Overview of the R&S®NRP-Zxx power sensors

Sensor type	Frequency range	Power range, max. average power / peak envelope power	Connector type
Universal power sensors			
R&S®NRP-Z11	10 MHz to 8 GHz	200 pW to 200 mW (–67 dBm to +23 dBm) max. 400 mW (AVG) / 1 W (PK, 10 µs)	N
R&S®NRP-Z21	10 MHz to 18 GHz	200 pW to 200 mW (–67 dBm to +23 dBm) max. 400 mW (AVG) / 1 W (PK, 10 µs)	N
R&S®NRP-Z31	10 MHz to 33 GHz	200 pW to 200 mW (–67 dBm to +23 dBm) max. 400 mW (AVG) / 1 W (PK, 10 µs)	3.5 mm
R&S®NRP-Z22	10 MHz to 18 GHz	2 nW to 2 W (–57 dBm to +33 dBm) max. 3 W (AVG) / 10 W (PK, 10 µs)	N
R&S®NRP-Z23	10 MHz to 18 GHz	20 nW to 15 W (–47 dBm to +42 dBm) max. 18 W (AVG) / 100 W (PK, 10 µs)	N
R&S®NRP-Z24	10 MHz to 18 GHz	60 nW to 30 W (–42 dBm to +45 dBm) max. 36 W (AVG) / 300 W (PK, 10 µs)	N
Wideband power sensors			
R&S®NRP-Z81	50 MHz to 18 GHz	1 nW to 100 mW (–60 dBm to +20 dBm) max. 200 mW (AVG) / 1 W (PK, 1 µs)	N
R&S®NRP-Z85	50 MHz to 40 GHz	1 nW to 100 mW (–60 dBm to +20 dBm) max. 200 mW (AVG) / 1 W (PK, 1 µs)	2.92 mm
R&S®NRP-Z86	50 MHz to 40 GHz	1 nW to 100 mW (–60 dBm to +20 dBm) max. 200 mW (AVG) / 1 W (PK, 1 µs)	2.40 mm
Thermal power sensors			
R&S®NRP-Z51	DC to 18 GHz	1 µW to 100 mW (–30 dBm to +20 dBm) max. 300 mW (AVG) / 10 W (PK, 1 µs)	N
R&S®NRP-Z55	DC to 40 GHz	1 µW to 100 mW (–30 dBm to +20 dBm) max. 300 mW (AVG) / 10 W (PK, 1 µs)	2.92 mm
R&S®NRP-Z56	DC to 50 GHz	300 nW to 100 mW (–35 dBm to +20 dBm) max. 300 mW (AVG) / 10 W (PK, 1 µs)	2.40 mm
R&S®NRP-Z57	DC to 67 GHz	300 nW to 100 mW (–35 dBm to +20 dBm) max. 300 mW (AVG) / 10 W (PK, 1 µs)	1.85 mm
Average power sensors			
R&S®NRP-Z91	9 kHz to 6 GHz	200 pW to 200 mW (–67 dBm to +23 dBm) max. 400 mW (AVG) / 1 W (PK, 10 µs)	N
R&S®NRP-Z92	9 kHz to 6 GHz	2 nW to 2 W (–57 dBm to +33 dBm) max. 3 W (AVG) / 10 W (PK, 10 µs)	N
Level control sensors			
R&S®NRP-Z28	10 MHz to 18 GHz	200 pW to 100 mW (–67 dBm to +20 dBm) max. 700 mW (AVG) / 4 W (PK, 10 µs)	N
R&S®NRP-Z98	9 kHz to 6 GHz	200 pW to 100 mW (–67 dBm to +20 dBm) max. 700 mW (AVG) / 4 W (PK, 10 µs)	N
Power sensor modules			
R&S®NRP-Z27	DC to 18 GHz	4 µW to 400 mW (–24 dBm to +26 dBm) max. 500 mW (AVG) / 30 W (PK, 1 µs)	N
R&S®NRP-Z37	DC to 26.5 GHz	4 µW to 400 mW (–24 dBm to +26 dBm) max. 500 mW (AVG) / 30 W (PK, 1 µs)	3.5 mm

Specifications in brief of the R&S®NRP-Zxx power sensors

Sensor type	Impedance matching (SWR)	Rise time Video BW	Zero offset (typical)	Noise (typical)	Uncertainty for power measurements at +20 °C to +25 °C absolute	 relative
Universal power sensors						
R&S®NRP-Z11	10 MHz to 2.4 GHz: < 1.13 > 2.4 GHz to 8.0 GHz: < 1.20				*0.047 dB to 0.083 dB*	*0.022 dB to 0.066 dB*
R&S®NRP-Z21	10 MHz to 2.4 GHz: < 1.13 > 2.4 GHz to 8.0 GHz: < 1.20 > 8.0 GHz to 18.0 GHz: < 1.25		64 pW	40 pW	*0.047 dB to 0.128 dB*	*0.022 dB to 0.110 dB*
R&S®NRP-Z31	10 MHz to 2.4 GHz: < 1.13 > 2.4 GHz to 8.0 GHz: < 1.20 > 8.0 GHz to 18.0 GHz: < 1.25 > 18.0 GHz to 26.5 GHz:< 1.30 > 26.5 GHz to 33.0 GHz:< 1.35				*0.051 dB to 0.137 dB*	*0.022 dB to 0.118 dB*
R&S®NRP-Z22	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 18.0 GHz:< 1.30	< 8 µs > 50 kHz	0.7 nW	0.4 nW	*0.079 dB to 0.178 dB*	*0.022 dB to 0.112 dB*
R&S®NRP-Z23	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 18.0 GHz:< 1.41		7 nW	4 nW	*0.078 dB to 0.199 dB*	*0.022 dB to 0.110 dB*
R&S®NRP-Z24	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 18.0 GHz:< 1.41		20 nW	13 nW	*0.078 dB to 0.222 dB*	*0.022 dB to 0.110 dB*
Wideband power sensors						
R&S®NRP-Z81	50 MHz to 2.4 GHz: < 1.16 > 2.4 GHz to 8.0 GHz: < 1.20 > 8.0 GHz to 18.0 GHz: < 1.25	< 13 ns > 30 MHz	220 pW	110 pW	*0.130 dB to 0.150 dB*	–
R&S®NRP-Z85 R&S®NRP-Z86	50 MHz to 2.4 GHz: < 1.16 > 2.4 GHz to 8.0 GHz: < 1.20 > 8.0 GHz to 18.0 GHz: < 1.25 > 18.0 GHz to 26.5 GHz:< 1.30 > 26.5 GHz to 40.0 GHz:< 1.35				*0.130 dB to 0.180 dB*	–
Thermal power sensors						
R&S®NRP-Z51	DC to 2.4 GHz: < 1.10 > 2.4 GHz to 12.4 GHz: < 1.15 > 12.4 GHz to 18.0 GHz:< 1.20				*0.052 dB to 0.100 dB*	*0.032 dB*
R&S®NRP-Z55	DC to 2.4 GHz: < 1.10 > 2.4 GHz to 12.4 GHz: < 1.15 > 12.4 GHz to 18.0 GHz:< 1.20 > 18.0 GHz to 26.5 GHz:< 1.25 > 26.5 GHz to 40.0 GHz:< 1.30	–	33 nW	20 nW	*0.057 dB to 0.114 dB*	*0.032 dB*
R&S®NRP-Z56	DC to 100 MHz: < 1.03 > 100 MHz to 2.4 GHz: < 1.06 > 2.4 GHz to 12.4 GHz: < 1.13 > 12.4 GHz to 18.0 GHz:< 1.16 > 18.0 GHz to 26.5 GHz:< 1.22 > 26.5 GHz to 40.0 GHz:< 1.28 > 40.0 GHz to 50.0 GHz:< 1.30		15 nW	15 nW	*0.040 dB to 0.142 dB*	*0.010 dB*
R&S®NRP-Z57	DC to 100 MHz: < 1.03 > 100 MHz to 2.4 GHz: < 1.06 > 2.4 GHz to 12.4 GHz: < 1.13 > 12.4 GHz to 18.0 GHz: < 1.16 > 18.0 GHz to 26.5 GHz: < 1.22 > 26.5 GHz to 40.0 GHz: < 1.28 > 40.0 GHz to 50.0 GHz: < 1.30 > 50.0 GHz to 67.0 GHz: < 1.35				*0.040 dB to 0.248 dB*	*0.010 dB*

Universal power sensors in R&S®Smart Sensor Technology™

R&S®NRP-Z11/-Z21 universal power sensors

Specifications from 8 GHz to 18 GHz apply only to the R&S®NRP-Z21.

