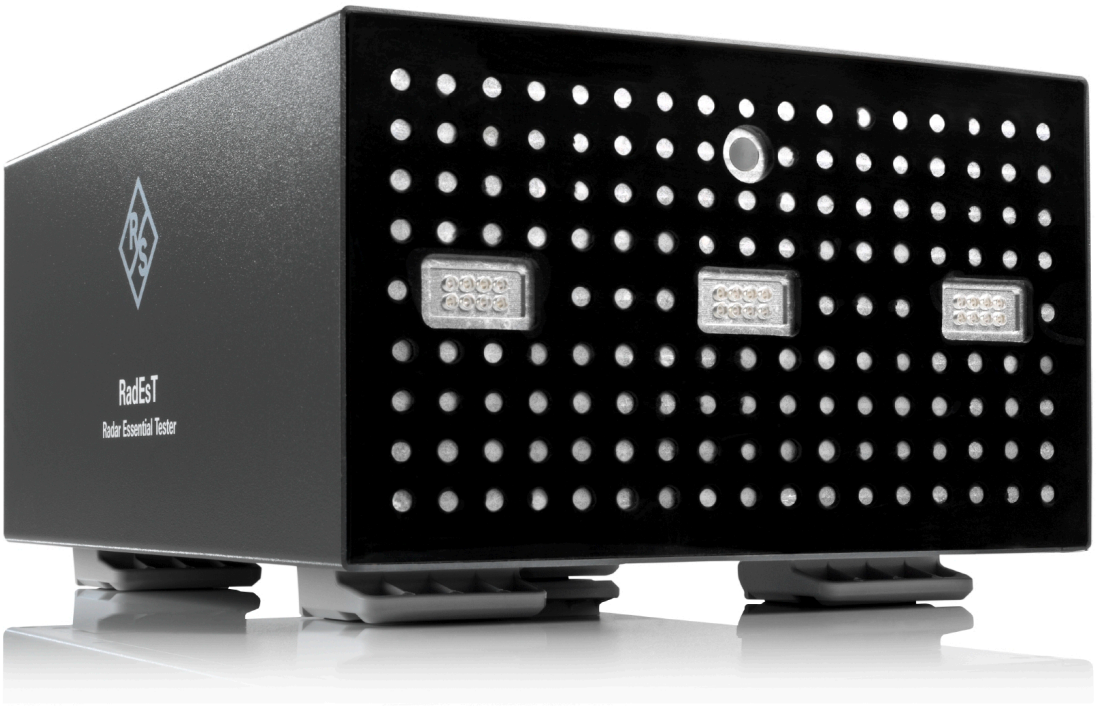
R&S®RadEsT
Radar Essential Tester
User Manual



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Version 02

ROHDE&SCHWARZ
Make ideas real

This document describes the following models and options:

- R&S®RadEsT (1344.0005K02)
- R&S RadEsT-Z5 self-test plate (order no. 1344.1699.02)
- R&S RadEsT-Z50 shielding system (order no.1341.0156.03)
- R&S RadEsT-Z55 shiedling system (order no.1341.0156.04)
- R&S RadEsT software (material no. 1344.0757.00)

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1179.8000.02 | Version 02 | R&S®RadEsT

Throughout this document, R&S®RadEsT is indicated as R&S RadEsT.

Contents

1 Safety and regulatory information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the following sections.

Intended use

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

Where do I find safety information?

Safety information is part of the product documentation. It warns you of potential dangers and gives instructions on how to prevent personal injury or damage caused by dangerous situations. Safety information is provided as follows:

- In Section 1.1, "Safety instructions", on page 7. The same information is provided in many languages as printed "Safety Instructions". The printed "Safety Instructions" are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

1.1 Safety instructions

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

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the specifications document, manuals and the printed "Safety Instructions" document. If you are unsure about the appropriate use, contact Rohde & Schwarz customer support.

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

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

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

Lifting and carrying the product

The maximum weight of the product is provided in the specifications document. You can lift or carry the product by yourself, if you can manage the weight on your own. Alternatively, you can use lifting or transporting equipment. Follow the instructions provided by the equipment manufacturer.

Choosing the operating site

Only use the product indoors. The product casing is not waterproof.

Observe the ambient conditions stated in the specifications document. Examples of ambient conditions are altitude, operating temperature and climatic loads.

Setting up the product

Always place the product on a stable, flat and level surface with the bottom of the product facing down. If the product is designed for different positions, secure the product so that it cannot fall over.

If the product has foldable feet, always fold the feet completely in or out to ensure stability. The feet can collapse if they are not folded out completely or if the product is moved without lifting it. The foldable feet are designed to carry the weight of the product, but not an extra load.

If stacking is possible, keep in mind that a stack of products can fall over and cause injury.

If you mount products in a rack, ensure that the rack has sufficient load capacity and stability. Observe the specifications of the rack manufacturer. Always install the products from the bottom shelf to the top shelf so that the rack stands securely. Secure the product so that it cannot fall off the rack.

Connecting the product

Before connecting the interfaces or measuring inputs of the product to other products or electrical circuits, make sure that the other products or electrical circuits provide special protection against electric shock. This protection principle is referred to as SELV (safety extra-low voltage) and is based on a low voltage level and increased insulation. Exceptions are indicated by a measurement category on the product and given in the specifications document.

Connecting to power

The product runs on DC voltage. Connect the product only to the external power supply that is delivered with the product.

Cleaning the product

Use a dry, lint-free cloth to clean the product. When cleaning, keep in mind that the casing is not waterproof. Do not use liquid cleaning agents.

Meaning of safety labels

Safety labels on the product and its accessories warn against potential hazards.

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

	DC - direct current Connect to a DC power supply of the specified voltage range.

1.2 Labels on the product

Labels on the casing inform about:

- Personal safety, see "Meaning of safety labels" on page 8
- Product and environment safety, see Table 1-1
- Device information is provided on a sticker attached to the rear panel of the product.
  For details, see Section 4.13, "Device ID", on page 17.

Table 1-1: Labels regarding product and environment safety

	Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its service life. For more information, see "Disposing of electrical and electronic equipment" on page 70.

1.3 Warning messages in the documentation

A warning message points out a risk or danger that you need to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if you do not follow the safety precautions.

WARNING

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

CAUTION

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

NOTICE

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

1.4 Regulatory information

The R&S RadEsT complies with the following regulations.

1.4.1 Regulations for the USA

FCC compliance

This equipment has been tested and found to comply with the limits for Industrial, Scientific and Medical Equipment (ISM), pursuant to part 18 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in an industrial installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference other devices, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult Rohde & Schwarz customer service for help.

1.4.2 Regulations for Canada

ICES-001 compliance

This class A ISM device complies with Canadian ICES-001.

Cet appareil ISM de la classe A est conforme à la norme NMB-001 du Canada.

2 Documentation overview

This section provides an overview of the R&S RadEsT user documentation.

Getting started

Introduces the R&S RadEsT and describes how to set up and start working with the product. A printed version is included in the delivery.

User manual

Contains the description of all R&S RadEsT instrument functions. It also provides information on maintenance, instrument interfaces and error messages.

The user manual is available on the R&S RadEsT internet at https://www.rohde-schwarz.com/product/radest.

Safety instructions

Contains safety instructions, operating conditions and further important information. A printed version is included in the delivery.

Specifications and brochure

The product specifications (also called data sheet) contain the technical specifications of the R&S RadEsT. It also lists the options and their order numbers as well as optional accessories.

The brochure provides an overview of the R&S RadEsT and shows their specific characteristics.

Both documents are available on the internet at https://www.rohde-schwarz.com/product/radest.

Release notes and open source acknowledgment

The release notes list new features, improvements and known issues of the current firmware version.

The open source acknowledgment document is part of the delivery and provides verbatim license texts of the used open source software.

3 Welcome to the R&S RadEsT

The R&S RadEsT is the versatile and extensive automotive radar target simulator designed to meet all testing needs from the lab to the vehicle level. With its robust features, wide range of use cases and exceptional value, R&S RadEsT opens new possibilities in radar testing. Experience the all-rounder advantage with R&S RadEsT – the perfect solution for precise, reliable and dynamic radar target simulation.

- Static and dynamic target simulation in the automotive radar frequency band from 76 GHz to 81 GHz (part of the waveguide E band in the frequency spectrum)
- Integrated analysis functionalities for radar signals in the automotive radar frequency ranges (24 GHz and 76 GHz to 81 GHz)
- Small form factor and light weight
- Self-check capability
- Reduced reflections and multipath effects
- Shielded environment for better results

4 Instrument tour

The front panel of the R&S RadEsT contains the measurement electronics consisting of 12 Tx antennas, 12 Rx antennas and an additional Rx antenna for 24 GHz signals. The rear panel contains the connectors and control elements.

Front panel

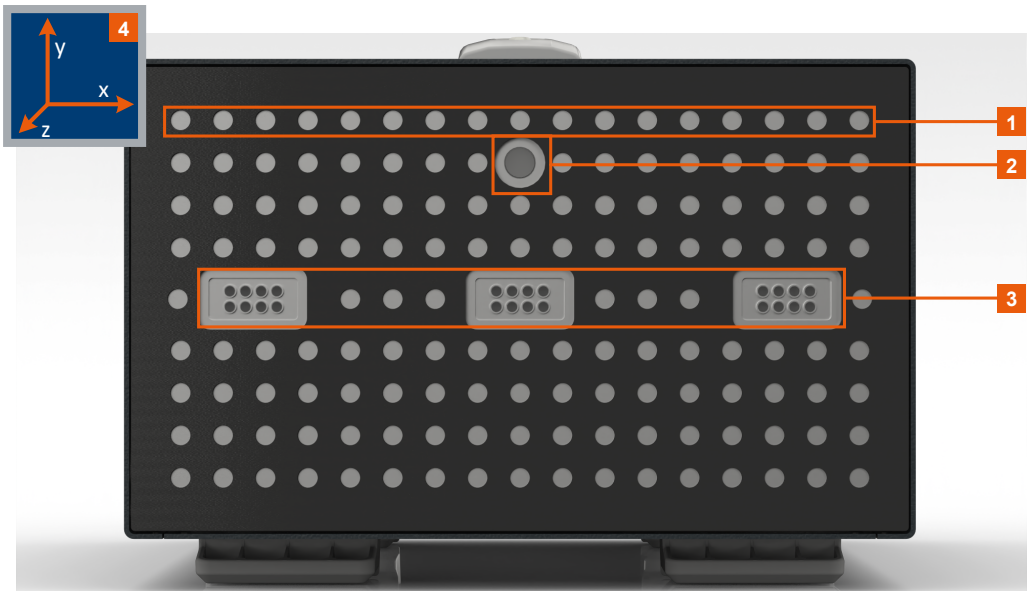


Figure 4-1: Front panel view

1 = Absorber structure
2 = Rx antenna for 24 GHz signals
3 = Rx and Tx antennas for 76 GHz to 81 GHz signals
4 = Global coordinate system (for polarization detection)

