



**ROHDE & SCHWARZ**

Test and Measurement  
Division

## Manual

# Average Power Sensor

## **R&S<sup>®</sup> NRP-Z11**

10 MHz to 8 GHz / 200 pW to 200 mW

**1138.3004.02**

## **R&S<sup>®</sup> NRP-Z21**

10 MHz to 18 GHz / 200 pW to 200 mW

**1137.6000.02**

Printed in the Federal  
Republic of Germany

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1137.7406.32-02-

2

## **Operation of Power Sensor R&S NRP-Z11 from R&S NRP base unit**

The power sensor shipped with this manual has firmware revision **02.00** or higher. For operation from an R&S NRP base unit, all software components within the base unit must also be of revision **02.00** or higher.

Revision numbers for the software components installed in the base unit can be displayed under menu item 'System Info', lines 'Main Program', 'Bootloader' and 'Keybd. Ctrl.'. The 'System Info' can be found in the 'File' menu for revision numbers lower than 02.00 and in the 'System' menu otherwise.



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Certificate of Quality  
EU Certificate of Conformity  
List of R&S Representatives

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Certificate No.: 2002-36

This is to certify that:

Equipment type	Stock No.	Designation
NRP	1143.8500.02	Power Meter
NRP-B1	1146.9008.02	Sensor Check Source
NRP-B2	1146.8801.02	Second Sensor Input
NRP-B5	1146.9608.02	3rd und 4th Sensor
NRP-B6	1146.9908.02	Rear-Panel Sensor
NRP-Z3	1146.7005.02	USB Adapter
NRP-Z4	1146.8001.02	USB Adapter
NRP-Z11	1138.3004.02	Average Power Sensor
NRP-Z21	1137.6000.02	Average Power Sensor

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits  
(73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility  
(89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995  
EN55011 : 1998 + A1 : 1999  
EN61326 : 1997 + A1 : 1998 + A2 : 2001

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 2002

**ROHDE & SCHWARZ GmbH & Co. KG**  
Mühldorfstr. 15, D-81671 München

Munich, 2002-06-27

Central Quality Management FS-QZ / Becker





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# 1 Putting into Operation



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

## Unpacking the sensor

Remove the 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 sensor is to be shipped or transported at a later date..



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

## Connecting the sensor



*To prevent EMI, the 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 sensor.*

*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.).*

## Operation with the R&S NRP basic unit

### Connecting the sensor to the R&S NRP basic unit

The sensor can be connected to the R&S NRP basic unit when it is in operation. The interface connector must be inserted, red marking upwards, into one of the R&S NRP basic unit's sensor connectors. When the sensor is connected, it is detected by the R&S NRP basic unit and initialized.

### Connecting the sensor to the DUT

The Sensor R&S NRP-Z11/-Z21 has a male N connector and so can be connected to any standard female N connector. Using light pressure, and keeping the male N connector perpendicular, insert it into the female N connector and tighten the N connector locking nut (right-hand thread).

## PC control

### Hardware and software requirements

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

- The PC must have a USB port.
- The PC's operating system must support the USB port. This is the case with Windows™ 98, Windows™ ME, Windows™ 2000, Windows™ XP and more recent versions of the Windows™ operating system.
- The USB device drivers in the supplied *NRP Toolkit* software package must be installed.

If these requirements are met, the sensor can be controlled using a suitable application program such as the NrpFlashup program contained in 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, the NRP Toolkit is automatically installed on your PC. The rest of the procedure is self-explanatory.

The sensor can be powered in two ways:

- *Self-powered* from a separate power supply via the Active USB Adapter R&S NRP-Z3.
- *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 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 with that name, start the **Device Manager**
- Open **USB Controller** (all USB controllers, hubs and USB devices are listed here)
- Double-click on **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.

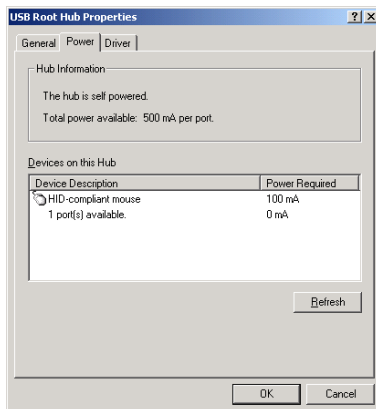


Fig. 1-1 Displaying the total available power of a USB port

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 Active USB Adapter R&S NRP-Z3

Figure 1-2 shows the configuration with the Active USB Adapter R&S NRP-Z3, which also makes it possible to feed in a trigger signal for the *Timeslot* and *Scope* modes. The order in which the cables are connected is not critical.

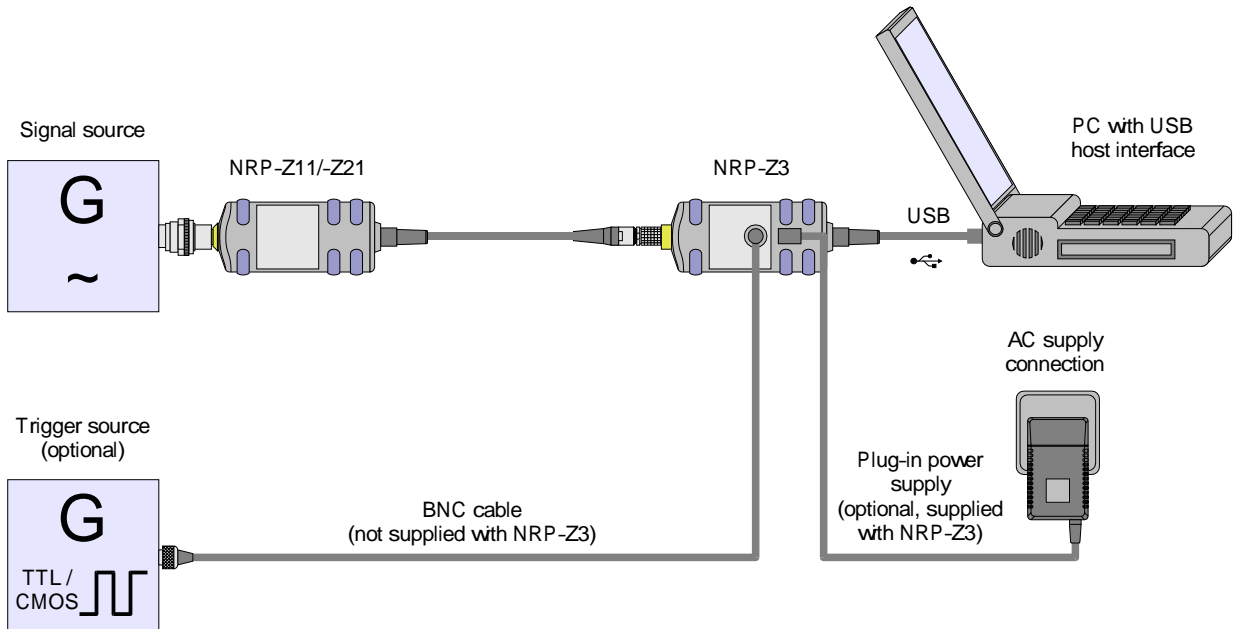


Fig. 1-2 Configuration with Active USB Adapter R&S NRP-Z3

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 autoselects 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. 1-3).

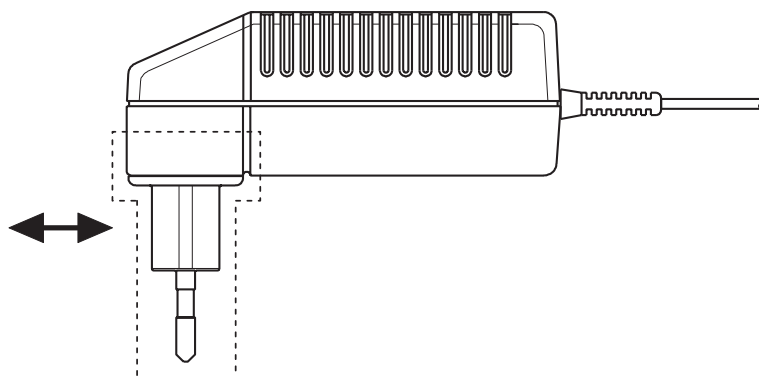


Fig. 1-3 Changing the primary adapter

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.



*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 Passive USB Adapter R&S NRP-Z4

Fig. 1-4 is a schematic of the measurement setup. The order in which the cables are connected is not critical.

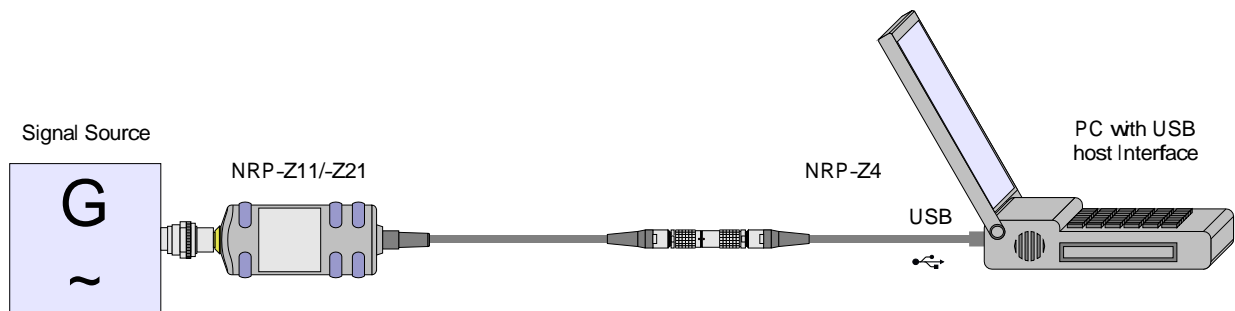


Fig. 1-4 Configuration with Passive USB Adapter R&S NRP-Z4

### Connecting the sensor to the DUT

See the section “Operation with the R&S NRP basic unit” for information on how to connect the sensor to the DUT.





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## 2 Virtual Power Meter

You will find the **NrpFlashup** program for controlling sensors with a PC under Windows™ on the CD-ROM that accompanies the 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 sensor's functions. This means that after an extremely brief familiarization period, the user can measure the average power of modulated signals.

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).

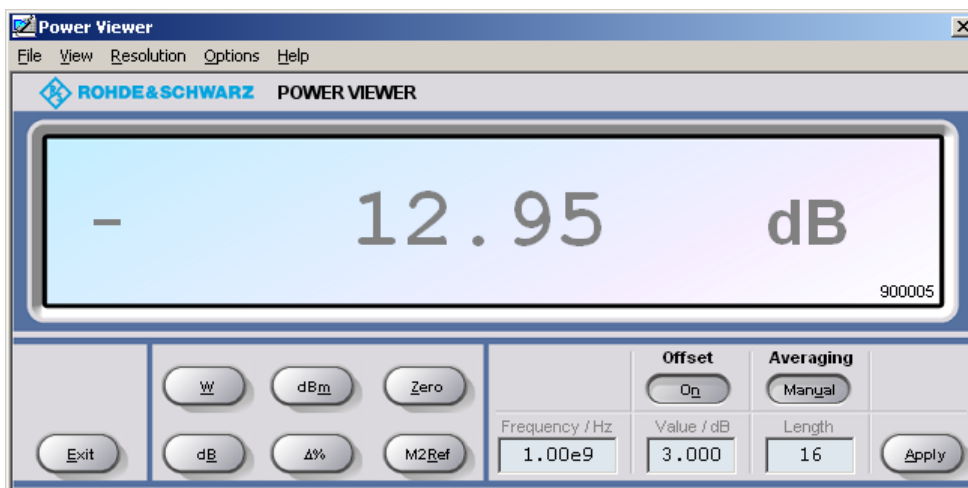


Fig. 2-1 **Power Viewer** – virtual power meter

The result display occupies most of the program window. The result, unit and additional sensor status information are displayed. The serial number of the sensor 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 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 offset correction for the sensor on or off. If the offset correction is Off, the <b>Offset/dB</b> entry field has a grey background.	Alt + N
Averaging Man/Auto	Turns auto-averaging on or off. When auto-averaging is on, the <b>Length</b> entry field has a grey background; the current averaging factor is displayed.	Alt + T
Apply	Accepts edited numerical values in the <b>Frequency/Hz</b> , <b>Value/dB</b> and <b>Length</b> entry fields and transfers them to the sensor.	Alt + A or Enter key

Table 2-2 Virtual power meter entry fields

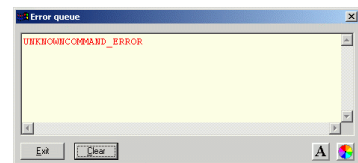
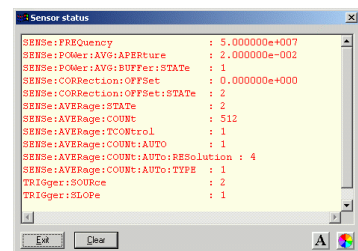
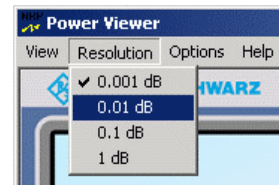
Entry field	Function
Frequency/Hz	Frequency of the RF carrier in Hertz.
Value/dB	Attenuation in dB of the twoport connected to the sensor. The valid range is -100 to 100. The offset correction must be activated beforehand with the <b>Offset On/Off</b> button if this entry field is to be edited.
Length	Length of the averaging filter (= averaging factor). The valid range is 1 to 65536. Averaging must be set to manual with the <b>Averaging Man/Auto</b> 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 sensor unless you use the **Apply** button or the Enter key to terminate the entry.

