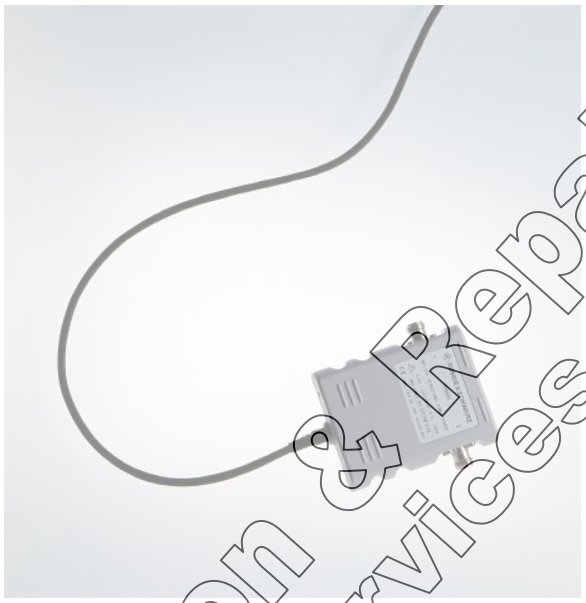
Technical Information



Directional Power Sensor R&S NRT-Z14

The right sensor when power counts

The new Directional Power Sensor R&S NRT-Z14 enables you to perform power and matching measurements on transmitters and antennas in the frequency bands of classic radiocommunications, thus replacing the tried-and-tested Power Sensors R&S NAP-Z3/4/5/10/11. Featuring innovative sensor technology, the R&S NRT-Z14 offers even more functionality and measurement accuracy. It is a complete power meter in a single sensor that can be connected to any PC.

- Frequency range 25 MHz to 1 GHz
- Power measurement range 6 mW to 300 W
- Measurement uncertainty 3.2 % of reading (0.14 dB)
- Measurement of average power irrespective of modulation mode
- Measurement of peak power, peak-to-average ratio, average burst power and reflection
- Operation on the R&S NRT or directly on a PC

Preliminary

When power counts

The new R&S NRT-Z14 meets the demands of many customers for Rohde & Schwarz to offer the innovative technology of the Directional Power Sensor R&S NRT-Z44 (frequency range: 200 MHz to 4 GHz) also in the classic frequency bands. Thus, the new power sensor is identical to the R&S NRT-Z44 except for frequency range and video bandwidth.

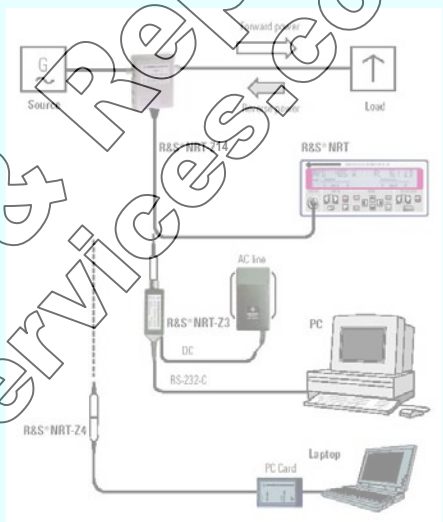
The R&S NRT-Z14 also provides the same measurement functions on the R&S NRT base unit, during direct control from a PC or via the graphical user interface that is supplied with the instrument.

The R&S NRT-Z14 more than fully replaces the trie-and-tested Power Sensors R&S NAP-Z3/4/5/10/11 – it also offers greater functionality and higher accuracy, giving you more for your money.

Directional power sensors are connected between an RF source and a load. They measure the power flow in both directions. The power applied to the load and the reflection can thus be measured.

Compared to low-cost instruments, power sensors like R&S NRT-Z14 provide a number of benefits, most important high measurement accuracy through excellent directivity and a measurement method that determines the average power like a thermal power meter. The instruments thus provide correct measurement results even in case of modulation or in the presence of several carriers.

