



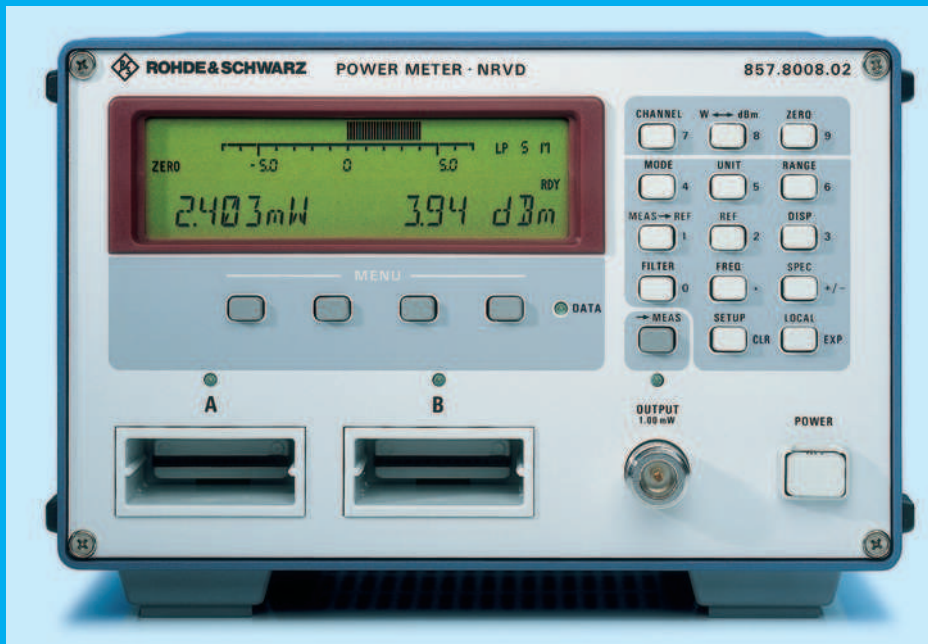
## Dual-channel Power Meter NRVD

Power, level and voltage measurements from DC to 40 GHz

- Accurate, general-purpose, easy-to-use
- Attenuation and reflection measurements
- Two independent channels measuring simultaneously
- Operating modes: average power, reflection, pulse power, AM, DC
- Manual or automatic range selection
- Intelligent measuring heads – just plug them in and measure straightaway
- Readout: Absolute in W, dBm, V, dBV, dBμV, relative in dB, %, A/B, B/A, A-B, B-A
- Remote control of all functions via IEC/IEEE bus to SCPI



**ROHDE & SCHWARZ**



The NRVD covers a total bandwidth of 40 GHz and a power span from 100 pW up to the kW range. Being individually and absolutely calibrated, the measuring heads can be interchanged as required without impairing specified error limits.

The wide range of measuring heads includes thermal power sensors as well as highly sensitive diode power sensors, peak power sensors, probes and insertion units for voltage measurements.

WF 43 223-3

## All you need – and lots more

- LC display with variable backlighting, separate digital readout for each channel, bargraph indicator
- Softkeys for control via menus
- Entry of reference values for level and attenuation
- 13 digital filters for noise suppression, manual or automatic filter selection
- Storage of 20 instrument setups
- Input/output option with DC frequency input, analog outputs, trigger input, ready output
- Rear connectors for measuring heads in system operation
- Generator for testing measuring heads
- Correction of frequency response of measuring heads:  
Frequency entry via keyboard, IEC/IEEE bus or by means of a frequency-proportional DC voltage.

## Two instruments in one

The NRVD is not just a power meter with two inputs, it functions like two independent measuring instruments

housed in one cabinet, that perform measurements simultaneously and exchange data with one another. The two channels can be separately set so that two completely different measurements can be carried out at the same time. The two measured values can also be related to each other for direct indication of reflection coefficient, SWR and return loss, for instance, when a SWR bridge is connected to the meter.

## Operation

Operation of the power meter is to a great extent via self-explanatory menus so that the user will hardly ever have to refer to the manual.

For setting the instrument rapidly to a specific status, 20 complete setups can be stored. A selectable write protection prevents inadvertent alteration of stored setup data.

All measuring and setting functions of the NRVD can be remote-controlled. The IEC/IEEE-bus syntax complies with the Standard Commands for Programmable Instruments (SCPI).