Rear panel

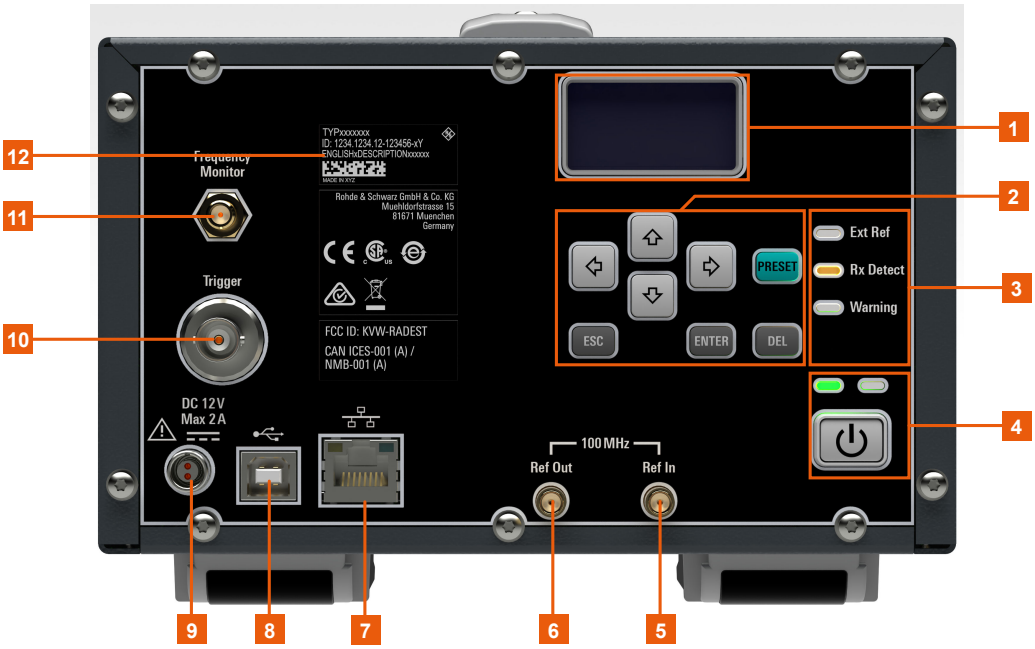


Figure 4-2: Rear panel view

1 = Display
2 = Control elements
3 = Status LEDs
4 = Power button
5 = 100 MHz frequency reference input
6 = 100 MHz frequency reference output
7 = LAN interface
8 = USB interface
9 = DC power connector
10 = Trigger input
11 = Frequency monitor output (currently not supported)
12 = Device ID

4.1 Absorber structure

The absorber structure is a passive element of the R&S RadEsT. It reduces the radar cross section of the R&S RadEsT, which in turn reduces the instrument's interference potential. Make sure not to damage the absorber structure while handling the R&S RadEsT.

To reduce interference even more, install the shielding system in front of the R&S RadEsT. The shielding system is available as an accessory.

4.2 Antennas

Number of antennas: The R&S RadEsT has 25 antennas:

- 12 Tx antennas for the 76 GHz to 81 GHz frequency range
- 12 Rx antennas for the 76 GHz to 81 GHz frequency range
- 1 Rx antenna for the 24 GHz frequency range

Function: The antennas in the 76 GHz to 81 GHz frequency range are the main feature of the R&S RadEsT. They receive and transmit the signals to simulate radar objects. The Rx antennas also receive and evaluate the signals for polarization and power measurements.

The 24 GHz Rx antenna measures the power of a 24 GHz radar sensor.

Antenna characteristics

The user interface of the R&S RadEsT software and this document refer to individual antennas by numbers or antenna groups. Note that the polarization of the antennas is fix and as indicated in Figure 4-3.

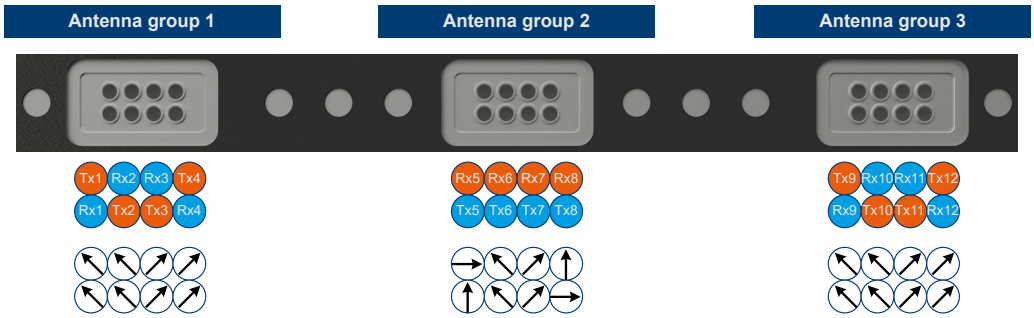


Figure 4-3: Antenna groups and numbering of individual antennas

↑ = vertical polarization
→ = horizontal polarization
↗ = +45° polarization
↖ = -45° polarization

4.3 Display

Type: OLED

Function: The display is the visual interface for interactions with the R&S RadEsT.

4.4 Control elements

Function: The control elements consist of various buttons that you can use to interact with the R&S RadEsT.

- "Preset": Presets the R&S RadEsT to its default configuration.
- "Del": Deletes an entry.
- "Enter": Confirms a selection or toggles the state of a parameter.
- "Esc": Exits a menu and returns to the previous menu level.
- Cursor keys: Navigate through the menus.

For an overview of all settings available in the user interface Section 6.1, "Controlling the R&S RadEsT with the rear panel controls", on page 23.

4.5 Status LEDs

Function: The status LED indicates the status of the R&S RadEsT.

- "Ext Ref": Illuminated green when an external reference is active.
- "Rx Detect": Illuminated orange when a power measurement is running.
- "Warning": Illuminated red when an error occurs (for example when an external reference is selected, but not connected).

4.6 Power button

Function: Turns the instrument on and off when it is connected to a power source (DC).

For more information about turning the R&S RadEsT on and off, see Section 5.7, "Switching on or off", on page 21.

4.7 Reference input

Connector type: SMA

Connector label: "Ref In"

Function: Input for an external frequency reference. Use this connector to synchronize the R&S RadEsT to the frequency of another device (100 MHz).

4.8 Reference output

Connector type: SMA connector

Connector label: "Ref Out"

Function: Output for the internal frequency reference. Use this connector to synchronize other instruments to the frequency of the R&S RadEsT (100 MHz).

4.9 LAN interface

Connector type: RJ45

Connector label: "LAN"

Function: LAN interface to connect the R&S RadEsT to a network.

For security reasons, we highly recommend using the R&S RadEsT in trusted networks only.

4.10 USB 2.0 port

Connector type: Standard B

Connector label: "USB"

Function: USB 2.0 port for service applications.

4.11 DC power connector

Connector label: "DC 12 V Max 2 A"

Function: DC input for a connection to an external power supply.

The power adapter and AC power cable necessary to connect the panel to an AC outlet are part of the delivery (with country-specific plug).

For more information about supplying the R&S RadEsT with power, see Section 5.6, "Connecting to power", on page 21.

4.12 Trigger input

Connector type: BNC

Connector label: "Trigger"

Function: Trigger input to control measurements. The trigger source is an external device that provides a TTL compatible trigger signal.

The voltage levels can range from 0.5 V to 5.5 V. The typical input impedance is 10 kΩ.

4.13 Device ID

The unique device identifier is provided on a barcode sticker. The device ID is made up of the device order number and a serial number (for example 1344.0005K02-123456-aa).

5 Preparing for use

Here, you can find basic information about setting up the product for the first time.

5.1 Lifting and carrying

Use the carrying handle on top of the housing to carry the R&S RadEsT.

Do not apply excessive external force to the handle.

For safety information, see "Lifting and carrying the product" on page 8.

5.2 Unpacking and checking

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

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

5.3 Choosing the operating site

Specific operating conditions ensure proper operation and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the specifications document.

For safety information, see "Choosing the operating site" on page 8.

Shielded environment

We recommend using the R&S RadEsT in a shielded environment for best results.

If you don not have access to a shielding chamber or similar room, we recommend using one of the shielding systems available for the R&S RadEsT as an accessory.

Electromagnetic compatibility classes

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the product is given in the specifications document.

- Class B equipment is suitable for use in:
  - Residential environments

  - Environments that are directly connected to a low-voltage supply network that supplies residential buildings
- Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments.
  If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

5.4 Setting up the product

For safety information, see:

- "Setting up the product" on page 8
- "Intended use" on page 7

To place the product on a bench top

The product is small and lightweight. Place the product on a stable, flat and level surface.

Stacking products

If you stack products, consider the following:

- Does the bench support the weight of the stack?
- How much weight can each of the products carry that you want to stack?
- Are the products suited for stacking?

The weight that a Rohde & Schwarz product can carry depends on its own weight.

Our lightweight products that weigh below 18 kg are not built to carry a heavy load. Thus, if you stack products, always place the lightweight product on top of the stack.

Our heavy products that weigh 18 kg and more can carry the following loads:

- 50 kg when a product of identical dimensions is stacked on top (1).
- 25 kg when a product of smaller dimensions is stacked on top (2).