Frequency range	R&S®NRP-Z11	10 MHz to 8 GHz	
	R&S®NRP-Z21	10 MHz to 18 GHz	
Impedance matching (SWR)	10 MHz to 2.4 GHz	< 1.13 (**1.11**)	( ): +15 °C to +35 °C
	> 2.4 GHz to 8.0 GHz	< 1.20 (**1.18**)	
	> 8.0 GHz to 18.0 GHz	< 1.25 (**1.23**)	
Power measurement range	Continuous Average	200 pW to 200 mW (–67 dBm to +23 dBm)	
	Burst Average	200 nW to 200 mW (–37 dBm to +23 dBm)	
	Timeslot/Gate Average	600 pW to 200 mW (–62 dBm to +23 dBm) [1]	
	Trace	10 nW to 200 mW (–50 dBm to +23 dBm) [2]	
Max. power	average power	0.4 W (+26 dBm), continuous	
	peak envelope power	1.0 W (+30 dBm) for max. 10 µs	
Measurement subranges	path 1	–67 dBm to –14 dBm	
	path 2	–47 dBm to +6 dBm	
	path 3	–27 dBm to +23 dBm	
Transition regions	with automatic path selection, user-defined crossover [3] set to 0 dB	(–19 ± 1) dBm to (–13 ± 1) dBm (+1 ± 1) dBm to (+7 ± 1) dBm	
Dynamic response	video bandwidth	> 50 kHz (100 kHz)	( ): +15 °C to +35 °C
	single-shot bandwidth	> 50 kHz (100 kHz)	
	rise time 10 %/90 %	< 8 µs (4 µs)	
Acquisition	sample rate (continuous)	133.358 kHz (default) or 119.467 kHz [4]	
Triggering	internal		
	threshold level range	–40 dBm to +23 dBm	
	threshold level accuracy	identical to uncertainty for absolute power measurements	
	threshold level hysteresis	0 dB to 10 dB	
	dropout [5]	0 s to 10 s	
	external	see R&S®NRP2 base unit, R&S®NRP-Z3 USB adapter or R&S®NRP-Z5 USB sensor hub	
	slope (external, internal)	pos./neg.	
	delay	–5 ms to +100 s	
	hold-off	0 s to 10 s	
	resolution (delay, hold-off, dropout)	sample period (≈ 8 µs)	
	source	internal, external, immediate, bus, hold	
Zero offset [6]	initial, without zeroing		( ): typical at 1 GHz +15 °C to +35 °C [ ]: 8 GHz to 18 GHz
	path 1	< 470 [500] (100) pW	
	path 2	< 47 [50] (10) nW	
	path 3	< 4.7 [5] (1) µW	
	after external zeroing [6] [7]		
	path 1	< 104 [110] (64) pW	
	path 2	< 10 [11] (6) nW	
	path 3	< 1.0 [1.1] (0.6) µW	
Zero drift [8]	path 1	< 35 [37] (0) pW	
	path 2	< 3.0 [3.2] (0) nW	
	path 3	< 0.30 [0.32] (0) µW	
Measurement noise [9]	path 1	< 65 [69] (40) pW	
	path 2	< 6.3 [6.6] (4.0) nW	
	path 3	< 0.63 [0.66] (0.4) µW	

R&S®NRP-Z11/-Z21 universal power sensors (continued)

Uncertainty for absolute power measurements [10] in dB

10 MHz to < 20 MHz / **20 MHz to < 100 MHz**

Temperature	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm
0 °C to +50 °C	*0.174*	*0.175*	*0.175*	*0.147*	*0.159*	*0.159*
+15 °C to +35 °C	*0.075*	*0.070*	*0.071*	*0.072*	*0.069*	*0.069*
+20 °C to +25 °C	*0.056*	*0.047*	*0.048*	*0.056*	*0.047*	*0.048*

Power level in dBm

100 MHz to 4 GHz / **> 4 GHz to 8 GHz**

Temperature	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm
0 °C to +50 °C	*0.150*	*0.162*	*0.164*	*0.160*	*0.170*	*0.174*
+15 °C to +35 °C	*0.081*	*0.077*	*0.081*	*0.096*	*0.089*	*0.097*
+20 °C to +25 °C	*0.066*	*0.058*	*0.063*	*0.083*	*0.072*	*0.082*

Power level in dBm

> 8 GHz to 12.4 GHz / **> 12.4 GHz to 18 GHz**

Temperature	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm	–67 to –19 dBm	–19 to +1 dBm	+1 to +23 dBm
0 °C to +50 °C	*0.168*	*0.176*	*0.184*	*0.188*	*0.196*	*0.210*
+15 °C to +35 °C	*0.106*	*0.096*	*0.110*	*0.133*	*0.120*	*0.142*
+20 °C to +25 °C	*0.094*	*0.079*	*0.096*	*0.123*	*0.103*	*0.128*

Power level in dBm

R&S®NRP-Z11/-Z21 universal power sensors (continued)

Uncertainty for relative power measurements [11] in dB

10 MHz to < 20 MHz

+23	0.226	0.229	0.027	0 °C to +50 °C
	0.084	0.080	0.022	+15 °C to +35 °C
+7	0.046	0.044	0.022	+20 °C to +25 °C
+1	0.226	0.027	0.229	0 °C to +50 °C
	0.083	0.022	0.080	+15 °C to +35 °C
–13	0.045	0.022	0.044	+20 °C to +25 °C
–19	0.023	0.226	0.226	0 °C to +50 °C
	0.022	0.083	0.084	+15 °C to +35 °C
–67	0.022	0.045	0.046	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

20 MHz to < 100 MHz

+23	0.206	0.215	0.027	0 °C to +50 °C
	0.082	0.078	0.022	+15 °C to +35 °C
+7	0.046	**0.044**	0.022	+20 °C to +25 °C
+1	0.205	0.027	0.215	0 °C to +50 °C
	0.081	0.022	0.078	+15 °C to +35 °C
–13	**0.044**	**0.022**	**0.044**	+20 °C to +25 °C
–19	0.023	0.205	0.206	0 °C to +50 °C
	0.022	0.081	0.082	+15 °C to +35 °C
–67	0.022	**0.044**	0.046	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

100 MHz to 4 GHz

+23	0.209	0.218	0.038	0 °C to +50 °C
	0.088	0.085	0.032	+15 °C to +35 °C
+7	0.055	0.047	0.031	+20 °C to +25 °C
+1	0.206	0.028	0.218	0 °C to +50 °C
	0.083	0.022	0.085	+15 °C to +35 °C
–13	0.048	0.022	0.047	+20 °C to +25 °C
–19	0.023	0.206	0.209	0 °C to +50 °C
	0.022	0.083	0.088	+15 °C to +35 °C
–67	0.022	0.048	0.055	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

> 4 GHz to 8 GHz

+23	0.215	0.223	0.049	0 °C to +50 °C
	0.097	0.093	0.044	+15 °C to +35 °C
+7	0.066	0.059	0.043	+20 °C to +25 °C
+1	0.210	0.030	0.223	0 °C to +50 °C
	0.088	0.022	0.093	+15 °C to +35 °C
–13	0.054	0.022	0.059	+20 °C to +25 °C
–19	0.024	0.210	0.215	0 °C to +50 °C
	0.022	0.088	0.097	+15 °C to +35 °C
–67	0.022	0.054	0.066	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

> 8 GHz to 12.4 GHz

+23	0.224	0.231	0.064	0 °C to +50 °C
	0.111	0.106	0.061	+15 °C to +35 °C
+7	0.084	0.077	0.060	+20 °C to +25 °C
+1	0.216	0.034	0.231	0 °C to +50 °C
	0.096	0.027	0.106	+15 °C to +35 °C
–13	0.063	0.025	0.077	+20 °C to +25 °C
–19	0.024	0.216	0.224	0 °C to +50 °C
	0.022	0.096	0.111	+15 °C to +35 °C
–67	0.022	0.063	0.084	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

> 12.4 GHz to 18 GHz

+23	0.244	0.245	0.086	0 °C to +50 °C
	0.135	0.128	0.084	+15 °C to +35 °C
+7	0.110	0.102	0.083	+20 °C to +25 °C
+1	0.230	0.040	0.245	0 °C to +50 °C
	0.112	0.034	0.128	+15 °C to +35 °C
–13	0.079	0.033	0.102	+20 °C to +25 °C
–19	0.024	0.230	0.244	0 °C to +50 °C
	0.022	0.112	0.135	+15 °C to +35 °C
–67	0.022	0.079	0.110	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23
Power level in dBm

R&S®NRP-Z31 universal power sensor

Frequency range		10 MHz to 33 GHz	
Impedance matching (SWR)	10 MHz to 2.4 GHz	< 1.13 (**1.11**)	( ): +15 °C to +35 °C
	> 2.4 GHz to 8.0 GHz	< 1.20 (**1.18**)	
	> 8.0 GHz to 18.0 GHz	< 1.25 (**1.23**)	
	> 18.0 GHz to 26.5 GHz	< 1.30 (**1.28**)	
	> 26.5 GHz to 33.0 GHz	< 1.35 (**1.33**)	
Power measurement range	Continuous Average	200 pW to 200 mW (–67 dBm to +23 dBm)	
	Burst Average	200 nW to 200 mW (–37 dBm to +23 dBm)	
	Timeslot/Gate Average	600 pW to 200 mW (–62 dBm to +23 dBm) [1]	
	Trace	10 nW to 200 mW (–50 dBm to +23 dBm) [2]	
Max. power	average power	0.4 W (+26 dBm), continuous	
	peak envelope power	1.0 W (+30 dBm) for max. 10 µs	
Measurement subranges	path 1	–67 dBm to –14 dBm	
	path 2	–47 dBm to +6 dBm	
	path 3	–27 dBm to +23 dBm	
Transition regions	with automatic path selection, user-defined crossover [3] set to 0 dB	(–19 ± 1) dBm to (–13 ± 1) dBm (+1 ± 1) dBm to (+7 ± 1) dBm	
Dynamic response	video bandwidth	> 50 kHz (100 kHz)	( ): +15 °C to +35 °C
	single-shot bandwidth	> 50 kHz (100 kHz)	
	rise time 10 %/90 %	< 8 µs (4 µs)	
Acquisition	sample rate (continuous)	133.358 kHz (default) or 119.467 kHz [4]	
Triggering	internal		
	threshold level range	–40 dBm to +23 dBm	
	threshold level accuracy	identical to uncertainty for absolute power measurements	
	threshold level hysteresis	0 dB to 10 dB	
	dropout [5]	0 s to 10 s	
	external	see R&S®NRP2 base unit, R&S®NRP-Z3 USB adapter or R&S®NRP-Z5 USB sensor hub	
	slope (external, internal)	pos./neg.	
	delay	–5 ms to +100 s	
	hold-off	0 s to 10 s	
	resolution (delay, hold-off, dropout)	sample period (≈ 8 µs)	
	source	internal, external, immediate, bus, hold	
Zero offset	initial, without zeroing		( ): typical at 1 GHz +15 °C to +35 °C [ ]: 8 GHz to 33 GHz
	path 1	< 470 [500] (100) pW	
	path 2	< 47 [50] (10) nW	
	path 3	< 2.4 [2.5] (0.5) µW	
	after external zeroing [6] [7]		
	path 1	< 104 [113] (64) pW	
	path 2	< 10 [11] (6) nW	
	path 3	< 0.5 [0.6] (0.3) µW	
Zero drift [8]	path 1	< 35 [38] (0) pW	
	path 2	< 3.0 [3.3] (0) nW	
	path 3	< 0.15 [0.18] (0) µW	
Measurement noise [9]	path 1	< 65 [71] (40) pW	
	path 2	< 6.3 [6.8] (4.0) nW	
	path 3	< 0.32 [0.37] (0.2) µW	

