

R&S® RT-ZS60

Active Voltage Probe

User Manual



1418734202

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

- R&S®RT-ZS60 (1418.7307.02)

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1418.7342.02 | Version 04 | R&S®RT-ZS60

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol and without product type numbers, e.g. R&S®RT-ZS60 is indicated as R&S RT-ZS60.

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 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.

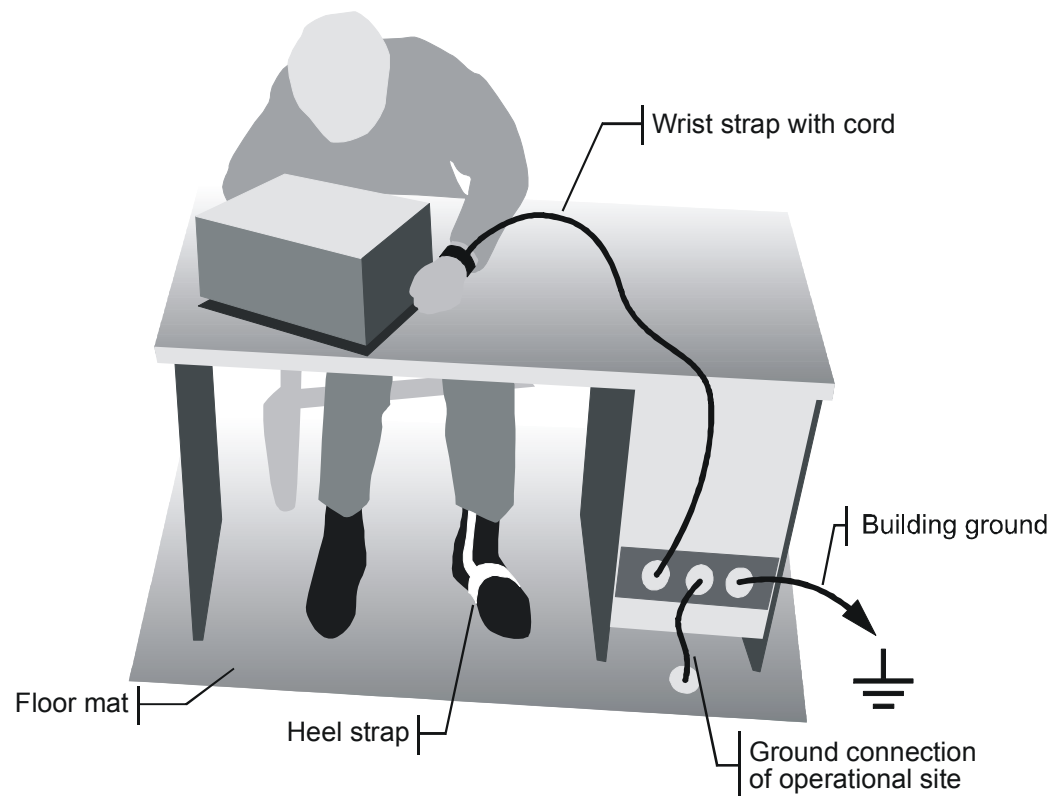
Therefore, handle the probe pins with great care. When transporting an active voltage probe, e.g. when carrying it in a pocket or tool bag, always use the box supplied with the probe. To exchange a probe pin, use tweezers or pliers to avoid injuries.

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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Contents

1 Product Description.....	5
1.1 Key Features and Key Characteristics.....	5
1.1.1 Key Characteristics.....	5
1.1.2 Key Features.....	6
1.2 Unpacking.....	7
1.2.1 Inspecting the Contents.....	7
1.3 Description of the Probe.....	8
1.3.1 Probe Head.....	8
1.3.2 Probe Box.....	9
1.4 Accessories and Items.....	9
1.4.1 Accessories Supplied.....	10
1.4.2 Optional Accessories.....	12
1.4.3 Service Accessories.....	13
2 Putting into Operation.....	14
2.1 Connecting the Probe to the Oscilloscope.....	15
2.2 Identification of the Probe.....	16
2.3 Using the Probe.....	16
2.3.1 Zero Adjustment.....	16
2.3.2 Micro Button.....	17
2.3.3 Offset Compensation.....	17
2.3.4 R&S ProbeMeter.....	18
3 Connecting the Probe to the DUT.....	20
4 Measurement Principles.....	25
4.1 Signal Integrity of the Transferred Signal.....	27

4.1.1 Bandwidth.....	27
4.1.2 Connection Inductance.....	29
4.1.3 Performance with Different Connection Types.....	30
4.2 Signal Loading of the Input Signal.....	32
4.2.1 Input Impedance.....	32
4.3 Probing Philosophy.....	35
5 Maintenance and Service.....	37
5.1 Service Strategy.....	37
5.2 Returning for Servicing.....	37
5.3 Cleaning.....	38
5.4 Calibration Interval.....	38
5.5 Discarding the Product.....	38
5.6 Spare Parts.....	38
6 Functional Check.....	41
Index.....	42

1 Product Description

1.1 Key Features and Key Characteristics

The R&S RT-ZS60 is a single-ended active voltage probe with high input impedance. It is used for ground-referenced voltage measurements from DC to 6 GHz. The R&S RT-ZS60 is optimized for single-ended measurements in environments characterized by 50 Ω impedance.

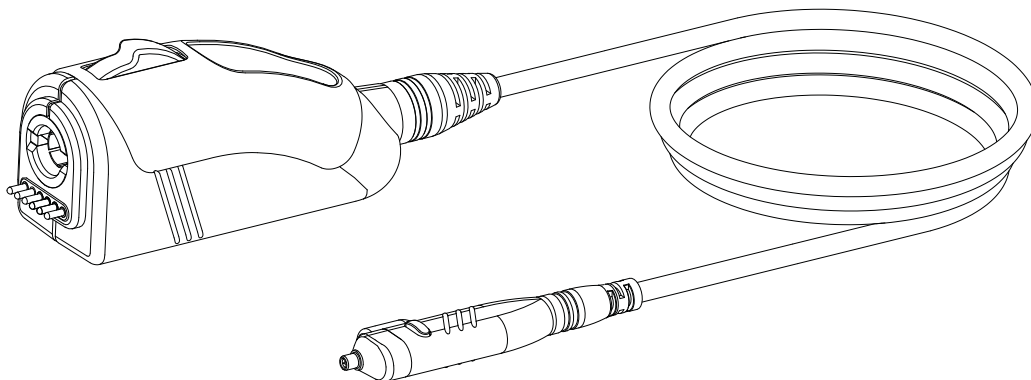
The comprehensive accessory set allows this probe to be connected to a wide variety of devices under test (DUT), not impairing the short rise time and the low input capacitance. Provided with special features such as the R&S ProbeMeter and the micro button, the R&S RT-ZS60 is designed to meet tomorrow's 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 6 GHz
Dynamic range	±8 V with ±10 V offset capability 16 V AC (V_{pp})
Maximum non-destructive input voltage	±30 V
Input resistance	1 MΩ
Input capacitance	0.3 pF
R&S ProbeMeter, measurement error	<0.1 %
Extremely low zero and gain errors throughout the entire temperature range, no significant temperature drift	
Extremely low noise and virtually no harmonic distortions	
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 17.

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.

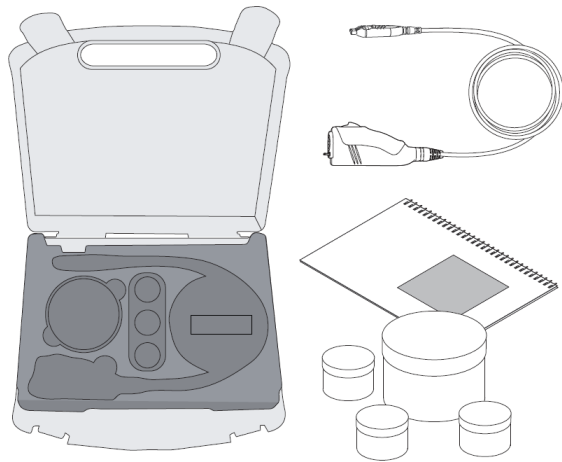
For details, see [Chapter 2.3.4, "R&S ProbeMeter"](#), on page 18.

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.

1.2 Unpacking

The carrying case contains the following items:



- R&S RT-ZS60 active voltage probe
- Carrying case
- Accessory boxes
- User manual
- R&S RT-ZS60 data sheet
- Calibration certificate
- Documentation of calibration values (if ordered)

1.2.1 Inspecting the Contents

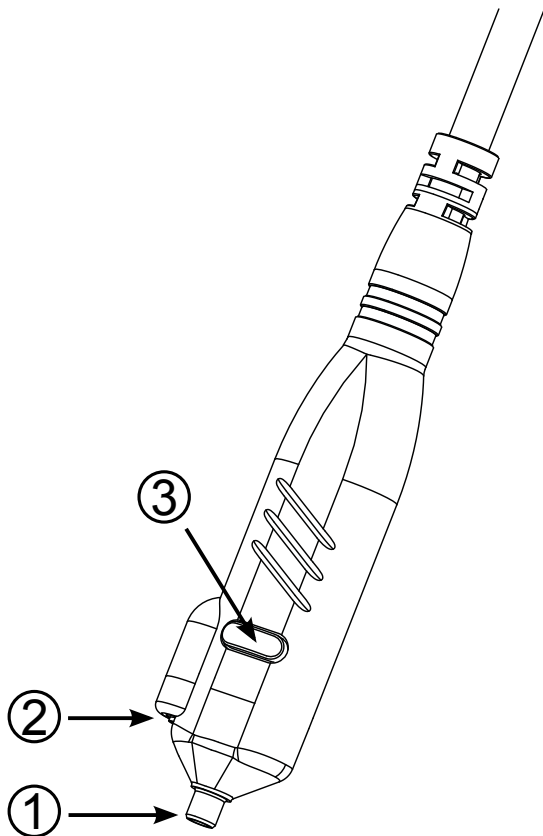
- Inspect the package for damage.
Keep the package and the cushioning material until the contents have been checked for completeness and the device has been tested.
If the packaging material shows any signs of stress, notify the carrier and your Rohde & Schwarz service center. Keep the package and cushioning material for inspection.
- Inspect the probe.
If there is any damage or defect, or if the R&S RT-ZS60 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.

