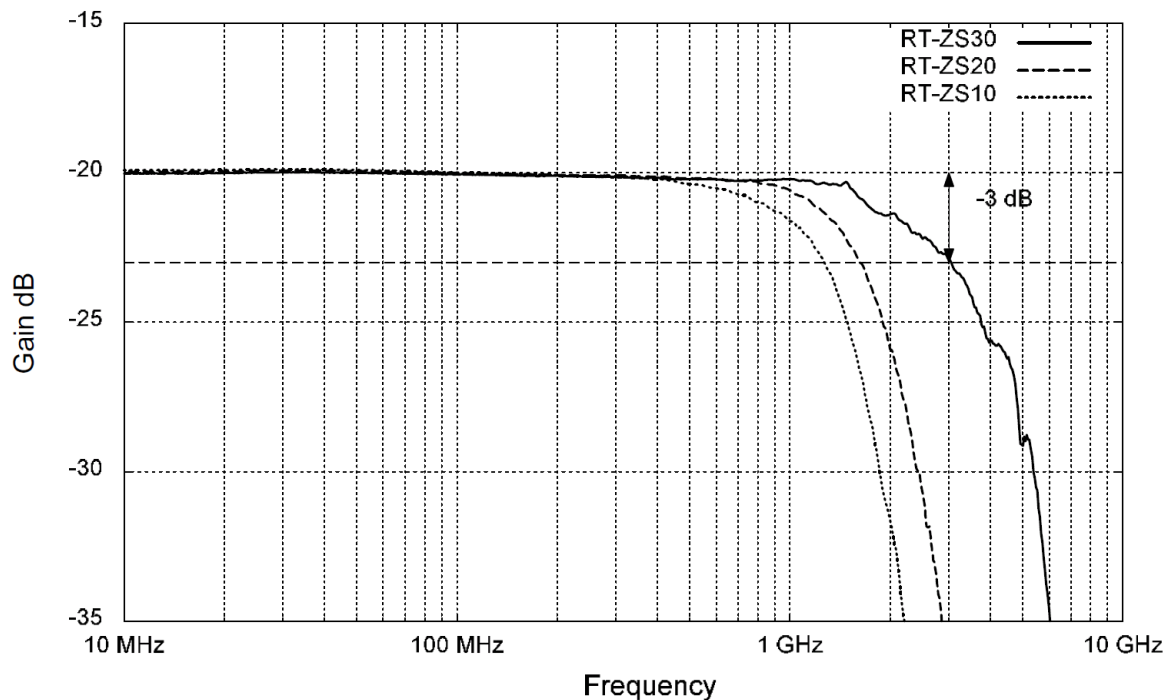


Figure 4-2: Amplitude/frequency response of the R&S RT-ZS10/20/30

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.

Signal Integrity of the Transferred Signal

- 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 4-2](#) 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 4-3](#) shows a typical step response of an R&S RT-ZS10/20/30 active voltage probe.

