ROHDE&SCHWARZ

Test and Measurement
Division

Manual

Average Power Sensor

R&S® NRP-Z22

10 MHz to 18 GHz / 2 nW to 1.5 W

1137.7506.02

R&S® NRP-Z23

10 MHz to 18 GHz / 20 nW to 15 W

1137.8002.02

R&S® NRP-Z24

10 MHz to 18 GHz / 60 nW to 30 W

1137.8502.02

Printed in the Federal
Republic of Germany

Dear Customer,

Operation of Power Sensors R&S NRP-Z22/-Z23/-Z24 from R&S NRP base unit

The power sensors shipped with this manual have firmware revision ***02.20*** or higher. For operation from an R&S NRP base unit, all software components within the base unit must 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.

Tabbed Divider Overview

Data Sheet

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

Tabbed Divider

Technical Information

Power Sensors R&S NRP-Z22, -Z23, -Z24

The right choice for medium-power applications

These power sensors with nominal powers of 2 W (R&S NRP-Z22), 15 W (R&S NRP-Z23) and 30 W (R&S NRP-Z24) expand the measurement capabilities of the R&S NRP family in the frequency range from 10 MHz to 18 GHz. They allow direct power measurement at the output of power amplifiers, radio equipment or digital mobile radio base stations. Tried-and-tested precision attenuators ahead of the power sensor ensure high measurement accuracy and excellent stability of the electrical characteristics. The new products are of great benefit, since they provide full accuracy even if they are used without an attenuator being connected. In this case, they behave like a standard R&S NRP-Z21 sensor with a nominal power of 200 mW and a lower measurement threshold of 200 pW (-67 dBm). The full functionality of this sensor type – including 90 dB dynamic range, suitability for modulated signals, time gating, etc – is available in every operating mode, i.e. also with adapted attenuator.

Preliminary

ROHDE & SCHWARZ

Specifications

Specifications apply when the power sensor is operated together with the supplied power attenuator (pad). Please refer to the specifications of the R&S NRP-Z21 in the R&S NRP data sheet (PD 0757.7023.21) when operating the power sensor alone.

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

Power Sensor R&S NRP-Z22

Frequency range		10 MHz to 18 GHz
Matching (SWR)	10 MHz to 2.4 GHz	< **1.14**
	> 2.4 GHz to 8.0 GHz	< **1.20**
	> 8.0 GHz to 12.4 GHz	< **1.25**
	> 12.4 GHz to 18 GHz	< **1.30**
Power measurement range	Continuous Average	2 nW to 2 W (-57 dBm to +33 dBm)
	Burst Average	2 µW to 2 W (-27 dBm to +33 dBm)
	Timeslot	7 nW to 2 W (-52 dBm to +33 dBm)[3]
	Scope	100 nW to 2 W (-40 dBm to +33 dBm)[4]
Max. power	Average	3 W (+35 dBm) continuous (see diagram)
	Peak envelope power	10 W (+40 dBm) for max. 10 µs
Measurement subranges	Path 1	-57 dBm to - 4 dBm
	Path 2	-37 dBm to +16 dBm
	Path 3	-17 dBm to +33 dBm
Transition ranges	With automatic path selection, user def'd crossover[5] set to 0 dB	(- 9±1.5) dBm to (- 3±1.5) dBm (+11±1.5) dBm to (+17±1.5) dBm
Display noise[14]	Path 1	< 0.8 nW (0.4 nW typ.)
	Path 2	< 80 nW (40 nW typ.)
	Path 3	< 8 µW (4 µW typ.)
Display noise, relative [15]	Measurement window 2 × 100 µs, without averaging	< 0.160 dB (0.1 dB typ.)
	Measurement window 2 × 20 ms, averaging factor 32 (measurement time approx. 1 s)	< 0.002 dB (0.001 dB typ.)
Zero offset[17]	Path 1	< 1.3 nW (0.7 nW typ.)
	Path 2	< 0.12 µW (60 nW typ.)
	Path 3	< 12 µW (6 µW typ.)
Zero drift[18]	Path 1	< 0.4 nW
	Path 2	< 40 nW
	Path 3	< 4 µW
Triggering	Source	Bus, External, Hold, Immediate, Internal
	Slope (external, internal)	pos./neg.
	Level	
	Internal	-30 dBm to +33 dBm
	External	See specs for R&S NRP and USB Adapter R&S NRP-Z3
	Delay	-5 ms to +100 s
	Holdoff	0 s to 10 s
	Hysteresis	0 dB to 10 dB

Power Sensor R&S NRP-Z22 (continued)

Uncertainty for absolute power measurements 31) in dB

10 MHz to < 100 MHz				100 MHz to < 4 GHz				
0.180	0.237	0.281	0.316	0.186	0.242	0.285	0.320	(0 to 35/40/50)°C
0.096	0.124	0.149	0.170	0.106	0.133	0.157	0.176	(15 to 35) °C
0.079	0.088	0.104	0.119	0.085	0.098	0.113	0.128	(20 to 25) °C
-30 37) to +20	to +30	to +32	to +33	-30 37) to +20	to +30	to +32	to +33	dBm

4 GHz to < 12.4 GHz				12.4 GHz to 18 GHz				
0.203	0.255	0.296	0.330	0.223	0.271	0.310	0.343	(0 to 35/40/50)°C
0.133	0.156	0.176	0.194	0.163	0.182	0.199	0.215	(15 to 35) °C
0.116	0.125	0.137	0.151	0.147	0.155	0.165	0.178	(20 to 25) °C
-30 37) to +20	to +30	to +32	to +33	-30 37) to +20	to +30	to +32	to +33	dBm

Uncertainty for relative power measurements 32), 33), 36) in dB

	10 MHz to < 100 MHz				100 MHz to 4 GHz			
+33	0.286	0.298	0.031	+33	0.272	0.289	0.041	(0 to 50) °C
	0.108	0.109	0.022		0.112	0.113	0.032	(15 to 35) °C
+18	0.052	0.045	0.022	+18	0.060	0.053	0.031	(20 to 25) °C
+10	0.283	0.031	0.298	+10	0.268	0.032	0.289	(0 to 50) °C
	0.108	0.022	0.109		0.108	0.022	0.113	(15 to 35) °C
-2	0.051	0.022	0.045	-2	0.054	0.022	0.053	(20 to 25) °C
-10	0.023	0.283	0.286	-10	0.024	0.268	0.272	(0 to 50) °C
	0.022	0.108	0.108		0.022	0.108	0.112	(15 to 35) °C
-30 37)	0.022	0.051	0.052	-30 37)	0.022	0.054	0.060	(20 to 25) °C
dBm -30 37)	-10 / -2	+10 / +18	+33	dBm -30 37)	-10 / -2	+10 / +18	+33	

	> 4 GHz to 12.4 GHz				>12.4 GHz to 18 GHz			
+33	0.284	0.299	0.066	+33	0.300	0.310	0.088	(0 to 50) °C
	0.131	0.130	0.061		0.152	0.148	0.084	(15 to 35) °C
+18	0.087	0.081	0.060	+18	0.112	0.106	0.083	(20 to 25) °C
+10	0.277	0.037	0.299	+10	0.288	0.043	0.310	(0 to 50) °C
	0.118	0.027	0.130		0.131	0.035	0.148	(15 to 35) °C
-2	0.068	0.025	0.081	-2	0.082	0.033	0.106	(20 to 25) °C
-10	0.024	0.277	0.284	-10	0.024	0.288	0.300	(0 to 50) °C
	0.022	0.118	0.131		0.022	0.131	0.152	(15 to 35) °C
-30 37)	0.022	0.068	0.087	-30 37)	0.022	0.082	0.112	(20 to 25) °C
dBm -30 37)	-10 / -2	+10 / +18	+33	dBm -30 37)	-10 / -2	+10 / +18	+33	

Power Sensor R&S NRP-Z23

Frequency range		10 MHz to 18 GHz
Matching (SWR)	10 MHz to 2.4 GHz >2.4 GHz to 8.0 GHz >8.0 GHz to 12.4 GHz >12.4 GHz to 18 GHz	<**1.14** <**1.25** <**1.30** <**1.41**
Power measurement range	Continuous Average Burst Average Timeslot Scope	20 nW to 15 W (-47 dBm to +42 dBm) 20 µW to 15 W (-17 dBm to +42 dBm) 70 nW to 15 W (-42 dBm to +42 dBm)3) 1 µW to 15 W (-30 dBm to +42 dBm)4)
Max. power	Average Peak envelope power	18 W (+42.5 dBm) continuous (see diagram) 100 W (+50 dBm) for max. 10 µs
Measurement subranges	Path 1 Path 2 Path 3	-47 dBm to + 6 dBm -27 dBm to + 26 dBm - 7 dBm to + 42 dBm
Transition ranges	With automatic path selection, user def'd crossover5) set to 0 dB	(+ 1±1.75) dBm to (+ 7±1.75) dBm (+21±1.75) dBm to (+27±1.75) dBm
Display noise14)	Path 1 Path 2 Path 3	< 8 nW (4 nW typ.) < 0.8 µW (0.4 µW typ.) < 80 µW (40 µW typ.)
Display noise, relative 15)	Measurement window 2 × 100 µs, without averaging Measurement window 2 × 20 ms, averaging factor 32 (measurement time approx. 1 s)	< 0.160 dB (0.1 dB typ.) < 0.002 dB (0.001 dB typ.)
Zero offset17)	Path 1 Path 2 Path 3	< 13 nW (7 nW typ.) < 1.3 µW (0.6 µW typ.) < 0.13 mW (60 µW typ.)
Zero drift18)	Path 1 Path 2 Path 3	< 5 nW < 0.4 µW < 40 µW
Triggering	Source	Bus, External, Hold, Immediate, Internal
	Slope (external, internal)	pos./neg.
	Level	
	Internal	-19 dBm to +42 dBm
	External	See specs for R&S NRP and USB Adapter R&S NRP-Z3
	Delay	-5 ms to +100 s
	Holdoff	0 s to 10 s
	Hysteresis	0 dB to 10 dB

Power Sensor R&S NRP-Z23 (continued)

Uncertainty for absolute power measurements[31] in dB

10 MHz to < 100 MHz				100 MHz to < 4 GHz				
0.194 0.096 0.078	0.203 0.106 0.081	0.227 0.137 0.111	0.257 0.175 0.149	0.187 0.105 0.087	0.197 0.115 0.094	0.222 0.144 0.120	0.253 0.181 0.156	(0 to 50) °C (15 to 35) °C (20 to 25) °C
-20[37] to +30	to +36	to +40	to +42	-20[37] to +30	to +36	to +40	to +42	dBm

4 GHz to < 12.4 GHz				12.4 GHz to 18 GHz				
0.209 0.133 0.117	0.217 0.140 0.122	0.240 0.165 0.144	0.269 0.198 0.175	0.238 0.166 0.151	0.245 0.172 0.155	0.266 0.193 0.172	0.292 0.221 0.199	(0 to 50) °C (15 to 35) °C (20 to 25) °C
-20[37] to +30	to +36	to +40	to +42	-20[37] to +30	to +36	to +40	to +42	dBm

Uncertainty for relative power measurements[32], [33], [36] in dB

10 MHz to < 100 MHz				100 MHz to 4 GHz				
+42 +28	0.226 0.084 0.046	0.229 0.080 0.044	0.027 0.022 0.022	+42 +28	0.209 0.088 0.055	0.218 0.085 0.047	0.038 0.032 0.031	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+20 +8	0.226 0.083 0.045	0.027 0.022 0.022	0.229 0.080 0.044	+20 +8	0.206 0.083 0.048	0.028 0.022 0.022	0.218 0.085 0.047	(0 to 50) °C (15 to 35) °C (20 to 25) °C
±0 -20[37]	0.023 0.022 0.022	0.226 0.083 0.045	0.226 0.084 0.046	±0 -20[37]	0.023 0.022 0.022	0.206 0.083 0.048	0.209 0.088 0.055	(0 to 50) °C (15 to 35) °C (20 to 25) °C
dBm -20[37]	±0 / +8	+20 / +28	+42	dBm -20[37]	±0 / +8	+20 / +28	+42	

> 4 GHz to 12.4 GHz				>12.4 GHz to 18 GHz				
+42 +28	0.224 0.111 0.084	0.231 0.106 0.077	0.064 0.061 0.060	+42 +28	0.244 0.135 0.110	0.245 0.128 0.102	0.086 0.084 0.083	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+20 +8	0.216 0.096 0.063	0.034 0.027 0.025	0.231 0.106 0.077	+20 +8	0.230 0.112 0.079	0.040 0.034 0.033	0.245 0.128 0.102	(0 to 50) °C (15 to 35) °C (20 to 25) °C
±0 -20[37]	0.024 0.022 0.022	0.216 0.096 0.063	0.224 0.111 0.084	±0 -20[37]	0.024 0.022 0.022	0.230 0.112 0.079	0.244 0.135 0.110	(0 to 50) °C (15 to 35) °C (20 to 25) °C
dBm -20[37]	±0 / +8	+20 / +28	+42	dBm -20[37]	±0 / +8	+20 / +28	+42	

Power Sensor R&S NRP-Z24

Frequency range		10 MHz to 18 GHz
Matching (SWR)	10 MHz to 2.4 GHz	<**1.14**
	>2.4 GHz to 8.0 GHz	<**1.25**
	>8.0 GHz to 12.4 GHz	<**1.30**
	>12.4 GHz to 18 GHz	<**1.41**
Power measurement range	Continuous Average	60 nW to 30 W (-42 dBm to +45 dBm)
	Burst Average	60 µW to 30 W (-12 dBm to +45 dBm)
	Timeslot	0.2 µW to 30 W (-37 dBm to +45 dBm)3)
	Scope	3 µW to 30 W (-25 dBm to +45 dBm)4)
Max. power	Average	36 W (+45.5 dBm) continuous (see diagram)
	Peak envelope power	300 W (+55 dBm) for max. 10 µs
Measurement subranges	Path 1	-42 dBm to +11 dBm
	Path 2	-22 dBm to +31 dBm
	Path 3	- 2 dBm to +45 dBm
Transition ranges	With automatic path selection, user def'd crossover5) set to 0 dB	(+ 6±2) dBm to (+12±2) dBm (+26±2) dBm to (+32±2) dBm
Display noise14)	Path 1	< 27 nW (13 nW typ.)
	Path 2	< 2.6 µW (1.2 µW typ.)
	Path 3	< 0.26 mW (0.12 mW typ.)
Display noise, relative 15)	Measurement window 2 × 100 µs, without averaging	< 0.160 dB (0.1 dB typ.)
	Measurement window 2 × 20 ms, averaging factor 32 (measurement time approx. 1 s)	< 0.002 dB (0.001 dB typ.)
Zero offset17)	Path 1	< 44 nW (20 nW typ.)
	Path 2	< 4.2 µW (2 µW typ.)
	Path 3	<0.42 mW (0.2 mW typ.)
Zero drift18)	Path 1	< 15 nW
	Path 2	< 1.3 µW
	Path 3	< 0.13 mW
Triggering	Source	Bus, External, Hold, Immediate, Internal
	Slope (external, internal)	pos./neg.
	Level	
	Internal	-14 dBm to +45 dBm
	External	See specs for R&S NRP and USB Adapter R&S NRP-Z3
	Delay	-5 ms to +100 s
	Holdoff	0 s to 10 s
	Hysteresis	0 dB to 10 dB