R&S®NRP-Z31 universal power sensor (continued)

Uncertainty for absolute power measurements [10] in dB

Power level in dBm

Frequency	–67 to –19	–19 to +1	+1 to +23	Temperature
10 MHz to < 20 MHz	*0.178*	*0.174*	*0.188*	0 °C to +50 °C
	0.080	*0.081*	*0.084*	+15 °C to +35 °C
	0.051	*0.053*	*0.054*	+20 °C to +25 °C
20 MHz to < 100 MHz	*0.150*	*0.158*	*0.171*	0 °C to +50 °C
	0.077	*0.079*	*0.082*	+15 °C to +35 °C
	0.051	*0.053*	*0.053*	+20 °C to +25 °C
100 MHz to 4 GHz	*0.156*	*0.163*	*0.175*	0 °C to +50 °C
	0.085	*0.087*	*0.089*	+15 °C to +35 °C
	0.061	*0.063*	*0.063*	+20 °C to +25 °C
> 4 GHz to 8 GHz	*0.163*	*0.169*	*0.179*	0 °C to +50 °C
	0.088	*0.090*	*0.091*	+15 °C to +35 °C
	0.063	*0.065*	*0.065*	+20 °C to +25 °C
> 8 GHz to 12.4 GHz	*0.175*	*0.178*	*0.186*	0 °C to +50 °C
	0.095	*0.097*	*0.098*	+15 °C to +35 °C
	0.070	*0.072*	*0.072*	+20 °C to +25 °C
> 12.4 GHz to 18 GHz	*0.196*	*0.198*	*0.202*	0 °C to +50 °C
	0.112	*0.114*	*0.116*	+15 °C to +35 °C
	0.089	*0.090*	*0.092*	+20 °C to +25 °C
> 18 GHz to 26.5 GHz	*0.217*	*0.222*	*0.228*	0 °C to +50 °C
	0.116	*0.120*	*0.129*	+15 °C to +35 °C
	0.088	*0.090*	*0.100*	+20 °C to +25 °C
> 26.5 GHz to 33 GHz	*0.247*	*0.257*	*0.273*	0 °C to +50 °C
	0.142	*0.149*	*0.167*	+15 °C to +35 °C
	0.116	*0.119*	*0.137*	+20 °C to +25 °C

R&S®NRP-Z31 universal power sensor (continued)

Uncertainty for relative power measurements [11] in dB

10 MHz to < 20 MHz

+23	0.245	0.221	0.040	0 °C to +50 °C
	0.099	0.095	0.022	+15 °C to +35 °C
+7	0.044	0.044	0.022	+20 °C to +25 °C
+1	0.227	0.029	0.221	0 °C to +50 °C
	0.093	0.022	0.095	+15 °C to +35 °C
–13	0.044	0.022	0.044	+20 °C to +25 °C
–19	0.030	0.227	0.245	0 °C to +50 °C
	0.022	0.093	0.099	+15 °C to +35 °C
–67	0.022	0.044	0.044	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

20 MHz to < 100 MHz

+23	0.217	0.219	0.026	0 °C to +50 °C
	0.093	0.094	0.022	+15 °C to +35 °C
+7	0.044	**0.044**	0.022	+20 °C to +25 °C
+1	0.204	0.024	0.219	0 °C to +50 °C
	0.090	0.022	0.094	+15 °C to +35 °C
–13	**0.044**	**0.022**	**0.044**	+20 °C to +25 °C
–19	0.022	0.204	0.217	0 °C to +50 °C
	0.022	0.090	0.093	+15 °C to +35 °C
–67	0.022	**0.044**	0.044	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

100 MHz to 4 GHz

+23	0.219	0.225	0.026	0 °C to +50 °C
	0.096	0.098	0.022	+15 °C to +35 °C
+7	0.044	0.045	0.022	+20 °C to +25 °C
+1	0.209	0.026	0.225	0 °C to +50 °C
	0.093	0.022	0.098	+15 °C to +35 °C
–13	0.044	0.022	0.045	+20 °C to +25 °C
–19	0.022	0.209	0.219	0 °C to +50 °C
	0.022	0.093	0.096	+15 °C to +35 °C
–67	0.022	0.044	0.044	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

> 4 GHz to 8 GHz

+23	0.226	0.232	0.029	0 °C to +50 °C
	0.100	0.102	0.023	+15 °C to +35 °C
+7	0.046	0.048	0.022	+20 °C to +25 °C
+1	0.217	0.028	0.232	0 °C to +50 °C
	0.097	0.022	0.102	+15 °C to +35 °C
–13	0.044	0.022	0.048	+20 °C to +25 °C
–19	0.022	0.217	0.226	0 °C to +50 °C
	0.022	0.097	0.100	+15 °C to +35 °C
–67	0.022	0.044	0.046	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

> 8 GHz to 12.4 GHz

+23	0.235	0.240	0.032	0 °C to +50 °C
	0.105	0.107	0.027	+15 °C to +35 °C
+7	0.051	0.053	0.026	+20 °C to +25 °C
+1	0.232	0.031	0.240	0 °C to +50 °C
	0.102	0.025	0.107	+15 °C to +35 °C
–13	0.045	0.02	0.053	+20 °C to +25 °C
–19	0.023	0.232	0.235	0 °C to +50 °C
	0.022	0.102	0.105	+15 °C to +35 °C
–67	0.022	0.045	0.051	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

> 12.4 GHz to 18 GHz

+23	0.249	0.255	0.039	0 °C to +50 °C
	0.115	0.117	0.034	+15 °C to +35 °C
+7	0.060	0.063	0.033	+20 °C to +25 °C
+1	0.252	0.034	0.255	0 °C to +50 °C
	0.109	0.029	0.117	+15 °C to +35 °C
–13	0.049	0.028	0.063	+20 °C to +25 °C
–19	0.024	0.252	0.249	0 °C to +50 °C
	0.022	0.109	0.115	+15 °C to +35 °C
–67	0.022	0.049	0.060	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

> 18 GHz to 26.5 GHz

+23	0.287	0.289	0.057	0 °C to +50 °C
	0.139	0.142	0.053	+15 °C to +35 °C
+7	0.086	0.088	0.052	+20 °C to +25 °C
+1	0.285	0.041	0.289	0 °C to +50 °C
	0.121	0.035	0.142	+15 °C to +35 °C
–13	0.057	0.034	0.088	+20 °C to +25 °C
–19	0.026	0.285	0.287	0 °C to +50 °C
	0.022	0.121	0.139	+15 °C to +35 °C
–67	0.022	0.057	0.086	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

> 26.5 GHz to 33 GHz

+23	0.327	0.331	0.073	0 °C to +50 °C
	0.169	0.172	0.074	+15 °C to +35 °C
+7	0.116	0.118	0.077	+20 °C to +25 °C
+1	0.312	0.047	0.331	0 °C to +50 °C
	0.132	0.041	0.172	+15 °C to +35 °C
–13	0.066	0.040	0.118	+20 °C to +25 °C
–19	0.028	0.312	0.327	0 °C to +50 °C
	0.022	0.132	0.169	+15 °C to +35 °C
–67	0.022	0.066	0.116	+20 °C to +25 °C

–67 –19/–13 +1/+7 +23

Power level in dBm

Additional characteristics of the R&S®NRP-Z11/-Z21/-Z31/-Z22/-Z23/-Z24 universal power sensors

Sensor type		three-path diode power sensor; R&S®NRP-Z22/-Z23/-Z24 with preceding RF power attenuator
Measurand		power of incident wave
		power of source (DUT) into 50 Ω [13]
RF connector	R&S®NRP-Z11/-Z21/-Z22/-Z23/-Z24	N (male)
	R&S®NRP-Z31	3.5 mm (male)
RF attenuation [14]	R&S®NRP-Z11/-Z21/-Z31	not applicable
	R&S®NRP-Z22	10 dB
	R&S®NRP-Z23	20 dB
	R&S®NRP-Z24	25 dB
Measurement functions	stationary and recurring waveforms	Continuous Average
		Burst Average
		Timeslot/Gate Average
		Trace
	single events	Trace
Continuous Average function	measurand	mean power over recurring acquisition interval
	aperture	10 µs to 300 ms (20 ms default)
	window function	uniform or von Hann [15]
	duty cycle correction [16]	0.001 % to 99.999 %
	capacity of measurement buffer [17]	1 to 1024 results
Burst Average function	measurand	mean power over burst portion of recurring signal (trigger settings required)
	detectable burst width	20 µs to 50 ms
	minimum gap between bursts	10 µs
	dropout period [18] for burst end detection	0 to 3 ms
	exclusion periods [19]	
	start	0 to burst width
	end	0 s to 3 ms
	resolution (dropout and exclusion periods)	sample period (≈ 8 µs)
Timeslot/Gate Average function	measurand	mean power over individual timeslots/gates of recurring signal
	number of timeslots/gates	1 to 128 (consecutive)
	nominal length	10 µs to 0.1 s
	start of first timeslot/gate	at delayed trigger event
	exclusion periods [19]	
	start	0 to nominal length
	end	0 s to 3 ms
	resolution (nominal length and exclusion periods)	sample period (≈ 8 µs)
Trace function	measurand	mean power over pixel length
	acquisition	
	length (Δ)	100 µs to 300 ms
	start (referenced to delayed trigger)	–5 ms to 100 s
	result	
	pixels (M)	1 to 1024
	resolution (Δ/M)	
	non-recurring or internally triggered	≥ 10 µs
	recurring and externally triggered	≥ 2.5 µs