## Menus

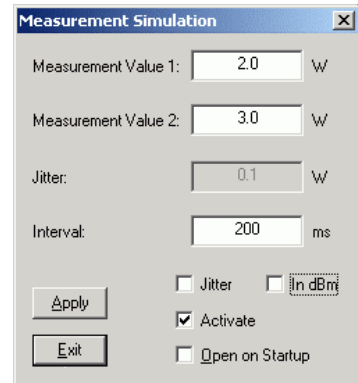
The menu bar can be used to call less frequently used functions.

<b>File</b>	<b>Start Log ...</b>	<p>Opens a file-selection dialog to specify the path and name of the log file. Clicking the <b>Save</b> 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)</p>
	<b>Stop Log</b>	<p>Ends the log-file recording.</p>
<b>View</b>	<b>Display Refresh Rate</b>	<p>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.</p>
	<b>Colours</b>	<p>Opens a dialog box to select the background colour for</p> <ul style="list-style-type: none"> <li>• the result,</li> <li>• the unit,</li> <li>• the text in the number fields or</li> <li>• the key labelling.</li> </ul>
	<b>Result Unit Edit Button</b>	
<b>Resolution</b>		<p>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.</p>
<b>Options</b>	<b>Read Sensor Status ...</b>	<p>Reads the current sensor status. A parameter list is output.</p>
	<b>Read Error Queue ...</b>	<p>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.</p>



**Simulation ...**

For trying out the functions of the virtual power meter without actually connecting a 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 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.

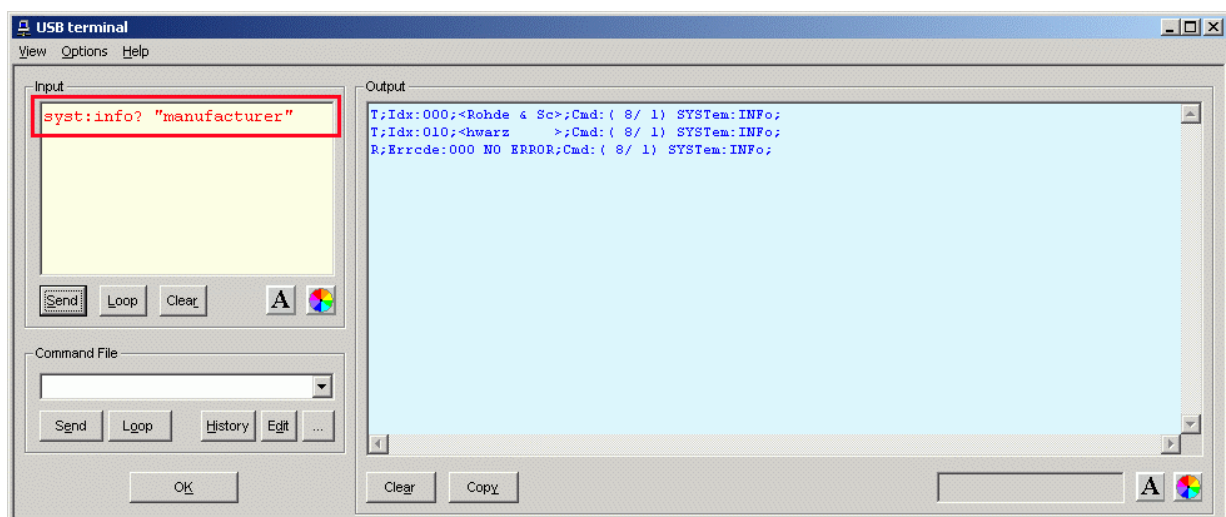


Fig. 3-1 Sending commands using the **Input** field

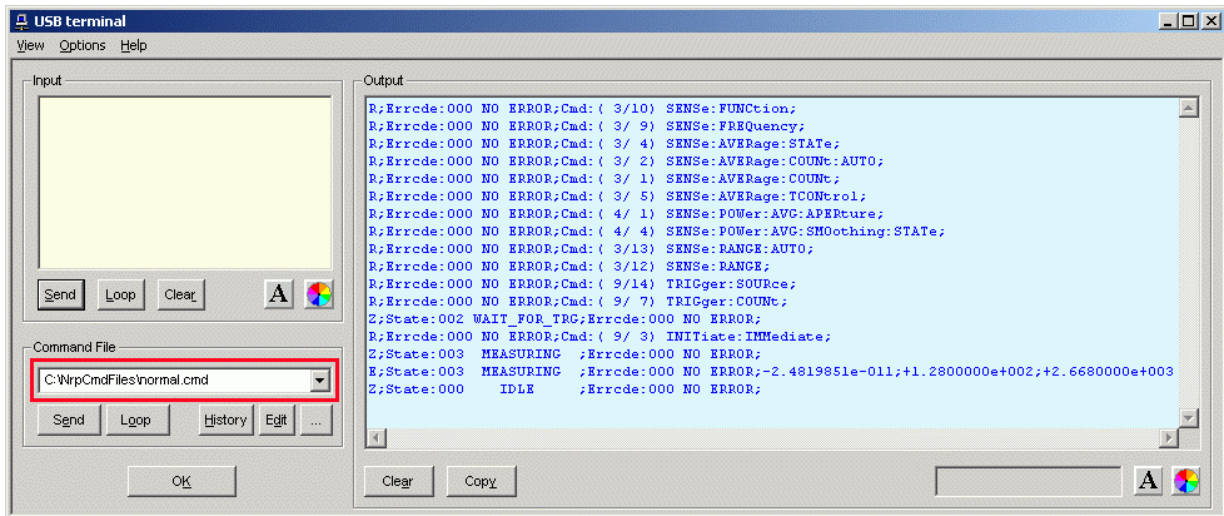


Fig. 3-2 Sending commands using command files

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

Button	Function	Key combination
Send	Sends the content of the <b>Input</b> entry field to the sensor.	Alt + S
Loop	With <b>Loop</b> 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 <b>View - Loop...</b>	Alt + L
Clear	Clears the content of the <b>Input</b> field.	Alt + R
Font key	Opens a dialog window where the font for the <b>Input</b> field can be selected.	
Colour key	Opens a dialog window where the background colour of the <b>Input</b> 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 <b>Loop</b> 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 <b>View - Loop...</b>	Alt + O
History	Opens a window for editing the command file name in the <b>Command File</b> 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.

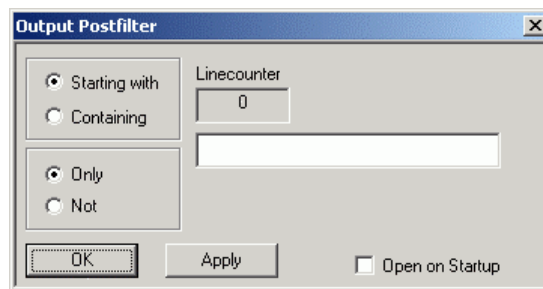
Table 3-3 Buttons assigned to the **Output** field

Button	Function	Key combination
Clear	Clears the content of the <b>Output</b> field	Alt + A
Copy	Copies the content of the <b>Output</b> field to the clipboard. (Another possibility: 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 <b>Copy</b> in the opened context menu.)	Alt + Y
Font button	Opens a dialog window where the font for the <b>Output</b> field can be selected.	
Colour button	Opens a dialog window where the background colour of the <b>Output</b> 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.

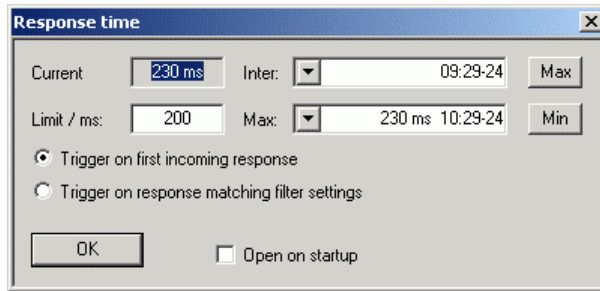
**Not + Containing:** Only lines not containing the entered character string are displayed.

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 sensor can be set.



**Current** indicates the time elapsed between dispatch of the last command and receipt of an acknowledgement from the 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.

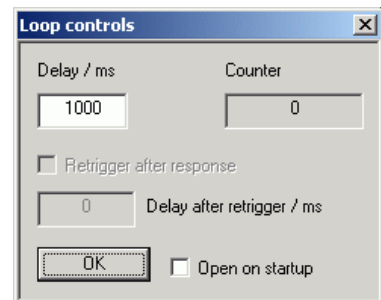
If **Open on startup** is active, the **Response Time** dialog is automatically displayed when the Terminal module is started. The dialog window is closed with **OK**.

**Loop ...**

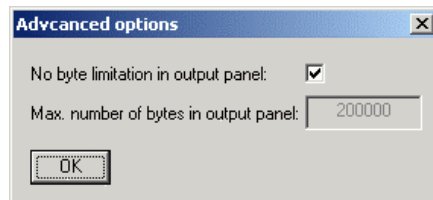
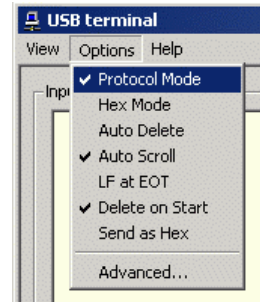
Opens the **Loop controls** dialog window where the cyclic transfer of commands and command sequences can be controlled.

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**.



<b>Options</b>	<b>Protocol Mode</b>	In this mode, a time stamp is added to each response block.
	<b>Hex Mode</b>	In this mode, the response blocks from the sensor are displayed in hexadecimal format.
	<b>Auto Delete</b>	With this option active, the <b>Output</b> field is automatically cleared when the <b>Send</b> button is pressed.
	<b>Auto Scroll</b>	With this option active, older items in the <b>Output</b> field are automatically shifted upward and off the display if space is required for new values.
	<b>LF at EOT</b>	With this option active, a line feed is appended to each response block from the sensor.
	<b>Delete on Start</b>	With this option active, the <b>Output</b> field is automatically cleared when the Terminal module is started.
	<b>Send as Hex</b>	With this option active, the text in the <b>Input</b> field is interpreted as a hexadecimal character sequence.
	<b>Advanced ...</b>	Opens a dialog window where the buffer size for the <b>Output</b> field can be set.



<b>Help</b>	<b>Contents</b>	Opens the table of contents for the online help.
	<b>About</b>	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 Sensor R&S NRP-Z11/-Z21 the influence of any twoport connected to the input on the measurement result can be corrected by way of calculation. A precondition is that a complete set of s-parameters of the twoport is available in the frequency range in question. The set of calibration data in the R&S NRP-Z11/-Z21 therefore includes an s-parameter table with up to 1000 measurement frequencies. The real and the imaginary part of each frequency as well as the uncertainty of s-parameters  $s_{11}$ ,  $s_{12}$ ,  $s_{21}$  and  $s_{22}$  can be stored. Since the measurement frequencies in the s-parameter table are independent of the calibration frequencies, they can be set so that the twoport frequency range of interest is optimally covered. The real and the imaginary parts between these measurement frequencies are linearly interpolated, while the more substantial measurement uncertainty at the two neighbouring frequency points is used for calculating the uncertainty of the measurement result. 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 an 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. Other noise parameters in the measurement data file are not evaluated.

Structure of the S2P measurement data file:

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.

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  $\Omega$ . 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 specified display format for the *option line*.

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

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

$\operatorname{Re} [s_{jk}(f_i)] \quad \operatorname{Im} [s_{jk}(f_i)]$  (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. Without this file, the measurement uncertainty cannot be correctly calculated in the sensor. 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 be above 1.0 GHz, e.g. 1.000001 GHz.

Structure of the uncertainty data file:

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  $\Omega$ . 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:

$f_i$  unc [ $s_{11}(f_i)$ ] unc [ $s_{21}(f_i)$ ] unc [ $s_{12}(f_i)$ ] unc [ $s_{22}(f_i)$ ].

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, NrpFlashup allows these values to be entered.



*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 NrpFlashup.
2. Activate **Update S-Parameters** in the menu. The corresponding dialog window is opened (Fig. 3-3).
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:TRANsmission` switch should be automatically set to `ON` when the sensor is put into operation.
8. 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.)

