Power Reflection Meter NRT

200 kHz to 4 GHz 0.3 mW to 2000 W

- Power measurement on transmitters, amplifiers, industrial RF and microwave generators
- Simultaneous display of power and reflection
- Measurement of average power irrespective of modulation mode
- Measurement of peak power, crest factor and average burst power
- Compatible with all main digital standards, eg GSM/EDGE, 3GPP (W-/TD-CDMA), CDMA (IS-95), CDMA2000, PHS, NADC, PDC, TETRA, DECT, DAB, DVB-T...
- Intelligent sensors: simply plug in and go
- IEC625 (IEEE488) bus and RS-232 interface
- Digital interface between sensor and basic unit
- Direct connection of sensor to a PC

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Power Reflection Meter NRT ...

- **For mobile use, service, development, production and quality management**
- **Up to 3 (4) measurement channels**
- **Digital sensor interface**
- **Sensor operation directly on PC**
- **Entire range of sensors of predecessor model NAP connectible**

Directional power meters are connected between source and load and 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 meters like NRT provide a number of benefits: most importantly 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. Power Sensors NRT-Z43/-Z44 feature low insertion loss, very good matching and excellent intermodulation characteristics: the signal to be measured is virtually unaffected, the sensor is fully transparent.

Directional power meters are used to measure power and reflection under operational conditions. Typical applications are in installation, maintenance and monitoring of transmitters, antennas and RF generators in industrial and medical fields.

Versatile measurement functions ...

Power Reflection Meter NRT is the right choice: rugged, accurate and compact. Due to the large variety of measurement functions and high accuracy it is suitable for classic applications in mobile use as well as for use in research, development, production and quality management.

... from HF through to digital radiocommunications

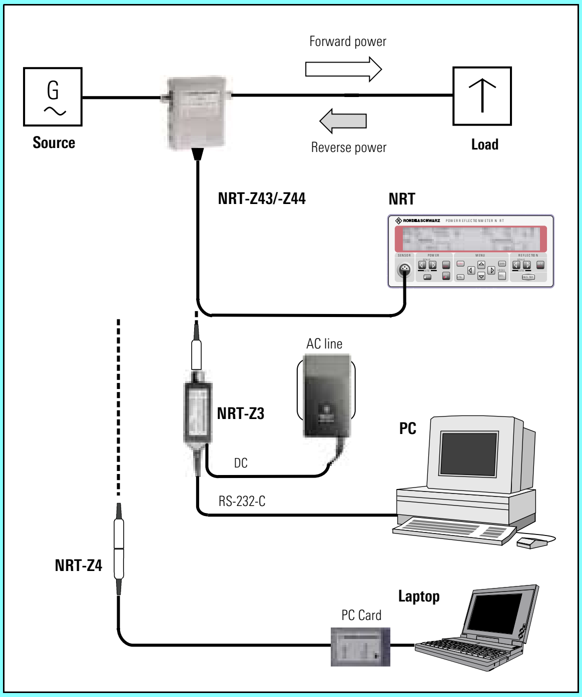
With Power Sensors NRT-Z43 and NRT-Z44, NRT is tailor-made to present and future requirements of radiocommunications: the wide frequency range from 200 (400) MHz to 4 GHz covers all relevant frequency bands, the measurement method is compatible with all common analog and in particular digital modulation standards: GSM/EDGE, 3GPP (W-/TD-CDMA), CDMA (IS-95), CDMA2000, PHS, NADC, PDC, TETRA, DECT, DAB, DVB-T and many more. The complete range of sensors of the predecessor model NAP is available for the customary frequency ranges, eg shortwave; the sensors can be connected via an option.

Measurement directly on PC

While conventional power sensors can only be used in conjunction with a basic unit, the NRT family is a step further ahead: the sensors are self-contained measuring instruments which are able to communicate with the basic unit or with a PC via a standard serial data interface.

Apart from the possibility of operating the sensor directly at the RS-232 or PC Card interface of a PC, this concept provides a number of further benefits: practically maintenance-free basic unit, high immunity to radiated interference – an important feature for measurements in the near field of antennas – and remote operation over very long distances (up to 500 m).

... a concept satisfying highest demands



Power and reflection measurement with NRT-Z43/-Z44: readout of results either on basic unit or directly on PC

Battery, NAP sensor connector and two NRT sensor connectors are accessible on the rear panel

Ease of operation

With its large display and a manageable number of clearly laid-out keys, operation of the NRT basic unit is extremely easy. Switchover between the main functions is made at a keystroke. Additional settings are selected in three clearly arranged menus, each of which can be accessed at a keystroke.

A large variety of functions is available for daily routine measurements:

- Choice between average power, average burst power, peak envelope power (PEP) and peak-to-average power ratio (crest factor)
- Switchover between forward power and absorbed power
- Measurement of power differences in dB or %
- Choice between return loss, SWR, reflection coefficient and reverse-to-forward power ratio in % in reflection measurements
- Display of amplitude distribution (CCDF) for modulated signals
- Consideration of cable loss between sensor and load
- Acoustic SWR monitoring
- Indication of maximum and minimum values
- Quasi-analog bargraph display
- Choice between measurement at the source or at the load

Versatile through options

The NRT basic unit comes with an IEC-bus (IEEE488) and RS-232 interface, both to SCPI standard. Three options allow the NRT to be adapted to different applications:

- An additional test input allows the sensors of predecessor model NAP to be connected, thus covering the frequency range from 200 kHz with power up to 1 kW and above (NRT-B1)
- Two additional test inputs for sensors of type NRT-Z (option NRT-B2) allow monitoring of up to three test points (to be scanned by manual or remote control)
- Battery and built-in charger enable mobile use (NRT-B3)

Sensor with PC interface

Directional Power Sensors NRT-Z43/-Z44

Power Sensors NRT-Z43 and NRT-Z44 can be used as self-contained measuring instruments with digital interface even without the basic unit. In addition to a directional coupler and analog section, they comprise a processor kernel for control of the hardware and remote interface and for processing the measured data (temperature compensation, linearization, zeroing and frequency-response correction). This compact concept allows a ensures of measurement functions without the restrictions of conventional analog solutions.