Additional characteristics of the R&S®NRP-Z11/-Z21/-Z31/-Z22/-Z23/-Z24 universal power sensors (continued)

Averaging filter	modes	AUTO OFF (fixed averaging number)	
		AUTO ON (continuously auto-adapted)	
		AUTO ONCE (automatically fixed once)	
	AUTO OFF		
	supported measurement functions	all	
	averaging number	2^N ; N = 0 to 16 (13 for Trace function)	
	AUTO ON/ONCE		
	supported measurement functions	Continuous Average, Burst Average, Timeslot/Gate Average	
	Normal operating mode	averaging number adapted to resolution setting and power to be measured	
	Fixed Noise operating mode	averaging number adapted to specified noise content	
	result output		
	Moving mode	continuous, independent of averaging number	
	rate	can be limited to 0.1 s^{-1}	
	Repeat mode	only final result	
Attenuation correction	function	corrects the measurement result by means of a fixed factor (dB offset)	
	range	–200.000 dB to +200.000 dB	
Embedding [20]	function	incorporates a two-port device at the sensor input so that the measurement plane is shifted to the input of this device	
	parameters	S_{11}, S_{21}, S_{12} and S_{22} of device	
	frequencies	1 to 1000	
Gamma correction	function	removes the influence of impedance mismatch from the measurement result so that the power of the source (DUT) into 50 Ω can be read	
	parameters	magnitude and phase of reflection coefficient of source (DUT)	
Frequency response correction	function	takes the frequency response of the sensor section and of the RF power attenuator into account (if applicable)	
	parameter	center frequency of test signal	
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute and relative power measurements	
Measurement times [21]	Continuous Average	2 × (aperture + 105 µs) × 2^N + t_z	
2^N: averaging number	buffered [17], without averaging	2 × (aperture + 250 µs) × buffer size + t_z	
T: set number of timeslots	Timeslot/Gate Average		
w: nominal length of timeslot	signal period – $T \times w$ > 100 µs	≤ 2 × signal period × (2^N + ½) + t_z	
	all other cases	≤ 4 × signal period × (2^N + ¼) + t_z t_z : < 1.6 ms (0.9 ms, typical)	
Zeroing (duration)	depends on setting of averaging filter		
	AUTO ON	4 s	
	AUTO OFF, integration time [22]		
	< 4 s	4 s	
	4 s to 16 s	integration time	
	> 16 s	16 s	
Measurement error due to harmonics [23]	R&S®NRP-Z11/-Z2x: all paths R&S®NRP-Z31: paths 1 and 2	n = 2 / n = 3	n: multiple of carrier frequency
	–30 dBc	< 0.001 dB / < 0.003 dB	
	–20 dBc	< 0.002 dB / < 0.010 dB	
	–10 dBc	< 0.010 dB / < 0.040 dB	
	R&S®NRP-Z31: path 3	n = 2 / n = 3	
	–40 dBc	< 0.001 dB / < 0.010 dB	
	–30 dBc	< 0.002 dB / < 0.040 dB	
	–20 dBc	< 0.010 dB / < 0.100 dB	
Measurement error due to modulation [24]	general	depends on CCDF and RF bandwidth of test signal	
	WCDMA (3GPP test model 1-64)		
	worst case	–0.02 dB to +0.07 dB	
	typical	–0.01 dB to +0.03 dB	

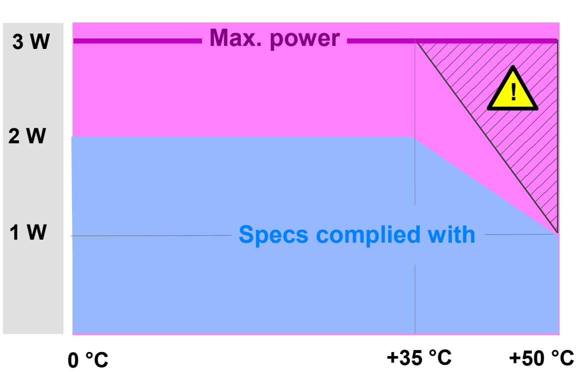
Additional characteristics of the R&S®NRP-Z11/-Z21/-Z31/-Z22/-Z23/-Z24 universal power sensors (continued)

Change of input reflection coefficient with respect to power [25]	10 MHz to 2.4 GHz	< 0.02 (0.01)	( ): +15 °C to +35 °C	
	> 2.4 GHz	< 0.03 (0.02)		
Calibration uncertainty [26]	R&S®NRP-Z11/-Z21	path 1	path 2	path 3
	10 MHz to < 100 MHz	*0.056 dB*	*0.047 dB*	*0.048 dB*
	100 MHz to 4.0 GHz	*0.066 dB*	*0.057 dB*	*0.057 dB*
	> 4.0 GHz to 8.0 GHz	*0.083 dB*	*0.071 dB*	*0.072 dB*
	> 8.0 GHz to 12.4 GHz	*0.094 dB*	*0.076 dB*	*0.076 dB*
	> 12.4 GHz to 18.0 GHz	*0.123 dB*	*0.099 dB*	*0.099 dB*
	R&S®NRP-Z31	path 1	path 2	path 3
	10 MHz to < 100 MHz	*0.051 dB*	*0.053 dB*	*0.053 dB*
	100 MHz to 4.0 GHz	*0.061 dB*	*0.062 dB*	*0.062 dB*
	> 4.0 GHz to 8.0 GHz	*0.063 dB*	*0.063 dB*	*0.063 dB*
	> 8.0 GHz to 12.4 GHz	*0.070 dB*	*0.069 dB*	*0.069 dB*
	> 12.4 GHz to 18.0 GHz	*0.088 dB*	*0.087 dB*	*0.087 dB*
	> 18.0 GHz to 26.5 GHz	*0.088 dB*	*0.085 dB*	*0.087 dB*
	> 26.5 GHz to 33.0 GHz	*0.116 dB*	*0.113 dB*	*0.117 dB*
	R&S®NRP-Z22/-Z23/-Z24 [27]	path 1	path 2	path 3
	10 MHz to < 100 MHz	*0.078 dB*	*0.072 dB*	*0.073 dB*
	100 MHz to 4.0 GHz	*0.084 dB*	*0.077 dB*	*0.077 dB*
	> 4.0 GHz to 12.4 GHz	*0.110 dB*	*0.095 dB*	*0.095 dB*
	> 12.4 GHz to 18.0 GHz	*0.139 dB*	*0.118 dB*	*0.118 dB*
Interface to host	power supply	+5 V/0.2 A (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 V/+3.3 V)		
	connector type	ODU Mini-Snap® L series, six-pole cylindrical straight plug		
	permissible total cable length	≤ 10 m (see also tables on page 52)		
Dimensions (W × H × L)	R&S®NRP-Z11/-Z21/-Z31	48 mm × 31 mm × 170 mm (1.89 in × 1.22 in × 6.69 in)		
	R&S®NRP-Z22	48 mm × 31 mm × 214 mm (1.89 in × 1.22 in × 8.42 in)		
	R&S®NRP-Z23	60 mm × 54 mm × 285 mm (2.36 in × 2.13 in × 11.22 in)		
	R&S®NRP-Z24	60 mm × 54 mm × 344 mm (2.36 in × 2.13 in × 13.54 in)		
	length including connecting cable	approx. 1.6 m (62.99 in)		
Weight	R&S®NRP-Z11/-Z21/-Z31	< 0.30 kg (0.66 lb)		
	R&S®NRP-Z22	< 0.37 kg (0.82 lb)		
	R&S®NRP-Z23	< 0.48 kg (1.06 lb)		
	R&S®NRP-Z24	< 0.63 kg (1.39 lb)		

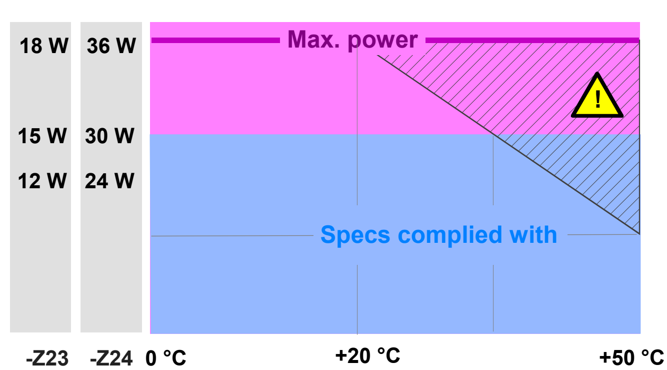
Power rating of the R&S®NRP-Z22/-Z23/-Z24

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

R&S®NRP-Z22



R&S®NRP-Z23/-Z24



Accessories for sensors

R&S®NRP-Z2 extension cables

Application		for extending the connection between an R&S®NRP-Zxx power sensor and the R&S®NRP2 base unit, another Rohde & Schwarz measuring instrument, an R&S®NRP-Z3/-Z4 USB adapter or an R&S®NRP-Z5 USB sensor hub
Connectors	type	ODU Mini-Snap® L series, size 2, six-pole receptacle
	sensor side	
	model .03/.05/.10	in-line receptacle
	model .15	panel-mount receptacle (bulkhead jack) for < 5 mm wall thickness
	host side	straight plug
Length	model .03	1.5 m
	model .05/.15	3.5 m
	model .10	8.5 m
Permissible total length	including power sensor and R&S®NRP2 base unit or R&S®NRP-Z3/-Z4 USB adapter or R&S®NRP-Z5 USB sensor hub, if applicable	see tables below

Supported combinations with R&S®NRP2 base unit or other Rohde & Schwarz measuring instruments with ODU Mini-Snap® receptacle (e.g. R&S®FSMR, R&S®SMA200A, R&S®SMF100A)