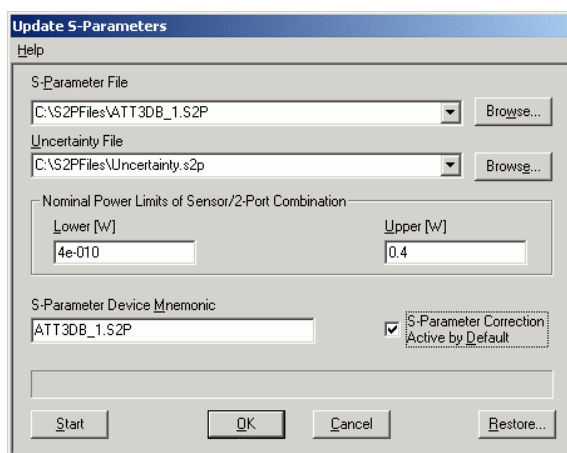


Fig. 3-3 Dialog window for loading an s-parameter table

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 `<batch number>_<date><time>.bak`, where `<batch number>` is the batch number of the sensor, `<date>` the date of the s-parameter update in `yymmdd` format and `<time>` the time of the s-parameter update in the format `hhmmss`.



*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:

- Press the **Restore...** button. The **Restore S-Parameters** window is opened (Fig. 3-4).
- 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.
- Press **OK** to start the restore procedure. (With **Cancel** the dialog window is exited without data being restored).

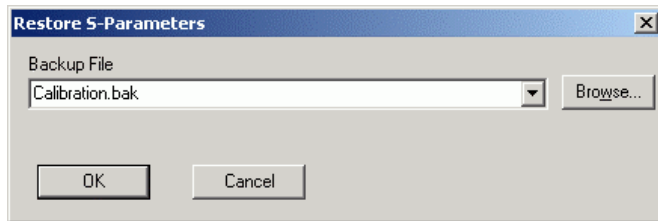


Fig. 3-4 Dialog window for loading the backup file of a calibration data set

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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. 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 <ul style="list-style-type: none"> <li>• that have no query form</li> <li>• that are available as query only</li> </ul>

**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:**

*NITiate: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>  
<variable>**

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

## 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-Z21 has the following structure:

*ROHDE&SCHWARZ,NRP-Z21,<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 sensors R&S NRP-Z11/-Z21 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 *NRPEROR\_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			
:RESet			No query
:STATe[?]	OFF   ON		
:TCONtrol[?]	MOVing   REPeat		
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF   ON   ONCE		
:TYPE[?]	RESolution   NSRatio		
:MTIME[?]	1.0 to 999.99	s	
:NSRatio[?]	0.0001 to 1.0	dB	
:RESolution[?]	1 to 4		
:SLOT[?]	1 to <SENSe:POWer:TSLot:AVG:COUNt>		
:CORRection			
:OFFSet[?]	-200.0 to 200.0	dB	
:STATe[?]	OFF to ON		
:DCYClE[?]	0.001 to 99.999	%	
:STATe[?]	OFF to ON		
:SPDeVice:STATe[?]	OFF to ON		
:FREQuency[?]	10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)	Hz	
:FUNcTion[?]	"POWer:AVG"   "POWer:TSLot:AVG"   "POWer:BURSt:AVG"   "XTIME:POWer"		
:POWer			
:AVG			
:APERture[?]	1.0e-6 to 0.3	s	
:BUFFer			
:STATe[?]	OFF   ON		
:SIZE[?]	1 to 1024		

Command	Parameter	Unit	Remarks
:SMOothing:STATe[?]	OFF   ON		
:BURSt:DTOLerance[?]	0.0 to 3.0e-3	s	
:TSLot:AVG			
:COUNt[?]	1 to 128		
:WIDTh[?]	10e-6 to 100e-3	s	
:RANGe [?]	0 to 2		
:AUTO[?]	OFF   ON		
:CLEVel[?]	0.0 to 20.0	dB	
:SAMPling[?]	FREQ1   FREQ2		
:SGAMma			
:CORRection:STATe[?]	OFF   ON		
:MAGNitude[?]	0.0 to 1.0		
:PHASe[?]	-360.0 to 360.0	degree	
:TRACe			
:AVERAge			
:STATe[?]	OFF   ON		
:TCONtrol[?]	MOVing   REPeat		
:COUNt[?]	1 to 65536		
:AUTO[?]	OFF   ON   ONCE		
TYPE[?]	RESolution   NSRatio		
:MTIME[?]	1.0 to 999.99	s	
:NSRatio[?]	0.0001 to 1.0	dB	
:RESolution[?]	1 to 4		
:POINt[?]	1 to <SENSe:TRACe:POINts>		
:MPWidth?		s	Query only
:OFFSet:TIME[?]	- (<TRIGger:DELay> + 0.005) to 100.0	s	
:POINts[?]	1 to 1024		
:REALtime[?]	OFF   ON		



Command	Parameter	Unit	Remarks
:TIME[?]	0.0001 to 0.3		
:TIMing			
:EXCLude			
:STAR[?]	0.0 to 3.0e-3	s	
:STOP[?]	0.0 to 3.0e-3	s	

### 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*. 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*.



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*. 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:** OFF

**SENSe:AVERage:COUNT:AUTO:MTIME[?] 1.0 to 999.99**

*SENSe:AVERage:COUNT:AUTO:MTIME* sets the settling time upper limit of the averaging filter in the auto-averaging mode for the *Continuous Average*, *Burst Average* and *Timeslot* modes and limits the length of the filter.

The query yields the current settling time upper limit of the averaging filter in the auto-averaging mode for the *Continuous Average*, *Burst Average* and *Timeslot* modes.

**Default setting:** 30.0 [s]

**SENSe:AVERage:COUNT:AUTO:NSRatio[?] 0.0001 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* 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* 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* 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, dB $\mu$ V 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* modes.

**Default setting:** 3

**SENSe:AVERage:COUNT:AUTO:SLOT[?] 1 to <SENSe:POWer:TSLot:AVG:COUNT>**

*SENSe:AVERage:COUNT:AUTO:SLOT* defines the timeslot, whose power is referenced by auto-averaging in the *Timeslot* 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* 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* 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* 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* 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 behaviour of the averaging filter in the *Continuous Average*, *Burst Average* and *Timeslot* 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 and the normal 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.)

The attenuation of an attenuator located ahead of the sensor or the coupling attenuation of a directional coupler is taken into account with a positive offset, i.e. the sensor calculates the power at the input of the attenuator or directional coupler. A negative offset can be used to correct the influence of a gain connected ahead.

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:SPDev:STATe[?] OFF | ON**

*SENSe:CORRection:SPDev:STATe ON* activates the s-parameter data set for a component (attenuator, directional coupler) connected ahead of the sensor. Parameter *OFF* deactivates it.

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. (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:SPDev: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 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)**

*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"	<p><b>Continuous Average</b></p> <p>After occurrence of the trigger event, the mean power is measured in a time interval (sampling window) whose width is defined with SENSE:POWer:AVG:APERTure.</p> <p>The single measurements are performed in pairs to obtain a more accurate measurement result by differentiation. With the averaging function activated, this operation is repeated the number of times specified by the averaging factor. With the averaging function activated, the actual measurement time is thus</p> $2 \times \langle \text{SENSe:AVERAge:COUNT} \rangle \times \langle \text{SENSe:POWer:AVG:APERTure} \rangle$ <p>and with deactivated averaging function</p> $2 \times \langle \text{SENSe:POWer:AVG:APERTure} \rangle.$ <p>Trigger events start one or several measurements in the Continuous Average mode (depending on the TRIGger:COUNT parameter).</p>
"POWer:TSLot:AVG"	<p><b>Timeslot</b></p> <p>The power is measured in a defined number of consecutive timeslots. Up to 128 timeslots have the same width, which is defined by SENSE:POWer:TSLot:WIDTH. Their quantity is defined by SENSE:POWer:TSLot:COUNT. The measurement result is an array, which contains as many elements as timeslots. Each element represents the average power in one of the timeslots. After each occurrence of the trigger event, a measurement is performed in all timeslots. The single measurements are also performed in pairs in this mode to obtain a more accurate measurement result by differentiation. With the averaging function activated, this operation is repeated the number of times specified by the averaging factor. With the averaging function activated, the actual measurement time is thus</p> $2 \times \langle \text{SENSe:AVERAge:COUNT} \rangle \times \langle \text{SENSe:POWer:TSLot:AVG:WIDTH} \rangle$ <p>and with deactivated averaging function</p> $2 \times \langle \text{SENSe:POWer:TSLot:AVG:WIDTH} \rangle.$ <p>Note that a corresponding number of trigger events must be available.</p>
"POWer:BURSt:AVG"	<p><b>Burst Average</b></p> <p>This mode is used for the measurement of the average power of repetitive single bursts, for example. The time interval (integration time) in which the average power is measured is not predefined. Instead, a special algorithm detects the beginning and end of the burst and ensures the synchronization of the sampling window. However, the user must define the dropout tolerance, a time criterion for detecting the pulse or burst end, using SENSE:POWer:BURSt:DTOLerance.</p> <p>In the Burst Average mode, external trigger events (irrespective of the setting of the TRIGger:SOURce parameter) and the TRIGger:DELay parameter are ignored.</p>
"XTIMe:POWer"	<p><b>Scope</b></p> <p>The Scope mode is similar to the Timeslot mode. Since, however, up to 1024 consecutive timeslots (called "points" here) are possible, the maximum averaging factor is limited to 8192 due to the storage capacity. In the Scope mode, other limits than in the Timeslot mode apply to the timeslot width. SENSE:TRACe:REALtime ON optimizes the time resolution. The differentiation and averaging filter are ignored.</p>

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*. (*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[?] 0.0001 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 (see *SENSe:POWer:AVG:SMOothing:STATe*) is sufficient in most cases. Another value, which is normally higher, is required when the measurement result shows variations due to modulation. Especially with low-frequency modulation, it is useful to adapt the size of the sampling window exactly to the modulation period, which yields an optimum stable display.

Table 6-4 Optimum selection of the sampling window size (N = 1, 2, 3, ...)

Smoothing	Optimum sampling window size
OFF	$N \times \text{modulation period} / 2$
ON	$N \times \text{modulation period} \times 2$

The theoretically shortest measurement time can then be obtained only with smoothing deactivated. As the number of modulation periods that fit into a sampling window increases, the issue of whether N is an integer becomes more critical. With smoothing activated, approx. 5 periods are sufficient to reduce variations due to modulation to an acceptable extent; variations are no longer perceptible with more than 9 periods. With smoothing deactivated, the situation is significantly unfavourable. In this case, 5 instead of 300 periods are required and the variations completely disappear as of 3000 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 behaviour 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 behaviour 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:** *ON*

**SENSe:POWer:BURSt:DTOLerance[?] 0.0 to 0.003**

*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]*



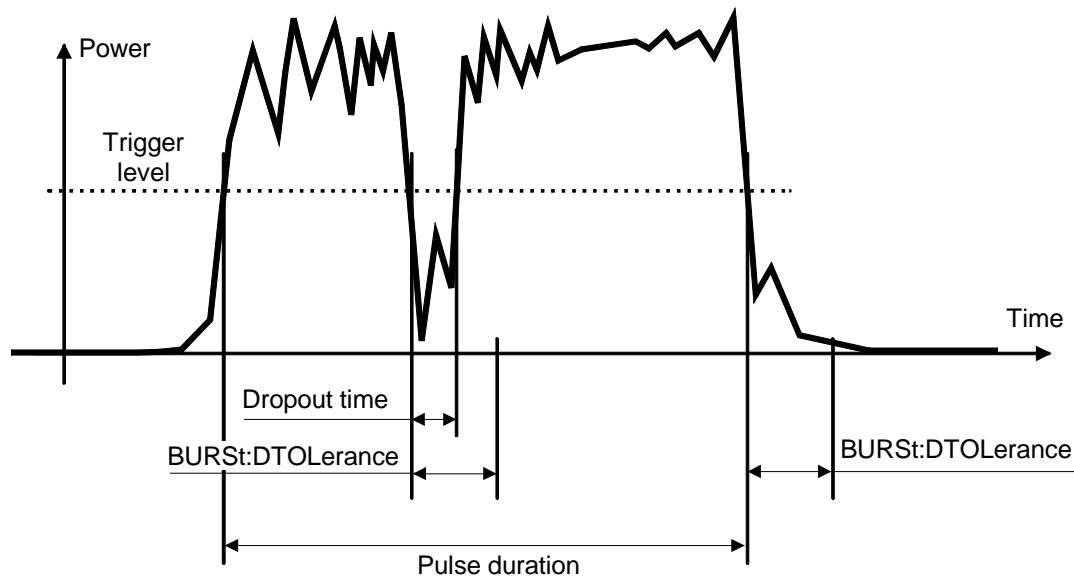


Fig. 6-1 Effect of `SENSe:POWer:BURSt:DTOLerance`

### **`SENSe:POWer:TSLot:AVG:COUNT[?]` 1 to 128**

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:** 1

### **`SENSe:POWer:TSLot:AVG:WIDTH[?]` 0.0001 to 0.1**

`SENSe:POWer:TSLot:AVG:WIDTH` sets the length of a timeslot in seconds for the Timeslot mode.

