R&S®NRP-Zxx
POWER SENSORS

Specifications

Specifications
Version 14.00

ROHDE&SCHWARZ
Make ideas real

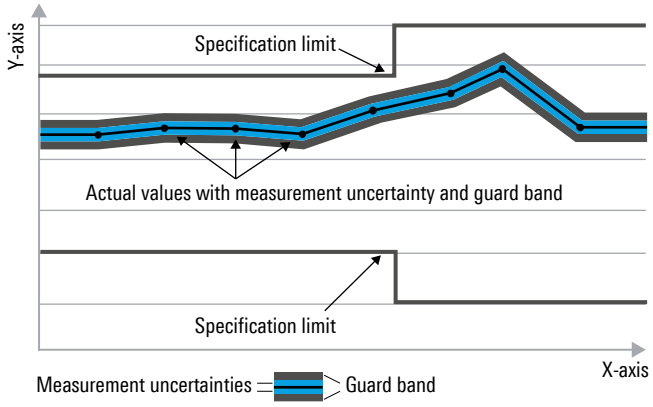
CONTENTS

Definitions

General
Product data applies under the following conditions:

- Three hours of storage at ambient temperature followed by 30 minutes of warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ± or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value, e.g. dimensions or resolution of a setting parameter. Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter, e.g. nominal impedance. In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: “parameter: value”.

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

In line with the 3GPP standard, chip rates are specified in million chips per second (Mcps), whereas bit rates and symbol rates are specified in billion bit per second (Gbps), million bit per second (Mbps), thousand bit per second (kbps), million symbols per second (Msps) or thousand symbols per second (ksps), and sample rates are specified in million samples per second (Msample/s). Gbps, Mcps, Mbps, Msps, kbps, ksps and Msample/s are not SI units.

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

Sensor type R&S®	Frequency range	Power range, max. average power / peak envelope power	Connector type
Level control sensors			
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
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			
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
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
NRP-Z47	DC to 50 GHz	5 µW to 1 W (–23 dBm to +30 dBm) max. 1.6 W (AVG) / 10 W (PK, 1 µs)	2.4 mm

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

<table>
<tr><th rowspan="2">Sensor type

R&S®</th><th rowspan="2">Impedance matching (SWR)</th><th rowspan="2">Rise time
Video BW</th><th rowspan="2">Zero offset (typ.)</th><th rowspan="2">Noise (typ.)</th><th colspan="2">Uncertainty for power measurements at +20 °C to +25 °C</th></tr>
<tr><th>absolute</th><th>relative</th></tr>
<tr><td colspan="7">Level control sensors</td></tr>
<tr><td>NRP-Z28</td><td>10 MHz to 2.4 GHz: < 1.11
> 2.4 GHz to 4.0 GHz: < 1.15
> 4.0 GHz to 8.0 GHz: < 1.22
> 8.0 GHz to 18 GHz: < 1.30</td><td>< 8 µs
> 50 kHz</td><td rowspan="2">67 pW</td><td rowspan="2">42 pW</td><td>0.047 dB to 0.130 dB</td><td>0.022 dB to 0.110 dB</td></tr>
<tr><td>NRP-Z98</td><td>9 kHz to 2.4 GHz: < 1.11
> 2.4 GHz to 4.0 GHz: < 1.15
> 4.0 GHz to 6.0 GHz: < 1.22</td><td>–</td><td>0.047 dB to 0.083 dB</td><td>0.022 dB to 0.066 dB</td></tr>
<tr><td colspan="7">Power sensor modules</td></tr>
<tr><td>NRP-Z27</td><td>DC to 2.0 GHz: < 1.15
> 2.0 GHz to 4.2 GHz: < 1.18
> 4.2 GHz to 8.0 GHz: < 1.23
> 8.0 GHz to 12.4 GHz: < 1.25
> 12.4 GHz to 18.0 GHz: < 1.35</td><td>–</td><td rowspan="3">200 nW</td><td rowspan="2">120 nW</td><td>0.070 dB to 0.112 dB</td><td>0.032 dB</td></tr>
<tr><td>NRP-Z37</td><td>DC to 2.0 GHz: < 1.15
> 2.0 GHz to 4.2 GHz: < 1.18
> 4.2 GHz to 8.0 GHz: < 1.23
> 8.0 GHz to 12.4 GHz: < 1.25
> 12.4 GHz to 18.0 GHz: < 1.30
> 18.0 GHz to 26.5 GHz: < 1.45</td><td>–</td><td>0.070 dB to 0.122 dB</td><td>0.032 dB</td></tr>
<tr><td>NRP-Z47</td><td>DC to 2.0 GHz: < 1.10
> 2.0 GHz to 4.2 GHz: < 1.18
> 4.2 GHz to 8.0 GHz: < 1.23
> 8.0 GHz to 12.4 GHz: < 1.25
> 12.4 GHz to 18.0 GHz: < 1.28
> 18.0 GHz to 26.5 GHz: < 1.40
> 26.5 GHz to 33.0 GHz: < 1.55
> 33.0 GHz to 40.0 GHz: < 1.70
> 40.0 GHz to 50.0 GHz: < 1.75</td><td>–</td><td>150 nW</td><td>0.070 dB to 0.176 dB</td><td>0.032 dB to 0.048 dB</td></tr>
</table>

