

Technical Information

Power Sensor R&S NRP-Z91

Universal power measurement from 9 kHz to 6 GHz

The Power Sensor R&S NRP-Z91 is designed for measuring average power in a very wide frequency range. In particular, it covers the frequency bands relevant for terrestrial radio-communication. It is thus ideal not only for EMC applications but also as a truly universal power sensor.

The sensor can be operated on the R&S NRP base unit and also as a standalone device on a PC or a PC-based measuring instrument.

- 90 dB dynamic range
- Able to handle signals with any type of modulation
- Very low measurement uncertainty
- Excellent matching
- Low sensitivity to harmonics
- Operable on a PC without power meter base unit

Specifications

Bold: Parameter 100% tested

Italics: Uncertainties calculated from the test assembly specifications and the modelled behaviour of the sensor.

Normal: Compliance with specifications is ensured by the design or derived from the measurement of related parameters

Power Sensor R&S NRP-Z91

Frequency range		9 kHz to 6 GHz
Matching (SWR)	9 kHz to 2.4 GHz > 2.4 GHz to 6.0 GHz	< 1.13 (1.11) < 1.20 (1.18)
Level-dependent matching change ²⁾	9 kHz to 2.4 GHz > 2.4 GHz to 6.0 GHz	< 0.05 (0.02) < 0.08 (0.05)
Power measurement range		200 pW to 200 mW (-67 dBm to +23 dBm)
Max. power	Average Peak envelope power	0.4 W (+26 dBm) continuous 1 W (+30 dBm) for max. 10 μs
Measurement subranges	Path 1 Path 2 Path 3	-67 dBm to -14 dBm -47 dBm to +6 dBm -27 dBm to +23 dBm
Transition ranges	With automatic path selection, user def'd crossover ⁵⁾ set to 0 dB	(-19±1) dBm to (-13±1) dBm (+1±1) dBm to (+7±1) dBm
Display noise¹⁴⁾	15°C to 35°C 0°C to 50°C	Path 1 2 3 < 60 pW (40 pW typ.) < 5.6 nW (3.6 nW typ.) < 0.56 μW (0.36 μW typ.) Path 1 2 3 < 65 pW < 6.3 nW < 0.63 μW
Display noise, relative¹⁵⁾	Measurement window 2 × 1 ms, without averaging Measurement window 2 × 20 ms, averaging factor 32 (measurement time approx. 1 s)	< 0.05 dB (0.03 dB typ.) < 0.002 dB (0.001 dB typ.)
Zero offset¹⁷⁾	15°C to 35°C 0°C to 50°C	Path 1 2 3 < 96 pW (64 pW typ.) < 9.0 nW (5.8 nW typ.) < 0.90 μW (0.58 μW typ.) Path 1 2 3 < 104 pW < 10.0 nW < 1.00 μW
Zero drift¹⁸⁾		Path 1 Path 2 Path 3 < 35 pW < 3 nW < 0.3 μW
Triggering	Source Slope (external, internal) Level Internal External Delay Holdoff Hysteresis	Bus, External, Hold, Immediate, Internal pos./neg. -40 dBm to +23 dBm See specs for R&S NRP and USB Adapter R&S NRP-Z3 -5 ms to +100 s 0 s to 10 s 0 dB to 10 dB

Power Sensor R&S NRP-Z91 (continued)