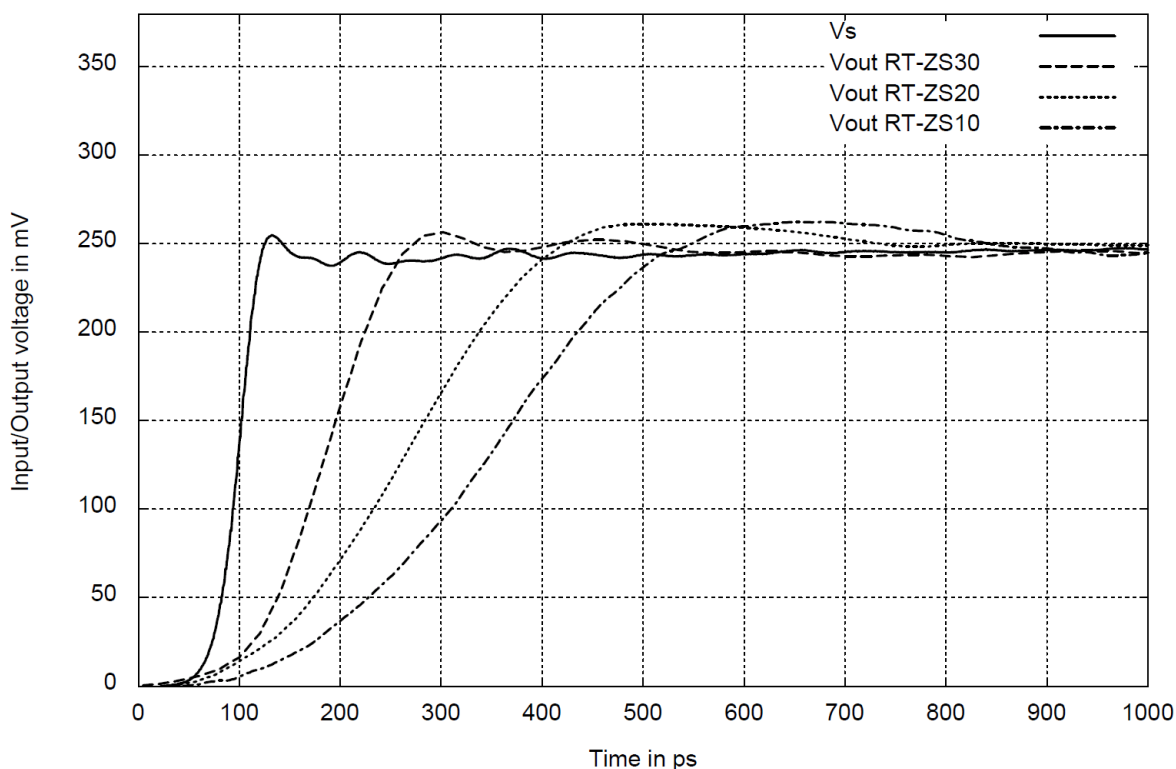


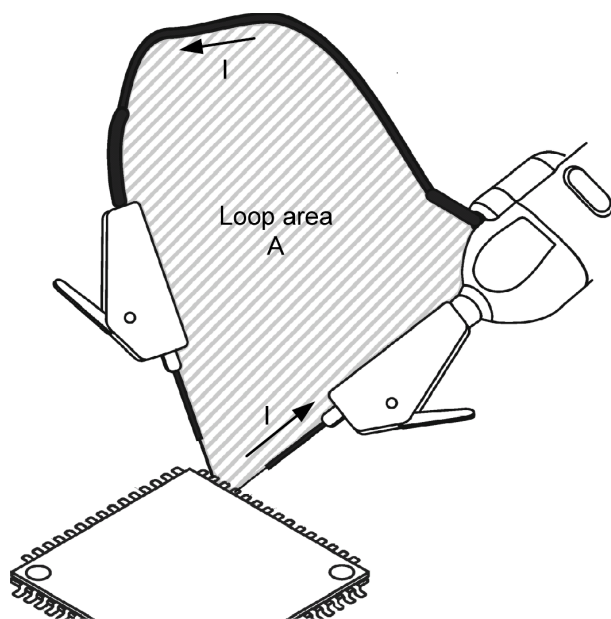
Figure 4-3: Step response of the R&S RT-ZS10/20/30

4.1.2 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 4-4](#).
- 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.