Level control sensors in R&S®Smart Sensor Technology

R&S®NRP-Z28 level control sensor

Frequency range		10 MHz to 18 GHz		
Impedance matching (SWR) and insertion loss		input SWR	output SWR [1]	insertion loss [2] ( ): typical
	10 MHz to 2.4 GHz	< 1.35	< 1.11	< 8.0 (7.0) dB
	> 2.4 GHz to 4.0 GHz	< 1.45	< 1.15	< 8.5 (7.5) dB
	> 4.0 GHz to 8.0 GHz	< 1.75	< 1.22	< 9.5 (8.5) dB
	> 8.0 GHz to 12.4 GHz	< 1.80	< 1.30	< 10.5 (9) dB
	> 12.4 GHz to 18.0 GHz	< 1.90	< 1.30	< 11.0 (10) dB
Power measurement range RF output	continuous average	200 pW to 100 mW (–67 dBm to +20 dBm)		
	burst average	200 nW to 100 mW (–37 dBm to +20 dBm)		
	timeslot/gate average	600 pW to 100 mW (–62 dBm to +20 dBm) [3]		
	trace	10 nW to 100 mW (–50 dBm to +20 dBm) [4]		
Maximum power RF input	average power			
	10 MHz to 2.4 GHz	0.7 W (+28.5 dBm)		continuous
	> 2.4 GHz to 8.0 GHz	0.9 W (+29.5 dBm)		
	> 8.0 GHz to 12.4 GHz	1.1 W (+30.5 dBm)		
	> 12.4 GHz to 18.0 GHz	1.3 W (+31.0 dBm)		
	peak envelope power	7.5 dB above max. average power (for 10 µs)		
Measurement subranges	path 1	–67 dBm to –14 dBm		
	path 2	–46 dBm to +6 dBm		
	path 3	–26 dBm to +20 dBm		
Transition regions	with automatic path selection [5]	(–19 – 1/+ 2) dBm to (–13 – 1/ +2) dBm (+1 – 1/+ 2) dBm to (+7 – 1/+ 2) 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 [6]		
Triggering	internal			
	threshold level range	–40 dBm to +20 dBm		
	threshold level accuracy	identical to uncertainty for absolute power measurements		
	threshold level hysteresis	0 dB to 10 dB		
	dropout [7]	0 s to 10 s		
	external	see R&S®NRX base unit 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		
	source	internal, external, immediate, bus, hold		
Zero offset	initial, without zeroing			( ): typical at 1 GHz +15 °C to +35 °C [ ]: 8 GHz to 18 GHz
	path 1	< 505 [600] (100) pW		
	path 2	< 52 [60] (10) nW		
	path 3	< 5.2 [6] (1) µW		
	after external zeroing [8, 9]			
	path 1	< 114 [132] (67) pW		
	path 2	< 11 [13] (6) nW		
	path 3	< 1.1 [1.3] (0.6) µW		
Zero drift [10]	path 1	< 39 [44] (0) pW		
	path 2	< 3.3 [3.8] (0) nW		
	path 3	< 0.33 [0.38] (0) µW		
Measurement noise [11]	path 1	< 72 [83] (42) pW		
	path 2	< 7 [8] (4) nW		
	path 3	< 0.7 [0.8] (0.4) µW		

Uncertainty for absolute power measurements [12] in dB

10 MHz to < 20 MHz

0.174	*0.175*	*0.175*
0.075	*0.070*	*0.071*
0.056	*0.047*	*0.048*

–67 –19 +1 +20

Power level in dBm

20 MHz to < 100 MHz

0.147	*0.160*	*0.160*	0 °C to +50 °C
0.073	*0.069*	*0.069*	+15 °C to +35 °C
0.056	*0.047*	*0.048*	+20 °C to +25 °C

–67 –19 +1 +20

Power level in dBm

100 MHz to 4 GHz

0.159	*0.170*	*0.172*
0.084	*0.080*	*0.084*
0.066	*0.058*	*0.064*

–67 –19 +1 +20

Power level in dBm

> 4 GHz to 8 GHz

0.176	*0.185*	*0.189*	0 °C to +50 °C
0.101	*0.095*	*0.102*	+15 °C to +35 °C
0.083	*0.073*	*0.083*	+20 °C to +25 °C

–67 –19 +1 +20

Power level in dBm

> 8 GHz to 12.4 GHz

0.191	*0.198*	*0.205*
0.114	*0.104*	*0.117*
0.095	*0.080*	*0.097*

–67 –19 +1 +20

Power level in dBm

> 12.4 GHz to 18 GHz

0.218	*0.224*	*0.237*	0 °C to +50 °C
0.142	*0.130*	*0.151*	+15 °C to +35 °C
0.124	*0.105*	*0.130*	+20 °C to +25 °C

–67 –19 +1 +20

Power level in dBm

Uncertainty for relative power measurements [13] in dB

10 MHz to < 20 MHz

	–67	–19/–13	±0/+8	+20	
+20	*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

Power level in dBm

20 MHz to < 100 MHz

	–67	–19/–13	±0/+8	+20	
+20	*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

Power level in dBm

100 MHz to 4 GHz

	–67	–19/–13	+1/+7	+20	
+20	*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

Power level in dBm

> 4 GHz to 8 GHz

	–67	–19/–13	+1/+7	+20	
+20	*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

Power level in dBm

> 8 GHz to 12.4 GHz

	–67	–19/–13	+1/+7	+20	
+20	*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

Power level in dBm

> 12.4 GHz to 18 GHz

	–67	–19/–13	+1/+7	+20	
+20	*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

Power level in dBm

R&S®NRP-Z98 level control sensor

Frequency range		9 kHz to 6 GHz		
Impedance matching (SWR) and insertion loss		input SWR	output SWR [1]	insertion loss [2] ( ): typical
	9 kHz to 2.4 GHz	< 1.35	< 1.11	< 8.0 (7.0) dB
	> 2.4 GHz to 4.0 GHz	< 1.45	< 1.15	< 8.5 (7.5) dB
	> 4.0 GHz to 6.0 GHz	< 1.75	< 1.22	< 9.5 (8.5) dB
Power measurement range RF output	continuous average	200 pW to 100 mW (–67 dBm to +20 dBm)		
Maximum power RF input	average power			
	9 kHz to 2.4 GHz	0.7 W (+28.5 dBm)		continuous
	> 2.4 GHz to 6.0 GHz	0.9 W (+29.5 dBm)		
	peak envelope power	7.5 dB above max. average power (for 10 µs)		
Measurement subranges	path 1	–67 dBm to –14 dBm		
	path 2	–46 dBm to +6 dBm		
	path 3	–26 dBm to +20 dBm		
Transition regions	with automatic path selection [5]	(–19 – 1/+ 2) dBm to (–13 – 1/+ 2) dBm (+1 – 1/+ 2) dBm to (+7 – 1/+ 2) dBm		
Dynamic response	rise time 10 %/90 %	< 5 ms		
Acquisition	sample rate (continuous)	133.358 kHz		
Zero offset	initial, without zeroing			( ): typical at 1 GHz +15 °C to +35 °C
	path 1	< 505 (100) pW		
	path 2	< 52 (10) nW		
	path 3	< 5.2 (1) µW		
	after external zeroing [8, 9]			
	path 1	< 114 (67) pW		
	path 2	< 11 (6) nW		
	path 3	< 1.1 (0.6) µW		
Zero drift [10]	path 1	< 39 (0) pW		
	path 2	< 3.3 (0) nW		
	path 3	< 0.33 (0) µW		
Measurement noise [11]	path 1	< 72 (42) pW		
	path 2	< 7 (4) nW		
	path 3	< 0.7 (0.4) µW		