Power Sensor R&S NRP-Z24 (continued)

Uncertainty for absolute power measurements 31) in dB

10 MHz to < 100 MHz				100 MHz to < 4 GHz				
0.199	0.218	0.249	0.291	0.193	0.212	0.244	0.287	(0 to 50) °C
0.098	0.120	0.158	0.208	0.108	0.128	0.164	0.213	(15 to 35) °C
0.078	0.091	0.128	0.178	0.088	0.102	0.136	0.184	(20 to 25) °C
-15 37) to +33	to +40	to +43	to +45	-15 37) to +33	to +40	to +43	to +45	dBm

4 GHz to < 12.4 GHz				12.4 GHz to 18 GHz				
0.214	0.231	0.260	0.301	0.242	0.258	0.284	0.322	(0 to 50) °C
0.135	0.151	0.183	0.228	0.167	0.181	0.208	0.248	(15 to 35) °C
0.118	0.129	0.157	0.201	0.151	0.160	0.183	0.222	(20 to 25) °C
-15 37) to +33	to +40	to +43	to +45	-15 37) to +33	to +40	to +43	to +45	dBm

Uncertainty for relative power measurements 32), 33), 36) in dB

	10 MHz to < 100 MHz			
+45 +33	0.226 0.084 0.046	0.229 0.080 0.044	0.027 0.022 0.022	
+25 +13	0.226 0.083 0.045	0.027 0.022 0.022	0.229 0.080 0.044	
+5 -15 37)	0.023 0.022 0.022	0.226 0.083 0.045	0.226 0.084 0.046	
dBm	-15 37)	+5 / +13	+25 / +33	+45

	100 MHz to 4 GHz			
+45 +33	0.209 0.088 0.055	0.218 0.085 0.047	0.038 0.032 0.031	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+25 +13	0.206 0.083 0.048	0.028 0.022 0.022	0.218 0.085 0.047	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+5 -15 37)	0.023 0.022 0.022	0.206 0.083 0.048	0.209 0.088 0.055	(0 to 50) °C (15 to 35) °C (20 to 25) °C
dBm	-15 37)	+5 / +13	+25 / +33	+45

	> 4 GHz to 12.4 GHz			
+45 +33	0.224 0.111 0.084	0.231 0.106 0.077	0.064 0.061 0.060	
+25 +13	0.216 0.096 0.063	0.034 0.027 0.025	0.231 0.106 0.077	
+5 -15 37)	0.024 0.022 0.022	0.216 0.096 0.063	0.224 0.111 0.084	
dBm	-15 37)	+5 / +13	+25 / +33	+45

	>12.4 GHz to 18 GHz			
+45 +33	0.244 0.135 0.110	0.245 0.128 0.102	0.086 0.084 0.083	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+25 +13	0.230 0.112 0.079	0.040 0.034 0.033	0.245 0.128 0.102	(0 to 50) °C (15 to 35) °C (20 to 25) °C
+5 -15 37)	0.024 0.022 0.022	0.230 0.112 0.079	0.244 0.135 0.110	(0 to 50) °C (15 to 35) °C (20 to 25) °C
dBm	-15 37)	+5 / +13	+25 / +33	+45

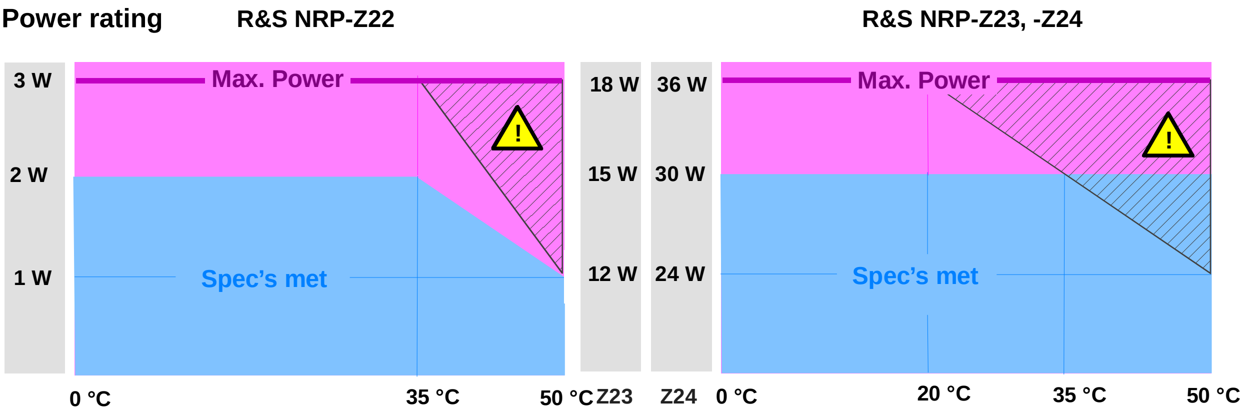
Additional characteristics of the R&S NRP-Z22/-Z23/-Z24

Sensor type		3-path diode sensor with preceding power attenuator		
Measurand		average power of incident wave average power of source into 50 Ω1)		
RF connector		N (male)		
Power attenuator	R&S NRP-Z22 R&S NRP-Z23 R&S NRP-Z24	10 dB 20 dB 25 dB		
Calibration uncertainty30) in dB (20 to 25) °C		Path 1	Path 2	Path 3
	0.01 GHz to < 0.1 GHz	*0.078*	*0.072*	*0.073*
	0.1 GHz to 4.0 GHz	*0.084*	*0.077*	*0.077*
	> 4 GHz to 12.4 GHz	*0.110*	*0.095*	*0.095*
	> 12.4 GHz to 18.0 GHz	*0.139*	*0.118*	*0.18*
Measurement functions	Stationary and periodically modulated signals	Continuous Average Burst Average Timeslot Scope		
	Non-recurring waveforms	Scope		
Continuous Average function Continuous measurement of average power	Measurement window7)	2 × (10 µs to 300 ms)		
	Duty cycle correction8)	0.001% to 100.00%		
	Smoothing	See under Measurement window		
	Capacity of measurement buffer9)	1 to 1024 results		
Burst Average function Measurement of average burst power with automatic detection of burst (trigger settings required)	Detectable burst width	20 µs to 100 ms		
	Minimum gap between bursts	10 µs		
	Dropout tolerance10)	0 ms to 3 ms		
	Exclusion periods11)			
	Exclude from Start	0 ms to 100 ms		
	Exclude from End	0 ms to 3 ms		
	Measurement window7)	2 × (burst width - Excl. from Start - Excl. from End)		
Timeslot function Measurement of average power in one or more equidistant, successive timeslots	Duration (nominal width)	10 µs to 100 ms		
	Number of timeslots	1 to 128 (26 in case of operation from R&S NRP basic unit)		
	Exclusion periods 11)			
	Excluded from Start	0 ms to 100 ms		
	Excluded from End	0 ms to 3 ms		
	Measurement window (per timeslot)7)	2 × (nom. width - Excl. from Start - Excl. from End)		
Scope function Measurement of power versus time	Modes	For recurring and non-recurring waveforms (single)		
	Measurement window Δ12)			
	Recurring	2 × (100 µs to 300 ms)		
	Non-recurring	100 µs to 300 ms		
	Number of measurement points M	1 to 1024		
	Resolution Δ / M	≥10 µs		
	Beginning of time window (referenced to trigger)	-5 ms to 100 s		

Dynamic behaviour of video path	Bandwidth	> 50 kHz (100 kHz) Values in ( ) for temp. range 15 °C to 35 °C
	Rise time 10% / 90%	< 8 µs (4 µs)
Sampling frequencies	Frequency 1 (default)	133.358 kHz
	Frequency 2 13)	119.467 kHz
Zeroing (duration)	Depends on setting of averaging filter	
	AUTO ON	4 s
	AUTO OFF	
	Integration time 16) < 4 s	4 s
	4 s to 16 s	Integration time 16)
	>16 s	16 s
Measurement error due to harmonics $n \times f_0$ of carrier frequency **19)** values in [ ]: typ. standard uncertainty	N = 3, 5, 7, ... 20) -30 dBc	<0.003 dB [0.0015 dB]
	-20 dBc	<0.010 dB [0.005 dB]
	-10 dBc	<0.040 dB [0.015 dB]
	N = 2, 4, 6, ... 20) -30 dBc	<0.001 dB [0.0003 dB]
	-20 dBc	<0.002 dB [0.001 dB]
	-10 dBc	<0.010 dB [0.003 dB]
Modulation influence 21) values in [ ]: User def'd crossover <-6 dB	General	measurement errors in subranges are proportional to power and depend on CCDF and modulation bandwidth of test signal
	WCDMA (3-GPP Test Model 1-64)	
	Worst case	-0.02 dB to +0.07 dB [-0.02 dB to +0.02 dB]
	Typical	-0.01 dB to +0.03 dB [-0.01 dB to +0.01 dB]
Averaging filter	Modes	AUTO OFF (fixed averaging factor) AUTO ON (continuously auto-adapted) AUTO ONCE (automatically fixed once)
	AUTO mode	
	Reference power	
	Continuous Average	non-averaged result in measurement window
	Burst Average	non-averaged result in measurement window
	Timeslot	non-averaged result in reference timeslot 25)
	Scope 22)	non-averaged result at reference point 25)
	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	0.0001 dB to 1 dB
	Max. measurement time 24)	0.01 s to 999 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)
Measurement window	Duration	as specified for the individual measurement functions
	Shape	rectangular (integrating behaviour; available for all measurement functions)
		Von Hann (smoothing filter, for efficient suppression of result variations due to modulation 26); only for Continuous Average function)

Measurement times[27]	Continuous Average	N × (duration of measurement window[7]+0.2ms) + t_z
	Buffered, without averaging	buffer size × (duration of measurement window[7] + 0.5 ms) + t_z
	Burst Average	(2 to 4) × N × burst period + t_z
	Timeslot, Scope	(2 to 4) × N × trigger period + t_z[28])
		t_z : <1.6 ms (0.9 ms on average)
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 **Note**: S-parameter correction is automatically switched on upon power-up of the sensor, taking into account the data of the supplied attenuator.	Function	Taking into account a component connected to the sensor input by loading its s-parameter data set into the sensor
	Number of frequencies	1 to 1000
	Parameters	s_{11}, s_{21}, s_{12} and s_{22} (in s2p format)
	Download	With R&S NRP tool kit (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	50 MHz (0.05 × f below 1 GHz) for specified measurement uncertainty
Interface to host	Power supply	+5 V / 200 mA typ. (USB high-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 x H x L	R&S NRP-Z22: 48 mm × 31 mm × 214 mm R&S NRP-Z23: 60 mm × 54 mm × 285 mm R&S NRP-Z24: 60 mm × 54 mm × 344 mm
		Length incl. connecting cable: approx. 1.6 m
Weight		R&S NRP-Z22: < 0.37 kg R&S NRP-Z23: < 0.48 kg R&S NRP-Z24: < 0.63 kg

Power rating

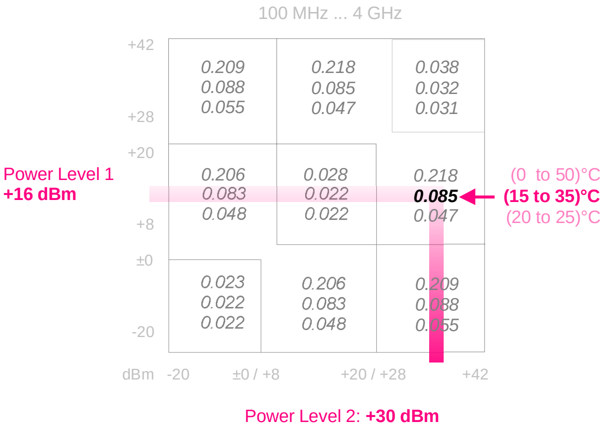


Hatched area: The maximum surface temperatures permitted to IEC 1010-1 are exceeded. Provide protection against inadvertent contacting or apply only short-term load to the sensor.

Footnotes

Please refer to the R&S NRP data sheet for footnotes not mentioned below. Please keep in mind that the power levels specified there are valid only for the power sensor section. Add +10 dB in the case of the R&S NRP-Z22, +20 dB in the case of the R&S NRP-Z23 or +25 dB in the case of the R&S NRP-Z24 to calculate the power incident on the pad preceding the sensor.

33) Reading the uncertainty for relative power measurements. The example shows a level step of approx. 14 dB (+16 dBm → +30 dBm) at 1.9 GHz and an ambient temperature of 28°C.



36) Specifications are based on the assumption that the measurements follow each other so fast (at intervals of not more than 10 s) that the temperature of the pad does not change significantly. With the R&S NRP-Z22, the average power shall not exceed 1 W to be compliant with accuracy specifications for relative power measurements.

37) For measurements at even lower levels the influence of zero offset and zero drift must be added to the specifications on an RSS basis. The same applies to noise exceeding a two-sigma value of 0.01 dB.

General specifications

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

Accessories

See the R&S NRP data sheet (PD 0757.7023.21).

Ordering information

Description	**Type**	**Order No.**
Power Sensors		
2 nW to 2 W; 10 MHz to 18 GHz	R&S NRP-Z22	1137.7506.02
20 nW to 15 W; 10 MHz to 18 GHz	R&S NRP-Z23	1137.8002.02
60 nW to 30 W; 10 MHz to 18 GHz	R&S NRP-Z24	1137.8502.02

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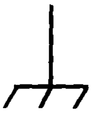
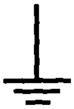
Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

	 32 kg						
Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.
15. Any additional safety instructions given in this manual are also to be observed.

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde & Schwarz quality management system is certified according to standards such as ISO 9001 and ISO 14001.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde & Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

ROHDE&SCHWARZ

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

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
NRP-Z22	1137.7506.02	Average Power Sensor
NRP-Z23	1137.8002.02	Average Power Sensor
NRP-Z24	1137.8502.02	Average Power Sensor
NRP-Z51	1138.0005.02	Thermal 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
Central Quality Management FS-QZ / Becker

Munich, 2003-06-30

Support Center

Telefon / Telephone: +49 (0)180 512 42 42

Fax: +49 89 41 29 137 77

E-mail: CustomerSupport@rohde-schwarz.com

Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen die Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr MEZ besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder E-Mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Um Ihr Gerät stets auf dem neuesten Stand zu halten, abonnieren Sie bitte Ihren persönlichen Newsletter unter

http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection.