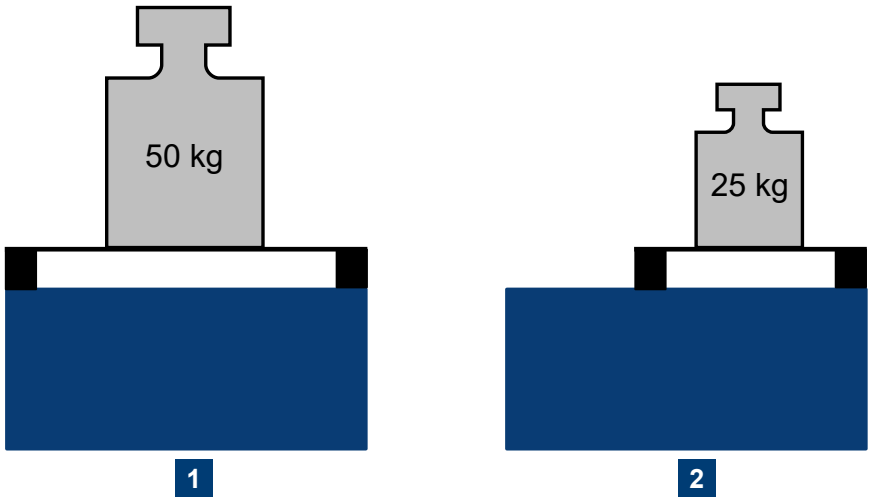


Figure 5-1: Load limits of Rohde & Schwarz heavy-duty products

Products of other manufacturers have other load limits. See the instructions provided by the manufacturer of the product.

To stack products

1. **WARNING!** A stack of products can fall over and cause injury. Never stack more than three products on top of each other. Instead, mount them in a rack.

   Build a stable stack:
   - If possible, stack products of the same dimensions.
   - If the products have different dimensions, stack according to size and weight.

2. Observe the load limit of each product. For example, if the second product in the stack already has the maximum weight that the product beneath can carry, only stack two products.

5.5 Considerations for test setup

Cable selection to minimize electromagnetic interference (EMI)

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, for example, double-shielded RF and LAN cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.

Signal input and output levels

Information on signal levels is provided in the specifications document. Keep the signal levels within the specified ranges to avoid damage to the product and connected devices.

5.6 Connecting to power

The R&S RadEsT runs on 12 V DC power. The external power supply is part of the delivery. It consists of an AC power cable and an adapter. Before connecting it to a power source for the first time, connect the AC power cable to the adapter.

Only use the adapter and cable delivered with the product.

1. Plug the DC power cable into the DC connector on the rear panel of the R&S RadEsT.
   A small red dot on the connector indicates which way is up.
   The connector is a secure connector that locks into place once connected.
2. Plug the AC power cable into a power outlet with ground contact.
   The required ratings are listed next to the power connector and in the specifications document.

5.7 Switching on or off

The LED above the power button indicates the current state of the R&S RadEsT.

Table 5-1: Overview of power states

Status	LED
Off	Off
Standby	orange
Ready	green

To switch on the product

The product is off but connected to power.

The LED of the [Power] button is orange. See Table 5-1.

► Press the [Power] button.
   The LED changes to green. The R&S RadEsT boots.

To shut down the product

The R&S RadEsT is on and running.

The LED of the [Power] button is green. See Table 5-1.

► Press the [Power] button.

The R&S RadEsT shuts down. The LED changes to orange.

To disconnect from power

The product is in the standby state.

1. Disconnect the product from the power source.
2. Pull the plug out of the socket to disconnect the DC cable from the rear panel. The connector has secure locking mechanism. Pulling the cable does not release the connector, instead you have to pull the plug itself.

6 Operation

The R&S RadEsT provides several means for interaction and configuration.

Rear panel controls

Instrument control using the rear panel controls.

Graphic user interface

Instrument control using software running on a computer connected to the R&S RadEsT.

Remote control

Instrument control from a remote computer in the same network as the radio using remote control commands.

6.1 Controlling the R&S RadEsT with the rear panel controls

The R&S RadEsT has a basic user interface that you can access via the keypad and display on the rear panel. No other devices are necessary.

For a comprehensive description of all settings available via rear panel control, see Section 9, "Instrument configuration", on page 32 and Section 8, "Measurements", on page 30.

Navigating the menu

1. Use the up and down arrow keys to browse the menu.
2. Enter a submenu with the "Enter" key.
3. Return to the main menu with the "Esc" key.
4. Change a setting as required.

Changing numbers

1. Use the left and right arrow keys to select the digit you want to change.
   Brackets around a number indicate the selected digit.
   Example: "12(3)4": the "3" is the selected digit
2. Use the up and down arrow keys to increase / decrease the number.
3. Confirm your entry with the "Enter" key.
   The new value appears in the menu.
   If you enter a number that is out of range, the confirmation with the "Enter" key has no effect.

Toggling the state of a setting

For settings that have a Boolean logic.

1. Select the menu item that you want to toggle.
2. Use the "Enter" key to toggle the state of the setting.
   The selected state is indicated next to the setting label.
   Example: "DHCP (On)"

Selecting menu entries

For settings that work like a radio button and allow you to select one out of x options.

1. Select the menu item that you want to use.
2. Confirm your selection with the "Enter" key.
   An "(x)" indicates the selected menu item.
   Example: "P45 (x)"

Starting events

Events are features that initiate some kind of action that the R&S RadEsT performs, for example measuring something.

1. Select the event that you want to initiate.
2. Start the event with the "Enter" key.
   Wait until the event is over. If the event has a result, you can see the result in the user interface.
   While the R&S RadEsT is occupied with its task, using any of its features is not possible.

Saving user settings

When you configure a measurement, you can save those settings and later reuse them without the need to configure everything from the start.

1. Configure the R&S RadEsT as required.
2. Select the "Save User Settings" available in all submenus.

6.2 Controlling the R&S RadEsT via software interface

A free software package is available for download on the product page of the R&S RadEsT. The software has the same functionality as the rear panel controls and remote control, but is easier to use in a graphical user interface.

For a comprehensive description of all settings available via R&S RadEsT software, see Section 10, "Software control", on page 39.

6.3 Controlling the R&S RadEsT remotely

In addition to using the rear panel control and the software interface, it is also possible to control the R&S RadEsT from a remote computer using remote commands.

A LAN connection is the only way to remote control the R&S RadEsT.

1. Connect the R&S RadEsT to a LAN.
2. Open a connection to the R&S RadEsT.
   The IP address depends on your network configuration. The default IP address of the R&S RadEsT is 192.168.0.10.

For a comprehensive description of all settings available via remote control, see Section 11, "Remote control", on page 45.

For additional information on remote control, see the following documents available from the Rohde & Schwarz website:

- Remote control via SCPI
- 1MA171: How to use Rohde & Schwarz Instruments in MATLAB

7 Test setup

The most basic test setup consists of a radar sensor under test (DUT) and an R&S RadEsT.

Considerations for the test setup

- Set up the R&S RadEsT in a shielded environment to achieve valid test results. We recommend using the optional shielding tube available for the R&S RadEsT.
- We recommend a distance of 0.5 m to 1.0 m between the two devices.
- An ideal setup aligns the antennas of the R&S RadEsT with the boresight of the radar sensor.
  For highest accuracy in power measurements, the respective Rx antenna of the R&S RadEsT has to be placed in the maximum beam direction of the DUT (usually boresight direction of the radar's antenna array) and the Rx antenna boresight direction must point towards the DUT antenna array. A translation or rotation of the R&S RadEsT reduces the accuracy of the power measurement results.
  Using the object generation functionality, the object's angles are determined by the utilized R&S RadEsT Rx and Tx antenna positions. We recommend utilizing Rx and Tx antennas that are located closely together. Activating Rx and Tx antennas that are off-boresight from the DUT generate targets in the geometrical relation between R&S RadEsT and DUT. Due to the large half-power beamwidth (> 90°) of the Rx and Tx antennas of the R&S RadEsT, rotations of the R&S RadEsT towards the DUT reduce the RCS accuracy only slightly.

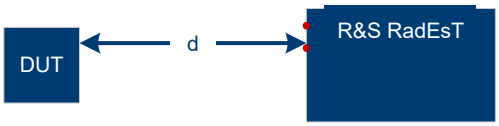


Figure 7-1: Basic setup for measurements with the R&S RadEsT

DUT = Radar sensor under test
R&S RadEsT = Simulated radar target or radar object
d = 0.5 m to 1.0 m

Static vs. dynamic simulations

The measurement type defines if the simulated targets are static or dynamic. The DUT and the R&S RadEsT remain in their position and do not move.

- Static test setups simulate radar objects that keep the distance between object and sensor constant throughout the test.
- Dynamic test setups, or scenarios, simulate radar objects whose simulation distance to the radar sensor changes during the test.
  You can configure test scenarios in the R&S RadEsT software or via remote commands.

Typical workflow

The following procedure shows the typical steps during a radar sensor test.

We assume that the R&S RadEsT is in a default state ("Preset").

1. The R&S RadEsT measures the polarization of the radar sensor.
   If you already know the polarization, you can directly set it in the user interface.
2. The DUT (or radar sensor under test) emits a radar signal.

3. The R&S RadEsT receives the radar signal.

   What the R&S RadEsT does with the radar signal depends on the test configuration.

   a) The R&S RadEsT measures the radar signal characteristics (power and frequency range).

   b) The R&S RadEsT processes the radar signal based on your test configuration.

4. The R&S RadEsT sends the processed radar signal (the echo of the radar signal) back to the DUT.

5. For dynamic scenarios only:
   The simulated object starts at the defined start distance and moves towards the defined end distance with the defined object speed. When the end distance is reached, the object remains static at the end distance.

Installing the shielding systems

Rohde & Schwarz provides two different shielding systems for the R&S RadEsT. The installation process is basically the same for both systems. All parts required for the installation are part of the delivery of the shielding system.

The R&S RadEsT-Z50 comes with an adapter to install the setup on a stand or similar object (the stand itself is not part of the delivery).

1. Remove the blind plugs from the sides of the R&S RadEsT.
2. **For R&S RadEsT-Z50:**
   Screw the shielding system to the R&S RadEsT with the knurled-head screws.