Average power (rms value)

This measurement function returns for any type of test signal – whether modulated, unmodulated or several carriers – the average value of the power, ie a result as provided by a thermal power meter. It features a measurement range of 35 dB to 40 dB as well as high measurement accuracy.

Peak envelope power (PEP) and crest factor

These two parameters provide information on the peak power of a modulated envelope and thus describe the overdrive characteristics of transmitter output stages. The result of the crest factor measurement is referred to the average power and read out in dB. The measurements are carried out with a video bandwidth adjustable in several steps and allow determination even of short-time, high power peaks generated, for example, by CDMA base stations.

Average burst power

This function can be used for measuring modulated and unmodulated bursts. The measurement is based on the average power and the duty cycle, which may be defined by the user or determined automatically by the power sensor.

Complementary cumulative distribution function (CCDF)

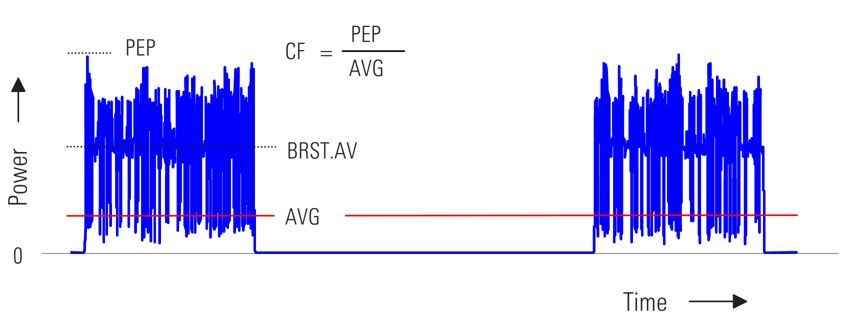
This function measures the probability of the peak envelope power exceeding a preset threshold so that the amplitude distribution of transmitted signals with non-determined envelope can be determined.

Matching

The power sensor calculates the matching of the load from the average values of forward and reverse power. This parameter can be output in all common representations – as return loss, SWR, reflection coefficient or power ratio in %. Since the reverse power measurement channel is 10 dB more sensitive than the forward channel, matching measurements can already be made at very low powers.

Excellent shielding

The power sensors feature excellent shielding so that emissions from the microprocessor or from the digital data stream on the connecting cable are completely blocked out. Any radiated emissions at the RF connectors are below the limit of detection. The excellent intermodulation characteristics keep unwanted frequency components resulting from the insertion of the power sensor to a minimum. These are all good reasons to use NRT-Z43 and NRT-Z44 not only for testing but also in fixed installations.



The main parameters of modulated RF shown in the example of a TDMA signal (one active timeslot) with $\pi/4$ DQPSK modulation:
average power (AVG)
peak envelope power (PEP)
crest factor (CF)
average burst power (BRST.AV)

Direct power monitoring on PC

This is the most economical way of performing high-precision power and reflection measurements with Power Sensors NRT-Z43 and NRT-Z44. Via Interface Converters NRT-Z3 and NRT-Z4, the two sensors can be operated on the serial RS-232 or PC Card interface of any PC. In addition to purely remote-controlled applications, eg power monitoring in transmitter stations and EMC test systems, this solution is ideal where the data are to be collected by a computer. This may be in the development laboratory as well as in the maintenance of base stations, where in addition to power and reflection other parameters have to be measured and recorded. 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.

Windows User Interface V-NRT

Interface Converter NRT-Z4

Directional Power Sensors NAP-Z

The power sensors of the predecessor model NAP cover all the main frequency bands, from the maritime radio frequencies at 200 kHz via the shortwave range and the aeronautical radio bands through to the GSM900 network at 900 MHz. The power measurement range extends from 0.3 mW to 2 kW.

Like Power Sensors NRT-Z43 and NRT-Z44, all sensors of the NAP-Z series are able to measure the average power irrespective of the modulation mode and some of them even the peak envelope power (PEP). All NAP-Z sensors up to 1 GHz have a directivity of at least 30 dB and thus allow very precise reflection and power measurements.

High directivity means high measurement accuracy

The two main parameters for specifying the accuracy of a directional power meter are the power measurement uncertainty with matched load and the directivity. The directivity is a measure of the selectivity of the directional coupler between forward and reflected wave and influences the accuracy both of the reflection and the power measurement.

Directivity defines the absolute maximum for the measurable return loss. The return loss of a load featuring good matching can only be measured with low measurement uncertainty if the directivity is sufficiently high, as for instance with Power Sensors NRT-Z and NAP-Z.

High directivity is also required for accurate power measurements on mismatched loads. The use of low-cost instruments may lead to a considerable measurement uncertainty, with too high or too low values being indicated depending on the phase of the load reflection coefficient.

Windows is a registered trademark of Microsoft Corp.

Versatile applications

NRT is also ideal for mobile use, eg for measurements on GSM antennas

Continuous monitoring of transmitter systems

Many applications call for continuous monitoring of power and reflection, eg to enable fast reaction in case of any damage to the antenna. Apart from providing high accuracy, the measuring instrument must not affect SWR and attenuation in the antenna feeder nor should it generate any interfering signals. This means very good matching, low insertion loss and excellent intermodulation characteristics: all these features are of course provided by Power Sensors NRT-Z43 and NRT-Z44 as standard. On top of this, the sum power is indicated when a multicarrier signal is applied – a feature rarely found in other directional power sensors. Since the length of the connecting cable is not critical because of digital data transfer, Directional Power Sensors NRT-Z43 and NRT-Z44 can be fitted where they measure most accurately: at the antenna feedpoint.