Sie erhalten dann regelmäßig Informationen über Rohde & Schwarz-Produkte Ihrer Wahl, über Firmware-Erweiterungen, neue Teiber und Applikationsschriften.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00 CET.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

To keep your instrument always up to date, please subscribe to your personal newsletter at

http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection.

As a subscriber, you will receive information about your selection of Rohde & Schwarz products, about firmware extensions, new drivers and application notes on a regular basis.

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Contents

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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 base unit

Connecting the sensor to the R&S NRP base unit

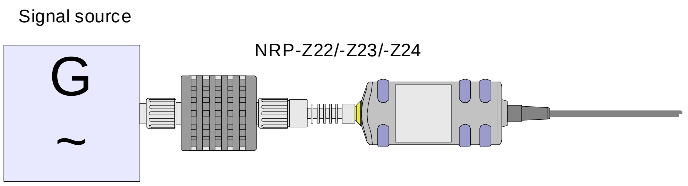
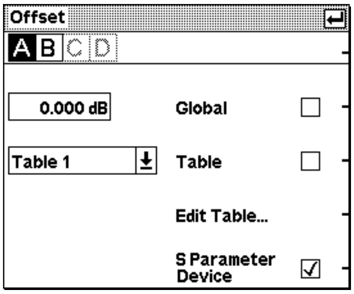
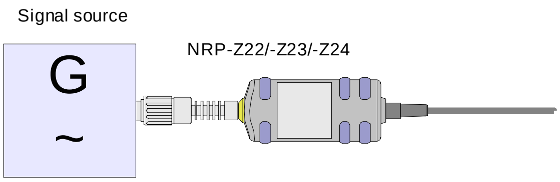
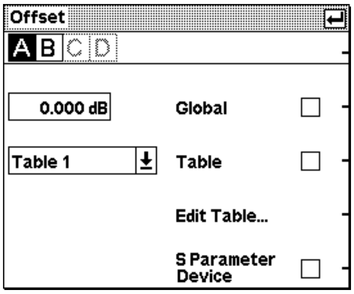
The sensor can be connected to the R&S NRP base unit when it is in operation. The interface connector must be inserted, red marking upwards, into one of the R&S NRP base unit's sensor connectors. When the sensor is connected, it is detected by the R&S NRP base unit and initialized.

Connecting the sensor to the DUT

The Sensor R&S NRP-Z22/-Z23/-Z24 is usually operated in combination with the attenuator supplied with the equipment. (Operation without attenuator or with another connected component is also possible, see Table 1-1 and part 3 of this user manual respectively.) Both the sensor and the attenuator are fitted with a male N connector for connection to all common female N connectors. 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). Connect first the sensor to the attenuator and then screw the male N connector of the attenuator on the DUT.

The test limits specified on the type label apply only if the supplied attenuator is used. For operation without attenuator, lower test limits apply (see data sheet).

Table 1-1 Sensor operating modes with corresponding settings in the Offset dialog

Sensor operation	**Setting in the Offset dialog**
when using the attenuator supplied in the delivery  	s-parameter correction activated (automatically after the R&S NRP is switched on or the sensor is plugged in)  0.000 dB Global ☐ Table 1 Table ☐ Edit Table... S Parameter Device ☑
without the attenuator  	s-parameter correction to be switched off (each time the R&S NRP is switched on or the sensor is plugged in)  0.000 dB Global ☐ Table 1 Table ☐ Edit Table... S Parameter Device ☐

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).

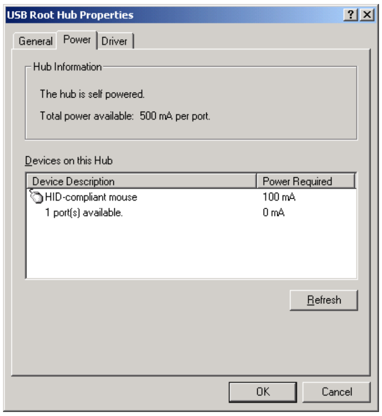
When you insert the CD-ROM supplied with the R&S NRP, the NRP Toolkit is automatically installed on your PC. The rest of the procedure is self-explanatory.

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.*



The hub is self powered.

Total power available: 500 mA per port.

Device Description	Power Required
HID-compliant mouse	100 mA
1 port(s) available.	0 mA

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

Fig. 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.

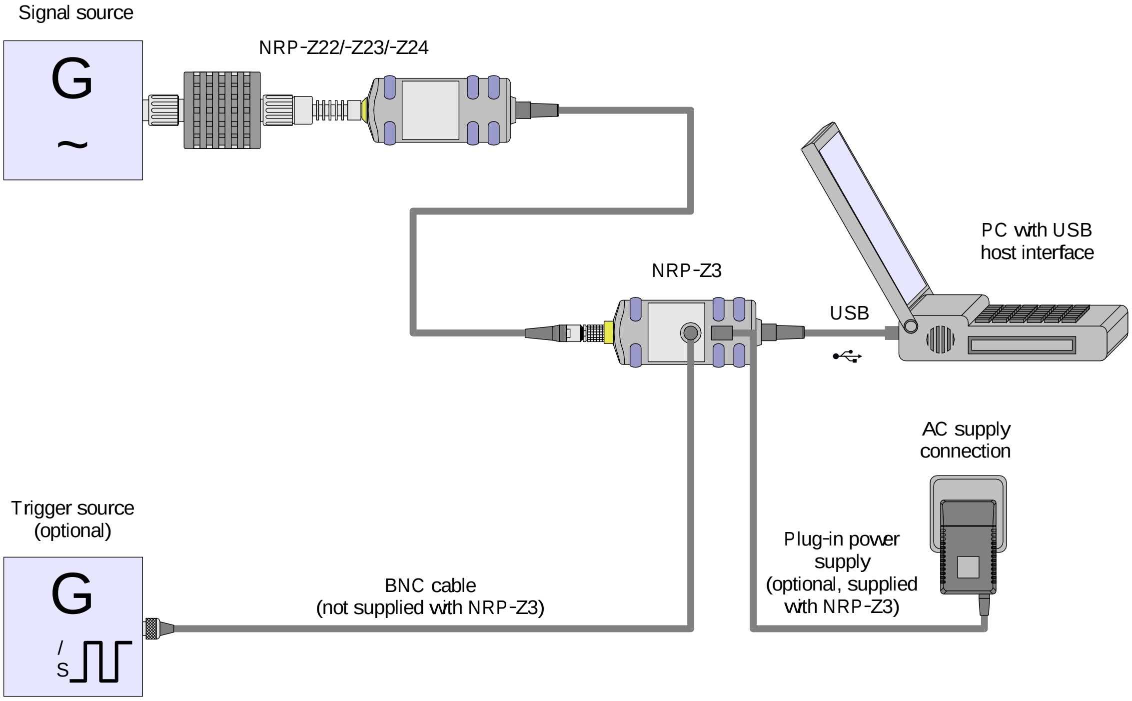


Fig. 1-2 Configuration with Active USB Adapter R&S NRP-Z3

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 autosets to the applied AC voltage. No manual voltage selection is required.

The plug-in power supply comes with four primary adapters for Europe, the UK, the USA and Australia. No tools of any kind are required to change the primary adapter. The adapter is pulled out manually and another adapter inserted until it locks (Fig. 1-3).

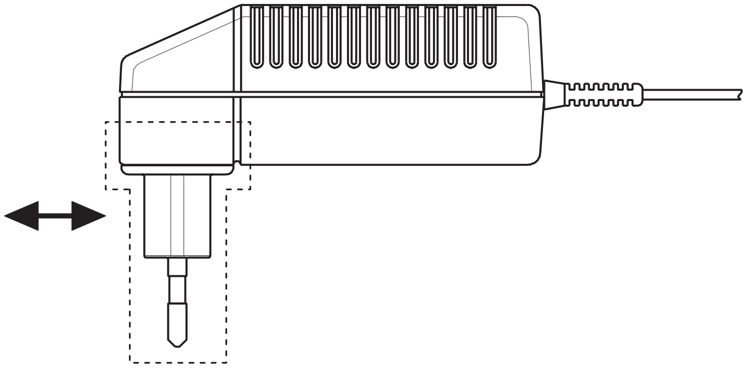


Fig. 1-3 Changing the primary adapter

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.

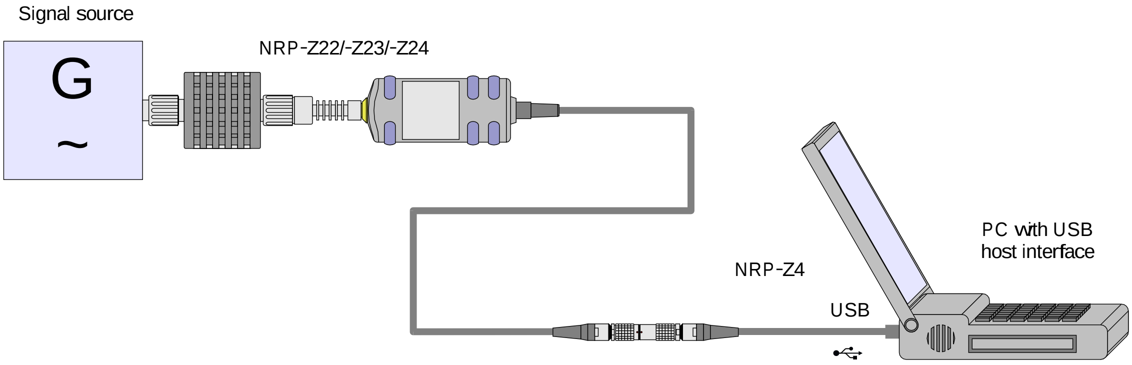


Fig. 1-4 Configuration with Passive USB Adapter R&S NRP-Z4

Connecting the sensor to the DUT

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

If the sensor is to be operated without an attenuator, s-parameter correction is to be switched off with the command *SENSe:CORRection:SPDevice :STATe OFF* (not possible in conjunction with the **Power Viewer** program module).

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2 Virtual Power Meter

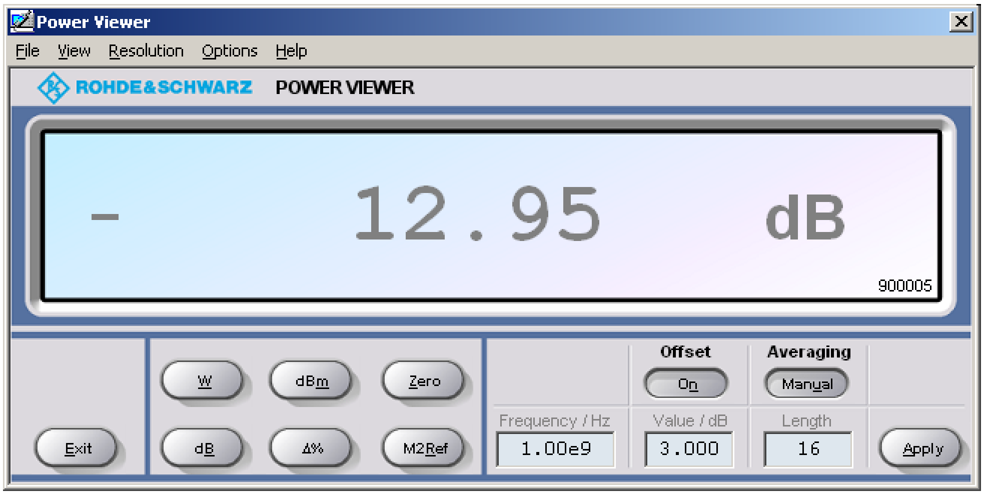
You will find the **NrpFlashup** program for controlling sensors with a PC under Windows™ on the CD-ROM that accompanies the sensor. The program comprises several modules which can be started centrally via the Windows™ start-menu entry **NRP Toolkit**.

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).



- 12.95 dB

900005

Offset: On

Averaging: Manual

Frequency / Hz: 1.00e9

Value / dB: 3.000

Length: 16

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
∆%	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 ...**

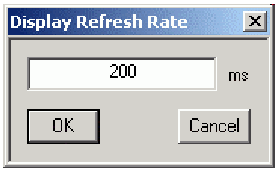
Opens a file-selection dialog to specify the path and name of the log file. Clicking the **Save** button starts the recording. All displayed values are written line-by-line to the log file with the date (format: YY/MM/DD) and time (format: hh:mm:ss.ms). Example:
`-22.51 dBm (03/02/25 15:37:25.310)`

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.



200 ms

Colours

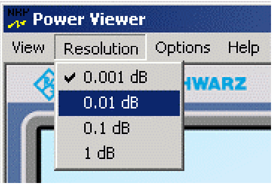
- **Result**
- **Unit**
- **Edit**
- **Button**

Opens a dialog box to select the background colour for

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

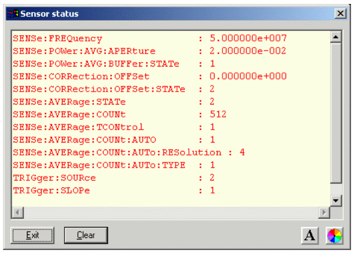
Resolution

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 …**

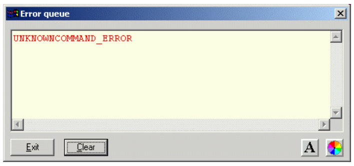
Reads the current sensor status. A parameter list is output.



