ROHDE&SCHWARZ

Test and Measurement
Division

Manual

Thermal Power Sensor

R&S® NRP-Z51

DC to 18 GHz / 1 µW to 100 mW

1138.0005.02

R&S® NRP-Z55

DC to 40 GHz / 1 µW to 100 mW

1138.2008.02

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Technical Information

Power Sensors R&S NRP-Z51, -Z55

Thermoelectric accuracy at its best

The new power sensors for the frequency ranges DC to 18 GHz (R&S NRP-Z51) and DC to 40 GHz (R&S NRP-Z55) for the first time combine the thermoelectric test cell with a complete power meter. The sensors feature not only all the advantages of the thermal measuring principle but also a further increase in accuracy since the influence of the base unit is eliminated; they also offer a continuous measurement range from 1 µW to 100 mW without range switching, Γcorrection to reduce matching errors and numerous other assets. The DC-coupled thermal test cell of the predecessor models R&S NRV-Z51 and R&S NRV-Z55 was adopted, allowing measurements starting at 0 Hz, plus reference to a low-frequency or DC standard. Like the other sensors of this instrument family, the new sensors can be operated via the R&S NRP base unit or a PC with a USB interface. A virtual user interface is part of the equipment supplied to enable operation from a PC.

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Preliminary

Specifications

(data above 18 GHz apply to R&S NRP-Z55 only)

Bold: Parameter 100% tested
Italics: Uncertainties calculated from the test assembly specifications and the modelled behaviour of the sensor.
Normal: Compliance with specifications is ensured by the design or derived from the measurement of related parameters

Sensor type		Thermoelectric sensor	
Measurand		Average power of incident wave average power of source into 50 Ω [1])	
Frequency range		DC to 18 GHz (R&S NRP-Z51) DC to 40 GHz (R&S NRP-Z55)	
Matching (SWR)	DC to 2.4 GHz > 2.4 GHz to 12.4 GHz > 12.4 GHz to 18.0 GHz > 18.0 GHz to 26.5 GHz > 26.5 GHz to 40.0 GHz	< **1.10** < **1.15** < **1.20** < **1.25** < **1.30**	
RF connector		N (male) for R&S NRP-Z51 2.92 mm (male) for R&S NRP-Z55	
Power measurement range		1 µW to 100 mW (-30 dBm to +20 dBm) cont., without subranges	
Max. power	Average Pulse energy	0.3 W (+25 dBm) continuous 10 Wµs	
Display noise [14)]		< 30 nW (20 nW typ.)	
Zero offset [17)]		< 50 nW (33 nW typ.)	
Zero drift [18)]		< 20 nW	
Linearity uncertainty [*)]		< **0.02 dB**	
Calibration uncertainty [**)] at (20 to 25°C)		**R&S NRP-Z51**	**R&S NRP-Z55**
	10 MHz to < 100 MHz	*0.047 dB*	*0.053 dB*
	100 MHz to 4 GHz	*0.057 dB*	*0.065 dB*
	> 4 GHz to 8 GHz	*0.071 dB*	*0.077 dB*
	> 8 GHz to 12.4 GHz	*0.076 dB*	*0.084 dB*
	> 12.4 GHz to 18 GHz	*0.098 dB*	*0.104 dB*
	> 18.0 GHz to 26.5 GHz		*0.086 dB*
	> 18.0 GHz to 30.0 GHz		*0.100 dB*
	> 30.0 GHz to 35.0 GHz		*0.112 dB*
	> 35.0 GHz to 40.0 GHz		*0.105 dB*
Temperature effect		< 0.004 dB/K (0.001 dB/K typ.)	

Uncertainty for absolute power measurements [***)] from -13 dBm to 20 dBm		**R&S NRP-Z51**	20°C to 25°C	15°C to 35°C	0°C to 50°C
	10 MHz to < 100 MHz		*0.052 dB*	*0.057 dB*	*0.075 dB*
	100 MHz to 4 GHz		*0.061 dB*	*0.066 dB*	*0.082 dB*
	> 4 GHz to 8 GHz		*0.074 dB*	*0.078 dB*	*0.092 dB*
	> 8 GHz to 12.4 GHz		*0.078 dB*	*0.082 dB*	*0.095 dB*
	> 12.4 GHz to 18 GHz		*0.100 dB*	*0.102 dB*	*0.113 dB*
		R&S NRP-Z55	20°C to 25°C	15°C to 35°C	0°C to 50°C
	10 MHz to < 100 MHz		*0.057 dB*	*0.062 dB*	*0.079 dB*
	100 MHz to 4 GHz		*0.068 dB*	*0.072 dB*	*0.087 dB*
	> 4 GHz to 8 GHz		*0.080 dB*	*0.083 dB*	*0.096 dB*
	> 8 GHz to 12.4 GHz		*0.084 dB*	*0.087 dB*	*0.100 dB*
	> 12.4 GHz to 18 GHz		*0.106 dB*	*0.108 dB*	*0.119 dB*
	> 18.0 GHz to 26.5 GHz		*0.092 dB*	*0.095 dB*	*0.106 dB*
	> 18.0 GHz to 30.0 GHz		*0.102 dB*	*0.104 dB*	*0.115 dB*
	> 30.0 GHz to 35.0 GHz		*0.114 dB*	*0.116 dB*	*0.126 dB*
	> 35.0 GHz to 40.0 GHz		*0.108 dB*	*0.110 dB*	*0.1203 dB*