Uncertainty for absolute power measurements [12] in dB

9 kHz to < 20 kHz

0.174	*0.175*	*0.175*
0.075	*0.070*	*0.071*
0.056	*0.047*	*0.048*

–67 –19 +1 +20
Power level in dBm

20 kHz to < 100 MHz

0.147	*0.160*	*0.160*	0 °C to +50 °C
0.073	*0.069*	*0.069*	+15 °C to +35 °C
0.056	*0.047*	*0.048*	+20 °C to +25 °C

–67 –19 +1 +20
Power level in dBm

100 MHz to 4 GHz

0.159	*0.170*	*0.172*
0.084	*0.080*	*0.084*
0.066	*0.058*	*0.064*

–67 –19 +1 +20
Power level in dBm

> 4 GHz to 6 GHz

0.176	*0.185*	*0.189*	0 °C to +50 °C
0.101	*0.095*	*0.102*	+15 °C to +35 °C
0.083	*0.073*	*0.083*	+20 °C to +25 °C

–67 –19 +1 +20
Power level in dBm

Uncertainty for relative power measurements [13] in dB

9 kHz to < 20 kHz

+20	*0.226*	*0.229*	*0.027*
	0.084	*0.080*	*0.022*
+7	*0.046*	*0.044*	*0.022*
+1	*0.226*	*0.027*	*0.229*
	0.083	*0.022*	*0.080*
–13	*0.045*	*0.022*	*0.044*
–19	*0.023*	*0.226*	*0.226*
	0.022	*0.083*	*0.084*
–67	*0.022*	*0.045*	*0.046*

–67 –19/–13 +1/+7 +20
Power level in dBm

20 kHz to < 100 MHz

+20	*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 +20
Power level in dBm

100 MHz to 4 GHz

+20	*0.209*	*0.218*	*0.038*
	0.088	*0.085*	*0.032*
+7	*0.055*	*0.047*	*0.031*
+1	*0.206*	*0.028*	*0.218*
	0.083	*0.022*	*0.085*
–13	*0.048*	*0.022*	*0.047*
–19	*0.023*	*0.206*	*0.209*
	0.022	*0.083*	*0.088*
–67	*0.022*	*0.048*	*0.055*

–67 –19/–13 +1/+7 +20
Power level in dBm

> 4 GHz to 6 GHz

+20	*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 +20
Power level in dBm

Additional characteristics of the R&S®NRP-Z28/-Z98 level control sensors

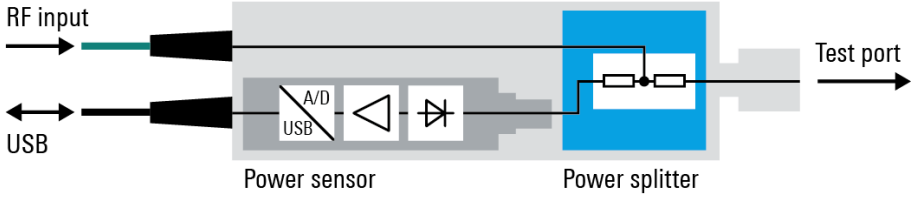
Shaded areas apply only to the R&S®NRP-Z28.

Sensor type		three-path diode power sensor combined with a resistive power splitter in a power leveling setup (see diagram at the end of this section)
Measurand		power available on a 50 Ω load
		power of wave emanating at RF output [14]
RF connectors		N (male)
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	
	R&S®NRP-Z28	10 µs to 300 ms (20 ms default)
	R&S®NRP-Z98	1 ms 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 s 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

Shaded areas apply only to the R&S®NRP-Z28.

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	function	incorporates a two-port device at the RF output so that the measurement plane is shifted to the output 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 wave emanating at the RF output can be read		
	parameters	magnitude and phase of reflection coefficient of DUT		
Frequency response correction	function	takes the frequency response of the sensor section and of the power splitter into account		
	parameter	center frequency of test signal		
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute and relative power measurements		
Measurement time [20] 2^N: averaging number *T:* set number of timeslots *w:* nominal length of timeslot	continuous average			
	R&S®NRP-Z28	2 × (aperture + 145 µs) × 2^N + t_z t_z : < 1.6 ms		
	R&S®NRP-Z98	2 × (aperture + 5 ms) × 2^N – 3.4 ms + t_d t_d must be taken into account with activated auto delay (1 ms to 20 ms depending on temperature) [21]		
	buffered [17], without averaging	2 × (aperture + 250 µs) × buffer size + t_z		
	timeslot/gate average			
	signal period – T × w > 100 µs	≤ 2 × signal period × (2^N + ½) + t_z		
	all other cases	≤ 4 × signal period × (2^N + ¼) + t_z		
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]		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	

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		
Calibration uncertainty [25] (R&S®NRP-Z98 up to 6 GHz only)		path 1	path 2	path 3
	< 100 MHz	*0.056* dB	*0.047* dB	*0.048* dB
	100 MHz to 4.0 GHz	*0.066* dB	*0.057* dB	*0.058* dB
	> 4.0 GHz to 8.0 GHz	*0.083* dB	*0.072* dB	*0.072* dB
	> 8.0 GHz to 12.4 GHz	*0.095* dB	*0.077* dB	*0.077* dB
	> 12.4 GHz to 18.0 GHz	*0.124* dB	*0.100* dB	*0.101* 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 19)		
Dimensions	W × H × L	48 mm × 50 mm × 250 mm (1.89 in × 1.97 in × 9.84 in)		
	length including connecting cable	approx. 1.75 m (68.89 in)		
Weight		< 0.7 kg (1.54 lb)		



Block diagram of the R&S®NRP-Z28/-Z98 level control sensors

Power sensor modules in R&S®Smart Sensor Technology

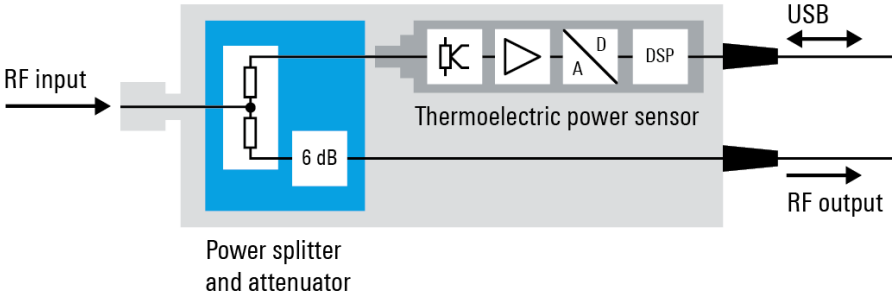
R&S®NRP-Z27/-Z37 power sensor modules

Specifications from 18 GHz to 26.5 GHz apply only to the R&S®NRP-Z37.