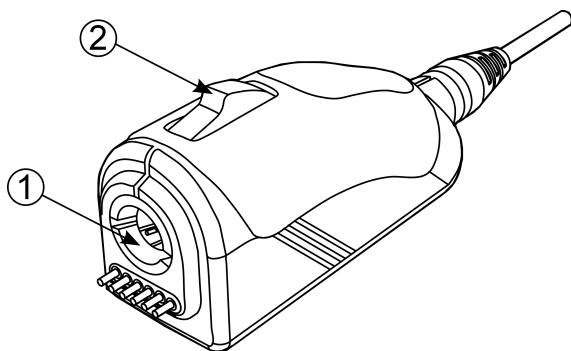
Signal and ground sockets are compatible with 0.64 mm (25 mil) square pins and 0.6 mm to 0.8 mm (24 mil to 35 mil) round pins.

NOTICE**Special accessories for signal socket**

The signal socket of the R&S RT-ZS60 has a special design to ensure optimal performance. The signal socket is *not* compatible to standard accessories based on 0.64 mm (25 mil) square pins or 0.8 mm (35 mil) round pins. Use only special accessories for R&S RT-ZS60 provided by Rohde & Schwarz.

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-ZS60 active voltage probe.

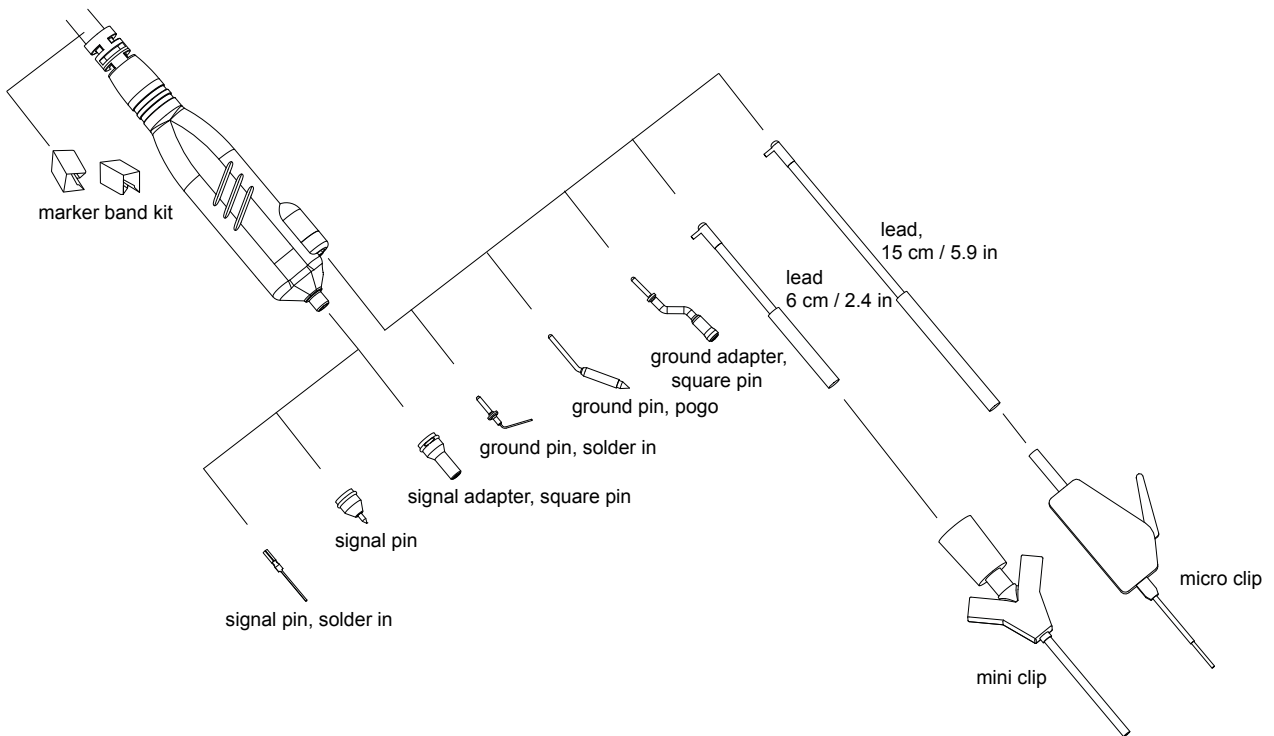
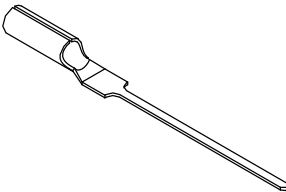
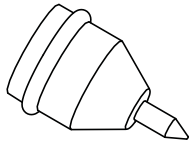


Figure 1-1: Available accessories

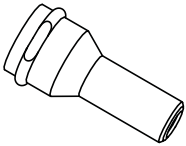
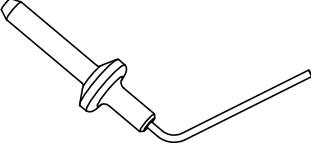
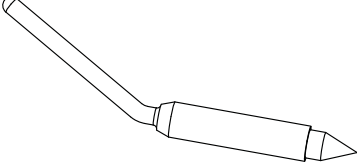
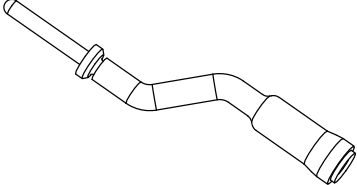
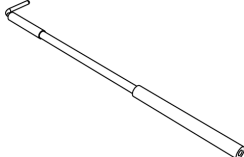
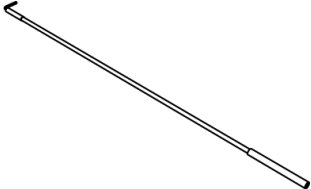
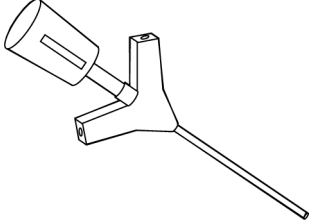
1.4.1 Accessories Supplied

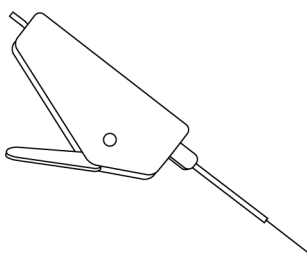
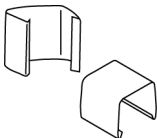
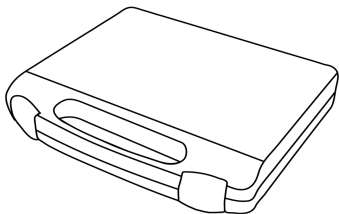
The following table shows the accessories supplied with the R&S RT-ZS60 active voltage probe.

Table 1-1: Accessories supplied

Item	Quantity	Description
	100	Signal pin, solder in
	5	Signal pin

Accessories and Items

Item	Quantity	Description
	2	Signal adapter, square pin
	20	Ground pin, solder in
	5	Ground pin, pogo
	2	Ground adapter, square pin
	2	Lead, 6 cm / 2.4 in
	2	Lead, 15 cm / 5.9 in
	2	Mini clip

Item	Quantity	Description
	2	Micro clip
	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-ZA4 mini clips

Item	Quantity	Description
Mini clip	10	Contains mini clips.

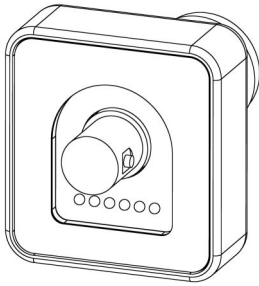
Table 1-3: R&S RT-ZA5 micro clips

Item	Quantity	Description
Micro clip	4	Contains micro clips.

Table 1-4: 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 1-5: R&S RT-ZA9 probe box to N / USB adapter

	<p>The adapter can be used to connect the R&S RT-ZS60 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>
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1.4.3 Service Accessories

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

Table 1-6: Service accessories

Item	Description
R&S RT-ZK2	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-ZS60 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-ZS60 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-ZS60 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 the standard BNC jack. The interface of the R&S RT-ZS60 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.