Results can be evaluated and recorded either at the NRT basic unit or directly at the PC. If fitted with three test inputs (option NRT-B2), NRT allows monitoring of several antennas.

Fit for mobile use

Low weight, ease of operation, clearly arranged result display and in particular its rugged design and battery powering facility make the NRT an ideal measuring instrument for use in installation, maintenance and repair, eg of digital mobile radio base stations.

The optional Battery Supply NRT-B3, consisting of battery and built-in quick charger, allows eight hours of continuous operation and recharging within two hours. And if the time factor is crucial, the instrument can be made fit for twenty minutes operation by charging the battery for as little as five minutes. Should recharging of the battery not be possible at all, the battery can be replaced in next to no time. The NRT and its accessories can be accommodated in a weatherproof carrying bag.

NRT during installation of a mobile radio base station

For **measurements on CDMA signals** to 3GPP, IS-95 or CDMA2000, the "peak envelope power" function can also be used to advantage besides the "average power" function. It enables measurement of the short-time peak values that are approx. 10 dB above the average value, thus providing information on the overdrive capability of the transmitter output stage. The peak envelope power can be read out as an absolute value in W or dBm or as a relative value in dB, referred to the average value (as crest factor).

The complementary cumulative distribution function (CCDF) is available for determining the signal amplitude distribution. This function provides information about the percentage of time during which the peak envelope power exceeds a preset threshold.

Power measurement with digital modulation

In contrast to many other directional power meters allowing measurement of RF and microwave signals with unmodulated envelope only, Power Sensors NRT-Z43 and NRT-Z44 have been designed to meet also the requirements of digitally modulated signals. The foremost feature of these sensors is that they are able to correctly measure the average power (rms value) of a signal independent of its envelope, ie they behave like a thermal power meter. This function provides the best in accuracy and measurement range (35 dB to 40 dB).

For **measurements in TDMA systems** the "average burst power" function allows measurement of the transmitter power in an active timeslot. If several timeslots are active, as in the case of base stations, the average power over all timeslots can be determined with the "average power" function. Overshoots at the beginning of a timeslot or peak values caused by modulation (eg with π/4 DQPSK) can be measured down to a minimum duration of 200 ns with the aid of the "peak envelope power" function.

Specifications

	Parameter / Sensor	NRT-Z43	NRT-Z44
General data (max. power see diagram)	**Power measurement range** [1]	0.0007 W to 30 W (average)/75 W (peak)	0.003 W to 120 W (average)/300 W (peak)
	Frequency range	400 MHz to 4 GHz	200 MHz to 4 GHz
	SWR (referred to 50 Ω)	1.07 max. from 0.4 GHz to 3 GHz 1.12 max. from 3 GHz to 4 GHz	1.07 max. from 0.2 GHz to 3 GHz 1.12 max. from 3 GHz to 4 GHz
	Insertion loss	0.06 dB max. from 0.4 GHz to 1.5 GHz 0.09 dB max. from 1.5 GHz to 4 GHz	0.06 dB max. from 0.2 GHz to 1.5 GHz 0.09 dB max. from 1.5 GHz to 4 GHz
	Directivity [2]	30 dB min. from 0.4 GHz to 3 GHz 26 dB min. from 3 GHz to 4 GHz	30 dB min. from 0.2 GHz to 3 GHz 26 dB min. from 3 GHz to 4 GHz
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] CF (crest factor): peak-to-average ratio	0.007 [0.0007] W to 75 W (CW, FM, φM, FSK, GMSK or equivalent) to 30 [3] W [6] ((W)CDMA, DAB/DVB-T) to 75 [7.5] W/CF [6] (other modulation modes)	0.03 [0.003] W to 300 W (CW, FM, φM, FSK, GMSK or equivalent) to 120 [12] W [6] ((W)CDMA, DAB/DVB-T) to 300 [30] W/CF [6] (other modulation modes)
	Modulation	for all kinds of analog and digital modulation; lowest frequency component of signal envelope should exceed 7 Hz for steady indication	
	Measurement uncertainty [7] at (18 to 28) °C, CW signal	3.2% of rdg (0.14 dB) [8] plus zero offset	3.2% of rdg (0.14 dB) [8] from 0.3 GHz to 4 GHz 4.0% of rdg (0.17 dB) [8] from 0.2 GHz to 0.3 GHz plus zero offset
	Modulated signal	same as CW signal, plus errors due to modulation	
	Zero offset	±0.001 [±0.0001] W [9]	±0.004 [±0.0004] 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) CDMA (IS-95), DAB [11]: ±1% of rdg (±0.04 dB) CDMA2000 (3X) [12]: ±2% of rdg (±0.09 dB)	W-CDMA [13]: ±2% of rdg (±0.09 dB) DVB-T [11]: ±2% of rdg (±0.09 dB) π/4-DQPSK: ±2% of rdg (±0.09 dB) 2 CW carriers: ±2% of rdg (±0.09 dB)
	Temperature coefficient [14]	0.25%/K (0.011 dB/K) 0.4 GHz to 4 GHz	0.25%/K (0.011 dB/K) 0.3 GHz to 4 GHz 0.40%/K (0.017 dB/K) 0.2 GHz to 0.3 GHz
	Measurement time/averaging factor [15] Values in ( ) for high resolution setting	1.4 (4.9) s / 32 (128) 0 W to 0.05 W 0.37 (1.4) s / 4 (32) 0.05 W to 0.5 W 0.26 (0.37) s / 1 (4) 0.5 W to 75 W	1.4 (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 (0.37) s / 1 (4) 2 W to 300 W
Average burst power measurement [3] [4] Video bandwidth 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 x T/t; t and T can be given (calculate mode) or measured (measure mode)	
	Power measurement range Calculate mode [5]	0.007 [0.0007] W x $\frac{T}{t}$	0.03 [0.003] W x $\frac{T}{t}$
		up to specified upper limit of average power measurement	
	Measure mode (only with forward direction 1 → 2)	same as for calculate mode, but at least 0.5 (1.25) W with NRT-Z43 and 2 (5) W with NRT-Z44; 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}/1 μs 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	
	Measurement uncertainty at (18 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 [16]	
	Temperature coefficient	same as for average power measurement	
	Measurement time/averaging factor [15] Calculate mode	see average power measurement with corresponding average power value (average burst power multiplied by t/T)	
	Measure mode with 0.1 duty cycle Values in ( ) for high resolution setting	1.6 (9.5) s / 4 (32) 0.5 W to 5 W 0.75 (1.6) s / 1 (4) 5 W to 75 W	1.6 (9.5) s / 4 (32) 2 W to 20 W 0.75 (1.6) s / 1 (4) 20 W to 300 W