Measurement window [7)]	Duration	2 × (1 ms to 300 ms)
	Shape	rectangular (integrating behaviour) Von Hann (smoothing filter, for efficient suppression of result variations due to modulation [26)])
Measurement time [27)]		N × (duration of measurement window + 0.5 ms) + t_z t_z : < 82 ms
Zeroing (duration)	Depends on setting of averaging filter	
	AUTO ON	4 s
	AUTO OFF Integration time [16)] < 4 s 4 s...16 s > 16 s	 4 s integration time [16)] 16 s
Averaging filter	Modes	AUTO OFF (fixed averaging factor) AUTO ON (continuously auto-adapted) AUTO ONCE (automatically fixed once)
	Normal operating mode [23)]	setting of filter depends on power to be measured and resolution
	Resolution	1 (1 dB), 2 (0.1 dB), 3 (0.01 dB), 4 (0.001 dB)
	Fixed Noise operating mode	filter set to specified noise content
	Noise content Max. measurement time [24)]	0.0001 dB to 1 dB 0.01 s to 1000 s
	Averaging factor N	1 to 2^{16} (number of averaged measurement windows)
	Result output	
	Moving Average	continuous with every newly evaluated measurement window (e.g. in case of manual operation via R&S NRP)
	Repeat	only final result (e.g. in case of remote control of R&S NRP)
Duty cycle correction [8)]		0.001 % to 99.999 %

Capacity of measurement buffer [9)]		1 to 1024 results
Triggering	Source	Bus, External, Hold, Immediate, Internal
	Slope (external, internal)	pos./neg.
	Level Internal External	 -16 dBm to +20 dBm see specs of R&S NRP and USB Adapter R&S NRP-Z3
	Delay	0 s to +100 s
	Holdoff	0 s to 10 s
	Hysteresis	0 dB to 10 dB
Attenuation correction	Function	Correcting the measurement result by means of a fixed factor (dB offset)
	Range	-100.000 dB to +100.000 dB
S-parameter-correction	Function	taking into account a component connected ahead of the sensor by loading ist s-parameter data set into the sensor
	Number of frequencies Parameters	1 to 1000 s_{11}, s_{21}, s_{12} and s_{21} (in s2p format)
	Download	with R&S NRP Toolkit (supplied with sensor) via USB Adapter R&S NRP-Z3 or R&S NRP-Z4.
Γ correction	Function	reducing the influence of mismatched sources [29)]
	Parameters	magnitude and phase of reflection coefficient of source
	Download	see under S-parameter correction
Frequency response correction	Function	taking into account the calibration factors relevant for the test frequency
	Parameter	Carrier frequency (center frequency)
	Permissible deviation from actual value	100 MHz (0.1 × f below 1GHz) for specified measurement uncertainty
Interface to host	Power supply	+5 V / 100 mA typ. (USB Low-power device)
	Remote control	as a USB device (function) in full-speed mode, compatible with USB 1.0/1.1/2.0 specifications
	Trigger input	differential (0 / +3.3 V)
Dimensions (W × H × L)		48 mm × 31 mm × 170 mm length incl. connecting cable: approx. 1.6 m
Weight		< 0.3 kg

*) For relative measurements referenced to 0 dBm.

**) Expanded uncertainty (k=2) for absolute power measurements at the calibration level (0 dBm) and the calibration frequencies (10 MHz, 50 MHz, 100 MHz; from 500 MHz to 18 GHz in increments of 500 MHz). Specifications include zero offset and display noise (up to a 2 σ value of 0.004 dB).

***) Includes the effects of calibration uncertainty, linearity, zero offset, temperature and display noise (up to a value of 0.004 dB). For power levels below -13 dBm the effect of zero set must be calculated separately.

General specifications

see the R&S NRP data sheet (PD 0757.7023.21), sensors R&S NRP-Z11/-Z21.

Accessories and numerical footnotes

see the R&S NRP data sheet (PD 0757.7023.21)

Ordering information

Description	Type	Order No.
Power Sensor 1 µW to 100 mW; DC to 18 GHz	R&S NRP-Z51	1138.0005.02
Power Sensor 1 µW to 100 mW; DC to 40 GHz	R&S NRP-Z55	1138.2008.02

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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. 1-3 is a schematic of the measurement setup. The order in which the cables are connected is not critical.