## Measurement rate

The sensitivity obtained not only depends on the noise of the measured parameter but also on the measurement rate, which must be matched to the measurement conditions. Taking into account the connected measuring head, the NRVD automatically selects the appropriate measurement rate by determining the optimum averaging time required for a noise-free display as a function of level and selected resolution. This automatic selection may be disabled and an averaging time of between 4 ms and 25 s may be set manually to further reduce the noise or to measure faster than in automatic operation.

## Test generator

This generator is provided to check the function of measuring heads, eg after overloading or excessive mechanical stress. It generates a low-distortion, highly accurate 50-MHz signal of 1-mW power (0 dBm).

## Readout

Measurement results are displayed with a selectable resolution on a five-digit LCD with adjustable backlighting. The values measured in the two channels or one measured value and an item of information, eg. the correction frequency, are displayed simultaneously.

All standard units of measurement or relative modes can be selected. Relative measurements are either referred to a stored reference value or to the value measured in the second channel. A high-resolution bargraph indicator with selectable scaling or autoscaling permits quasi-analog display of measured values with any unit or resolution.

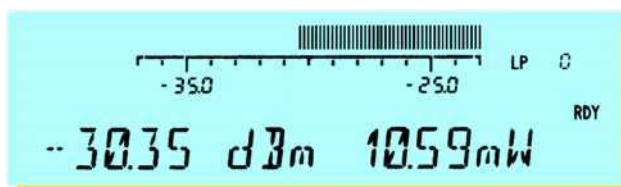
The characters "PEP" or "PUL" preceding the numerical value denote the maximum envelope power (measured with a Peak Power Sensor of the NRV-Z3x series) or the pulse power, respectively. The pulse power is a calculated peak value for RF bursts with rectangular envelope. It is based on the duty factor and the average power value. Pulse power measurements can be made using thermocouple sensors as well as diode power sensors operated in the square-law region. On request, the modulation depth of an amplitude-modulated signal can be determined from the power variation when switching the modulation on.

After entering the SWR of the source, the expected measurement uncertainty can be displayed together with the measured value for all thermocouple sensors and some diode sensors.

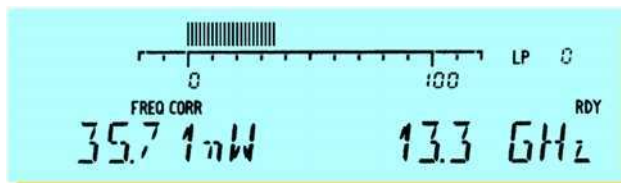
## I/O Option NRVD-B2

Option NRVD-B2 is provided with a number of inputs and outputs that extend the application range of the NRVD. For instance, a 12-bit resolu-

Dual-channel measurement and readout: left channel in dBm, right channel in mW; bargraph allocated to left channel



Readout of correction frequency (see also under "Measuring heads") together with measured value



Readout of pulse power after entry of duty factor



Readout of modulation depth of an amplitude-modulated signal



Readout of reflection coefficient



tion, analog output with free scaling is allocated to each measuring channel for connecting a recorder or for control purposes. With the aid of the trigger input or the ready output, measurements can be automated by simple control means. Another input serves for taking up the frequency-proportional DC voltage from a sweep generator that may be used for driving the test setup. The NRVD uses this information for an automatic frequency response correction (see also under "Measurement accuracy").

## Measuring heads

Power meters cover a wide range of applications and a great variety of frequency and power ranges. Since suitable measuring heads are available for the various applications and ranges, the only factors to influence the selection of a power meter are versatility, system compatibility and ease of operation. In these aspects the NRVD is a top-class unit. NRVD measuring heads are not type-specific and may therefore be used with any unit of the power and voltmeter families.

Thermal power sensors measure the average power irrespective of the signal shape and meet the highest demands on accuracy. Diode power sensors are more sensitive – they are able to measure power down to the pW range – but their measurement accuracy is impaired when high-level, non-sinusoidal signals are to be measured. In the medium sensitivity range it is recommended to use diode power sensors with integrated attenuator, e.g. NRV-Z2. This combination not only allows considerably faster level measurements in the range between 10 and 100  $\mu$ W than a thermal power sensor, it also offers better matching than a highly sensitive diode detector and still measures true rms power.