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

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

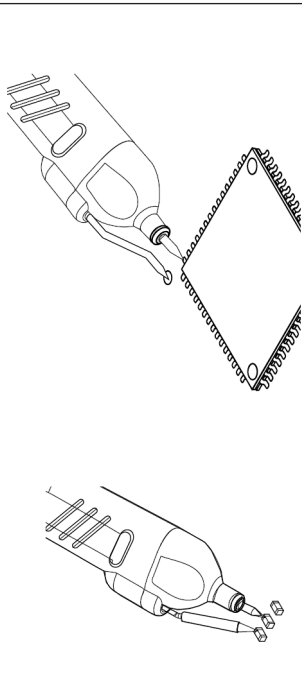
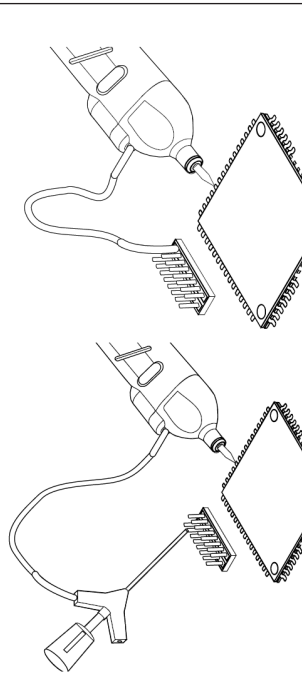
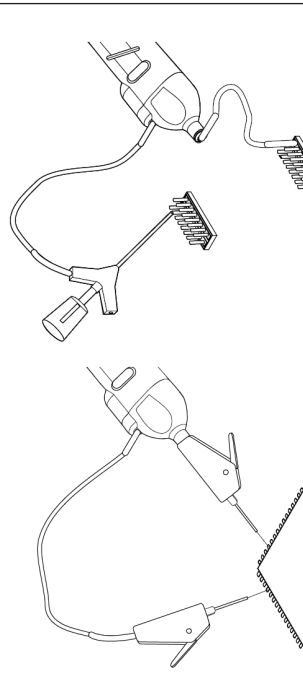
$$BW \text{ proportional to } \frac{1}{\sqrt{L_{con}}}$$

Figure 4-4: 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.