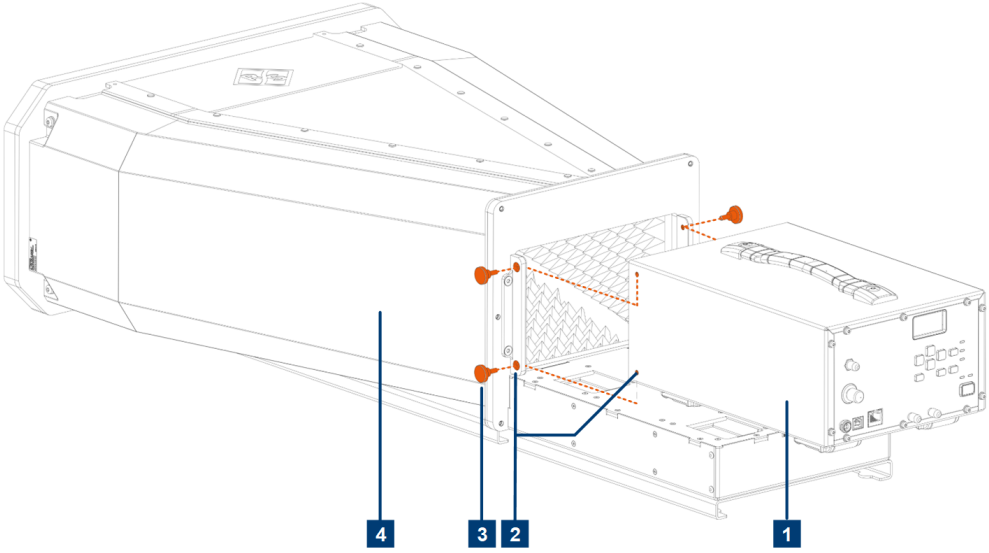


Figure 7-2: Installing shielding kit R&S RadEsT-Z50

1 = R&S RadEsT
2 = Mounting holes (behind blind plugs)
3 = Knurled-head screws
4 = Shielding system

3. Screw the adapter to the bottom of the shielding system (Torx screwdriver T10). Thus equipped, screw the R&S RadEsT to a stand.

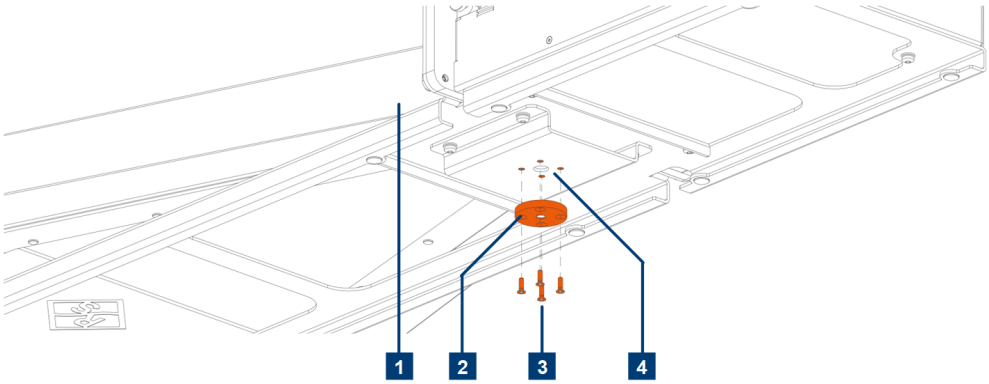


Figure 7-3: Installing stand adapter

1 = Shielding system
2 = Adapter
3 = Torx screws
4 = Mounting holes on the bottom of the shielding system

4. **For R&S RadEsT-Z55:**
   Screw the shielding system to the R&S RadEsT with the knurled-head screws.

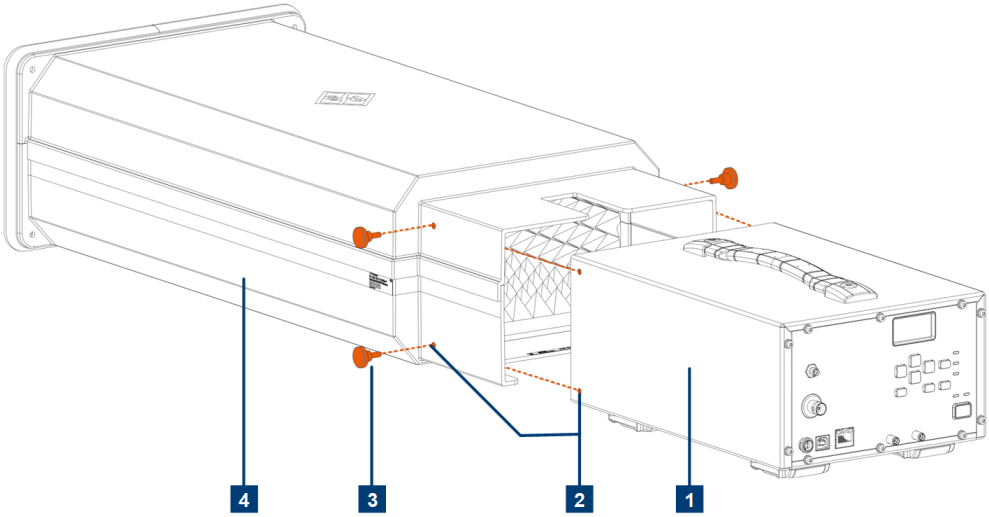


Figure 7-4: Installing shielding kit R&S RadEsT-Z55

1 = R&S RadEsT
2 = Mounting holes (behind blind plugs)
3 = Knurled-head screws
4 = Shielding system

8 Measurements

In addition to simulating a radar object, the R&S RadEsT also provides a few measurements to get more information about the radar sensor under test and the signal it emits.

About equivalent isotropic radiated power (EIRP)

A hypothetical isotropic antenna is able to channel the input power equally in all directions. In reality, such an antenna does not exist - (directional) antennas usually have one direction where the the radiated electromagnetic field is strongest. This direction is known as the boresight axis.

The EIRP describes how much of the input power the antenna can channel into its main direction.

In basic terms: EIRP = input power + realized antenna gain

Power measurements

Starts a measurement to determine the peak power of the radar signal that the DUT emits.

The power measurement is available for both automotive frequency bands (24 GHz and E band).

The result of the measurement is the effective isotropic radiated power (EIRP). The R&S RadEsT calculates the EIRP like this.

EIRP = P_Rx + FSPL + correction_coefficient

- The correction coefficient is a device-specific parameter obtained during calibration.
- The free-space path loss (FSPL) is the loss in signal level caused by empty space between antenna and signal receiver.

$$FSPL = 20 * log_{10}\left(\frac{4\pi r_A}{\lambda}\right)$$

Figure 8-1: Calculation of FSPL

r_A = Distance between radar sensor and antenna (air gap)
λ = Wavelength

Remote command:
E band: `MEASure:GET:77GHz:EIRP?` on page 60
24 GHz band:`MEASure:GET:24GHz:EIRP?` on page 60

Polarization measurement

Starts a measurement to determine the polarization of the DUT. The polarization setting automatically changes depending on the result of the polarization measurement.

The polarization of the DUT in turn determines which Rx and Tx antennas you can use for target simulation.

The polarization measurement is available for E band signals.

The measurement time for the polarization measurement depends on the warm-up time and the max hold interval.

Meas. time = 44 * (WarmupTime + MaxHoldInterval)

Example:

- Max hold interval = 1200 ms
- Warm-up time = 600 ms

Measurement time for polarization measurement = 79 200 ms.

Remote command:
`MEASure:GET:POLarization` on page 62

Frequency range measurement
Starts a measurement to determine the frequency range of the signal that the DUT emits.

The result is a value range in GHz. The R&S RadEsT automatically sets the center frequency and system bandwidth according to the result.

Example:

If the frequency measurement determines a signal in the range from 77 GHz to 79 GHz, the R&S RadEsT sets a center frequency at 78 GHz and a system bandwidth of 2 GHz.

The frequency range measurement is available for the E band.

The measurement time for the frequency range measurement depends on the warm-up time, the max hold interval and the frequency and bandwidth of the signal.

Meas. time = [23 * (WarmupTime + MaxHoldInterval); 69 * (WarmupTime + MaxHoldInterval)]

Example:

- Max hold interval = 1200 ms
- Warm-up time = 600 ms

Measurement time for frequency range measurement is between 41 400 ms and 124 200 ms, depending on the frequency and bandwidth of the signal.

Remote command:
`MEASure:GET:FREQuencyrange?` on page 60

9 Instrument configuration

The R&S RadEsT has a basic user interface that you can access via the keypad and display on the rear panel.

For more information about using the rear panel controls, see Section 6.1, "Controlling the R&S RadEsT with the rear panel controls", on page 23.

9.1 System settings

Access: "System Setting"

System settings define the characteristics of the test setup.

Air Gap Distance
Defines the physical distance between the DUT and the radar object in the test setup (here: the frontend of the R&S RadEsT).

An ideal air gap distance is in the range from 0.5 m to 1.0 m, but it can differ, depending on the specifications of the radar sensor.

Remote command:
`SYSTem:SET:AIRGap` on page 52

Center Frequency
Defines the center frequency of the radar sensor under test.

- For tests in the E band, the center frequency is in the range from 76 GHz to 81 GHz.
- For test in the 24 GHz band, the center frequency is always at 24 GHz.

Remote command:
`SYSTem:SET:CENTerfreq` on page 52

System Bandwidth
Defines the bandwidth of the radar signal that the radar sensor emits.

The system bandwidth is in the range from 0.1 GHz to 5.0 GHz.

The system bandwidth is required for target simulation.

For power measurements, the system bandwidth is irrelevant, it always occurs on the center frequency.

Remote command:
`SYSTem:SET:BANDwidth` on page 53

Polarization E Band
Selects the antenna polarization of the radar sensor in the E band.

Selecting the correct polarization is important - with the wrong polarization, the power measurement can yield wrong results.

The selected polarization also determines available antennas, both Rx and Tx. Depending on the polarization, you can only select antennas that are not cross-polarized to the selected polarization.

"H" Horizontal polarization

"V" Horizontal polarization

"P45" +45° polarization

"M45" -45° polarization

Remote command:
Horizontal: `SYSTem:SET:POLarization:77GHz:H` on page 53
Vertical:`SYSTem:SET:POLarization:77GHz:V` on page 53
-45°: `SYSTem:SET:POLarization:77GHz:M45` on page 53
+45°: `SYSTem:SET:POLarization:77GHz:P45` on page 53

Polarization 24 GHz
Selects the antenna polarization of the DUT in the 24 GHz radar band.

Selecting the correct polarization is important - with the wrong polarization, the power measurement can yield wrong results.

"H" Horizontal polarization

"V" Horizontal polarization

Remote command:
Horizontal: `SYSTem:SET:POLarization:24GHz:H` on page 53
Vertical: `SYSTem:SET:POLarization:24GHz:V` on page 53

Reference
Selects the source of the frequency reference.

"Internal" Uses the internal reference frequency (100 MHz).

"External" Uses an external reference frequency (100 MHz).

Remote command:
Internal reference: `SYSTem:SET:REF:INT` on page 54
External reference: `SYSTem:SET:REF:EXT` on page 54

9.2 Radar target settings

Access: "Target"

Radar target settings define the characteristics of the simulated radar object.

Distance
Defines the simulated distance between DUT and the simulated radar object in m.

The simulated distance is the sum of the air gap and the distance simulated by the signal delay.