The maximum envelope power of modulated signals can be measured by means of a Peak Power Sensor of the NRV-Z3x series. These sensors are suitable for sync peak power measurements on TV transmitters and transmitter power measurements on TDMA radio equipment or for general applications. Peak Power Sensors, which consist of a fast diode detector followed by a peak-hold circuit, are calibrated individually like all Rohde&Schwarz power sensors. Besides the NRV-Z power sensors, all voltage probes of the URV5-Z series can be used with the NRVD.

## Measurement accuracy

The accuracy of an RF power measurement essentially depends on the characteristics of the power sensor. Errors encountered in this case are a function of level, temperature and frequency and cannot be eliminated completely by design.

Error sources of power sensors:

- Non-linearity
- Level-dependent temperature effect
- Frequency response

To be able to measure correctly under any conditions, deviations from the ideal must be registered numerically and considered in the measurement result. The usual way to obtain accurate results is to calibrate the sensors with the aid of a generator prior to their use. The disadvantages of this method are obvious: a calibration has to be performed before each measurement, for each individual sensor and even at intervals during a measurement (in the case of temperature variations). For this reason, Rohde&Schwarz has for years been producing sensors that offer great convenience to the user, although at a higher expenditure to the manufacturer. This technique can be summarized as:

### Plug in and go

All relevant parameters are measured in the factory individually for each measuring head and then stored in the head. The level-dependent temperature effect is represented as a two-dimensional characteristic with a great number of measurement points.

Each measuring head comprises a temperature sensor, the signal of which is evaluated in the power meter at regular intervals. From the measured temperature and level values, the stored characteristic yields the correction values for the output voltage of the measuring head. The input power is then calculated from this corrected voltage with the aid of a transfer function which is also stored in the head.

Finally, frequency-response correction is carried out. The NRVD multiplies the calculated input power with the correction factor for the signal frequency. This frequency is either obtained from the frequency input of option NRVD-B2 or entered by the user.

This comprehensive error correction technique offers the following advantages:

- Unrestricted exchange of measuring heads thanks to individual calibration
- Optimum measurement accuracy
- Calibration of measuring heads directly traceable to PTB standards
- Fast and convenient operation

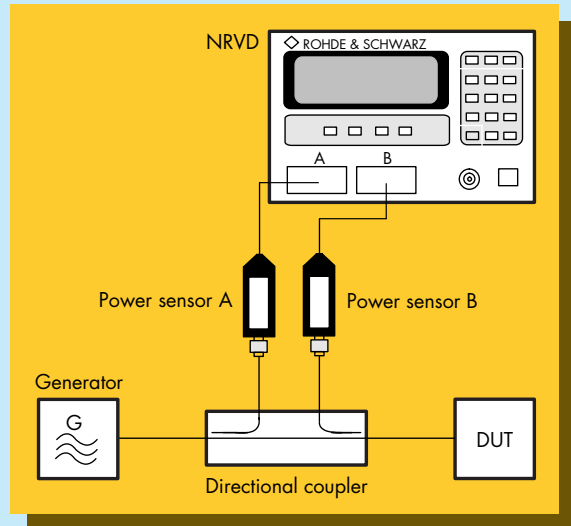
In spite of all these corrective measures, one uncertainty remains which is not caused by the measuring head but by a possible mismatch of measuring head and signal source.

As an example, the power applied from a source to a load with a characteristic impedance  $Z_0$  (50 or 75  $\Omega$ ) is to be measured. The output impedance of the source and the input impedance of the measuring head, which acts as a load, deviate from  $Z_0$  to some extent. This mismatch at both ends causes a measurement error which is often ignored because it cannot be specified for the measuring head separately. The error depends on the degree of mismatch between source and measuring head (see diagram on page 9). Since, generally, the SWR of the source cannot be varied, the measurement accuracy can only be increased by selecting a low-reflection measuring head. Since all NRV-Z power sensors offer excellent SWR characteristics, no wrong choice can be made.

## Applications

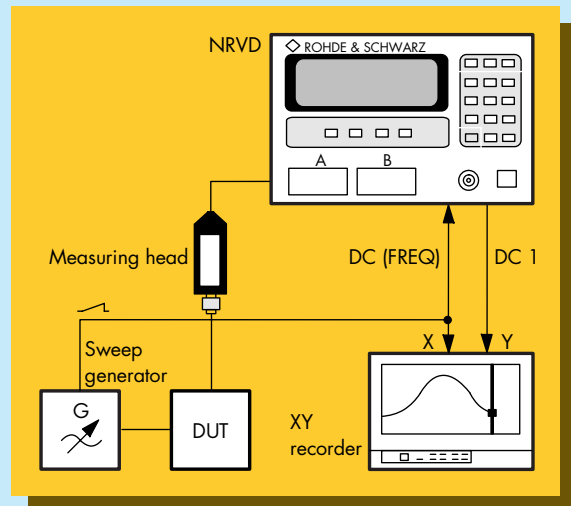
### SWR measurement

Simultaneous measurement of forward and reflected power allows direct readout of reflection coefficient, SWR or return loss.