Uncertainty for absolute power measurements³¹⁾ in dB

9 kHz to < 20 kHz

0.174	0.175	0.175	(0...50) °C
0.075	0.070	0.071	(15...35) °C
0.056	0.047	0.048	(20...25) °C

-40³⁷⁾ to -19 to +1 to +23 dBm

20 kHz to < 100 MHz

0.147	0.159	0.159	(0...50) °C
0.072	0.069	0.069	(15...35) °C
0.056	0.047	0.048	(20...25) °C

-40³⁷⁾ to -19 to +1 to +23 dBm

100 MHz to 4 GHz

0.150	0.162	0.164	(0...50) °C
0.081	0.077	0.081	(15...35) °C
0.066	0.058	0.063	(20...25) °C

-40³⁷⁾ to -19 to +1 to +23 dBm

> 4 GHz to 6 GHz

0.160	0.170	0.174	(0...50) °C
0.096	0.089	0.097	(15...35) °C
0.083	0.072	0.082	(20...25) °C

-40³⁷⁾ to -19 to +1 to +23 dBm

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

9 kHz to < 20 kHz

+23	0.226 0.084 0.046	0.229 0.080 0.044	0.027 0.022 0.022
+7			
+1	0.226 0.083 0.045	0.027 0.022 0.022	0.229 0.080 0.044
-13			
-19	0.023 0.022 0.022	0.226 0.083 0.045	0.226 0.084 0.046
-40 ³⁷⁾			

dBm -40³⁷⁾ -19 / -13 ±0 / +8 +23

20 kHz to < 100 MHz

+23	0.206 0.082 0.046	0.215 0.078 0.044	0.027 0.022 0.022	(0...50) °C (15...35) °C (20...25) °C
+7				
+1	0.205 0.081 0.044	0.027 0.022 0.022	0.215 0.078 0.044	(0...50) °C (15...35) °C (20...25) °C
-13				
-19	0.023 0.022 0.022	0.205 0.081 0.044	0.206 0.082 0.046	(0...50) °C (15...35) °C (20...25) °C
-40 ³⁷⁾				

dBm -40³⁷⁾ -19 / -13 ±0 / +8 +23

100 MHz to 4 GHz

+23	0.209 0.088 0.055	0.218 0.085 0.047	0.038 0.032 0.031
+7			
+1	0.206 0.083 0.048	0.028 0.022 0.022	0.218 0.085 0.047
-13			
-19	0.023 0.022 0.022	0.206 0.083 0.048	0.209 0.088 0.055
-40 ³⁷⁾			

dBm -40³⁷⁾ -19 / -13 ±0 / +8 +23

> 4 GHz to 6 GHz

+23	0.215 0.097 0.066	0.223 0.093 0.059	0.049 0.044 0.043	(0...50) °C (15...35) °C (20...25) °C
+7				
+1	0.210 0.088 0.054	0.030 0.022 0.022	0.223 0.093 0.059	(0...50) °C (15...35) °C (20...25) °C
-13				
-19	0.024 0.022 0.022	0.210 0.088 0.054	0.215 0.097 0.066	(0...50) °C (15...35) °C (20...25) °C
-40 ³⁷⁾				