R&S®NRP-Zxx power sensor	+	R&S®NRP-Z2 model .03	R&S®NRP-Z2 model .05 .15	R&S®NRP-Z2 model .10	=	total length in m
•		•	–	–		3.0
•		–	•	–		5.0
•		–	–	•		10.0

shaded combinations not permissible for R&S®NRP-Z81/-Z85/-Z86 power sensors

Supported combinations with R&S®NRP-Z3/-Z4 USB adapters

R&S®NRP-Zxx power sensor	+	R&S®NRP-Z2 model .03	R&S®NRP-Z2 model .05 .15	+	R&S®NRP-Z4 model .04	R&S®NRP-Z3/-Z4 model .02	=	total length in m
•		–	–		•	–		2.0
•		–	–		–	•		3.5
•		•	–		–	•		5.0
•			•		•	–		5.5
•			•		–	•		7.0

Supported combinations with R&S®NRP-Z5 USB sensor hub (cable between sensor and hub)

R&S®NRP-Zxx power sensor	+	R&S®NRP-Z2 model .03	R&S®NRP-Z2 model .05 .15	R&S®NRP-Z2 model .10	+	R&S®NRP-Z5 USB sensor hub	=	total length in m
•		•	–	–		•		3.0
•		–	•	–		•		5.0
•		–	–	•		•		10.0

Supported combinations with R&S®NRP-Z5 USB sensor hub (cable between hub and host)

R&S®NRP-Z5 USB sensor hub	+	R&S®NRP-Z2 model .03	R&S®NRP-Z2 model .05 .15	R&S®NRP-Z4 model .04	R&S®NRP-Z4 model .02	standard USB cable (max. length: 5 m)	=	total length in m
•		•	–	–	–	–		3.0
•		–	•	–	–	–		5.0
•		–	–	•	–	–		0.5
•		–	–	–	•	–		2.0
•		–	–	–	–	•		5.0

R&S®NRP-Z3 active USB adapter

Application		for connecting an R&S®NRP-Zxx power sensor to a USB host (PC or Rohde & Schwarz measuring instrument with type A receptacle)
Trigger input	maximum voltage	±15 V
	logic level	
	low	< 0.8 V
	high	> 2.0 V
	input impedance	approx. 5 kΩ
Connectors	sensor	ODU Mini-Snap® L series, size 2, six-pole receptacle
	USB host	USB type A plug
Plug-in power supply	voltage/frequency	100 V to 240 V / 50 Hz to 60 Hz
	tolerance	±10 % for voltage, ±3 Hz for frequency
	current consumption	25 mA (typical) with sensor connected
	connection	via adapter to all common AC supplies (Europe, UK, USA, Australia)
Dimensions (W × H × L)	USB adapter	48 mm × 45 mm × 140 mm (1.89 in × 1.77 in × 5.51 in)
	length including connecting cable	approx. 2 m (78.74 in)
	plug-in power supply	52 mm × 73 mm × 110 mm (2.05 in × 2.87 in × 4.33 in)
	length of line to USB adapter	approx. 2 m (78.74 in)
Weight	USB adapter	< 0.2 kg (0.44 lb)
	plug-in power supply	< 0.3 kg (0.66 lb)

R&S®NRP-Z4 passive USB adapter cable

Application		for connecting an R&S®NRP-Zxx power sensor to a USB host (PC or Rohde & Schwarz measuring instrument with type A receptacle)
Connectors	sensor side	ODU Mini-Snap® L series, size 2, six-pole receptacle
	host side	USB type A plug
Dimensions (length)	model .02	approx. 2 m (78.74 in)
	model .04	approx. 0.5 m (19.69 in)

R&S®NRP-Z5 USB sensor hub

Application		for connecting up to four R&S®NRP-Zxx power sensors to • a USB host (PC or Rohde & Schwarz measuring instrument with type A receptacle) • a Rohde & Schwarz measuring instrument (other than the R&S®NRP2) with circular sensor connector (ODU Mini-Snap® L series, size 2, six-pole receptacle)
Trigger input	maximum voltage	±8 V
	logic level	
	low	< 0.8 V
	high	> 2.0 V
	input impedance	approx. 10 kΩ
	minimum pulse width	35 ns (without R&S®NRP-Z2 extension cable)
Trigger output	high-level output voltage	< 5.3 V (no load), > 2.0 V (50 Ω)
	low-level output voltage	< 0.4 V at 5 mA sink current
Power supply	voltage/power	12 V to 24 V (DC) / 24 W
	source	AC adapter supplied with the equipment or equivalent DC voltage source no supply from extra-low voltage supply systems or via secondary cables > 30 m (98.43 ft)
Connectors	sensors A to D	ODU Mini-Snap® L series, size 2, six-pole receptacle
	USB host	USB type B receptacle (certified USB 2.0 high-speed cable supplied with the equipment)
	for Rohde & Schwarz instrument	ODU Mini-Snap® L series, size 2, six-pole plug
	trigger input, trigger output	BNC receptacle
	power supply	receptacle for DC barrel connector, ∅ 5.5 mm × ∅ 2.1 mm × 9.5 mm; inner conductor is positive pole
Dimensions (W × H × L)	sensor hub	140.6 mm × 36.6 mm × 138 mm (5.54 in × 1.44 in × 5.43 in)
Weight	excluding accessories	< 0.55 kg (1.21 lb)
AC adapter	input voltage/frequency	100 V to 240 V / 50 Hz to 60 Hz
	tolerance	±10 % for voltage, ±3 Hz for frequency
	input connector	C14 receptacle in line with IEC 60320
	output voltage/power	12 V (DC) / 36 W
	length of secondary cable	approx. 1.2 m (47.24 in)
	dimensions (W × H × L)	120 mm × 52 mm × 31 mm (4.72 in × 2.05 in × 1.22 in)
	weight	< 0.3 kg (0.66 lb)

R&S®NRP2 base unit

Application		multichannel power meter
Sensors		R&S®NRP-Zxx series
Measurement channels	R&S®NRP2	1
	R&S®NRP2 + R&S®NRP-B2	2
	R&S®NRP2 + R&S®NRP-B2 + R&S®NRP-B5	4
Measurement functionality	single-channel	see sensor specifications, plus: relative measurement referenced to result or user-selectable reference value, storage of minima and maxima (max, min, max – min), limit monitoring
	display	
	absolute	in W, dBm and dBμV
	relative	in dB, as change in percent (Δ %) or as quotient
	multichannel	simultaneous measurement in up to 4 channels; individual results, ratios, relative ratios [53] or difference of results of 2 channels can be displayed
	display	
	ratio	in dB, as change in percent (Δ %), as quotient or as one of the following impedance matching parameters: SWR, return loss, reflection coefficient
	relative ratio [53]	in dB, as change in percent (Δ %) or as quotient
	difference	difference of powers in W, expressed in W or dBm
Display	type	color TFT graphics screen[54], ¼ VGA (320 × 240 pixel), full size, with adjustable backlighting
	result representation	
	numeric measurements	up to 4 results can simultaneously be displayed in separate windows (full size, ½ size or ¼ size, depending on number of results)
	format	digital, digital and analog
	resolution	
	digital values	selectable in 4 steps: 0.001 dB/0.01 %/4½ digits (W, quotient) 0.01 dB/0.1 %/3½ digits (W, quotient) 0.1 dB/1.0 %/2½ digits (W, quotient) 1 dB/1.0 %/2½ digits (W, quotient)
	analog display	depending on user-definable scale end values
	additional information	min, max, max – min, mean, stdev and number of recent measurements, frequency
	measurement of power versus time	one or two[54] traces can be displayed in one full-size window: absolute power, difference in or ratio of the power of two channels
	additional information	marker, gate and timeslot measurements within view area
	power envelope statistics	CCDF, CDF and PDF versus absolute power in dBm or versus relative power referenced to the average power level
	additional information	marker measurements

R&S®NRP2 base unit (continued)

Manual operation		Windows-oriented menus with hotkeys for the most important functions
Remote control	systems	IEC 60625.1 (IEEE488.1) and IEC 60625.2 (IEEE488.2)
	command set	SCPI-1999.0
	IEC/IEEE bus	
	interface functions	SH1, AH1, L3, LE3, T5, TE5, SR1, PP1, PP2, RL1, DC1, E2, DT1, C0
	connector	24-pin Amphenol (female)
	USB TMC	
	connector	USB type B receptacle
	Ethernet LAN 10/100BaseT	
	connector	RJ-45 modular socket
Firmware download		from the R&S®NRP toolkit via the USB type B receptacle using a Windows-compatible program
Inputs/outputs (front panel)	A, B (R&S®NRP-B2 option)	test inputs for R&S®NRP-Zxx power sensors
	connector	ODU Mini-Snap® L series, size 2, six-pole receptacle
	POWER REF (R&S®NRP-B1 option)	1 mW/50 MHz test signal output
	connector	N (female)
Inputs/outputs (rear panel)	OUT1 / TRIG OUT	
	modes	TRIG OUT: Trigger Output [54] OUT1: Analog Output, Pass/Fail, OFF
	Trigger Output	output for trigger signal from/to sensors
	high-level output voltage	< 5.3 V (no load), > 2.0 V (50 Ω)
	low-level output voltage	< 0.4 V at 5 mA sink current
	output impedance	50 Ω
	Analog Output	recorder output; user-definable linear relation to measurement result of display windows 1 to 4
	Pass/Fail	limit indicator with two user-selectable output voltages for identifying the pass and fail states in the case of limit monitoring
	OFF	0 V
	voltage range OUT1	0 V to +3.3 V
	setting accuracy	±1 % of voltage reading + (0/+8 mV)
	resolution	12 bit (monotone)
	output impedance OUT1	1 kΩ
	connector	BNC (female)
	TRIG IN / OUT 2	
	modes	Analog Output and Trigger Input
	Analog Output	recorder output; user-definable linear relation to measurement result of display windows 1 to 4
	electrical characteristics	see OUT1
	Trigger Input	input for trigger signal to sensors
	maximum voltage	–7 V/+10 V
	logic level	
	low	< 0.8 V
	high	> 2.0 V
	impedance	10 kΩ//100 pF
	connector	BNC (female)
	sensor input C (A); D (B) (R&S®NRP-B5/-B6 option)	test inputs for R&S®NRP-Zxx power sensors
	connector	ODU Mini-Snap® L series, size 2, six-pole receptacle
Power supply	voltage, frequency	220 V to 240 V, 50 Hz to 60 Hz 100 V to 120 V, 50 Hz to 60 Hz and 400 Hz
	tolerance	±10 % for voltage and frequency
	apparent power	< 80 VA (including current consumption of up to four R&S®NRP-Zxx power sensors)
Dimensions	W × H × D	274 mm × 112 mm × 267 mm (10.79 in × 4.41 in × 10.51 in)
Weight		< 3.0 kg (6.61 lb)