This distance is relevant only for radar target simulation. The supported value range depends on the air gap distance:

Value range = 2.5 m + air gap distance ; 249.5 m + air gap distance

Example:

With a 0.5 m air gap distance, the simulation distance range is between 3 m and 250 m.

Remote command:
`TARGet:SET:DISTance` on page 55

Speed
Defines the speed of the simulated radar object.

The value is the difference between the speed of the radar sensor and the radar object and can be negative if the radar object travels slower than the radar sensor under test. For example if the radar object travels with a speed of 50 km/h and the sensor with a speed of 60 km/h, the speed is -10 km/h.

Note: In the software and remote control, the logic is different: "speed away" defines radar sensors that travel faster than the object, "speed towards" radar sensors that are slower than the object. Both speeds are defined as positive values.

Remote command:
Positive speed: `TARGet:SET:VELocity:AWAY` on page 55
Negative speed: `TARGet:SET:VELocity:TOWards` on page 55

Rx Select
Selects the active Rx antenna.

Usually you can only choose an Rx antenna from a given set. Available antennas depend on the polarization settings - the R&S RadEsT automatically deactivates antennas that would result in a cross-polarized measurement. Cross-polarized measurements usually yield invalid results.

Only the selected antenna receives and processes the radar signal.

Remote command:
`SYSTem:SET:RX` on page 56

Tx Select
Selects the active Tx antenna.

Usually you can only choose a Tx antenna from a given set. Available antennas depend on the polarization settings - the R&S RadEsT automatically deactivates antennas that would result in a cross-polarized measurement. Cross-polarized measurements usually yield invalid results.

Only the selected antenna transmits the processed radar signal.

Remote command:
`SYSTem:SET:TX` on page 56

Attenuation
Defines the attenuation for the radar signal that the R&S RadEsT emits.

1 dB attenuation corresponds to about 4 dB less power at the receiving end of the test (usually the radar sensor).

Note that, especially for low attenuation, the attenuation is not linear.

You can also use the attenuation setting to simulate distance. Higher attenuation corresponds to a larger distance between the radar object and the DUT.

Remote command:
`SYSTem:SET:ATTenuation` on page 56

9.3 Power measurement settings

Access: "Power Measurement"

The power measurement determines the signal power of the radar sensor. The measurement itself occurs on the selected receive antenna on the R&S RadEsT front panel. The R&S RadEsT uses these settings and other parameters like the distance to calculate the transmit power of the radar sensor under test.

E-Band EIRP Measurement
Opens a submenu to measure the power in the E-Band.

- The "Measure" menu item starts the power measurement when the DUT is in place.

For the E-Band power measurement, you can normalize the measurement before the actual measurement. The difference is the attenuation of the DUT. A use case, for example, would be to measure a radar sensor without mounting a radome in front of the sensor (normalization) and later measure the power with the radome installed. The difference between the two measurements is the attenuation that the radome introduces.

- The "Normalize" menu item starts the normalization.
- The "Measure" menu item starts the actual measurement with the DUT in place.

Usually, the measurements take a few seconds.

You can read out the results in dBm on the display of the R&S RadEsT.

Remote command:
`MEASure:GET:77GHz:EIRP?` on page 60

24 GHz EIRP Measurement
Opens a submenu to measure the power in the 24 GHz band.

The "Measure" menu item starts the power measurement.

Usually, the measurements take a few seconds.

You can read out the results in dBm on the display of the R&S RadEsT.

Remote command:
`MEASure:GET:24GHz:EIRP?` on page 60

Max Hold Interval
Defines the measurement time for power measurements.

The R&S RadEsT measures the power multiple times during that time period. The result is the highest power level that was measured in that period.

Remote command:
MEASure:SET:INTerval on page 61

Warmup Interval
Defines a warm-up time for the power measurement.

The warm-up time is the time the R&S RadEsT waits for the hardware components to be ready before starting the measurement.

We recommend using the default warm-up time of 500 ms.

Remote command:
MEASure:SET:WARMup on page 63

9.4 Polarization detection settings

Access: "Polarization Detection"

The polarization detection measurement determines the polarization of the radar sensor under test.

Perform Detection
Initiates a test that determines the polarization of the radar sensor that you are testing.

The measurement can take a few minutes. When the measurement is done, you can read out the result on the display. The result is the polarization type.

- H: Horizontal polarization
- V: Vertical polarization
- P45: +45° polarization
- M45: -45° polarization

The polarization measurement automatically writes its result to the polarization setting in the system settings. Antennas whose polarization is orthogonal to the detected polarization are unavailable.

Remote command:
MEASure:GET:POLarization on page 62

9.5 Frequency range detection settings

Access: "Freq. Range Detection"

The frequency range detection measurement determines the bandwidth of the signal that the radar sensor under test emits.

Perform Detection
Initiates a test that determines the frequency range and bandwidth of the radar sensor you are testing.

The measurement takes a few minutes. When the measurement is done, you can read out the result on the display.

The frequency range measurement automatically writes its result to the frequency and bandwidth setting.

Remote command:
MEASure:GET:FREQuencyrange? on page 60

9.6 Network settings

Access: "Network Settings"

Network settings define the network properties of the R&S RadEsT.

DHCP
Turns dynamic IP address assignment on and off.

When dynamic IP address assignment is on, the DHCP server automatically assigns a free IP address to the connected R&S RadEsT.

Remote command:
SET:LAN:DHCP:ON on page 49

IP
Defines the IPv4 address of the R&S RadEsT.

The default IP address is 192.168.0.10.

When DHCP is on, the network automatically assigns an IP address, the setting is read-only in that case.

Remote command:
SET:LAN:GW on page 50

Sub
Defines the address of the subnet that the R&S RadEsT uses.

When DHCP is on, the network automatically assigns a subnet address, the setting is read-only in that case.

Remote command:
SET:LAN:SNMask on page 50

GW
Defines the gateway address that the R&S RadEsT uses.

Remote command:
SET:LAN:GW on page 50

9.7 Device status

Access: "Device Status"

The "Device Status" menu provides various information about your R&S RadEsT.

State
Shows the general state of the R&S RadEsT.

"OK"	Device is running with no issues.
"Error"	Device has one or more issues. Use the `SYSTem:ERRor?` to find out the type of error.

Remote command:
`SYSTem:ERRor?` on page 47

HW Version
Shows the hardware version of the R&S RadEsT.

Remote command:
`*IDN?` on page 46

SW Version
Shows the software version of the R&S RadEsT.

Remote command:
`*IDN?` on page 46

Serial Number
Shows the serial number of the R&S RadEsT.

The serial number of the devie is also indicated on a sticker on the rear panel.

Remote command:
`*SERial?` on page 46
`*IDN?` on page 46

10 Software control

The R&S RadEsT software is a software package to control the R&S RadEsT. You can download and use the software for free from the R&S RadEsT product page.

The software provides a graphical user interface which makes it easier to configure and control the R&S RadEsT. Compared to the internal user interface, the software also has additional features that are otherwise only available via remote control, for example measurement scenarios.

Most of the settings, however, are the same as those that you can access with the rear panel controls.

System requirements

No specific system requirements.

The software runs on any modern PC with a Windows 10 or Windows 11 operating system that you can connect to the R&S RadEsT in a local area network (LAN).

Installing the software

Installation requires administrator rights in the operating system.

1. Download the installer from the R&S RadEsT product website.
2. Run the installer and wait until the installation is done (a few minutes maximum). The software requires approximately 200 MB on a hard disk.
3. Start the software with the desktop shortcut.

10.1 UI overview

The R&S RadEsT software has the following layout.

Figure 10-1: Overview of the R&S RadEsT software

1 = Menu bar
2 = Network and remote control settings
3 = Measurement configuration
4 = Antenna configuration

10.2 Menu bar

The menu bar contains information about the R&S RadEsT, including the open source acknowledgment.

10.3 Network and remote control

Network and remote control settings provide functionality to connect the software to the R&S RadEsT.

IP address and Port
Sets the IP address of the connected R&S RadEsT and the port used for communication.

The default port is 2101. We recommend using this port.

Select "Connect" to establish the connection. The button turns green if the connection is successful.

Remote command prompt
Allows you to send a remote command to the R&S RadEsT. If you send a remote command, the prompt also shows the return string of the command, usually the status of the operation. For example, if you send the command `SYSTEM:SET:REF:INT`, the prompt returns `0,"OK"` and the time the operation took.

Note: Changing a parameter with a remote command has no effect on the settings in the user interface of the software. The settings in the user interface remain the same.

10.4 System settings

System settings are a subset of the settings available via the rear panel control.

For more information about the settings, refer to the following topics:

- "System Bandwidth" on page 32
- "Air Gap Distance" on page 32
- "Reference" on page 33
- "Polarization E Band" on page 32 / "Polarization 24 GHz" on page 33
- "Polarization measurement" on page 30

10.5 Target configuration

Radar target settings are a subset of the settings available via the rear panel control.

For more information about the settings, refer to the following topics:

- "Attenuation" on page 34
- "Distance" on page 33
- "Speed" on page 34

10.6 Scenario configuration

A scenario defines a dynamic behavior of the simulated radar object.

A scenario allows you to define different speeds for DUT and simulated radar object and therefore varying distances between the two over time.

Start and stop distance
Defines the distance between DUT and radar target at the beginning of the scenario and the end of the scenario.

Remote command:
Start: `SCENario:DISTance:STARt` on page 63
End: `SCENario:DISTance:END` on page 63

Velocity
Defines the speed with which the radar object travels.

Remote command:
`SCENario:VELocity` on page 64

Looped scenarios
Turns looped scenarios on and off.

Looping a scenario repeats the scenario until you stop it. You can define a pause between the end of a scenario and the beginning of the next repetition of the scenario.

10.7 Measurements

The software provides the same measurements as the R&S RadEsT.

For more information about the measurements, refer to the following topics:

- "Power measurements" on page 30
- "Polarization measurement" on page 30

"Auto Save" automatically stores the result when the measurement is done.

10.8 Antenna configuration

Shows the characteristics of the front end antennas. The antenna arrangement in the software corresponds to the arrangement shown in Figure 4-3.

Antenna type

Shows the antenna type.

- Blue: Tx antenna
- Red: Rx antenna

Antenna state

Indicates the state of the antenna.

- Not highlighted: antenna is not active
- Highlighted: antenna is active

Depending on the selected DUT polarization, the software automatically determines and activates the antenna pair (Rx and Tx) that is calibrated for setting the RCS accurately.