	Parameter / *Sensor*	NRT-Z43	NRT-Z44
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 x (measurement error of peak hold circuit in W divided by peak envelope power)	
	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.)	0.1 W to 75 W, from 100 µs width {4 kHz} 0.25 W to 75 W, from 2 µs width {200 kHz} 0.5 W to 75 W, from 0.2 µs width {"FULL"}	0.4 W to 300 W, from 100 µs width {4 kHz} 1 W to 300 W, from 2 µs width {200 kHz} 2 W to 300 W, from 0.2 µs width {"FULL"}
	CDMA (IS-95), W-CDMA, CDMA2000, DAB, DVB-T	1 W to 75 W {"FULL" with modulation correction switched on}	4 W to 300 W {"FULL" with modulation correction switched on}
	Other type	see burst signal of equivalent burst width	
	Measurement uncertainty at (18 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 + 0.012 W) [9] from 200 µs {4 kHz} ±(3% of rdg + 0.05 W) [9] from 4 µs {200 kHz} ±(7% of rdg + 0.1 W) [9] from 1 µs {"FULL"}	±(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 1 µs {"FULL"}
	at repetition rates from 20/s to 100/s	add ±(1.6% of rdg + 0.04 W)	add ±(1.6% of rdg + 0.15 W)
	at duty cycles from 0.001 to 0.1	add ±0.025 W {200 kHz, "FULL"} add ±0.013 W {4 kHz}	add ±0.10 W {200 kHz, "FULL"} add ±0.05 W {4 kHz}
	at burst widths from 0.5 µs to 1 µs (0.2 µs to 0.5 µs)	add ±5% (10%) of rdg	
	Typ. measurement errors of peak hold circuit with spread-spectrum signals [17] CDMA (IS-95), DAB [11] CDMA2000 (3X) [12], W-CDMA [13], DVB-T	±(5% of rdg + 0.1 W) ±(15% of rdg + 0.1 W)	±(5% of rdg + 0.4 W) ±(15% of rdg + 0.4 W)
	Temperature coefficient [14]	0.35%/K (0.015 dB/K) 0.4 GHz to 4 GHz	0.35%/K (0.015 dB/K) 0.3 GHz to 4 GHz 0.50%/K (0.022 dB/K) 0.2 GHz to 0.3 GHz
	Measurement time/averaging factor [15] Values in ( ) for high resolution setting	PEP measurement only[18] (not possible in combination with NRT): 0.28 (0.40) s / 1 (4) {4 kHz, 200 kHz}; 0.40 (0.55) s / 4 (8) {4 MHz} with simultaneous reflection measurement: 0.7 (1.5) s / 1 (4) {4 kHz, 200 kHz}; 1.5 (2.7) s / 4 (8) {4 MHz}	
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 to 28) °C	0.2% [19]	
	Threshold level range	0.25 W to 75 W	1 W to 300 W
	Accuracy of threshold level setting at (18 to 28) °C	±(5% of threshold level in W + 0.13 W)	±(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 possible in combination with NRT): 0.7 (1.6) s / 1 (4)	
Reflection measurement [4] Values in { }: 3 GHz to 4 GHz	**Definition**	measurement of load match in terms of SWR, return loss or reflection coefficient	
	Reflection measurement range Return loss/SWR/reflection coefficient	0 dB to 23 {20} dB / 1.15 {1.22} to ∞ / 0.07 {0.10} to 1	
	Min. forward power	0.007 [0.07] W (specs met from 0.05 [0.5] W)	0.03 [0.3] W (specs met from 0.2 [2] W)
	Measurement uncertainty	see diagram	
	Measurement time/averaging factor	same as measurement time of selected power measurement function, shortest with average power measurement	