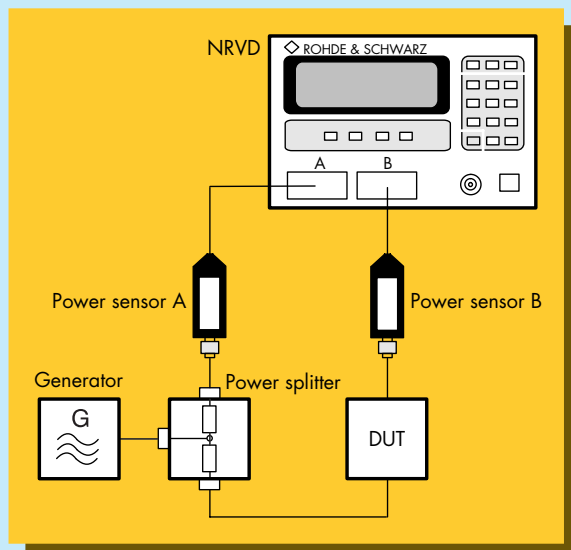
### Sweep tester with automatic frequency response correction

For correcting the frequency response of a measuring head, the NRVD is able to calculate the test frequency from a voltage as is available at the sawtooth output of a sweep generator. The result is an easy-to-use sweep tester with automatic frequency response correction.



### Attenuation measurements

This setup is used for highly accurate attenuation measurements. By using a reference sensor (A), test results are independent from generator level variations. The power splitter reduces matching errors.







WF 43 230



WF 39 823



WF 39 821

## Power sensors

<b>NRV-Z1</b> <b>828.3018.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 10 MHz to 18 GHz, 200 pW to 20 mW	Power measurements of highest sensitivity up to 18 GHz in 50- $\Omega$ systems
<b>NRV-Z2</b> <b>828.3218.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 10 MHz to 18 GHz, 20 nW to 500 mW	Power measurements with minimum mismatch, for high powers in 50- $\Omega$ systems
<b>NRV-Z3</b> <b>828.3418.02</b>	<b>Diode Power Sensor 75 <math>\Omega</math></b> 1 MHz to 2.5 GHz, 100 pW to 13 mW	Power measurements in 75- $\Omega$ systems
<b>NRV-Z4</b> <b>828.3618.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 100 kHz to 6 GHz, 100 pW to 20 mW	Power measurements of highest sensitivity in the frequency range 100 kHz to 6 GHz, very large dynamic range
<b>NRV-Z5</b> <b>828.3818.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 100 kHz to 6 GHz, 10 nW to 500 mW	Like NRV-Z4, but for high powers and minimum mismatch
<b>NRV-Z6</b> <b>828.5010.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 50 MHz to 26.5 GHz, 400 pW to 20 mW	Power measurements up to 26.5 GHz with high sensitivity in 50- $\Omega$ systems (PC 3.5)
<b>NRV-Z15</b> <b>1081.2305.02</b>	<b>Diode Power Sensor 50 <math>\Omega</math></b> 50 MHz to 40 GHz, 400 pW to 20 mW	Power measurements up to 40 GHz with high sensitivity in 50 $\Omega$ systems (2.92 mm)
<b>NRV-Z31</b> <b>857.9604.02/3/4</b>	<b>Peak Power Sensor 50 <math>\Omega</math></b> 30 MHz to 6 GHz, 1 $\mu$ W to 20 mW	Peak power measurements, pulse width $\geq 2$ (200) $\mu$ s, pulse repetition rate $\geq 10$ (100) Hz, 3 models
<b>NRV-Z32</b> <b>1031.6807.04/5</b>	<b>Peak Power Sensor 50 <math>\Omega</math></b> 30 MHz to 6 GHz, 100 $\mu$ W to 2(4) W	Peak power measurements, pulse width $\geq 2$ (200) $\mu$ s, pulse repetition rate $\geq 25$ (100) Hz, 2 models
<b>NRV-Z33</b> <b>1031.6507.03/4</b>	<b>Peak Power Sensor 50 <math>\Omega</math></b> 30 MHz to 6 GHz, 1 mW to 20 W	Peak power measurements up to 20 W, pulse width $\geq 2$ (200) $\mu$ s, pulse repetition rate $\geq 100$ Hz, 2 models
<b>NRV-Z51</b> <b>857.9004.02</b>	<b>Thermal Power Sensor 50 <math>\Omega</math></b> DC to 18 GHz, 1 $\mu$ W to 100 mW	High-precision power measurement also with non-sinusoidal signals, N connector
<b>NRV-Z52</b> <b>857.9204.02</b>	<b>Thermal Power Sensor 50 <math>\Omega</math></b> DC to 26.5 GHz, 1 $\mu$ W to 100 mW	Same as NRV-Z51, but with PC 3.5 connector for measurements up to 26.5 GHz
<b>NRV-Z53</b> <b>858.0500.02</b>	<b>Thermal Power Sensor 50 <math>\Omega</math></b> DC to 18 GHz, 100 $\mu$ W to 10 W	High-power measurements up to 10 W also with non-sinusoidal signals
<b>NRV-Z54</b> <b>858.0800.02</b>	<b>Thermal Power Sensor 50 <math>\Omega</math></b> DC to 18 GHz, 300 $\mu$ W to 30 W	High-power measurements up to 30 W also with non-sinusoidal signals
<b>NRV-Z55</b> <b>1081.2005.02</b>	<b>Thermal Power Sensor 50 <math>\Omega</math></b> DC to 40 GHz, 1 $\mu$ W to 100 mW	Same as NRV-Z51, but with 2.92 mm connector for measurements up to 40 GHz