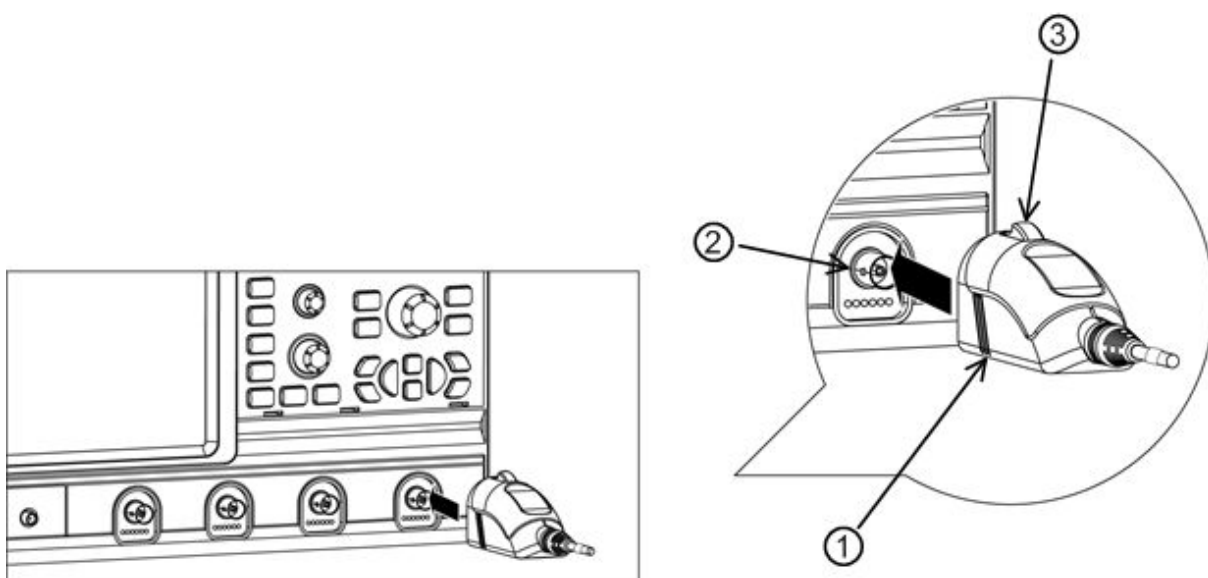


Figure 2-1: Connecting the probe to the Rohde & Schwarz oscilloscope

- ▶ 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.

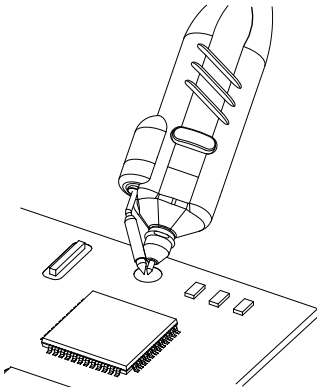
2.3 Using the Probe

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.

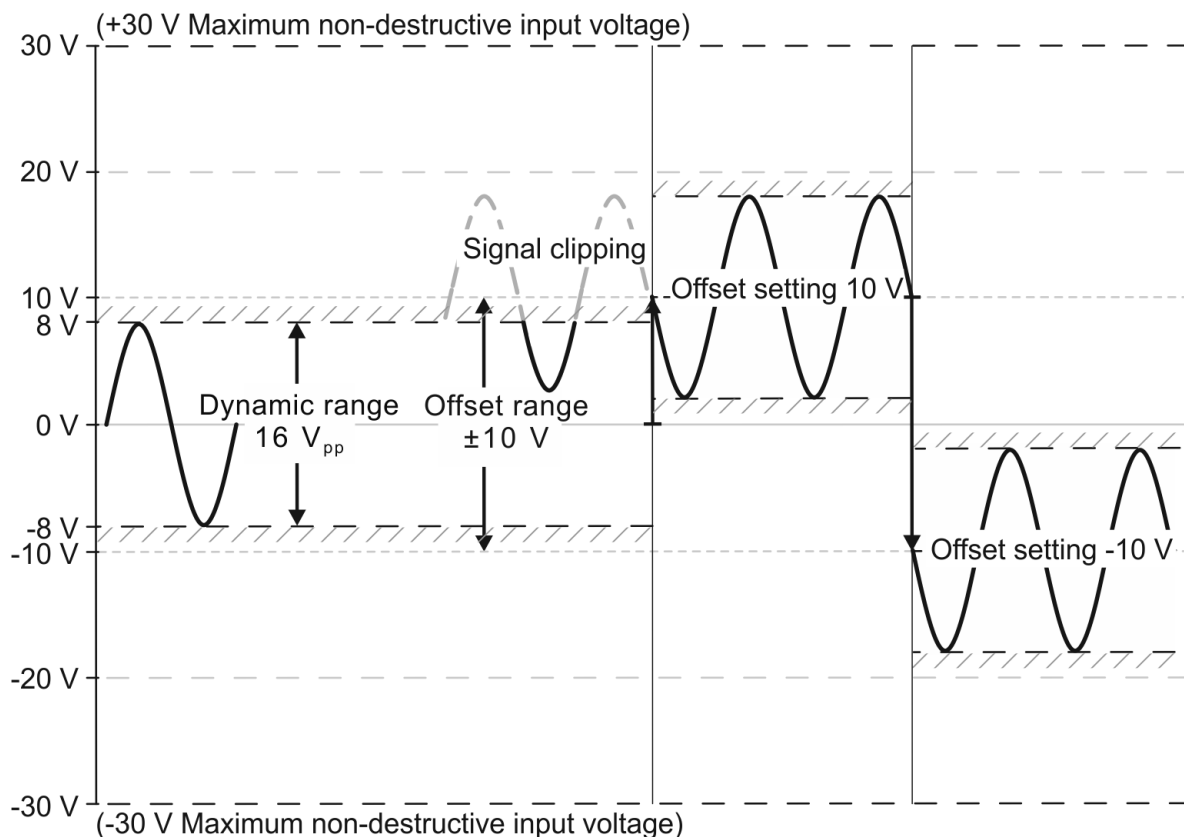


Figure 2-2: Offset compensation voltage and dynamic range

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 17.

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 16.

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

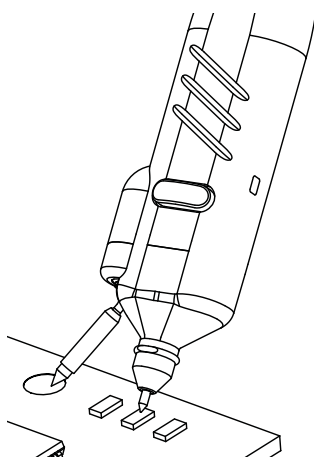
The included probe pins are exceptionally sharp and must be handled with extreme care. To prevent injuries, always use tweezers when inserting or removing pins.



Some solder-in accessories are very fine and sensitive. Stabilize the probe using appropriate means (e.g. adhesive pads, probe positioner) in order to protect the solder joint from excessive mechanical stress.

Pins

Signal pin and ground pin, pogo



Using the signal pin and ground pin, manual measurements can be performed without or with only minor limitation of the measurement bandwidth. Best results are achieved if the distance between signal and ground is small. Even with maximum distance, rise times shorter 70 ps can be reached.

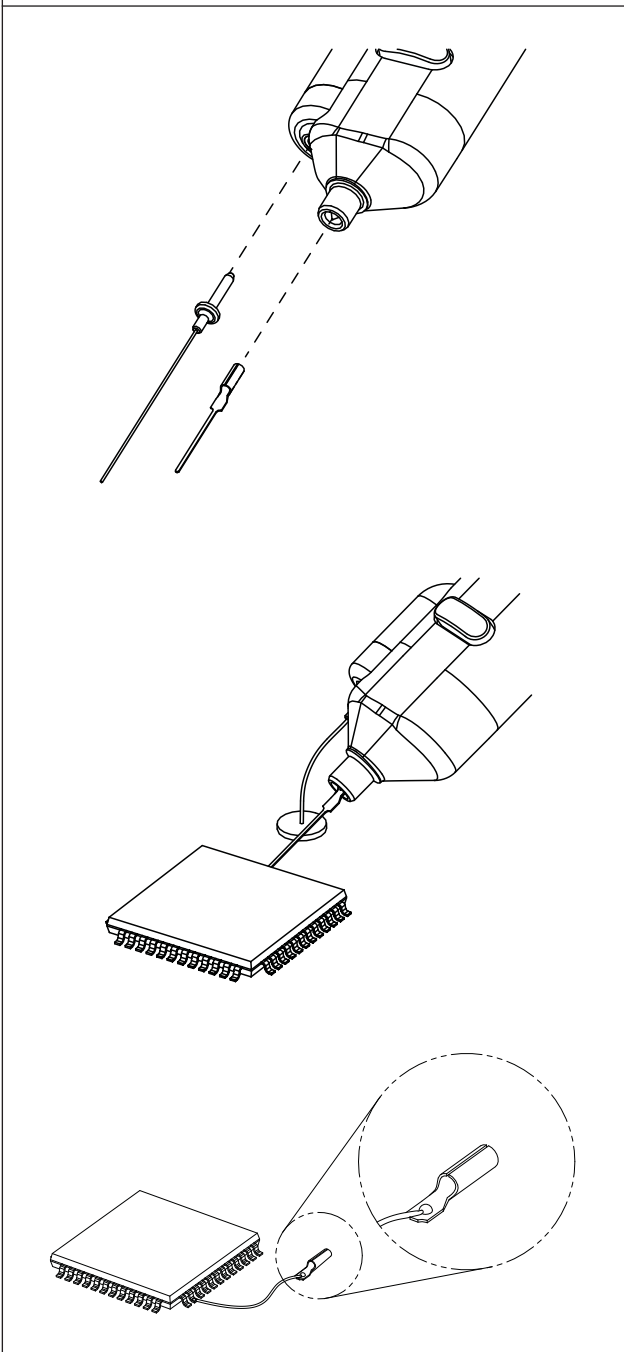
Because the spring-loaded ground pin compensates for minor unevenness and movements, this pin can establish a firm contact with the test point. It fits into the ground socket of the probe head.