	Parameter / Sensor	NAP-Z3	NAP-Z4	NAP-Z5	NAP-Z6	NAP-Z7	NAP-Z8
General data (max. power see diagrams)	**Power measurement range** [1]	0.01 W to 35 W	0.03 W to 110 W	0.1 W to 350 W	0.3 W to 1100 W	0.05 W to 200 W	0.5 W to 2000 W
	Frequency range	25 MHz to 1 GHz				0.4 MHz to 80 MHz	0.2 (0.4 *)) MHz to 80 MHz
	SWR (referred to 50 Ω)	1.07 max.			1.07 max.	1.03 max. (1.02 max. from 1.5 MHz to 30 MHz)	
	Insertion loss up to 0.3 GHz up to 0.5 GHz whole frequency range	 0.10 dB max. 0.25 dB max. 0.75 dB max.	 0.08 dB max. 0.15 dB max. 0.35 dB max.	 0.08 dB max. 0.15 dB max. 0.20 dB max.	 0.05 dB max. 0.10 dB max. 0.15 dB max.	 – – 0.015 dB max.	
	Directivity [2]	27 dB min. from 30 MHz to 1 GHz, 26 dB min. from 25 MHz to 30 MHz			min. 25 dB	35 dB min. from 1.5 MHz to 30 MHz (other frequencies see table)	
Average power measurement [3]	**Measurement range** [5]	0.01 W to 35 W	0.03 W to 110 W	0.1 W to 350 W	0.3 W to 1100 W	0.05 W to 200 W	0.5 W to 2000 W
	Measurement uncertainty [20] at 20°C to 25°C	6% max. of rdg plus zero offset				6 [4] % max. of rdg [22] plus zero offset (1.5 MHz to 30 MHz), (other frequencies see table)	
	Zero offset [9]	±0.0013 W	±0.004 W	±0.013 W	±0.04 W	±0.01 W	±0.1 W
	Temperature coefficient	0.25%/K max., to be considered outside temperature range 20°C to 25°C					
	Measurement time [21]	0.4 s				0.5 s	
Peak envelope power measurement [3]	**Measurement range** AM Burst width t Repetition rate 1/T					0.5 W to 200 W 30 Hz to 10 kHz 20 μs min. 30/s min.	5 W to 2000 W
	Measurement uncertainty at 20°C to 25°C					same as for average power measurement plus measurement error of peak hold circuit	
	Error limits of peak hold circuit					±(2 (7)% of rdg + 0.04% of P_{nom})[23] for two superimposed CW carriers of equal amplitude, frequency offset 0.3 kHz to 3 kHz (0.03 kHz to 0.3 kHz and 3 kHz to 10 kHz)	
	Temperature coefficient					same as for average power measurement plus 0.003% of P_{nom} [23]/K	
	Measurement time [21]					1.5 s	
Reflection measurement	**Reflection measurement range** Return loss/SWR/ reflection coefficient	0 dB to 23 dB / 1.15 to ∞ / 0.07 to 1 (30 MHz to 1 GHz)				0 dB to 28 dB / 1.08 to ∞ / 0.04 to 1 (1.5 MHz to 30 MHz)	
	Minimum forward power	0.1 (0.6) W	0.3 (2) W	1 (6) W	3 (20) W	0.5 (10) W	5 (100) W
		specs met at power values in ( )					
	Measurement uncertainty	see diagram – specifications are valid only after zero adjustment and selection of average power measurement function					
	Measurement time	same as measurement time of selected power measurement function; shortest with average power measurement					

Power measurement with NAP-Z sensors and option NRT-B1

Measurement channels	2 identical channels (for forward and reverse power) with same specifications
Range selection	automatic
Frequency response correction	with NAP-Z7 and -Z8 under consideration of reported calibration factors
Zero adjustment	with RF level switched off, duration approx. 5 s
RF connectors	N male/N female (NAP-Z6: 7/16 male, 7/16 female)
Length of connecting cable	1.5 m
Length of extension cable	max. 25 m (NAP-Z2)
Dimensions/weight	118 mm x 105 mm x 45 mm / 0.6 kg (NAP-Z3 to -Z5) 125 mm x 105 mm x 45 mm / 0.6 kg (NAP-Z6) 118 mm x 118 mm x 45 mm / 0.7 kg (NAP-Z7, -Z8, -Z10, -Z11)

Specifications of Power Sensors NAP-Z7/-Z8 outside the 1.5 MHz to 30 MHz frequency range (20°C to 25°C).
Values in [ ] taking into account the reported calibration factors. Calibration interval: 1 year

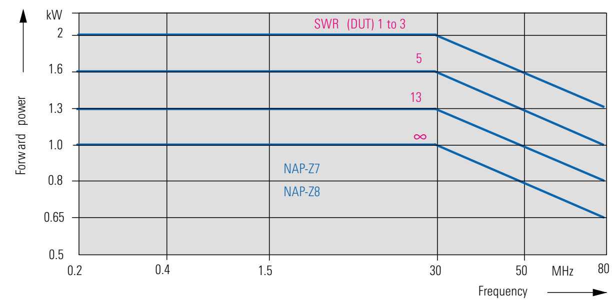
Frequency		0.2 to 0.4	0.4 to 1.5	30 to 50	50 to 80	MHz
Directivity	NAP-Z7 NAP-Z8	– 25	23 30	30 30	20 20	dB (min.) dB (min.)
Uncertainty for average power measurement	NAP-Z7 NAP-Z8	– 32 [15]	35 [12] 13 [6]	11 [4] 11 [4]	25 [5] 25 [5]	% of rdg (max.) % of rdg (max.)

Certified Quality System
ISO 9001
DQS REG. NO 1954

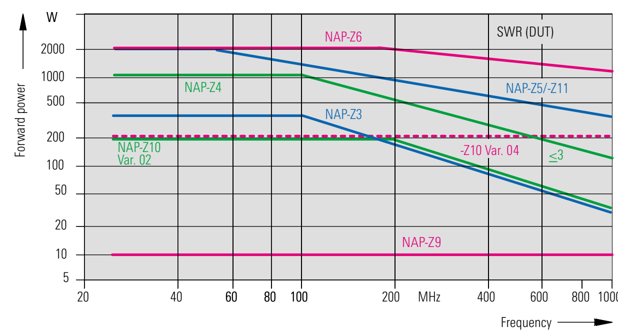
Certified Environmental System
ISO 14001
REG. NO 1954

