Operating Manual

Level Control Sensor

R&S® NRP-Z28
1170.8008.02

R&S® NRP-Z98
1170.8508.02

ROHDE&SCHWARZ
Test and Measurement

Dear Customer,

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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 the Getting Started manual, Chapter 1.1 "Safety instructions". The same information is provided in many languages as printed "Safety Instructions". Both documents are delivered with the power sensor.

- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

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1 Putting into Operation

NOTICE   *Follow the instructions below precisely to prevent damage to the sensor – particularly when you are putting the power sensor into operation for the first time.*

Unpacking the sensor

Remove the power sensor from its packing and check that nothing is missing. Inspect all items for damage. If you discover any damage, inform the carrier responsible immediately and keep the packing to support any claims for compensation.

It is also best to use the original packing if the power sensor is to be shipped or transported at a later date.

The power sensor contains components which can be destroyed by electrostatic discharges. To prevent this from happening, never touch the inner conductor of the RF connector and never open the power sensor.

Connecting the sensor

NOTICE   *To prevent EMI, the power sensor must never be operated with its enclosure wholly or partially removed. Only use shielded cables that meet the relevant EMC standards.*

Never exceed the maximum RF power limit. Even brief overloads can destroy the integrated power sensor.

To prevent erroneous measurements, always terminate the RF output of the power sensor (at the cable end) with a matched load or matched measuring instrument input.

In many cases, the RF connector only requires manual tightening. However, for maximal measurement accuracy, the RF connector must be tightened using a torque wrench with a nominal torque of 1.36 Nm (12" lbs.).
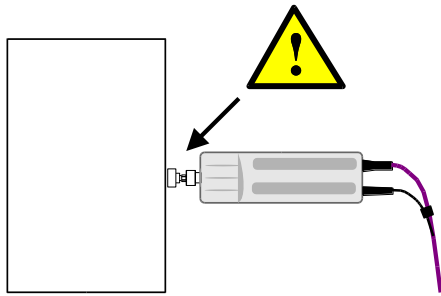
Do not apply excessive mechanical force to the RF connectors of the R&S NRP-Z28/-Z98 and DUT!

F

F
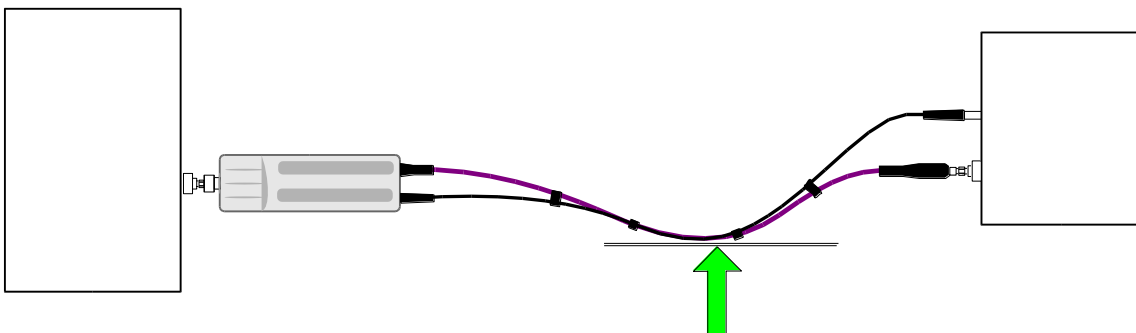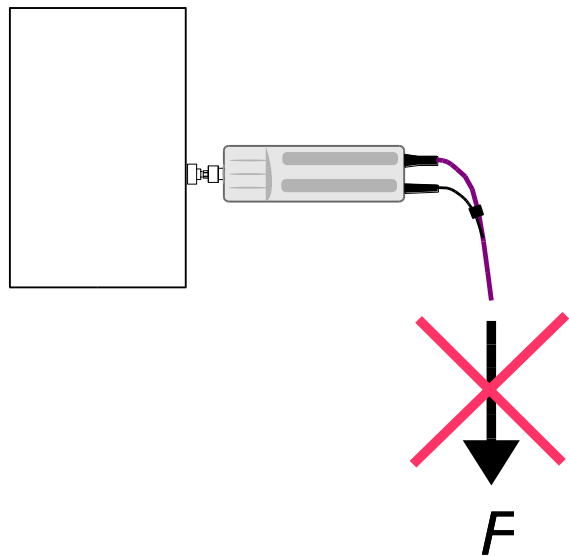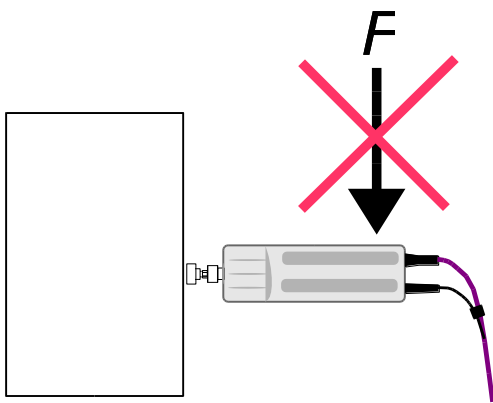
Make sure the bending radius of the RF connecting cable is at least 50 mm!

> 100 mm
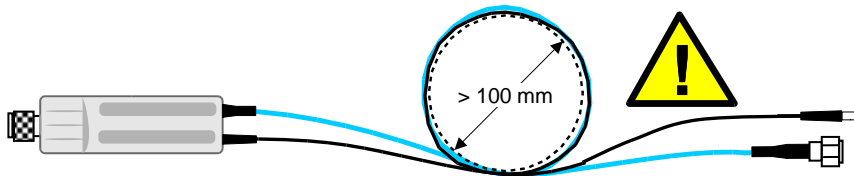
A tighter bend can permanently impair the matching of the RF input!
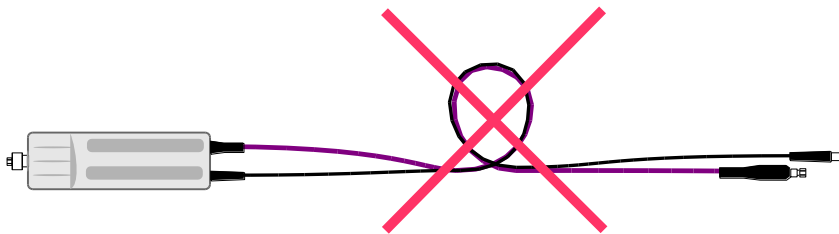
Operation with the R&S NRP/NRP2 power meter

Connecting the power sensor

The power sensor can be connected to the R&S NRP/NRP2 base unit when it is in operation. The multiple circular plug-in connector must be inserted, red marking upwards, into one of the R&S NRP/NRP2 base unit's sensor connectors. When the power sensor is connected, it is detected by the R&S NRP/NRP2 base unit and initialized.

Connect the RF connector of the connecting cable to the output of a signal source, and connect the RF connector of the power meter to the input of the DUT. To screw on the power sensor more easily and without tilting it, slightly lift it.
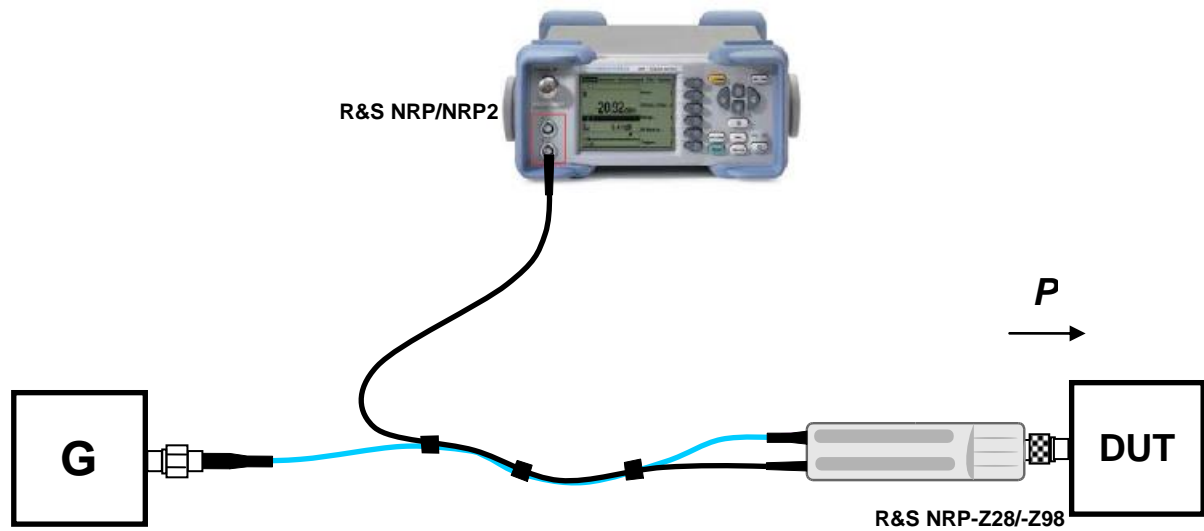
Fig. 1-1   Configuration with the R&S NRP/NRP2

Performing measurements

The R&S NRP-Z28/-Z98 power sensors behave in a similar manner as the R&S NRP-Z21 and R&S NRP-Z91 multipath diode sensors. Unlike these, however, instead of the power fed to the sensor, the power P supplied to the DUT is measured. By means of the *S-parameter correction* function, adapters or attenuators connected ahead of the DUT can be taken into consideration. The *gamma correction* function allows the influence of a mismatched DUT to be reduced.

PC control

Hardware and software requirements

The following requirements must be met if the power sensor is to be controlled by a PC via an interface adapter:

- The PC must have a USB port.

- Either Microsoft Windows XP (32 Bit), Microsoft Windows Vista (32 or 64 Bit), Microsoft Windows 7 (32 or 64 Bit), or x86 Linux (with kernel 2.6.8 oder more recent) must be installed as the operating system of the PC. 64-bit versions of Microsoft Windows XP are not supported. Operation with older versions of Microsoft Windows with USB support (especially Microsoft Windows 2000) is normally possible but cannot be guaranteed.

- The USB device drivers in the supplied *NRP Toolkit* software package must be installed.

If these requirements are met, the power sensor can be controlled using a suitable application program such as the *NrpFlashup* program contained in the Microsoft Windows version of the *NRP Toolkit* (includes the modules *Power Viewer*, *USB Terminal*, *Firmware Update* and *Update S-Parameters*).

When you insert the CD-ROM supplied with the R&S NRP power sensor, the *NRP Toolkit* is automatically installed on your PC. The rest of the procedure is self-explanatory.

The power sensor can be powered in two ways:

- *Self-powered* from a separate power supply via the Active USB Adapter R&S NRP-Z3 or the Sensor Hub R&S NRP-Z5.

- *Bus-powered* from the PC or a USB hub with its own power supply (*self-powered hub*) via the Active USB Adapter R&S NRP-Z3 or via the Passive USB Adapter R&S NRP-Z4.

As the power sensor is a *high-power device*, there is no guarantee that it can be powered from all types of laptop or notebook in the *bus-powered* mode. To be sure, you should determine the current at the USB connectors beforehand:

- *In the Windows™ start menu, select **Settings – Control Panel***

- *Select the **System** icon*

- *Select the **Hardware** tab*

- *By clicking on the button of that name, start the **Device Manager***

- *Open **USB Controller** (all USB controllers, hubs and USB devices are listed here)*

- *Double-click **USB Root Hub** or select **Properties** in the context menu (use the right-hand mouse button)*

- *Select the **Power** tab (Fig. 1-1). If the hub is self-powered and the total power available is, as indicated by **Hub Information**, 500 mA per port, high-power devices can be connected.*
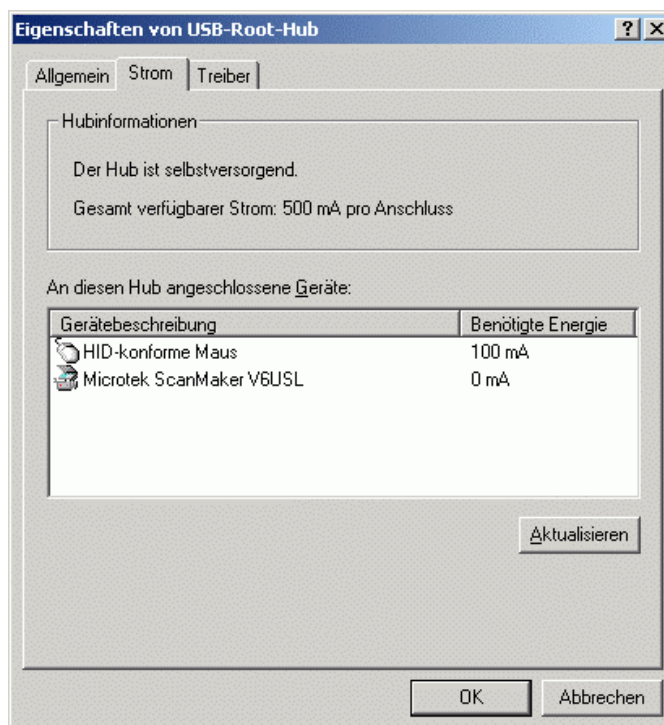
Fig. 1-2   Displaying the total available power of a USB port

If you have any doubts, ask the manufacturer if the USB port on your laptop or notebook can handle *high-power devices.*

Operation via the R&S NRP-Z4 passive USB adapter

Fig. 1-3 is a schematic of the measurement setup. The order in which the cables are connected is not critical.
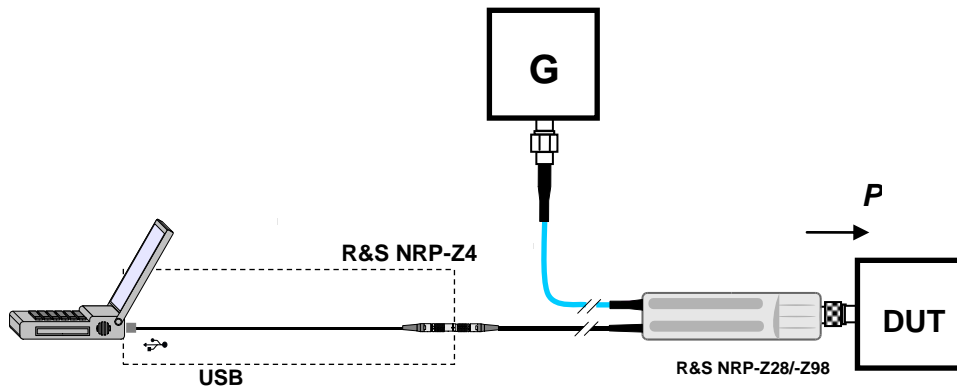
Fig. 1-3   Power measurement on PC with the R&S NRP-Z4 passive USB adapter

Operation via the R&S NRP-Z3 active USB adapter

Fig. 1-4 shows the configuration with the R&S NRP-Z3 active USB adapter. The order in which the cables are connected is not critical.
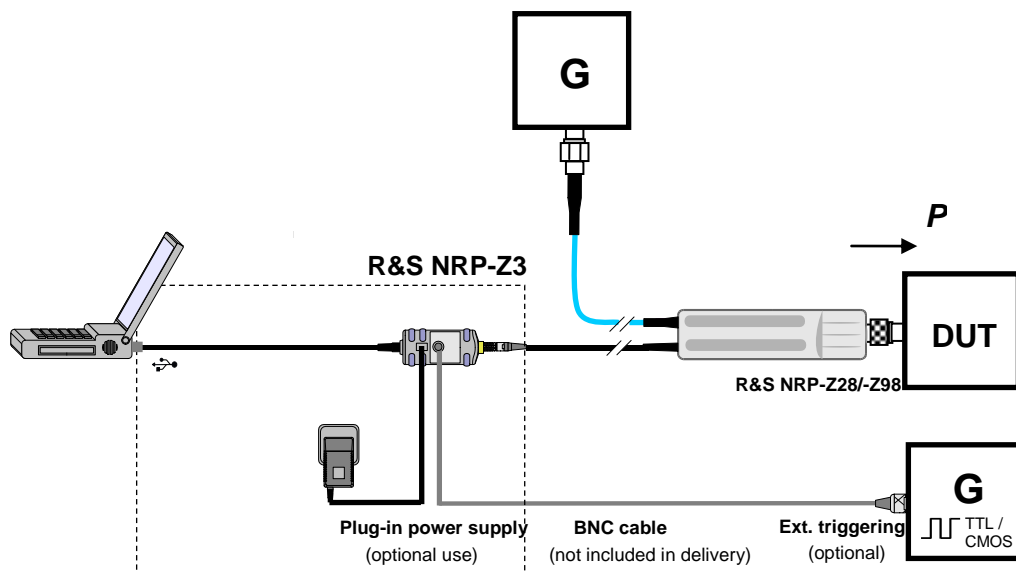
Fig. 1-4   Power measurement on PC with the R&S NRP-Z3 active USB adapter

The plug-in power supply for the R&S NRP-Z3 can be powered from a single-phase AC source with a nominal voltage range of 100 V to 240 V and a nominal frequency between 50 Hz and 60 Hz. The plug-in power supply autosets to the applied AC voltage. No manual voltage selection is required.