In particular, the calibrated antenna pairs for horizontal and vertical polarization are.

- Tx2 and Rx3 (antenna group 1)
- Tx3 and Rx2 (antenna group 1)
- Tx6 and Rx7 (antenna group 2)

- Tx7 and Rx6 (antenna group 2)
- Tx10 and Rx11 (antenna group 3)
- Tx11 and Rx10 (antenna group 3)

For +45° and -45° polarization, the calibrated antenna pairs are:

- Tx5 and Rx5 (antenna group 2)
- Tx 8 and Rx8 (antenna group 2)

In an antenna group, there are always two antenna pairs best suited for the task on hand. Within an antenna group, switch the possible antenna pair with the corresponding interface. The currently selected antenna pair is highlighted.

Otherwise, you can of course select arbitrary antenna pairs, for example Tx1 and Rx12, if it is better for your measurement task.

Antenna polarization

Indicates the antenna polarization. Each of the 24 antennas has a fix polarization as indicated in the software's user interface.

- →: Horizontal polarization
- ↑: Vertical polarization
- ↗: +45° polarization
- ↖: -45° polarization

10.9 Accessing, retrieving and handling data

Depending on the origin and content, this description distinguishes between the following data types:

- Operational data
- Non-operational data

The R&S RadEsT on its own does not store any data.

If you are using the R&S RadEsT software to control the R&S RadEsT, data is generated and stored on the computer with the software. You can access both operational and non-operational data in the following directory:

`C:\Users\<user_name>\AppData\Local\Programs\Rohde-Schwarz\Radest_Software`

with `<user_name>` being the name of the user that is currently logged into the computer.

Operational data (data for intended use)

Your R&S RadEsT uses and creates this data because of its intended use and according to the settings and configuration you have made. Thus, this data makes up most of the data that the R&S RadEsT creates, such as user files that contain user-defined configurations or data, like instrument settings or measurement data.

You can access, retrieve and delete user files via a file explorer is the above mentioned directory.

Non-operational data (usage data)

The R&S RadEsT software creates this data during and through its use. Such data is collected e.g. for troubleshooting or to help our customer support center find solutions quickly.

The R&S RadEsT software generates this data continuously and in real-time; this data is stored locally on the computer that hosts the software. The product is not capable of storing the data on a remote server.

The R&S RadEsT generates the following data:

- User and authentication data
- Network and communication data
- Diagnostic and troubleshooting data

This data is stored in a TXT file that contains a log of all events that occured during a session. The volume of the non-operational data depends on the usage of the product and typically amounts to about 100 kB per session (a session starts each time you start the software).

You can access, retrieve and delete user files via a file explorer is the above mentioned directory.

11 Remote control

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a remote command consists of a header and, usually, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, they are separated by a comma from one another.

The following conventions are used in the remote command descriptions:

- *Command usage*
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- *Parameter usage*
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as "Setting parameters".
  Parameters required only to refine a query are indicated as "Query parameters".
  Parameters that are only returned as the result of a query are indicated as "Return values".
- *Asynchronous commands*
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an "Asynchronous command".
- *Reset values (*RST)*
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as "*RST" values, if available.
- *Default unit*
  The default unit is used for numeric values if no other unit is provided with the parameter.
- *Manual operation*
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

11.1 General configuration

SYSTem:SLEep <state>

Turns the R&S RadEsT on and off (standby mode).

Parameters:

<state>
0
Turns the R&S RadEsT on.
1
Turns the R&S RadEsT off (standby mode).

Example:
//Enter standby mode
```
SYST:SLE 1
```

***IDN?**

Identification

Returns the instrument identification.

Return values:

<ID>
"Rohde&Schwarz,<device type>,<serial number>,<firmware version>"

Example:
```
Rohde&Schwarz,RadEsT,12345678,V1.00
```

Usage:
Query only

Manual operation:
See "HW Version" on page 38
See "SW Version" on page 38
See "Serial Number" on page 38

***SERial?**

Returns the serial number of the R&S RadEsT.

Parameters:

<SerialNumber>
"<serial number>"

Example:
```
12345678
```

Usage:
Query only

Manual operation:
See "Serial Number" on page 38

***OPC?**

Operation complete

Queries the state of the command that was sent last.

Parameters:

<State>
1
Execution of the last command is completed.
0
Execution of the last command is still in progress.

Usage: Query only

HANDshake?
HANDshake:OFF
HANDshake:ON

Turns handshake functionality on and off or queries the current state of the handshake.

When the handshake is on, the R&S RadEsT returns feedback each time you send a remote command. This feedback consists of a confirmation that the command was sent successfully and the new state of the corresponding setting.

When the handshake is off, the R&S RadEsT does not return any feedback, even if something went wrong.

Usage: Setting only

SYSTem:CLEar

Clears the error queue.

Example:
```
//Query and clear error queue
SYST:ERR?
SYST.CLE
```

Usage: Event

SYSTem:ERRor?

Queries a list of recent device errors in the error queue.

- If an error occurs, try one of the solutions provided in the table below.
- If there is no solution, remove the R&S RadEsT from its power source for 30 seconds and restart it.
- If the error remains, call your service representative.

You can clear the error queue with `SYSTem:CLEar`.

Parameters:

<Error> Error code, see Table 11-1.

Example:
```
//Query errors
SYST:ERR?
//returns
4
```

Usage: Query only

Manual operation: See "State" on page 38

Table 11-1: Error code list

Error code	Error	Solution
0	Status OK	
1	Unknown variant	
2	Variant error	
3	Invalid TVR header data in EEPROM	
4	Timeout during communication with PLL, RX, or TX chips	
5	ASDL distance file missing or corrupted	
6	Radest factory settings are invalid	
7	Selftest values missing	
8	Scenario attenuation correction values not calculated	Try the following commands again: • `SCENARIO:RCS:LIMITS?` • `SCENARIO:RCS`
9	Device data, organized as structs, exceed the allocated flash memory space	
10	PLL not locked	• Check the external reference signal. • Select the internal reference.
11	Failure during precalculation for scenario attenuation	Try the following commands again: • `SCENARIO:RCS:LIMITS?` • `SCENARIO:RCS`
12	Selftest failed	Run the self test again.
13	RCS recalculation failed	
14	RCS recalculation for scenario failed	
15	Memory allocation failed	

SYSTem:WRITe:SETTings

Saves the current instrument configuration.

You can restore the user preset with `SYSTem:PRESet:USER`.

Example: //Define custom instrument configuration (5 m air gap)
```
SYST:SET:AIRGap 5
```
//Save configuration
```
SYST:WRIT:SETT
```
//Change custom instrument configuration (10 m air gap)
```
SYST:SET:AIRGap 10
```
//Restore user preset (5 m air gap)
```
SYST:PRES:USER
```

Usage: Event

SYSTem:PRESet:USER

Presets the R&S RadEsT with the user settings.

Prerequisites for this command

- Custom configuration is available (`SYSTem:WRITe:SETTings`).

Example: See `SYSTem:WRITe:SETTings`.

Usage: Event

***RST**
SYSTem:PRESet

Restores the factory system configuration.

Example: //Reset the instrument
```
SYST:PRES
```

Usage: Event

11.2 Network configuration

SHOW:LAN:DHCP?
SET:LAN:DHCP:OFF
SET:LAN:DHCP:ON

Controls DHCP for the R&S RadEsT.

Example: //turn on DHCP
```
SET:LAN:DHCP:ON
```
//query DHCP state
```
SHOW:LAN:DHCP?
```
//returns:
```
ON
```

Usage: Setting only

Manual operation: See "DHCP" on page 37

SHOW:LAN:IP?
SET:LAN:IP <ipaddress>

Defines or queries the IP address that the R&S RadEsT uses.

Prerequisites for this command

- DHCP = off (`SET:LAN:DHCP:OFF`)

Parameters:
<ipaddress> *RST: 0.0.0.0

Example:
```
//define IP address
SET:LAN:IP 192.0.2.0
//query IP address
SHOW:LAN:IP?
//returns:
192.0.2.0
```

Usage: Setting only

SHOW:LAN:SNMask?
SET:LAN:SNMask <subnetmask>

Defines or queries the subnet mask that the R&S RadEsT uses.

Prerequisites for this command

- DHCP = off (`SET:LAN:DHCP:OFF`)

Parameters:
<subnetmask> *RST: 0.0.0.0

Example:
```
//define IP address
SET:LAN:SNM 255.255.255.0
//query IP address
SHOW:LAN:SNM?
//returns:
255.255.255.0
```

Usage: Setting only

Manual operation: See "Sub" on page 37

SHOW:LAN:GW?
SET:LAN:GW <gateway>

Defines or queries the gateway that the R&S RadEsT uses.

Prerequisites for this command

- DHCP = off (`SET:LAN:DHCP:OFF`)

Parameters:
<gateway> *RST: 0.0.0.0

Example: //define IP address
```
SET:LAN:GW 255.255.0.0
```
//query IP address
```
SHOW:LAN:GW?
```
//returns:
```
255.255.0.0
```

Usage: Setting only

Manual operation: See "IP" on page 37
See "GW" on page 37

SHOW:LAN:HOST:NAME?
SET:LAN:HOST:NAME <hostname>

Defines or queries the hostname for the R&S RadEsT.

Setting available for remote control only.

Prerequisites for this command

- DHCP = on (`SET:LAN:DHCP:ON`)

Parameters:
<hostname> String with the hostname.
*RST: ---

Example: //Set hostname
```
SET:LAN:HOST:NAME 'simulator'
```
//Query host name
```
GET:LAN:HOST:NAME?
```
//returns:
```
'simulator'
```

Usage: Setting only

SHOW:LAN:MAC:ADDRess?

Queries the MAC address of the R&S RadEsT.

Return values:
<macaddress>

Example: //query MAC address
```
SHOW:LAN:MAC:ADDR?
```
returns
```
11-22-AA-3B-44-CC
```

Usage: Query only

SET:LAN:INIT

Applies the changed network settings.

Example: //configure network settings
```
SET:LAN:IP 192.0.2.0
SET:LAN:SNM 255.255.255.0
SET:LAN:GW 255.255.0.0
```
//apply the settings
```
SET:LAN:INIT
```

Usage: Setting only

11.3 System settings

SYSTem:GET:AIRGap?
SYSTem:SET:AIRGap <distance>

Defines or queries the distance between DUT and R&S RadEsT.