## RF insertion units

<b>URV5-Z2</b> <b>395.1019.02</b>	<b>10-V Insertion Unit 50 <math>\Omega</math></b> 200 $\mu$ V to 10 V, 9 kHz to 3 GHz	Low-load RF voltage measurements in 50- $\Omega$ coaxial systems, low-loss power measurements on well-matched RF lines
<b>URV5-Z4</b> <b>395.1619.02</b>	<b>100-V Insertion Unit 50 <math>\Omega</math></b> 2 mV to 100 V, 100 kHz to 3 GHz	Virtually no-load RF voltage measurements in coaxial 50- $\Omega$ systems even at higher voltages. Due to minimum insertion loss and reflection coefficient this unit leaves a 50- $\Omega$ line practically unaffected

## Probes

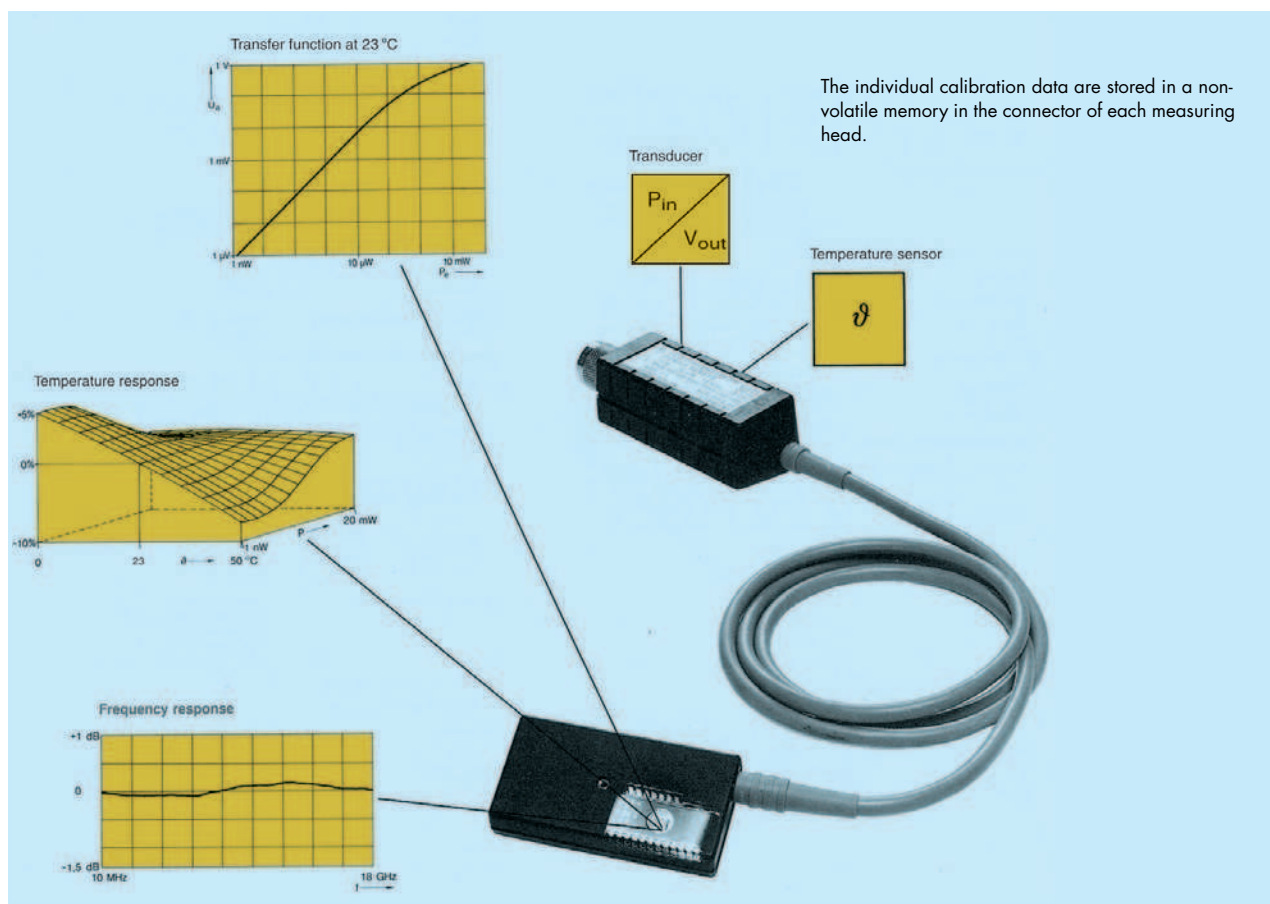
<b>URV5-Z7</b> <b>395.2615.02</b>	<b>RF Probe</b> 200 $\mu$ V to 10 V, 20 kHz to 1 GHz	For measurements in RF circuits at low capacitive and resistive load
with 20-dB plug-on divider*)	2 mV to 100 V, 1 to 500 MHz	The 20-dB and 40-dB plug-on dividers increase the voltage measurement range of the RF probe; the high Q factor of the capacitive divider makes the resistive loading negligible, the capacitive loading goes down to 0.5 pF (40-dB divider)
with 40-dB plug-on divider*)	20 mV to 1000 V, 500 kHz to 500 MHz	