Frequency range	R&S®NRP-Z27	DC to 18 GHz		
	R&S®NRP-Z37	DC to 26.5 GHz		
Impedance matching (SWR)	RF input	R&S®NRP-Z27	R&S®NRP-Z37	
	DC to 2.0 GHz	< 1.15	< 1.15	
	> 2.0 GHz to 4.2 GHz	< 1.18	< 1.18	
	> 4.2 GHz to 8.0 GHz	< 1.23	< 1.23	
	> 8.0 GHz to 12.4 GHz	< 1.25	< 1.25	
	> 12.4 GHz to 18.0 GHz	< 1.35	< 1.30	
	> 18.0 GHz to 26.5 GHz	–	< 1.45	
	RF output	R&S®NRP-Z27	R&S®NRP-Z37	
	DC to 8.0 GHz	< 1.6	< 1.6	
	> 8.0 GHz to 26.5 GHz	< 2.0	< 2.0	
Power measurement range		4 µW to 400 mW (–24 dBm to +26 dBm), continuous, in a single range		
Maximum power	average power	0.5 W (+27 dBm), continuous 1.0 W (+30 dBm) for max. 10 minutes		
	peak envelope power	30 W (+45 dBm) for max. 1 µs		
Acquisition	sample rate	20.833 kHz (sigma-delta)		
Zero offset	after external zeroing [8, 9]	< 400 nW (typ. 200 nW at 1 GHz)		
Zero drift [10]		< 160 nW		
Measurement noise [11]		< 240 nW (typ. 120 nW at 1 GHz)		
Uncertainty for absolute power measurements [26]		+20 °C to +25 °C	+15 °C to +35 °C	0 °C to +50 °C
	with matched load on RF output (SWR < 1.05)			
	DC to < 100 MHz	*0.070 dB*	*0.077 dB*	*0.103 dB*
	100 MHz to 4.2 GHz	*0.075 dB*	*0.082 dB*	*0.106 dB*
	> 4.2 GHz to 8.0 GHz	*0.087 dB*	*0.094 dB*	*0.119 dB*
	> 8.0 GHz to 12.4 GHz	*0.093 dB*	*0.101 dB*	*0.130 dB*
	> 12.4 GHz to 18.0 GHz	*0.112 dB*	*0.121 dB*	*0.151 dB*
	> 18.0 GHz to 26.5 GHz	*0.122 dB*	*0.137 dB*	*0.190 dB*
	with R&S®FSMR26 connected to RF output			
	DC to < 100 MHz	*0.104 dB*	*0.109 dB*	*0.128 dB*
	100 MHz to 4.2 GHz	*0.116 dB*	*0.120 dB*	*0.138 dB*
	> 4.2 GHz to 8.0 GHz	*0.163 dB*	*0.166 dB*	*0.181 dB*
	> 8.0 GHz to 18.0 GHz	*0.183 dB*	*0.187 dB*	*0.207 dB*
	> 18.0 GHz to 26.5 GHz	*0.226 dB*	*0.235 dB*	*0.269 dB*
	with R&S®FSMR26 connected to RF output and activated load interference correction			
	DC to < 100 MHz	*0.067 dB*	*0.074 dB*	*0.101 dB*
	100 MHz to 4.2 GHz	*0.077 dB*	*0.083 dB*	*0.107 dB*
	> 4.2 GHz to 8.0 GHz	*0.092 dB*	*0.099 dB*	*0.123 dB*
	> 8.0 GHz to 12.4 GHz	*0.099 dB*	*0.107 dB*	*0.135 dB*
	> 12.4 GHz to 18.0 GHz	*0.122 dB*	*0.130 dB*	*0.159 dB*
	> 18.0 GHz to 26.5 GHz	*0.154 dB*	*0.167 dB*	*0.212 dB*
Uncertainty for relative power measurements [27]		*0.032 dB*		

Sensor type		thermoelectric power sensor with signal pick-off at RF output (see diagram at the end of this section)	
Measurand		power of incident wave	
		power of source (DUT) into 50 Ω [14]	
RF connectors	input		
	R&S®NRP-Z27	N (male)	
	R&S®NRP-Z37	3.5 mm (male)	
	RF signal output	3.5 mm (male)	
Insertion loss Between RF input and RF output	DC to 2.0 GHz	< 14 (12.5) dB	( ): typical
	> 2.0 GHz to 4.2 GHz	< 15 (13.5) dB	
	> 4.2 GHz to 8.0 GHz	< 16 (14.0) dB	
	> 8.0 GHz to 12.4 GHz	< 17 (14.5) dB	
	> 12.4 GHz to 18.0 GHz	< 18 (15.5) dB	
	> 18.0 GHz to 26.5 GHz	< 19 (16.5) dB	
Measurement function	stationary and recurring waveforms	continuous average	
Continuous average function	measurand	mean power over recurring acquisition interval	
	aperture	1 ms 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	
Averaging filter	modes	auto off (fixed averaging number)	
		auto on (continuously auto-adapted)	
		auto once (automatically fixed once)	
	auto off		
	averaging number	2^N ; N = 0 to 16	
	auto on/once		
	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	
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 power splitter into account	
	parameter	center frequency of test signal	
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute power measurements	
Load interference correction	function	removing the influence of the load on the RF signal output from the power measurement result	
	parameters	magnitude and phase of reflection coefficient of load	
	residual uncertainty	see specification of load interference error	