The Directional Power Sensor R&S NRT-Z14 features extremely low insertion loss, very good matching and excellent intermodulation characteristics. The signal to be measured is virtually unaffected, and the sensor is fully transparent.



Power and reflection measurement with the R&S NRT-Z14: read-out of results either on base unit or directly on PC

Direct power monitoring on PC

This is the most economical way of performing high-precision power and reflection measurements with Directional Power Sensor R&S NRT-Z14. Via the Interface Adapters R&S NRT-Z3 and R&S NRT-Z4, the sensor can be operated on the serial RS-232-C or PC card interface of any PC. In addition to purely remote-controlled applications, e.g. power monitoring in transmitter stations and EMC test systems, this solution is ideal when data is to be collected by a computer. A Windows user interface (V-NRT, supplied with the sensors) is available for all these applications. This program allows setting of all the available measurement functions as well as display and storage both of individual results and of whole measurement series.

Specifications of R&S NRT-Z14

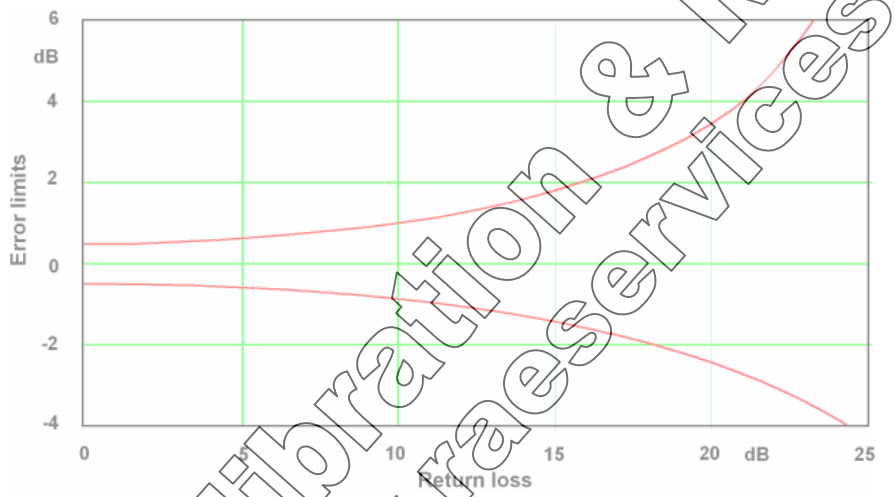
General data (max. power see diagram)	**Power measurement range** [1])	0.006 W to 120 W (average) / 300 W (peak)
	Frequency range	25 MHz to 1 GHz
	SWR (referenced to 50 Ω)	1.06 max.
	Insertion loss	0.06 dB max.
	Directivity [2])	30 dB min.
Average power measurement [3,4])	**Definition**	mean value of carrier power, averaged over several modulation cycles (thermal equivalent, true rms value in case of voltage measurement)
	Power measurement range [5])	0.03 [0.006] W to 300 W (CW, FM, φM, FSK or GMSK) 0.03 [0.006] W to 300[50] W / CF [6]) (other modulation modes) CF (crest factor): peak-to-average ratio
	Modulation	for all kinds of analog and digital modulation; lowest frequency component of signal envelope should exceed 7Hz for steady indication
	Measurement uncertainty [8]) at 18°C to 28°C, CW signal Modulated signal	3.2% of rdg (0.14 dB) [7]) from 40 MHz to 1 GHz 4.0% of rdg (0.17 dB) [7]) from 25 MHz to 40 MHz plus zero offset same as CW signal, plus errors due to modulation
	Zero offset	±0.004 [±0.0008] W [9])
	Typ. errors due to modulation [10])	FM, φM, FSK, GMSK ±0% of rdg (0 dB) AM (80%) ±3% of rdg (±0.13 dB) EDGE, TETRA [11]) ±0.5% of rdg (±0.02 dB) 2 CW carriers ±2.0% of rdg (±0.09 dB)
	Temperature coefficient [14])	0.25%/K (0.011 dB/K) 40 MHz to 1 GHz 0.40%/K (0.017 dB/K) 25 MHz to 40 MHz
	Measurement time / averaging factor [15]) Values in ( ) for high-resolution setting	1.40 (4.9) s / 32 (128) 0 W to 0.2 W 0.37 (1.4) s / 4 (32) 0.2 W to 2 W 0.26 (0.4)s / 1 (4) 2 W to 300 W
Average burst power measurement [3,4]) Video bandwith settings in { }	**Definition**	average on-power of periodic carrier bursts, based on measurement of average power under consideration of burst width t and repetition rate 1/T: average burst power = average power × T / t t and T can be given (calculate mode) or measured (measure mode)
	Power measurement range Calculate mode [5]) Measure mode (only with forward direction 1→ 2)	$0.03\,[0.006]\,\mathrm{W}\times\frac{T}{t}$ up to specified upper limit of average power measurement same as for calculate mode, but at least 2(4) W; values in ( ) for "FULL" video bandwidth setting
	Burst width (t) Calculate mode Measure mode	 0.2 µs to 150 ms 500 µs to 150 ms {4 kHz} / 10 µs to 150 ms {200 kHz} 2µs to 150 ms {"FULL"}
	Repetition rate (1/T)	7/s min.
	Duty cycle (t/T) Calculate mode Measure mode	 as defined by burst width and repetition rate 0.01 to 1