The query yields the length of a timeslot in seconds for the Timeslot 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  $\mu$ W (-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. It is therefore 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:AUTO:CLeVei[?] -20.0 to 0.0**

*SENSe:RANGe:AUTO:CLeVei* 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 133.400 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 of the source defined with *SENSe:SGAMma:MAGNitude* and *SENSe:SGAMma:PHASe* for the correction of interactions between the sensor, the source and the components connected between them (see *SENSe:CORRection:SPDevice:STATe*). This compensates for the source mismatch, which often largely contributes to measurement uncertainty.

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 source. A value of *0.0* corresponds to an ideal matched source 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:PHASe* defines the phase angle (in degrees) of the complex reflection coefficient of the source.

The query yields the set phase angle.

**Default setting:** *0.0 [°]*

**SENSe:TRACe:AVERage:COUNT[?] 1 to 65536**

*SENSe:TRACe:AVERage:COUNT* is used to set the number of measured values to be averaged in the *Scope* mode for the formation of the measurement result. The higher this averaging factor, the lesser the fluctuation the measured values and the longer the measurement time. The parameter is rounded off to the next power-of-two number.

The query yields the averaging factor used in the *Scope* mode.



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

**Default setting:** *4*

**SENSe:TRACe:AVERage:COUNT:AUTO[?] OFF | ON | ONCE**

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

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

The query yields

- 1 for *OFF*,
- 2 for *ON*.

**Default setting:** *OFF*

**SENSe:TRACe:AVERAge:COUNT:AUTO:MTIME[?] 1.0 to 999.99**

*SENSe:TRACe:AVERAge:COUNT:AUTO:MTIME* sets the settling time upper limit of the averaging filter in the auto-averaging mode for the *Scope* mode and limits the length of the filter.

The query yields the current settling time upper limit of the averaging filter in the auto-averaging mode for the *Scope* mode.

**Default setting:** 30.0 [s]

**SENSe:TRACe:AVERAge:COUNT:AUTO:NSRatio[?] 0.0001 to 1.0**

*SENSe:TRACe:AVERAge:COUNT:AUTO:NSRatio* determines the relative noise component in the measurement result for the *Scope* mode if auto-averaging is operated in the corresponding mode (*SENSe:TRACe: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 measurement result in the *Scope* mode.

**Default setting:** 0.01 [dB]

**SENSe:TRACe:AVERAge:COUNT:AUTO:RESolution[?] 1 to 4**

*SENSe:TRACe:AVERAge:COUNT:AUTO:RESolution* sets the resolution index for the automatic averaging filter in the *Scope* mode when it is operated in the *RESolution* mode. The resolution index is equal to the number of decimal places that have to be taken into account for the further processing of the measurement result in dBm, dB $\mu$ V or dB. Thus, the design of the normal mode is similar to that 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) being actually set. The *NSRatio* setting is recommended instead.

The query yields the resolution index for the *Scope* mode.

**Default setting:** 3

**SENSe:TRACe:AVERAge:COUNT:AUTO:POINT[?] 1 to <SENSe:TRACe:POINTS>**

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

The query yields the number of the current "point" whose power is referenced by auto-averaging in the *Scope* mode.

**Default setting:** 1

**SENSe:TRACe:AVERAge:COUNT:AUTO:TYPE[?] RESolution | NSRatio**

*SENSe:TRACe:AVERAge:COUNT:AUTO:TYPE* defines the mode of the automatic averaging filter in the *Scope* mode. 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:TRACe:AVERAge:STATe[?] OFF | ON**

*SENSe:TRACe:AVERAge:STATe* switches the averaging filter on or off for the *Scope* mode.

The query yields

- 1 for *OFF*,
- 2 for *ON*.

**Default setting:** *ON*

**SENSe:TRACe:AVERAge:TCONtrol[?] MOVing | REPEAT**

*SENSe:TRACe:AVERAge:TCONtrol* (*terminal control*) defines the behaviour of the averaging filter in the *Scope* mode. As soon as a new measured value is shifted to the FIR filter, a new mean 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 trends 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:TRACe:MPWidth?**

*SENSe:TRACe:MPWidth?* provides the *minimum point width* for the *Scope* mode, i.e. time resolution in seconds is determined as a function of the *TRIGger:SOURce* parameter while taking into consideration how the sensor operates. The display may be incorrect if

$$\langle \text{SENSe:TRACe:POINts} \rangle \times \langle \text{SENSe:TRACe:MPWidth} \rangle < \text{SENSe:TRACE:TIME} \rangle$$

One way to prevent this is to decrease the number of points of the *Scope* measurement sequence.

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

This command is used to shift the timeslot for measured-data acquisition along the time axis in the *Scope* mode without modifying the value of *TRIGger:DELay*. Positive values yield an additional delay and negative values a correspondingly earlier measured-data acquisition.

The query yields the set time in seconds.

**Default setting:** 0.0 [s]

**SENSe:TRACe:POINts[?] 1 to 1024**

This command defines the time resolution of the measurement result. Each "point" represents a time interval whose duration is obtained from the length of the timeslot (command *SENSe:TRACe:TIME*) divided by 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**

*SENSe:TRACe:REALtime ON* suppresses the measured-value acquisition in pairs so that single operations can be recorded in this setting. Since the averaging filter of the sensor is not used, *SENSe:AVERAge:STATe* is ignored, but is not affected.

The query yields

- 1 for *OFF*,
- 2 for *ON*.

**Default setting:** *OFF*

**SENSe:TRACe:TIME[?] 0.0001 to 0.3**

*SENSe:TRACe:TIME* sets the duration of the timeslot in the *Scope* mode. This timeslot 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 duration of the timeslot in the *Scope* mode (in s).

**Default setting:** 0.01 [s]

**SENSe:TIMing:EXCLude:STARt[?] 0.0 to 0.1**

*SENSe:TIMing:EXCLude:STARt* defines the exclusion time at the beginning of the measurement window in the *Burst Average* (Fig. 6-2) and *Timeslot* (Fig. 6-3) modes.

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

**Default setting:** 0.0 [s]

**SENSe:TIMing:EXCLude:STOP[?] 0.0 to 0.003**

SENSe:TIMing:EXCLude:STOP defines the exclusion time at the end of the measurement window in the Burst Average (Fig. 6-2) and Timeslot (Fig. 6-3) modes.

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

**Default setting:** 0.0 [s]

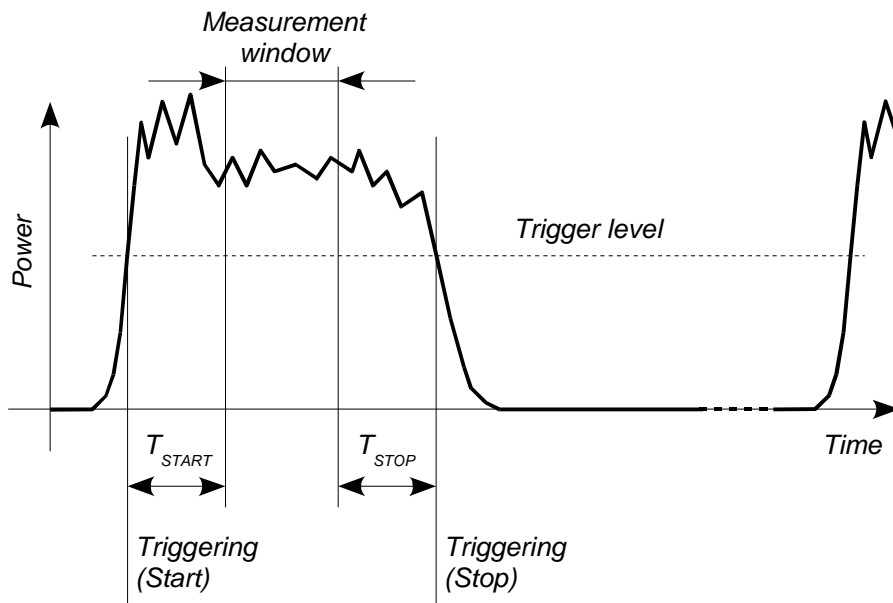


Fig. 6-2 Effect of SENSe:TIMing:EXCLude:START and :END in the Burst Average mode

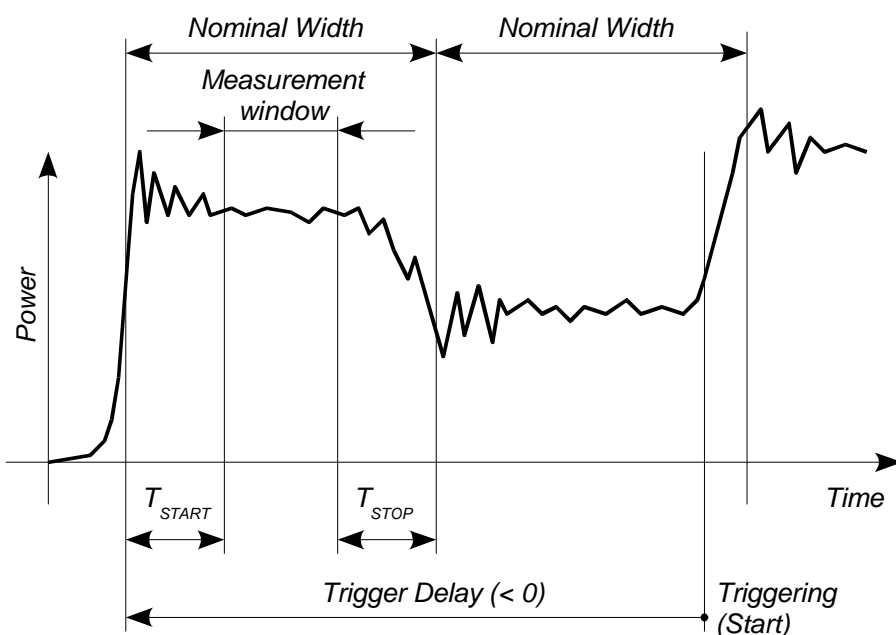


Fig. 6-3 Effect of SENSe:TIMing:EXCLude:START and :END in the Timeslot mode

## 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 6-5 Commands of the SYSTEM system

Command	Parameter	Unit	Remarks
SYSTEM			
:INFO? [Item]			Query only
:INITialize			No query
MINPower?		W	Query only
: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 6-6 Meaning of *Item* in the SYSTEM:INFO? command

Item	Information string	Remarks
"MANUFACTURER"	"Rohde & Schwarz GmbH & Co. KG"	Manufacturer
"TYPE"	"NRP-Z11" or "NRP-Z21"	Type designation
"STOCK NUMBER"	"1138.3004.02" or "1137.6000.02"	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 Terminating"	The R&S NRP-Z11/-Z21 is a termination power sensor.



Item	Information string	Remarks
"MINPOWER"	"<nominal lower test limit in W>"	The nominal lower test limit of the R&S NRP-Z11/-Z21 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-Z11/-Z21 is 200 mW, i.e. with s-parameter correction deactivated, the sensor returns the information string "0.2" 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"	The minimum measuring frequency of the R&S NRP-Z11/-Z21 is 10 MHz.
"MAXFREQ"	"8e+09" or "1.8e+10"	The maximum measuring frequency is 8 GHz for the R&S NRP-Z11 and 18 GHz for the R&S NRP-Z21.
"RESOLUTION"	"2.5µs Ext, 10µs Int"	The maximum time resolution that can be reached in the Scope mode is 2.5 µs for internal triggering and 10 µs for external triggering.
"IMPEDANCE"	"50"	The R&S NRP-Z11/-Z21 RF input has a nominal input impedance of 50 Ω.
"COUPLING"	"AC/DC"	The RF input of the R&S NRP-Z11/-Z21 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.
"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: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 6-7 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.

## TRIGger

Table 6-8 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 $2 \times 10^9$		
:DELay[?]	x to 100.0	s	
:AUTO[?]	OFF   ON		
:HOLDoff[?]	0.0 to 10.0	s	
:HYSTeresis[?]	0.0 to 3.0	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 is automatically started when a measurement is terminated. The sensor first enters the *WAIT\_FOR\_TRIGGER* state and begins with the measurement as soon as the trigger condition is fulfilled. Once the measurement is completed, the sensor again enters the *WAIT\_FOR\_TRIGGER* state. The sensor will measure continuously assuming continuous trigger events.