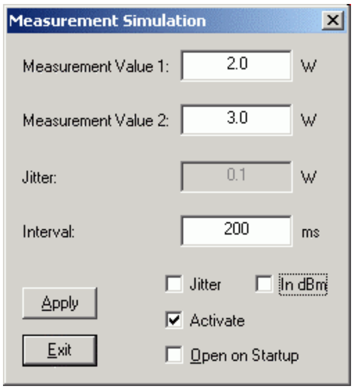
```
SENSe:FREQuency                    : 5.000000e+007
SENSe:POWer:AVG:APERture           : 2.000000e-002
SENSe:POWer:AVG:BUFFer:STATe       : 1
SENSe:CORRection:OFFSet            : 0.000000e+000
SENSe:CORRection:OFFSet:STATe      : 2
SENSe:AVERage:STATe                : 2
SENSe:AVERage:COUNt                : 512
SENSe:AVERage:TCONtrol             : 1
SENSe:AVERage:COUNt:AUTO           : 1
SENSe:AVERage:COUNt:AUTo:RESolution : 4
SENSe:AVERage:COUNt:AUTo:TYPE      : 1
TRIGger:SOURce                     : 2
TRIGger:SLOPe                      : 1
```

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.



```
UNKNOWNCOMMAND_ERROR
```



Measurement Value 1: 2.0 W
Measurement Value 2: 3.0 W
Jitter: 0.1 W
Interval: 200 ms
☐ Jitter ☐ In dBm
☑ Activate
☐ Open on Startup

	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:

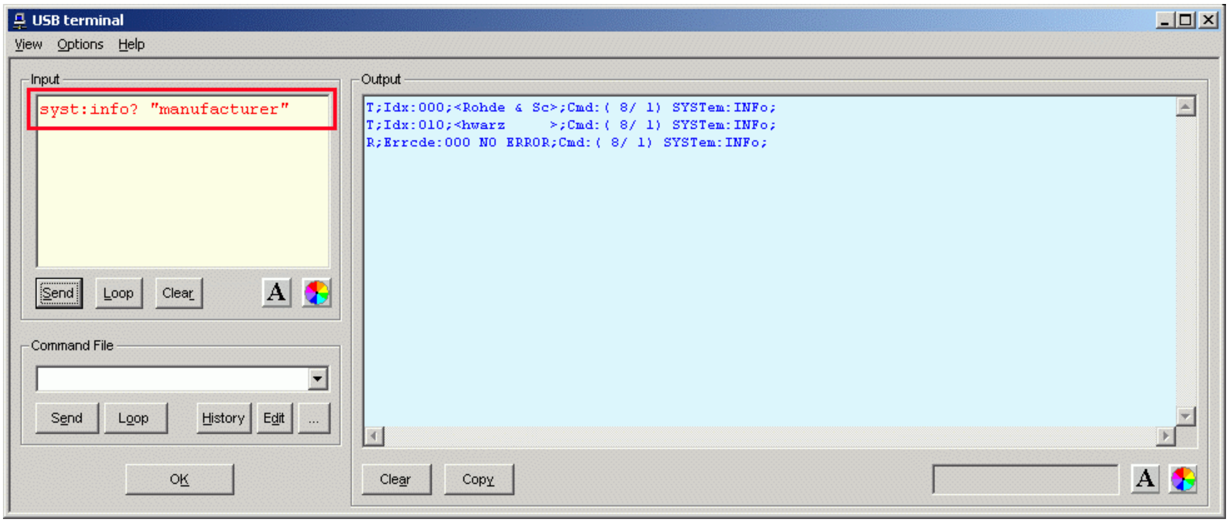
Power Viewer:	A detailed description of this virtual power meter module is provided in section 2.
Terminal:	Program module for sending commands and command sequences to the sensor and for displaying measurement results, status information and other data from the sensor
Firmware Update:	Program module 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:

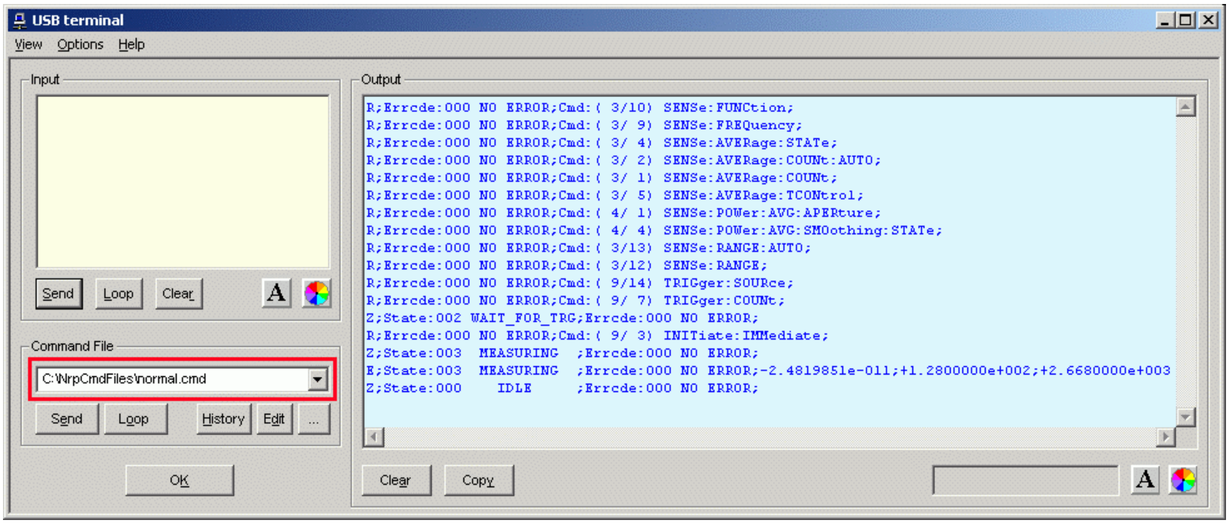
- Commands are entered in the **Input** field (Fig. 3-1). Consecutive commands can be entered as separate lines, one below the other. The buttons associated with the **Input** field are described in Table 3-1.
- Commands or command sequences are stored in *command files*. Command files are created with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



```
syst:info? "manufacturer"
```

```
T;Idx:000;<Rohde & Sc>;Cmd:( 8/ 1) SYSTem:INFo;
T;Idx:010;<hwarz     >;Cmd:( 8/ 1) SYSTem:INFo;
R;Errcde:000 NO ERROR;Cmd:( 8/ 1) SYSTem:INFo;
```

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



Command File: C:\NrpCmdFiles\normal.cmd

```
R;Errcde:000 NO ERROR;Cmd:( 3/10) SENSe:FUNCtion;
R;Errcde:000 NO ERROR;Cmd:( 3/ 9) SENSe:FREQuency;
R;Errcde:000 NO ERROR;Cmd:( 3/ 4) SENSe:AVERage:STATe;
R;Errcde:000 NO ERROR;Cmd:( 3/ 2) SENSe:AVERage:COUNt:AUTO;
R;Errcde:000 NO ERROR;Cmd:( 3/ 1) SENSe:AVERage:COUNt;
R;Errcde:000 NO ERROR;Cmd:( 3/ 5) SENSe:AVERage:TCONtrol;
R;Errcde:000 NO ERROR;Cmd:( 4/ 1) SENSe:POWer:AVG:APERture;
R;Errcde:000 NO ERROR;Cmd:( 4/ 4) SENSe:POWer:AVG:SMOothing:STATe;
R;Errcde:000 NO ERROR;Cmd:( 3/13) SENSe:RANGE:AUTO;
R;Errcde:000 NO ERROR;Cmd:( 3/12) SENSe:RANGE;
R;Errcde:000 NO ERROR;Cmd:( 9/14) TRIGger:SOURce;
R;Errcde:000 NO ERROR;Cmd:( 9/ 7) TRIGger:COUNt;
Z;State:002 WAIT_FOR_TRG;Errcde:000 NO ERROR;
R;Errcde:000 NO ERROR;Cmd:( 9/ 3) INITiate:IMMediate;
Z;State:003  MEASURING  ;Errcde:000 NO ERROR;
E;State:003  MEASURING  ;Errcde:000 NO ERROR;-2.4819851e-011;+1.2800000e+002;+2.6680000e+003
Z;State:000    IDLE     ;Errcde:000 NO ERROR;
```

Fig. 3-2 Sending commands using command files

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

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

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

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

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

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

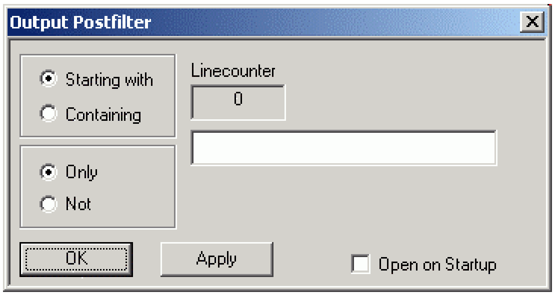
Table 3-3 Buttons assigned to the **Output** field

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

Close the USB terminal with OK.

Menus

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



Output Postfilter

● Starting with
○ Containing

Linecounter 0

● Only
○ Not

☐ Open on Startup

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.

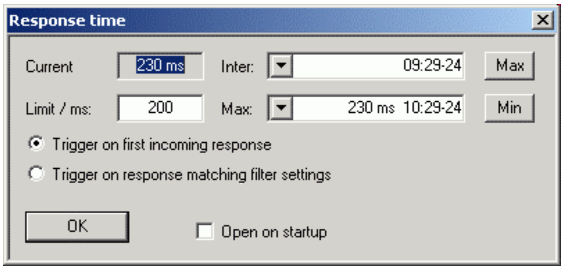
Not + **Containing**: Only lines not containing the entered character string are displayed.

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: 230 ms
Inter: 09:29:24
Limit / ms: 200
Max: 230 ms 10:29:24
● Trigger on first incoming response
○ Trigger on response matching filter settings
☐ Open on startup

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.

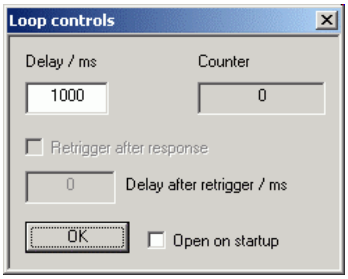
If **Open on startup** is active, the **Response Time** dialog is automatically displayed when the Terminal module is started. The dialog window is closed with **OK**.

Loop ...

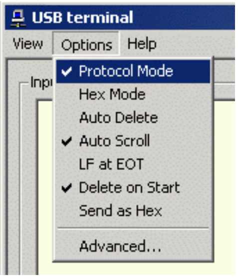
Opens the **Loop controls** dialog window where the cyclic transfer of commands and command sequences can be controlled.

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

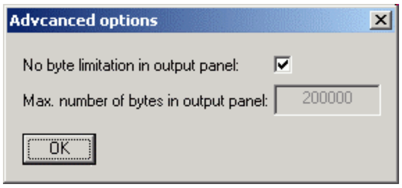
The number of completed transfer cycles is displayed in the **Counter** field. If **Open on startup** is active, the **Response time** dialog is automatically opened when the Terminal module is started. The dialog window is closed with **OK**.



Delay / ms: 1000
Counter: 0
☐ Retrigger after response
0 Delay after retrigger / ms
☐ Open on startup



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



No byte limitation in output panel: ☑

Max. number of bytes in output panel: 200000

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

Program module "Firmware Update"

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

Program module "Update S-Parameters"

Fundamentals

This program module allows you to modify an s-parameter data set located in the data memory of R&S NRP sensors. This s-parameter data set is required in order to automatically account for the influence of a twoport connected ahead of the sensor. In the case of the R&S NRP-Z22/-Z23/-Z24 sensors, the data set contains the s-parameters of the attenuator supplied in the delivery. The program module **Update S-Parameters** can be used to update these values after the attenuator is calibrated or to save another data set – for a separate attenuator or twoport – to the data memory.

The R&S NRP-Z22/-Z23/-Z24 sensors and the attenuator supplied in the delivery are measured separately during calibration. If the attenuator is used, its affect on the result value of the sensor is corrected arithmetically. The set of calibration data in the R&S NRP-Z22/-Z23/-Z24 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.

For maximum measurement sensitivity, the sensor R&S NRP-Z22/-Z23/-Z24 can be operated without a connected attenuator. In this case, the s-parameter correction must be deactivated.

Moreover, with the sensor R&S NRP-Z22/-Z23/-Z24 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 calibration data set comes factory-set with the s-parameters of the supplied attenuator; the s-parameter correction is activated as standard.

To ensure compatibility with a great number of network analyzers, the program module **Update S-Parameters** 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 Ω must be used for the s-parameters. Additional noise parameters in the measurement data file are ignored.

Structure of the S2P measurement data file:

1. The *option line* has the following format:
   # [<frequency unit>] [<parameter>] [<format>] [<R n>]
   # identifies the *option line*.
   The <frequency unit> may be Hz, kHz, MHz or GHz. If a frequency unit is not specified, GHz is implicitly assumed.
   If a parameter is specified, S must be used in <parameter> for s-parameter files. If a parameter is not specified, S is implicitly assumed.
   The <format> may be MA (linear magnitude and phase in degree), DB (magnitude in dB, phase in degree) or RI (real and imaginary part). If a format is not specified, MA is implicitly assumed.
   R is optional and followed by the reference impedance in Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] [S] [MA | DB | RI] [R 50]

2. The measurement frequencies in ascending order are specified as follows:
   $f_i \;\; s_{11}(f_i) \;\; s_{21}(f_i) \;\; s_{12}(f_i) \;\; s_{22}(f_i),$
   where $s_{jk}(f_i)$ is the display format as specified in the *option line*:
   $\left|s_{jk}(f_i)\right| \;\; \arg s_{jk}(f_i)$ (display format for linear magnitude and phase in degree) or
   $20 \cdot \lg\left|s_{jk}(f_i)\right| \;\; \arg s_{jk}(f_i)$ (display format for magnitude in dB and phase in degree)
   $\mathrm{Re}\left[s_{jk}(f_i)\right] \;\; \mathrm{Im}\left[s_{jk}(f_i)\right]$ (display format for real and imaginary part)

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

To characterize the measurement uncertainty of the s-parameter test system, another data file can optionally be created. 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 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 Ω. If an entry is made for R, R50 must be specified. If no entry is made, R50 is implicitly assumed.
   The *option line* should therefore read:
   # [HZ | KHZ | MHZ | GHZ] U [MA | DB | RI] [R 50]

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

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

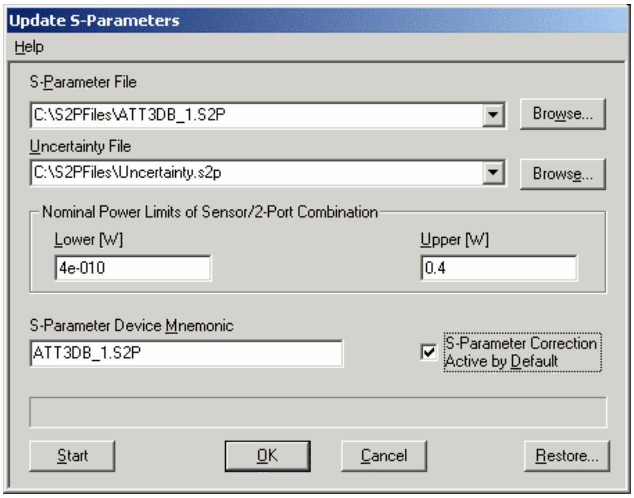
Two additional values must be specified when the s-parameters are loaded: the lower and the upper nominal measurement limit of the sensor-twoport combination. If s-parameter correction is active, these values are transferred by the sensor in response to SYSTem:INFO? The values cannot always be derived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



S-Parameter File: C:\S2PFiles\ATT3DB_1.S2P

Uncertainty File: C:\S2PFiles\Uncertainty.s2p

Lower [W]: 4e-010

Upper [W]: 0.4

S-Parameter Device Mnemonic: ATT3DB_1.S2P

☑ S-Parameter Correction Active by Default

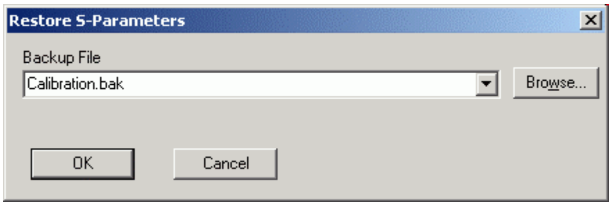
Fig. 3-3 Dialog window for loading an s-parameter table

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).