Specifications of R&S NRT-Z14 (continued)

Average burst power measurement [3,4] Video bandwith settings in { }	**Measurement uncertainty** at 18°C to 28°C Calculate mode Measure mode	 same as for average power measurement; stated zero offset multiplied by T/t same as for calculate mode plus 2 % of rdg (0.09 dB) at 0.1 duty cycle [25]
	Temperature coefficient	same as for average power measurement
	Measurement time / averaging factor [15] Calculate mode Measure mode with 0.1 duty cycle Values in ( ) for high resolution setting	 see average power measurement with corresponding average power value (average burst power multiplied by t/T) 1.6 (9.5) s / 4 (32) 2 W to 20 W 0.75 (1.6)s / 1 (4) 20 W to 300 W
Peak-to-average ratio measurement (crest factor)	**Definition**	ratio of peak envelope power to average power in dB (only with 1→2 forward direction)
	Power measurement range	see average power and peak envelope power specifications
	Measurement uncertainty	approx. 4.3 dB × (measurement error of peak hold circuit in W divided by peak envelope power in W)
	Measurement time / averaging factor	see specifications for peak envelope power measurement with simultaneous reflection measurement
Peak envelope power measurement (PEP) [3] Video bandwidth settings in { }	Definition	peak value of carrier power (only with 1→2 forward direction)
	Power measurement range Burst signals (repetition rate 20/s min.) Other type	 0.4 W to 300 W, from 100 µs width {4kHz} 1.0 W to 300 W, from 2 µs width {200 kHz} 2.0 W to 300 W, from 1.5 µs width ["FULL"] see burst signal of equivalent burst width
	Measurement uncertainty at 18°C to 28°C	same as average power measurement, plus measurement error of peak hold circuit
	Measurement error limits of peak hold circuit for burst signals with given burst width, repetition rate 100/s min., duty cycle 0.1 min.	±(3% of rdg + 0.05 W) [9]) from 200 µs {4 kHz} ±(3% of rdg + 0.2 W) [9]) from 4 µs {200 kHz} ±(7% of rdg + 0.4 W) [9]) from 2 µs {"FULL"}
	at repetition rates from 20/s to 100/s	add ±(1.6% of rdg + 0.15 W)
	at duty cycles from 0.001 to 0.1	add ±0.10 W {200 kHz, "FULL"} add ±0.05 W {4 kHz}
	Temperature coefficient [14])	0.35%/K (0.015 dB/K) 40 MHz to 1 GHz 0.50%/K (0.022 dB/K) 25 MHz to 40 MHz
	Measurement time / averaging factor [15]) Values in ( ) for high resolution setting	 PEP measurement only (not possible in combination with NRT) [18]) 0.28(0.40)s /1 (4) {4/200 kHz} 0.40(0.55)s /4 (8) {"FULL"} with simultaneous reflection measurement 0.70(1.50)s /1 (4) {4/200 kHz} 1.50(2.70)s / 4 (8) {"FULL"}
Reflection measurement [4]	**Definition**	measurement of load match in terms of SWR, return loss or reflection coefficient
	Reflection measurement range Return loss / SWR / reflection coefficient	0 to 23 dB / 1.15 to ∞ / 0.07 to 1
	Min. forward power	0.06 [0.3] W (specs met from 0.4 [2] W)
	Measurement uncertainty	see diagram
	Measurement time / averaging factor	same as measurement time of selected power measurement function, shortest with average power measurement