Parameters:
<distance> *RST: 0.5
Default unit: m

Example: //define distance
```
SYST:SET:AIRG 0.5
```
//query distance
```
SYST:GET:AIRG?
```
//returns
```
0.5
```

Usage: Setting only

Manual operation: See "Air Gap Distance" on page 32

SYSTem:GET:CENTerfreq?
SYSTem:SET:CENTerfreq <frequency>

Defines or queries the center frequency of the radar signal.

Parameters:
<frequency> *RST: 76.5
Default unit: GHz

Example: //define frequency
```
SYST:SET:CENT 77GHZ
```
//query frequency
```
SYST:GET:CENT?
```
//returns
```
77
```

Usage: Setting only

Manual operation: See "Center Frequency" on page 32

SYSTem:GET:BANDwidth?
SYSTem:SET:BANDwidth <bandwidth>

Defines or queries the bandwidth of the radar signal.

Parameters:
<bandwidth> *RST: 1.0
Default unit: GHz

Example:
```
//define bandwidth
SYST:SET:BAND 0.75
//query bandwidth
SYST:GET:BAND?
//returns
0.75
```

Manual operation: See "System Bandwidth" on page 32

SYSTem:GET:POLarization:24GHz:SETTing?
SYSTem:GET:POLarization:77GHz:SETTing?
SYSTem:SET:POLarization:24GHz:H
SYSTem:SET:POLarization:24GHz:V
SYSTem:SET:POLarization:77GHz:H
SYSTem:SET:POLarization:77GHz:V
SYSTem:SET:POLarization:77GHz:M45
SYSTem:SET:POLarization:77GHz:P45

Selects or queries the polarization of the DUT (radar sensor).

The last two syntax elements indicate the frequency range and polarization.

- `:24GHz:H`: horizontal polarization for the 24 GHz band.
- `:24GHz:V`: vertical polarization for the 24 GHz band.
- `:77GHz:H`: horizontal polarization for the E-band.
- `:77GHz:V`: vertical polarization for the E-band.
- `:77GHz:M45`: -45° polarization for the E-band.
- `:77GHz:P45`: +45° polarization for the E-band.

Note: these commands query the polarization setting only (when you deliberately set it).

To query the result of the polarization measurement, use the following commands:

- `MEASure:GET:POLarization`

The return values for the queries are `H`, `V`, `M45` and `P45`.

Example:
```
//select polarization
SYST:SET:POL:77GH:H
//query polarization
SYST:GET:POL:24GH:SETT?
//returns
H
```

Usage: Setting only

Manual operation: See "Polarization E Band" on page 32

SYSTem:GET:REF?
SYSTem:SET:REF:EXT
SYSTem:SET:REF:INT

Selects or queries the selected frequency reference.

- `:SET:EXT`: external reference
- `:SET:INT`: internal reference
- `:GET:REF`: query selected reference

Example:
```
//select internal reference
SYST:SET:REF:INT
//query selected reference
SYST:GET:REF?
//returns
INTERNAL
```

Usage: Setting only

Manual operation: See "Reference" on page 33

11.4 Target configuration

TARGet:SET <distance>,<speed>[,<rx>][,<tx>]

Defines a static test setup (distance between radar sensor and radar object remain the same).

It is also possible to define the parameters with the following individual commands:

- Distance: `TARGet:SET:DISTance`
- Speed: `TARGet:SET:VELocity:TOWards`
- Rx antenna selection: `SYSTem:SET:RX`
- Tx antenna selection:`SYSTem:SET:TX`

Parameters:

<distance>
*RST: 40
Default unit: m(eter)

<speed>
*RST: 0
Default unit: km/h

<rx>
Optional parameter.
Range: 1 to 12
*RST: 7

<tx> Optional parameter.

Range: 1 to 12
*RST: 7

Example: //Defining a static test using custom antennas
```
TARG:SET 100,-15,3,4
```

TARGet:GET:DISTance?
TARGet:SET:DISTance <distance>

Defines or queries the simulated distance.

Parameters:
<distance> *RST: 40
Default unit: m(eter)

Example: //define distance
```
TARG:SET:DIST 100
```
//query distance
```
TARG:GET:DIST?
```
//returns
```
100
```

Manual operation: See "Distance" on page 33

TARGet:GET:VELocity?
TARGet:SET:VELocity:AWAY <speed>
TARGet:SET:VELocity:TOWards <speed>

Defines or queries the speed of the radar object.

- `:AWAY`: positive speed (target faster than sensor)
- `:TOWards`: negative speed (target slower than sensor)

Parameters:
<speed> For both commands (`:AWAY` and `TOWards`), the command allows only positive values.

*RST: 0
Default unit: km/h

Example: //define speed for a target traveling slower than the sensor
```
TARG:SET:VEL:TOW 5
```
//query speed
```
TARG:GET:VEL?
```
//returns
```
5
```

Usage: Setting only

Manual operation: See "Speed" on page 34

SYSTem:GET:ATTenuation?
SYSTem:SET:ATTenuation <attenuation>

Defines or queries the signal attenuation for target simulation.

Parameters:

<attenuation>
Range: 0 to 31.75
Increment: 0.25
*RST: 0
Default unit: dB

Example:

```
//define attenuation
SYST:SET:ATT 0.25
//query attenuation
SYST:GET:ATT?
//returns
0.25
```

Usage: Setting only

Manual operation: See "Attenuation" on page 34

SYSTem:GET:RX?
SYSTem:SET:RX <antenna>

Selects or queries the receive antenna.

This command can throw an error if you select an antenna that does not work for your configuration, because it would result in an incompatible polarization.

Parameters:

<antenna>
Range: 1 to 12
*RST: 7

Example:

```
//select receive antenna
SYST:SET:RX 8
//query receive antenna
SYST:GET:RX?
//returns
8
```

Usage: Setting only

Manual operation: See "Rx Select" on page 34

SYSTem:GET:TX?
SYSTem:SET:TX <antenna>

Selects or queries the transmit antenna.

This command can throw an error if you select an antenna that does not work for your configuration, because it would result in an incompatible polarization.

Parameters:

<antenna> Range: 1 to 12
*RST: 6

Example:
//select transmit antenna
`SYST:SET:TX 8`
//query transmit antenna
`SYST:GET:TX?`
//returns
`8`

Usage: Setting only

Manual operation: See "Tx Select" on page 34

11.5 RCS configuration (static simulations)

TARGet:GET:RCS:LIMits?

Queries the minimum and maximum radar-cross section for the current system configuration in a static setup (distance between radar sensor and radar object remains the same).

To get the value range for the RCS, the command considers the current polarization and measures the EIRP before calculating the RCS limits.

Return values:

<result> The command returns several values:
`<polarization>,<eirp>,<rcs_min>,<rcs_max>`

<polarization>
Polarization of the radar sensor.

<eirp>
Power of the radar signal.

<rcs_min>
Minimum possible RCS for the test setup.

<rcs_max>
Maximum possible RCS for the test setup.

Example: See `TARGet:SET:RCS` on page 57.

Usage: Query only

TARGet:SET:RCS <rcs>

Defines the radar cross-section of the simulated radar object in a static setup (distance between radar sensor and radar object remains the same).

Prerequisites for this command

- Determine the allowed value range for the current test setup (`TARGet:GET:RCS:LIMits?`).

Parameters:

<rcs> The allowed value range depends on the results returned by TARGet:GET:RCS:LIMits?. Other values are not accepted.

*RST: 0.0
Default unit: dBm²

Example:

```
//Set a static radar cross-section
TARG:GET:RCS:LIM?
//returns
"VERTICAL",29.345292,-20.882952,30.114332
TARG:SET:RCS 34.5
```

11.6 RCS configuration (dynamic simulations)

Knowing the radar cross section (RCS) of the simulated radar object is important for the whole setup and the validity of the test results. The R&S RadEsT simulates the RCS of an object by adjusting the attenuation of the radar echo, depending on various settings like the distance, the air gap and the EIRP. Currently, you can define the radar cross section directly via remote control only.

An alternative method to adjust the output power is to change the attenuation of the emitted signal. The underlying procedures for static and dynamic scenarios are similar. For a static object, the attenuation of the output signal is adjusted once to simulate the corresponding RCS which was set. In dynamic scenarios, it is possible to either work with constant output power or constant RCS mode. For the constant output power mode, the procedure is similar to a static target simulation, thus, the attenuation of the output signal is set once and kept constant over the whole scenario, leading to increasing (decreasing) RCS at larger (smaller) distances. In the constant RCS mode, an attenuation table applied during the scenario to keep the RCS constant over varying distances.

The basic procedure goes like this.

1. Define all system settings.
2. Define the target and scenario settings.
3. Query the RCS limits using the corresponding remote commands.
4. Define the RCS with the corresponding remote command.

SCENario:RCS <rcs>

Defines the radar cross-section of the simulated radar object in a measuremen scenario (distance between radar sensor and radar object can change).

Prerequisites for this command

- Determine the allowed value range for the current test setup (SCENario:RCS:LIMits?).

Parameters:

<rcs> The allowed value range depends on the results returned by `SCENario:RCS:LIMits?`. Other values are not accepted.

*RST: 0.0
Default unit: dBm²

Example:

```
//Set a radar cross-section for scenarios
SCEN:RCS:CONS 0
SCEN:RCS:LIM?
//returns
"VERTICAL",29.345292,-20.882952,30.114332
SCEN:RCS 34.5
```

SCENario:RCS:CONSt <state>

Turns the use of a constant radar cross-section throughout the test on and off.

A constant RCS means that the attenuation used to simulate the RCS remains the same. Otherwise, the R&S RadEsT adjusts the attenuation, depending on the scenario.

Parameters:

<state>

0
RCS remains the same throughout the scenario, regardless of the movements of the radar object.

1
RCS is variable, depending on the scenario configuration.

*RST: 0

Example: See `SCENario:TRIGger`

SCENario:RCS:LIMits?

Queries the minimum and maximum radar-cross section for the current scenario configuration in a measurement scenario (distance between radar sensor and radar object can change).

To get the value range for the RCS, the command considers the current polarization and measures the EIRP before calculating the RCS limits.

Return values:

<result> The command returns several values:
`<polarization>,<eirp>,<rcs_min>,<rcs_max>`

<polarization>
Polarization of the radar sensor.

<eirp>
Power of the radar signal.

<rcs_min>
Minimum possible RCS for the test setup.

<rcs_max>
Maximum possible RCS for the test setup.

Example: See `SCENario:TRIGger`

Usage: Query only

11.7 Measurement control

MEASure:GET:24GHz:EIRP?
MEASure:GET:77GHz:EIRP?