In contrast, each measurement cycle must be explicitly started with the *INITiate:IMMediate* command after the *INITiate:CONTInuous OFF* command has been sent. After triggering and completion of the measurement, the sensor enters the *IDLE* status and remains in this status 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 with the measurement as soon as the trigger condition is fulfilled. Once the measurement is completed, the sensor again enters the *IDLE* state. Since the command is ignored during measurement, it normally has no effect in the continuous mode (setting *INITiate:CONTinuous ON*).

## TRIGger:ATRigger:STATe[?] OFF | ON

*TRIGger:ATRigger:STATe ON* causes an artificial trigger event to be triggered if no trigger is recorded more than 10 s after the measurement has been started (only in the *Scope* mode). *TRIGger:ATRigger:STATe OFF* deactivates the trigger automatic function.

The query yields

- 1 for OFF,
- 2 for ON.

**Default setting:** OFF

## TRIGger:COUNt[?] 1 to $2 \times 10^9$

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.



*The TRIGger:COUNt command does not define the number of trigger events required for performing the entire measurement task. The number may vary depending on the measurement mode.*

*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**

*TRIGger:DElay* defines the delay (in seconds) between the occurrence of the trigger event and the beginning of the measurement itself for the *Timeslot* and *Scope* modes. This parameter is ignored in the *Burst Average* mode. Pretriggering is obtained by means of negative values; with bus-triggered measurements (see *TRIGger:SOURce*), the parameter must be set to positive values or zero to avoid measurement errors.

The query yields the set trigger delay for the *Timeslot* and *Scope* modes (in seconds).

**Lower limit x of the parameter**

Modes *Continuous Average*, *Burst Average* and *Timeslot*:  $x = -0.005$

Mode *Scope*:  $x = - (<SENSe:TRACe:OFFSet:TIME> + 0.005)$

**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 important when thermal sensors are used. The automatically determined delay is ignored if a longer period was set with *TRIGger:DElay*. This does not overwrite the value of *TRIGger:DElay*. *TRIGger:DElay:AUTO OFF* deactivates this function.

The query yields

- 1 for OFF,
- 2 for ON.

**Default setting:** ON

**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*.



## List of Remote-Control Commands

The remote-control commands of the R&S NRP-Z11/-Z21 have a syntax based on standard SCPI 1999.0, but they comply with it only to a limited extent.

Table 6-9 List of remote-control commands

Command	Parameter	Unit	Default setting	Page
<b>* Commands</b>				
*IDN?				6.2
*RST				6.2
*TRG				6.2
*TST?				6.2
<b>CALibration Commands</b>				
CALibration:DATA[?]	<calibration data set as definite length block>			6.3
CALibration:DATA:LENGth?		Bytes		6.3
CALibration:ZERO:AUTO[?]	OFF   ON   ONCE		OFF (fixed)	6.4
<b>SENSe Commands</b>				
SENSe:AVERage:COUNT[?]	1 to 65536		4	6.7
SENSe:AVERage:COUNT:AUTO[?]	OFF   ON   ONCE		ON	6.7
SENSe:AVERage:COUNT:AUTO:MTIME[?]	1.0 to 999.99	s	30.0	6.8
SENSe:AVERage:COUNT:AUTO:NSRatio[?]	0.0001 to 1.0	dB	0.01	6.8
SENSe:AVERage:COUNT:AUTO:RESolution[?]	1 to 4		3	6.8
SENSe:AVERage:COUNT:AUTO:SLOT[?]	1 to <SENSe:POWer:TSLot:AVG:COUNT>		1	6.8
SENSe:AVERage:COUNT:AUTO:TYPE[?]	RESolution   NSRatio		RESolution	6.9
SENSe:AVERage:RESet				6.9
SENSe:AVERage:STATe[?]	OFF   ON		ON	6.9
SENSe:AVERage:TCONtrol[?]	MOVing   REPeat		REPeat	6.9
SENSe:CORRection:DCYClE[?]	0.001 to 99.999	%	1.0	6.10
SENSe:CORRection:DCYClE:STATe[?]	OFF   ON		OFF	6.10
SENSe:CORRection:OFFSet[?]	-200.0 to 200.0	dB	0.0	6.10



Command	Parameter	Unit	Default setting	Page
SENSe:CORRection:OFFSet:STATe[?]	OFF   ON		OFF	6.10
SENSe:CORRection:SPDev:STATe[?]	OFF   ON		OFF (can be modified by the user)	6.11
SENSe:FREQuency[?]	10.0e6 to 8.0e9 (NRP-Z11) or 18.0e9 (NRP-Z21)	Hz	50.0e6	6.11
SENSe:FUNcTION[?]	"POWer:AVG"   "POWer:TSLot:AVG"   "POWer:BURSt:AVG"   "XTIME:POWer"		"POWer:AVG"	6.12
SENSe:POWer:AVG:APERture[?]	0.0001 to 0.3	s	0.02	6.13
SENSe:POWer:AVG:BUFFer:SIZE[?]	1 to 1024		1	6.13
SENSe:POWer:AVG:BUFFer:STATe[?]	OFF   ON		OFF	6.14
SENSe:POWer:AVG:SMOothing:STATe[?]	OFF   ON		ON	6.14
SENSe:POWer:BURSt:DTOLerance[?]	0.0 to 0.003	s	0.0001	6.14
SENSe:POWer:TSLot:AVG:COUNt[?]	1 to 128		8	6.15
SENSe:POWer:TSLot:AVG:WIDTh[?]	0.0001 to 0.1	s	0.001	6.15
SENSe:RANGe[?]	0 to 2		2	6.15
SENSe:RANGe:AUTO[?]	OFF   ON		ON	6.16
SENSe:RANGe:AUTO:CLeVel[?]	-20.0 to 0.0	dB	0.0	6.16
SENSe:SAMPLING[?]	FREQ1   FREQ2		FREQ1	6.16
SENSe:SGAMma:CORRection:STATe[?]	OFF   ON		OFF	6.16
SENSe:SGAMma:MAGNitude[?]	0.0 to 1.0		0.0	6.17
SENSe:SGAMma:PHASe[?]	-360.0 to 360.0	degree	0.0	6.17
SENSe:TRACe:AVERAge:COUNt[?]	1 to 65536		4	6.17
SENSe:TRACe:AVERAge:COUNt:AUTO[?]	OFF   ON   ONCE		ON	6.17
SENSe:TRACe:AVERAge:COUNt:AUTO:MTIME[?]	1.0 to 999.99	s	30.0	6.18
SENSe:TRACe:AVERAge:COUNt:AUTO:NSRatio[?]	0.0001 to 1.0	dB	0.01	6.18
SENSe:TRACe:AVERAge:COUNt:AUTO:POINt[?]	1 to <SENSe:TRACe:POINts>		1	6.18
SENSe:TRACe:AVERAge:COUNt:AUTO:RESolution[?]	1 to 4		3	6.18
SENSe:TRACe:AVERAge:COUNt:AUTO:TYPE[?]	RESolution   NSRatio		RESolution	6.19

Command	Parameter	Unit	Default setting	Page
SENSe:TRACe:AVERage:STATe[?]	OFF   ON		ON	6.19
SENSe:TRACe:AVERage:TCONtrol[?]	MOVing   REPeat		REPeat	6.19
SENSe:TRACe:MPWidth?		s		6.19
SENSe:TRACe:OFFSet:TIME[?]	– (<TRIGger:DELay> + 0.005) to 100.0	s	0.0	6.19
SENSe:TRACe:POINts[?]	1 to 1024		100	6.20
SENSe:TRACe:REALtime[?]	OFF   ON		OFF	6.20
SENSe:TRACe:TIME[?]	0.0001 to 0.3	s	0.01	6.20
SENSe:TIMing:EXCLude:STARt[?]	0.0 to 0.003	s	0.0	6.20
SENSe:TIMing:EXCLude:STOP[?]	0.0 to 0.003	s	0.0	6.20
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<b>Test Commands</b>				
TEST:SENSor?				6.25
<b>Triggersystem Commands</b>				
ABORt				6.26
INITiate:CONTinuous[?]	OFF   ON		OFF	6.26
INITiate:IMMediate				6.27
TRIGger:ATRigger:STATe[?]	OFF   ON		OFF	6.27
TRIGger:COUNt[?]	1 to 2×10 <sup>9</sup>		1	6.27
TRIGger:DELay[?]	x to 100.0	s	0.0	6.28
TRIGger:DELay:AUTO[?]	OFF   ON		OFF	6.28
TRIGger:HOLDoff[?]	0.0 to 10.0	s	0.0	6.28
TRIGger:HYSTeresis[?]	0.0 to 10.0	dB	0.0	6.28

Command	Parameter	Unit	Default setting	Page
TRIGger:IMMediate				6.28
TRIGger:LEVel[?]	x to y	W	1.0e-6	6.29
TRIGger:SLOPe[?]	POSitive   NEGative		POSitive	6.29
TRIGger:SOURce[?]	BUS   EXTernal   HOLD   IMMediate   INTernal		IMMediate	6.29
<b>SERvice Commands</b>				
SERvice:CALibration:DITHer	ONCE		OFF	
SERvice:CALibration:DITHer:DATA?			0	
SERvice:CALibration:TEMP	ONCE		OFF	
SERvice:CALibration:TEMP:DATA?		K	0.0	
SERvice:CALibration:TEST[?]			-1	
SERvice:CALibration:ZERO:NEG0?			1	
SERvice:CALibration:ZERO:POS0?			2	
SERvice:CALibration:ZERO:NEG1?			3	
SERvice:CALibration:ZERO:POS1?			4	
SERvice:CALibration:ZERO:NEG2?			5	
SERvice:CALibration:ZERO:POS2?			6	
SERvice:DITHer	OFF   ON		ON	
SERvice:MVCorrection[?]	0 to 63		63	
SERvice:PARAmeter:RTEmp[?]	<float value>	K	0.0	
SERvice:PARAmeter:RNULL0[?]	<float value>	$\Omega$	0.0	
SERvice:PARAmeter:RNULL1[?]	<float value>	$\Omega$	0.0	
SERvice:PARAmeter:RNULL2[?]	<float value>	$\Omega$	0.0	
SERvice:PARAmeter:RBAHN[?]	<float value>	$\Omega$	0.0	
SERvice:PARAmeter:NREF[?]	<float value>		0.0	
SERvice:PARAmeter:ATHERM[?]	<float value>	$K^{-1}$	0.0	
SERvice:PARAmeter:B THERM[?]	<float value>	K	0.0	
SERvice:PARAmeter:C THERM[?]	<float value>	$K^{-1}$	0.0	
SERvice:PARAmeter:D THERM[?]	<float value>	$K^{-1}$	0.0	

Command	Parameter	Unit	Default setting	Page
SERVice:PARAmeter:CJUNC[?]	<float value>	F	0.0	
SERVice:RCount[?]	1 to 32767		0	
SERVice:RESult[?]	0.0 to 1.0e6	W	0.0	
SERVice:SAMPlE[?]	0 to 99999999		1000	
SERVice:TDEScriptor?				
SERVice:TDEScriptor:LENGth?		Bytes		
SERVice:UNLock	1234			



**ROHDE & SCHWARZ**

Test and Measurement  
Division

## Service Instructions



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# 1 Performance Test

## Preliminary Remarks

Verifying the data sheet specifications for the Power Sensors R&S NRP-Z11 and R&S NRP-Z21 requires a considerable amount of equipment and care. Rohde & Schwarz therefore recommends using the Power Calibration System R&S NRVC or corresponding equipment that yields the same accuracy. The tests are to be carried out directly at the manufacturer, its representatives or subsidiaries or at calibration sites that are equipped accordingly.

A **quick test** (see page 1.5) is recommended for checking the sensor with simple means.

## Test Instructions

- The tests are to be performed at an ambient temperature of 20°C to 25°C. The DUT should be connected to the (activated) R&S NRP base unit for at least 30 minutes before the tests are performed.
- The test limits used in the following sections are based on the data sheet for the sensors R&S NRP-Z11 and R&S NRP-Z21. The test limits are valid only on the conditions defined in the corresponding test step. They are therefore not legally binding as accuracy specifications; only data sheet specifications are legally binding.

## Measuring Equipment and Accessories

Item	Type of unit	Recommended characteristics	Recommended units	R&S order number	Application
1	Power calibration system	10 MHz to 18 GHz Calibration level 0 dBm	R&S NRVC R&S NRVC-B1 R&S SMP02 R&S NRVD	1109.0500.02 1109.1007.02 1035.5005.02 0857.8008.02	Absolute measuring accuracy
2	Linearity calibration system	-30 dBm to +23 dBm Test frequency 50 MHz	R&S NRVC-B2 R&S SMGL	1109.1207.02 1020.2005.52	Linearity
3	Network analyzer	10 MHz to 18 GHz Test port: N connector	R&S ZVM	1127.8500.60	Matching
4	Controller <sup>1</sup>	PC with IEC/IEEE-bus card (NI)			In connection with R&S NRVC and R&S NRVC-B2
5	Power meter	To connect the DUT	R&S NRP	1143.8500.02	Absolute measuring accuracy

<sup>1</sup> For program-controlled calibration in connection with Calibration Kit R&S NRVC and Calibration Software *Recal*.