Measurement time [20] 2^N: averaging number		2 × (aperture + 450 µs) × 2^N + 4 ms + t_d t_d (80 ms) must be taken into account when auto delay [21] is active	
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	
Calibration uncertainty [28]	DC to < 100 MHz	*0.063 dB*	
	100 MHz to 4.2 GHz	*0.070 dB*	
	> 4.2 GHz to 8.0 GHz	*0.082 dB*	
	> 8.0 GHz to 12.4 GHz	*0.088 dB*	
	> 12.4 GHz to 18.0 GHz	*0.109 dB*	
	> 18.0 GHz to 26.5 GHz	*0.118 dB*	
Temperature effect [29]	DC to 4.2 GHz	< 0.004 dB/K	
	> 4.2 GHz to 8.0 GHz	< 0.005 dB/K	
	> 8.0 GHz to 12.4 GHz	< 0.005 dB/K	
	> 12.4 GHz to 18.0 GHz	< 0.006 dB/K	
	> 18.0 GHz to 26.5 GHz	< 0.009 dB/K	
Linearity [30]	for power levels < 100 mW (+20 dBm)	*0.020 dB*	
Power coefficient [31]		< (0.02 + 0.002 × *f* / GHz) dB/W	
Load interference error [32] From RF signal output	DC to 2.0 GHz	< 0.061 (0.003) dB	values in ( ) after load interference correction
	> 2.0 GHz to 12.4 GHz	< 0.050 (0.012) dB	
	> 12.4 GHz to 18.0 GHz	< 0.043 (0.016) dB	
	> 18.0 GHz to 26.5 GHz	< 0.043 (0.022) dB	
Interface to host	power supply	+5 V/0.1 A (USB low-power device)	
	remote control	as a USB device (function) in full-speed mode, compatible with USB 1.0/1.1/2.0 specifications	
	trigger input	differential (0 V/+3.3 V)	
	connector type	ODU Mini-Snap L series, six-pole cylindrical straight plug	
	permissible cable length	≤ 10 m (see also tables on page 19)	
Dimensions	W × H × L	44 mm × 51 mm × 250 mm (1.73 in × 2.01 in × 9.84 in)	
	length including connecting cable	approx. 1.75 m (68.89 in)	
Weight		< 0.7 kg (1.54 lb)	



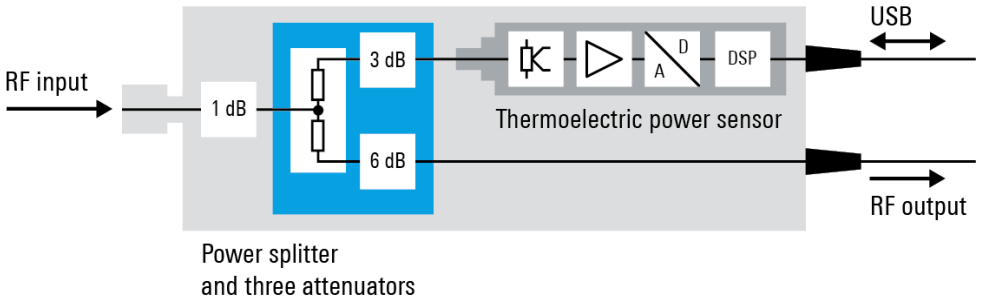
Block diagram of the R&S®NRP-Z27/-Z37 power sensor modules

R&S®NRP-Z47 power sensor module

Frequency range		DC to 50 GHz		
Impedance matching (SWR)	RF input			
	DC to 2.0 GHz	< 1.10		
	> 2.0 GHz to 4.2 GHz	< 1.18		
	> 4.2 GHz to 8.0 GHz	< 1.23		
	> 8.0 GHz to 12.4 GHz	< 1.25		
	> 12.4 GHz to 18.0 GHz	< 1.28		
	> 18.0 GHz to 26.5 GHz	< 1.40		
	> 26.5 GHz to 33.0 GHz	< 1.55		
	> 33.0 GHz to 40.0 GHz	< 1.70		
	> 40.0 GHz to 50.0 GHz	< 1.75		
	RF output			
	DC to 8.0 GHz	< 1.6		
	> 8.0 GHz to 50.0 GHz	< 2.0		
Power measurement range		5 µW to 1 W (–23 dBm to +30 dBm), continuous, in a single range		
Maximum power	average power	1.6 W (+32 dBm), continuous		
	peak envelope power	10 W (+40 dBm) for max. 1 µs		
Acquisition	sample rate	50 kHz (sigma-delta)		
	accuracy of time base	±5 ppm (typ.)		
Zero offset	after external zeroing [8]	< 400 nW (typ. 200 nW at 1 GHz)		
Zero drift [10]		< 160 nW		
Measurement noise [11]		< 400 nW (typ. 150 nW at 1 GHz)		
Uncertainty for absolute power measurements [26]		+20 °C to +25 °C	+15 °C to +35 °C	0 °C to +50 °C
	with matched load on RF output (SWR < 1.05)			
	DC to 100 MHz	*0.070 dB*	*0.076 dB*	*0.103 dB*
	> 100 MHz to 4.2 GHz	*0.075 dB*	*0.081 dB*	*0.106 dB*
	> 4.2 GHz to 8.0 GHz	*0.087 dB*	*0.092 dB*	*0.115 dB*
	> 8.0 GHz to 12.4 GHz	*0.093 dB*	*0.098 dB*	*0.119 dB*
	> 12.4 GHz to 18.0 GHz	*0.112 dB*	*0.116 dB*	*0.135 dB*
	> 18.0 GHz to 26.5 GHz	*0.122 dB*	*0.126 dB*	*0.143 dB*
	> 26.5 GHz to 33.0 GHz	*0.134 dB*	*0.137 dB*	*0.154 dB*
	> 33.0 GHz to 40.0 GHz	*0.147 dB*	*0.150 dB*	*0.165 dB*
	> 40.0 GHz to 50.0 GHz	*0.176 dB*	*0.179 dB*	*0.192 dB*
	with R&S®FSMR3050 connected to RF output (based on typical R&S®FSMR specifications)			
	DC to 100 MHz	*0.085 dB*	*0.090 dB*	*0.113 dB*
	> 100 MHz to 4.2 GHz	*0.085 dB*	*0.090 dB*	*0.113 dB*
	> 4.2 GHz to 8.0 GHz	*0.100 dB*	*0.104 dB*	*0.125 dB*
	> 8.0 GHz to 12.4 GHz	*0.110 dB*	*0.114 dB*	*0.133 dB*
	> 12.4 GHz to 18.0 GHz	*0.120 dB*	*0.124 dB*	*0.142 dB*
	> 18.0 GHz to 26.5 GHz	*0.140 dB*	*0.143 dB*	*0.159 dB*
	> 26.5 GHz to 33.0 GHz	*0.164 dB*	*0.167 dB*	*0.180 dB*
	> 33.0 GHz to 40.0 GHz	*0.177 dB*	*0.180 dB*	*0.193 dB*
	> 40.0 GHz to 50.0 GHz	*0.196 dB*	*0.199 dB*	*0.210 dB*
	with R&S®FSMR3050 connected to RF output and activated load interference correction			
	DC to 100 MHz	*0.073 dB*	*0.081 dB*	*0.108 dB*
	> 100 MHz to 4.2 GHz	*0.080 dB*	*0.086 dB*	*0.111 dB*
	> 4.2 GHz to 8.0 GHz	*0.092 dB*	*0.097 dB*	*0.120 dB*
	> 8.0 GHz to 12.4 GHz	*0.098 dB*	*0.103 dB*	*0.124 dB*
	> 12.4 GHz to 18.0 GHz	*0.117 dB*	*0.121 dB*	*0.140 dB*
	> 18.0 GHz to 26.5 GHz	*0.127 dB*	*0.131 dB*	*0.148 dB*
	> 26.5 GHz to 33.0 GHz	*0.164 dB*	*0.167 dB*	*0.180 dB*
	> 33.0 GHz to 40.0 GHz	*0.177 dB*	*0.180 dB*	*0.193 dB*
	> 40.0 GHz to 50.0 GHz	*0.196 dB*	*0.199 dB*	*0.210 dB*
	with 12 dB mismatch connected to RF output and activated load interference correction			
	DC to 100 MHz	*0.076 dB*	*0.082 dB*	*0.109 dB*
	> 100 MHz to 4.2 GHz	*0.081 dB*	*0.087 dB*	*0.112 dB*
	> 4.2 GHz to 8.0 GHz	*0.093 dB*	*0.098 dB*	*0.121 dB*
	> 8.0 GHz to 12.4 GHz	*0.099 dB*	*0.104 dB*	*0.125 dB*
	> 12.4 GHz to 18.0 GHz	*0.118 dB*	*0.122 dB*	*0.141 dB*
	> 18.0 GHz to 26.5 GHz	*0.128 dB*	*0.132 dB*	*0.149 dB*
	> 26.5 GHz to 33.0 GHz	*0.137 dB*	*0.140 dB*	*0.157 dB*
	> 33.0 GHz to 40.0 GHz	*0.150 dB*	*0.153 dB*	*0.168 dB*
	> 40.0 GHz to 50.0 GHz	*0.179 dB*	*0.182 dB*	*0.195 dB*