The plug-in power supply comes with four primary adapters for Europe, the UK, the USA and Australia. No tools of any kind are required to change the primary adapter. The adapter is pulled out manually and another adapter inserted until it locks (Fig. 1-5).
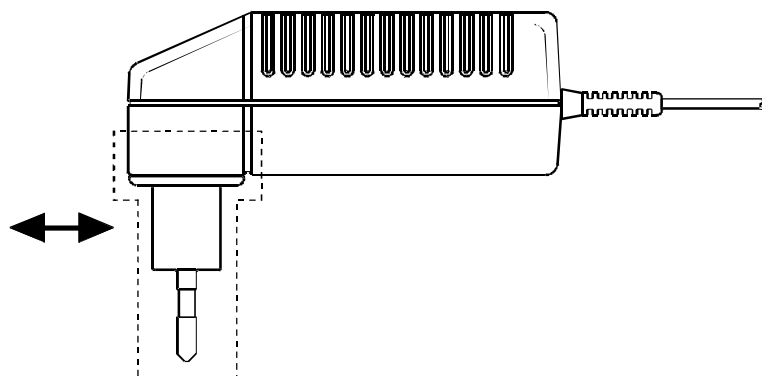
Fig. 1-5   Changing the primary adapter

The plug-in power supply is short-circuit-proof and has an internal fuse. It is not possible to replace this fuse or open the plug-in power supply.

NOTICE   *The plug-in power supply is not intended for outdoor use.*

Keep within the temperature range of 0 °C to 50 °C.

If there is any condensation on the plug-in power supply, dry it off before connecting it to the AC supply.

Operation via the R&S NRP-Z5 Sensor Hub

The R&S NRP-Z5 sensor hub allows up to four power sensors to be operated on one PC. It combines the following functions:
- 4-port USB 2.0 hub
- Power supply
- Through-wired trigger bus
- Trigger input and trigger output via BNC sockets

Equipment Supplied and Alternative Accessories

The following equipment is supplied:
- Sensor hub
- External power supply
- Power cable
- USB cable

Instead of the supplied, 2 m long USB cable, it is possible to use any other USB-2.0-certified cable (USB connector type A to USB connector type B) with a maximum length of 5 m. If a locking connection is required at the instrument end, it is also possible to use the passive R&S NRP-Z4 interface adapter instead of a standard USB cable.

As an alternative to the supplied external power supply, power can also be supplied using a DC voltage source with an output voltage of 12 V to 24 V and a power output of at least 24 W. Make sure that the polarity is correct (positive pole inside, negative pole outside). The alternative DC voltage source must be in the same building as the R&S NRP-Z5 and must be connected to the latter via a cable with a maximum length of 30 m. Power must not be supplied from a low-voltage supply system.

The supplied external power supply is short-circuit-proof and is also protected by an internal fuse. It is not possible to change the fuse or open the unit.

NOTICE   *The external power supply is not intended for outdoor use.*

Keep within the temperature range of 0°C to 50°C.

If there is any condensation on the external power supply, dry it off before connecting it to the AC supply.

Ports and LEDs

The power sensors are connected to the front panel of the R&S NRP-Z5. The ports and LEDs on the front panel of the R&S NRP-Z5 are shown in Fig. 1-6.

1–4   Sockets for connecting the power sensors
5–8   Green LEDs for indicating normal operation
9–12   Yellow LEDs for indicating faults
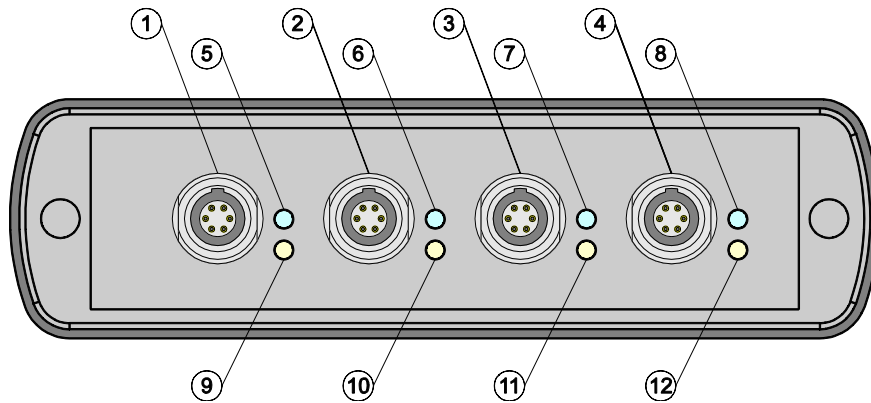
Fig. 1-6   Ports and LEDs on front panel

On the rear panel are the ports for power supply, USB host, trigger input and trigger output. The ports on the rear panel are shown in Fig. 1-7.

1   Trigger output (BNC socket)
2   Trigger input (BNC socket)
3   Plug allowing connection to Rohde & Schwarz measuring instruments (via R&S NRP-Z2) or to a PC (via R&S NRP-Z4)
4   USB socket (type B) for connection to the USB host (PC or Rohde & Schwarz measuring instrument without sensor socket)
5   Power supply socket (supplied external power supply unit or alternative power supply (12 V to 24 V/24 W))
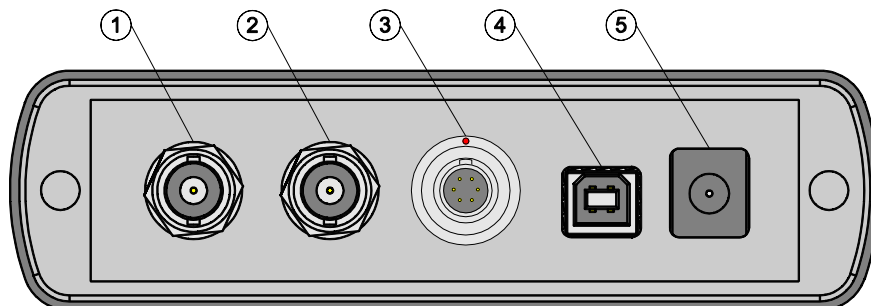
Fig. 1-7   Ports on rear panel

Unlatch the R&S Instrument *connector on the rear panel by pressing down the unlatching ring of the built-in plug and pulling off the cable jack at the same time (Fig. 1-8).*

Fig. 1-8   Unlatching the *R&S Instrument* connector
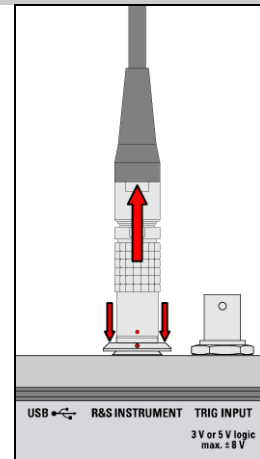
Test Setup

Fig. 1-9 shows a typical test setup:

1	R&S NRP-Z5 sensor hub
2	External power supply unit (supplied)
3	Power cable (supplied)
4	AC power supply
5	USB cable (supplied)
6	PC with USB host port
7, 8	BNC cable (optional, not supplied)
9	Trigger source (optional)
10	Triggered device (optional)
11-14	R&S NRP-Zxx power sensors (one to four sensors)
15	Signal source
16	DUT

The sequence in which the cables are connected is not important.

As already mentioned in section *Ports and LEDs*, the R&S NRP-Z4 passive interface adapter can also be used as an alternative to a standard USB cable for connecting to the PC. This adapter is connected to the *R&S Instrument* port. Simultaneous operation at two USB hosts is not possible as the USB host connected to the *R&S Instrument* port always has priority.

It is possible to cascade several R&S NRP-Z5 sensor hubs by connecting the *R&S Instrument* port of an R&S NRP-Z5 to one of the sensor ports of another R&S NRP-Z5. However, external triggering and the use of the *Trigger Master* function are then not possible. Instead, it is recommended to connect all R&S NRP-Z5 hubs individually to the USB host or to an interposed USB hub, and to feed the external trigger signal to all R&S NRP-Z5 hubs via their trigger inputs; or to forward the external trigger signal from the trigger output of the R&S NRP-Z5 to which the *Trigger Master* is connected to the trigger inputs of the other R&S NRP-Z5 hubs.
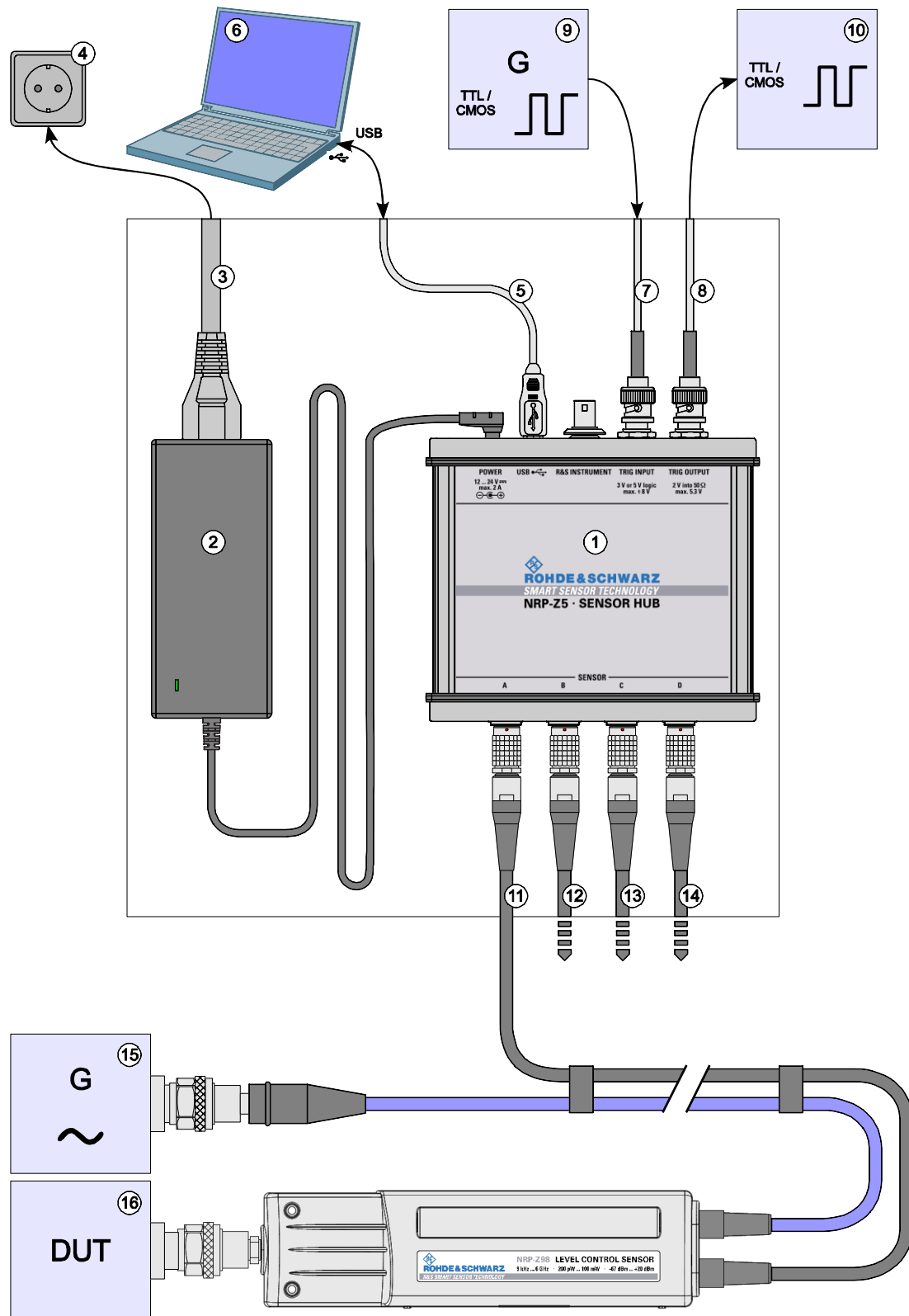
Fig. 1-9   Typical test setup with R&S NRP-Z5 and PC

Troubleshooting

A frequent problem, especially in the case of operation under Microsoft Windows XP, is that the R&S NRP-Z5 fails to respond after a power sensor connected to the R&S NRP-Z5 is disconnected and reconnected. It is then necessary to restart the PC.

This problem is not specific to the R&S NRP-Z5, but occurs with all USB hubs. You can try to eliminate the problem by switching off the *Selective Suspend* for the USB port of the PC on which the R&S NRP-Z5 is operated. The following step-by-step description is based on an English version of Windows XP:

1. Connect the R&S NRP-Z5 and put it into operation. Connect at least one power sensor.
2. Start the Device Manager and change the view by selecting **View - Devices by connection** (Fig. 1-10).
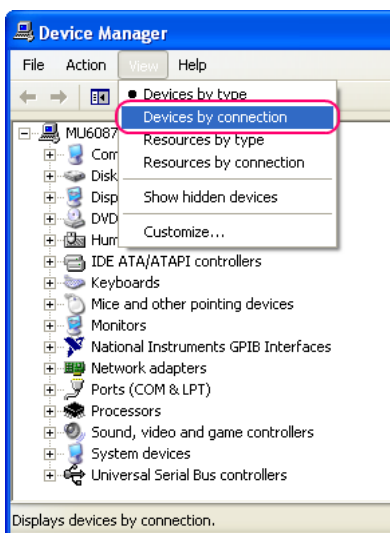
Fig. 1-10   Changing the view in Device Manager

3. Now identify the USB root hub on which the R&S NRP-Z5 is operated. To do so, expand the hierarchical display of the PC components, as shown in Fig. 1-11. Under **PCI bus**, find the USB host controller to whose root hub the R&S NRP-Z5 is connected. The R&S NRP-Z5 is shown as the **Generic USB Hub**. It can be distinguished from other USB hubs by the power sensor connected to it.
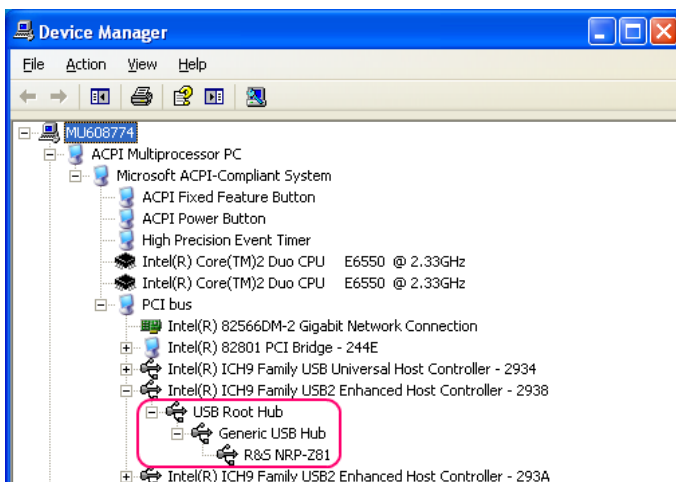
Fig. 1-11   Identification of USB root hub on which R&S NRP-Z5 is operated

4. Double-clicking **USB Root Hub** opens the **USB Root Hub Properties** dialog box. Select the Power Management tab. Remove the check mark next to **Allow the computer to turn off this device to save power** and confirm this with **OK**.
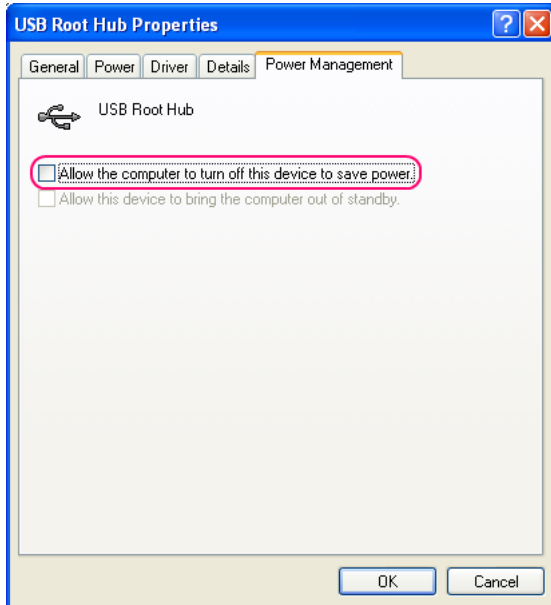
Fig. 1-12   Deactivation of *Selective Suspend* for a USB root hub

Connecting the sensor to the source and the DUT

Connect the RF connector of the connecting cable to the output of a signal source, and connect the RF connector of the power meter to the input of the DUT. By slightly lifting the power sensor, you can screw it on more easily without tilting it.

Performing measurements

The R&S NRP-Z28/-Z98 power sensors behave in a similar manner as the R&S NRP-Z21 and R&S NRP-Z91 multipath diode sensors. Unlike these, however, instead of the power fed to the sensor, the power P supplied to the DUT is measured. By means of the *S-parameter correction* function, adapters or attenuators connected ahead of the DUT can be taken into consideration. The *gamma correction* function allows the influence of a mismatched DUT to be reduced.