Options for the R&S®NRP2 base unit

R&S®NRP-B1 sensor check source

Sensor check source	application	as a power reference for testing sensors
	frequency	50 MHz
	power	1.00 mW
	uncertainty	
	+20 °C to +25 °C	*0.85 %*
	0 °C to +50 °C	*1.00 %*
	SWR	< 1.05
	RF connector	N (female)

R&S®NRP-B2 second test input

Second test input (B)	application	for R&S®NRP-Zxx power sensors (available as standard on front panel)
	connector	ODU Mini-Snap® L series, size 2, six-pole receptacle

R&S®NRP-B5 third and fourth test input

Third (C) and fourth (D) test input	application	for R&S®NRP-Zxx power sensors (only on rear panel)
	connector	ODU Mini-Snap® L series, size 2, six-pole receptacle

R&S®NRP-B6 rear panel assembly

Rear-panel assembly	application	for test inputs A and B (only possible if the R&S®NRP-B5 option is not installed)

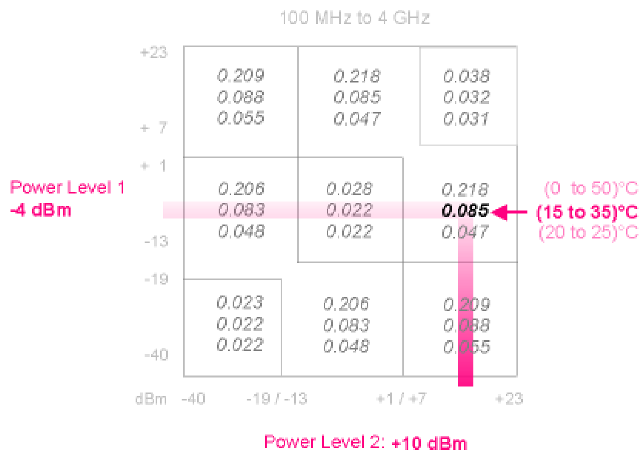
General data

Temperature loading [55]	operating and permissible temperature range (in [ ] if different)	in line with IEC 60068
	R&S®NRP2 base unit with options, R&S®NRP-Z5 USB sensor hub	0 °C to +50 °C
	R&S®NRP-Zxx power sensors, R&S®NRP-Z2 extension cables	0 °C [–10 °C] to +50 °C [+55 °C]
	R&S®NRP-Z3/-Z4 USB adapters	0 °C to +40 °C
	storage temperature range	
	R&S®NRP2 base unit with options, R&S®NRP-Z5 USB sensor hub	–20 °C to +70 °C
	R&S®NRP-Zxx power sensors, R&S®NRP-Z2 extension cables and R&S®NRP-Z3/-Z4 USB adapters	–40 °C to +70 °C
Climatic resistance		in line with EN 60068
	damp heat	+25 °C/+40 °C cyclic at 95 % relative humidity
	R&S®NRP-Zxx power sensors, R&S®NRP-Z3 USB adapters, R&S®NRP-Z5 USB sensor hub	with restrictions: non-condensing
Mechanical resistance	vibration	
	sinusoidal	5 Hz to 55 Hz, max. 2 g 55 Hz to 150 Hz, 0.5 g constant, in line with EN 60068
	random	10 Hz to 500 Hz, 1.9 g (RMS), in line with EN 60068
	shock	40 g shock spectrum, in line with EN 60068
	air pressure	
	operation	795 hPa (2000 m) to 1060 hPa
	transport	566 hPa (4500 m) to 1060 hPa
Electromagnetic compatibility		in line with EN 61326, EN 55011
Safety		in line with EN 61010-1
Calibration interval	for R&S®NRP-Z8x power sensors	1 year
	for all other R&S®NRP-Zxx power sensors and R&S®NRP-B1 sensor check source	2 years

Appendix

Reading the uncertainty of three-path diode power sensors for relative power measurements

The example shows a level step of approx. 14 dB (–4 dBm → +10 dBm) at 1.9 GHz and an ambient temperature of +28 °C for an R&S®NRP-Z21 power sensor.



Ordering information

Designation	Type	Order No.
Base unit		
Power Meter	R&S®NRP2	1144.1374.02
Options		
Sensor Check Source	R&S®NRP-B1	1146.9008.02
Second Sensor Input (B)	R&S®NRP-B2	1146.8801.02
3rd and 4th Sensor Inputs (C, D) [56]	R&S®NRP-B5	1146.9608.02
Rear-Panel Sensor Inputs A and B [57]	R&S®NRP-B6	1146.9908.02
Universal Power Sensors		
200 pW to 200 mW, 10 MHz to 8 GHz	R&S®NRP-Z11	1138.3004.02
200 pW to 200 mW, 10 MHz to 18 GHz	R&S®NRP-Z21	1137.6000.02
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
200 pW to 200 mW, 10 MHz to 33 GHz	R&S®NRP-Z31	1169.2400.02
Wideband Power Sensors		
1 nW to 100 mW, 50 MHz to 18 GHz	R&S®NRP-Z81	1137.9009.02
1 nW to 100 mW, 50 MHz to 40 GHz (2.92 mm)	R&S®NRP-Z85	1411.7501.02
1 nW to 100 mW, 50 MHz to 40 GHz (2.40 mm)	R&S®NRP-Z86	1417.0109.40
Thermal Power Sensors		
1 µW to 100 mW, DC to 18 GHz	R&S®NRP-Z51	1138.0005.02
1 µW to 100 mW, DC to 40 GHz	R&S®NRP-Z55	1138.2008.02
300 nW to 100 mW, DC to 50 GHz	R&S®NRP-Z56	1171.8201.02
300 nW to 100 mW, DC to 67 GHz	R&S®NRP-Z57	1171.8401.02
Average Power Sensors		
200 pW to 200 mW, 9 kHz to 6 GHz	R&S®NRP-Z91	1168.8004.02
2 nW to 2 W, 9 kHz to 6 GHz	R&S®NRP-Z92	1171.7005.02/42 [58]
Level Control Sensors		
200 pW to 100 mW, 9 kHz to 6 GHz	R&S®NRP-Z98	1170.8508.02
200 pW to 100 mW, 10 MHz to 18 GHz	R&S®NRP-Z28	1170.8008.02
Power Sensor Modules		
4 µW to 400 mW, DC to 18 GHz	R&S®NRP-Z27	1169.4102.02
4 µW to 400 mW, DC to 26.5 GHz	R&S®NRP-Z37	1169.3206.02
Recommended extras		
Sensor Extension Cable to 3 m	R&S®NRP-Z2	1146.6750.03
Sensor Extension Cable to 5 m	R&S®NRP-Z2	1146.6750.05
Sensor Extension Cable to 10 m	R&S®NRP-Z2	1146.6750.10
Panel-Mount Extension Cable to 5 m	R&S®NRP-Z2	1146.6750.15
USB Adapter (active)	R&S®NRP-Z3	1146.7005.02
USB Adapter (passive)	R&S®NRP-Z4	1146.8001.02
USB Sensor Hub	R&S®NRP-Z5	1146.7740.02
19" Rack Adapter (for one R&S®NRP2 power meter and one empty casing)	R&S®ZZA-T26	1109.4387.00
19" Rack Adapter (for two R&S®NRP2 power meters)	R&S®ZZA-T27	1109.4393.00
Service options		
Two-Year Calibration Service	R&S®CO2NRP2	Please contact your local Rohde & Schwarz sales office
Three-Year Calibration Service	R&S®CO3NRP2	
Five-Year Calibration Service	R&S®CO5NRP2	
One-Year Repair Service following the warranty period	R&S®RO2NRP2	
Two-Year Repair Service following the warranty period	R&S®RO3NRP2	
Four-Year Repair Service following the warranty period	R&S®RO5NRP2	

Footnotes

1 Specifications apply to timeslots/gates with a duration of 12.5 % referenced to the signal period (duty cycle 1:8). For other waveforms, the following equation applies: lower measurement limit = lower measurement limit for Continuous Average mode / √(duty cycle).

2 With a resolution of 256 pixels.

3 Transition regions can be lowered by as much as –20 dB using an adequate crossover setting.

4 To prevent aliasing in the case of signals with discrete modulation frequencies between 100 kHz and 1 MHz.

5 Time span prior to triggering, where the trigger signal must be entirely below the threshold level in the case of a positive slope and vice versa in the case of a negative slope.

6 Specifications expressed as an expanded uncertainty with a confidence level of 95 % (two standard deviations). For calculating zero offsets at higher confidence levels, use the properties of the normal distribution (e.g. 99.7 % confidence level for three standard deviations).

7 Specifications apply to zeroing with a duration of 4 s. Zeroing for more than 4 s lowers uncertainty correspondingly (half values for 16 s).