Uncertainty for relative power measurements [27]	for power levels ≤ 400 mW (+26 dBm)	*0.032 dB*	
	for power levels ≤ 1 W (+30 dBm)	*0.048 dB*	
Sensor type		thermoelectric power sensor with signal pick-off at RF output (see diagram at the end of this section)	
Measurand		power of incident wave	
		power of source (DUT) into 50 Ω [14]	
RF connectors	RF signal input	2.4 mm (male)	
	RF signal output	2.4 mm (male)	
Insertion loss Between RF input and RF output	DC to 2.0 GHz	< 15.0 (13.5) dB	( ): typical
	> 2.0 GHz to 4.2 GHz	< 16.0 (14.5) dB	
	> 4.2 GHz to 8.0 GHz	< 17.0 (15.0) dB	
	> 8.0 GHz to 12.4 GHz	< 17.5 (15.5) dB	
	> 12.4 GHz to 18.0 GHz	< 18.5 (16.5) dB	
	> 18.0 GHz to 26.5 GHz	< 19.5 (17.5) dB	
	> 26.5 GHz to 33.0 GHz	< 20.0 (18.0) dB	
	> 33.0 GHz to 40.0 GHz	< 21.0 (19.0) dB	
	> 40.0 GHz to 50.0 GHz	< 22.0 (20.0) dB	
Measurement function	stationary and recurring waveforms	continuous average	
Continuous average function	measurand	mean power over recurring acquisition interval	
	aperture	0.5 ms to 300 ms (5 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 8192 results	
Averaging filter	modes	auto off (fixed averaging number)	
		auto on (continuously auto-adapted)	
		auto once (automatically fixed once)	
	auto off		
	averaging number	1, 2, 4, 6, 8, 10 to 65536 (1 or all even numbers between 2 and 65536)	
	auto on/once		
	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	
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 power splitter into account	
	parameter	center frequency of test signal	
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute power measurements	
Load interference correction	function	removing the influence of the load on the RF signal output from the power measurement result	
	parameters	magnitude and phase of reflection coefficient of load	
	residual uncertainty	see specification of load interference error	
Measurement time [20] Av: averaging number		2 × (aperture + 300 µs) × Av + 4 ms + t_d t_d (40 ms) must be taken into account when auto delay [21] is active	
Zeroing (duration)		10 s	

Calibration uncertainty [28]	DC to 100 MHz	*0.036 dB*	
	> 100 MHz to 2.0 GHz	*0.046 dB*	
	> 2.0 GHz to 2.4 GHz	*0.047 dB*	
	> 2.4 GHz to 8.0 GHz	*0.057 dB*	
	> 8.0 GHz to 12.4 GHz	*0.062 dB*	
	> 12.4 GHz to 18.0 GHz	*0.079 dB*	
	> 18.0 GHz to 26.5 GHz	*0.076 dB*	
	> 26.5 GHz to 33.0 GHz	*0.095 dB*	
	> 33.0 GHz to 40.0 GHz	*0.108 dB*	
	> 40.0 GHz to 50.0 GHz	*0.137 dB*	
Linearity [30]	for power levels ≤ 400 mW (+26 dBm)	*0.020 dB*	
	for power levels ≤ 1 W (+30 dBm)	*0.043 dB*	
Power coefficient [31]		< (0.01 + 0.0005 f/GHz) dB/W	
Load interference error [32] From RF signal output	DC to 2.0 GHz	< 0.065 (0.005) dB	values in ( ) after load interference correction
	> 2.0 GHz to 12.4 GHz	< 0.056 (0.010) dB	
	> 12.4 GHz to 18.0 GHz	< 0.045 (0.013) dB	
	> 18.0 GHz to 26.5 GHz	< 0.040 (0.016) dB	
	> 26.5 GHz to 33.0 GHz	< 0.036 (0.018) dB	
	> 33.0 GHz to 40.0 GHz	< 0.033 (0.020) dB	
	> 40.0 GHz to 50.0 GHz	< 0.030 (0.022) dB	
Interface to host	mechanical	8-pin male M12 connector (A-coded), a six-pole interface cable is connected at delivery	
	power supply	+5 V/0.5 A (USB high-power device)	
	speed	supports high-speed and full-speed modes according to the specification	
	remote control protocols	supports USB test and measurement device class (USBTMC) and legacy mode for compatibility with other R&S®NRP-Zxx power sensors	
	reference clock		
	signal level	LVDS	
	frequency	20 MHz	
	trigger input EXTernal[1]	differential (0 V/+3.3 V)	
	permissible cable length	≤ 5 m	
Trigger I/O EXTernal2	mechanical	SMB built-in jack	
	impedance		
	input	10 kΩ (nom.) or 50 Ω (nom.) selectable	
	output	50 Ω (nom.)	
	signal level		
	input	compatible with 3 V or 5 V logic, max. –1 V to +6 V	
	output	≥ 2 V into 50 Ω load, max. 5.3 V	
Interface cable	included in scope of delivery		
	connectors		
	sensor side	8-pin female M12 connector (A-coded)	
	host side	six-pole circular plug with push-pull locking	
	length	0.9 m	
	alternative cables	any R&S®NRP-ZK6, R&S®NRP-ZK8, R&S®NRP-ZKU or R&S®NRP-ZKC interface cable, dependent on the application; see R&S®NRP Power Meter Family product brochure (PD 5213.5539.12)	
Dimensions	W × H × L (including bend relief)	48 mm × 53 mm × 220 mm (1.89 in × 2.09 in × 8.66 in)	
	length including connecting cable	approx. 0.99 m (39 in)	
Weight		approx. 0.52 kg (1.15 lb)	