Operation with other Rohde & Schwarz test instruments

Hardware and software requirements

Many Rohde & Schwarz test instruments allow power measurements using power sensors of the R&S NRP-Zxx series. The power sensors are generally connected to the USB ports of the test instrument via one of the two interface adapters, R&S NRP-Z3 or R&S NRP-Z4, or the Sensor Hub R&S NRP-Z5. On some instruments, such as the R&S SMU signal generator, there is also an R&S NRP sensor connector available for a direct connection. The R&S NRP-Z5 can be hooked up to this connector via an extension cable R&S NRP-Z2 (Model .03, .05, or .15). For that purpose, the *R&S Instrument* connector of the R&S NRP-Z5 is used.

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2 Virtual Power Meter

You will find the **NrpFlashup** program that enables you to operate the power sensor with a PC under Windows™ on the CD-ROM that accompanies the power sensor. The program comprises several modules which can be started centrally via the Windows™ start-menu entry **NRP Toolkit**.

This section describes the **Power Viewer** program module. This is a virtual power meter which only uses a cut-down set of the power sensor's functions. This means that after an extremely brief familiarization period, you can perform measurements.

The other modules in **NrpFlashup** are described in Chapter 3 of the operating manual (**Terminal** and **Update S-Parameters** modules) or in the service manual (**Firmware Update** module).

Overview

Start the virtual power meter using the **NRP Toolkit** – **Power Viewer** start-menu entry. The **Power Viewer** program window is displayed (Fig. 2-1).
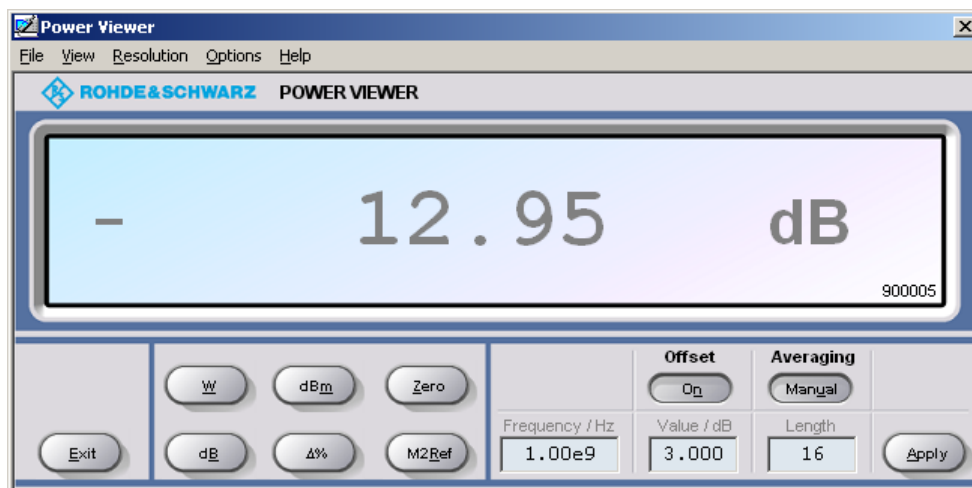

Fig. 2-1   **Power Viewer –** virtual power meter

The result display occupies most of the program window. The result, unit and additional power sensor status information are displayed. The serial number is displayed in the bottom right. The program window also contains animated buttons and entry fields (see Table 2-1 and Table 2-2).

Table 2-1   Virtual power meter keys

Button	Function	Key combination
Exit	Terminates the program. The current settings are saved and recalled the next time the program is started.	Alt + E
W	Selects Watt as the display unit.	Alt + W
dBm	Selects dBm as the display unit.	Alt + M
Zero	Zeroes the power sensor.	Alt + Z
dB	Selects dB as the display unit. This is the log of the ratio of the measured value to the reference value.	Alt + B
Δ%	Selects % as the display unit. The difference between the measured value and the reference value is expressed as a percentage.	Alt + %
M2Ref	Makes the current measured value the reference value for the relative display units dB and %.	Alt + R
Offset On/Off	Turns the global offset correction for the power sensor on or off. If the offset correction is Off, the **Offset/dB** entry field has a grey background.	Alt + N
Averaging Man/Auto	Turns auto-averaging on or off. When auto-averaging is on, the **Length** entry field has a grey background; the current averaging factor is displayed.	Alt + T
Apply	Accepts edited numerical values in the **Frequency/Hz**, **Value/dB** and **Length** entry fields and transfers them to the sensor.	Alt + A or Enter key

Table 2-2   Virtual power meter entry fields

Entry field	Function
Frequency/Hz	Frequency of the RF carrier in Hertz.
Value/dB	Attenuation in dB of the component connected to the power sensor. The valid range is −100 to 100. The offset correction must be activated beforehand with the **Offset On/Off** button if this entry field is to be edited.
Length	Length of the averaging filter (= averaging factor). The valid range is 1 to 65536. Averaging must be set to manual with the **Averaging Man/Auto** button if this entry field is to be edited.

Scientific notation can also be used for the entry fields. If an invalid entry is made, an error message is output. An edited numerical value will not be transferred to the power sensor unless you use the **Apply** button or the Enter key to terminate the entry.

Menus

The menu bar can be used to call less frequently used functions.

File	**Start Log ...**	Opens a file-selection dialog to specify the path and name of the log file. Clicking the **Save** button starts the recording. All displayed values are written line-by-line to the log file with the date (format: YY/MM/DD) and time (format: hh:mm:ss.ms). Example: `-22.51 dBm (03/02/25 15:37:25.310)`
	Stop Log	Ends the log-file recording.
View	**Display Refresh Rate**	Opens a dialog box to adjust the display refresh rate. The time in milliseconds between two refresh operations is entered. The default setting is 200 ms.
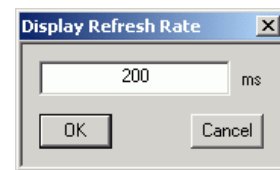
	Colours	Opens a dialog box to select the background colour for
	Result	• the result,
	Unit	• the unit,
	Edit	• the text in the number fields or
	Button	• the key labelling.
Resolution		For setting the result resolution. If auto-averaging has been selected, a higher resolution leads to a greater averaging factor, which means a longer result settling time.
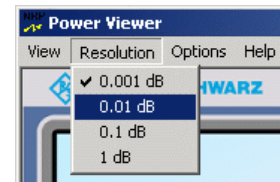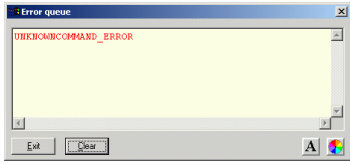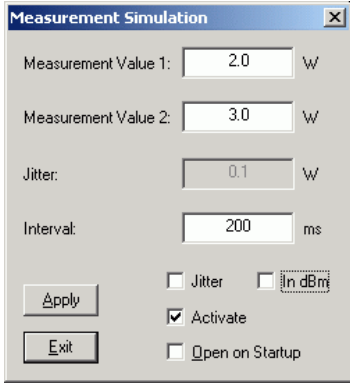
| **Options** | **Read Sensor Status …** | Reads the current status of the power sensor. A parameter list is output. |

Read Error Queue …	Reads the error queue. All the error messages that have been issued since the last call are read line-by-line. A tick before this menu entry indicates that an error has occurred.	
Simulation …	Allows you to try out the functions of the virtual power meter even without a power sensor. The display alternates between **Measurement Value 1** & **Measurement Value 2** with a period given by **Interval**. Simulation can be activated immediately with the **Activate** check box.	
Reset Sensor	Initializes the power sensor. Any previous zeroing remains valid.	
Help **Contents**	Opens the table of contents for the online-help facility.	
About	Displays information about the program version used, etc.	

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3 Manual Operation

The previous section describes the **Power Viewer** program module supplied with the instrument. This module simplifies the most frequently used function of a power meter – measuring the average power of an RF signal of almost any modulation. Other program modules are also part of the supplied equipment and can be selected in the Start menu:

- **Power Viewer**:   A detailed description of this virtual power meter module is provided in section 2.

- **Terminal**:   Program module for sending commands and command sequences to the sensor and for displaying measurement results, status information and other data from the sensor

- **Firmware Update**:   Program module for updating the sensor firmware

- **Update S-Parameters**:   Program module for loading an s-parameter table into the sensor

Program module "Terminal"

Main control elements

With the USB terminal, commands and command sequences can be sent to the sensor in two different ways:

- Commands are entered in the **Input** field (Fig. 3-1). Consecutive commands can be entered as separate lines, one below the other. The buttons associated with the **Input** field are described in Table 3-1.

- Commands or command sequences are stored in *command files*. Command files are created with a text editor, for instance, and then stored. They can be called as often as required (Fig. 3-2). The buttons of the **Command File** field are described in Table 3-2.
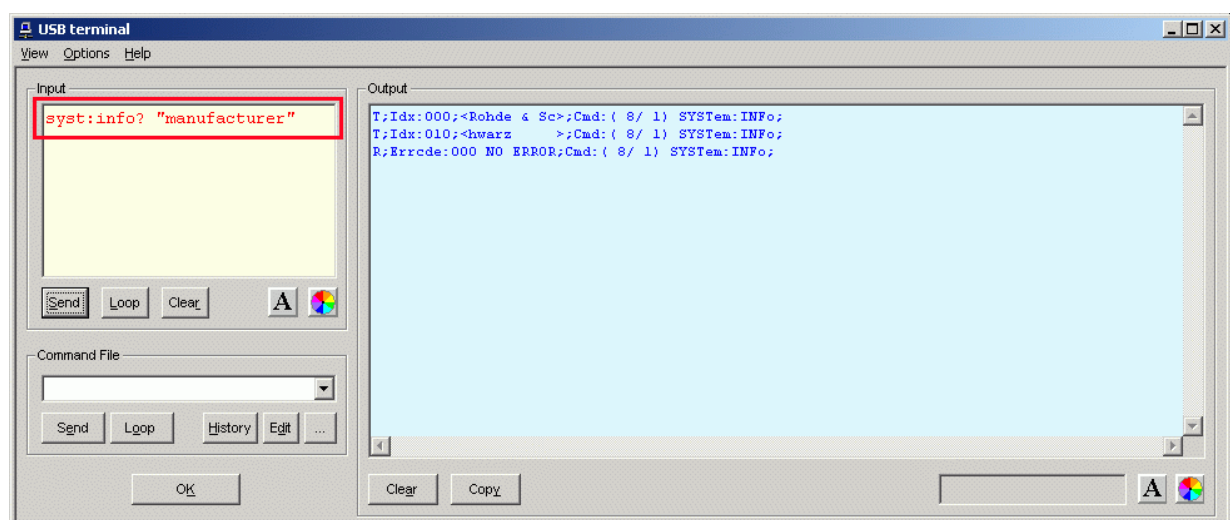
Fig. 3-1   Sending commands using the **Input** field
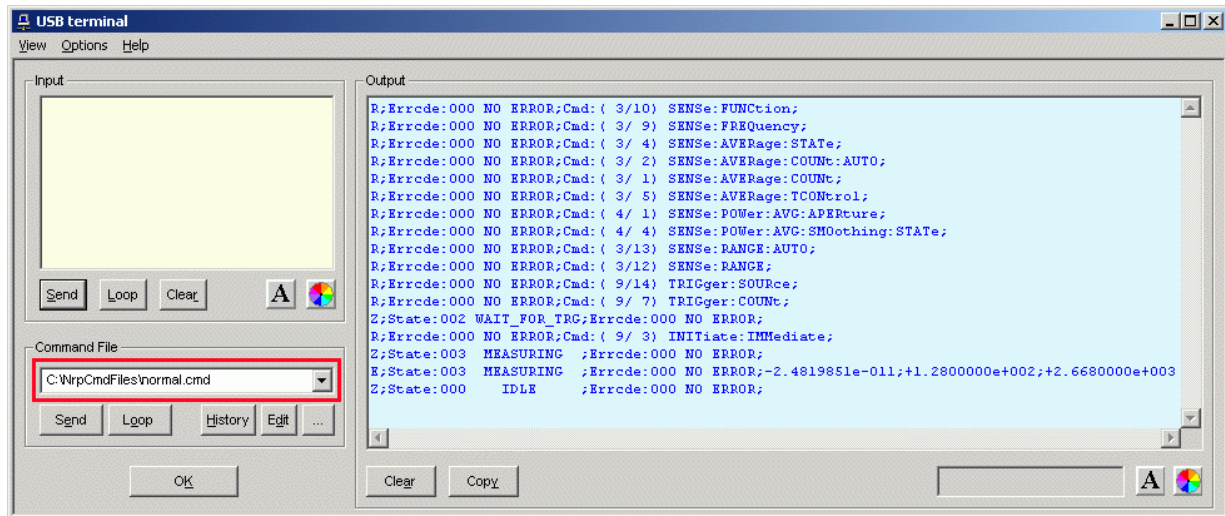
Fig. 3-2   Sending commands using command files

Table 3-1   Buttons assigned to the **Input** field

Button	Function	Key combination
Send	Sends the content of the **Input** entry field to the sensor.	Alt + S
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + L
Clear	Clears the content of the **Input** field.	Alt + R
Font key	Opens a dialog window where the font for the **Input** field can be selected.	
Colour key	Opens a dialog window where the background colour of the **Input** field can be selected.	

Table 3-2   Buttons assigned to the **Command File** field

Button	Function	Key combination
Send	Sends the content of the command file to the sensor.	Alt + E
Loop	With **Loop** the command or command sequence is cyclically sent. Pressing the button again terminates the cyclic transmission. The repetition rate is set in a dialog window that can be opened with **View - Loop...**	Alt + O
History	Opens a window for editing the command file name in the **Command File** field.	Alt + H
Edit	Opens the selected command file in the Windows™ text editor.	Alt + D
…	Opens a file opening dialog for selecting the command file.	

A command line starting with a tab, a blank or a special character is considered a comment and not forwarded to the sensor.

Measurement results, parameters and status information returned by the sensor are displayed in the **Output** field.

Table 3-3   Buttons assigned to the **Output** field

Button	Function	Key combination
Clear	Clears the content of the **Output** field	Alt + A
Copy	Copies the content of the **Output** field to the clipboard. (Another possiblity: mark the desired information in the output window with the mouse cursor, press the right mouse key or Ctrl+C and then copy the selected text to the clipboard using the menu item **Copy** in the opened context menu.)	Alt + Y
Font button	Opens a dialog window where the font for the **Output** field can be selected.	
Colour button	Opens a dialog window where the background colour of the **Output** field can be selected.	

Close the USB terminal with OK.

Menus

View   **Post Filter …**   Opens the **Output Postfilter** dialog window where the lines stored in the input buffer can be filtered according to different criteria.
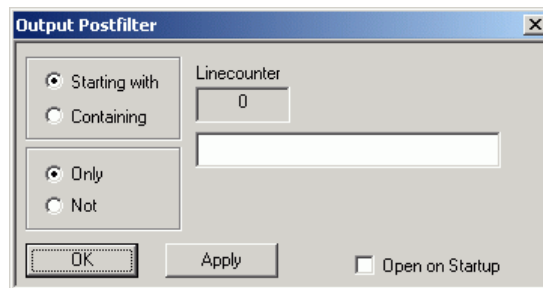
Filter criteria:

Only + **Starting with**: Only lines starting with the entered character string are displayed.

Not + **Starting with**: Only lines not starting with the entered character string are displayed.

Only + **Containing**: Only lines containing the entered character string are displayed.

Not + **Containing**: Only lines not containing the entered character string are displayed.

Lines not matching the specific filter criterion are blanked but not cleared.

Filtering is started with **Apply**. The number of lines matching the filter criterion is displayed in the **Linecounter** field. If **Open on startup** is active, the **Output Postfilter** dialog is automatically opened when the terminal is started. The dialog window is closed with **OK**.

Response Time … Opens the **Response time** dialog window where the response time of the power sensor can be set.
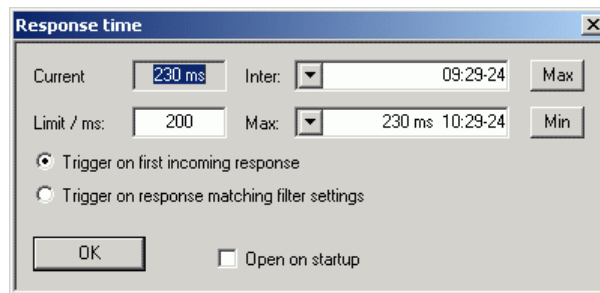
Current indicates the time elapsed between dispatch of the last command and receipt of an acknowledgement from the power sensor. When the **Max** button is clicked, the response times exceeding the value in the **limit / ms** field are recorded. When the **Min** button is clicked, the response times within the value in the **limit / ms** field are recorded.

If **Trigger on first incoming response** is active, the time measurement is terminated as soon as the first response arrives after a command is sent. If **Trigger on response matching filter settings** is active, the time measurement is terminated as soon as the first response matching the filter criterion in the **Output Postfilter** dialog window is received.

If **Open on startup** is active, the **Response Time** dialog is automatically displayed when the Terminal module is started. The dialog window is closed with **OK**.