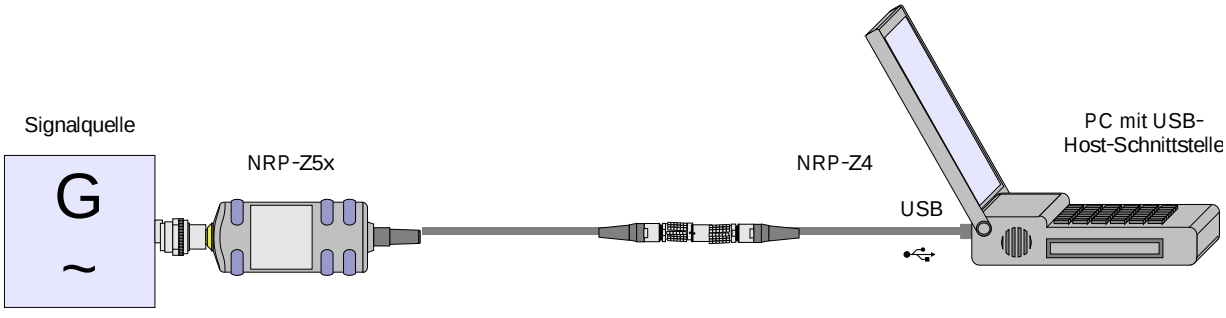


Fig. 1-3 Configuration with Passive USB Adapter R&S NRP-Z4

Connecting the sensor to the DUT

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

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).

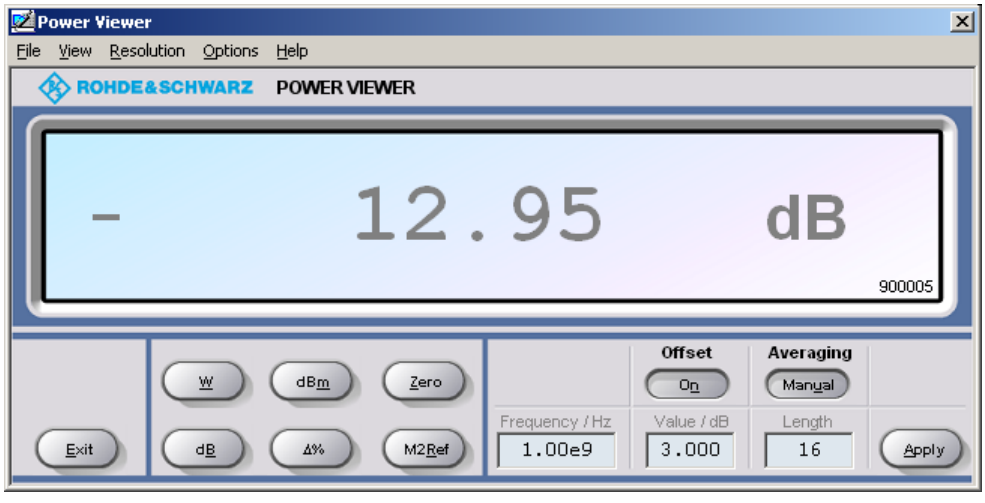


Fig. 2-1 **Power Viewer –** virtual power meter

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 **Offset/dB** entry field has a grey background.	Alt + N
Averaging Man/Auto	Turns auto-averaging on or off. When auto-averaging is on, the **Length** entry field has a grey background; the current averaging factor is displayed.	Alt + T
Apply	Accepts edited numerical values in the **Frequency/Hz**, **Value/dB** and **Length** entry fields and transfers them to the sensor.	Alt + A or Enter key

Table 2-2 Virtual power meter entry fields

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

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

Menus

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

File

Start Log ...

Opens a file-selection dialog to specify the path and name of the log file. Clicking the **Save** button starts the recording. All displayed values are written line-by-line to the log file with the date (format: YY/MM/DD) and time (format: hh:mm:ss.ms). Example:
`-22.51 dBm (03/02/25 15:37:25.310)`

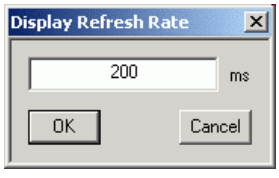
Stop Log

Ends the log-file recording.

View

Display Refresh Rate

Opens a dialog box to adjust the display refresh rate. The time in milliseconds between two refresh operations is entered. The default setting is 200 ms.



Colours

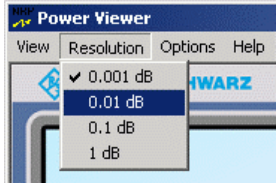
Result
Unit
Edit
Button

Opens a dialog box to select the background colour for

- the result,
- the unit,
- the text in the number fields or
- the key labelling.

Resolution

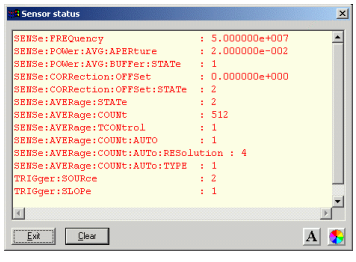
For setting the result resolution. If auto-averaging has been selected, a higher resolution leads to a greater averaging factor, which means a longer result settling time.



Options

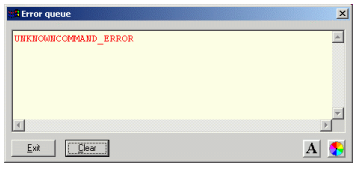
Read Sensor Status ...

Reads the current sensor status. A parameter list is output.



Read Error Queue ...

Reads the error queue. All the error messages that have been issued since the last call are read line-by-line. A tick before this menu entry indicates that an error has occurred.



	Simulation ...	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.