*) 0.4 MHz for PEP measurement only

NAP-Z10	NAP-Z11
Models 02	
0.005 W to 20 W	0.05 W to 200 W
35 MHz to 1 GHz	
1.07 max.	
0.10 dB max. 0.25 dB max. 0.75 dB max.	0.08 dB max. 0.15 dB max. 0.20 dB max.
27 dB min. from 40 MHz to 1 GHz 26 dB min. from 35 GHz to 40 GHz	
0.005 W to 20 W	0.05 W to 200 W
6.5% max. of rdg plus zero offset	
±0.001 W	±0.01 W
0.25%/K max., to be considered outside temperature range 20°C to 25°C	
0.5 s	
0.05 W to 20 W	0.5 W to 200 W
50 Hz to 100 kHz 4.5 µs min. 50/s min.	
same as for average power measurement, plus measurement error of peak hold circuit	
±(2 (3)% of rdg + 0.02% of P_{nom}) [23] for burst signals with 0.05 to 1 (0.005 to 0.05) duty cycle and a repetition rate of 200/s to 200 000/s. Other rep. rates: ±0.02% of P_{nom} [23], plus ±3.5 (5)% of rdg from 100/s to 200/s, 6.5 (8)% of rdg from 50/s to 100/s	
same as for average power measurement plus 0.001% of P_{nom} [23]/K	
1.5 s	
0 dB to 23 dB / 1.15 to ∞ / 0.07 to 1 (40 MHz to 1 GHz)	
0.05 (0.35) W	0.5 (3.5) W
specs met at power values in ( )	
see diagram – specifications are valid only after zero adjustment and selection of average power measurement function	
same as measurement time of selected power measurement function, shortest with average power measurement	



1



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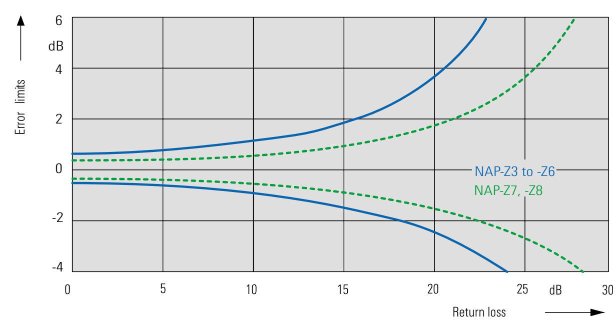
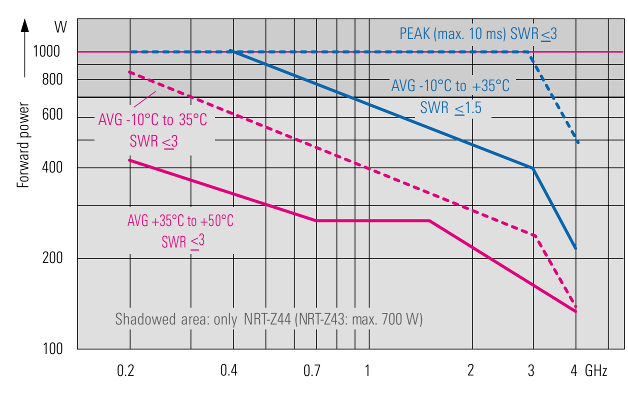
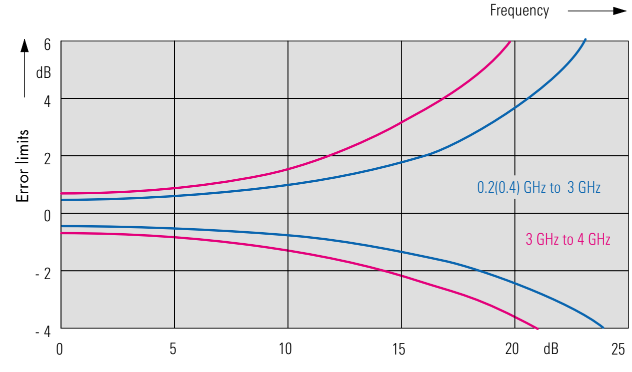


3



4



5

Directional Power Sensors NAP-Z

Figs 1 and 2:
Maximum continuous power rating of sensors
(with modulated signals: peak envelope power (PEP))

Fig. 3:
Error limits (two standard deviations) for
reflection measurements with NAP-Z power sensors
(for min. forward power see sensor specifications)

Directional Power Sensors NRT-Z

Fig. 4:
Max. forward power vs. frequency (any direction)

Fig. 5:
Error limits (two standard deviations) for reflection measurements.
Min. forward power (1 ⟶ 2 forward direction):
0.05 W for NRT-Z43, 0.20 W for NRT-Z44