Backup File: Calibration.bak

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 base unit of the physical parameters (must not be sent with parameters).
Remarks:	Identification of all commands • that have no query form • that are available as query only

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-Z23 has the following structure:

ROHDE&SCHWARZ,NRP-Z23,<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-Z22/-Z23/-Z24 are controlled via the groups of commands

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

CALibration

Table 6-1 Commands of the *CALibration* system

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

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

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

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

CALibration:DATA:LENGth?

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

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

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

Repeat zeroing

- *during warm-up after switching on or connecting the instrument*
- *after a substantial variation of the ambient temperature*
- *after fastening the sensor to an RF connector at high temperature*
- *after several hours of operation*
- *when very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.*

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

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

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

SENSe (Sensor Configuration)

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

Table 6-2 Commands of the *SENSe* system

Command	**Parameter**	**Unit**	**Remarks**
SENSe			
:AVERage			
: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 18.0e9	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			
:STARt[?]	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, dBµV or dB. The normal mode is designed in a similar manner as for the predecessors R&S NRVS and R&S NRVD or other commercial power meters. The higher the selected index, the better the measurement result is filtered without the last significant place (0.01 dB with an index of 3) actually being set. The NSRatio setting is recommended instead.

The query yields the resolution index for the *Continuous Average*, *Burst Average* and *Timeslot* 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, 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:SPDevice: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 attenuator supplied with the sensor comes with a factory-set s-parameter data set. If the sensor is operated without a connected component, this parameter must be set to *OFF*.

The query yields

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

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

SENSe:FREQuency[?]   10.0e6 to 18.0e9

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

The query yields the set carrier frequency in Hz.

Default setting: *50.0e6 [Hz]*

SENSe:FUNCtion[?] <sensor_function>

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

Table 6-3 Measurement modes

<sensor_function>	**Description of the measurement mode**
"POWer:AVG"	**Continuous Average** 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. 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 2 × <SENSe:AVERage:COUNt> <SENSe:POWer:AVG:APERture> and with deactivated averaging function 2 × <SENSe:POWer:AVG:APERture>. Trigger events start one or several measurements in the Continuous Average mode (depending on the TRIGger:COUNt parameter).
"POWer:TSLot:AVG"	**Timeslot** 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 2 × <SENSe:AVERage:COUNt> <SENSe:POWer:TSLot:AVG:WIDTh> and with deactivated averaging function 2 × <SENSe:POWer:TSLot:AVG:WIDTh>. Note that a corresponding number of trigger events must be available.
"POWer:BURSt:AVG"	**Burst Average** 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. In the Burst Average mode, external trigger events (irrespective of the setting of the TRIGger:SOURce parameter) and the TRIGger:DELay parameter are ignored.
"XTIMe:POWer"	**Scope** 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.

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 × modulation period / 2
ON	N × modulation period × 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]*

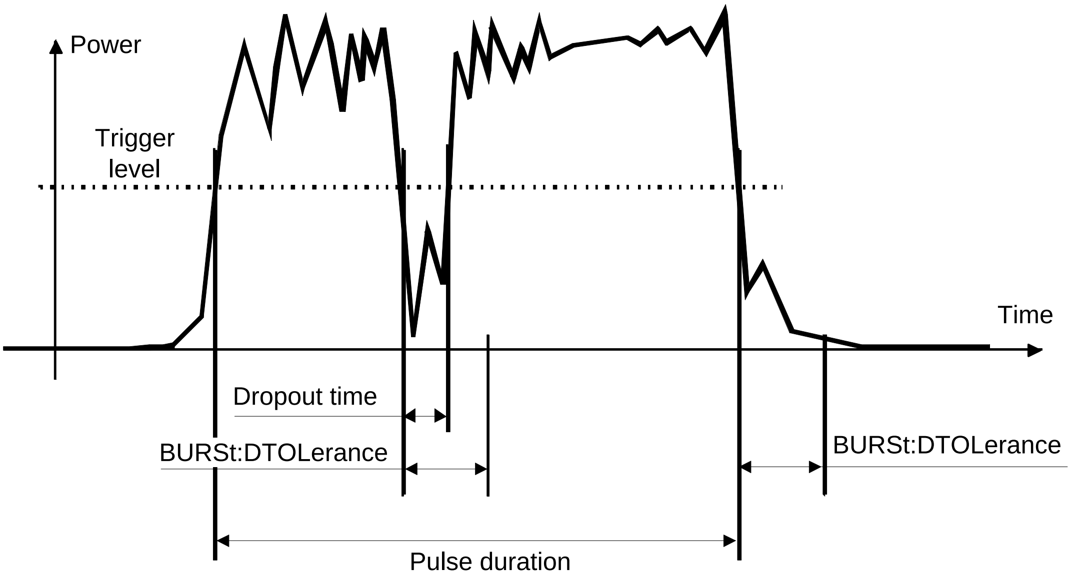

Fig. 6-1 Effect of SENSe:POWer:BURSt:DTOLerance

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 µW(–14 dBm) for the most sensitive measurement path, 4 mW (6 dBm) for the medium one and 400 mW (26 dBm) for the least sensitive. These values refer to the sensor without a connected attenuator. If the supplied attenuator is used, these dynamic range limits shift upwards as follows: +10 dB with the NRP-Z22, +20 dB with the NRP-Z23 and +25 dB with the NRP-Z24.

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:CLEVel[?] –20.0 to 0.0

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

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

Default setting: *0.0 [dB]*

SENSe:SAMPling[?] FREQ1 | FREQ2

SENSe:SAMPling is used to vary the sampling frequency of the analog-digital converter in the sensor. With parameter specification *FREQ1* the sampling frequency is 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:MAGNitude 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, dBµV 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

<SENSe:TRACe:POINts> × *<SENSe:TRACe:MPWidth>* < *SENSe:TRACE:TIME>*

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]*

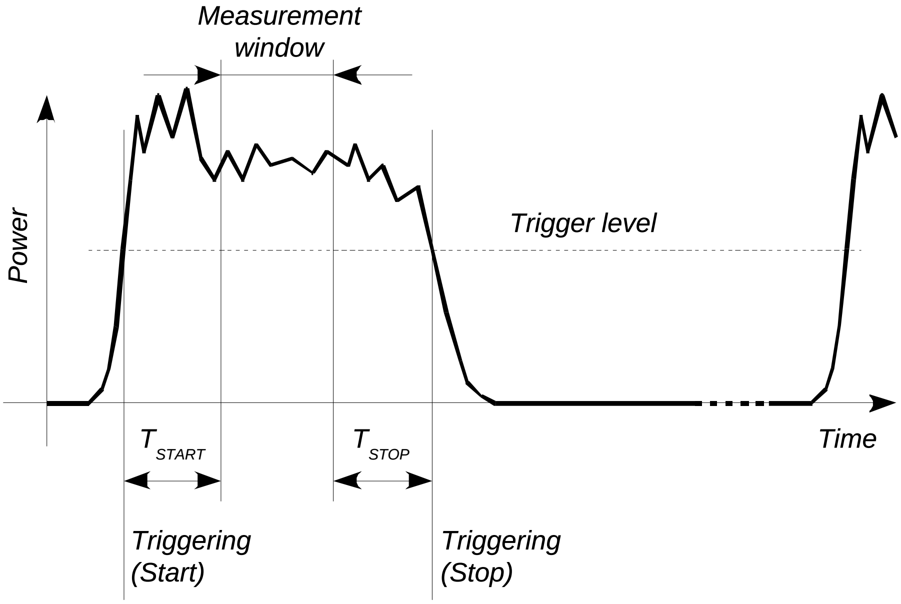

Fig. 6-2 Effect of *SENSe:TIMing:EXCLude:STARt* and *:END* in the *Burst Average* mode

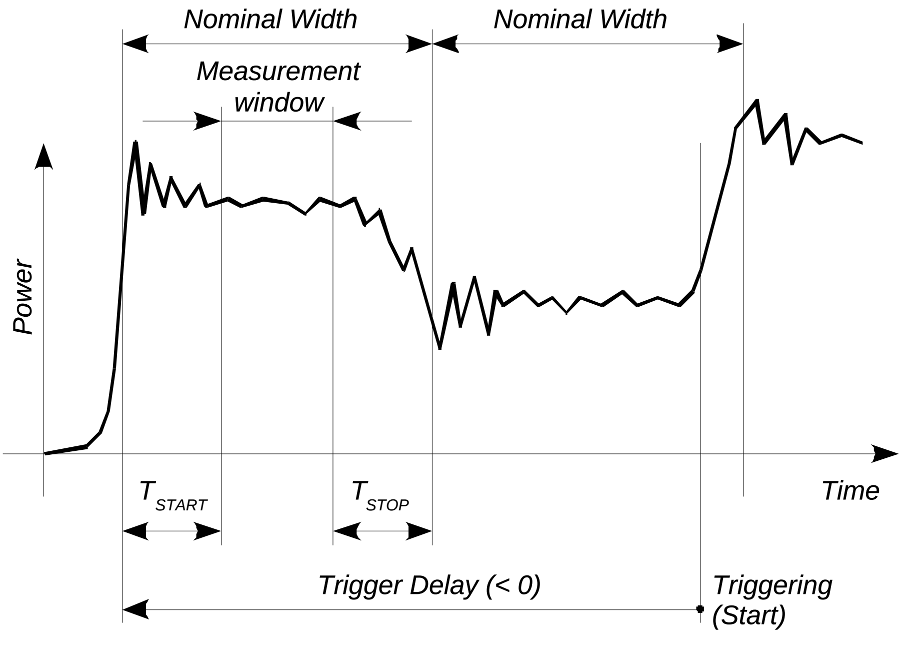

Fig. 6-3 Effect of *SENSe:TIMing:EXCLude:STARt* and *:END* in the *Timeslot* mode

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-Z22" or "NRP-Z23" or "NRP-Z24"	Type designation
"STOCK NUMBER"	"1137.7506.02" or "1137.8002.02" or "1137.8502.02"	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

Item	Information string	Remarks
"FUNCTION"	"Power Terminating"	The R&S NRP-Z22/-Z23/-Z24 is a terminating power sensor.
"MINPOWER"	"<nominal lower test limit in W>"	If the supplied attenuator or another twoport is used and the s-parameter correction is activated, the information string depends on the nominal lower test limit of the sensor/twoport combination. Without a connected attenuator and with deactivated s-parameter correction, the nominal lower test limit is 200 pW, i.e. the sensor responds to SYSTem:INFo? "MINPOWER" with the information string "2e-10".
"MAXPOWER"	"<nominal upper test limit in W>"	If the supplied attenuator or another twoport is used and the s-parameter correction is activated, the information string depends on the nominal upper test limit of the sensor/twoport combination. Without a connected attenuator and with deactivated s-parameter correction, the nominal upper test limit is 200 mW, i.e. the sensor responds to SYSTem:INFo? "MAXPOWER" with the information string "0.2".
"MINFREQ"	"1e+07"	The minimum measuring frequency of the R&S NRP-Z22/-Z23/-Z24 is 10 MHz.
"MAXFREQ"	"1.8e+10"	The maximum measuring frequency of the R&S NRP-Z22/-Z23/-Z24 is 18 GHz.
"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-Z22/-Z23/-Z24 RF input has a nominal input impedance of 50 .
"COUPLING"	"AC/DC"	The RF input of the R&S NRP-Z22/-Z23/-Z24 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 2×10^9		
: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 2×10^9

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*.

TRIGger:LEVel[?] x to y

TRIGger:LEVel sets the trigger threshold for internal triggering derived from the test signal (in W). This setting is irrelevant to all other trigger sources.

The query yields the trigger threshold in W.
Lower limit x and upper limit y of parameter

SENSe:CORRection:OFFSet:STATe OFF: x = 500 × <lower test limit>
y = <upper test limit >

SENSe:CORRection:OFFSet:STATe ON: x = 500 × < lower test limit > ×
10^(<*SENSe:CORRection:OFFSet*> / 10)
y = < upper test limit > ×
10^(<*SENSe:CORRection:OFFSet*> / 10)

< lower test limit >: nominal lower test limit if the supplied attenuator is used
or entered lower test limit of the sensor/twoport combination
(with *SENSe:CORRection:SPDevice:STATe ON*) or 200.0e-12
(with *SENSe:CORRection:SPDevice:STATe OFF*)

< upper test limit >: nominal upper test limit if the supplied attenuator is used
or entered upper test limit of the sensor/twoport combination
(with *SENSe:CORRection:SPDevice:STATe ON*) or 0.2
(with *SENSe:CORRection:SPDevice:STATe OFF*)

Default setting: 10 × x

TRIGger:SLOPe[?] POSitive | NEGative

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

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

Default setting: *POSitive*

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

TRIGger:SOURce sets the trigger source.

- *BUS*: Triggering with command **TRG* or *TRIGger:IMMediate*.
- *EXTernal*: Triggering via USB Adapter R&S NRP-Z3. Relevant trigger parameters: *TRIGger:DELay* and *TRIGger:SLOPe*.
- *HOLD*: Triggering only with command *TRIGger:IMMediate*.
- *IMMediate*: Automatic triggering without explicit event.
- *INTernal*: Triggering by the measurement signal. Relevant trigger parameters: *TRIGger:LEVel, TRIGger:DELay* and *TRIGger:SLOPe* (not in the *Burst Average* mode).