with 50- $\Omega$ adapter URV-Z50	200 $\mu$ V to 10 V, 20 kHz to 1 GHz	With integrated termination for power or level measurements on test items with a source impedance of 50 $\Omega$ up to 1 GHz
with 75- $\Omega$ adapter URV-Z3	200 $\mu$ V to 10 V, 20 kHz to 500 MHz	With integrated termination for power or level measurements in 75- $\Omega$ systems such as antenna arrays or video equipment
<b>URV5-Z1</b> <b>395.0512.02</b>	<b>DC Probe</b> 1 mV to 400 V, 9 M $\Omega$    3 pF	For low-capacitance DC voltage measurements in RF circuits at minimum loading

## Automatic filter setting depending on measurement range

Resolution	Filter number						
HIGH 0.001 dB	11	9	7	7	7	7	7
MEDIUM 0.01 dB	9	7	3	3	3	3	3
LOW 0.1 dB	7	3	0	0	0	0	0
NRV-Z1, -Z3, -Z4, -Z6, -Z15	10 nW	100 nW	1 $\mu$ W	10 $\mu$ W	100 $\mu$ W	1 mW	20 mW
NRV-Z2, -Z5	1 $\mu$ W	10 $\mu$ W	100 $\mu$ W	1 mW	10 mW	100 mW	500 mW
NRV-Z31	–	1 $\mu$ W	10 $\mu$ W	100 $\mu$ W	1 mW	20 mW	–
NRV-Z32	–	100 $\mu$ W	1 mW	10 mW	100 mW	2 (4) W	–
NRV-Z33	–	1 mW	10 mW	100 mW	1 W	20 W	–
NRV-Z51, -Z52, -Z55	10 $\mu$ W	100 $\mu$ W	1 mW	10 mW	100 mW	–	–
NRV-Z53	1 mW	10 mW	100 mW	1 W	10 W	–	–
NRV-Z54	10 mW	100 mW	1 W	10 W	30 W	–	–
URV5-Z2, -Z7	–	1 mV	10 mV	100 mV	1 V	10 V	–
URV5-Z4	–	10 mV	100 mV	1 V	10 V	100 V	–