Signal Integrity of the Transferred Signal

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 |

Signal Integrity of the Transferred Signal

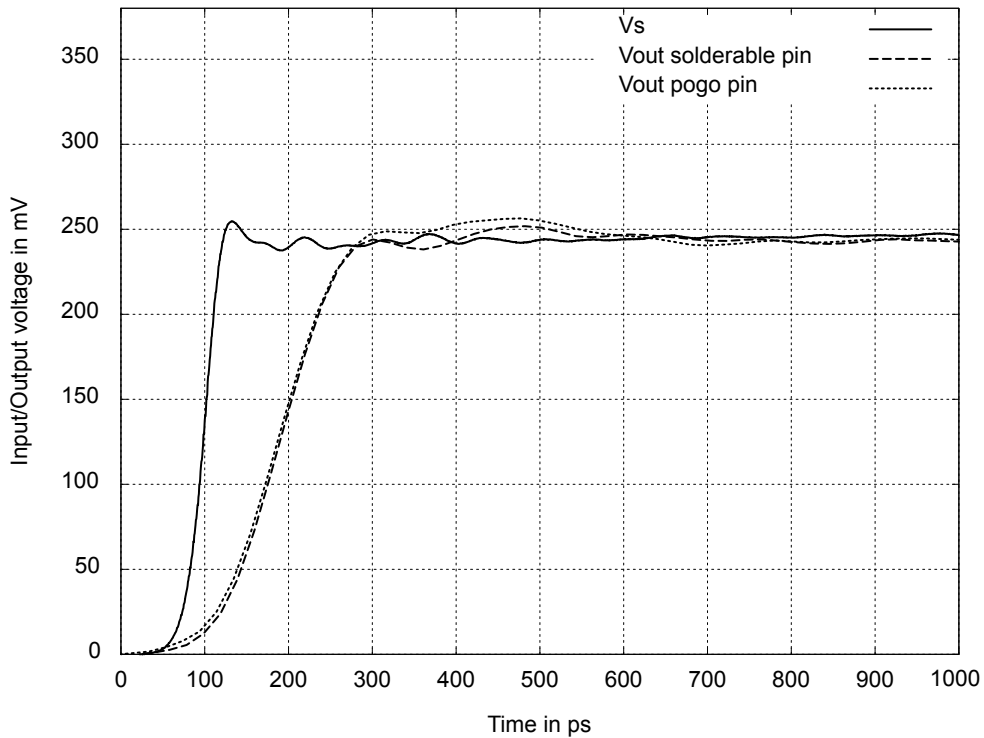


Figure 4-5: Step response of the R&S RT-ZS30 with a type 1 connection

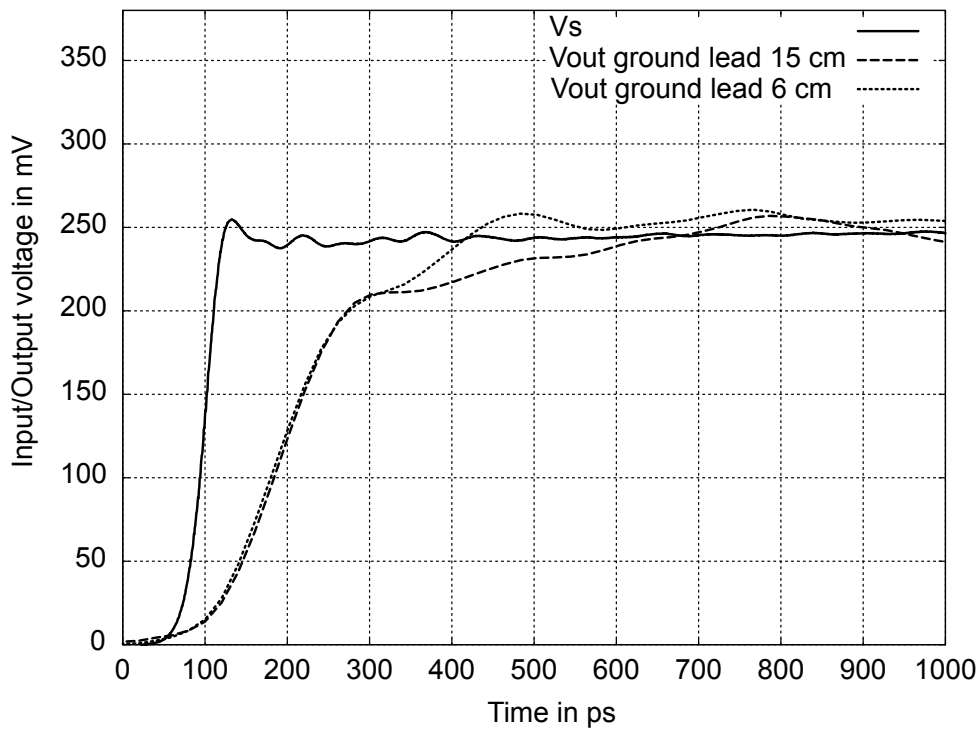


Figure 4-6: Step response of the R&S RT-ZS30 with a type 2 connection

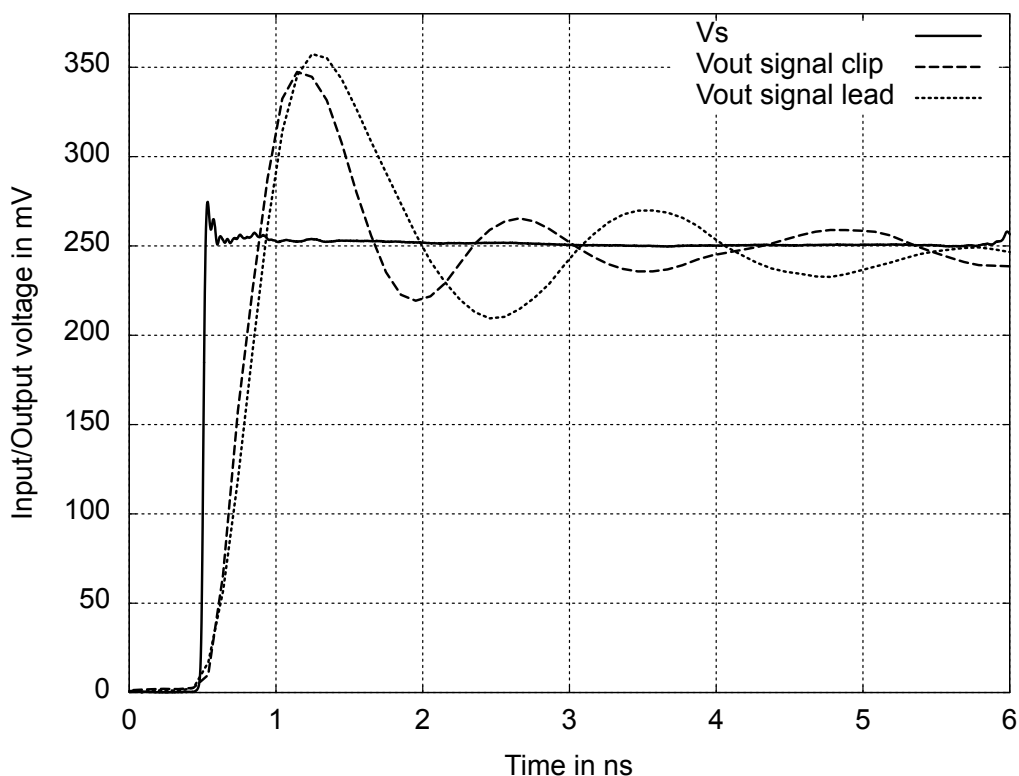


Figure 4-7: Step response of the R&S RT-ZS30 with a type 3 connection

4.2 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.

4.2.1 Input Impedance

The input signal loading caused by the probe is determined by its input impedance Z_{in} . The Figure 4-1 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}

Signal Loading of the Input Signal

The resulting input impedance versus frequency is indicated in [Figure 4-8](#). 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 4-9](#).