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

Default setting: *IMMediate*

List of Remote-Control Commands

The remote-control commands of the R&S NRP-Z22/-Z23/-Z24 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**
*** Commands**				
*IDN?				6.2
*RST				6.2
*TRG				6.2
*TST?				6.2
CALibration Commands				
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
SENSe Commands				
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		ON (can be modified by the user)	6.11
SENSe:FREQuency[?]	10.0e6 to 18.0e9	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
SYSTem Commands				
SYSTem:INFO? [Item]				6.22
SYSTem:INITialize				6.24
SYSTem:MINPower?		W		6.24
SYSTem:TRANsaction:BEGin				6.24
SYSTem:TRANsaction:END				6.24
Test Commands				
TEST:SENSor?				6.25
Triggersystem Commands				
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 2×10^9		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				6.29
TRIGger:LEVel[?]	x to y	W	10 × x	6.29
TRIGger:SLOPe[?]	POSitive | NEGative		POSitive	6.29
TRIGger:SOURce[?]	BUS | EXTernal | HOLD | IMMediate | INTernal		IMMediate	6.30
SERVice Commands				
SERVice:CALibration:DITHer	ONCE		OFF	
SERVice:CALibration:DITHer:DATA?			0	
SERVice:CALibration:TEMPerature	ONCE		OFF	
SERVice:CALibration:TEMPerature: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>	Ω	0.0	
SERVice:PARameter:RNULL1[?]	<float value>	Ω	0.0	
SERVice:PARameter:RNULL2[?]	<float value>	Ω	0.0	
SERVice:PARameter:RBAHN[?]	<float value>	Ω	0.0	
SERVice:PARameter:NREF[?]	<float value>		0.0	
SERVice:PARameter:ATHERM[?]	<float value>	K^{-1}	0.0	
SERVice:PARameter:BTHERM[?]	<float value>	K	0.0	
SERVice:PARameter:CTHERM[?]	<float value>	K^{-1}	0.0	
SERVice:PARameter:DTHERM[?]	<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-Z22, R&S NRP-Z23 and R&S NRP-Z24 requires a considerable amount of equipment and care. Rohde & Schwarz therefore recommends using the Calibration Kit 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.

To check the sensor using simple means, a ***quick test*** (see page 1.7) is recommended.

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-Z22, R&S NRP-Z23 and R&S NRP-Z24. However, they 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.
- 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 kHz**].

Successive entries are separated by [:], e.g. [**FREQ** : **3 GHz**]. **3 GHz**]

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/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 measurement accuracy
2	Linearity calibration system	-30 dBm to +23 dBm/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	PC with IEC/IEEE bus card (NI)			In conjunction with R&S NRVC
5	Power meter	To connect the DUT	R&S NRP	1143.8500.02	Absolute measurement accuracy Linearity

Performance Test with Calibration Kit R&S NRVC and Calibration Softw. *Recal*

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

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

Performance Test with Other Measuring Equipment

This section describes the required test steps but does not specify a test report with fixed test limits because such limits are highly dependent on the uncertainty of the calibration systems used.

Checking Zeroing

Test setup	- With the sensor (DUT) connected to the R&S NRP, no power is fed to the input of the RF sensor.
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**]
	- [**ZERO/CAL**: **ZERO/CAL**]
Test	- "Zeroing A(B/C/D) successful" message.
	- Display values within the limits for the quick test (starting on page 1.10).

Checking Absolute Measurement Accuracy

Since the sensor has three measurement paths and since it can be used either with or without attenuator, a total of four test steps are to be carried out (Table 1-1).

The maximum permissible measurement error depends on the calibration uncertainty of the sensor (Table 1-2 and Table 1-3) and on the uncertainty of the calibration system. The recommended procedure is to combine both uncertainties in accordance with the RSS method (square root based on the sum of squares) and to use the expanded combined uncertainty as a test limit.

To calibrate measurement path 1 (item 4), the test result from measurement path 2 can be applied if the calibration system does not supply a calibration power of 10 µW or if its uncertainty is too large. In this case, merely the display diifference between the two measurement paths is checked (Table 1-4).

Table 1-1 Test steps

Item	Configuration	Measurement path	Calibration power
1	RF sensor with attenuator	**2** (R&S NRP-Z22) **1** (R&S NRP-Z23/-Z24)	1 mW (0 dBm)
2	RF sensor without attenuator	**2**	
3		**3**	
4		**1**	10 µW (-20 dBm)

Table 1-2 Expanded calibration uncertainties of the Sensor R&S NRP-Z22 (in dB)

Frequency **Test step (item)**	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
1	0.072	0.072	0.077	0.095	0.095	0.118
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
4	0.056	0.056	0.066	0.083	0.094	0.123

Table 1-3 Expanded calibration uncertainties of the Sensors R&S NRP-Z23/-Z24 (in dB)

Frequency **Test step (Item)**	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
1	0.078	0.078	0.084	0.110	0.110	0.139
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
4	0.056	0.056	0.066	0.083	0.094	0.123

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

Table 1-4 Max. permissible measurement error (in dB) between meas. paths 1 and 2 of the RF sensor

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
Meas. error	0.045	0.044	0.048	0.054	0.063	0.079

Procedure (item 1):

Test setup	- Sensor (DUT) is connected to the output of the power calibration system and to one of the test inputs of the R&S NRP: attenuator is screwed on
Calibration system setting	- Switch off output power
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**]
	- [**ZERO/CAL**: **ZERO/CAL**]
	- [Sensor: Filter: Auto [ß]: Auto Config: Fixed Noise: **0.005 dB**]
	- [Window: Resolution: **0.001 dB**]
with R&S NRP-Z22	- [Sensor: Range: Auto ☐: Path 2]
with R&S NRP-Z23/-Z24	- [Sensor: Range: Auto ☐: Path 1]
Calibration system setting	- Set level 0 dBm at first calibration frequency (e.g. 10 MHz).
Setting on R&S NRP	- [**FREQ**: **10 MHz**]

Test	- Test level difference between calibration system and display value of the R&S NRP for compliance with calculated test limits.

Continue the performance test for the remaining frequency points as required. In the case of frequencies exceeding 1 GHz, it is recommended to obtain the average value from at least three measurements with different attenuator positions. This requires that the attenuator be turned by 90° to 120° with respect to the output connector of the calibration system and the input of the RF sensor.

Procedure (items 2 and 3):

Test setup	- RF sensor without attenuator connected to the output of the power calibration system and to one of the measurement inputs of the R&S NRP
Calibration system setting	- Switch off output power
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**: Sensor: Offset: S Parameter Device ☐] - [**ZERO/CAL**: **ZERO/CAL**] - [Sensor: Filter: Auto [ß]: Auto Config: Fixed Noise: **0.005 dB**] - [Window: Resolution: **0.001 dB**] - [Sensor: Range: Auto ☐: Path 2]
Calibration system setting	- Set level 0 dBm at first calibration frequency (e.g. 10 MHz)
Setting on R&S NRP	- [**FREQ**: **10 MHz**]
Test	- Test level difference between calibration system and display value of the R&S NRP for compliance with test limits calculated for measurement path 2
Setting on R&S NRP	- [Sensor: Range: Auto ☐: Path 3]
Test	- Test level difference between calibration system and display value of the R&S NRP for compliance with test limits calculated for measurement path 3

Continue the performance test for the remaining frequency points as required. In the case of frequencies exceeding 1 GHz, it is recommended to obtain the average value from at least three measurements with different attenuator positions. This requires that the attenuator be turned by 90° to 120° with respect to the output connector of the calibration system.

Procedure (item 4):

The measurement sequence is to be selected corresponding to item 2/3. If the power required to calibrate measurement path 1 is not available at the required level of accuracy, measurement path 2 can be used as a reference in an alternative procedure:

Procedure (item 4) with reference to meas. path 2:

Test setup	- RF sensor without attenuator connected to the output of the power calibration system and to one of the measurement inputs of the R&S NRP
Calibration system setting	- Switch off output power
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**: Sensor: Offset: S Parameter Device ☐] - [**ZERO/CAL**: **ZERO/CAL**] - [Sensor: Filter: Auto [ß]: Auto Config: Fixed Noise: **0.005 dB**] - [Window: Resolution: **0.001 dB**]
Setting on R&S NRP	- [Sensor: Range: Auto ☐: Path 2]
Calibration system setting	- Set level -20 dBm at first calibration frequency (e.g. 10 MHz)
Setting on R&S NRP	- [**FREQ**: **10 MHz**: Measurement: Relative On: Relative Reset]
Measurement	- The R&S NRP must display approx. 0.000 dB
Setting on R&S NRP	- [Sensor: Range: Auto ☐: Path 1]
Test	- Check display value of the R&S NRP for compliance with limits specified in Table 1-4

Continue the performance test for the remaining frequency points as required. It is not necessary to turn the connector.

Checking 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 RF sensor (Table 1-5) 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 1-5 Expanded linearity uncertainty of the RF sensor for Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24 at 50 MHz (in dB, with reference to 0 dBm)

Meas. 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:

Test setup	- RF sensor without attenuator connected to the output of the calibration system and to one of the measurement inputs of the R&S NRP
Calibration system setting	- Switch off output power
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**: Sensor: Offset: S Parameter Device ☐]

- [**ZERO/CAL**: **ZERO/CAL**]
- [Sensor: Filter: Auto [ß]: Auto Config: Fixed Noise: **0.005 dB**]
- [Window: Resolution: **0.001 dB**]
- [**FREQ**: **50 MHz**] (preferred value; otherwise, same as for frequency of calibration system)

Calibration system setting	- Level 0 dBm, frequency 50 MHz
Setting on R&S NRP	- [Measurement: Relative On: Relative Reset]
Measurement	- The R&S NRP must display approx. 0.000 dB
Calibration system setting	- Level x dBm
Test	- Check level difference between the R&S NRP and calibration system for compliance with the calculated limits

Continue testing for the remaining levels accordingly.

Checking Matching

The matching measurements include the inputs of the attenuator and RF sensor. In these measurements, the RF sensor can be operated with or without the R&S NRP base unit. The attenuator for the R&S NRP-Z22 and R&S NRP-Z23 must always be measured with the sensor connected.

The measurement uncertainty of the network analyzer that is used should not exceed a value of ±0.03 (for the SWR).

Table 1-6 Max. SWR of the RF sensor section for the Sensors R&S NRP-Z22/-Z23/-Z24

Frequency		10 MHz to 2.4 GHz	> 2.4 GHz to 8 GHz	> 8 GHz to 12.4 GHz	> 12.4 GHz to 18 GHz
Max. SWR	R&S NRP-Z22	1.11	1.18	1.23	1.23
	R&S NRP-Z23/-Z24	1.11	1.18	1.23	1.30

Table 1-7 Max. SWR of the Sensors R&S NRP-Z22/-Z23/-Z24
(at input of the attenuator)

Frequency		10 MHz to 2,4 GHz	> 2,4 GHz to 8 GHz	> 8 GHz to 12,4 GHz	> 12,4 GHz to 18 GHz
Max. SWR	R&S NRP-Z22	1.14	1.20	1.25	1.30
	R&S NRP-Z23/-Z24	1.14	1.25	1.30	1.41

Quick Test

The following tests are used to check the R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24 with simple means. If the tests are passed, compliance of the sensors with the specifications throughout the complete frequency and power range is largely ensured.

The test consists of:

- Zeroing
- Absolute measurement accuracy of the entire sensor (RF sensor + attenuator)
- Absolute measurement accuracy of the RF sensor
- 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 legally binding as accuracy specifications; only data sheet specifications are legally binding.
- 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	R&S NRP R&S NRP-B1	1143.8500.02 1146.9008.02	Absolute measurement accuracy
2	System-voltmeter	4-wire resistance measurement at 50 Ω, expanded measurement uncertainty <0.2 Ω			Input resistance
3	Adapter	BNC (plug) to 4 mm sockets (2-pin)		0017.6742.00	Input resistance
4	Adapter	BNC (socket) to N (socket)			Input resistance

*) With firmware rev. 3.0 or higher

Checking Zeroing

Test setup	- Sensor (DUT) connected to the R&S NRP (channel A or B); no power supplied to the input of the RF sensor
Setting on R&S NRP	- [**(PRE)SET**: **(PRE)SET**]
	- [**ZERO/CAL**: **ZERO/CAL**]
Test	- "Zeroing A(B/C/D) successful" message
	- Display values within the limits of the test report

Checking Absolute Measurement Accuracy (RF Sensor + Attenuator)

Test setup	- Sensor (DUT) and attenuator connected to the R&S NRP; the attenuator input is connected with the output of the power reference
Setting on R&S NRP	- [**ZERO/CAL**: Test at Power Ref (…with pad)]
Test	- The test must be completed without error messages
Setting on R&S NRP	- [**ZERO/CAL**: Report…]
Test	- The displayed meas. error must not exceed the test report limits

Checking Absolute Measurement Accuracy (RF Sensor)

Test setup	- Sensor (DUT) without attenuator connected to the R&S NRP; the RF sensor input is connected with the output of the power reference
Setting on R&S NRP	- [**ZERO/CAL**: Test at Power Ref (…Sensor only)]
Test	- The test must be completed without error messages
Setting on R&S NRP	- [**ZERO/CAL**: Report…]
Test	- The displayed meas. error must not exceed the test report limits

Checking Input Resistance

Test setup	- System voltmeter set to 4-wire resistance measurement and connected to DUT as shown in figure (RF sensor or input of the attenuator)

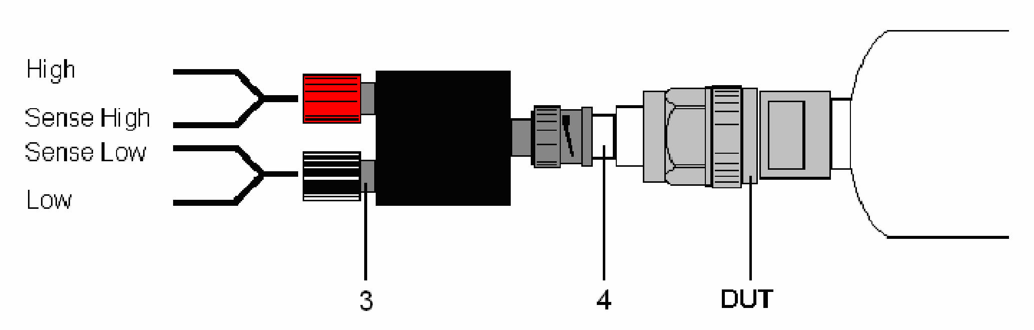


Fig. 1-1 Connection of DUT for measuring the input resistance

Test	- Check input resistance of the RF sensor section and attenuator for compliance with limits of test report

Test Report

Quick test

Power Sensor R&S NRP-Z22

Stock number: 1137.7506.02 Name: ....

Serial number: .... Date: ....

Item no.	Characteristic		Min. value	Actual value	Max. value	Unit
1	Zeroing		-------		-56.0	dBm
2	Absolute measurement accuracy with attenuator		-0.12		+0.12	dB
3	Absolute measurement accuracy without attenuator	Path 1	-0.10		+0.10	dB
4		Path 2	-0.10		+0.10	dB
5		Path 3	-0.10		+0.10	dB
6	Input resistance	RF sensor	50.2		51.8	Ω
7		Attenuator	48.0		52.0	Ω

Quick test

Power Sensor R&S NRP-Z23

Stock number: 1137.8002.02 Name: ....