## Measurement time in seconds (from trigger to output of first byte) depends on filter setting

Filter number	0	1	2	3	4	5	6	7	8	9	10	11	12
NRV-Z1 to -Z15	0.045	0.05	0.06	0.08	0.15	0.27	0.49	0.95	1.85	3.6	7.2	14.5	28.5
NRV-Z31 Mod. 02	1.04	1.04	1.05	1.07	1.13	1.24	1.44	1.84	2.7	4.3	7.5	14	27
NRV-Z31, -Z33 Mod. 03/04 NRV-Z32 Mod. 04	0.135	0.14	0.15	0.17	0.23	0.34	0.54	0.94	1.77	3.4	6.6	13	26
NRV-Z32 Mod. 05	0.435	0.44	0.45	0.47	0.53	0.64	0.84	1.24	2.07	3.7	6.9	14	27
NRV-Z51 to -Z55	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	13	26
URV5-Z2, -Z4, -Z7	0.065	0.07	0.08	0.10	0.20	0.38	0.72	1.45	2.8	5.5	11	22	44



## Specifications

Measurement functions	unmodulated and modulated power (average power, pulse power, peak envelope power, AM), reflection, DC and AC voltage (depending on measuring head)
Frequency and level range	DC to 40 GHz, 100 pW to 30 W (depending on measuring head)
Measuring heads	all voltage and power measuring heads NRV-Z and URV5-Z
Display	LCD for figures, units, user prompting and analog display; adjustable backlighting
Readout absolute relative	W, dBm, V, dBV, dBμV dB, difference, %, ratio, referred to a stored reference value or to the second measurement channel; SWR, reflection coefficient, return loss in dB, modulation depth with AM; single-channel display: numeric readout of one channel and display of correction frequency or measurement uncertainty (not with all measuring heads) or dual-channel display, single-channel analog display, automatic or with selectable scale
Resolution of digital display	5 digits max., resolution adjustable in 3 steps: HIGH: 12 000 steps or 0.001 dB MEDIUM: 1 200 steps or 0.01 dB LOW: 120 steps or 0.1 dB
Averaging filter	over 1 to 512 readings for reducing the display noise; manual or automatic setting depending on measurement range and resolution, see table (page 7)
Display noise	see data sheet of measuring heads
Measurement rate	see table (page 7)
Error limits of power readout in W (excluding measuring head)	18 to 28°C 10 to 40°C 0 to 50°C 0.013 dB (0.3 %) + 1 digit 0.035 dB (0.8 %) + 1 digit 0.057 dB (1.3 %) + 1 digit
Zero adjustment	manual or via IEC/IEEE bus, duration approx. 4 s
Frequency response correction	stored frequency response of measuring head taken into account by numerical entry of test frequency (manually or via IEC/IEEE bus) or (optionally) by applying a frequency proportional DC voltage
Attenuation compensation	attenuation or gain connected ahead taken into account; entry of attenuation value (±200 dB) via keyboard or IEC/IEEE bus
Reference value	one reference value per channel for relative measurements: numeric entry via keyboard or IEC/IEEE bus, use of stored measured value or current value of second channel
Reference impedance	for conversion between voltage and power, automatic readout of reference impedance from data store in the measuring head or numeric entry via keyboard or IEC/IEEE bus (for RF probe)

## Remote control

control of all instrument functions via IEC 625/IEEE interface to SCPI; interface functions: SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP1

## Test generator

### Output power

1.00 mW, factory set to ±0.7% (traceable to PTB)

### Deviation from nominal

1.2% worst case (0.9% RSS) at

### Frequency

0 to 50 °C for one year

### SWR

50 MHz

### RF connector

≤1.03

N female; N male/SMA female adapter for NRV-Z6/-Z52/-Z15/-Z55 included

## I/O Option NRVD-B2

### Output impedance

two analog outputs for simultaneous output of measurement results of both channels