Loop … Opens the **Loop controls** dialog window where the cyclic transfer of commands and command sequences can be controlled.

In the **Delay / ms** field, the time interval for the cyclic transfer is specified in milliseconds.

The number of completed transfer cycles is displayed in the **Counter** field. If **Open on startup** is active, the **Response time** dialog is automatically opened when the Terminal module is started. The dialog window is closed with **OK**.
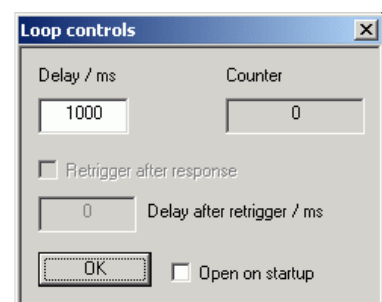
Options	**Protocol Mode**	In this mode, a time stamp is added to each response block.	
	Hex Mode	In this mode, the response blocks from the power sensor are displayed in hexadecimal format.	
	Auto Delete	With this option active, the **Output** field is automatically cleared when the **Send** button is pressed.	
	Auto Scroll	With this option active, older items in the **Output** field are automatically shifted upward and off the display if space is required for new values.	
	LF at EOT	With this option active, a line feed is appended to each response block from the power sensor.	
	Delete on Start	With this option active, the **Output** field is automatically cleared when the Terminal module is started.	
	Send as Hex	With this option active, the text in the **Input** field is interpreted as a hexadecimal character sequence.	

Advanced …   Opens a dialog window where the buffer size for the **Output** field can be set.

Help	**Contents**	Opens the table of contents for the online help.
	About	Displays information about the program version, etc.

Program module "Firmware Update"

A detailed description of the program module for firmware updates is provided in the Service Manual.

Program module "Update S-Parameters"

Fundamentals

With the R&S NRP-Z28/-Z98 sensors, the influence of any twoport – e.g. an adapter – between the sensor output and the DUT can be considered, allowing the power P actually fed to the DUT to be calculated.
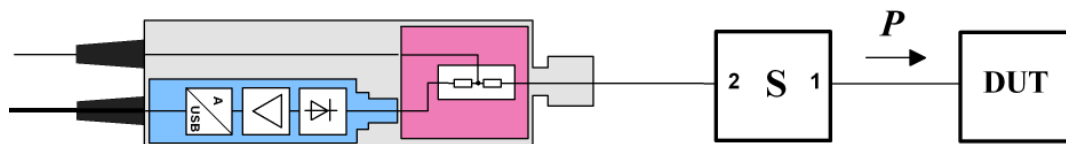
Fig. 3-1   Operation with twoport between sensor output and DUT

A precondition is that a complete set of s-parameter data of the twoport is available in the frequency range in question. The set of calibration data of the sensor therefore includes a table with up to 1000 measurement frequencies. The real and the imaginary part as well as the uncertainty of the s-parameters s_{11}, s_{12}, s_{21} and s_{22} are stored for each frequency.

Important: The set of s-parameter data must be defined such that port 2 corresponds to the port on the sensor end and port 1 to the port on the DUT end.

The measurement frequencies in the s-parameter table can be selected independent of the calibration frequencies of the sensor, allowing the twoport frequency range of interest to be optimally covered. The real and the imaginary parts are linearly interpolated between these measurement frequencies, thus permitting phase changes of ±15° between neighboring measurement frequencies. Below the first and above the last measurement frequency, the values of the first and the last measurement frequency are used, respectively.

The NrpFlashup program (menu item **Update S-Parameters**) is used for loading the s-parameter table. To ensure compatibility with a great number of network analyzers, NrpFlashup can process measurement data files in S2P format. All standard frequency units (Hz, kHz, MHz, GHz) and display formats (real and imaginary part, linear magnitude and phase, magnitude in dB and phase) are supported. The only restriction is that a reference impedance of $50\,\Omega$ must be used for the s-parameters. Additional noise parameters in the measurement data file are ignored.

Structure of the S2P measurement data file:

1. The *option line* has the following format (square brackets indicate that the enclosed content is optional):

     # [<frequency unit>] [<parameter>] [<format>] [<R n>]

     # identifies the *option line*.

     The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.

     If a parameter is specified, S must be used in <parameter> for s-parameter files. If a parameter is not specified, S is implicitly assumed.

     The <format> may be MA (linear magnitude and phase in degree), DB (magnitude in dB, phase in degree) or RI (real and imaginary part). If a format is not specified, MA is implicitly assumed.

     R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.

     The *option line* should therefore read:

     # [HZ | KHZ | MHZ | GHZ] [S] [MA | DB | RI] [R 50]

2. The measurement frequencies in ascending order are specified as follows:

$$f_i \quad s_{11}(f_i) \quad s_{21}(f_i) \quad s_{12}(f_i) \quad s_{22}(f_i),$$

where $s_{jk}(f_i)$ is the display format as specified in the *option line*:

$$\left| s_{jk}(f_i) \right| \quad \arg s_{jk}(f_i)$$ (display format for linear magnitude and phase in degree) or

$$20 \cdot \lg \left| s_{jk}(f_i) \right| \quad \arg s_{jk}(f_i)$$ (display format for magnitude in dB and phase in degree)

$$\mathrm{Re}\left[s_{jk}(f_i) \right] \quad \mathrm{Im}\left[s_{jk}(f_i) \right]$$ (display format for real and imaginary part)

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

To characterize the measurement uncertainty of the s-parameter test system, another data file can optionally be created. The syntax of the uncertainty data file is similar to that of the S2P data file but U is specified as <Parameter> in the *option line* so that the *option line* reads # Hz U for frequencies in Hz. The measurement frequencies must not be identical to those of the S2P measurement data files. In most cases a few entries will be sufficient to characterize the measurement uncertainty of the s-parameter test system. An s-parameter uncertainty as high as that of the neighbouring measurement frequencies of the uncertainty data file is then selected. If different values are available, the higher one is chosen. This is illustrated in the example below:

Table 3-4   Uncertainties of the s-parameter test system (example)

f in GHz	unc [$s_{ik}(f)$]
0.1	0.01
1.0	0.01
1.1	0.005
10.0	0.005
10.1	0.01
40.0	0.01

Table 3-5   Interpolated uncertainties of measurement frequencies for s-parameters (example)

f in GHz	unc [$s_{ik}(f)$]
0.9	0.01
0.95	0.01
1.0	0.01
1.05	0.01
1.1	0.005
1.15	0.005
1.2	0.005

At 1.05 GHz, the higher uncertainty of the two adjacent 1.0 GHz and 1.1 GHz measurement frequencies is entered in the s-parameter table. If an uncertainty of 0.005 is desired for all frequencies above 1.0 GHz, the first measurement frequency in the uncertainty data file must above 1.0 GHz, e.g. 1.000001 GHz.

Structure of the uncertainty data file (square brackets indicate that the enclosed content is optional):

1. The *option line* has the following format:
   # [<frequency unit>] <parameter> [<format>] [<R n>]
   # identifies the *option line*.
   The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
   U must be specified for <parameter> in uncertainty data files. If a parameter is not specified, S is implicitly assumed and as a result an error message is triggered.
   <format> is ignored in uncertainty measurement files; the entry is therefore irrelevant.
   R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] U [MA | DB | RI] [R 50]

2. Measurement frequencies in ascending order are specified in the following form:
$$f_i \quad \text{unc}\left[s_{11}(f_i)\right] \quad \text{unc}\left[s_{21}(f_i)\right] \quad \text{unc}\left[s_{12}(f_i)\right] \quad \text{unc}\left[s_{22}(f_i)\right].$$
   The s-parameters uncertainties are forwarded as follows:
   * as extended absolute uncertainties ($k = 2$) for the magnitude of reflection parameters s_{11} and s_{22}, for instance 0.015,
   * as extended uncertainties ($k = 2$) in dB for the magnitude of transmission parameters s_{21} and s_{12}, for instance 0.015.

3. Comments: Any line starting with an exclamation mark (!) is interpreted as a comment line.

Two additional values must be specified when the s-parameters are loaded: the lower and the upper nominal measurement limit of the sensor-twoport combination. If s-parameter correction is active, these values are transferred by the sensor in response to *SYSTem:INFO?* The values cannot always be derived from the lower or upper measurement limit of the sensor alone and from the loss or gain of the preconnected twoport. The upper measurement limit of the sensor-twoport combination may also be limited by the twoport's maximum power-handling capacity. Furthermore, the lower measurement limit may be raised not only by the loss but also by the inherent noise of the twoport. For this reason, these values must be entered manually.

NOTICE   *The upper nominal measurement limit of the sensor-twoport combination entered when loading the s-parameters should be carefully specified, as automatic test systems may evaluate it and an incorrect value may cause the sensor and/or the twoport to be overloaded.*

Procedure

To load an s-parameter table into the calibration set of the sensor, proceed as follows:

1. Connect the sensor to the USB port of the PC and start the program module **Update S-Parameters**. The corresponding dialog window is opened (Fig. 3-3).

2. Make sure **Keep Current S-Parameter Data** is deactivated.

3. Under **S-Parameter File** enter the search path and the name of the S2P file containing the parameters. Press the **Browse**... button to open a file-opening dialog where the S2P measurement data file can be easily selected.

4. Under **Uncertainty File** enter the search path and the name of the measurement uncertainty file containing the measurement uncertainty of the s-parameter test system. Press the **Browse**... button to open a file-opening dialog where the measurement uncertainty file can be easily selected.

5. Enter the upper and lower nominal measurement limit of the sensor-twoport combination in the **Lower Power Limit** and **Upper Power Limit** fields**.**

6. Enter a name for the loaded s-parameter set in the **S-Parameter Device Mnemonic** field. This name can later be queried with *SYSTem:INFO? "SPD Mnemonic"* and is displayed on the NRP basic unit when s-parameter correction is switched on.

7. Activate **S-Parameter Correction on by Default** if the *SENSe:CORRection:SPDevice:STATe* switch should be automatically set to *ON* when the sensor is put into operation.

8. Designations for calibration laboratory and person responsible for calibration may be entered in the **Calibration Lab** and **Calibration Engineer** fields. These designations are stored in the calibration data set. They are implicitly set to „user lab" and „user", respectively, if the fields are left blank.

9. Press **Start** for loading. (The dialog is closed with **OK** and the set parameters are retained. When the dialog is exited with **Cancel**, all parameter modifications are ignored.)
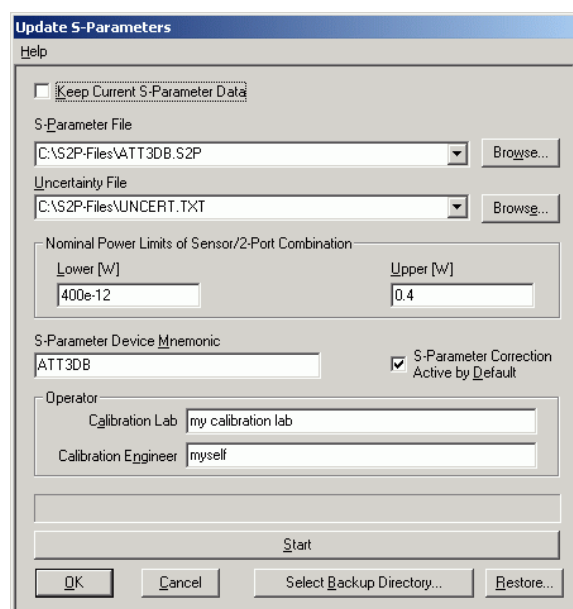
Fig. 3-3   Dialog window for loading an s-parameter table

During loading, the current calibration data set of the sensor is overwritten. To be on the safe side, a backup copy of the current calibration data set is therefore automatically stored before s-parameters are loaded. The names of the backup files have the structure <type>_<batch number>_<date>_<time>.bak, where <type> is the sensor type, <batch number> is the batch number of the sensor, <date> the date of the s-parameter update in yyyymmdd format and <time> the time of the s-parameter update in the format hhmmss. By default, a subdirectory named "Backup" is created for the backup files in the program directory. With **Select Backup Directory …** it is possible to select a different directory.

Store the automatically created backup files on a separate data medium (e.g. diskette, CD-ROM or network drive) and, if required, assign a meaningful name to them to simplify reloading. With the aid of these files, a previously used calibration data set of the sensor can be restored.

To reload the backup file of a calibration data set into the sensor, proceed as follows:

1. Press the **Restore...** button. The **Restore S-Parameters** window is opened (Fig. 3-4).

2. Enter the search path and the name of the backup file in the **Backup File** field. Press the **Browse**... button to open a dialog where the backup file can be easily selected.

3. Press **OK** to start the restore procedure. (With **Cancel** the dialog window is exited without data being restored).
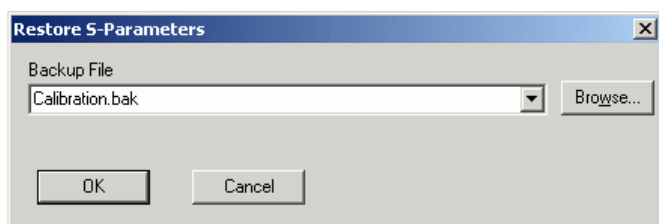
Fig. 3-4　　　Dialog window for loading the backup file of a calibration data set

To be able to determine if the s-parameter correction is active after plugging in or resetting the sensor, proceed as follows:

1. Connect the sensor to the USB port of the PC and start the program module **Update S-Parameters**.

2. Make sure **Keep Current S-Parameter Data** is activated (Fig. 3-5).

3. Activate **S-Parameter Correction on by Default** if the *SENSe:CORRection:SPDevice:STATe* switch should be automatically set to *ON* when the sensor is put into operation, otherwise deactivate it.

4. Press **Start** for loading.

Fig. 3-5   Subsequently changing the default behavior of the s-parameter correction

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5 Remote Control – Fundamentals

Rohde & Schwarz recommends to utilize the VXI Plug & Play Driver for the remote control of R&S NRP power sensors and power sensor modules. This driver can be found on the CD-ROM supplied with the sensor or downloaded in its most recent version via the internet (http://rohde-schwarz.com/).

The old remote control interface provided by the *Dynamic Link Library NrpControl.dll* is not developed further, but remains on the CD-ROM and can be downloaded via the internet.

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6 Remote Control – Commands

Notation

In the following sections, all commands implemented in the sensor are first listed in a table according to command systems and are then described in detail. The notation is largely in line with the SCPI standard.

Command tables For a quick overview of available commands, the commands are listed in a table before they are described. These tables contain the following four columns:

Command:	Commands and their tree structure.
Parameters:	Possible parameters.
Unit:	The basic unit of the physical parameters (must not be sent with parameters).
Remarks:	Identification of all commands

- that have no query form
- that are available as query only
- that are only available with the R&S NRP-Z28 (Z28 only)

Indentations The various levels of the SCPI command hierarchy are shown in the table by indentations to the right. The lower the level, the greater the indentation to the right. It should be noted that the complete notation of the command includes the higher levels too.

Example:
SENSe:AVERage:COUNt is represented in the table as follows:
SENSe   first level
  :AVERage   second level
    :COUNt   third level

In the individual description, the command is shown in full length. An example of the command is given at the end of the description.

[?]
?
A question mark in square brackets at the end of a command indicates that this command can either be used as a setting command (without question mark) or as a query (with question mark). If the question mark is not in square brackets, the command is a query only.

Example:
SENSe:POWer:AVG:APERture[?]
SENSe:POWer:AVG:APERture 1e-3 sets the length of the sampling window to 1 ms.
SENSe:POWer:AVG:APERture? Returns the currently set length as a response.

*IDN? Queries the sensor identification string that of course cannot be changed. For this reason, this command is only available as a query.

Special characters | for parameters
A vertical bar between parameters is used to separate alternative options (OR link).

Example:
INITiate:CONTinuous OFF | ON
The parameter *OFF* or *ON* can be entered.

{numeric expression}
A numeric expression in braces means that it has been rounded to the nearest integral value.

<parameter>   A parameter or a variable in triangular brackets expresses its current value.
<variable>

Z28 only   This command is only available with the R&S NRP-Z28.

Commands as per IEEE 488.2

The sensor supports a subset of the possible setting commands and queries *(Common Commands and Queries)* in line with IEEE 488.2.

*IDN? – Identification Query

IDN? returns a string with information on the sensor's identity (device identification code). In addition, the version number of the installed firmware is indicated. The string for a sensor of type R&S NRP-Z28 has the following structure:

ROHDE&SCHWARZ,NRP-Z28,<serial number>,<firmware version>

<serial number>: Serial number in ASCII
<firmware version>: Firmware version number in ASCII

*RST – Reset

RST sets the sensor to the default state, i.e. the default settings for all test parameters are loaded.

*TRG – Trigger

TRG triggers a measurement. For this purpose, the sensor is in the *WAIT_FOR_TRIGGER* state and the source for the trigger event is set to *BUS* (*TRIGger:SOURce BUS*).

*TST? – Self Test Query

TST? starts a selftest and returns 0 (no error found) or 1 (an error has occurred). The selftest comprises the following functions:

- RAM test
- Operating voltages
- Temperature measurement
- Calibration data set
- Noise
- Zero-point offsets.