Block diagram of the R&S®NRP-Z47 power sensor module

Accessories for sensors

R&S®NRP-Z2 extension cables

Note: R&S®NRP-Z2 extension cables are not suitable for R&S®NRP-Z47.

Application		for connecting an R&S®NRP-Z28/-Z98/-Z27/-Z37 power sensor to: • an R&S®NRX base unit • other Rohde & Schwarz measuring instruments • an R&S®NRP-Z4 USB adapter cable • an R&S®NRP-Z5 USB sensor hub
Connectors	type	ODU Mini-Snap L series, size 1, six-pole receptacle
	sensor side	
	models .03/.05/.10	with in-line receptacle
	model .15	with bulkhead receptacle for panel mounting < 5 mm wall thickness
	host side	straight plug
Length	model .03	1.5 m
	models .05/.15	3.5 m
	model .10	8.5 m
Permissible total cable length	including power sensor and R&S®NRX base unit or R&S®NRP-Z4 USB adapter cable or R&S®NRP-Z5 USB sensor hub, if applicable	see tables below

Supported combinations with R&S®NRX 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 -Z28/-Z98/ -Z27/-Z37 power sensor	+	R&S®NRP-Z2 models			=	total length in m
		.03	.05/.15	.10		
●		●	–	–		3.0
●		–	●	–		5.0
●		–	–	●		10.0

(shaded combination only supported by R&S®NRX base unit)

Supported combinations with R&S®NRP-Z4 USB adapter cables

R&S®NRP -Z28/-Z98/ -Z27/-Z37 power sensor		R&S®NRP-Z2 models			R&S®NRP-Z4 models					total length in m
		.03	.05/.15		.06	.04	.11	.02		
●	+	–	–	+	●	–	–	–	=	1.6
●		–	–		–	●	–	–		2.0
●		–	–		–	–	●	–		2.5
●		–	–		–	–	–	●		3.5
●		●	–		–	–	–	●		5.0
●		–	●		●	–	–	–		5.1
●		–	●		–	●	–	–		5.5
●		–	●		–	–	●	–		6.0
●		–	●		–	–	–	●		7.0

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

R&S®NRP -Z28/-Z98/ -Z27/-Z37 power sensor		R&S®NRP-Z2 models			R&S®NRP-Z5 USB sensor hub		total length in m
		.03	.05/.15				
●	+	●	–	+	●	=	3.0
●		–	●		●		5.0

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-Z4 models				standard USB cable (max. length: 5 m)		total length in m
		.06	.04	.11	.02			
●	+	●	–	–	–	–	=	0.1
●		–	●	–	–	–		0.5
●		–	–	●	–	–		1.0
●		–	–	–	●	–		2.0
●		–	–	–	–	●		5.0

R&S®NRP-Z4 USB adapter cable

Note: R&S®NRP-Z4 USB adapter cable is not suitable for R&S®NRP-Z47.

Application		for connecting an R&S®NRP-Z28/-Z98/-Z27/-Z37 power sensor to a USB host (PC or Rohde & Schwarz measuring instruments with type A receptacle)
Connectors	sensor side	ODU Mini-Snap L series, size 1, six-pole receptacle
	models .02/.04/.06	with in-line receptacle
	model .11	with bulkhead receptacle for panel mounting < 5 mm wall thickness
	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)
	model .06	approx. 0.15 m (5.91 in)
	model .11	approx. 1 m (39.37 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 instruments with type A receptacle) • a Rohde & Schwarz measuring instrument (other than the R&S®NRX) with circular sensor connector (ODU Mini-Snap L series, size 1, 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 1, six-pole receptacle
	USB host	USB type B receptacle (certified USB 2.0 high-speed cable supplied with the equipment)
	for Rohde & Schwarz instruments	ODU Mini-Snap L series, size 1, 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. 0.72 m (28.35 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)