### Voltage range

1 kΩ

### Resolution

0 to 3 V

### DC input for analog frequency response correction

1 mV, error ≤5 mV

voltage range ±12 V, input impedance 1 MΩ, trigger input (TTL, active low), ready output (TTL, active high)

## General data

### Temperature range

to DIN IEC 68-2-1/68-2-2

### Operating

0 to +50 °C

### Storage

−40 to +70 °C

### Permissible humidity

max. 80%, without condensation

### Sinusoidal vibration

5 to 55 Hz, max. 2 g; 55 to 150 Hz, 0.5 g cont. (DIN IEC 68-2-6, IEC 1010-1, MIL-T-28800 D, class 5 complied with)

### Random vibration

10 to 500 Hz, 1.9 g rms (to DIN IEC 68-2-36)

### Shock

40 g shock spectrum (to MIL-STD 810 D; DIN IEC 68-2-27 complied with)

### EMC

to EN 50081-1 and 50082-1, EMC directive of EC (89/336/EEC) and EMC law of the Federal Republic of Germany; MIL-STD-461 C, RE 02, CE 03, RS 03, CS 02 complied with

### Safety

to EN 61010-1

### Power supply

100 V/120 V/220 V ±10%, 230 V −6/+15%, 47 to 400 Hz, 25 VA

### Dimensions (W x H x D), weight

219 mm x 147 mm x 350 mm, 4.5 kg

## Ordering information

### Order designation

#### Dual-channel Power Meter

NRVD

857.8008.02

#### I/O Option

NRVD-B2

857.8908.02

### Recommended extras

#### Rack Adapter

ZZA-98

827.4533.00

#### Transit Case

ZZK-983

1013.9172.00

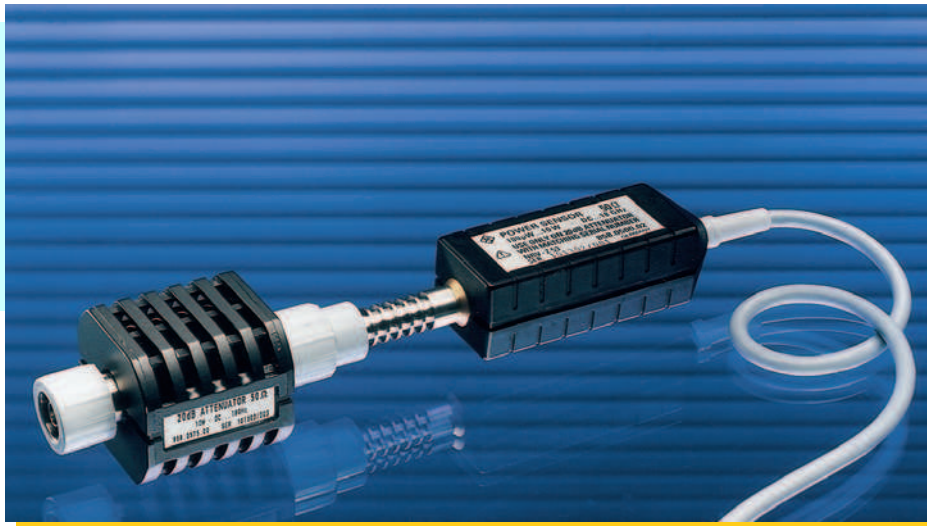
#### Service Kit

NRVD-S1

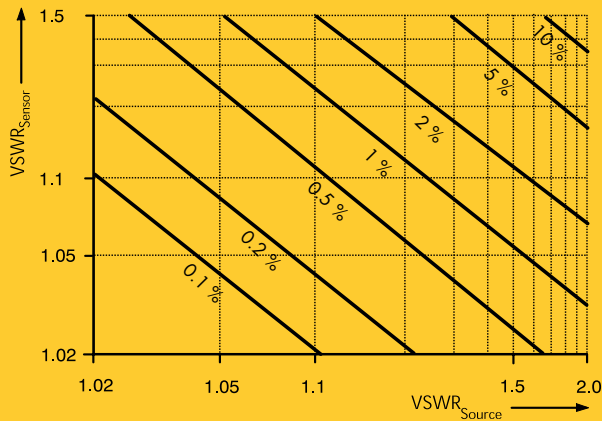
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WF 40 977



Thermal Power Sensor NRV-Z53



Limits of power measurement uncertainty caused by mismatch of sensor and signal source.

WF 40 099



Rear panel view of NRVD



**ROHDE & SCHWARZ**

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