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

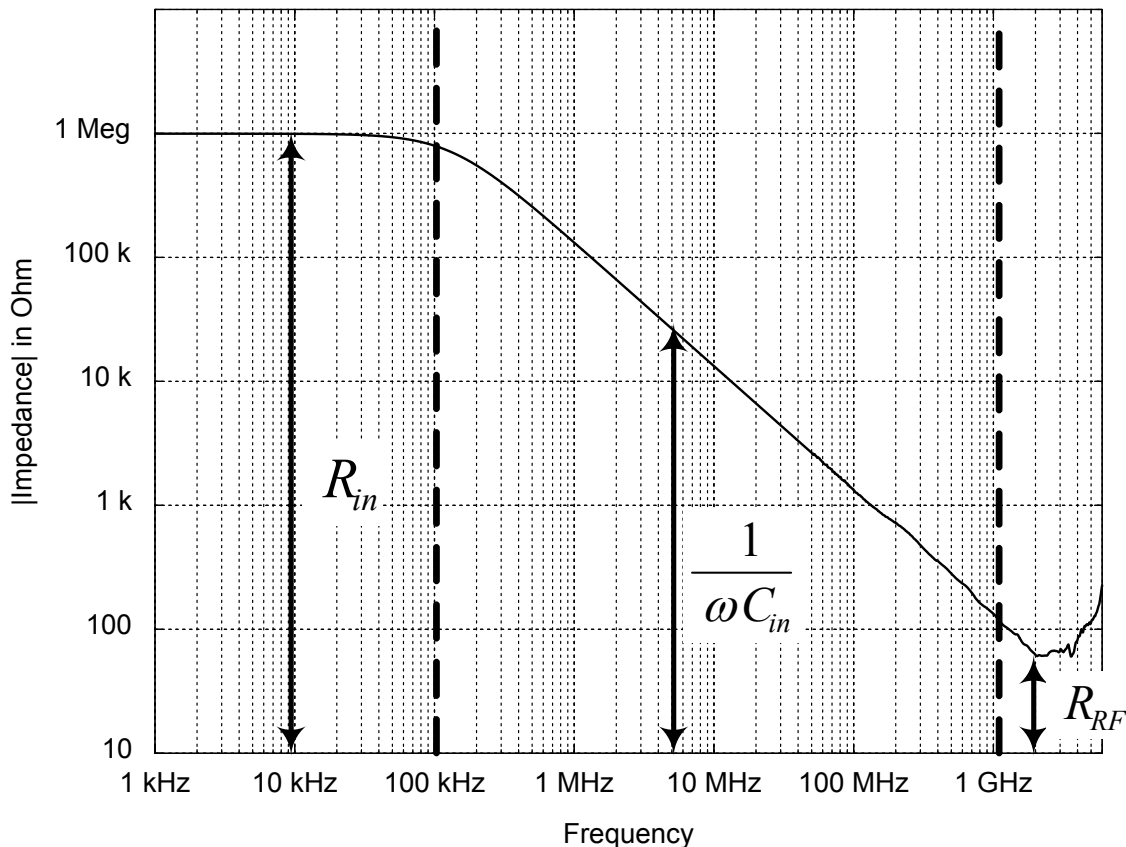


Figure 4-8: Magnitude of the input impedance of the R&S RT-ZS10/20/30 probe as a function of frequency