## Performance Test with Calibration Kit NRVC and Calibration Software *Recal*

For detailed information about the performance test, refer to the operating manual for Calibration Kit R&S NRVC.

SWR measurement has to be carried out on a separate network analyzer. Evaluation is performed by Calibration Software *Recal*.

## Performance Test with Other Measuring Equipment

### Checking Absolute Measuring Accuracy

The sensor contains three measurement paths. Individual calibration factors are stored for these measurement paths in the sensor. The measurement paths therefore have to be checked separately. (Table 1-1 and Table 1-2). The maximum permissible error depends on the calibration uncertainties of the sensor (Table 1-2) and the uncertainties of the calibration system. It is recommended to combine both uncertainties according to the RSS method (square root based on the sum of squares) and to use the expanded combined uncertainty as the test limit.

To calibrate measurement path 1, the measurement result of measurement path 2 can be used if the calibration system does not provide a calibration power of 10  $\mu$ W or if its uncertainty is too high. In this case, only the displayed difference between the two measurement paths will be checked (Table 1-3).

Table 1-1 Calibration powers

Measurement path	Power measurement range		Calibration power
1	200 $\mu$ W to 50 $\mu$ W	(-67 dBm to -13 dBm)	10 $\mu$ W
2	20 nW to 5 mW	(-47 dBm to +7 dBm)	1 mW
3	2 $\mu$ W to 200 mW	(-27 dBm to +23 dBm)	1 mW

Table 1-2 Expanded calibration uncertainties of Sensors R&S NRP-Z11/-Z21 (in dB)

Frequency	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
Measurement path	Only R&S NRP-Z21					
1	0.056	0.056	0.066	0.083	0.094	0.123
2	0.047	0.047	0.057	0.071	0.076	0.099
3	0.048	0.047	0.057	0.072	0.076	0.099

**Calibration frequencies:** 10 MHz, 15 MHz, 20 MHz, 30 MHz, 50 MHz, 100 MHz;  
from 250 MHz to 18 GHz in 250 MHz steps.

Table 1-3 Max. measurement error (in dB) between meas. paths 1 and 2 at –20 dBm (10 μW)

Frequency	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
					Only R&S NRP-Z21	
Measurement error	0.045	0.044	0.048	0.054	0.063	0.079

**Procedure:**

- Perform zeroing (without power applied).
- Set measurement path in **Sensor – Range** menu on the R&S NRP.
- Set calibration frequency in **Frequency** menu on the R&S NRP.
- Read power on the R&S NRP and compare with power value of calibration system. At least three measurements are recommended, with the sensor set to a different position with respect to the output connector of the calibration system each time.

**Checking the Linearity**

The linearity check is performed at 50 MHz with autoranging activated. The reference power is 1 mW (0 dBm). The maximum permissible linearity error depends on the linearity uncertainty of the sensor (Table 1-4) and the linearity uncertainty of the calibration system. It is recommended to combine both uncertainties according to the RSS method (square root based on the sum of squares) and to use the expanded combined uncertainty as the test limit.

Table 1-4 Expanded linearity uncertainties of Sensors R&amp;S NRP-Z11 and R&amp;S NRP-Z21 at 50 MHz (in dB, with reference to 0 dBm)

Test level	-30 dBm to -13 dBm	-13 dBm to +1 dBm	+1 dBm to +23 dBm
Uncertainty	0.044	0.022	0.044

**Calibration levels:** -30 dBm, -25 dBm, -20 dBm, -15 dBm, -10 dBm, -5 dBm, 0 dBm, +5 dBm, +10 dBm, +15 dBm, +20 dBm, +23 dBm

**Procedure:**

- Perform zeroing (without power applied).
- Set autoranging in **Sensor – Range** menu on the R&S NRP.
- Set 50 MHz in **Frequency** menu on the R&S NRP.
- Apply level of 0 dBm and activate **Relative On** in the **Measurement** menu on the R&S NRP. Use the current measurement value as the reference value (**Reset**). Set unit to **dB**.
- Set the calibration level and compare the relative level measured by the R&S NRP with that of the calibration system.

## Checking Matching

For these measurements, the sensor can be operated with or without the R&S NRP base unit. The measurement procedure depends on the network analyzer used.

Table 1-5 Max. SWR of Sensors R&S NRP-Z11 and R&S NRP-Z21

Frequency	10 MHz to <30 MHz	30 MHz to 2.4 GHz	>2.4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
				Only R&S NRP-Z21	
<b>Max. SWR</b>	1.13	1.11	1.18	1.23	1.23

## Quick Test

The following tests are used to check the R&S NRP-Z11 and R&S NRP-Z21 with simple means. If the tests are passed, compliance of the sensors with the specifications within the complete frequency and power range is largely ensured.

The test consists of:

- Zeroing.
- Absolute measuring accuracy at 0 dBm (50 MHz).
- Linearity when changing the measurement path (50 MHz).
- Input resistance (for DC voltage/current).

## Test Instructions

- The tests are to be performed at an ambient temperature of 15°C to 35°C. The DUT should be connected to the (activated) R&S NRP base unit for at least 30 minutes before the tests are performed.
- The test limits used in the following sections are based on the data sheet but are valid only on the conditions defined for the corresponding test step. They are therefore not binding as far as accuracy is concerned but are strictly data sheet information.
- The entries made on the Power Meter R&S NRP are abbreviated as follows:
  - [<KEY>] Press front-panel key, e.g. [**FREQ**].
  - [<SOFTKEY>] Press softkey, e.g. [Range].
  - [<nn unit>] Enter value and confirm with unit, e.g. [**3 GHz**].Successive entries are separated by [:], e.g. [**FREQ : 3 GHz**].

## Measuring Equipment and Accessories Required for the Quick Test

Item	Type of unit	Recommended characteristics	Recommended units	R&S order number	Application
1	Power meter	For connecting the DUT with power reference 1 mW / 50 MHz Expanded uncertainty <1.2 %	R&S NRP R&S NRP-B1	1143.8500.02 1146.9008.02	Absolute measuring accuracy Linearity
2	Signal generator	50 MHz Output level -20 dBm ... 0 dBm	R&S SML01	1090.3000.11	Linearity
3	System voltmeter	4-wire resistance measurement at 50 $\Omega$ Expanded measurement uncertainty <0.2 $\Omega$			Input resistance
4	Adapter	BNC (plug) to 4-mm sockets (2-pin).		0017.6742.00	Input resistance
5	Adapter	BNC (socket) to N (socket).			Input resistance

## Checking Zeroing

- Test setup
- Sensor (DUT) is connected to power reference output of power meter (1).
  - Power reference is switched off.
- Settings on R&S NRP
- [ **(PRE)SET: (PRE)SET** ]
  - [ **ZERO/CAL: ZERO/CAL** ]
- Test
- Message "Zeroing A(B) successful".
  - Display value is within limits of test report.



## Checking the Absolute Measuring Accuracy

Test setup	- Sensor (DUT) is connected to power reference output. - Power reference is switched off.
Setting on R&S NRP	- [ (PRE)SET: (PRE)SET: System: Power Ref On ]
Test	- Display value is within the limits of test report.

## Checking the Linearity

Test setup	- Sensor is connected to signal generator output
Setting on signal generator	- Frequency 50 MHz, output level -20 dBm, unmodulated.
Setting on R&S NRP	- [ (PRE)SET: (PRE)SET: Sensor: Range: Auto <input type="checkbox"/> : Path 1 ]
Measurement	- On R&S NRP, approx. -20 dBm must be displayed.
Setting on R&S NRP	- [ Measurement: Relative On: Reset]
Measurement	- On R&S NRP, 0.00 dB must be displayed.
Setting on R&S NRP	- [ Sensor: Range: Auto <input type="checkbox"/> : Path 2]
Test	- Displayed value is within limits of Performance Test Report.
Setting on signal generator	- Frequency 50 MHz, output level 0 dBm, unmodulated.
Setting on R&S NRP	- [ Sensor: Range: Auto <input type="checkbox"/> : Path 2]
Measurement	- On R&S NRP, approx. 0 dBm must be displayed.
Setting on R&S NRP	- [ Measurement: Relative On: Reset]
Measurement	- On R&S NRP, 0.00 dB must be displayed.
Setting on R&S NRP	- [ Sensor: Range: Auto <input type="checkbox"/> : Path 3]
Test	- Displayed value is within limits of Performance Test Report.

## Checking Input Resistance

Test setup

- System voltmeter is set to 4-wire impedance measurement and is connected to DUT according to figure.

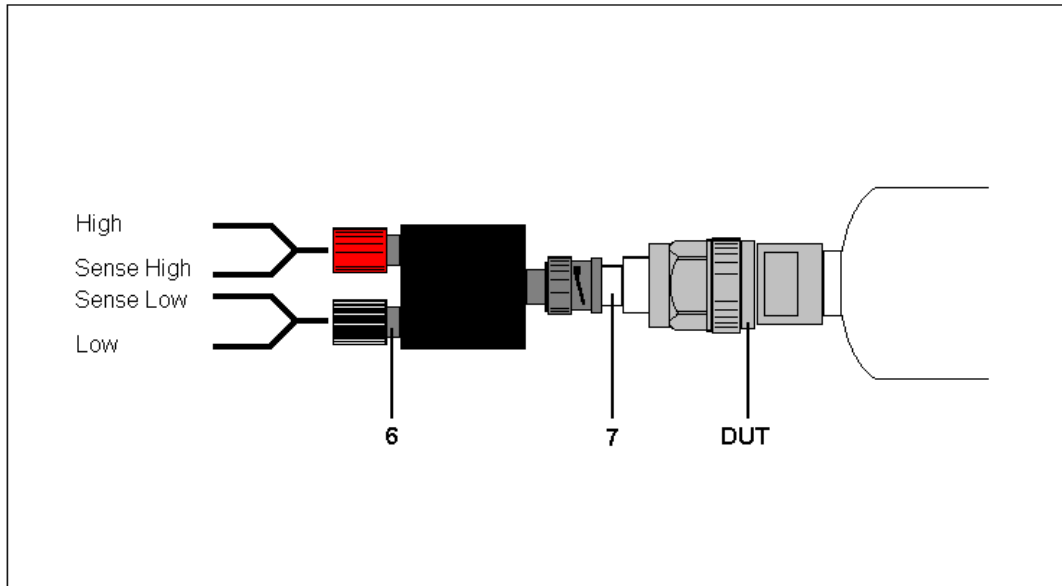


Fig. 1-1 Connection of DUT for measuring the input resistance

Test

- Check input resistance of sensor for compliance with limits of test report.

## Test Report

<b>Quick test</b>					
<b>Power Sensor R&amp;S NRP-Z11</b>					
Stock number: 1138.3004.02			Name: .....		
Serial number: .....			Date: .....		
Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
1	Zeroing	-----		-67.0	dBm
2	Absolute measuring accur. at 0 dBm / 50 MHz	-0.10		+0.10	dBm
3	Linear. of meas. path 1 → 2	-0.10		+0.10	dB
4	Linear. of meas. path 2 → 3	-0.10		+0.10	dB
5	Input resistance	50.2		51.8	Ω

<b>Quick test</b>					
<b>Power Sensor R&amp;S NRP-Z21</b>					
Stock number: 1137.6000.02			Name: .....		
Serial number: .....			Date: .....		
Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
6	Zeroing	-----		-67.0	dBm
7	Absolute measuring accur. at 0 dBm / 50 MHz	-0.10		+0.10	dBm
8	Linear. of meas. path 1 → 2	-0.10		+0.10	dB
9	Linear. of meas. path 2 → 3	-0.10		+0.10	dB
10	Input resistance	50.2		51.8	Ω



## 2 Adjustment

### Preliminary Remarks

The Sensors R&S NRP-Z11 and R&S NRP-Z21 cannot be adjusted manually but have to be adjusted by updating the calibration data in the memory. Calibration Software **Recal**, which is part of the equipment supplied with the Calibration Kit R&S NRVC, is therefore required. The measurement results for the absolute calibration of the three measurement paths which can be obtained during a performance test (see Section 1) form the basis of the adjustment. The Calibration Kit R&S NRVC is recommended but is not mandatory.

To ensure that the measuring accuracy corresponds to the data sheet values after the adjustment, the calibration system must not have any inaccuracies that are higher than those given in the table below.

Table 2-1 Uncertainty of power calibration system at 0 dBm (in dB, including mismatch)

Frequency	10 MHz to <20 MHz	20 MHz to <100 MHz	100 MHz to 4 GHz	>4 GHz to 8 GHz	>8 GHz to 12.4 GHz	>12.4 GHz to 18 GHz
					Only R&S NRP-Z21	
	0.04	0.04	0.05	0.065	0.07	0.09

For further details, refer to the operating manual for the Calibration Kit R&S NRVC or the online help for the **Recal** program.