SCPI Commands

The R&S NRP-Z28/-Z98 sensors are controlled via the groups of commands

- CALibration (zeroing)
- SENSe (measurement configurations)
- SYSTem
- TRIGger
- SERVice.

CALibration

Table 6-1   Commands of the *CALibration* system

Command	Parameter	Unit	Remarks
CALibration			
:DATA[?]	<calibration data set as definite length block>		
:LENGth?		Bytes	Query only
:ZERO			
:AUTO[?]	OFF | ON | ONCE		

CALibration:DATA[?]   <calibration data set as *definite length block>*

CALibration:DATA is used for writing a calibration data set in the flash memory of the sensor.

The query yields the calibration data set currently stored in the flash memory as a *definite length block*.

CALibration:DATA:LENGth?

CALibration:DATA:LENGth? yields the length in bytes of the calibration data set currently stored in the flash memory. Programs that read out the calibration data set can use this information to determine the capacity of the buffer memory required.

CALibration:ZERO:AUTO[?]   OFF | ON | ONCE

The commands *CALibration:ZERO:AUTO ON* and *CALibration:ZERO:AUTO ONCE* zeroes the three measurement paths of the sensor. For this purpose, the test signal must be deactivated or the sensor disconnected from the signal source. The sensor automatically detects the presence of any significant power to be measured. This causes zeroing to be aborted and error message *NRPERROR_CALZERO* to be output. The *CALibration:ZERO:AUTO OFF* is ignored. Zeroing takes four seconds at a minimum, but at least as long as the selected averaging filter needs for settling (only fixed-filter mode).

Repeat zeroing

- *during warm-up after switching on or connecting the instrument*

- *after a substantial variation of the ambient temperature*

- *after fastening the sensor to an RF connector at high temperature*

- *after several hours of operation*

- *when very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.*

For zeroing switch off the test signal and do not remove the sensor from the signal source. Apart from keeping the thermal balance, this has the advantage that the noise superimposed on the test signal (e.g. from a broadband amplifier) can be detected on zeroing and does not impair the measurement result.

The query always yields *1* (= *OFF*).

Default setting

After a power-on reset, the zero offsets determined during the last calibration are used until the first zeroing. Therefore, very slight zero offsets are to be expected with a warmed up sensor. Initialization by means of **RST* or *SYSTem:INITialize* has no influence on the current zero offsets.

SENSe (Sensor Configuration)

The sensor is configured by means of the commands of the groups *SENSe* and *TRIGger*.

Table 6-2   Commands of the *SENSe* system

Command	Parameter	Unit	Remarks
SENSe			
:AVERage			
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF | ON | ONCE		
:MTIMe[?]	0.01 to 999.99	s	
:NSRatio[?]	0.0 to 1.0	dB	
:RESolution[?]	1 to 4		
:SLOT[?]	1 to <SENSe:POWer:TSLot:AVG:COUNt>		Z28 only
:TYPE[?]	RESolution | NSRatio		
:RESet			No query
:STATe[?]	OFF | ON		
:TCONtrol[?]	MOVing | REPeat		
:CORRection			
:DCYCle[?]	0.001 to 99.999	%	
:STATe[?]	OFF to ON		
:OFFSet[?]	-200.0 to 200.0	dB	
:STATe[?]	OFF to ON		
:SPDevice:STATe[?]	OFF to ON		
:FREQuency[?]	10.0e6 to 18.0e9 (NRP-Z28) or 9.0e3 to 6.0e9 (NRP-Z98)	Hz	
:FUNCtion[?]	"POWer:AVG" | "POWer:TSLot:AVG" | "POWer:BURSt:AVG" | "XTIME:POWer"(NRP-Z28) or "POWer:AVG" (NRP-Z98)		
:POWer			
:AVG			
:APERture[?]	10.0e-6 to 0.3	s	
:BUFFer			

Command	Parameter	Unit	Remarks
:SIZE[?]	1 to 1024		
:STATe[?]	OFF | ON		
:SMOothing:STATe[?]	OFF | ON		
:BURSt:DTOLerance[?]	0.0 to 3.0e-3	s	Z28 only
:TSLot:AVG			Z28 only
:COUNt[?]	1 to 128		Z28 only
:WIDTh[?]	10.0e-6 to 0.1	s	
:RANGe [?]	0 to 2		
:AUTO[?]	OFF | ON		
:CLEVel[?]	–20.0 to 0.0	dB	
:SAMPling[?]	FREQ1 | FREQ2		
:SGAMma			
:CORRection:STATe[?]	OFF | ON		
:MAGNitude[?]	0.0 to 1.0		
:PHASe[?]	-360.0 to 360.0	degree	
:TIMing			Z28 only
:EXCLude			Z28 only
:STARt[?]	0.0 to 0.1	s	Z28 only
:STOP[?]	0.0 to 0.003	s	Z28 only
:TRACe			Z28 only
:AVERage			Z28 only
:COUNt[?]	1 to 8192		Z28 only
:STATe[?]	OFF | ON		Z28 only
:TCONtrol[?]	MOVing | REPeat		Z28 only
:MPWidth?		s	Z28 only, Query only
:OFFSet:TIME[?]	– (<TRIGger:DELay> + 0.005) to 100.0	s	Z28 only
:POINts[?]	1 to 1024		Z28 only
:REALtime[?]	OFF | ON		Z28 only
:TIME[?]	0.0001 to 0.3		Z28 only

SENSe:AVERage:COUNt[?]   1 to 65536

SENSe:AVERage:COUNt sets the number of measured values that have to be averaged for forming the measurement result in the modes *Continuous Average*, *Burst Average* and *Timeslot Average*. The higher this averaging factor, the less the measured values fluctuate and the longer the measurement time lasts. The parameter is rounded off to the nearest power-of-two number.

The query yields the averaging factor used in the modes *Continuous Average*, *Burst Average* and *Timeslot Average*.

> *The averaging function must be activated with* SENSe:AVERage:STATe ON *so that the set averaging factor becomes effective.*

Default setting: *4*

SENSe:AVERage:COUNt:AUTO[?]   OFF | ON | ONCE

SENSe:AVERage:COUNt:AUTO activates (auto-averaging) or deactivates (fixed-filter mode) automatic determination of the averaging factor in the modes *Continuous Average*, *Burst Average* and *Timeslot Average*. If auto-averaging is activated, the averaging factor is continuously determined and set depending on the level of power and other parameters.

SENSe:AVERage:COUNt:AUTO ON activates auto-averaging and *SENSe:AVERage:COUNt :AUTO OFF* deactivates it. On deactivation, the previous, automatically determined averaging factor is used in the fixed-filter mode. The *SENSe:AVERage:COUNt:AUTO ONCE* command ensures that a new averaging factor is determined by the filter automatic function under the current measurement conditions and used in the fixed-filter mode.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *ON*

SENSe:AVERage:COUNt:AUTO:MTIMe[?]   0.01 to 999.99

SENSe:AVERage:COUNt:AUTO:MTIMe sets an upper limit for the settling time of the auto-averaging filter in the *NSRatio* mode and thus limits the length of the filter.

The query returns the time that has been set.

Default setting: *4.0 [s]*

SENSe:AVERage:COUNt:AUTO:NSRatio[?]   0.0 to 1.0

SENSe:AVERage:COUNt:AUTO:NSRatio determines the relative noise component in the measurement result for the *Continuous Average*, *Burst Average* and *Timeslot Average* modes if auto-averaging is operated in the corresponding mode (*SENSe:AVERage:COUNt:AUTO:TYPE NSRatio*). The noise component is defined as the magnitude of the level variation in dB caused by the inherent noise of the sensor (two standard deviations).

The query yields the relative noise component in the result for the *Continuous Average*, *Burst Average* or *Timeslot Average* modes.

Default setting: *0.01 [dB]*

SENSe:AVERage:COUNt:AUTO:RESolution[?]   1 to 4

SENSe:AVERage:COUNt:AUTO:RESolution sets the resolution index for the automatic averaging filter in the *Continuous Average*, *Burst Average* and *Timeslot Average* modes if it is operated in the *RESolution* mode. The resolution index equals the number of decimal places that have to be taken into account for the further processing of the measurement result in dBm, dBµV or dB. The normal mode is designed in a similar manner as for the predecessors R&S NRVS and R&S NRVD or other commercial power meters. The higher the selected index, the better the measurement result is filtered without the last significant place (0.01 dB with an index of 3) actually being set. The *NSRatio* setting is recommended instead.

The query yields the resolution index for the *Continuous Average*, *Burst Average* and *Timeslot Average* modes.

Default setting: *3*

SENSe:AVERage:COUNt:AUTO:SLOT[?]
1 to <SENSe:POWer:TSLot:AVG:COUNt> Z28 only

SENSe:AVERage:COUNt:AUTO:SLOT defines the timeslot, whose power is referenced by auto-averaging in the *Timeslot Average* mode. The timeslot is addressed via its number, the counting beginning with 1. The timeslot number must not exceed the number of the currently set timeslots. If a valid timeslot number is initially set and then the number of timeslots reduced to a value that is smaller than the initial timeslot number, the initial value is automatically set to the new timeslot number, i.e. auto-averaging references the most recent timeslot.

The query yields the number of the current timeslot, whose power is referenced by auto-averaging in the *Timeslot Average* mode.

Default setting: *1*

SENSe:AVERage:COUNt:AUTO:TYPE[?]   RESolution | NSRatio

SENSe:AVERage:COUNt:AUTO:TYPE defines the automatic averaging filter mode in the *Continuous Average*, *Burst Average* and *Timeslot Average* modes. The *RESolution* parameter sets the mode usual for power meters; *NSRatio* predefines the compliance to an exactly defined noise component.

The query yields
- *1* for *RESolution*,
- *2* for *NSRatio*.

Default setting: *RESolution*

SENSe:AVERage:RESet

SENSe:AVERage:RESet initializes the averaging filter for the *Continuous Average*, *Burst Average* or *Timeslot Average* modes. This is useful if a high averaging factor is set in the *SENSe:AVERage :TCONtrol MOVing* filter mode and if the power to be measured has significantly decreased since the previous measurement, e.g. by several powers of ten. In this case, previous measurement results still contained in the averaging filter strongly affect the settling of the display; as a result, the advantage of the *SENSe:AVERage:TCONtrol MOVing* filter mode, i.e. the ability to detect trends in the measurement result while the measurement is still in progress, is lost. The *SENSe:AVERage:RESet* command solves this problem by deleting all previous measurement results that the averaging filter contains. After initialization, the filter length gradually increases from 1 to its nominal value *SENSe:AVERage:COUNt*, so that trends in the measurement result become quickly apparent. However, this procedure does not shorten the measurement time required in order for the averaging filter to settle completely.

SENSe:AVERage:STATe[?]   OFF | ON

SENSe:AVERage:STATe switches on or off the averaging filter for the *Continuous Average*, *Burst Average* and *Timeslot Average* modes.

The query yields
- *1* for *OFF,*
- *2* for *ON*.

Default setting: *ON*

SENSe:AVERage:TCONtrol[?]   MOVing | REPeat

SENSe:AVERage:TCONtrol (terminal control) defines the behavior of the averaging filter in the *Continuous Average*, *Burst Average* and *Timeslot Average* modes. As soon as a new measured value is shifted to the FIR filter, a new average value is available at the filter output, which is obtained from the new measured value and the other values stored in the filter.

The *MOVing* parameter defines that each new average value is output as a measurement result. This allows tendencies in the result to be recognized during the measurement procedure.

The *REPeat* parameter defines that a new result is output after the FIR filter has been filled with new measured values. This ensures that no redundant information is output.

The query yields
- *1* for *MOVing*,
- *2* for *REPeat*.

Default setting: *MOVing*

SENSe:CORRection:DCYCle[?]   0.001 to 99.999

SENSe:CORRection:DCYCle sets the duty cycle to a percent value for the correction of pulse-modulated signals. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power. Since the duty cycle is only useful in the *Continuous Average* mode, it is evaluated only there.

The query yields the current duty cycle in percent.

Default setting: *1.0 [%]*

SENSe:CORRection:DCYCle:STATe[?]   OFF | ON

SENSe:CORRection:DCYCle:STATe ON activates the duty cycle correction and thus the pulse-power measurement whereas *SENSe:CORRection:DCYCle:STATe OFF* deactivates it.

The query yields
• *1* for *OFF,*
• *2* for *ON.*

Default setting: *OFF*

SENSe:CORRection:OFFSet[?]   –200.0 to 200.0

SENSe:CORRection:OFFSet defines a fixed offset in dB, which is used to correct the measured value. (When a log scale is used, the offset is added to the measured value; this is the reason why the command has this name.)

An attenuator connected between the sensor and the DUT is taken into account with a negative offset. In this case, the power detected by the sensor is reduced in line with the attenuation value, so that the power is output at the input of the DUT. A positive offset could be used to correct the influence of a gain.

The query yields the set offset in dB.

Default setting: *0.0 [dB]*

SENSe:CORRection:OFFSet:STATe[?]   OFF | ON

SENSe:CORRection:OFFSet:STATe ON activates the offset correction and
SENSe:CORRection:OFFSet:STATe OFF deactivates it.

The query yields
• *1* for *OFF,*
• *2* for *ON.*

Default setting: *OFF*

SENSe:CORRection:SPDevice:STATe[?]   OFF | ON

SENSe:CORRection:SPDevice:STATe ON activates the s-parameter data set stored in the sensor in order to take a component (attenuator, adapter) connected between the sensor and the DUT into account in the measurement result. It is thus possible to calculate the power *P* fed to the DUT from the measured value of the power sensor and the s-parameters of the attenuator or adapter.

Important: The set of s-parameter data must be defined such that port 2 corresponds to the port on the sensor end and port 1 to the port on the DUT end.
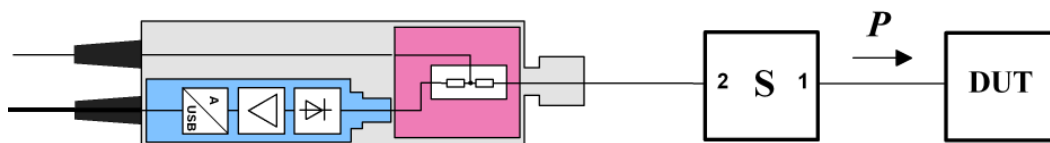
The use of s-parameters instead of a fixed offset (see group of commands *SENSe:CORRection :OFFSet*) allows more precise measurements, since the interactions between the sensor, the source and components connected between them can be taken into account. To take the influence of the DUT into account, however, its complex reflection coefficient Γ_{DUT} at the current measurement frequency must be transmitted to the sensor and the gamma correction must be activated (see group of commands *SENSe:SGAMma*).

For detailed information on loading s-parameter data sets, refer to section 3. The sensor has no factory-set s-parameter data set. In this state, the *SENSe:CORRection:SPDevice:STATe ON* command generates an error message.

The query yields
*   *1* for *OFF,*
*   *2* for *ON.*

Default setting:
The factory-set default setting of the sensor is *OFF*. On loading an s-parameter table, the default setting can be redefined (see section 3).

SENSe:FREQuency[?]   10.0e6 to 18.0e9 (NRP-Z28), or 9.0e3 to 6.0e9 (NRP-Z98)

SENSe:FREQuency transfers the carrier frequency of the RF signal to be measured; this frequency is used for the frequency-response correction of the measurement result. The center frequency is set for broadband signals (*spread-spectrum* signals, multicarrier signals).

The query yields the set carrier frequency in Hz.