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)

Signal pin, solder in, and ground pin, solder-in



Using two solder-in pins for ground and signal, the R&S RT-ZS60 is soldered directly into the circuit.

The pins can be exchanged on the probe and can remain in the circuit. Thus, you can plug the probe on different test points.

Use tweezers to insert the solder-in pins into the sockets on the probe, and then cut to the appropriate length. Keep the pins as short as possible.

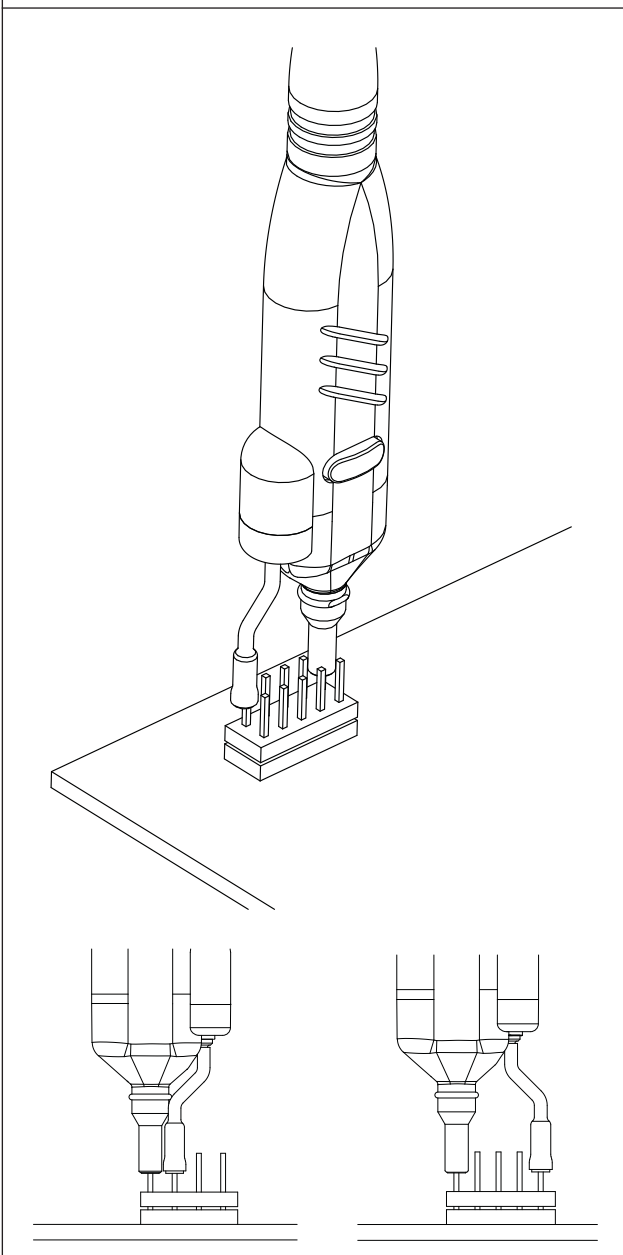
The fine wires on this adapter are best suited to make secure contact with small contact points, such as SMT components or IC pins.

Alternatively, the signal pin has a solder tail for direct soldering of wires.

Distance range:

0 mm to 20 mm (0 mil to 800 mil)

Signal adapter, square pin, and ground adapter, square pin



Using two square-in pin adapters for ground and signal, the probe can be connected directly to a pin strip.

The 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.

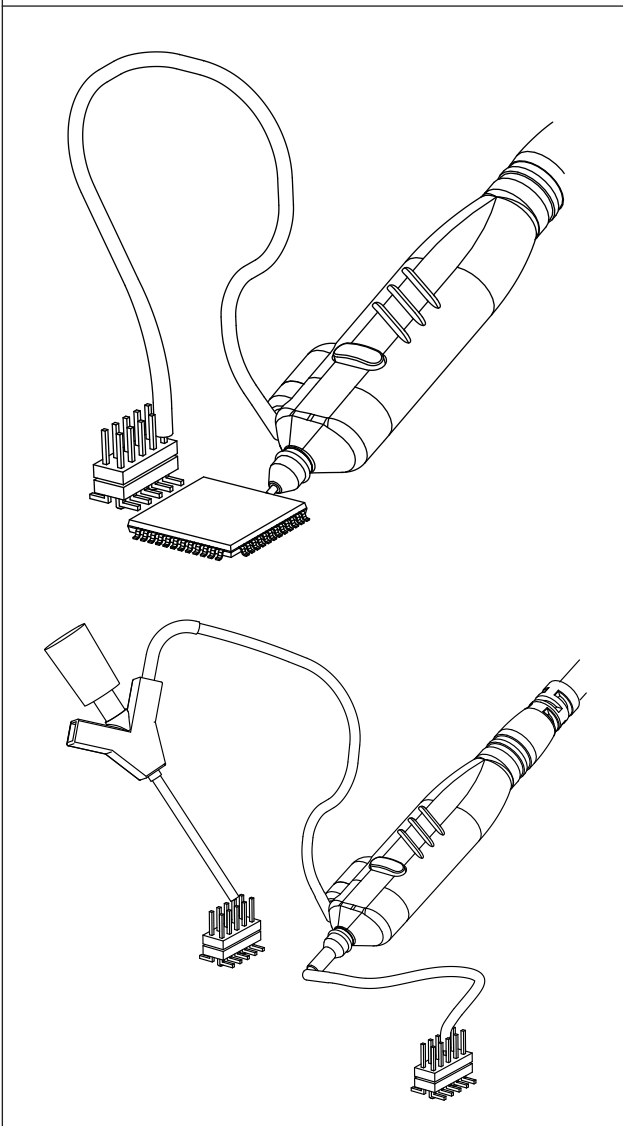
The distance between the signal and ground adapter can be adjusted by turning the ground adapter.

Distance range:

2.54 mm to 10.16 mm (100 mil to 400 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.

Connecting a lead to the signal socket of the R&S RT-ZS60 requires a signal adapter, square pin.

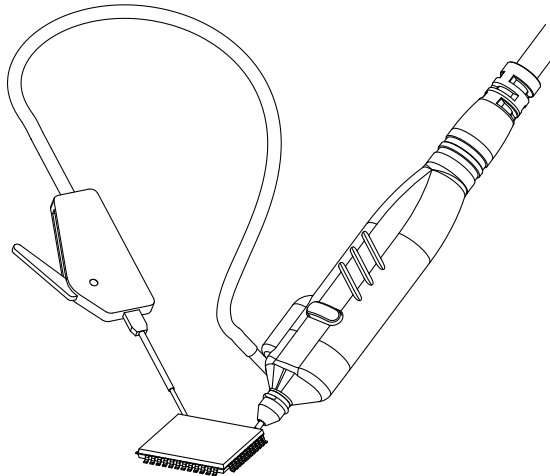
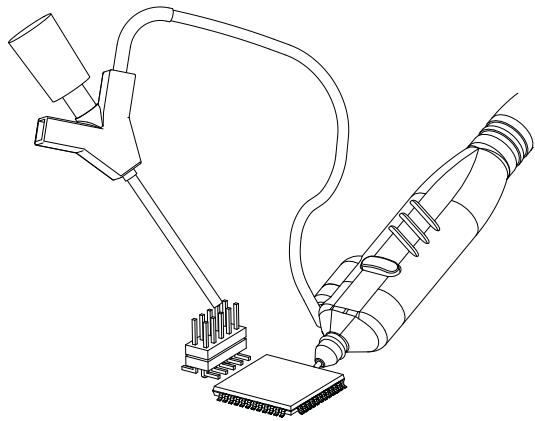
Length:

Short lead: 6 mm (236 mil)

Long lead: 15 mm (591 mil)

Clips

Mini and micro clips



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

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

Clips can be used to contact ground and signal.

To connect a clip to the ground socket, a lead is required.

To connect a clip to the signal socket, the signal adapter, square pin, is required.

4 Measurement Principles

The R&S RT-ZS60 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.