Serial number: .... Date: ....

Item no.	Characteristic		Min. value	Actual value	Max. value	Unit
1	Zeroing		-------		-46.0	dBm
2	Absolute measurement accuracy with attenuator		-0.12		+0.12	dB
3	Absolute measurement accuracy without attenuator	Path 1	-0.10		+0.10	dB
4		Path 2	-0.10		+0.10	dB
5		Path 3	-0.10		+0.10	dB
6	Input resistance	RF sensor	50.2		51.8	Ω
7		Attenuator	48.0		52.0	Ω

Quick test

Power Sensor R&S NRP-Z24

Stock number: 1137.8502.02

Name: ....

Serial number: ....

Date: ....

Item no.	Characteristic		Min. value	Actual value	Max. value	Unit
1	Zeroing		-------		-41.0	dBm
2	Absolute measurement accuracy with attenuator		-0.12		+0.12	dB
3	Absolute measurement accuracy without attenuator	Path 1	-0.10		+0.10	dB
4		Path 2	-0.10		+0.10	dB
5		Path 3	-0.10		+0.10	dB
6	Input resistance	RF sensor	50.2		51.8	Ω
7		Attenuator	48.0		52.0	Ω

2 Adjustment

Preliminary Remarks

The data memories of the Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24 contain separate calibration data for the RF sensor and the lead-in attenuator. Therefore, the two components can be adjusted separately.

RF Sensor

The ***Recal*** calibration software is required in order to adjust the RF sensor. It is supplied as part of the Calibration Kit R&S NRVC. It is used to calculate and store correction data on the basis of the measurement results for the absolute calibration of the three measurement paths. This measurement data is obtained during a performance test (see Chapter 1). The Calibration Kit R&S NRVC is recommended for this purpose although it is not mandatory. A vector network analyzer is required in order to perform matching measurements.

To ensure that the measurement accuracy of the RF sensor complies with the data sheet specifications after the adjustment, the calibration system must not have any uncertainties that are higher than those specified in the table below.

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

Frequency	**10 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**
	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.

Attenuator

Measuring Equipment and Accessories

Item	**Type of unit**	**Recommended characteristic**	**Rec. units**	**R&S order number**	**Application**
1	Vector network analyzer	10 MHz to 18 GHz Test ports: N sockets and plugs Expanded meas. uncertainty s_{11}, s_{22}: 10 MHz to 2.4 GHz: ≤ 0.010 dB 2.41 GHz to 8 GHz: ≤ 0.011 dB 8.01 GHz to 18 GHz: ≤ 0.14 dB Expanded meas. uncertainty s_{21}, s_{12}: 10 MHz to 90 MHz: ≤0.050 dB 100 MHz to 8 GHz: ≤0.040 dB 8.01 GHz to 12.4 GHz: ≤0.045 dB 12.41 GHz to 18.0 GHz: ≤0.050 dB	R&S ZVM	1127.8500.60	Meas. of the S-parameters
2	USB adapter	To connect the DUT to a PC	R&S NRP-Z3 R&S NRP-Z4	1146.7005.02 1146.8001.02	Storage of the S-par. data set in the sensor

Measuring and Storing the S-Parameters

The attenuator is treated as an S-parameter device that can be supported with all sensors of the R&S NRP-Z series. All four S-parameters are determined at a number of frequencies and stored in the sensor. For details regarding the storage and format of S-parameters, refer to the section ***Program Module "Update of the S-parameters"*** in Chapter 3 of the operating manual. Table 2-2 contains a few parameters that are to be entered in a dialog window of the specified program module.

Table 2-3 contains all essential settings for a network analyzer of type R&S ZVM. If other network analyzers are used, the specified frequency reference points must always be implemented.

Table 2-2 Additional data for loading the S-parameters

Sensor type	**Nominal power limits of sensor/2-port combination**		**S-parameter device mnemonic**	**S-parameter correction active by default**
	Lower [W]	Upper [W]		
R&S NRP-Z22	2e-9	2	Pad for Z22	√
R&S NRP-Z23	20e-9	15	Pad for Z23	√
R&S NRP-Z24	60e-9	30	Pad for Z24	√

Table 2-3 Setting of the sweep segments on the R&S ZVM

Segment	**Start frequency**	**Stop frequency**	**Points**	**Generator level**	**IF bandwidth**	**Averaging**
1	10 MHz	100 MHz	10	–10 dBm	1 kHz	256
2	110 MHz	200 MHz	10			16
3	210 MHz	16 GHz	1580			1
4	16.01 GHz	18 GHz	200			16

3 Repair

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

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

Design and Circuit Description

Block Diagram

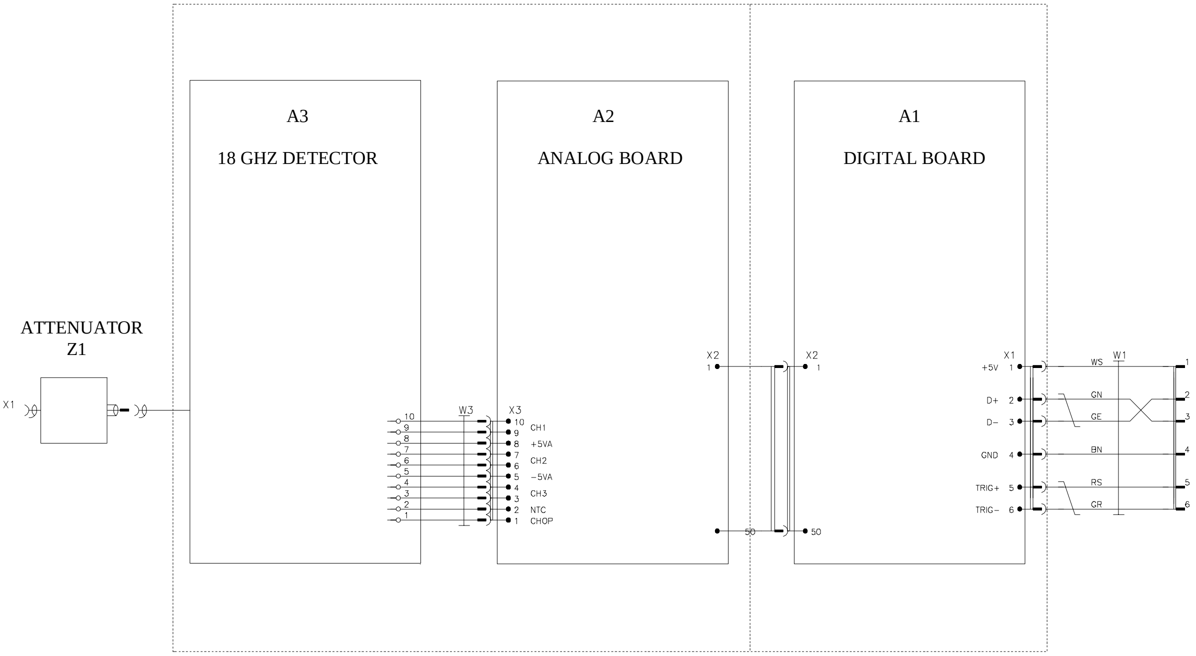


Fig. 3-1 Block diagrams of Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24

Description of the Block Diagram

The Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24 can measure the average power of nearly any modulated RF signals over a large dynamic range. They include all modules required for analog and digital signal processing and deliver completely corrected measured values. Communication with the R&S NRP base unit is handled via a USB interface.

The sensors consist of an RF sensor that is largely of the same design as the Sensor R&S NRP-Z21 and an attenuator for level reduction. Because of the high level of self-warming when measuring higher powers, the attenuator for the Sensors R&S NRP-Z23 and R&S NRP-Z24 is thermally insulated from the RF sensor.

Three detectors are used in the RF sensor to cover the large dynamic range of 90 dB; 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 measurement paths are driven to such an extent 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 measurement 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.

Attenuator

Attenuator Z1 is designed in such a manner that a power of approx. 200 mW is fed to the RF sensor if nominal power is applied. Due to the high level of self-warming, the attenuators for the Sensors R&S NRP-Z23 and R&S NRP-Z24 are protected against direct contact by a plastic cage (cover) and insulating rubber caps over the coupling rings of the N connectors. For reasons of safety, these elements must always be replaced if lost or damaged.

Microwave Detector

The microwave detector A3 is a hybrid circuit. It contains the three measurement 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 (see Table 3-1):

Table 3-1 Assignment of the 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 least sensitive measurement path
W3:5	–5VA	Negative operating voltage for the choppers
W3:6 W3:7	CH2	Output of the medium measurement path
W3:8	+5VA	Positive operating voltage for the choppers
W3:9 W3:10	CH1	Output of the most sensitive measurement 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 quick-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 includes an 8-bit D/A converter for generating a noise-like 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 ± 5 V and +1.75 V operating voltages. 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 a 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 processor based on an Intel StrongARM SA1110 microcontroller, two SRAMs (total of 1 Mbyte) as random access memory and two flash PROMs (total of 2 Mbyte).

The interface to the R&S NRP base unit is formed by connector X1 on the digital board. In addition to the four conductors for the USB port, the sensor cable contains two signal wires for supplying a differential trigger signal.

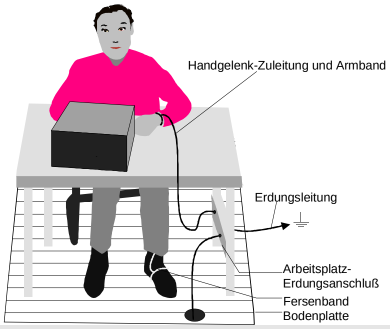
The connection to the analog board is established by press-in connector X2.

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

This section describes how to exchange the outer casing (shell halves) and replace the connecting cable and attenuator. 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 heel strap.*

Required Tools

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 Chapter 5.

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

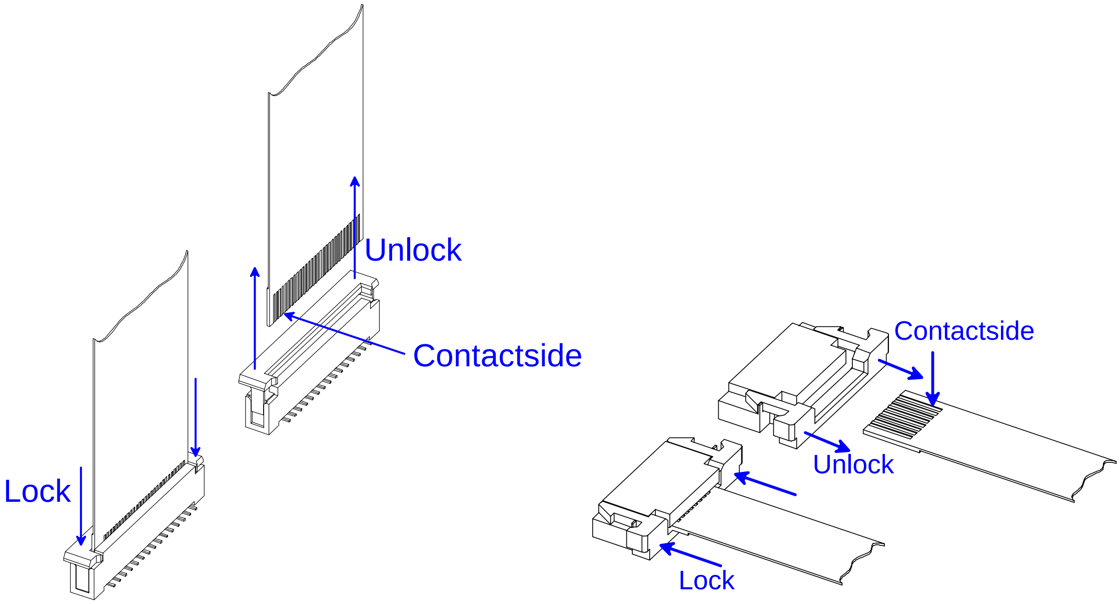


Fig. 3-2 Membrane cables

Note:

Remove membrane cables:
Membrane cables can be removed after unlocking the female connector.
Connect membrane cables:
Note the contact side and lock the female connector.

List of Modules

Table 3-2 List of modules/spare parts for the R&S NRP-Z22/-Z23/-Z24

Item No.	Designation	Electrical identification	Stock No.
20	ANALOG BOARD	A2	****)**
30	POWER SENSOR CABLE	W1	1137.7141.02
40	DIGITAL BOARD	A1	****)**
50	18 GHZ DETECTOR	A3	****)**
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 ***)**
70	SENSOR HOUSING		1137.6022.00
80	LABEL 1 R&S NRP-Z22 LABEL 1 R&S NRP-Z23 LABEL 1 R&S NRP-Z24		1137.7535.00 1137.8031.00 1137.8531.00
90	LABEL 2 R&S NRP-Z22 LABEL 2 R&S NRP-Z23 LABEL 2 R&S NRP-Z24		1137.7541.00 1137.8048.00 1137.8548.00
100	LABEL (PAD) R&S NRP-Z22 LABEL (PAD) R&S NRP-Z23 LABEL (PAD) R&S NRP-Z24		1137.7793.00 1137.8131.00 1137.8560.00
110	ATTENUATOR (10 DB) R&S NRP-Z22 ATTENUATOR (20 DB) R&S NRP-Z23 ATTENUATOR (25 DB) R&S NRP-Z24	Z1	1137.7770.00 0858.0598.00 0858.0898.00
120	PROTECTION CAP (ONLY FOR R&S NRP-Z23 AND R&S NRP-Z24)		0858.0717.00
130	COVER (PAD)		0858.0700.00
140	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 ***)**
150	SHIELDING		1137.6068.00 ***)**
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 ***)**

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[*] *) 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.

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 on the body on the RF connector side. Slightly bend and unlock the shielding by firmly pressing on the two narrow sides and pull it off in the cable direction.

Reassembly

- Push the shielding on and lock it into the catch on 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).