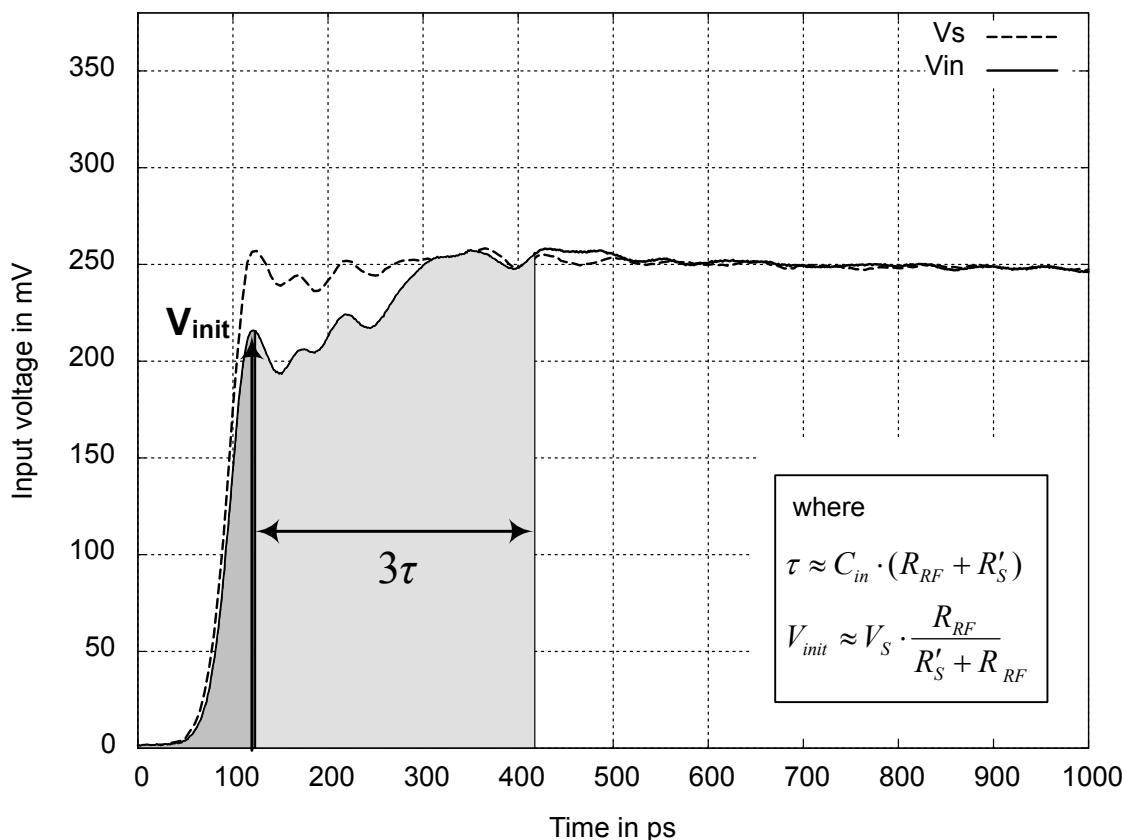


Figure 4-9: Signal loading caused by the R&S RT-ZS10/20/30 probe at an effective source impedance of 25 Ω

4.2.1.1 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).

4.2.1.2 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 4-9](#).

4.2.1.3 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 4-9](#).

4.3 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's screen is always a direct representation of the unloaded signal V_S , see [Figure 4-10](#).

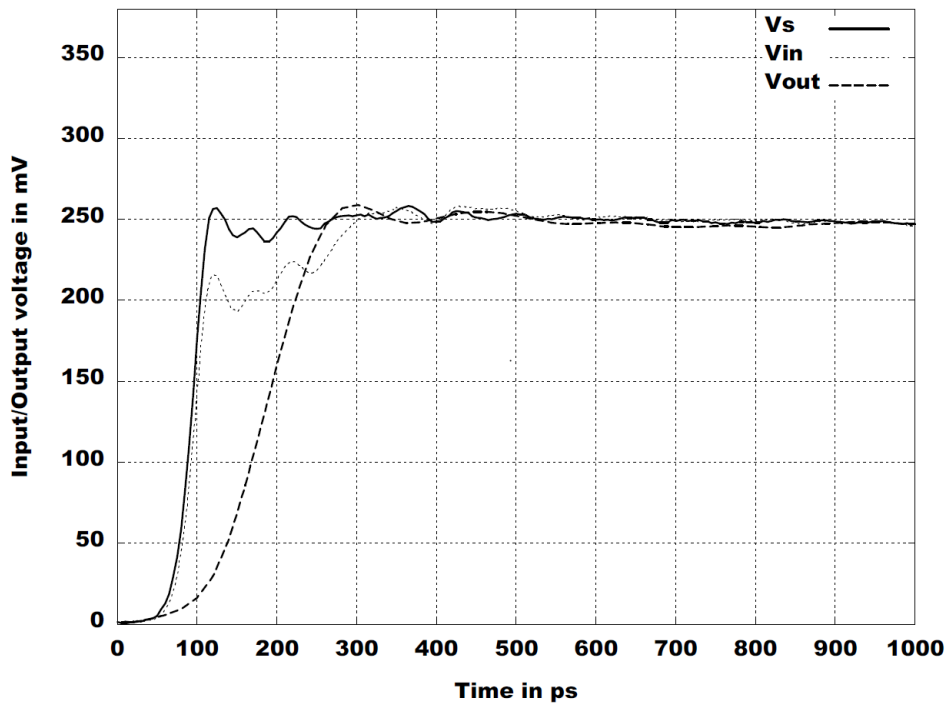


Figure 4-10: Unloaded and loaded input signal and step response (for RT-ZS30)

5 Maintenance and Service

5.1 Service Strategy

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

You can return the R&S RT-ZS10/20/30 active voltage probe for calibration. The service personnel carry out the required tests.

5.2 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.

5.3 Cleaning

NOTICE

Product damage caused by cleaning agents

Cleaning agents contain substances that can damage the product, 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.

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

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 5.2, "Returning for Servicing"](#), on page 37).