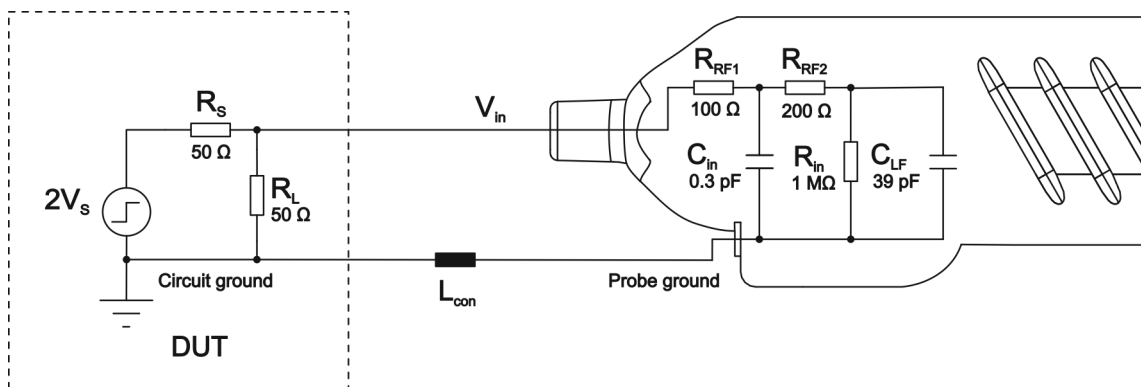


Figure 4-1: Equivalent circuit model of the R&S RT-ZS60 probe

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}	RF input capacitance of the probe
C_{LF}	LF input capacitance of the probe
R_{RF1}, R_{RF2}	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.

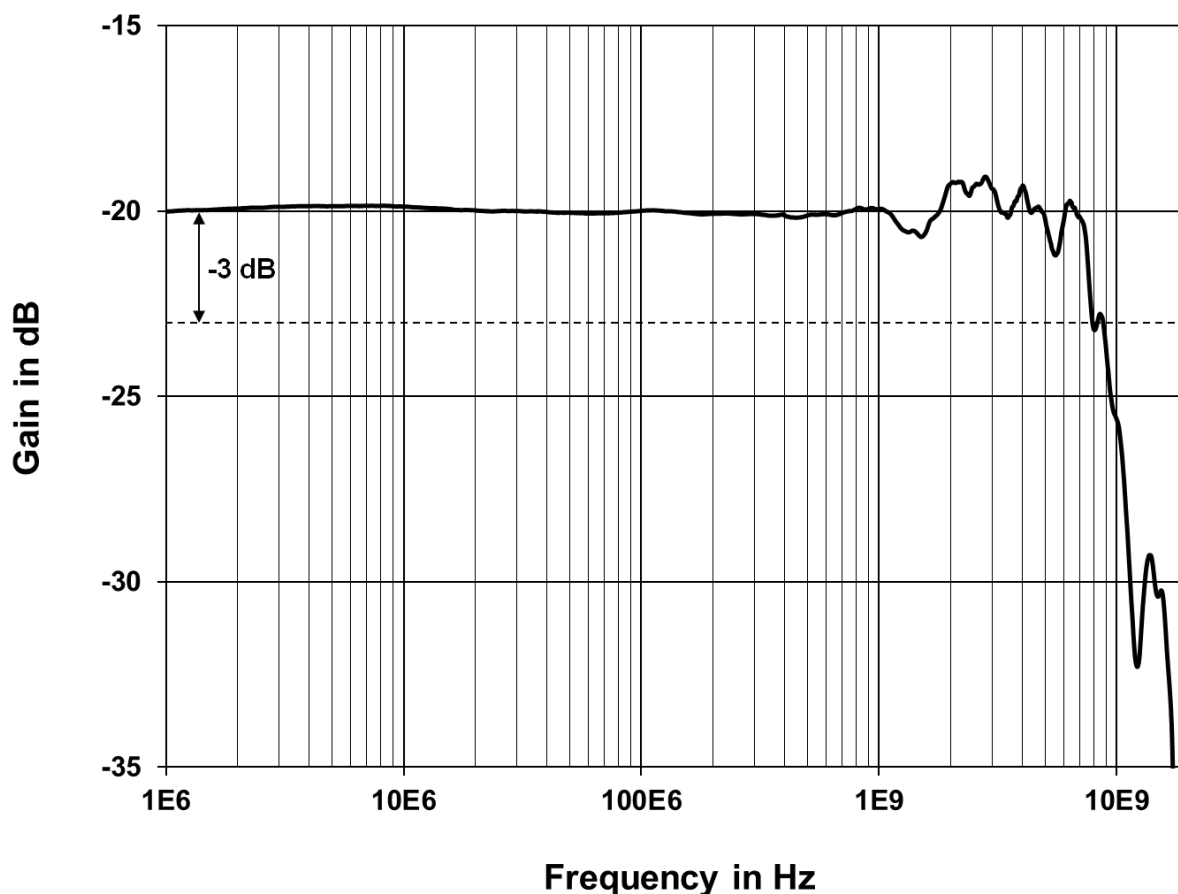


Figure 4-2: Amplitude/frequency response of the R&S RT-ZS60

The bandwidth:

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

Signal Integrity of the Transferred Signal

- 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 4-2](#) shows the typical amplitude/frequency response of an R&S RT-ZS60 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-ZS60 active voltage probe.

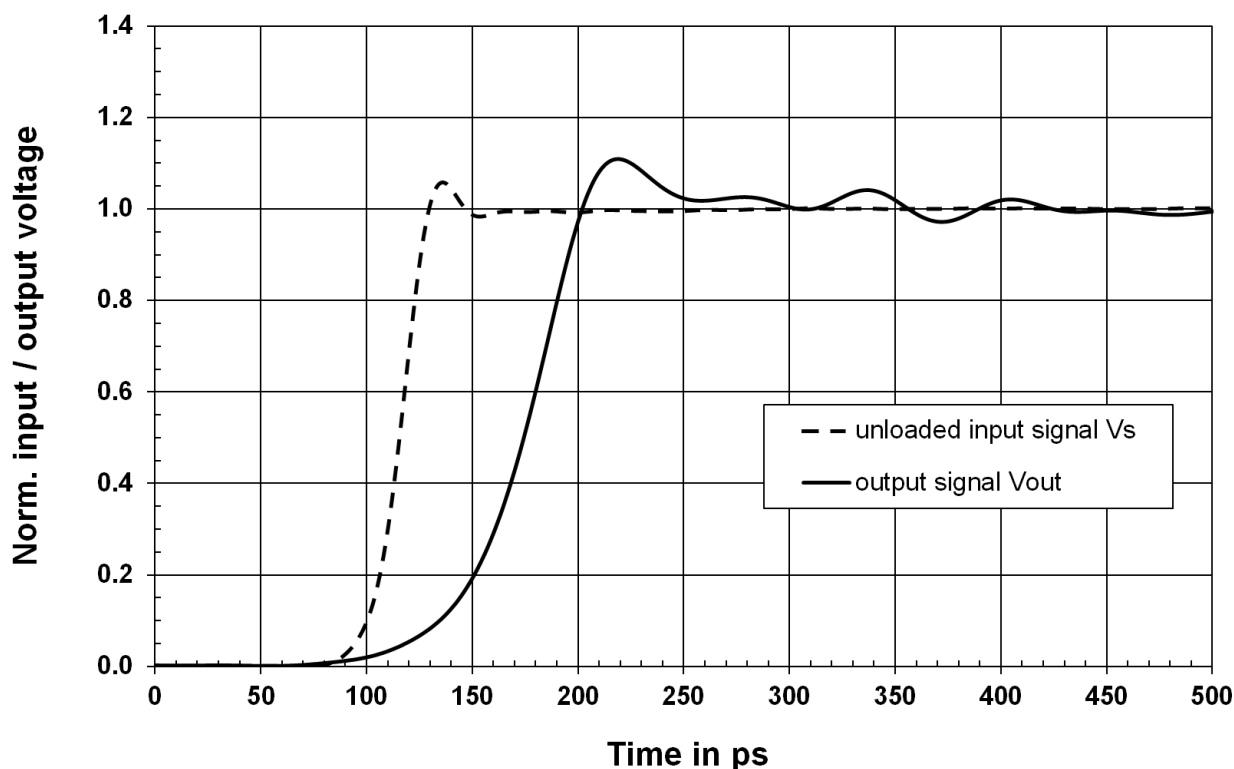


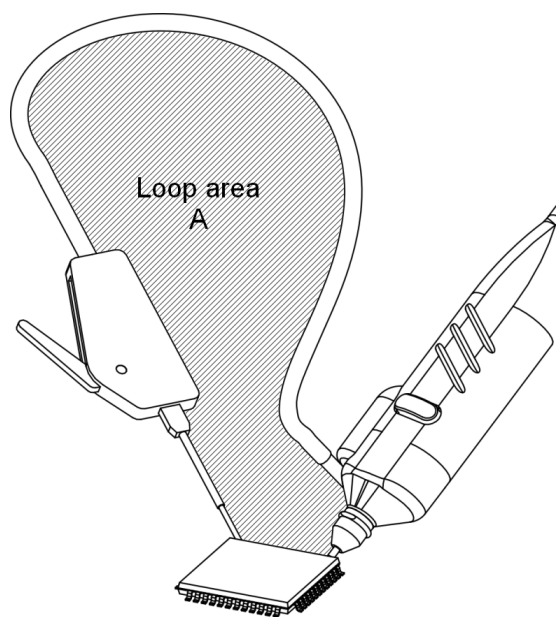
Figure 4-3: Step response of the R&S RT-ZS60

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 .
- 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.