dBm -40³⁷⁾ -19 / -13 ±0 / +8 +23

Additional characteristics of R&S NRP-Z91

Sensor type		3-path diode sensor		
Measurand		average power of incident wave average power of source into $50 \Omega^1)$		
RF connector		N (male)		
Calibration uncertainty³⁰⁾ in dB (20 to 25) °C	9 kHz to < 100 MHz 0.1 GHz to 4.0 GHz > 4 GHz to 6 GHz	Path 1 0.056 0.066 0.083	Path 2 0.047 0.057 0.071	Path 3 0.048 0.057 0.072
Measurement function		Continuous Average		
	Measurement window ⁷⁾ Duty cycle correction ⁸⁾ Smoothing	2 × (1 ms to 300 ms) 0.001% to 100.00% See under Measurement window		
Dynamic behaviour of video path	Rise time 10% / 90%	< 5 ms		
Sampling frequency		133.358 kHz		
Zeroing (duration)	Depends on setting of averaging filter AUTO ON AUTO OFF Integration time ¹⁶⁾ < 4 s 4 s to 16 s >16 s	4 s 4 s Integration time ¹⁶⁾ 16 s		
Measurement error due to harmonics $n \times f_0$ of carrier frequency ¹⁹⁾ values in []: typ. standard uncertainty	$N = 3, 5, 7, \dots^{20)}$ $N = 2, 4, 6, \dots^{20)}$	-30 dBc -20 dBc -10 dBc -30 dBc -20 dBc -10 dBc	<0.003 dB [0.0015 dB] <0.010 dB [0.005 dB] <0.040 dB [0.015 dB] <0.001 dB [0.0003 dB] <0.002 dB [0.001 dB] <0.010 dB [0.003 dB]	
Modulation influence²¹⁾ values in []: User def'd crossover ≤ -6 dB	General WCDMA (3-GPP Test Model 1-64) AM (80 %) Worst case Typical	measurement errors in subranges are proportional to power and depend on CCDF and modulation bandwidth of test signal -0.02 dB to +0.07 dB [-0.02 dB to +0.02 dB] -0.01 dB to +0.03 dB [-0.01 dB to +0.01 dB]		
Measurement window	Duration Shape	as specified for the measurement function rectangular (integrating behaviour) Von Hann (smoothing filter, for efficient suppression of result variations due to modulation ²⁶⁾		
Measurement times²⁷⁾		$N \times (\text{duration of meas. window}^7) + 10\text{ms}$ -3.4 ms+ t_d t_d must be considered with activated auto delay (1ms to 20 ms dependent from temperature)		
Auto delay		If activated, the beginning of a measurement is delayed so, that settled readings for a power step up to ± 10 dB are obtained (to ± 0.005 dB) .		

Averaging filter	Modes	AUTO OFF (fixed averaging factor) AUTO ON (continuously auto-adapted) AUTO ONCE (automatically fixed once)
	AUTO mode Normal operating mode ²³⁾	setting of filter depends on power to be measured and resolution
	Resolution	1 (1 dB), 2 (0.1 dB), 3 (0.01 dB), 4 (0.001 dB)
	Fixed Noise operating mode	filter set to specified noise content
	Noise content	0.0001 dB to 1 dB
	Max. measurement time ²⁴⁾	0.01 s to 999 s
	Averaging factor N	1 to 2 ¹⁶ (number of averaged measurement windows)
Result output Moving Average	continuous with every newly evaluated measurement window (e.g. in case of manual operation via R&S NRP)	
Repeat	only final result (e.g. in case of remote control of R&S NRP)	
Attenuation correction	Function	correcting the measurement result by means of a fixed factor (dB offset)
	Range	-100.000 dB to +100.000 dB
S-parameter correction	Function	Taking into account a component connected to the sensor input by loading its s-parameter data set into the sensor
	Number of frequencies Parameters	1 to 1000 S ₁₁ , S ₂₁ , S ₁₂ and S ₂₂ (in s2p format)
	Download	With R&S NRP tool kit (supplied with sensor) via USB Adapter R&S NRP-Z3 or R&S NRP-Z4
Γ correction	Function	Reducing the influence of mismatched sources ²⁹⁾
	Parameters	Magnitude and phase of reflection coefficient of source
	Download	see under S-parameter correction
Frequency response correction	Function	taking into account the calibration factors relevant for the test frequency
	Parameter	carrier frequency (center frequency)
	Permissible deviation from actual value	50 MHz (0.05 × f below 1 GHz) for specified measurement uncertainty
Interface to host	Power supply	+5 V / 200 mA typ. (USB high-power device)
	Remote control	As a USB device (function) in full-speed mode, compatible with USB 1.0/1.1/2.0 specifications
	Trigger input	differential (0 / +3.3 V)
Dimensions	W x H x L	48 mm × 31 mm × 170 mm Length incl. connecting cable: approx. 1.6 m
Weight		< 0.3 kg

Footnotes

Please refer to the R&S NRP data sheet for footnotes not mentioned below.

- ³³⁾ Reading the uncertainty 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.



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

General specifications

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

Accessories

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

Ordering information

Description	Type	Order No.
Average Power Sensor 200 pW to 200 mW; 9 kHz to 6 GHz	R&S NRP-Z91	1168.8004.02