Initiates the power measurement.

The result is either the actual power measured at the receive antenna for power measurements or the EIRP of the measured signal, depending which command you are using.

Return values:
<power> numeric value
Default unit: dBm

Example:
//measure power (E-band))
```
MEAS:GET:77GH?
```
//measure EIRP (24 GHz band)
```
MEAS:GET:24GHZ:EIRP?
```

Usage: Query only

Manual operation: See "Power measurements" on page 30
See "E-Band EIRP Measurement" on page 35

MEASure:GET:FREQuencyrange?

Queries the frequency range of the radar sensor under test.

Return values:
<frequency> numeric value
Default unit: GHz

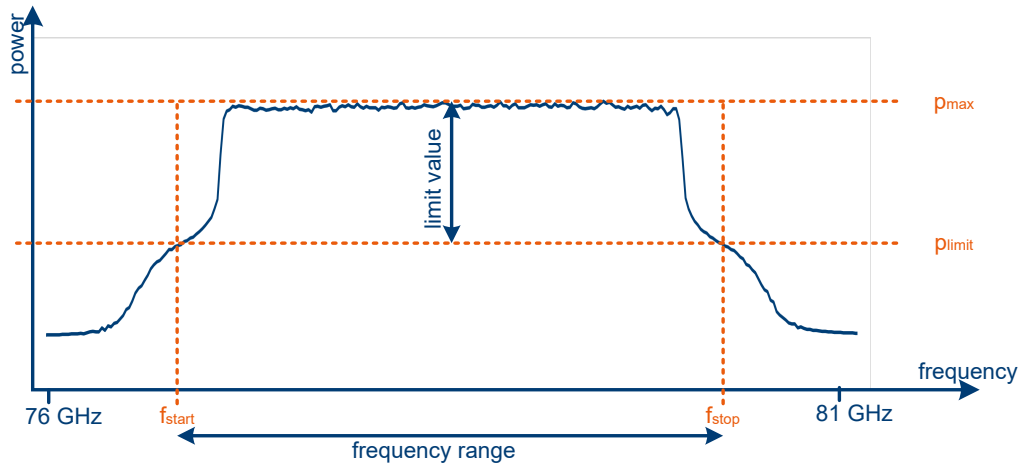
Example:
//Query frequency range
```
MEAS:GET:FREQ?
```
//returns
```
76
```

Usage: Query only

Manual operation: See "Frequency range measurement" on page 31
See "Perform Detection" on page 36

MEASure:GET:FREQuencyrange:LIMit?
MEASure:SET:FREQuencyrange:LIMit

Defines the search criteria in terms of power level for the frequency range measurement.



P_{max} = Measured peak power
P_{max} = Power limit for the frequency range measurement
f_{start} / f_{stop} = Signal bandwidth

Return values:

<power> Difference between peak power and the frequency range search range.

*RST: 10
Default unit: dB

Example: //Set power limit for the frequency range measurement
`MEAS:SET:FREQ:LIM 3`

Usage: Setting only

MEASure:GET:INTerval?
MEASure:SET:INTerval <time>

Defines or queries the max hold interval for power measurements.

Parameters:

numeric value *RST: 1000
Default unit: ms

Example: //define max hold interval
`MEAS:SET:INT 1000`
//query max hold interval
`MEAS:GET:INT?`
//returns
`1000`

Manual operation: See "Max Hold Interval" on page 35

MEASure:GET:NORMeirp? <antenna>

Initiates a power measurement.

The result is the normalized EIRP value.

Parameters:

<antenna> Selects the Rx antenna used for the normalization measurement.

Range: 1 to 12

Return values:

<eirp> Normalized EIRP.

Default unit: dBm

Example:

```
//Normalize measurement
MEAS:SET:NORM
//Measure normalized EIRP
MEAS:GET:NORM?
```

Usage: Query only

MEASure:GET:NORMvalue?
MEASure:SET:NORMvalue

Initiates a power measurement.

The resulting EIRP value is used as the normalization value for normalized measurements.

Parameters:

<antenna> Selects the Rx antenna used for the normalized EIRP measurement.

Range: 1 to 12

Example:

```
//Normalize measurement
MEAS:SET:NORM
//Query normalization value
MEAS:GET:NORM?
//returns
29.345292
```

Usage: Event

MEASure:GET:POLarization

Queries the polarization of the radar sensor under test.

Return values:

<polarization> **H**
Horizontal polarization

M45
-45° polarization (E-band only)

P45
45° polarization (E-band only)

V
Vertical polarization

Example:
//Query polarization
`MEAS:GET:POL?`
//returns
`V`

Manual operation: See "Polarization measurement" on page 30
See "Perform Detection" on page 36

MEASure:GET:WARMup?
MEASure:SET:WARMup <time>

Defines or queries the warmup time for power measurements.

Parameters:
<time>
*RST: 500
Default unit: ms

Example:
//define warmup time
`MEAS:SET:WARM 500`
//query warmup time
`MEAS:GET:WARM?`
//returns
`500`

Manual operation: See "Warmup Interval" on page 36

11.8 Scenarios (remote control only)

SCENario:DISTance:STARt <distance>
SCENario:DISTance:END <distance>

Defines the start and end distances between radarsensor and object for a measurement scenario.

Parameters:
<scenario>
*RST: 3 (start) / 30 (end)
Default unit: m

Example: See `SCENario:TRIGger`

Manual operation: See "Start and stop distance" on page 41

SCENario:TRIGger

Starts a measurement scenario.

Example:

```
//Run a scenario
SCEN:DIST:STAR 50
SCEN:DIST:END 100
SCEN:VEL 75
SCEN:RCS:LIM?
//returns
"VERTICAL",29.345292,-20.882952,30.114332
SCEN:RCS 40
SCEN:TRIG
```

Usage: Event

SCENario:VELocity <speed>

Defines the speed of the radar object in a measurement scenario.

Parameters:

<speed> *RST: 5
Default unit: km/h

Example: See `SCENario:TRIGger`

Manual operation: See "Velocity" on page 42

12 Maintenance

We advise to check the nominal data from time to time.

Cleaning

How to clean the product is described in "Cleaning the product" on page 8.

Do not use any liquids for cleaning. Cleaning agents, solvents, acids and bases can damage the front panel labeling, plastic parts and display.

13 Troubleshooting

Running a self-test

A self-test checks the performance of the R&S RadEsT.

If the R&S RadEsT stops working as expected, run a self-test. The self-test requires a metallic verification plate installed on the front panel - the metal plate is available as an accessory (R&S RadEsT-Z5).

1. Screw the verification plate to the front panel of the R&S RadEsT.

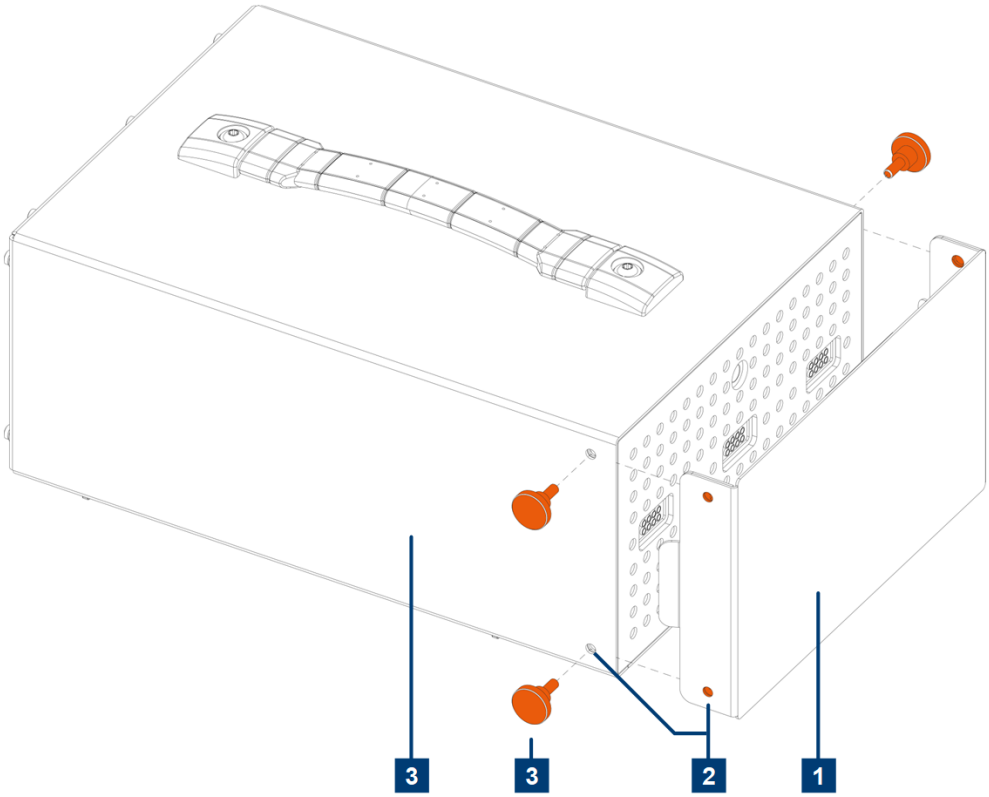


Figure 13-1: Installing the verification plate

1 = Verification plate
2 = Mounting holes (4x)
3 = M4 knurled head-screws (4x)
4 = R&S RadEsT

2. Position the R&S RadEsT in a shielded environment.
3. Turn on the R&S RadEsT.
4. Select "Self-test" from the user interface.
   The self-test checks all Rx and Tx channels and checks the results against the values of factory calibration. If the values deviate from the factory calibration, the self-test fails.
5. Wait until the self-test is done and read out the result.

- If the self-test passes, the R&S RadEsT is alright.
- If the self-test fails, contact your Rohde & Schwarz service representative.

If you need to transport or ship the product, see Section 15, "Transport", on page 69.

14 Storage

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

15 Transport

Lifting and carrying

For safety information, see:

- "Lifting and carrying the product" on page 8
- Section 5.1, "Lifting and carrying", on page 18

Packing

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection. You can also contact your local Rohde & Schwarz service center for advice.

Securing

When moving the product in a vehicle or using transporting equipment, make sure that the product is properly secured. Only use items intended for securing objects.

Transport altitude

The maximum transport altitude without pressure compensation is specified in the specifications document.

16 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

Disposing of electrical and electronic equipment

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

Figure 16-1: Labeling in line with EU directive WEEE

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

17 Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:

Figure 17-1: QR code to the Rohde & Schwarz support page

List of commands