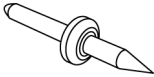
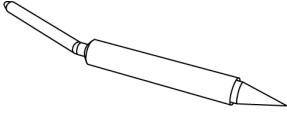
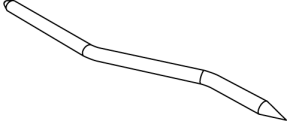
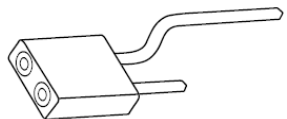
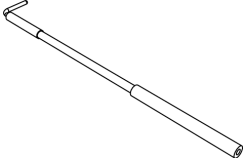
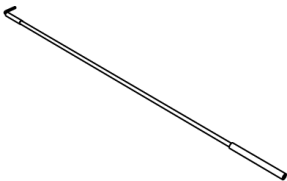
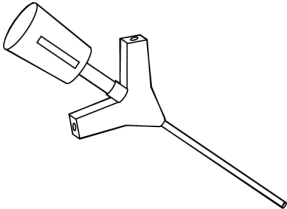
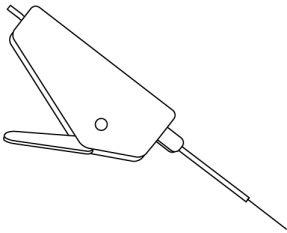
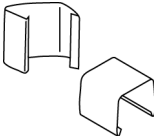
5.5 Discarding the Product

Handle and dispose the product in accordance with local regulations.

5.6 Spare Parts

The following accessories can be ordered at 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 |

R&S®RT-ZS10E/10/20/30**Maintenance and Service**

Spare Parts

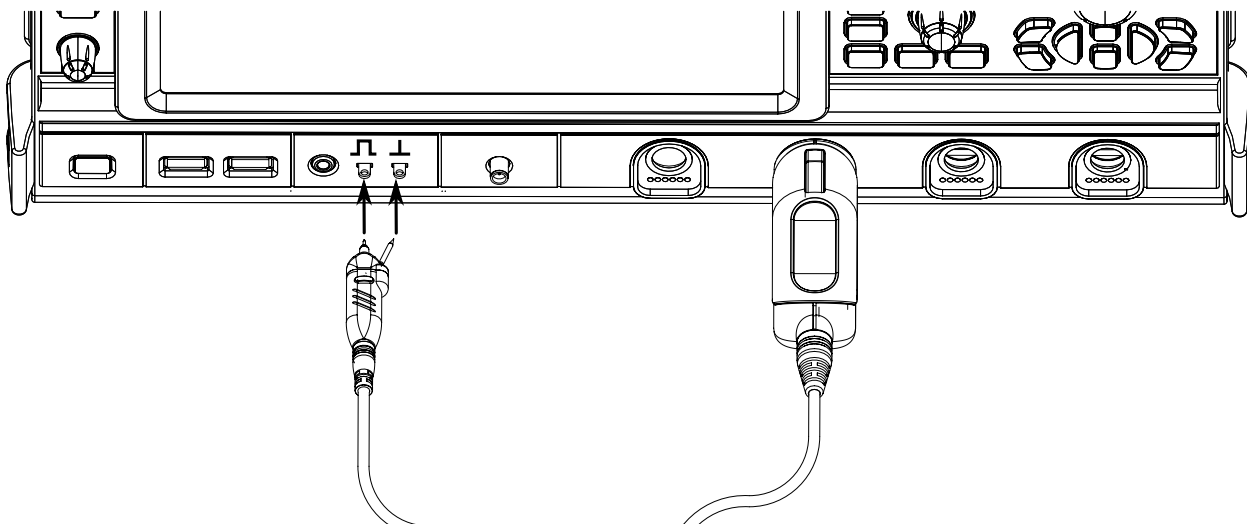
| Pos. | Item | Description | Material number |
|------|------------|----------------------------|-----------------|
| 10 | Pogo pin | Pogo pin connector, 6 pins | 3584.6396.00 |
| 11 | R&S RT-ZK1 | R&S RT-ZK1 service kit | 1410.5157.02 |

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 2.1, "Connecting the Probe to the Oscilloscope"](#), on page 16.
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 with 1 V amplitude between 0 V and 1 V is displayed on the display.

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