1) Dependent on measurement function.
2) Ratio of measured forward and reverse power in dB with perfectly matched load.
3) Specifications apply to measurement of forward power.
4) Values in [ ]: 2 → 1 forward direction (if different from 1 → 2 forward direction).
5) Power measurement below the given limits is possible at the expense of an increased influence of zero offset.
6) Measurement of average power up to the CW limits is possible at the expense of increased measurement errors.
7) With matched load (SWR 1.2 max.) under consideration of the carrier frequency that must be input to an accuracy of 1%; measurement results referred to the load end of the sensor, averaging filter set to automatic mode (high resolution). The influence of harmonics of the carrier can be neglected provided they are below –30 dBc up to 4 GHz, –35 dBc from 4 GHz to 10 GHz and –60 dBc above 10 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) x load reflection coefficient for carrier frequencies up to 3 GHz and 10% of rdg (0.4 dB) x load reflection coefficient from 3 to 4 GHz. 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) in the frequency range up to 3 GHz. Overall measurement uncertainty will be increased to
$\sqrt{3.2^2 + 3^2}\,\% = 4.4\,\%$ of rdg. (0.19 dB).
8) Expanded uncertainty with a coverage factor k=2, which for a normal distribution corresponds to a coverage probability of 95 %.
9) After zero adjustment.
10) In temperature range (18 to 28)°C, relative to a CW signal. The error depends from case to case on the modulation parameters, eg the modulation frequency with AM, and the individual sensor characteristics. The specified tolerances refer to 1→2 forward direction and a power of 30 W (NRT-Z43) or 120 W (NRT-Z44). With burst signals, the specified errors refer to an average burst power of 30 W (NRT-Z43) or 120 W (NRT-Z44). Since errors due to modulation are proportional to power, they become smaller the lower the power: a W-CDMA signal with an average power of 30 W for instance will only cause a very small error of about ±0.5 % of Sensor NRT-Z44 with modulation correction switched on.
11) With modulation correction switched on.
12) With modulation correction switched on (same as W-CDMA), chip rate set to 3.6864 Mc/s.
13) Signal similar to test model 1 with 64 channels for downlink with 3.84 Mc/s in line with 3GPP standard 3G TS 25.141 V3.1.0 (2000-03); modulation correction switched on, chip rate set according to test signal.
14) Statistically distributed with a mean value of 0%/K, the stated temperature coefficients corresponding to approximately two standard deviations. Temperature coefficients must be considered for calculation of measurement uncertainty below 18°C and above 28°C. Example: at +5°C and 1 GHz a temperature drift of (18 - 5) x 0.25% = 3.25% of rdg (0.14 dB) for average power measurement can be expected relative to 18°C. Combined with the measurement uncertainty of 3.2% at 18°C to 28°C the overall uncertainty will be
$\sqrt{3.2^2 + 3.25^2}\,\% = 4.6\,\%$ of rdg. (0.19 dB) at 5°C.
15) Settled readings, with level-dependent (automatic) averaging of measurement results. Measurement times are defined as from input of trigger command to completion of answer string (baud rate 38400). Measurement results comprise two values, one for the selected forward power function and another for the chosen reflection parameter (SWR, return loss, reflection coefficient, or reverse power). Add 0.05 s when operating the power sensor on NRT.
16) With unmodulated burst signal with rectangular envelope, after zero adjustment. Burst power must be 1 W min. for NRT-Z43 and 4 W min. for NRT-Z44, burst width must exceed 2 ms {4 kHz}, 40 µs {200 kHz}, 5 µs {"FULL"}. Please note that measurement uncertainty is inversely proportional to burst width and power, thus smaller or bigger values than stated are possible with other waveforms.
17) In temperature range (18 to 28) °C, video bandwidth "FULL", PEP defined as power with a CCDF value $<10^{-6}$.
18) Setting must be initiated with a "rev:pow" command in addition to the setting command for the forward measurement function via the remote interface of the sensor. Since the sensor measures average reverse power with this setting (a parameter normally not of interest in combination with any function other than average power measurement), the setting is denoted as "PEP measurement only" or "CCDF measurement only".
19) With unmodulated burst signal with rectangular envelope, after zero adjustment, threshold level set to half burst power. Burst power must be 1 W min. for NRT-Z43 and 4 W min. for NRT-Z44, repetition rate must be lower than 50/s {4 kHz}, 2500/s {200 kHz} and 20000/s {"FULL"}. Please note that measurement uncertainty is proportional to repetition rate and inversely proportional to power, thus smaller or bigger values than stated are possible with other waveforms. For spread-spectrum signals such as CDMA (IS-95), CDMA2000, W-CDMA, DAB and DVB-T, measurement uncertainty is described best as an uncertainty used for setting the threshold value and taken into account in addition to the specified uncertainty. With modulation correction switched on, this additional uncertainty is about 5% of the power in W for the specified standards.
20) With matched load (SWR 1.2 max.), test signal with unmodulated envelope (CW, FM, φM, FSK, GMSK or equivalent), measurement results referred to load end of sensor. The maximum uncertainty given in the table is approximately equal to an expanded uncertainty with a coverage factor of k=2. 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 in percent (coverage factor of 2) equals 6% x load reflection coefficient for directivity of 30 dB. Example: a mismatched load with 3.0 SWR yields a 0.5 reflection coefficient leading to an additional uncertainty of 6 x 0.5% = 3%.
21) Settled readings over IEEE bus.
22) Values in [ ] taking into account the reported calibration factors of the sensor.
23) Upper limit of power measurement range.

NRT basic unit

Frequency range	200 kHz to 4 GHz [1]
Power measurement range	0.3 mW to 2 kW [1]
Measurement inputs	1 to 3 (4), one active
for NRT-Z sensors	one input on front panel, two additional inputs on rear panel (option NRT-B2)
for NAP-Z sensors	one input on rear panel (option NRT-B1)
Measurement functions	
Power	forward power and power absorbed by the load in W, dBm, dB or % (dB and % referred to measured value or reference value)
Power parameters [1]	average power, average burst power, peak envelope power, peak-to-average ratio (crest factor), complementary cumulative distribution function
Reflection	SWR, return loss, reflection coefficient, reverse-to-forward power ratio in %, reverse power
Frequency response correction	upon input of RF frequency, the stored correction factors of the power sensor being taken into account; for NAP-Z sensors the NRT basic unit offers memory for 3 sets of calibration factors
Zero adjustment	selectable with RF power switched off, duration approx. 5 s
Measurement uncertainty	see sensor specifications
Display	LCD
Digital	simultaneous indication of power, reflection, and carrier frequency (input value)
Resolution	HIGH: 4½ digits (0.001 dB) LOW: 3½ digits (0.01 dB)
Analog	two 50-element bargraphs for indication of power and reflection with selectable or predefined scale-end values
Averaging	automatic, depending on selected resolution and sensor characteristics
Max/Min Hold	indication of current maximum, minimum or max/min value for the selected measurement functions
Remote control	to SCPI-1995.0 command set
IEC/IEEE bus	to IEC625 (IEEE488); interface functions SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1
Serial interface	9-pin sub-D connector to EIA-232E; 1200, 2400, 4800 and 9600 baud; RTS/CTS or XON/XOFF handshake selectable
Measurement time	
with NAP-Z sensors	see NAP-Z specifications
with NRT-Z sensors	add 0.05 s to NRT-Z sensor specifications
AUX connector	BNC connector as signalling output or trigger input (TTL)
Beeper	for SWR monitoring (power and SWR threshold selectable) and acoustic echoing of keystrokes
Setups	last setting, default setting and up to four user-defined instrument settings

[1] Sensor-dependent.