Default setting: *50.0e6 [Hz]*

SENSe:FUNCtion[?]   <sensor_function>

SENSe:FUNCtion <sensor_function> sets the sensor to one of the following measurement modes:

Table 6-3   Measurement modes

<sensor_function>	Description of the measurement mode
"POWer:AVG"	**Continuous Average** In this mode, the average power of the measurement signal is asynchronously measured within definable time intervals (sampling windows). The width of a sampling window is set with the *SENSe:POWer:AVG:APERture* command. The measurements are performed with chopper stabilization to obtain more accurate measurement results with reduced noise and zero offset. Therefore, a single measurement is always performed over two sampling windows, the polarity of the detector output signal being reversed for the second window. By taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized. When the averaging function is activated, the averaging factor determines how often the described measurement cycle is repeated. A measurement should be started with the command *INITiate:IMMediate* (once) or *INITiate:CONTinuous ON* (continuously), the trigger source being set to *IMMediate* with the *TRIGger:SOURce* command (asynchronous measurement).
"POWer:TSLot:AVG" Z28 only	**Timeslot Average** The average power of a definable number of successive timeslots within a frame structure with equal spacing is measured. The width of one slot must be defined with *SENSe:POWer:TSLot[:AVG]:WIDTh*; the number of slots is defined by *SENSe:POWer:TSLot[:AVG]:COUNt*. It is essential to define the parameter *TRIGger:DELay* to ensure that the beginning of the first slot to be measured coincides with the delayed trigger point. The measurement result is an array with the same number of elements as timeslots. Each element represents the average power in a particular timeslot. To minimize noise and zero offset, the measurement is performed with chopper stabilization. The polarity of the detector output signal is therefore reversed from frame to frame. By subsequently taking the difference of the output signals, the effect of the video path on noise and zero drift is reduced. Time intervals that are to be excluded from the measurement can be set at the beginning and end of each timeslot (see commands *SENSe:TIMing:EXCLude:STARt* and *SENSe:TIMing:EXCLude:STOP*). A measurement is initiated with the command *INITiate:IMMediate* (once, irrespective of the number of repetitions required for averaging) or *INITiate:CONTinuous ON* (continuously). The trigger source must be set to *INTernal* or *EXTernal* with the *TRIGger:SOURce* command. After each occurrence of a trigger event, the power is measured sequentially in all timeslots. Note that a trigger event must be available for each frame.
"POWer:BURSt:AVG" Z28 only	**Burst Average** This mode is used to measure the average power of bursts. The time interval in which the average power is measured starts when the power exceeds the trigger threshold and stops when the trigger logic detects the end of the pulse. To prevent power drops due to modulation from being erroneously interpreted as the end of a pulse, the user must define the dropout tolerance with *SENSe:POWer:BURSt:DTOLerance*. To minimize noise and zero offset, the measurement is performed with chopper stabilization. The polarity of the detector output signal is therefore reversed from burst to burst. By subsequently taking the difference of the output signals, the effect of the video path on noise and zero drift is minimized. In the *Burst Average* mode, only internal trigger events (from the signal) are evaluated (irrespective of the setting of the *TRIGger:SOURce* parameter). The *TRIGger:DELay* parameter is also ignored, so that the measurement interval begins exactly when the signal exceeds the trigger threshold. Time intervals that are to be excluded from the measurement can be set at the beginning and at the end of the measurement interval (see commands *SENSe:TIMing:EXCLude:STARt* and *SENSe:TIMing:EXCLude:STOP*).

<sensor_function>	Description of the measurement mode
"XTIMe:POWer" Z28 only	**Trace** In the *Trace* mode, the envelope power can be recorded as a function to time. This is done by sampling power over a time interval that can be specified by the user (*SENSe:TRACe:OFFSet:TIME* and *SENSe:TRACe:TIME* commands), and then assigning the power values that have been determined to a number of pixels that are largely user-selectable (*SENSe:TRACe:POINts* command). The time interval represented by a pixel is obtained by dividing the trace length by N-1, where N is the number of pixels. In the simplest case, each pixel is assigned a single sampling value which fully characterizes it. If several sampling values are assigned to a pixel, the average power is made available for the time interval in question. In the *SENSe:TRACe:REALtime ON* setting (realtime processing), the measurement is performed without chopper stabilization, i.e. a measurement consists of a single sampling sequence activated by a trigger event, independent of the setting of the averaging filter. Otherwise a second sampling sequence with reversed polarity of the detector output voltage is recorded, and the difference of the measured values of the two sampling sequences is determined for each pixel. This suppresses low-frequency noise and increases the measurement accuracy for the average power of the individual pixels. The averaging factor determines how often the cycle is repeated.

Time intervals that are excluded from the measurement can be set at the beginning and the end of the sampling window or timeslot in the measurement modes *Burst Average* and *Timeslot Average*. (*SENSe:TIMing:EXCLude:STARt* and *-:STOP*).

The query yields
- *1* for *"POWer:AVG"*,
- *2* for *"POWer:TSLot:AVG"*,
- *4* for *"POWer:BURSt:AVG"*,
- *8* for *"XTIMe:POWer"*.

Default setting: *"POWer:AVG"*

SENSe:POWer:AVG:APERture[?]   10e-6 to 0.3

SENSe:POWer:AVG:APERture defines the time interval (sampling window) for the *Continuous Average* mode; measured values are continuously recorded in this interval. In manual operation, the default setting of 20 ms in conjunction with the activated smoothing is sufficient in most cases.

Larger sampling windows are needed when the measurement shows fluctuations due to modulation. It is then useful to adapt the size of the sampling window exactly to the modulation period, which yields an optimally stable display. If the modulation period varies or is not precisely known, the *Smoothing* function should also be activated (see command group *SENSe:POWer:AVG:SMOothing*). With smoothing activated, approx. 5 periods within a sampling window are sufficient to reduce the fluctuations caused by modulation to an acceptable degree; fluctuations are no longer perceptible with more than 9 periods. With smoothing deactivated, the situation is considerably more unfavorable. In this case, 300 instead of 5 periods are required, and the fluctuations do not disappear completely until there are 3000 or more periods.

The query yields the currently set width of the sampling window in seconds.

Default setting: *0.02 [s]*

SENSe:POWer:AVG:BUFFer:SIZE[?]   1 to 1024

SENSe:POWer:AVG:BUFFer:SIZE sets the buffer size for the buffered *Continuous Average* mode.

The query yields the current buffer size for the buffered *Continuous Average* mode.

Default setting: *1*

SENSe:POWer:AVG:BUFFer:STATe[?]   OFF | ON

The buffered *Continuous Average* mode is activated with *ON* and deactivated with *OFF*. In this mode, the results generated by trigger events are collected in the sensor until the buffer is filled. All results are then transferred as block data. The measurement rate obtained is thus higher than in the non-buffered *Continuous Average* mode. The maximum measurement rate is obtained by combining the buffered mode with multiple triggering (see parameter *TRIGger:COUNt*). The size of the result buffer is set with the *SENSe:POWer:AVG:BUFFer:SIZE* command.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:POWer:AVG:SMOothing:STATe[?]   OFF | ON

The *ON* parameter activates a smoothing filter for modulated signals in the *Continuous Average* mode and *OFF* deactivates it. The smoothing filter is a steep-edge digital lowpass filter used to suppress variations of results caused by low-frequency modulation. This parameter should be activated to reduce variations in results due to modulation when the size of the sampling window cannot or should not be exactly adapted to the modulation period. If the selected sampling window is 5 to 9 times larger than a modulation period, the variations in display are normally sufficiently reduced. With smoothing deactivated, 300 to 3000 periods are required to obtain the same effect.

With smoothing deactivated, the sampling values are considered equivalent and averaged in a sampling window, which yields an integrating behavior of the measuring instrument. As described above, optimum suppression of variations in the result is thus obtained when the size of the sampling window is exactly adapted to the modulation period. Otherwise, the modulation can have a considerable influence, even if the sampling window is much larger than the modulation period. The behavior can be considerably improved by subjecting sampling values to weighting (raised-von-Hann window), which corresponds to video filtering. This is exactly what happens with activated smoothing.

Since the smoothing filter increases the inherent noise of the sensor by approx. 20%, it should remain deactivated if it is not required.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:POWer:BURSt:DTOLerance[?]   0.0 to 0.003 $\boxed{\text{Z28 only}}$

SENSe:POWer:BURSt:DTOLerance defines the dropout tolerance, a parameter for reliably detecting the burst end in the *Burst Average* mode with modulated signals (e. g. with digital standards NADC, PDC, PHS, etc.). The dropout tolerance should be selected larger than the longest amplitude drop and smaller than the gap between two consecutive bursts. The default value is sufficient for all usual digital communication standards.

The query yields the dropout tolerance for the *Burst Average* mode.

Default setting: *0.0001 [s]*
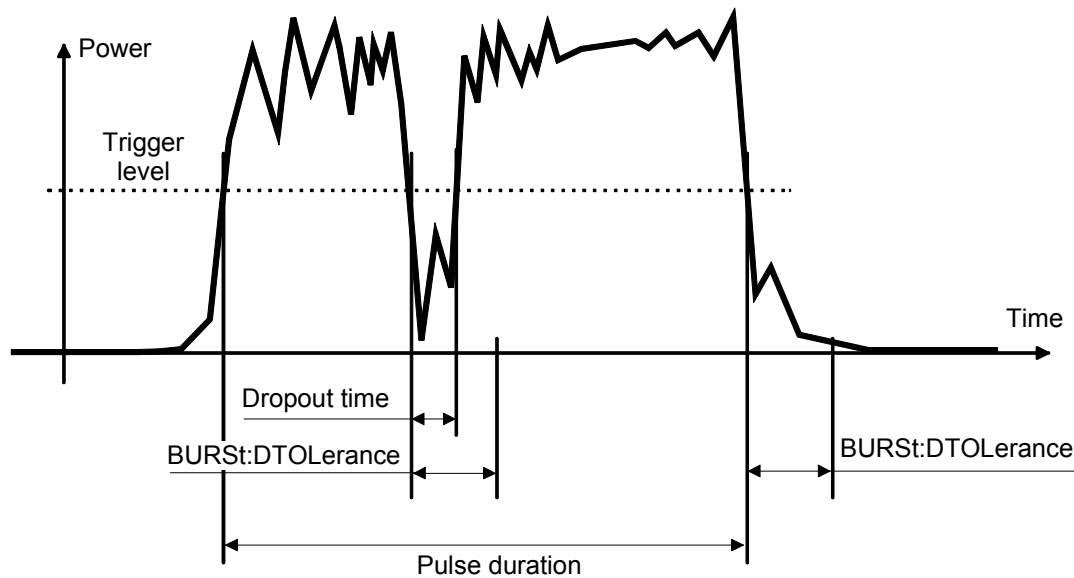
Fig. 6-1   Effect of SENSe:POWer:BURSt:DTOLerance

SENSe:POWer:TSLot:AVG:COUNt[?]   1 to 128 Z28 only

For the Timeslot mode, *SENSe:POWer:TSLot:AVG:COUNt* sets the number of consecutive timeslots that are to be processed after each trigger event.

The query yields the number of consecutive timeslots.

Default setting: *8*

SENSe:POWer:TSLot:AVG:WIDTh[?]   10.0e-6 to 0.1 Z28 only

SENSe:POWer:TSLot:AVG:WIDTh sets the length of a timeslot for the *Timeslot Average* mode (in s).

The query yields the length of a timeslot for the *Timeslot Average* mode.

Default setting: *0.001 [s]*

SENSe:RANGe[?]   0 to 2

SENSe:RANGe selects the measurement path of the sensor. The sensor has three separate measurement paths. Path 1 is the most sensitive, path 2 medium and path 3 the least sensitive. *SENSe:RANGe 0* selects path 1, *SENSe:RANGe 1* path 2 and *SENSe:RANGe 2* path 3.
The dynamic ranges of these measurement paths depend on temperature and are model-specific. Reference values are 40 µW(–14 dBm) for the most sensitive measurement path, 4 mW (6 dBm) for the medium one and 400 mW (26 dBm) for the least sensitive.

The query yields
- *0* for path 1,
- *1* for path 2,
- *2* for path 3.

If the measurement path is selected manually (*SENSe:RANGe:AUTO OFF*), the currently selected measurement path is output. With automatic selection, the last path that was set manually is output. Since this setting has been saved, it is immediately reset after deactivating the automatic function.

Default setting: *2* (least sensitive path)

SENSe:RANGe:AUTO[?]   OFF | ON

SENSe:RANGe:AUTO ON activates the automatic selection of the measurement path and *SENSe:RANGe:AUTO OFF* deactivates it.

The query yields
* *1* for *OFF,*
* *2* for *ON.*

Default setting: *ON*

SENSe:RANGe:CLEVel[?]   –20.0 to 0.0

SENSe:RANGe:CLEVel is used to reduce the transition range between measurement paths 1 and 2 or 2 and 3 by the indicated value (in dB). This can improve the measurement accuracy for signals with a high *peak-to-average* ratio, since the headroom for modulation peaks becomes larger. The disadvantage is that the S/N ratio is reduced at the lower limits of the transition ranges.

The query yields the offset of transition ranges between measurement channels 1 and 2 or 2 and 3.

Default setting: *0.0 [dB]*

SENSe:SAMPling[?]   FREQ1 | FREQ2

SENSe:SAMPling is used to vary the sampling frequency of the analog-digital converter in the sensor. With parameter specification *FREQ1* the sampling frequency is 134.400 kHz, and 119.467 kHz with parameter *FREQ2*. This is provided to suppress interfering low-frequency mixture products from signal components and the sampling frequency.

The query yields
* *1* for *FREQ1,*
* *2* for *FREQ2.*

Default setting: *FREQ1*

SENSe:SGAMma:CORRection:STATe[?]   OFF | ON

SENSe:SGAMma:CORRection:STATe ON initiates the use of the complex reflection coefficient Γ_{DUT} of the DUT defined with *SENSe:SGAMma:MAGNitude* and *SENSe:SGAMma:PHASe* for the correction of interactions between the sensor and the DUT. This makes it possible to determine the power P fed to the DUT with considerably greater accuracy. The equivalent reflection coefficient Γ_{eq} of the sensor, which is also required for the correction, is prestored in the calibration data memory for a large number of frequencies.
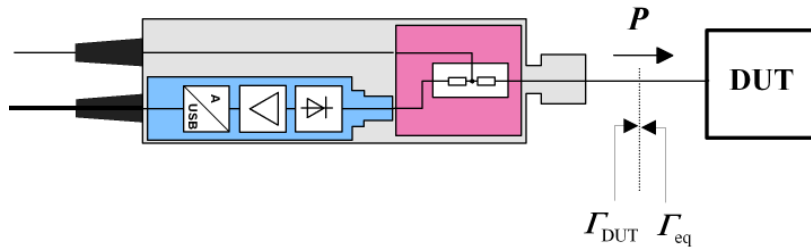
Fig. 6-2   Correction of interactions between the power sensor and the DUT

If the gamma correction is made in connection with an s-parameter correction (setting *SENSe:CORRection:SPDevice:STATe ON*), the interaction of the DUT with the s-parameter device on the one hand and the output of the sensor on the other hand (depending on the magnitude of the term $|s_{12}s_{21}|$) is corrected. The interaction between the equivalent output reflection coefficient Γ_{eq} of the sensor and the parameter s_{22} is always taken into account when the s-parameter correction is activated – independent of the gamma correction in connection with the DUT.

$$\Gamma_{DUT} \sim s_{11} + (s_{12}s_{21} - s_{11}s_{22})\Gamma_{eq}$$
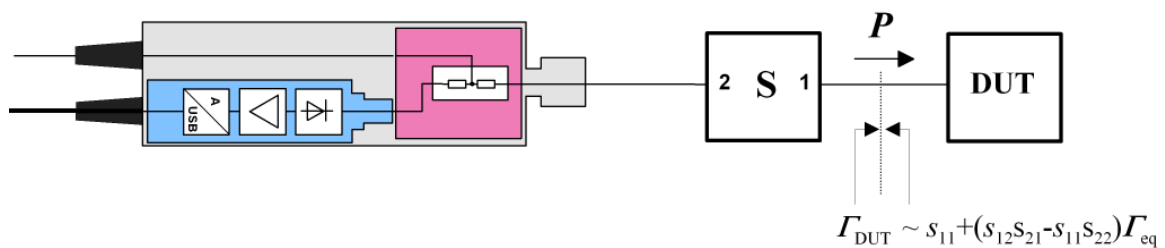
Fig. 6-3   Correction of interactions between the power sensor, the DUT, and the s-parameter device

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:SGAMma:MAGNitude[?]   0.0 to 1.0

SENSe:SGAMma:MAGNitude defines the magnitude of the complex reflection coefficient of the DUT. A value of *0.0* corresponds to an ideal match and a value of *1.0* to total reflection.

The query yields the set magnitude.

Default setting: *0.0*

SENSe:SGAMma:PHASe[?]   –360.0 to 360.0

SENSe:SGAMma:MAGNitude defines the phase angle (in degrees) of the complex reflection coefficient of the DUT.

The query yields the set phase angle.

Default setting: *0.0 [°]*

SENSe:TIMing:EXCLude:STARt[?]   0.0 to 0.1   Z28 only

SENSe:TIMing:EXClude:STARt defines an exclusion time at the start of a measurement window in the *Burst Average* and *Timeslot Average* modes. It is indicated by T_{START} in Figs. 6-4 and 6-5.

The query yields the exclusion time at the start of the measurement window.

Default setting: *0.0 [s]*

SENSe:TIMing:EXCLude:STOP[?]   0.0 to –0.003   Z28 only

SENSe:TIMing:EXClude:STOP defines an exclusion time at the end of a measurement window in the *Burst Average* and *Timeslot Average* modes. It is indicated by T_{STOP} in Figs. 6-4 and 6-5.

The query yields the exclusion time at the end of the measurement window.