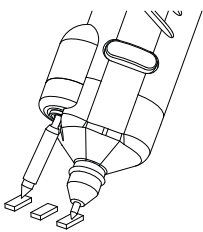
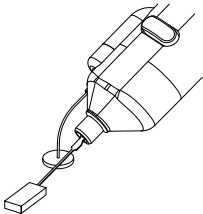
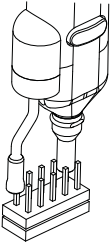
$$L_{con} \text{ proportional to } A$$
$$f_{resonance} \approx \frac{1}{2\pi\sqrt{L_{con} \cdot C_{in}}}$$
$$BW \text{ proportional to } \frac{1}{\sqrt{L_{con}}}$$

Figure 4-4: Ground connection and connection inductance

4.1.3 Performance with Different Connection Types

The [Table 4-2](#) shows three types of connection between probe and DUT as well as the associated rise times, bandwidths, input impedances and overshoots.

Table 4-2: Typical rise time, bandwidth, input impedance and overshoot with different connection types

No	Connection Type	Connection			Rise time	Bandwidth	Min. input impedance $ Z_{\min} $	Over-shoot
		Signal socket	Ground socket					
1		signal pin	ground pin, pogo	wide spacing	64 ps	6 GHz	150 Ω	9 %
				narrow spacing	55 ps	8 GHz	110 Ω	25 %
2		signal pin, solder in	ground pin, solder in	short pins	66 ps	6.5 GHz	155 Ω	8 %
				long pins	70 ps	4.5 GHz	235 Ω	11 %
3		signal adapter, square pin	ground adapter, square pin	wide spacing	64 ps	5.5 GHz	120 Ω	11 %
				narrow spacing	52 ps	9 GHz	75 Ω	34 %

Signal Integrity of the Transferred Signal

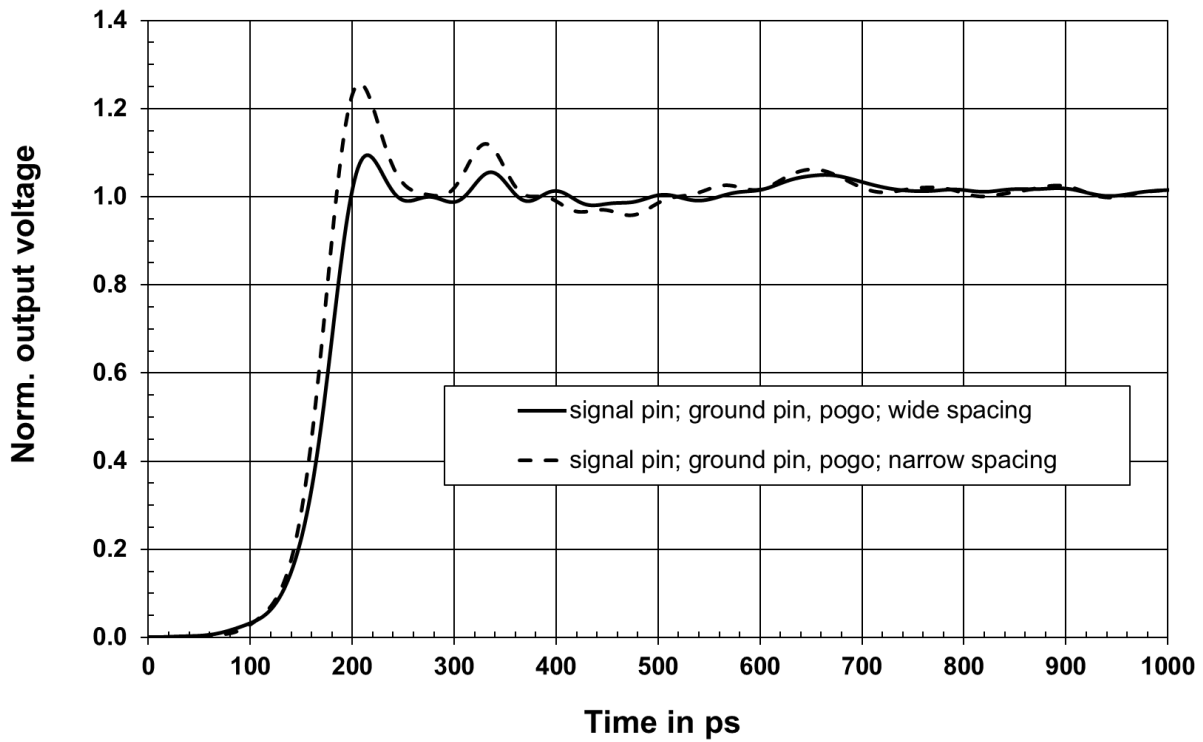


Figure 4-5: Step response of the R&S RT-ZS60 with a type 1 connection

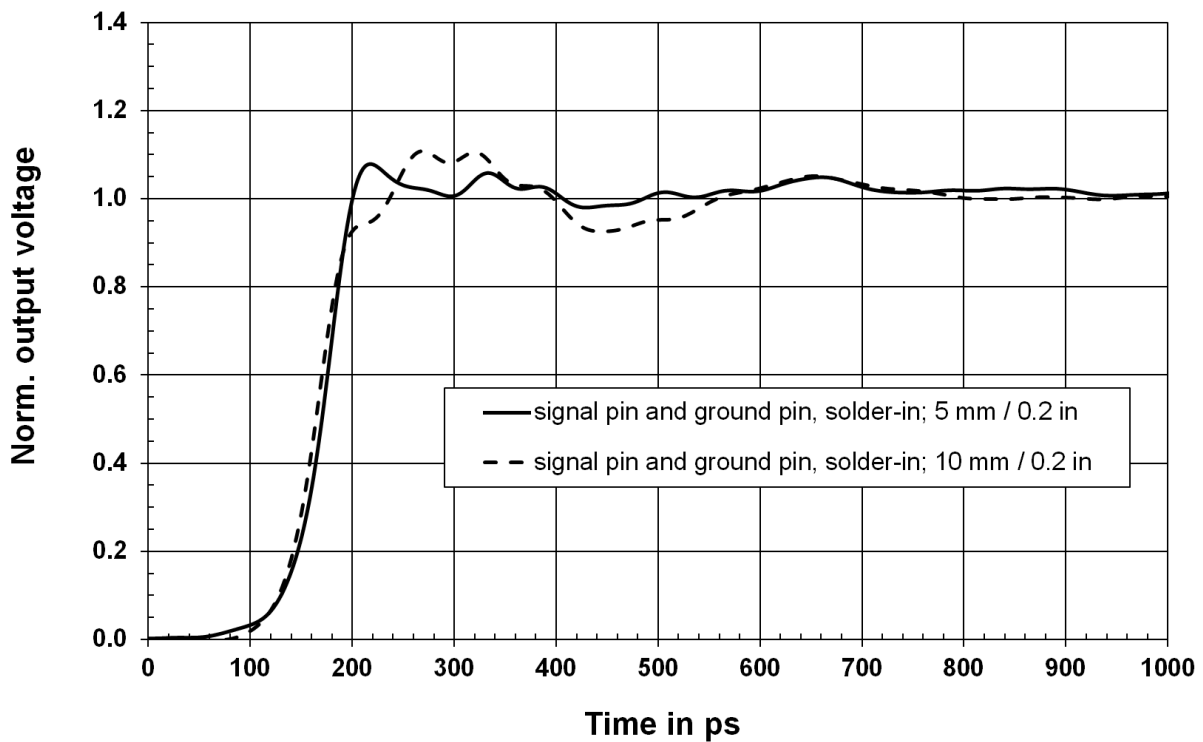


Figure 4-6: Step response of the R&S RT-ZS60 with a type 2 connection

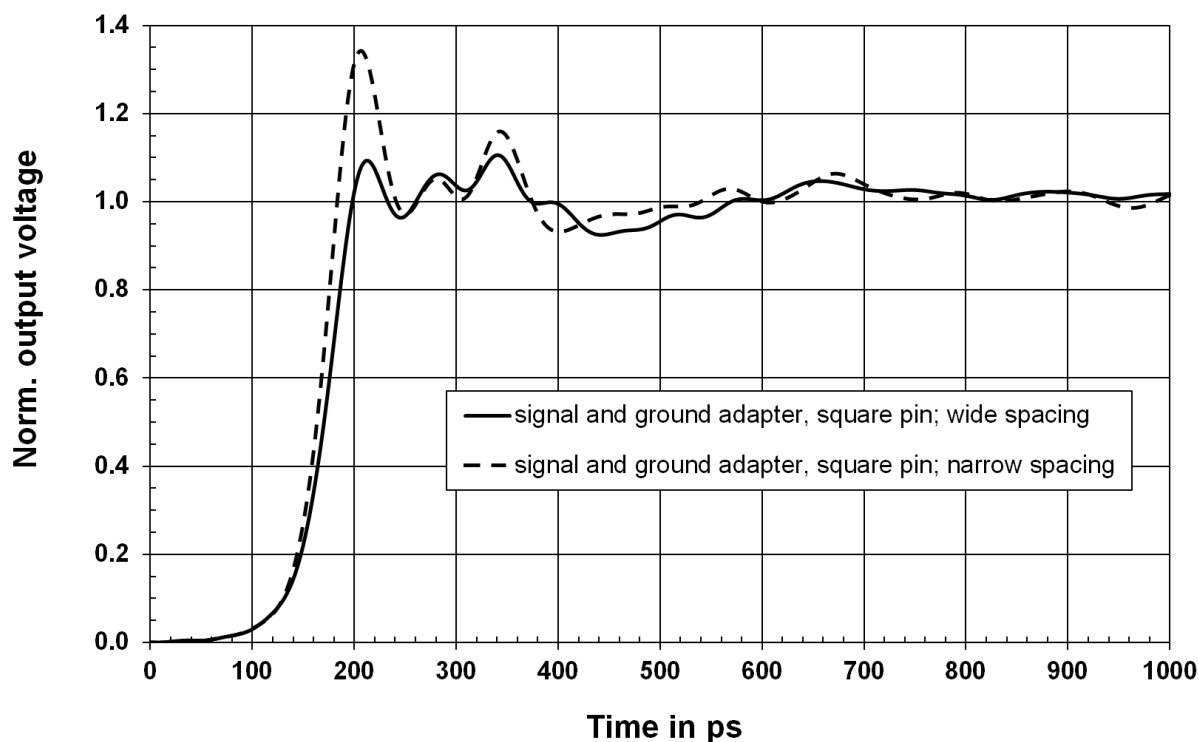


Figure 4-7: Step response of the R&S RT-ZS60 with a type 3 connection

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}
- LF input capacitance C_{LF}
- RF resistance $R_{RF1} + R_{RF2}$
- RF input capacitance C_{in}
- Minimum input impedance $|Z_{min}|$

Signal Loading of the Input Signal

The resulting input impedance versus frequency is indicated in Figure 4-8. The trace shows five characteristic areas, which can be assigned to R_{in} , C_{LF} , R_{RF} , C_{in} , and $|Z_{min}|$. 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.