### 3 Repair of Sensors R&S NRP-Z11/-Z21

This section describes the design and simple measures for repairing and determining faults as well as the replacement of modules.

The firmware update is explained in section 4 of this service manual.

## Design and Circuit Description

### Block Diagram

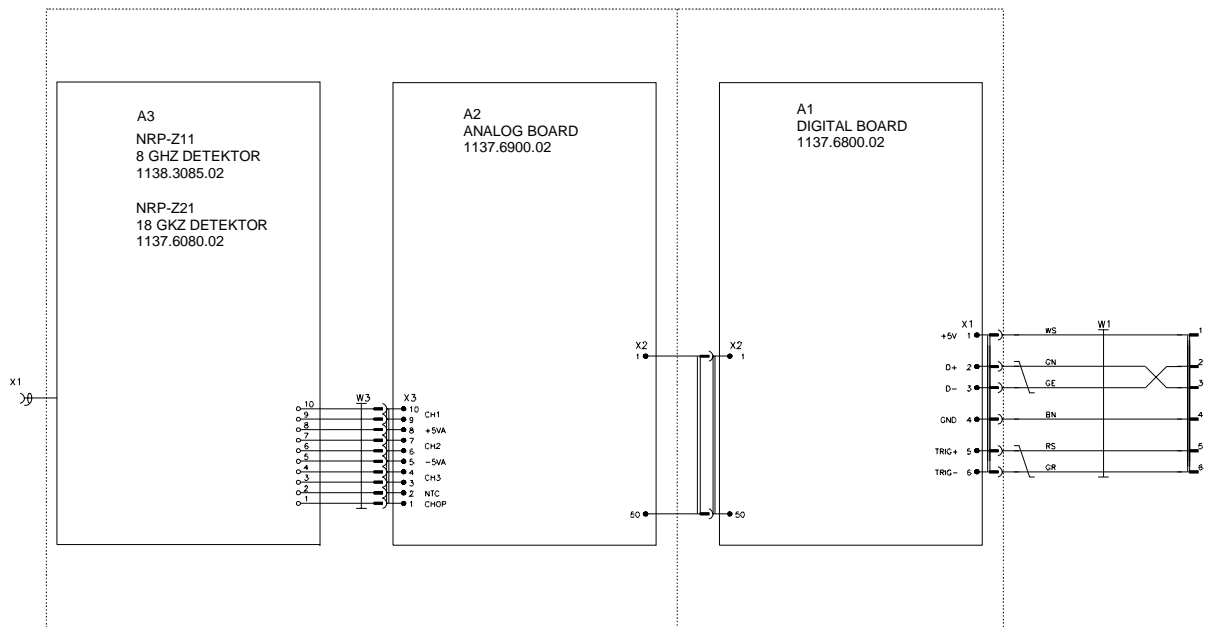


Fig. 3-1 Block diagram of Sensors R&S NRP-Z11 and R&S NRP-Z21

## Description of Block Diagram

The Sensors R&S NRP-Z11 and R&S NRP-Z21 can determine the average power of almost any modulated RF signal over a large dynamic range. They include all modules required for analog and digital signal processing and provide fully corrected measured values. Communication with the R&S NRP base unit is handled via a USB interface.

Three detectors are used to obtain the large dynamic range of 90 dB (–67 dBm to +23 dBm); the input signal is fed unattenuated to path 1, attenuated by 20 dB to path 2 and attenuated by 40 dB to path 3. Sensitivity is highest on path 1, medium on path 2 and lowest on path 3.

Depending on the RF input signal level, one or two test paths are driven at such a level that these paths can be evaluated. A channel is always either driven at a very low level or overdriven. The output voltages of the three detectors are amplified and digitized independently of each other to obtain a continuous transition between the test paths. The digital values provided by the A/D converters undergo various corrections (zero offset, temperature, linearity). A weighting algorithm then decides which path or – in transition ranges – which two paths are to be evaluated, and forms a weighted measured value. Integration values that represent the average power of the RF signal in a predefined integration period are derived by averaging all sampling values within the integration period.

The final measured values are the averaged result from several integration values.

## Microwave Detector

The microwave detector A3 is a hybrid circuit. It contains the three test paths and a thermistor for temperature measurement. The detector has an RF signal input and a flexstrip connector for output signals, control signals and operating voltages with the following assignment:

Table 3-1 Assignment of flexstrip connector W3

Connector	Signal name	Description
W3:1	CHOP	Logic signal for controlling the choppers
W3:2	NTC	Thermistor connector (the other connector of the thermistor is connected to ground)
W3:3 W3:4	CH3	Output of the most insensitive test path
W3:5	–5VA	Negative operating voltage for the choppers
W3:6 W3:7	CH2	Output of the medium test path
W3:8	+5VA	Positive operating voltage for the choppers
W3:9 W3:10	CH1	Output of the most sensitive test path

The casing of the detector is at ground potential.



## Analog Board

The analog board A2 contains three test channels of the same design, each consisting of an instrumentation amplifier, a buffer amplifier and a 14-bit A/D converter. The instrumentation amplifiers amplify the output difference voltage of the detectors and convert it into a ground-referenced voltage. The buffer amplifiers are quickly settling operational amplifiers with negative current feedback; they isolate the instrumentation amplifiers from the current peaks occurring at the A/D converter inputs. The A/D converters operate on the successive approximation principle. They have serial outputs.

The serial output data streams of the A/D converters are subjected to serial-parallel conversion in a CPLD and stored in three addressable registers. The digital board consecutively addresses and reads out these registers.

The analog board also comprises an 8-bit D/A converter for generating a noise-line large-scale dither signal that is controlled by the digital board with a sequence of pseudo-random digital values.

The analog board contains a four-channel 12-bit A/D converter for measuring the substrate temperature of the detector as well as for monitoring the operating voltages  $\pm 5$  V and +1.75 V. The 12-bit A/D converter is supplied by the 3.3 V operating voltage of the digital board and is thus operational even if the voltage supply of the analog board is defective. It is connected to the synchronous serial interface of the digital board and utilizes the MICROWIRE™ protocol.

The +5 V operating voltage of the analog board is generated from +3.3 V by a charge pump doubler with subsequent linear regulator. The 5 V operating voltage is generated by a switching regulator with a very low output ripple voltage.

## Digital Board

The digital board A1 mainly consists of a controller based on a microcontroller Intel StrongARM SA1110, two SRAMs (together 1 Mbyte) as random access memory and two flash PROMs (together 2 Mbyte).

The interface to the R&S NRP base unit is formed by connector X1 on the digital board. Besides the four lines for the USB interface, the sensor cable contains two signal lines for applying a differential trigger signal.

The connection to the analog board is established by press-in connector X2.

The digital board contains two DC/DC converters that generate the voltages +3.3 V and +1.75 V (for the microcontroller core) from the +5 V operating voltage.

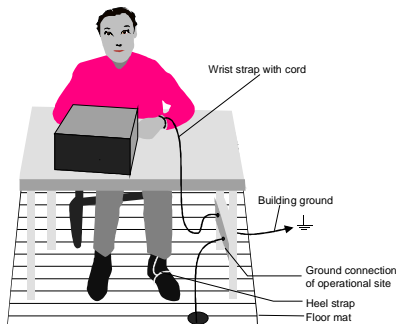
## Module Replacement

The following section describes how to exchange the plastic shell halves and how to replace the connecting cable. If one of the electronic modules (microwave detector, analog board or digital board) is defective, the sensor has to be sent to Rohde & Schwarz Central Service for repair.



### Caution!

- *Observe the safety instructions at the beginning of this manual.*
- *To avoid damaging electronic components, the instrument should only be opened on a workplace protected against electrostatic discharges.*



*The following methods can be used separately or combined to ensure protection against electrostatic discharges:*

- *Anti-static wrist strap with grounding cable.*
- *Conductive flooring with foot strap.*

## Tools Required

Torx screwdriver	Size	T8
	Thread	M 2.5



### Note:

*The numeric values in brackets refer to the item in the list of mechanical parts and spare parts in section 5.*

*These items are identical to the item numbers in the drawings illustrating the module replacement.*

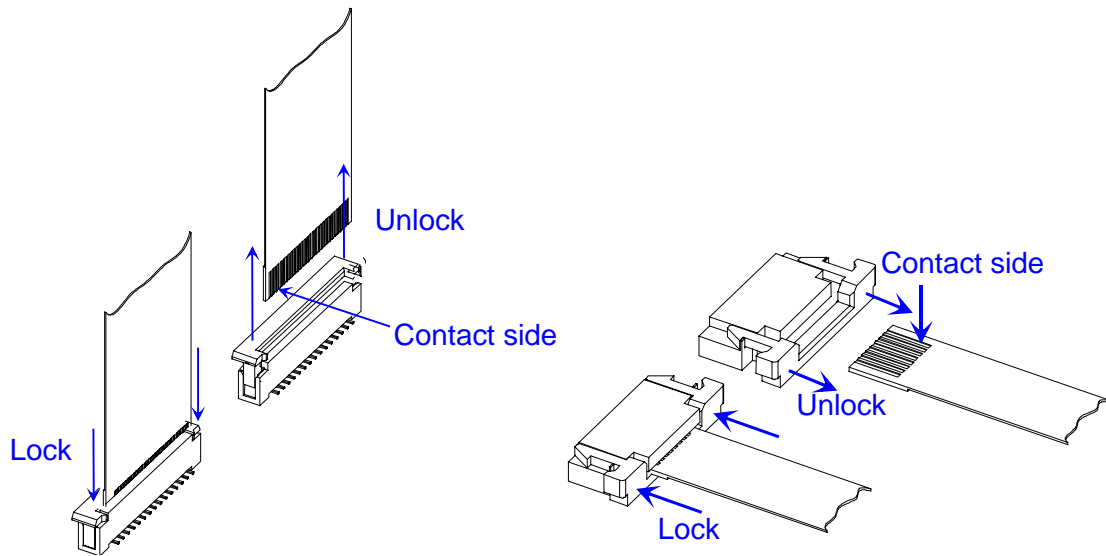


Fig. 3-2 Membrane cables

**Note:****Remove membrane cables:**

Membrane cables can be removed after unlocking the female connector.

**Connect membrane cables:**

Observe the contact side and lock the female connector.

## List of Modules

Table 3-2 List of modules/spare parts for R&amp;S NRP-Z11 and R&amp;S NRP-Z21

Item No.	Designation	Electrical identification	Stock No.
20	ANALOG BOARD	A2	**)
40	POWER SENSOR CABLE	W1	1137.7141.02
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 *)
80	DIGITAL BOARD	A1	**)
90	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 *)
100	18 GHZ DETECTOR (NRP-Z21)	A3	**)
101	8 GHZ DETECTOR (NRP-Z11)	A3	**)
150	SHIELDING		1137.6068.00 *)
160	SENSOR HOUSING		1137.6022.00
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 *)
180	LABEL 1 R&S NRP-Z11		1138.3033.00
190	LABEL 2 R&S NRP-Z11		1138.3040.00
200	LABEL 1 R&S NRP-Z21		1137.6039.00
210	LABEL 2 R&S NRP-Z21		1137.6045.00

\*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.

\*\*) Spare part not available; to be replaced only by Rohde &amp; Schwarz Central Service.

## Opening and Reassembly (Exchange of Plastic Shell Halves)

### Opening

- Undo two screws (170) on the two sides of the cable connector.
- First pull off the plastic shell halves of the cable connector and take them apart by twisting them at the RF connector.
- The shielding is attached by a catch of the body on the RF connector side. Slightly bend and unlock the shielding by firmly pressing on the two slim sides and pull it off in the cable direction.

### Reassembly

- Push the shielding and lock it into the catch of the body.
- Insert the sensor into one of the shell halves and lock the second shell half on the RF connector side and close at the cable connector.
- Attach the shell halves to the body using two screws (170).