Default setting: *0.0 [s]*
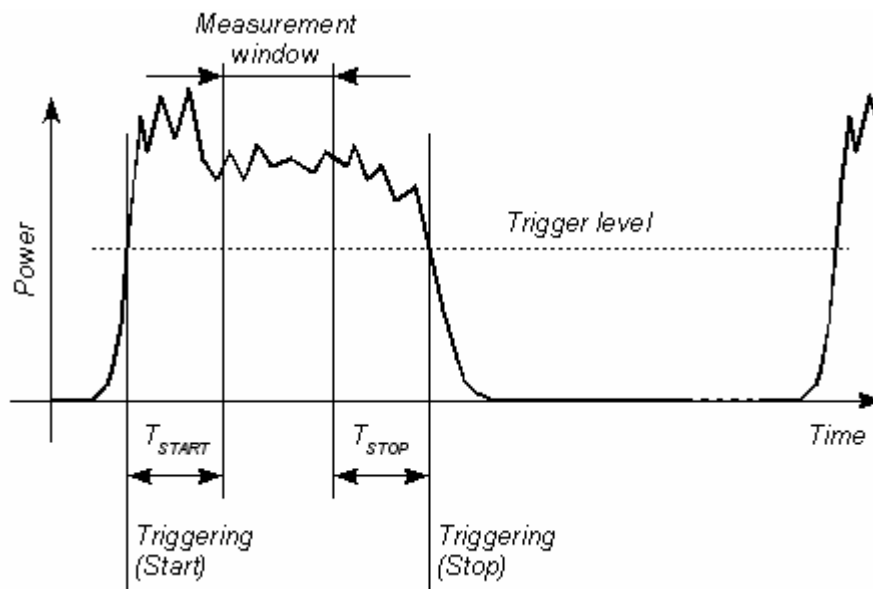
Fig. 6-4   Effect of *SENSe:TIMing:EXCLude:STARt* and *:STOP* in the *Burst Average* mode
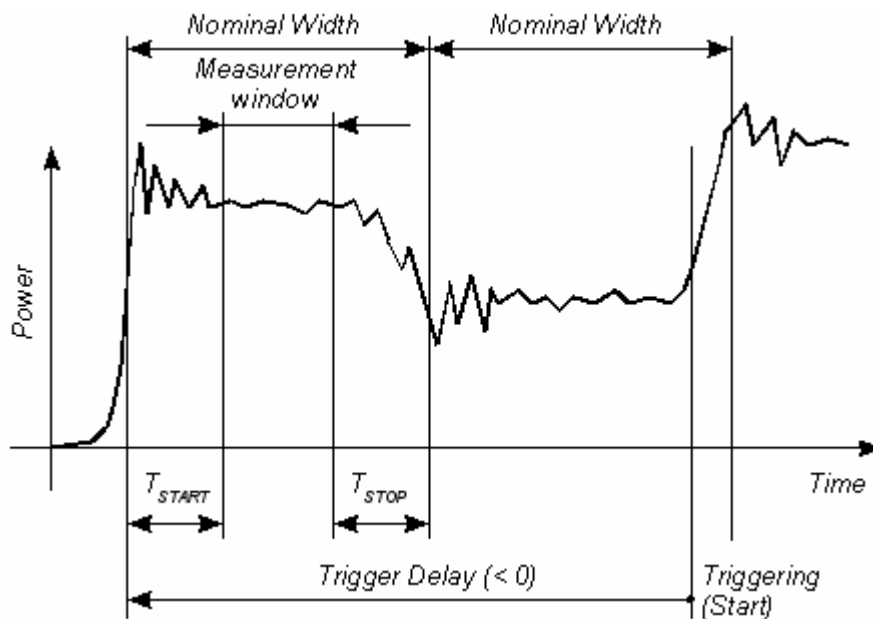
Fig. 6-5   Effect of *SENSe:TIMing:EXCLude:STARt* and *:STOP* in the *Timeslot Average* mode

SENSe:TRACe:AVERage:COUNt[?]   1 to 8192 Z28 only

SENSe:TRACe:AVERage:COUNt is used to set the averaging factor for the *Trace* mode. To put the setting into effect, you must also activate averaging for the *Trace* mode and deactivate the *Realtime* mode (settings *SENSe:TRACe:AVERage:STATe ON* and *SENSe:TRACe:REALtime OFF*). When trace averaging is activated, the measurement is always performed with chopper stabilization, i.e. the number of recorded sampling sequences is twice as large as the averaging factor (alternating measurements with reversed and non-reversed polarity). The result is that two sampling sequences are recorded if the averaging factor is 1, eight if the averaging factor is 4, and so forth. If the averaging factor transmitted to the sensor is not a power of two, the parameter is rounded up or off to the next power-of-two number.

The query yields the averaging factor used in the sensor for the *Trace* mode.

Default setting: *4*

SENSe:TRACe:AVERage:STATe[?]   OFF | ON Z28 only

SENSe:TRACe:AVERage:STATe switches the averaging filter on or off for the *Trace* mode.

The query yields
* *1* for *OFF,*
* *2* for *ON.*

Default setting: *ON*

SENSe:TRACe:AVERage:TCONtrol[?]   MOVing | REPeat [Z28 only]

SENSe:TRACe:AVERage:TCONtrol (terminal control) defines how the measurement results are to be output in the *Trace* mode if the averaging filter has been activated.

The *REPeat* parameter specifies that a measurement result is not output until the entire measurement has been completed. This means that the number of measurement cycle repetitions is equal to the set averaging factor. If the averaging factor is large, the measurement time can be very long.

When settings are made with the *MOVing* parameter, intermediate values are output to facilitate early detection of changes in the measured quantity. In the settled state – i.e. the number of measurements specified by the averaging factor have been performed – a moving average is output in the *Trace* mode. The *SYStem:RUTime* command can be used to vary the output rate over a wide range so that some intermediate results can be ignored.

The query yields
- *1* for *MOVing*,
- *2* for *REPeat*.

Default setting: *REPeat*

SENSe:TRACe:MPWidth? [Z28 only]

With *SENSe:TRACe:MPWidth?*, the attainable time resolution can be read out for the *Trace* mode. The readout value is the smallest possible distance between two pixels – in other words, it is the smallest time interval that can be assigned to a pixel. With internal triggering (setting *TRIGger:SOURce INTernal*), this value is 10 µs and is thus nearly identical with the reciprocal of the sampling frequency. With external triggering (setting *TRIGger:SOURce EXTernal*), the value can be reduced down to 2.5 µs. However, the prerequisite for this is that realtime processing is deactivated (setting *SENSe:TRACe:REALtime OFF*) so that more than one sampling sequence can be recorded. By offsetting the sampling sequences to each other by a certain time (equivalent time sampling), the sensor can then attain a better time resolution. The number of repetitions the sensor needs for this is equal to 32 times the averaging factor.

If the user sets a point matrix that is denser than the resolution it corresponds to (10 µs or 2.5 µs), a value is output for each of these points, but neighboring points may be assigned the same value.
Note: The point matrix to be output is defined by the trace length (setting *SENSe:TRACE:TIME*) and the number of points (setting *SENSe:TRACe:POINts*).

SENSe:TRACe:OFFSet:TIME[?]   – (<TRIGger:DELay> + 0.005) to 100.0 [Z28 only]

SENSe:TRACe:OFFSet:TIME is used to specify the start of recording for the *Trace* mode. It is identical with the first pixel. The time associated with the last pixel is the time associated with the first pixel plus the trace length. The start of recording is referenced to the delayed trigger point (settable with the *TRIGger:DELay* command). Negative values indicate that the start of recording occurs before the trigger point.

Due to the hardware limitations of the power sensor, the recording cannot start at any point in time before the physical trigger event, i.e. the sum of the parameters *TRIGger:DELay* and *SENSe:TRACe:OFFSet:TIME* must be limited at the negative end. This limit amounts to –5 ms.

Example: The trigger delay is set to –500 µs. This means that the start of recording can be set to occur max. 4.5 ms before the delayed trigger point.

The query yields the start of recording in seconds, referenced to the delayed trigger.

Default setting: *0.0 [s]*

SENSe:TRACe:POINts[?]   1 to 1024 `Z28 only`

This command defines the time resolution of the measurement result. Each "point" represents a time interval whose duration is obtained from the trace length (command *SENSe:TRACe:TIME*) divided by N-1, where N is the number of "points". The measurement result for a "point" equals the average power over the associated time interval.

The query yields the number of set "points".

Default setting: *100*

SENSe:TRACe:REALtime[?]   OFF | ON `Z28 only`

SENSe:TRACe:REALtime ON activates realtime processing for the *Trace* mode so that single events can also be recorded in this setting. Only one sampling sequence per measurement is recorded. Since the averaging filter of the sensor is not used, the settings made with *SENSe:TRACe:AVERage:STATe* and *SENSe:TRACe:AVERage:COUNt* are ignored. However, they remain unchanged, and are thus applied again when realtime processing is deactivated*.

The query yields
- *1* for *OFF,*
- *2* for *ON.*

Default setting: *OFF*

SENSe:TRACe:TIME[?]   0.0001 to 0.3 `Z28 only`

SENSe:TRACe:TIME sets the trace length in the *Trace* mode. This time period is divided into a number of equal intervals, in which the average power is determined. The number of intervals equals the number of test points, which is set with the command *SENSe:TRACe:POINts.*

The query yields the set length in s.

Default setting: *0.01 [s]*

SYSTem

With the aid of the SYSTem system, administrative device settings can be defined and queried. This includes detailed information on the sensor and its initialization and the transfer of available commands and their parameter limits.

Table 6-4   Commands of the *SYSTem* system

Command	Parameter	Unit	Remarks
SYSTem			
:INFO? [Item]			Query only
:INITialize			No query
:MINPower?		W	Query only
:RUTime[?]	0.0 to 10.0	s	
:SUTime[?]	0.0 to 10.0	s	
:TRANsaction			
:BEGIN:			No query
:END			No query

SYSTem:INFO? [Item]

SYSTem:INFO? yields a string containing information that is more detailed than the identification string delivered by the sensor as a response to *IDN?*. If no *Item* is specified, the response string is a sequence of entries in the form *Item:Information-String* separated by *CR* and *LF* (in C notation: \r\n). With the *Item* optionally appended to the command, the entry for the required *Item* can be queried. The response string is zero-terminated, i.e. its end identification is a zero byte (in C notation: \0).

Table 6-5   Meaning of *Item* in the *SYSTem:INFO?* command

Item	Information string	Remarks
"MANUFACTURER"	"Rohde & Schwarz GmbH & Co. KG"	Manufacturer
"TYPE"	"NRP-Z28" or "NRP-Z98"	Type designation
"STOCK NUMBER"	"1170.8008.02" or "1170.8508.02"	Material number
"SERIAL"	"<serial number>"	6-digit serial number
"HWVERSION"	"000000000"	Hardware version (standard)
"HWVARIANT"	"000000000"	Hardware model (standard)
"SW BUILD"	"<build number>"	Version number of sensor firmware
"TECHNOLOGY"	"3 Path Diode"	Detector technology used
"FUNCTION"	"Power Source"	The R&S NRP-Z28/-Z98 is a power sensor that functions as a source.
"MINPOWER"	"<nominal lower test limit in W>"	The nominal lower test limit of the R&S NRP-Z28/-Z98 is 200 pW, i.e. with s-parameter correction deactivated, the sensor returns the information string "2e-10" as a response to *SYSTem:INFo? "MINPOWER"*. With s-parameter correction activated, the information string depends on the nominal lower limit of the sensor/twoport combination.
"MAXPOWER"	"<nominal upper test limit in W>"	The nominal upper test limit of the R&S NRP-Z28/-Z98 is 100 mW, i.e. with s-parameter correction deactivated, the sensor returns the information string "0.1" as a response to *SYSTem:INFo? "MAXPOWER"*. With s-parameter correction activated, the information string depends on the nominal upper limit of the sensor/twoport combination.
"MINFREQ"	"1e+07" or "9e+03"	The minimum measuring frequency is 10 MHz for the R&S NRP-Z28 and 9 kHz for the R&S NRP-Z98.
"MAXFREQ"	"1.8e+10" or "6e+09"	The maximum measuring frequency is 18 GHz for the R&S NRP-Z28 and 6 GHz for the R&S NRP-Z98.
"RESOLUTION"	"2.5µs Ext, 10µs Int"	The maximum time resolution that can be reached in the *Trace* mode is 2.5 µs for internal triggering and 10 µs for external triggering.
"IMPEDANCE"	"50"	The RF input has a nominal input impedance of 50 Ω.
"COUPLING"	"AC/DC"	The RF input is DC-coupled, but DC voltages superimposed on the RF signal are suppressed by the measurement amplifier.
"CAL. ABS."	"<date>"	Date of absolute calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. REFL."	"<date>"	Date of reflection-coefficient calibration in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.

Item	Information string	Remarks
"CAL. S PARA."	"<date>"	Date of s-parameter calibration in the format YYYY-MM-DD. If no S parameter set is loaded, the sensor returns the string "not applicable". "Invalid Calibration Date" is returned with an invalid date entry.
"CAL. MISC."	"<date>"	Date of the calibration of other parameters in the format YYYY-MM-DD. "Invalid Calibration Date" is returned with an invalid date entry.
"SPD MNEMONIC"	"<mnemonic string>"	Clear-text designation of the components connected ahead of the sensor.

SYSTem:INITialize

SYSTem:INITialize sets the sensor to the standard state, i.e. the default settings for all test parameters are loaded in the same way as with **RST*. The sensor then outputs a complete list of all supported commands and parameters. With the command, the remote-control software can automatically adapt to the features of different types of sensors with different functionality.

SYSTem:MINPower?

SYSTem:MINPower? yields the lower test limit of the sensor or the combination comprising the sensor and components connected ahead of it, if the *SENSe:CORRection:SPDevice* parameter has the *ON* value. This query can be used to determine a useful resolution for the result display near the lower test limit.

SYSTem:RUTime[?]   0.0 to 10.0

This command is used to limit the output rate of measurements with continuous output of measurement results (setting *INITiate:CONTinuous ON*). This is practical if the measurement time is very short or if intermediate values are output (command *SENSe:AVERage:TCONtrol MOVing* or *SENSe:TRACe:AVERage:TCONtrol MOVing*). Without this limitation, the controlling host can be overloaded very fast or excessively occupied with accepting measured values.

The parameter in the *SYSTem:RUTime* command is selected so that it equals the desired minimum interval between two measured value outputs. This is equivalent to the reciprocal of the output rate. If the measurement takes longer to begin with, the output rate decreases proportionately.

Default setting: *0.1 [s]*

SYSTem:SUTime[?]   0.0 to 10.0

This command is used to reduce the frequency of messages concerning status changes of the sensor from the *WAIT_FOR_TRIGGER* state to the *MEASURING* state.

Normally this status change is always sent to the control unit. If measurement times are very short and/or trigger events occur at a high frequency, however, this may lead to a heavy load on the remote-control connection which cannot be handled by the control unit (or host). The *SUTime* parameter can be used to define how long the sensor may remain in the *WAIT_FOR_TRIGGER* state without the corresponding status message being output.

SUTime is usually set to a value that is slightly smaller than the response time of the control system. Trigger events that have not yet occurred can then still be detected in time. At high trigger frequencies, the result is that after the start of the measurement, only the first changeover to the *WAIT_FOR_TRIGGER* state and the subsequent changeover to the *MEASURING* state are reported. The next message would not come until the transition to the IDLE state following the completion of the measurement.

Default setting: *0.0001 [s]*

SYSTem:TRANsaction:BEGin

SYSTEM:TRANsaction:BEGin marks the beginning of a sequence of setting commands between which the parameter limits must not be checked. This prevents the display of error messages when a setting command causes a conflict that is resolved by a subsequent setting command. See *SYSTEM:TRANsaction:END*.

SYSTem:TRANsaction:END

SYSTEM:TRANsaction:END marks the end of a sequence of setting commands between which the parameter limits must not be checked. After this command, the parameter limits are checked.

TEST

Table 6-6   Commands of the *TEST* system

Command	Parameter	Unit	Remarks
TEST:SENSor?			Query only

TEST:SENSor?

TEST:SENSor? triggers a selftest of the sensor. In contrast to **TST*, this command yields detailed information, which is useful for troubleshooting.

> *No signal may be applied to the sensor while the selftest is running.*
>
> *If the selftest is carried out with a signal being present, error messages may erroneously be output for the test steps "Offset Voltages" and/or "Noise Voltages".*

TRIGger

Table 6-7   Commands of the *TRIGger* system

Command	Parameter	Unit	Remarks
ABORt			No query
INITiate			
:CONTinuous[?]	OFF | ON		
:IMMediate			No query
TRIGger			
:ATRigger:STATe[?]	OFF | ON		
:COUNt[?]	1 to 2^{31}		
:DELay[?]	x to 100.0	s	
:AUTO[?]	OFF | ON		
:HOLDoff[?]	0.0 to 10.0	s	
:HYSTeresis[?]	0.0 to 10.0	dB	
:IMMediate			No query
:LEVel[?]	x to y	W	
:SLOPe[?]	POSitive | NEGative		
:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		

ABORt

ABORt interrupts the current measurement and sets the sensor to the *IDLE* state (normal case). However, if the sensor is in the continuous measurement mode (setting *INITiate:CONTinuous ON*), the *IDLE* state is immediately exited and the sensor enters the *WAIT_FOR_TRIGGER* state.