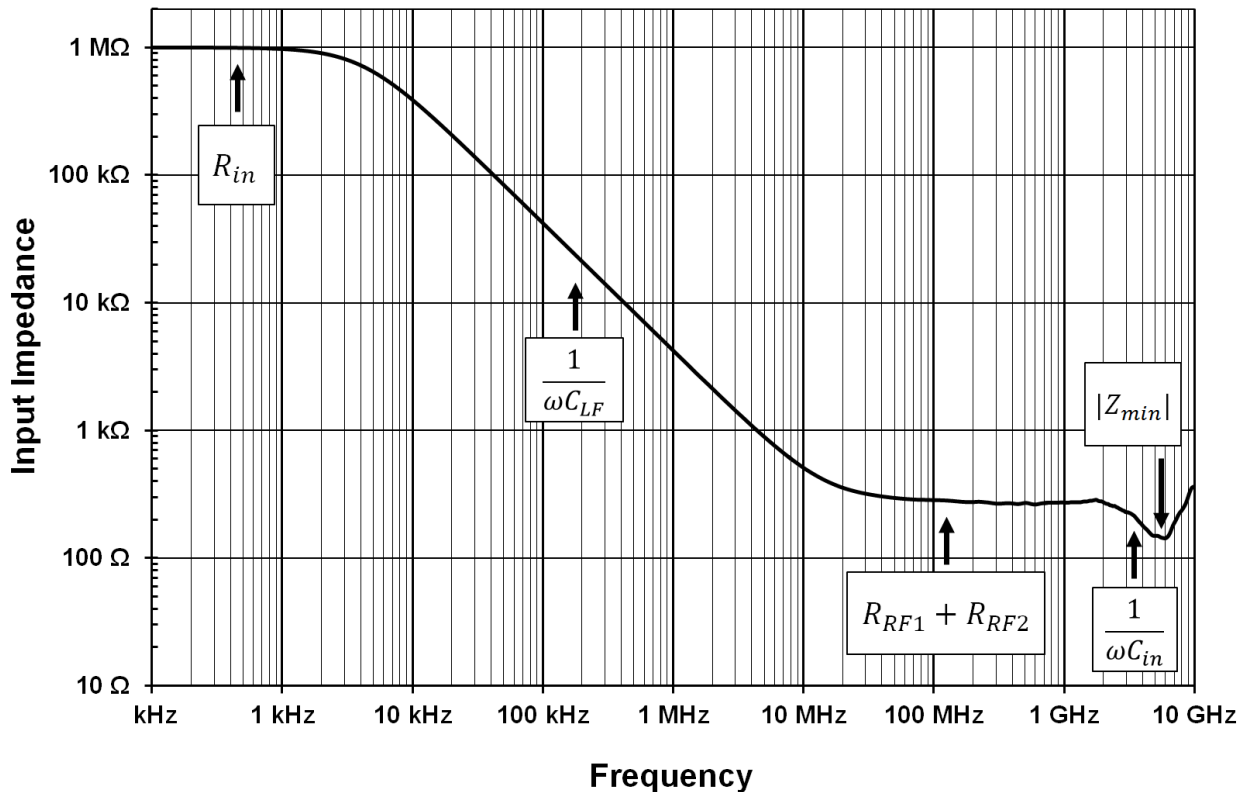


Figure 4-8: Magnitude of the input impedance of the R&S RT-ZS60 probe as a function of frequency

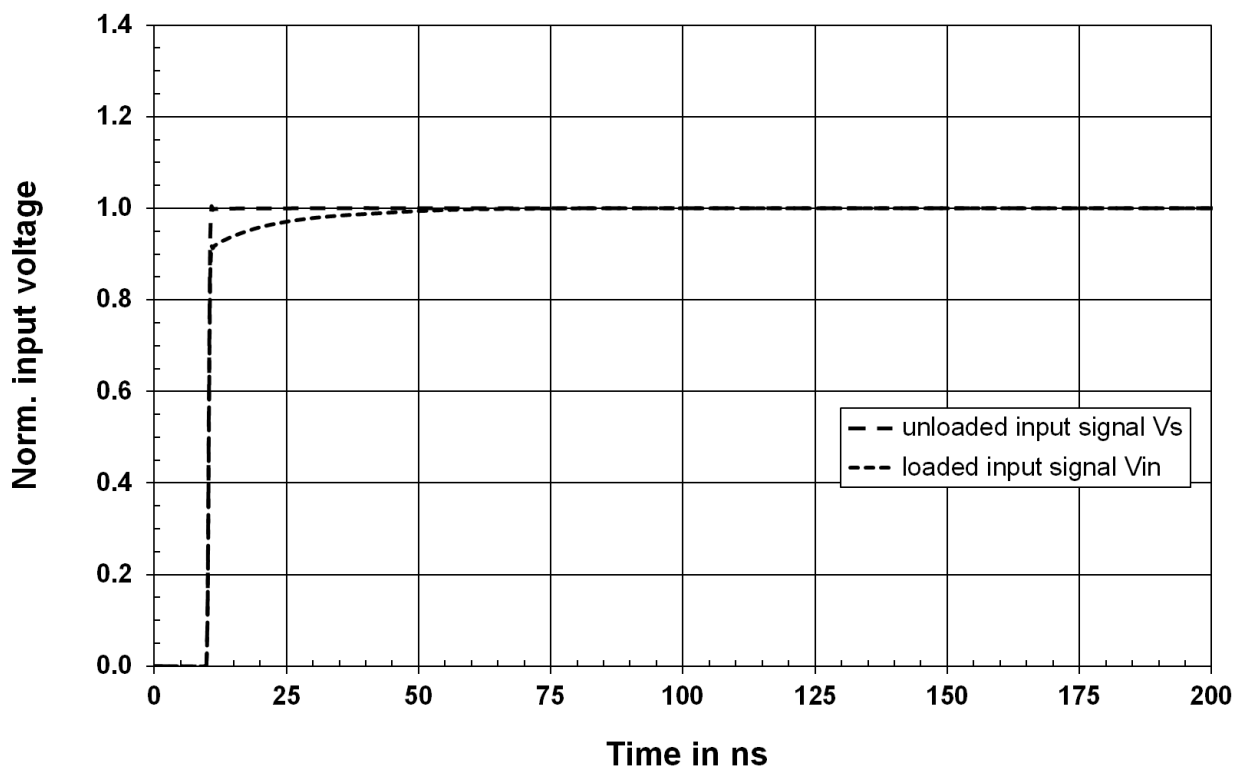


Figure 4-9: Signal loading caused by the R&S RT-ZS60 probe at an effective source impedance of 25Ω

4.2.1.1 Input Resistance

The input resistance R_{in} determines the loading of the DUT at DC and low frequencies (< 4 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-ZS60 probe due to the high input resistance of the probe ($1 \text{ M}\Omega$).

4.2.1.2 LF Capacitance

The LF capacitance C_{LF} causes the input impedance to decrease in the low frequency range (4 kHz to 20 MHz). The LF capacitance affects the settling time of the loaded input voltage for fast transients, see [Figure 4-9](#).

4.2.1.3 RF Resistance

R_{RF1} and R_{RF2} (summarized R_{RF}) determine the input impedance in the frequency range from 20 MHz to 2 GHz. Due to the constantly high input impedance of $300\ \Omega$ over the whole range, the loading of high-frequency signals in $50\ \Omega$ environments is very small.

4.2.1.4 Input Capacitance C_{in} and Minimum Input Impedance $|Z_{min}|$

The input capacitance C_{in} causes the input impedance to decrease for high frequencies above 2 GHz. C_{in} is very low - Typically under 300 fF.

The minimum input impedance $|Z_{min}|$ mainly depends on the connection inductance and the connection type. An overview is given in [Table 4-2](#).

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](#).