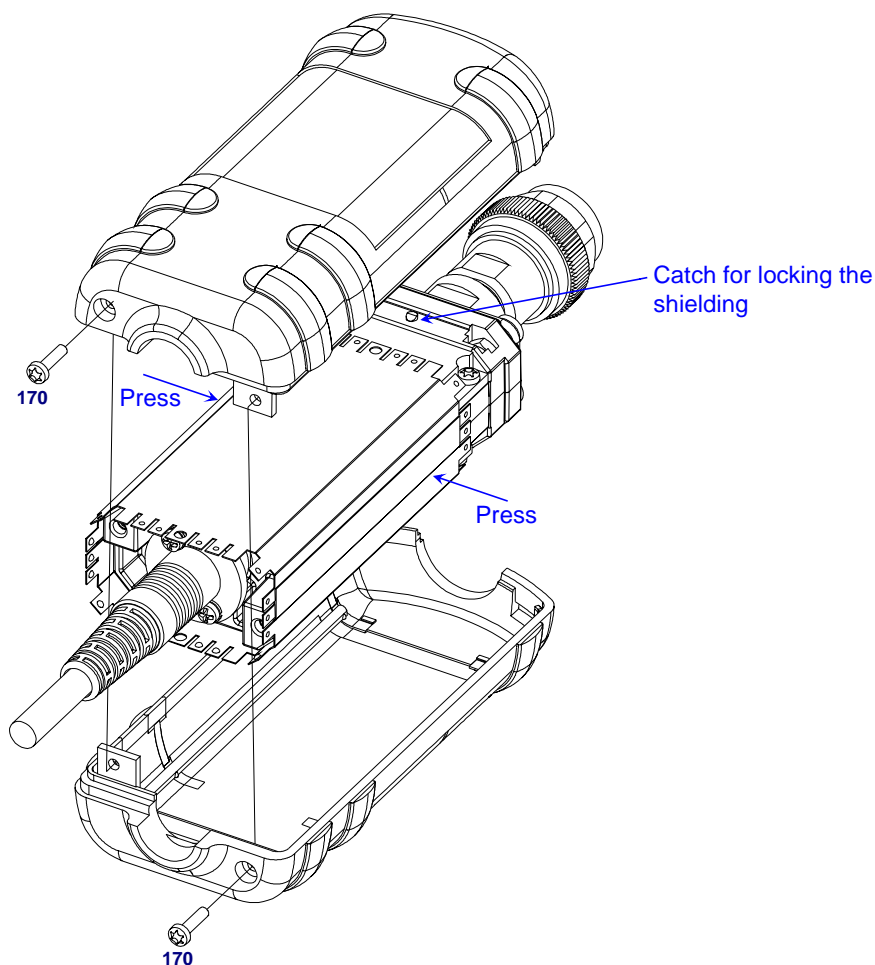


Fig. 3-3 Opening the sensor



**Caution:**

*Observe a torque of 29 Ncm for all screws.*

---



## Troubleshooting

Malfunctions may sometimes be due to simple reasons but may also result from defective components.

These troubleshooting instructions permit malfunctions or errors to be traced down to module level.

Module replacement and further diagnosis of errors or malfunctions should be carried out by our customer service. It is therefore recommended to send the unit to the nearest service center (see list of addresses at the beginning of this manual).



**Caution:**

*Prior to opening sensor and replacing modules, disconnect sensor from base unit (R&S NRP) or USB adapters (R&S NRP-Z3 or R&S NRP-Z4).*

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## Overview of Errors, Causes and Corrective Steps

This section provides an overview of possible errors, their causes and corrective steps.

### Problems when plugging in the sensor or switching on the R&S NRP base unit

- **Error: The power sensor is not found (neither measured values nor error messages are displayed on the R&S NRP base unit).**

Troubleshooting instruction	Potential error source and further corrective steps
Unplug sensor from base unit and check male and female connector for damage.	Defective connection. <i>Replace the sensor cable and/or the connector in the R&amp;S NRP.</i>
⇓	
Check whether the error also occurs on another base unit or in another channel.	Error source within base unit. <i>Refer to chapter 3 of the R&amp;S NRP service manual for detailed troubleshooting.</i>
	Error source within sensor. Open sensor and check connection of sensor cable W1 with digital board. <i>Exchange sensor cable.</i> <i>Send sensor in for repair (digital board possibly defective).</i>

- **Error: The R&S NRP base unit has detected an error (pop-up window contains error message, e.g. *Sensor communication error*).**

Troubleshooting instruction	Potential error source and further corrective steps
⇓	
Load current firmware into sensor and base unit according to section 4.	Base unit and sensor cannot communicate with each other. The firmware versions may not be compatible.  <i>If updated firmware does not correct problem, perform the same measures as described above (sensor is not found).</i>

- Error: The power sensor has detected an error (*HW Error* displayed at extreme right of title bar).

Troubleshooting instruction	Potential error source and further corrective steps
<p style="text-align: center;">⇓</p> <p>Check whether error also occurs on a different base unit.</p>	<p>The sensor detected an error during selftest or during communication (hardware defect or defective voltage supply).</p> <p>Error source within base unit. <i>Refer to chapter 3 of the R&amp;S NRP service manual for detailed troubleshooting.</i></p> <p>Error source within sensor. <i>Send sensor in for repair (analog board or digital board is defective).</i></p>

### Problems during measurement

- Error: Measured power readings are erroneous.

Troubleshooting instruction	Potential error source and further corrective steps
<p>Perform performance test or selftest according to section 1.</p>	<p>Sensor was overloaded: indicated by very poor matching and/or errors in measurement path 1. <i>Send sensor in for repair (microwave detector is defective).</i></p> <p>Other parts of sensor hardware are defective. <i>Send sensor in for repair (microwave detector or analog board is defective).</i></p> <p>Sensor hardware is probably ok since test limits are only slightly exceeded. <i>Perform update of calibration factors in data memory of sensor according to section 2.</i></p>

## 4 Firmware Update/Installation of Options

Chapter 4 provides information on the software update and the installation of options. Descriptions enclosed with the software update or options can be filed here.

### Installation of New R&S NRP-Z11/-Z21 Software

Use the Firmware Update program module to load new firmware for the Power Sensors R&S NRP-Z11 and NRP-Z21. The module is part of the R&S NRP Toolkit that is supplied on a CD-ROM together with the power sensors and enables you to update the boot loader and the application firmware.

The current firmware versions can be downloaded from the R&S homepage on the Internet, since the CD-ROM accompanying the power sensors contains the firmware status at the time of delivery.

### Hardware and software requirements

The system requirements for a firmware update are the same as for the operation of the power sensor on a PC (an update via the power meter is not possible):

- PC with free USB port.
- USB Interface Adapter R&S NRP-Z3 or R&S NRP-Z4.
- Operating system Windows™ 98, Windows™ ME, Windows™ 2000, or Windows™ XP.
- **The R&S NRP Toolkit software must already be installed on your PC.**
- One of the following files must be selected (depending on the software component to be updated):
  - <Type>\_Sensor<Version Number>.nrp      Application
  - Bootloader\_<Version Number>.nrp,      Boot loader

The files are available in the \software\firmware\sensors directory of the CD-ROM.

## **Preparation**

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- Connect the R&S NRP power sensor to the PC using one of the two USB interface adapters.
- If a second R&S NRP-Z power sensor or an R&S NRP is connected to the PC, unplug these devices from the PC.
- Shortly afterwards, the PC should have identified the new USB hardware and assigned the appropriate driver from the **R&S NRP Toolkit** to the power sensor (brief message in a small window).



*If you forgot to install the R&S NRP Toolkit beforehand, Windows will try in vain to find a USB driver for the power sensor. If this happens, the R&S NRP-Zxx is highlighted by a yellow exclamation mark in the Windows device manager. In this case, proceed as follows:*

- *Abort the dialog for driver installation.*
  - *Install the R&S NRP Toolkit from the CD-ROM.  
Then manually assign the USB driver from the toolkit to the power sensor.*
  - *Go to Control Panel – Add/Remove Hardware and start the hardware assistant to search for new components.*
  - *Mark the R&S NRP-Zxx in the list of hardware components and complete the driver installation.*
  - *Unplug the power sensor and reconnect it.*
-

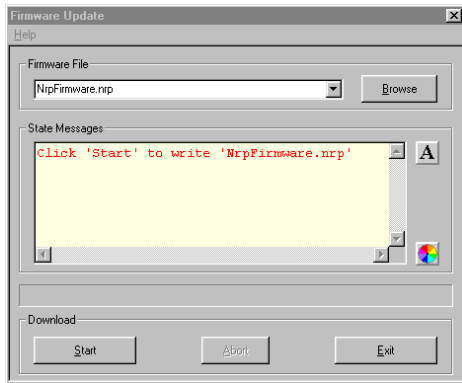
## Updating the application firmware



The update can be started as follows:

- Either double-click the icon of the update file named <Type>\_Messkopf\_<Version Number>.nrp
- Or start **NRP Toolkit – Firmware Update** from the Windows Start menu.

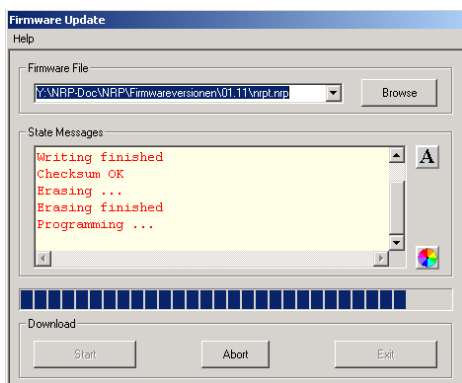
The dialog box on the left is displayed next.



- If the update was started via the Windows Start menu, enter the file name of the application firmware in the **Firmware File** box (or search for the name by using the **Browse** button).
- Click the **Start** button to start the file transfer, which is performed automatically.

- Observe the following:

- Do not disconnect the power sensor from the PC.
- Neither connect nor disconnect the power supply for the R&S NRP-Z3 adapter.
- Exit the Firmware Update program only after it has been completely executed.



- During the update, the State Messages box informs you of the progress. The update has been completed successfully if the message 'Device <Type Designation><Serial Number> is active' appears.
- You can then use the power sensor for measuring.

### Potential problems

- Error in the compatibility and consistency checks.

In this case, the update is aborted and an error message is output.

- Unplug the power sensor, reconnect it and start the update again.



## Updating the boot loader

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Bootloader\_00\_20.  
nrp



The boot loader update is similar to the update of the application firmware (see above).

- Instead of the application, however, you must load the new boot loader named

Bootloader\_<Version Number>.nrp

Strictly observe the warnings under "Updating the application firmware", since the destruction of the boot loader will generally require a repair of the power sensor.

### Potential problems

- The power sensor cannot be accessed after the update (error message).
  - Exit the Firmware Update program, unplug the power sensor from the PC and reconnect it. The power sensor is now ready for operation.
-

## 5 Documents

This section provides information for ordering spare parts and contains the relevant documents for the Rohde & Schwarz Power Sensors R&S NRP-Z11 and R&S NRP-Z21.

### Shipping of Instrument and Ordering of Spare Parts

Please contact your Rohde & Schwarz support center or our spare parts express service if you need to request service, repair your equipment, or order spare parts and modules.

The list of Rohde & Schwarz representatives and the address of our spare parts express service are provided in the front section of this service manual.

You will need to provide the following information in order for us to respond to your inquiries quickly and accurately and to determine whether the warranty for your instrument is still valid:

- Instrument model
- Serial number
- Detailed error description in case of repair
- Contact partner for checkbacks

### Shipping of Instrument

When shipping the instrument, be sure to provide sufficient mechanical and anti-static protection:

- Repack the instrument as it was originally packed. The antistatic packing foil prevents unintentional electrostatic charging from occurring.
- If you do not use the original packaging, include sufficient padding to prevent the instrument from slipping inside the package. Wrap antistatic packing foil around the instrument to protect it from electrostatic charging.

### Ordering Spare Parts

To deliver replacement parts promptly and correctly, we need the following information:

- R&S stock number (refer to the spare part lists in this section)
- Designation
- Number of units
- Instrument type for the replacement part
- Contact person for possible questions

The R&S stock number to be used when ordering replacement parts and modules as well as power cables can be found further below.

## **Ordering Replacement Sensors**

Rohde & Schwarz maintains a replacement program for a number of power sensors. Within this program, it is possible to provide a fully operational power sensor to replace a defective one at short notice and at a fixed price. Please note that replacement sensors are used equipment but are always tested. They are therefore equivalent to new sensors even though they may exhibit slight signs of use. If required, the delivery of replacement sensors can include a new calibration. If interested, please contact your nearest Rohde & Schwarz office.



## Spare Parts

The R&S stock numbers necessary for ordering replacement parts and modules can be found in the spare part lists provided below.

### List of R&S NRP-Z11/-Z21 Spare Parts

The following table lists available spare parts together with their R&S stock numbers.

Item No.	Designation	Electrical identification	Stock No.
20	ANALOG BOARD	A2	**)
40	POWER SENSOR CABLE	W1	1137.7141.02
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 *)
80	DIGITAL BOARD	A1	**)
90	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 *)
100	18 GHZ DETECTOR (NRP-Z21)	A3	**)
101	8 GHZ DETECTOR (NRP-Z11)	A3	**)
150	SHIELDING		1137.6068.00 *)
160	SENSOR HOUSING		1137.6022.00
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 *)
180	LABEL 1 R&S NRP-Z11		1138.3033.00
190	LABEL 2 R&S NRP-Z11		1138.3040.00
200	LABEL 1 R&S NRP-Z21		1137.6039.00
210	LABEL 2 R&S NRP-Z21		1137.6045.00

**Note:** The reference can be found in the drawings 3-3 and 3-4 in Section 3.

\*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.

\*\*\*) Spare part not available; to be replaced only by Rohde & Schwarz Central Service.