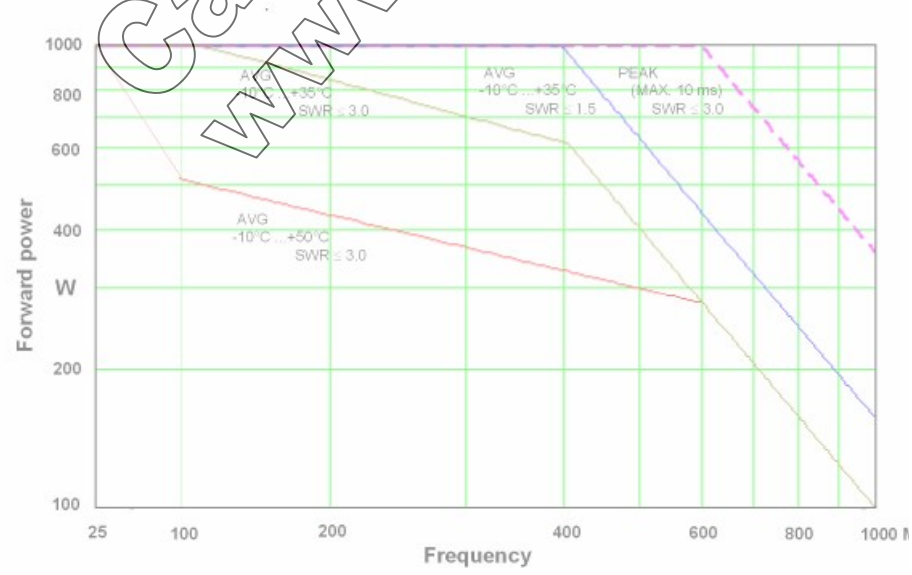
Specifications of R&S NRT-Z14 (continued)

Complementary cumulative distribution function measurement (CCDF)	**Definition**	probability in % of forward power envelope exceeding a given threshold (only with 1→ 2 forward direction)
	Measurement range	0% to 100%
	Measurement uncertainty at 18°C to 28°C	± 0.2% [19])
	Threshold level range	1 W to 300 W
	Accuracy of threshold level setting at 18°C to 28°C	±(5% of threshold level in W + 0.5 W)
	Measurement time / averaging factor [15]) values in ( ) for high resolution setting	CCDF measurement only [18]) 0.26 (0.37)s / 1 (4) with simultaneous reflection measurement, not in combination with NRT 0.70 (1.60)s / 1 (4)



Error limits for reflection measurements

Two standard deviations,
min. 0.4 W forward power
(1→ 2 forward direction)



Max. forward power
(any direction)

Specifications of R&S NRT-Z14 (continued)