INITiate:CONTinuous[?]   OFF | ON

INITiate:CONTinuous ON activates the continuous measurement mode. In this mode, a new measurement cycle is automatically started after the previous one has been terminated. The sensor first enters the *WAIT_FOR_TRIGGER* state and begins with the measurement as soon as the trigger condition is fulfilled. Depending on the number of trigger events that are required for the final measurement result, e.g. in the case of averaging, the *WAIT_FOR_TRIGGER* state can be entered several times before a measurement result is output. Once the entire measurement cycle is completed, the sensor also enters the *WAIT_FOR_TRIGGER* state and – assuming continuous trigger events – will continue measuring.

If the continuous measurement mode is switched off by means of the *INITiate:CONTinuous OFF* command, single measurements can be started with the *INITiate:IMMediate* command (see below). After triggering and completion of the measurement, the sensor enters the *IDLE* state and remains in this state until a new measurement is started with the *INITiate:IMMediate* command.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

INITiate:IMMediate

INITiate:IMMediate starts a single measurement cycle. The sensor first changes from the *IDLE* state to the *WAIT_FOR_TRIGGER* state and begins the measurement as soon as the trigger condition is fulfilled. Depending on the number of trigger events that are required, e.g. for averaging, the *WAIT_FOR_TRIGGER* state can be entered several times. Once the entire measurement is completed, a measurement result is available and the sensor enters the *IDLE* state again. The *INITiate:IMMediate* command should only be used after the continuous measurement mode has been switched off with the *INITiate:CONTinuous OFF command*.

TRIGger:ATRigger:STATe[?]   OFF | ON

TRIGger:ATRigger:STATe ON generates an artificial trigger if more than 300 ms have elapsed after the start of measurement and no trigger event has been recorded. The command is only evaluated in the *Trace* mode and, irrespective of the set averaging factor, only one trace will be recorded. *TRIGger:ATRigger:STATe OFF* deactivates the automatic trigger function.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

TRIGger:COUNt[?]   1 to 2^{31}

This setting is designed for applications in which several consecutive measurements have to be performed by sending the *INITiate:IMMediate* command only once, e.g. to obtain a higher measurement speed. The gap between a single measurement and the continuous measurement mode is thus closed. The number of measurements is defined with the parameter associated with the *TRIGger:COUNt* command. This number equals the number of results yielded by the sensor at the end of the measurement. A measurement result can contain several numeric results, e.g. power values for the points of a trace.

The TRIGger:COUNt *command does not define the number of trigger events required for performing the entire measurement task. The number is either identical or a whole-number multiple, if averaging was activated.*

A further increase in the measurement speed can be obtained by combining the mode used with the buffered mode. The results are not made available immediately but as a block at the end of the measurement sequence (see group commands SENSe:POWer:AVG:BUFFer).

The query yields the number of measurements performed with the *INIT:IMMediate* command after a measurement start.

Default setting: *1*

TRIGger:DELay[?]   x to 100.0

This command is used to set a trigger delay for all measurements in sync with the signal except in the *Burst Average* mode. It provides a time offset to the physical trigger event equal to the entered value. The trigger can thus be shifted to a point in time of the measurement signal that is significant for the measurement, for example to the start of the first timeslot for the *Timeslot Average* mode. If external triggering is used, delay differences between the external trigger signal and the measurement signal can be compensated for with a trigger delay.

It is possible to set negative trigger delays, i.e. the trigger point can occur before the physical trigger event. No matter which measurement mode is selected, the negative limit is –5 ms. If the trigger delay is entered in the *Trace* mode, an additional condition must be met: The sum of the start of recording and the trigger delay must not exceed the length of –5 ms (see notes on the *SENSe:TRACe:OFFSet:TIME* command). If full use is made of this value, the order in which the trigger delay and the start of recording are entered determines whether a trigger delay down to –5 ms can be set. When a different measurement mode is selected, the full –5 ms become immediately available again. When switching (back) to the *Trace* mode, the trigger delay that has been set is retained and, if there is a conflict, the start of recording is adjusted automatically.

The time resolution of the trigger delay is approx. 7 µs with internal triggering and approx. 1 µs with external triggering.

Any trigger delay that is set comes into effect irrespective of the defined trigger source, but this is only useful with the *Internal* und *External* settings.

Lower limit x of the parameter
Timeslot Average mode: x = –0.005
Trace mode: x = – (<*SENSe:TRACe:OFFSet:TIME*> + 0.005)

Default setting: *0.0 [s]*

TRIGger:DELay:AUTO[?]   OFF | ON

TRIGger:DELay:AUTO ON ensures by means of an automatically determined delay that a measurement is only started after the sensor has settled. This is relevant mainly for the R&S NRP-Z98 sensor, which takes up to 20 ms to fully settle after a sharp change of the input power (negligible for the R&S NRP-Z28). If the automatic trigger delay was activated with the *TRIGger:DELay:AUTO ON* command, it has the following effect:

After exiting the *WAIT_FOR_TRIGGER* state – initiated by the trigger event – the first analog-digital conversion is not performed until the settling time of the sensor has elapsed once. If the measurement cycle has to be repeated due to an averaging factor other than one, no further delay occurs.

The automatically determined delay is ignored if a longer period was set with *TRIGger:DELay*.

TRIGger:DELay:AUTO OFF deactivates the automatic trigger delay.

The query yields
- *1* for *OFF*,
- *2* for *ON*.

Default setting: *OFF*

TRIGger:HOLDoff[?]   0.0 to 10.0

TRIGger:HOLDoff suppresses trigger events within the set holdoff time (in s), starting from the time of the last successful triggering.

The query yields the set holdoff time (in s).

Default setting: *0.0 [s]*

TRIGger:HYSTeresis[?]   0.0 to 10.0

TRIGger:HYSTeresis sets the hysteresis of the internal trigger threshold (parameter *TRIGger:LEVel*). Hysteresis is the magnitude (in dB) by which the trigger signal level falls below the trigger threshold (with positive trigger edge) to enable triggering again. The case is exactly the opposite with a negative trigger edge. The trigger hysteresis setting is only relevant to the *INTernal* trigger source.

The query yields the trigger hysteresis in dB.

Default setting: *0.0 [dB]*

TRIGger:IMMediate

TRIGger:IMMediate triggers a generic trigger event that causes the sensor to exit immediately the *WAIT_FOR_TRIGGER* state irrespective of the trigger source and the trigger delay and begin with the measurement. The command is the only means of starting a measurement when the trigger source is set to *HOLD*. Only one measurement cycle is performed, irrespective of the set averaging factor.

TRIGger:LEVel[?]   x to y

TRIGger:LEVel sets the trigger threshold for internal triggering derived from the test signal (in W). This setting is irrelevant to all other trigger sources. If an s-parameter device is active and/or if a component with a global offset upstream from the sensor is considered, the currently effective trigger threshold as well as a trigger threshold to be input are referenced to the appropriately shifted sensor interface. When the s-parameter device and the offset correction are switched off, then the trigger threshold and its input limits are adjusted as necessary.

The query yields the currently effective trigger threshold in W.

Lower limit x and upper limit y of the trigger threshold
SENSe:CORRection:OFFSet:STATe OFF
x =<lower test limit in W> $\times$ 500
y = <upper test limit in W>

SENSe:CORRection:OFFSet:STATe ON
x = <lower test limit in W> $\times$ 500 $\times 10^{OFFSET/10\ dB}$
y = <upper test limit in W> $\times 10^{OFFSET/10\ dB}$

<lower test limit in W>:   The nominal lower test limit of the sensor or of the twoport/sensor
                                combination (with activated s-parameter correction)
<upper test limit in W>:   The nominal upper test limit of the sensor or of the twoport/sensor
                                combination (with activated s-parameter correction)

The nominal test limits can be read out with the *SYSTem:INFO? "MINPOWER"* and *SYSTem:INFO? "MAXPOWER"* command.

Default setting: 10 $\times$ x

TRIGger:SLOPe[?]   POSitive | NEGative

TRIGger:SLOPe defines the edge of the trigger event with internal and external triggering in the *Continuous Average, Timeslot Average,* and *Trace* modes. In this connection, positive means increasing envelope power (with internal triggering) or increasing voltage (with external triggering). As in the *Burst Average* mode, this command has no effect in conjunction with trigger sources *BUS*, *HOLD* and *IMMediate.*

The query yields
- *1* for *POSitive*,
- *2* for *NEGative*.

Default setting: *POSitive*

TRIGger:SOURce[?]   HOLD | IMMediate | INTernal | BUS | EXTernal |

TRIGger:SOURce sets the trigger source.

- *HOLD*:   Triggering only with command *TRIGger:IMMediate*.
- *IMMediate*: Automatic triggering without explicit event.
- *INTernal*:   Triggering by the measurement signal. Relevant parameters:
                TRIGger:LEVel, TRIGger:SLOPe, TRIGger:DELay, TRIGger:HYSTeresis,
                TRIGger:HOLDoff.
- *BUS*:   Triggering with command **TRG* or *TRIGger:IMMediate*.
- *EXTernal*:   Triggering via the hardware trigger bus, e.g. via the R&S NRP-Z3 USB adapter
                or the R&S NRP base unit. Relevant parameters:
                TRIGger:SLOPe, TRIGger:DELay, TRIGger:HOLDoff.

The query yields

- *1* for *HOLD,*
- *2* for *IMMediate,*
- *4* for *INTernal,*
- *8* for *BUS,*
- *16* for *EXTernal.*

Default setting: *IMMediate*

List of Remote-Control Commands

The remote-control commands of the R&S NRP-Z28/-Z98 have a syntax based on standard SCPI 1999.0, but they comply with it only to a limited extent.

Table 6-8   List of remote-control commands

Command	Parameter	Unit	Default setting	Page
* Commands				
*IDN?				6.3
*RST				6.3
*TRG				6.3
*TST?				6.3
CALibration Commands				
CALibration:DATA[?]	<calibration data set as definite length block>			6.4
CALibration:DATA:LENGth?		Bytes		6.4
CALibration:ZERO:AUTO[?]	OFF | ON | ONCE		OFF (fixed)	6.5
SENSe Commands				
SENSe:AVERage:COUNt[?]	1 to 65536		4	6.8
SENSe:AVERage:COUNt:AUTO[?]	OFF | ON | ONCE		ON	6.8
SENSe:AVERage:COUNt:AUTO:MTIMe[?]	0.01 to 999.99	s	4.0	6.8
SENSe:AVERage:COUNt:AUTO:NSRatio[?]	0.0 to 1.0	dB	0.01	6.9
SENSe:AVERage:COUNt:AUTO:RESolution[?]	1 to 4		3	6.9
SENSe:AVERage:COUNt:AUTO:SLOT[?] Z28 only	1 to <SENSe:POWer:TSLot:AVG :COUNt>		1	6.9
SENSe:AVERage:COUNt:AUTO:TYPE[?]	RESolution | NSRatio		RESolution	6.10
SENSe:AVERage:RESet				6.10
SENSe:AVERage:STATe[?]	OFF | ON		ON	6.10
SENSe:AVERage:TCONtrol[?]	MOVing | REPeat		REPeat	6.10
SENSe:CORRection:DCYCle[?]	0.001 to 99.999	%	1.0	6.11
SENSe:CORRection:DCYCle:STATe[?]	OFF | ON		OFF	6.11
SENSe:CORRection:OFFSet[?]	-200.0 to 200.0	dB	0.0	6.11

Command	Parameter	Unit	Default setting	Page
SENSe Commands				
SENSe:CORRection:OFFSet:STATe[?]	OFF | ON		OFF	6.11
SENSe:CORRection:SPDevice:STATe[?]	OFF | ON		OFF (can be modified by the user)	6.12
SENSe:FREQuency[?]	10.0e6 to 18.0e9 (NRP-Z28) or 9.0e3 to 6.0e9 (NRP-Z98)	Hz	50.0e6	6.12
SENSe:FUNCtion[?]	"POWer:AVG" | "POWer:TSLot:AVG" | "POWer:BURSt:AVG" | "XTIMe:POWer" (NRP-Z28) or "POWer:AVG" (NRP-Z98)		"POWer:AVG"	6.13
SENSe:POWer:AVG:APERture[?]	10.0e–6 to 0.3	s	0.02	6.14
SENSe:POWer:AVG:BUFFer:SIZE[?]	1 to 1024		1	6.14
SENSe:POWer:AVG:BUFFer:STATe[?]	OFF | ON		OFF	6.15
SENSe:POWer:AVG:SMOothing:STATe[?]	OFF | ON		OFF	6.15
SENSe:POWer:BURSt:DTOLerance[?] `Z28 only`	0.0 to 0.003	s	0.0001	6.15
SENSe:POWer:TSLot:AVG:COUNt[?] `Z28 only`	1 to 128		8	6.16
SENSe:POWer:TSLot:AVG:WIDTh[?] `Z28 only`	10.0e–6 to 0.1	s	0.001	6.16
SENSe:RANGe[?]	0 to 2		2	6.16
SENSe:RANGe:AUTO[?]	OFF | ON		ON	6.17
SENSe:RANGe:CLEVel[?]	–20.0 to 0.0	dB	0.0	6.17
SENSe:SAMPLING[?]	FREQ1 | FREQ2		FREQ1	6.17
SENSe:SGAMma:CORRection:STATe[?]	OFF | ON		OFF	6.17
SENSe:SGAMma:MAGNitude[?]	0.0 to 1.0		0.0	6.18
SENSe:SGAMma:PHASe[?]	–360.0 to 360.0	degree	0.0	6.18
SENSe:TIMing:EXCLude:STARt[?] `Z28 only`	0.0 to 0.003	s	0.0	6.19
SENSe:TIMing:EXCLude:STOP[?] `Z28 only`	0.0 to 0.003	s	0.0	6.23
SENSe:TRACe:AVERage:COUNt[?] `Z28 only`	1 to 65536		4	6.20
SENSe:TRACe:AVERage:STATe[?] `Z28 only`	OFF | ON		ON	6.19
SENSe:TRACe:AVERage:TCONtrol[?] `Z28 only`	MOVing | REPeat		REPeat	6.21
SENSe:TRACe:MPWidth? `Z28 only`		s		6.21

Command		Parameter	Unit	Default setting	Page
SENSe Commands					
SENSe:TRACe:OFFSet:TIME[?]	`Z28 only`	– (<TRIGger:DELay> + 0.005) to 100.0	s	0.0	6.21
SENSe:TRACe:POINts[?]	`Z28 only`	1 to 1024		100	6.22
SENSe:TRACe:REALtime[?]	`Z28 only`	OFF | ON		OFF	6.22
SENSe:TRACe:TIME[?]	`Z28 only`	0.0001 to 0.3	s	0.01	6.22
SYSTem Commands					
SYSTem:INFO? [Item]					6.23
SYSTem:INITialize					6.25
SYSTem:MINPower?			W		6.25
SYSTem:RUTime		0.0 to 10.0	s	0.1	6.25
SYSTem:SUTime		0.0 to 10.0	s	0.0001	6.25
SYSTem:TRANsaction:BEGin					6.25
SYSTem:TRANsaction:END					6.26
Test Commands					
TEST:SENSor?					6.27

Command	Parameter	Unit	Default setting	Page
Triggersystem Commands				
ABORt				6.28
INITiate:CONTinuous[?]	OFF | ON		OFF	6.28
INITiate:IMMediate				6.29
TRIGger:ATRigger:STATe[?]	OFF | ON		OFF	6.29
TRIGger:COUNt[?]	1 to 2^{31}		1	6.29
TRIGger:DELay[?]	x to 100.0	s	0.0	6.30
TRIGger:DELay:AUTO[?]	OFF | ON		OFF	6.30
TRIGger:HOLDoff[?]	0.0 to 10.0	s	0.0	6.31
TRIGger:HYSTeresis[?]	0.0 to 10.0	dB	0.0	6.31
TRIGger:IMMediate				6.31
TRIGger:LEVel[?]	x to y	W	$10 \times x$	6.31
TRIGger:SLOPe[?]	POSitive | NEGative		POSitive	6.32
TRIGger:SOURce[?]	HOLD | IMMediate | INTernal | BUS | EXTernal		IMMediate	6.32

7 Transporting

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.

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

Unless otherwise specified in the data sheet, the maximum transport altitude without pressure compensation is 4500 m above sea level.

8 Maintenance, Storage and Disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable to check the nominal data from time to time.

Regular Checks

If the power sensor is used frequently, check the RF connectors for visible damage - bent inner conductors, broken contact springs and so on. If the RF connectors are damaged, stop using the power sensor and contact the Rohde & Schwarz customer service.

Cleaning

1. Disconnect the power sensor:
   a) From the DUT.
   b) From the computer or base unit.

2. Clean the outside of the power sensor using a lint-free cloth. You can dampen the cloth with water but keep in mind that the casing is not waterproof. If you use isopropyl alcohol or ethanol instead of water, be careful not to damage the labeling. Do not use cleaning agents that can damage the instrument such as solvents, acids or alkalis.

3. Clean the RF connectors as follows:
   a) Dislodge any particles using compressed air.
   b) Clean the inside and the connector threads using a foam swab or lint free cloth dampened with isopropyl alcohol or ethanol.

Storage

Put plastic end caps on the RF connectors to protect them from damage. Protect the power sensor against dust.

Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the data sheet.

Disposal

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

Disposing Electrical and Electronic Equipment

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

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.