Options	
NRT-B1	for measurement with one NAP-Z sensor at the rear
NRT-B2	two additional NRT-Z sensor inputs at the rear
NRT-B3	battery supply with built-in charger and NiMH battery
Calibration interval	3 years, only in conjunction with option NRT-B1; no calibration required for NRT basic unit and the other options
General data	
AC power supply	IEC connector for single-phase AC voltage of 90 V to 264 V, 47 Hz to 63 Hz or 90 V to 132 V, 47 Hz to 440 Hz; 35 VA, max. 0.4 A
Battery supply	with option NRT-B3, operating time approx. 8 h with one NRT-Z power sensor and option NRT-B1; recharging within 2 hours by quick-charge management; switch-on time selectable; battery can be exchanged without opening the instrument
Dimensions	219 mm × 103 mm × 240 mm
Weight	3.5 kg with all options

Power Sensors NRT-Z43/-Z44

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 and "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 V 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 NRT-Z3, NRT-Z4 or line-operated NRT) 30 m with 7 V supply voltage (battery-operated NRT)
Dimensions	120 mm x 95 mm x 39 mm
Weight	0.65 kg

RS-232 Interface Adapter NRT-Z3

Power supply	90 V to 264 V, 47 Hz to 63 Hz via supplied plug-in power supply with adapter for all AC supply standards (Euro, UK, USA, Australia)
RS-232 interface	9-pin sub-D female connector
Length of connecting cable	approx. 1.3 m
Weight	0.3 kg (adapter); 0.1 kg (power supply)
Operating temperature range	0°C to +50°C

PC Card Interface Adapter NRT-Z4

Compatibility	PCMCIA Release 2.1, card type II (5 mm thick)
Current drain	350 mA (with sensor connected) at 5 V (approx. 10% of power consumption of commercial laptops)
Required system	PC with PC Card slot, operating system Win3.x/95/98/NT/2000
Length of connecting cable	approx. 2 m
Weight	0.25 kg
Operating temperature range	0°C to +50°C

Environmental conditions for NRT and Power Sensors NRT-Z and NAP-Z

Temperature loading	to IEC68-2-1, IEC68-2-2 and MIL-T-28800D class 5
Operational	–10 °C to +55 °C
Specs complied with	0 °C to 50 °C (unless otherwise stated)
Storage temperature range	–40 °C to +70 °C
Climatic resistance	95% rel. humidity, cyclic test at +25 °C/ +40 °C (without condensation) to IEC68-2-30
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 55 Hz, max. 2 g; 55 Hz to 150 Hz, 0.5 g constant; to IEC68-2-6, EN61010-1 and MIL-T-28800 D
Vibration, random	10 Hz to 500 Hz, 1.9 g (rms) to IEC 68-2-36
Shock	40 g shock spectrum to MIL-STD-810 C, IEC68-2-27 and MIL-T-28800 D class 5
Electromagnetic compatibility	to EN50081-1 and EN50082-2, EMC directive of EU and MIL-STD-461C, CE03, RE02, CS02 and RS03 (with raised field strength of 20 V/m)
Safety	to EN61010-1

Ordering information

Basic unit		
Power Reflection Meter	NRT	1080.9506.02
Directional Power Sensors NRT-Z (incl. demo software)		
30 (75) W, 0.4 GHz to 4 GHz	NRT-Z43	1081.2905.02
120 (300) W, 0.2 GHz to 4 GHz	NRT-Z44	1081.1309.02
Directional Power Sensors NAP-Z		
35 W, 25 MHz to 1000 MHz	NAP-Z3	0392.6610.55
110 W, 25 MHz to 1000 MHz	NAP-Z4	0392.6910.55
350 W, 25 MHz to 1000 MHz	NAP-Z5	0392.7116.55
1100 W, 25 MHz to 1000 MHz	NAP-Z6	0392.7316.56
200 W, 0.4 MHz to 80 MHz	NAP-Z7	0350.8214.02
2000 W, 0.2 MHz to 80 MHz	NAP-Z8	0350.4619.02
20 W, 35 MHz to 1000 MHz	NAP-Z10	0858.0000.02
200 W, 35 MHz to 1000 MHz	NAP-Z11	0852.6707.02
Options		
Interface for Power Sensors NAP-Z	NRT-B1	1081.0902.02
Two rear inputs for Power Sensors NRT-Z	NRT-B2	1081.0702.02
Battery supply with built-in charger and NiMH battery	NRT-B3	1081.0502.02
Recommended extras		
NiMH Battery	NRT-Z1	1081.1209.02
10 m Extension Cable for NRT-Z Power Sensors	NRT-Z2	1081.2505.10
30 m Extension Cable for NRT-Z Power Sensors	NRT-Z2	1081.2505.30
25 m Extension Cable for NAP-Z Power Sensors	NAP-Z2	0392.5813.02
RS-232 Interface Adapter for NRT-Z Power Sensors including AC Power Supply	NRT-Z3	1081.2705.02
PC Card Interface Adapter for NRT-Z Power Sensors	NRT-Z4	1120.5005.02
Carrying Bag with Straps and Pocket for Accessories	ZZT-222	1001.0500.00
19" Rack Adapter	ZZA-97	0827.4527.00

PD 0757.2396.23 · Power Reflection Meter NRT · Trade names are trademarks of the owners · Subject to change · Data without tolerances: typical values
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