Measurement channels	2 (for forward and reverse power)
Forward direction 1→2	standard for all measurement functions
2→1	only for measurement of average and average burst power (at lower levels)
Measurement functions	forward power and reflection
Power parameters	average power, average burst power, peak envelope power, peak-to-average ratio, complementary cumulative distribution function
Reflection	return loss, SWR, reflection coefficient, reverse-to-forward power ratio in %, reverse power
Range selection	automatic
Video bandwidth	4 kHz, 200 kHz, 600 kHz ("FULL") for all power parameters except average power
Frequency response correction	upon input of RF frequency, the stored correction factors of both measurement channels being taken into account
Zero adjustment	upon remote command with RF level switched off, duration approx. 5 s
RF connectors	N (female) on both ends
Remote control	via serial RS-422 interface, 4.8, 9.6, 19.2 or 38.4 kbaud, XON/XOFF handshake, SCPI-like command set; LEMOSA 6-pin, size 2 plug for RXD/TXD cable pairs and power supply (see below)
Calibration interval	2 years
General data	
Power supply	6.5 to 28 V, approx. 1.5 W
Length of connecting cable	1.5 m
Max. length of extension cable	500 m with 12 V supply voltage (via R&S NRT-Z3 or line-operated R&S NRT) 30 m with 7 V supply voltage (battery-operated R&S NRT)
Dimensions	120 mm × 95 mm × 39 mm
Weight	0.65 kg
Environmental conditions	
Temperature loading	
Permissible range	-10°C to 55°C
Operating range	0°C to 50°C
Storage range	-40°C to 70°C
Electromagnetic compatibility	meets EN 61326, EN 55011
Safety	meets EN 61010-1
Further environmental specs	see the R&S NRT data sheet PD 0757.2396.23

Footnotes

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

[24]) With matched load (SWR 1.2 max.) under consideration of the carrier frequency that must be input to an accuracy of 1%; measurement results referenced to the load end of the sensor, averaging filterset to automatic mode (high resolution). The influence of harmonics of the carrier can be ignored provided they are below -30 dBc up to 5 GHz. With a load SWR of more than 1.2, the influence of directivity on measured forward power is to be considered. The associated expanded uncertainty with a coverage factor of k=2 equals 6% of rdg (0.25 dB) × load reflection coefficient. Example: A mismatched load with 3.0 SWR yields a 0.5 reflection coefficient leading to an additional uncertainty of 3% of rdg (0.13 dB) Overall measurement uncertainty will be increased to

$$\sqrt{3.2^2 + 3^2}\ \% = 4.4\ \%\,\text{of rdg}\,(0.19\text{dB})\cdot$$

[25]) With unmodulated burst signal with rectangular envelope, after zero adjustment. Burst power must be 4 W min., burst width must exceed 2 ms {4 kHz}, 40 µs {200 kHz}, 10 µs {"FULL"}. Please note that measurement uncertainty is inversely proportional to burst width and power, thus smaller or larger values than stated are possible with other waveforms.

[26]) With unmodulated burst signal with rectangular envelope, after zeroadjustment, threshold level set to half burst power. Burst power must be 4 W min., repetition rate must be lower than 50/s {4 kHz}, 2500/s {200 kHz} and 10000/s {"FULL"}. Please note that measurement uncertainty is proportional to repetition rate and inversely proportional to power, thus smaller or larger values than stated are possible with other waveforms.

Ordering information

Description	Type	Order No.
Directional Power Sensor 120 (300) W, 25 MHz to 1 GHz	R&S NRT-Z14	1120.5505.02
Documentation of Calibration Values	R&S NRTZ14DCV	0240.2187.06
Power Reflection Meter	R&S NRT	1080.9506.02
RS-232-C Interface Adapter for Power Sensors R&S NRT-Z including AC power supply	R&S NRT-Z3	1081.2705.02
PC Card Interface Adapter for Power Sensors R&S NRT-Z	R&S NRT-Z4	1120.5005.02

Options and further recommended extras

See the R&S NRT data sheet (PD 0757.2396.23).