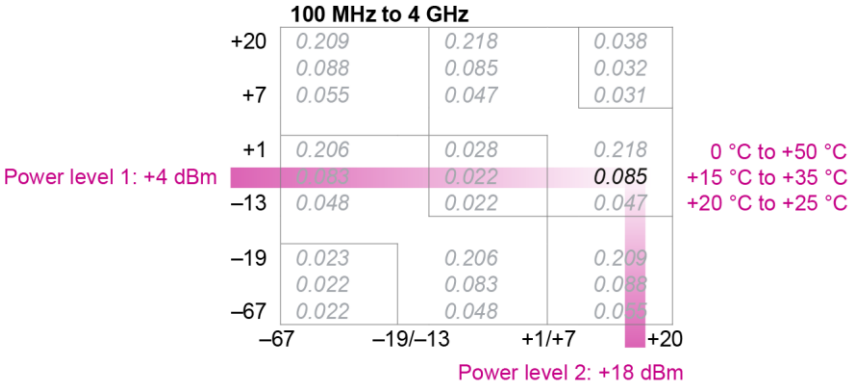
General data

Temperature loading [33]	R&S®NRP-Z5 USB sensor hub and R&S®NRP-Z4 USB adapter cables	
	operating temperature range	0 °C to +50 °C
	storage temperature range	–40 °C to +70 °C
	R&S®NRP-Zxx power sensors, R&S®NRP-Z2 extension cables	
	operating temperature range	0 °C to +50 °C
	permissible temperature range	–10 °C to +55 °C
	storage temperature range	–40 °C to +70 °C
Climatic resistance	damp heat	+25 °C/+55 °C cyclic at 95 % relative humidity with restrictions: noncondensing, in line with EN 60068-2-30
Mechanical resistance	vibration	
	sinusoidal	5 Hz to 55 Hz, 0.15 mm amplitude, 1.8 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g constant, in line with EN 60068-2-6
	random	8 Hz to 650 Hz, 1.9 g (RMS), in line with EN 60068-2-64
	shock	45 Hz to 2 kHz, max. 40 g shock spectrum, in line with MIL-STD-810E, method 516.4, procedure I
Air pressure	operating	795 hPa (2000 m) to 1060 hPa
	transport	566 hPa (4500 m) to 1060 hPa
Electromagnetic compatibility	EU: in line with EMC Directive 2014/30/EU	applied harmonized standards: • EN 61326-1 (industrial environment) • EN 55011 (class B)
Safety		in line with EN 61010-1, IEC 61010-1, CAN/CSA-C22.2 No. 61010-1-04, UL STD. No. 61010-1
RoHS	EU: in line with Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment	applied harmonized standard: EN IEC 63000
Calibration interval	recommended	2 years

Appendix

Reading the uncertainty of diode power sensors for relative power measurements

The example shows a level step of approx. 14 dB (+4 dBm → +18 dBm) at 1.9 GHz and an ambient temperature of +28 °C for an R&S®NRP-Z28 power sensor. The expanded uncertainty for relative power measurements in this example is 0.085 dB.



Ordering information

Designation	Type	Order No.
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
5 µW to 1 W, DC to 50 GHz	R&S®NRP-Z47	1444.1748.02
Recommended extras		
for R&S®NRP-Z28/-Z98/-Z27/-Z37		
R&S®NRPV virtual power meter (PC application), activation for one R&S®NRP-Z28/-Z98/-Z27/-Z37 power sensor (not necessary for R&S®NRP-Z47)	R&S®NRPZ-K1	1418.9800.03
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 5 m (with bulkhead receptacle for panel mounting)	R&S®NRP-Z2	1146.6750.15
Sensor extension cable to 10 m	R&S®NRP-Z2	1146.6750.10
USB adapter cable (passive, length: 0.15 m)	R&S®NRP-Z4	1146.8001.06
USB adapter cable (passive, length: 0.5 m)	R&S®NRP-Z4	1146.8001.04
USB adapter cable (passive, length: 1.0 m, with bulkhead receptacle for panel mounting)	R&S®NRP-Z4	1146.8001.11
USB adapter cable (passive, length: 2.0 m)	R&S®NRP-Z4	1146.8001.02
for R&S®NRP-Z28/-Z98/-Z27/-Z37/-Z47		
USB sensor hub	R&S®NRP-Z5	1146.7740.02

Warranty and service

Warranty		
Base unit and power sensors		3 years
All other items		1 year
Service options		
	Service plans	**On demand**
Calibration	up to five years [34]	pay per calibration
Warranty and repair	up to five years [34]	standard price repair
Contact your Rohde & Schwarz sales office for further details.		

Endnotes

[1] Equivalent source SWR.

[2] Between RF input and RF output (test port).

[3] 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).

[4] With a resolution of 256 pixel.

[5] Specifications apply to the default transition setting of 0 dB. The transition regions can be shifted by as much as –20 dB using an adequate offset.

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

[7] 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.

[8] 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).

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

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

[11] 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.

[12] Expanded uncertainty (k = 2) for absolute power measurements on CW signals with automatic path selection and the default transition 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.

[13] Expanded uncertainty (k = 2) for relative power measurements on CW signals of the same frequency with automatic path selection and a default transition 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.

Example: The uncertainty of a power step from 1 mW (0 dBm) to 100 nW (–40 dBm) at 5.4 GHz is to be determined for an R&S®NRP-Z28. The ambient temperature is +20 ºC and the averaging number is set to 2 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 –40 dBm measurement, the typical absolute uncertainty due to zero offset is 100 pW after external zeroing, which corresponds to a relative measurement uncertainty of
$10 \times \lg \frac{100\ \text{nW} + 100\ \text{pW}}{100\ \text{nW}} = 0.004\ \text{dB}.$

Using the formula in endnote 11, the absolute noise contribution of path 1 is typically 42 pW × √(10.24 s/(2 × 2 × 0.02 s)) = 475 pW, which corresponds to a relative measurement uncertainty of
$10 \times \lg \frac{100\ \text{nW} + 475\ \text{pW}}{100\ \text{nW}} = 0.021\ \text{dB}.$

Combined with the uncertainty of 0.054 dB for relative power measurements under the given conditions, the total expanded uncertainty is
$\sqrt{0.004^2 + 0.021^2 + 0.054^2}\ \text{dB} = 0.058\ \text{dB}.$

[14] Gamma correction activated.

[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] 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®NRX 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®NRX.

[21] 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.

[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.

[24] Measurement error referenced to a CW signal of equal power and frequency.

[25] Expanded uncertainty (k = 2) for absolute power measurements on CW signals at the calibration level 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).

Calibration frequencies: 10/15/20/30/50/100 MHz; in steps of 250 MHz from 250 MHz to the upper frequency limit

[26] Expanded uncertainty (k = 2) for absolute power measurements up to 100 mW (+20 dBm) at the calibration frequencies (see endnote 28). 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 endnote 31). 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.

[27] Expanded uncertainty (k = 2) for relative power measurements on CW signals of the same frequency. 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 endnote 11 for taking into account zero offset and noise with relative measurements.

[28] 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: 0/0.1/0.5/1/3/5/10/50 MHz; in steps of 100 MHz from 100 MHz to the upper frequency limit.

[29] 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).

[30] Expanded uncertainty for relative power measurements on CW signals of the same frequency, referenced to the calibration level (0 dBm) and excluding zero offset, zero drift and measurement noise.

[31] 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.

R&S®NRP-Z27/37: The power coefficient should be taken into account if the input power exceeds 100 mW (+20 dBm).

R&S®NRP-Z47: The power coefficient should be taken into account if the input power exceeds 400 mW (+26 dBm).

[32] 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).

R&S®NRP-Z27/-Z37: 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.

R&S®NRP-Z47: The error introduced by an R&S®FSMR3050 at the RF signal output does not exceed ±0.06 dB from DC to 3.5 GHz, ±0.11 dB up to 18 GHz, ±0.13 dB up to 26.5 GHz and ±0.15 dB up to 50 GHz (input attenuation ≥ 10 dB, no load interference correction).

[33] 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.

[34] For extended periods, contact your Rohde & Schwarz sales office.

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