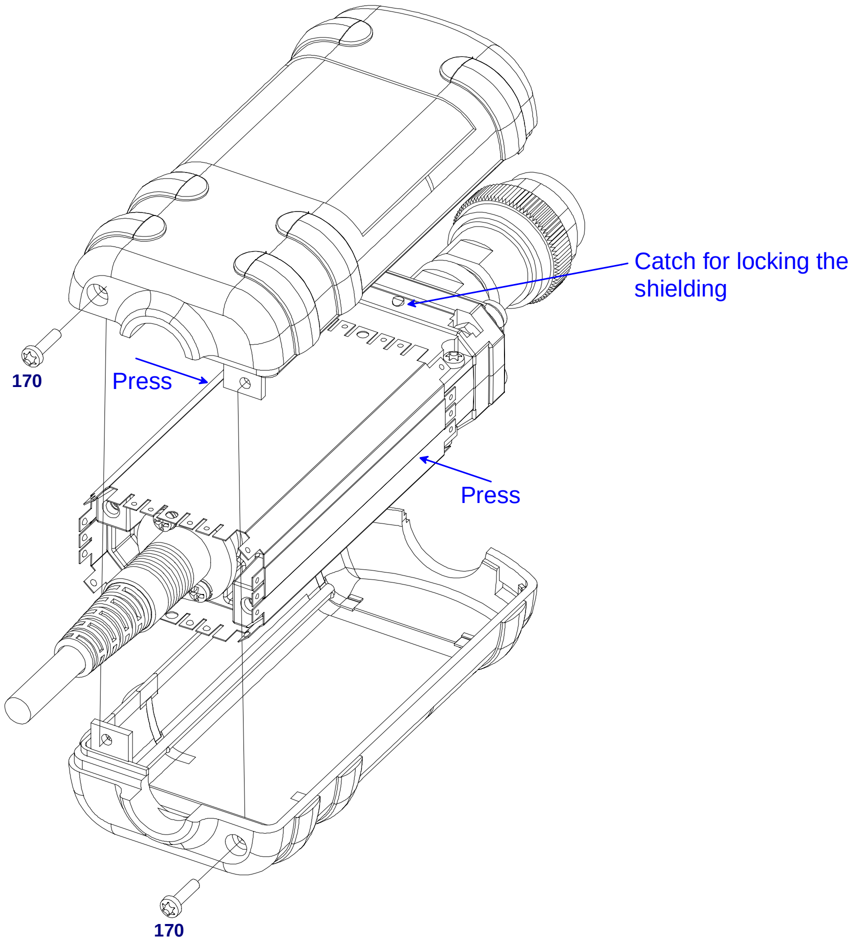


Fig. 3-3 Opening the sensor

⚠

Caution:

Adhere to a torque of 29 Ncm for all screws.

Replacement of Sensor Cable W1

Removing the Sensor Cable

- Open the sensor (see page 3.8).
- Undo 6 screws (140).
- Carefully remove digital board A1 from the body.
- Unplug sensor cable W1 from the digital board.
- For removing sensor cable W1, undo two screws (60) and remove the cable from the body.

Installing the Sensor Cable

- Install in the reverse order.
- Ensure that the guide pins of press-in connector X2 lock into the corresponding boreholes of the digital board.

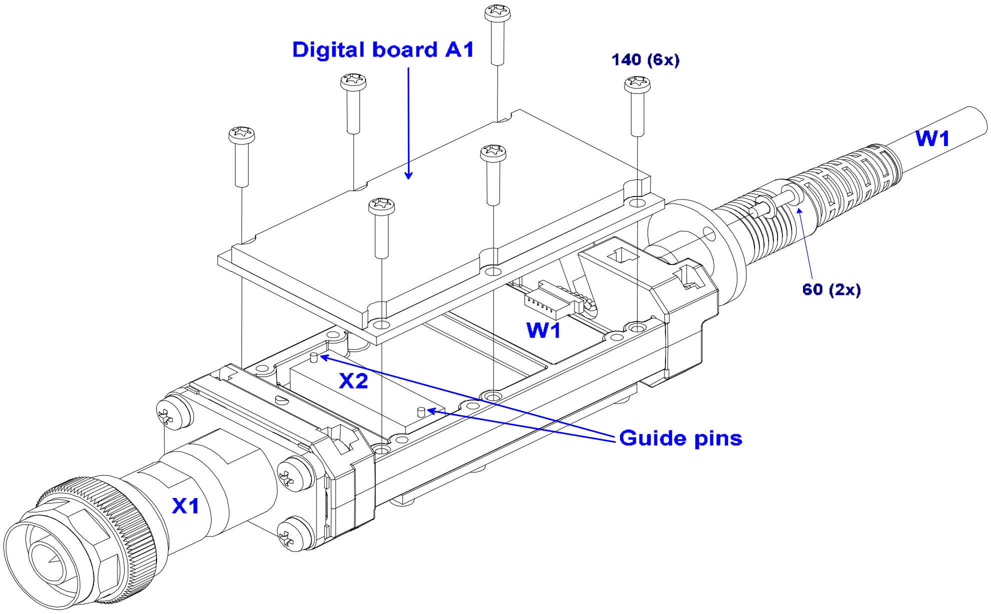


Fig. 3-4 Replacement of sensor cable

Replacement of Attenuator

Removing Protection against Accidental Contact (only R&S NRP-Z23/-Z24)

➢ Press the shell halves (130) together at the indicated locations (Fig. 3-5) to unlock them.

➢ Remove attenuator (110).

Assembling Protection against Accidental Contact (only R&S NRP-Z23/-Z24)

➢ Insert new attenuator into the shell halves (130).

➢ Press the shell halves firmly together until the locking catches engage.

Measuring Attenuator and Store S-Parameters in Sensor

➢ Measure attenuator and store the S-parameters in the sensor (see description in Chapter 2 of this service manual and in Chapter 3 of the operating manual).

⚠ If the data of the old attenuator is used to operate the sensor, it must be assumed that the measurement accuracy no longer complies with the specifications!

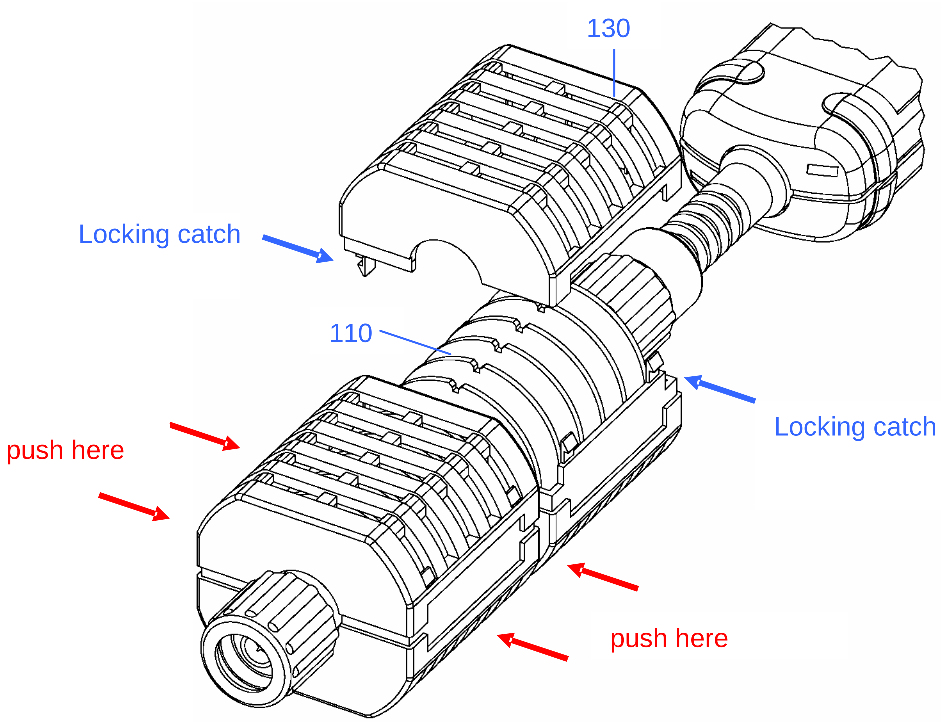


Fig. 3-5 Removing the protection against accidental contact for R&S NRP-Z23 and R&S NRP-Z24

Troubleshooting

Malfunctions may sometimes be due to simple reasons but may also result from defective components. These troubleshooting instructions will enable you to isolate the error down to the module level. Module replacement and repair 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 the sensor and replacing modules, disconnect the sensor from the base unit (R&S NRP) or USB adapters (R&S NRP-Z3 or R&S NRP-Z4).

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. *Replace the sensor cable and/or the connector on the R&S NRP*
⇓	
Check whether the error also occurs on another base unit or in another channel.	Error source within base unit. *Refer to Chapter 3 of the R&S NRP service manual for detailed troubleshooting*
	Error source within sensor. *Open sensor and check connection of sensor cable W1 with digital board.* *Exchange sensor cable.* *Send sensor in for repair (digital board possibly defective).*

- **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
	Base unit and sensor cannot communicate with each other. The firmware versions may not be compatible.
⇓	
Load current firmware into sensor and base unit according to Chapter 4	*If updated firmware does not correct the problem, perform the same measures as described above (sensor is not found).*

- **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
	The sensor detected an error during selftest or during communication (hardware defect or defective voltage supply).
⇓	
Check whether the error also occurs on a different base unit.	Error source within base unit. *Refer to Chapter 3 of the R&S NRP service manual for detailed troubleshooting.* Error source within sensor. *Send sensor in for repair (analog board or digital board possibly defective).*

Problems during measurement

- **Error: Measured power readings are erroneous.**

Troubleshooting instruction	Potential error source and further corrective steps
Perform performance test or selftest according to Chapter 1.	The RF sensor or the attenuator was overloaded: indicated by very poor matching and/or large measurement errors. *Send the RF sensor and/or attenuator in for repair (microwave detector or attenuator defective). The attenuator can also be replaced onsite if it is possible to measure its S-parameters (see section **Replacement of Attenuator**)* Other parts of sensor hardware are defective. *Send sensor in for repair (microwave detector or analog board defective).* Sensor hardware is probably ok since test limits are only slightly exceeded. *Send sensor in for calibration.*

4 Firmware Update

Chapter 4 provides information on the firmware update. Descriptions enclosed with the firmware update can be filed here.

Installation of New R&S NRP-Z22/-Z23/-Z24 Firmware

Use the Firmware Update program module to load new firmware for the Power Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24. 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

- 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).

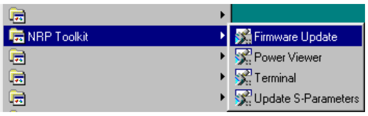
If you forgot to install the R&S NRP Toolkit beforehand, Windows will try in vain to find a USB driver for the power sensor. If this happens, the R&S NRP-Zxx is highlighted by a yellow exclamation mark in the Windows device manager. In this case, proceed as follows:

- *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

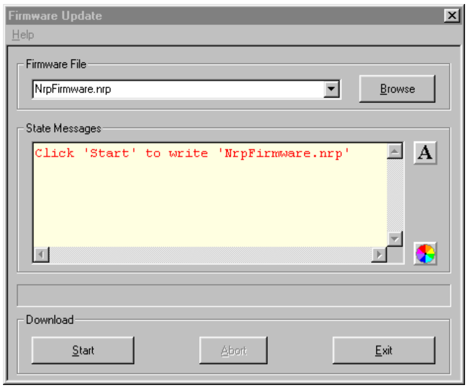
The update can be started as follows:

- ➢ 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.

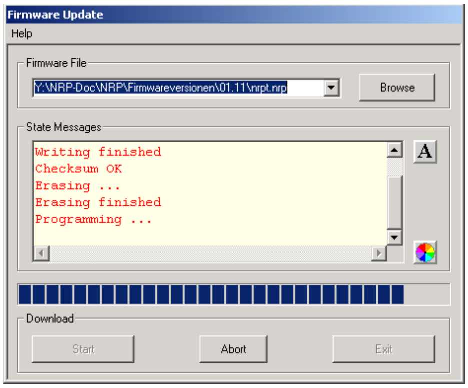


Firmware File: NrpFirmware.nrp

```
Click 'Start' to write 'NrpFirmware.nrp'
```

- ➢ 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.*



Firmware File: Y:\NRP-Doc\NRP\Firmwareversionen\01.11\nrpt.nrp

```
Writing finished
Checksum OK
Erasing ...
Erasing finished
Programming ...
```

- ➢ 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

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 Chapter provides information for ordering spare parts and contains the relevant documents for the Rohde & Schwarz Power Sensors R&S NRP-Z22, R&S NRP-Z23 and R&S NRP-Z24.

Shipping of Instrument and Ordering of Spare Parts

For service and repair work as well as ordering spare parts and modules, please contact your Rohde & Schwarz representative or our spare parts express service.

A list of addresses of all Rohde & Schwarz representatives as well as our spare parts express service is provided at the beginning of this service manual.

The following data is required so that we can process your requests quickly and correctly and determine if your instrument is still under warranty:

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

Shipping of Instrument

For the transport of the instrument, ensure that it is sufficiently protected against mechanical damage and use antistatic packaging materials.

➢ Repack the instrument as it was originally packed. The antistatic packaging foil prevents unintentional electrostatic charging.

➢ If you do not use the original packaging, include sufficient padding to prevent the instrument from slipping inside the package. Wrap the instrument in antistatic packaging foil to protect it against electrostatic charges.

Ordering of Spare Parts

The following data is required so that we can deliver spare parts quickly and correctly:

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

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 of 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 parts list provided below.

Table 5-1 List of modules/spare parts for the R&S NRP-Z22/-Z23/-Z24

Item No.	**Designation**	**Electrical identification**	**Stock No.**
20	ANALOG BOARD	A2	****)**
30	POWER SENSOR CABLE	W1	1137.7141.02
40	DIGITAL BOARD	A1	****)**
50	18 GHZ DETECTOR	A3	****)**
60	SCREW 7985/ISR-M2X8-A4 FOR POWER SENSOR CABLE W1		1148.2600.00 ***)**
70	SENSOR HOUSING		1137.6022.00
80	LABEL 1 R&S NRP-Z22 LABEL 1 R&S NRP-Z23 LABEL 1 R&S NRP-Z24		1137.7535.00 1137.8031.00 1137.8531.00
90	LABEL 2 R&S NRP-Z22 LABEL 2 R&S NRP-Z23 LABEL 2 R&S NRP-Z24		1137.7541.00 1137.8048.00 1137.8548.00
100	LABEL (PAD) R&S NRP-Z22 LABEL (PAD) R&S NRP-Z23 LABEL (PAD) R&S NRP-Z24		1137.7793.00 1137.8131.00 1137.8560.00
110	ATTENUATOR (10 DB) R&S NRP-Z22 ATTENUATOR (20 DB) R&S NRP-Z23 ATTENUATOR (25 DB) R&S NRP-Z24	Z1	1137.7770.00 0858.0598.00 0858.0898.00
120	PROTECTION CAP (ONLY FOR R&S NRP-Z23 AND R&S NRP-Z24)		0858.0717.00
130	COVER (PAD)		0858.0700.00
140	SCREW 7985/ISR-M2X10-A4 FOR DIGITAL BOARD A1		1148.2917.00 ***)**
150	SHIELDING		1137.6068.00 ***)**
170	SCREW 7985/ISR-M2X8-A4 FOR OUTER CASING		1148.2600.00 ***)**

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*) 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.