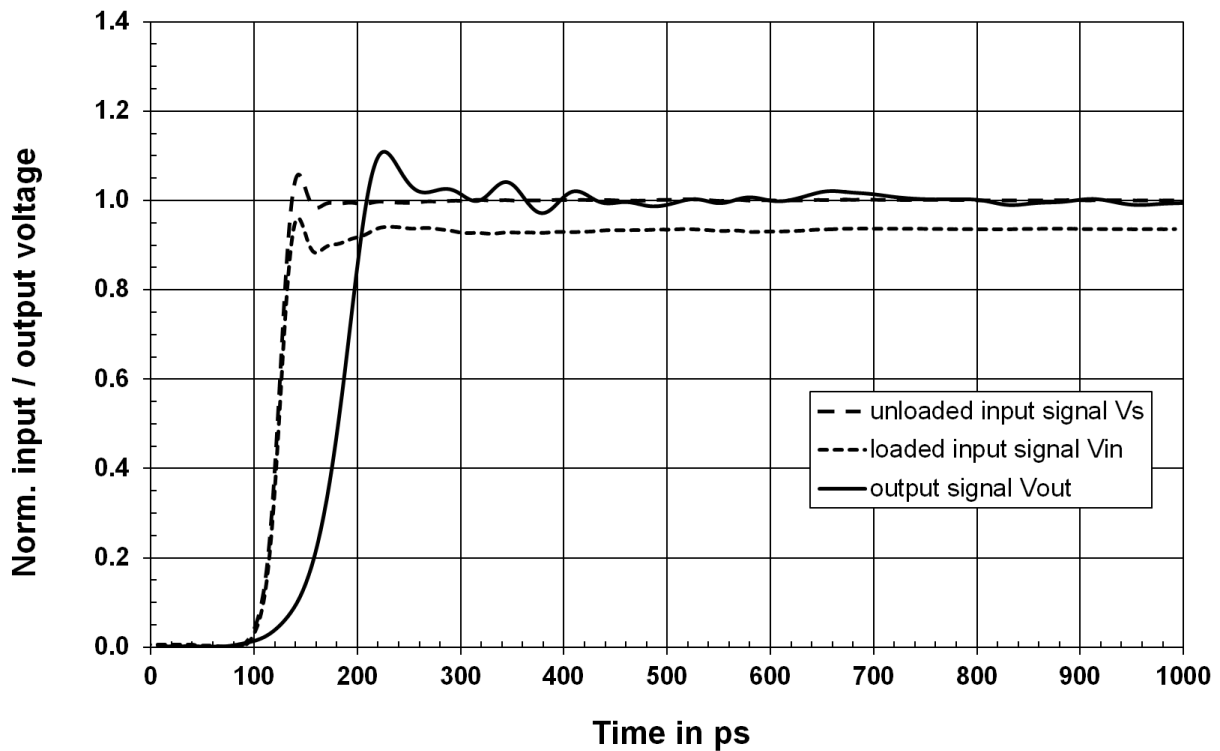


Figure 4-10: Unloaded and loaded input signal and step response using the example of R&S RT-ZS60

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-ZS60 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-ZS60 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-ZS60 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).

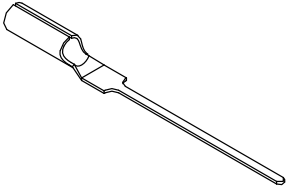
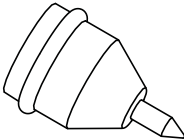
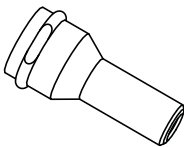
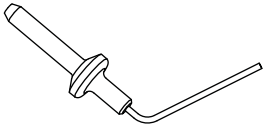
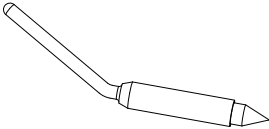
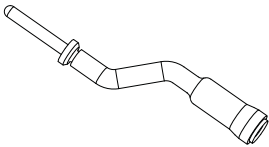
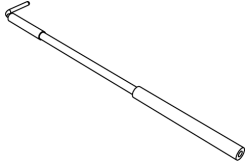
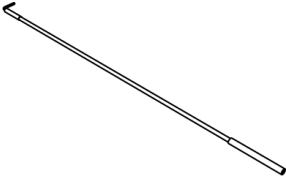
5.5 Discarding the Product

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: Accessory spare parts

Pos.	Item	Description	Material number
1		Signal pin, solder in	1417.0838.00
2		Signal pin	1175.7651.00
3		Signal adapter, square pin	1175.7668.00
4		Ground pin, solder in	1417.0538.00
5		Ground pin, pogo	1175.7716.00
6		Ground adapter, square pin	1175.7597.00
7		Lead, 6 cm / 2.4 in	1416.0128.00
8		Lead, 15 cm / 5.9 in	1416.0134.00

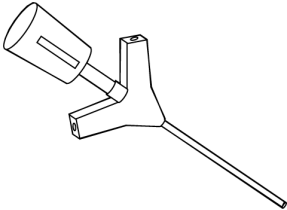
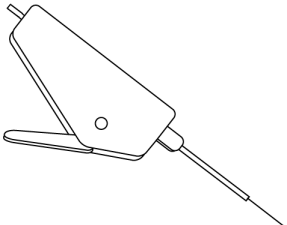
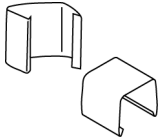
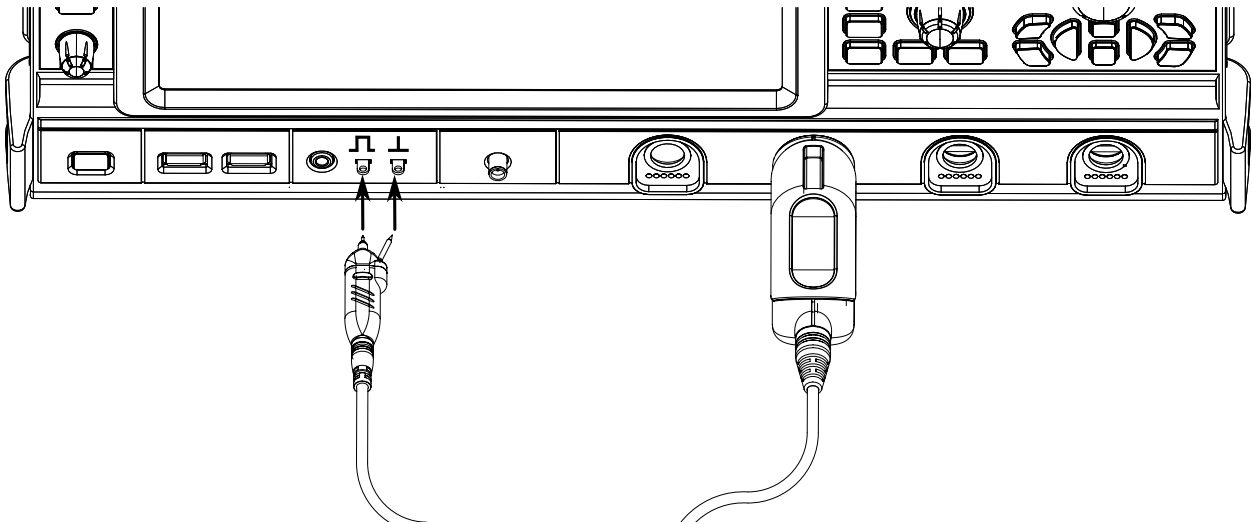
Pos.	Item	Description	Material number
9		Mini clip	1416.0105.00
10		Micro clip	1416.0111.00
11		Marker band kit	1416.0205.00
12	Pogo pin	Pogo pin connector, 6 pins	3584.6396.00
13	R&S RT-ZK2	R&S RT-ZK2 service kit	1410.5305.02



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-ZS60 active voltage probe. The functional check is not suitable for verifying compliance with the probe specifications.



1. Connect the R&S RT-ZS60 probe to a Rohde & Schwarz oscilloscope as described in [Chapter 2.1, "Connecting the Probe to the Oscilloscope"](#), on page 15.
2. Connect the signal pin to the square wave output  of the oscilloscope.
3. Connect the ground pin to the probe ground connector  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.

Index

A

Accessories	10
Spare Parts	38
AutoZero	16

B

Bandwidth	6, 27
-----------------	-------

C

Cleaning	38
Clips	12, 24
Connecting to DUT	20
Connecting to oscilloscope	15
Connection inductance	29

D

Data memory	6
DC component of input signal	17
DC measurement	18
Dynamic range	6, 17

E

Electrostatic discharge	15
ESD	15

F

Functional check	41
------------------------	----

I

Inductance	29
Input capacitance	6
Input impedance	32
Input resistance	6, 34

L

Leads	13, 23
LF capacitance	34

M

Micro button	6, 17
--------------------	-------

N

N/USB adapter	13
---------------------	----

O

Offset compensation	17
---------------------------	----

P

Pins	
Inserting and removing	20
Usage	20
Probe box	9
Probe head	8
Probe identification	16
ProbeMeter	6, 18
Probing principles	25
Product description	5

R

RF resistance	35
---------------------	----

S

Service kit	13
Service manual	13
Signal integrity	27
Signal loading	32
Spare parts	38
Step response	28

U

Unpacking	7
Using accessories	
Ground adapter, square pin	22
Ground pin, pogo	20
Ground pin, solder in	21
Leads	23
Micro clip	24
Mini clip	24
Signal adapter, square pin	22
Signal pin	20
Signal pin, solder in	21

Z

Zero error correction	16
-----------------------------	----