8 Within one hour after zeroing, permissible temperature change ±1 °C, following a two-hour warm-up of the power sensor.

9 Two standard deviations at 10.24 s integration time in Continuous Average mode, with aperture time set to default value. The integration time is defined as the total time used for signal acquisition, i.e. the product of twice the aperture time and the averaging number. Multiplying the noise specifications by √(10.24 s/integration time) yields the noise contribution at other integration times. Using a von Hann window function increases noise by a factor of 1.22.

10 Expanded uncertainty (k = 2) for absolute power measurements on CW signals with automatic path selection and a user-defined crossover setting of 0 dB. Specifications include calibration uncertainty, linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –35 dBm for the R&S®NRP-Z11/-Z21/-Z31/-Z91, –25 dBm for the R&S®NRP-Z22/-Z92 and –15 dBm for the R&S®NRP-Z24. The contribution of measurement noise depends on power and integration time and can be neglected below 0.01 dB.

Example: The uncertainty of a power measurement at 3.2 nW (–55 dBm) and 1.9 GHz is to be determined for an R&S®NRP-Z11. The ambient temperature is +29 ºC and the averaging number is set to 32 in the Continuous Average mode with an aperture time of 20 ms.

Since path 1 is used for the measurement, the typical absolute uncertainty due to zero offset is 64 pW (typical) after external zeroing, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{3.2\,\text{nW} + 64\,\text{pW}}{3.2\,\text{nW}} = 0.086\,\text{dB}$$

Using the formula in footnote 9, the absolute noise contribution of path 1 is typically 40 pW × √(10.24 s/(32 × 2 × 0.02 s)) = 113 pW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{3.2\,\text{nW} + 113\,\text{pW}}{3.2\,\text{nW}} = 0.151\,\text{dB}$$

Combined with the uncertainty of 0.081 dB for absolute power measurements under the given conditions, the total expanded uncertainty is

$$\sqrt{0.086^2 + 0.151^2 + 0.081^2}\,\text{dB} = 0.192\,\text{dB}\,.$$

The contribution of zero drift has been neglected in this case. It must be treated like zero offset if it is relevant for total uncertainty.

11 Expanded uncertainty (k = 2) for relative power measurements on CW signals with automatic path selection and a user-defined crossover setting of 0 dB. For reading the measurement uncertainty diagrams of universal, average and level control sensors, see the Appendix.

Specifications include calibration uncertainty (only if different paths are affected), linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –35 dBm for the R&S®NRP-Z11/-Z21/-Z31/-Z91, –25 dBm for the R&S®NRP-Z22/-Z92 and –15 dBm for the R&S®NRP-Z24. The contribution of measurement noise depends on power and integration time and can be neglected below 0.01 dB.

Example: The uncertainty of a power step from 1 mW (0 dBm) to 10 nW (–50 dBm) at 5.4 GHz is to be determined for an R&S®NRP-Z11. The ambient temperature is +20 ºC and the averaging number is set to 16 for both measurements in the Continuous Average mode with an aperture time of 20 ms. For the calculation of total uncertainty, the relative contribution of noise, zero offset and zero drift must be taken into account for both measurements . In this example, all contributions at 0 dBm and the effect of zero drift have been neglected.

Since path 1 is used for the –50 dBm measurement, the typical absolute uncertainty due to zero offset is 64 pW after external zeroing, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{10\,\text{nW} + 64\,\text{pW}}{10\,\text{nW}} = 0.028\,\text{dB}$$

Using the formula in footnote 9, the absolute noise contribution of path 1 is typically 40 pW × √(10.24 s/(16 × 2 × 0.02 s)) = 160 pW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{10\,\text{nW} + 160\,\text{pW}}{10\,\text{nW}} = 0.069\,\text{dB}$$

Combined with the uncertainty of 0.054 dB for relative power measurements under the given conditions, the total expanded uncertainty is

$$\sqrt{0.028^2 + 0.069^2 + 0.054^2}\,\text{dB} = 0.092\,\text{dB}$$

[12] Specifications are based on the assumption that the measurements follow each other so fast (at intervals of no more than 10 s) that the temperature of the power attenuator does not change significantly. In the case of the R&S®NRP-Z22/-Z92, the average power must not exceed 1 W to be compliant with accuracy specifications for relative power measurements.

[13] Gamma correction activated.

[14] Preceding sensor section (nominal value).

[15] Preferably used with determined modulation when the aperture time cannot be matched to the modulation period. Compared to a uniform window, measurement noise is about 22 % higher.

[16] For measuring the power of periodic bursts based on an average power measurement.

[17] To increase measurement speed, the power sensor can be operated in buffered mode. In this mode, measurement results are stored in a buffer of user-definable size and then output as a block of data when the buffer is full. To enhance measurement speed even further, the sensor can be set to record the entire series of measurements when triggered by a single event. In this case, the power sensor automatically starts a new measurement as soon as it has completed the previous one.

[18] This parameter enables power measurements on modulated bursts. The parameter must be longer in duration than modulation-induced power drops within the burst.

[19] To exclude unwanted portions of the signal from the measurement result.

[20] If embedding is used in conjunction with the R&S®NRP-Z22/-Z23/-Z24/-Z92, the data of the RF power attenuator preceding the sensor section is taken into account (automatically upon power-up of the sensor).

[21] Valid for Repeat mode, extending from the beginning to the end of all transfers via the USB interface of the power sensor. Measurement times under remote control of the R&S®NRP2 base unit via IEC/IEEE bus are approximately 2.5 ms longer, extending from the start of the measurement up to when the measurement result has been supplied to the output buffer of the R&S®NRP2.

[22] Integration time is defined as the total time used for signal acquisition, i.e. taking into account the chosen aperture/acquisition time and the averaging number.

[23] Magnitude of measurement error referenced to an ideal thermal power sensor that measures the sum power of carrier and harmonics. Specifications apply to automatic path selection and power levels up to +20 dBm, referenced to the input of the sensor section. Use the nominal RF attenuation of the R&S®NRP-Z22/-Z23/-Z24/-Z92 to calculate the equivalent input power for these power sensors. Above the mentioned power limit, specifications must be raised by a factor of 1.25 per 1 dB rise in power level. Within a subrange, measurement errors are proportional to the measured power in W. Specifications apply to 10 µW (–20 dBm) for path 1, 1 mW (0 dBm) for path 2 and 100 mW (+20 dBm) for path 3, referenced to the input of the sensor section.

[24] Measurement error referenced to a CW signal of equal power and frequency. Specifications apply to automatic path selection and power levels up to +20 dBm, referenced to the input of the sensor section. Use the nominal RF attenuation of the R&S®NRP-Z22/-Z23/-Z24/-Z92 to calculate the equivalent input power for these power sensors. Above the mentioned power limit, specifications must be raised by a factor of 1.25 per 1 dB rise in power level. Within a subrange, measurement errors are proportional to the measured power in W. Specifications apply to 10 µW (–20 dBm) for path 1, 1 mW (0 dBm) for path 2 and 100 mW (+20 dBm) for path 3, referenced to the input of the sensor section.

[25] Applies to the R&S®NRP-Z11/-Z21/-Z31/-Z91 and the sensor section of the R&S®NRP-Z22/-Z23/-Z24/-Z92, referenced to 0 dBm

[26] Expanded uncertainty (k = 2) for absolute power measurements on CW signals at the calibration level (–20 dBm for path 1, 0 dBm for paths 2 and 3) within a temperature range from +20 °C to +25 °C and at the calibration frequencies (10 MHz, 15 MHz, 20 MHz, 30 MHz, 50 MHz, 100 MHz; in steps of 250 MHz from 250 MHz to the upper frequency limit). Specifications include zero offset and display noise (up to a 2σ value of 0.004 dB).

[27] Specifications include sensor section and RF power attenuator.

[28] With full video bandwidth. Reduce the specified minimum levels according to the reduction of sampling noise at lower bandwidths.

[29] Specifications are valid from +15 °C to +50 °C ambient temperature. Below +15 °C, video bandwidth and single-shot bandwidth continuously decrease down to 20 MHz (typical) at 0 °C. Accordingly, the sensor rise time increases up to 50 ns for signals below 500 MHz and up to 20 ns for higher frequencies (typical at 0 °C).

[30] Specifications are valid at +23 °C ambient temperature for power levels ≤ –20 dBm and frequencies ≥ 500 MHz. For measurements at other temperatures levels and/or frequencies, use the multipliers from table A.

[31] Measured over a one-minute interval, at constant temperature, two standard deviations.

[32] 512k averages taken with the aperture time set to default (10 µs). The measurement noise with other averaging numbers can be calculated by applying the multipliers indicated below:

Averaging number	512k	128k	32k	8k	2k	512	128	32	8
Integration time	10.5 s	3.9 s	1.0 s	0.25 s	60 ms	15 ms	3.8 ms	1.0 ms	0.24 ms
Noise multiplier	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**

Using a von Hann window function further increases noise by a factor of 1.22. Integration time is defined as the total time used for signal acquisition, i.e. the product of twice the aperture time and the averaging number.

The measurement noise is always minimal for the default aperture time. Increasing the aperture time above this value is only useful for suppressing modulation-induced fluctuations of the measurement result, e.g. by matching the aperture time to the modulation period.

[33] Expanded uncertainty (k = 2) for absolute power measurements on CW signals. Specifications include calibration uncertainty, linearity, reflection of sensor-induced harmonics on the DUT, and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset and zero drift can be neglected for power levels above –35 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.02 dB.

Example: The power to be measured is 40 nW (–44 dBm) at 12 GHz in the Continuous Average mode; ambient temperature +35 ºC; averaging number set to 32k with an aperture time of 10 µs (1 s integration time).

The typical absolute uncertainty due to zero offset is 220 pW at +23 °C. From table A, a multiplier of 1.4 can be taken to read a typical zero offset of 308 pW at +35 °C. The corresponding relative measurement uncertainty can be calculated as follows:

$$10 \times \lg \frac{40\,\text{nW} + 308\,\text{pW}}{40\,\text{nW}} = 0.033\,\text{dB}$$

Using the noise multiplier (4) from footnote 32 and the multiplier (1.4) from table A, the absolute noise contribution is typically 110 pW × 4 × 1.4 = 616 pW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{40\,\text{nW} + 616\,\text{pW}}{40\,\text{nW}} = 0.066\,\text{dB}$$

Combined with the value of 0.18 dB specified for the uncertainty of absolute power measurements at 12 GHz, the total expanded uncertainty is

$$\sqrt{0.18^2 + 0.033^2 + 0.066^2}\,\text{dB} = 0.195\,\text{dB}$$

The contribution of zero drift has been neglected in this case. It must be treated like zero offset if it is relevant for total uncertainty.

[34] Magnitude of measurement error referenced to an ideal thermal power sensor that measures the sum power of carrier and harmonics. For power levels below –10 dBm, the specifications for 2 × f_0 (3 × f_0) can be lowered by a factor of √10 (10) per 10 dB below –10 dBm. Example: At 12 GHz/–30 dBm, the influence of the second harmonic, suppressed by 20 dBc, will cause an error of max. 0.25 dB ÷ 10 = 0.025 dB. Standard uncertainties can be assumed to be half the values.

[35] Expanded uncertainty (k = 2) for absolute power measurements on CW signals at the calibration level (–10 dBm) within a temperature range from +20 °C to +25 °C and at the calibration frequencies (50/55/60/68/80/100/200/300/400/499.99/500/600/720/850/1000/1500 MHz; R&S®NRP-Z81: in steps of 0.5 GHz from 2 GHz to the upper frequency limit; R&S®NRP-Z85/-Z86: in steps of 1 GHz from 2 GHz to 26 GHz and in steps of 0.5 GHz from 26.5 GHz to 40 GHz). Specifications include zero offset and display noise (up to a 2σ value of 0.01 dB).

[36] Expanded uncertainty (k = 2) for absolute power measurements. Specifications include calibration uncertainty, linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –15 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB.

Example: The power to be measured with an R&S®NRP-Z51 is 5 µW (–23 dBm) at 0.9 GHz; ambient temperature +29 ºC; averaging number set to 16 in Continuous Average mode with an aperture time of 20 ms. The typical absolute uncertainty due to zero offset (after external zeroing) is 33 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{5\,\mu\text{W} + 33\,\text{nW}}{5\,\mu\text{W}} = 0.029\,\text{dB}$$

Using the formula in footnote 9, the absolute noise contribution is typically 20 nW × √(10.24 s/(16 × 2 × 0.02 s)) = 80 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{5\,\mu\text{W} + 80\,\text{nW}}{5\,\mu\text{W}} = 0.069\,\text{dB}$$

Combined with the value of 0.066 dB specified for the uncertainty of absolute power measurements, the total expanded uncertainty is

$$\sqrt{0.066^2 + 0.029^2 + 0.069^2}\,\text{dB} = 0.100\,\text{dB}$$

[37] Expanded uncertainty (k = 2) for relative power measurements. Specifications include linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –15 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB. See also the example in footnote 11 for taking into account zero offset and noise with relative measurements.

[38] Expanded uncertainty (k = 2) for absolute power measurements at the calibration level (0 dBm) within a temperature range from +20 °C to +25 °C and at the calibration frequencies (10 MHz, 50 MHz, 100 MHz; in steps of 500 MHz from 500 MHz to the upper frequency limit). Specifications include zero offset and measurement noise (up to a 2σ value of 0.004 dB).

[39] Error of an absolute power measurement with respect to temperature.

[40] Expanded uncertainty for relative power measurements referenced to the calibration level (0 dBm), excluding zero offset, zero drift and measurement noise.

41 Expanded uncertainty (k = 2) for absolute power measurements. Specifications include calibration uncertainty, linearity and temperature effect. Zero offset and measurement noise must additionally be taken into account when measuring low powers, whereas zero drift is negligible over the entire measurement range. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –20 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB.

Example: The power to be measured with an R&S®NRP-Z56 is 5 µW (–23 dBm) at 48 GHz; ambient temperature +29 ºC; averaging number set to 64 in Continuous Average mode with an aperture time of 5 ms (default).

The absolute uncertainty due to zero offset (after external zeroing) is 25 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{5\,\mu W + 25\,nW}{5\,\mu W} = 0.022\,dB$$

Using the formula in footnote 9, the absolute noise contribution is 25 nW × √(10.24 s/(64 × 2 × 0.005 s)) = 100 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{5\,\mu W + 100\,nW}{5\,\mu W} = 0.086\,dB$$

Combined with the value of 0.149 dB specified for the uncertainty of absolute power measurements at 48 GHz and +29 ºC ambient temperature, the total expanded uncertainty is

$$\sqrt{0.149^2 + 0.022^2 + 0.086^2} = 0.173\,dB$$

42 Expanded uncertainty (k = 2) for relative power measurements. Specifications include linearity and temperature effect. Zero offset and measurement noise must additionally be taken into account when measuring low powers, whereas zero drift is negligible over the entire measurement range. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –20 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB. See also the example in footnote 11 for taking into account zero offset and noise with relative measurements.

43 With activated auto delay, the beginning of a measurement sequence is delayed so that settled readings are obtained even if the measurement command (remote trigger) coincides with a signal step up to ±10 dB.

44 Expanded uncertainty (k = 2) for absolute power measurements at the calibration level (0 dBm) within a temperature range from +20 °C to +25 °C and at the calibration frequencies (DC, 10 MHz, 50 MHz, 100 MHz; in steps of 500 MHz from 500 MHz to the upper frequency limit). Specifications include zero offset and measurement noise (up to a 2σ value of 0.004 dB).

45 Equivalent source SWR.

46 Between RF input and RF output (test port).

47 Expanded uncertainty (k = 2) for absolute power measurements up to 100 mW (+20 dBm) at the calibration frequencies (see footnote 49). Specifications include calibration uncertainty, linearity, temperature effect and interference from the wave reflected by the load on the RF output. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. If the measured power exceeds 100 mW, the power coefficient of the integrated power splitter must be taken into account (see footnote 51). As a rule of thumb, the contribution of zero offset can be neglected for power levels above –7 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB.

Example: The power to be measured with an R&S®NRP-Z37 is 50 µW (–13 dBm) at 19 GHz; ambient temperature +29 ºC; averaging number set to 64 in Continuous Average mode with an aperture time of 20 ms.

The maximum absolute uncertainty due to zero offset (after external zeroing) is 400 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{50\,\mu W + 400\,nW}{50\,\mu W} = 0.035\,dB$$

Using the formula in footnote 9, the maximum absolute noise contribution is 240 nW × √(10.24 s/(64 × 2 × 0.02 s)) = 480 nW, which corresponds to a relative measurement uncertainty of

$$10 \times \lg \frac{50\,\mu W + 480\,nW}{50\,\mu W} = 0.042\,dB$$

Combined with the value of 0.137 dB specified for the uncertainty of absolute power measurements, the total expanded uncertainty is

$$\sqrt{0.035^2 + 0.042^2 + 0.137^2}\,dB = 0.148\,dB$$

48 Expanded uncertainty (k = 2) for relative power measurements. Specifications include linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –7 dBm if external zeroing has been applied. The contribution of measurement noise can be neglected below 0.01 dB. See also the example in footnote 11 for taking into account zero offset and noise with relative measurements.

49 Expanded uncertainty (k = 2) for absolute power measurements at the calibration level (0 dBm) within a temperature range from +20 °C to +25 °C and at the calibration frequencies. Specifications include zero offset and measurement noise (up to a 2σ value of 0.004 dB). The load on the RF signal output must be of a low-reflection type (SWR < 1.05) or load interference correction must be applied.

Calibration frequencies: 0.1/0.5/1/3/5/10/50/100 MHz; in steps of 100 MHz from 100 MHz to the upper frequency limit.

50 Error of an absolute power measurement with respect to temperature, taking into account the power sensor section, the power splitter and the RF cable (temperature-dependent interference from the load on the RF signal output due to phase change).

51 Maximum change of insertion loss of the power splitter with respect to input power, leading to an equivalent measurement error of the power sensor module and a change of the power available at the RF signal output. The power coefficient should be taken into account if the input power exceeds 100 mW (+20 dBm).

[52] Measurement error due to interference of the wave reflected by a mismatched load on the RF signal output. Specifications are indicated for a 0.1 reflection coefficient of the load. Since the load interference error is proportional to the amplitude of the reflected wave, half (twice) the values will be encountered for a reflection coefficient of 0.05 (0.2). The error introduced by an R&S®FSMR26 at the RF signal output does not exceed ±0.06 dB from DC to 2 GHz, ±0.10 dB up to 18 GHz, and ±0.14 dB up to 26.5 GHz.

Values in ( ) represent residual error contribution after numeric load interference correction. This correction function requires the complex reflection coefficient of the load to be transferred to the power sensor module. The residual error contribution of an R&S®FSMR26 at the RF signal output does not exceed ±0.003 dB from DC to 2 GHz, ±0.04 dB up to 18 GHz, and ±0.07 dB up to 26.5 GHz.

[53] Quotient of a measured and a stored power ratio, e.g. for measuring gain compression of amplifiers.

[54] The complete functionality of the R&S®NRP2 will be available from mid 2011. It mainly includes color display, activation of trigger output and support of trigger master functionality (from spring 2011), as well as two-channel measurements in Trace mode (from mid 2011). All previously delivered base units can be upgraded free of charge.

[55] The operating temperature range defines the span of ambient temperature in which the instrument complies with specifications. In the permissible temperature range, the instrument is still functioning but compliance with specifications is not warranted.

[56] R&S®NRP-B2 option required.

[57] Not in conjunction with the R&S®NRP-B5 option.

[58] Order No. 1171.7005.42 includes an R&S®NRP-Z4 USB adapter cable (model .04; 0.5 m long).