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Millivoltmeter URV55

Voltage, level and power measurements

- 200 µV to 1000 V, 9 kHz to 3 GHz with voltage sensors
- 100 pW to 30 W, DC to 40 GHz with power sensors
- Accurate, general-purpose, easy-to-use
- Intelligent measuring heads: plug in and measure
- Remote control of all functions via IEC/IEEE bus
- Analog output
- Optional test generator 1 mW/50 MHz

ROHDE&SCHWARZ

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Uncompromising technology and ease of operation make the URV55 an ideal instrument for any kind of voltage measurement in manifold laboratory and system applications. Thanks to its unique measuring heads with calibration data memory and temperature sensor, which make adjustments by the user superfluous, the URV55 measures always with high accuracy and free of operator's errors. The comprehensive range of measuring heads of the URV5-Z series includes high-impedance voltage probes as well as insertion units for voltage measurements on coaxial lines. In addition, all thermal power and diode sensors of the NRV-Z series can be used with the URV55. The URV55 measures voltages in the range from 200 µV to 1000 V and covers the frequency range from DC to 3 GHz. Power measurements are possible up to 40 GHz.

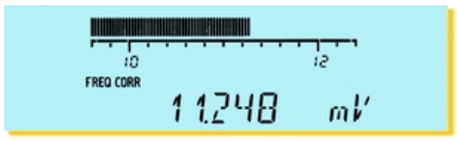
Operation

Operation of the RF millivoltmeter 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. Selectable write protection prevents inadvertent alteration of stored setup data.

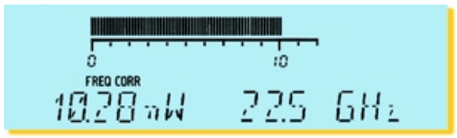
Measurement rate

The measurement rate not only depends on the type of measuring head used but also on the setting of the averaging filter, which must be matched to the measurement conditions. Taking into account the connected measuring head, the URV55 automatically selects the appropriate measurement rate by determining the optimum averaging time required for a steady readout 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 measure faster than in automatic operation or to further reduce noise.

When a measuring head is connected, the URV55 first reads the information stored in the connector and then sets itself to the type of sensor. With a power sensor connected, the URV55 automatically selects the correct operating and display mode.







Certified Quality System
ISO 9001
DQS REG. NO 1954-04

Certified Environmental System
ISO 14001
REG. NO 1954

Readout

Measurement results, units and various items of information are displayed on a large 4 $\frac{1}{2}$-digit LC display in three steps of resolution.

All standard units of measurement or relative modes can be selected. A high-resolution bargraph indicator with selectable scaling or autoscaling permits quasi-analog display of measured values with any unit or resolution.

Photo 43 228-3



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Measuring heads

RF millivoltmeters cover a wide range of applications and a great variety of frequency and voltage ranges. Since suitable measuring heads are available for the various applications and ranges, the only factors that influence the selection of an RF millivoltmeter are versatility, system compatibility and ease of operation. In these aspects the URV55 is a top-class unit. URV55 measuring heads are not type-specific and may therefore be used with any member of the Rohde&Schwarz power meter and voltmeter families.

The high-impedance voltage probe URV5-Z7 is particularly suitable for measurements on PCBs. Plug-on dividers extend the measurement range and increase the input impedance so that the DUT is practically unloaded during the measurement. DC Probe URV5-Z1 has been designed especially for measuring DC voltages in high-frequency circuits. The 9 MΩ resistor in the probe tip ensures that the RF source is loaded with no more than a few pF.

Insertion Units URV5-Z2 and URV5-Z4 are used for measuring voltages on coaxial lines. They have good matching characteristics and low insertion loss. For instance, the 100 V Insertion Unit URV5-Z4 practically does not affect the line, so it can even be used for no-loss power measurements in well-matched, low-reflection coaxial lines, eg in transmitter systems. In addition, all power sensors of the NRV-Z series can be used with the URV55.



Typical application of RF millivoltmeters: field-strength measurement for the determination of EMS (Photo 43206-4)

Measurement accuracy

The accuracy of an RF voltage measurement essentially depends on the characteristics of the measuring head. Errors encountered in this case are a function of level, temperature and frequency and cannot be eliminated completely by design. Error sources are:

- 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. For this reason, Rohde&Schwarz has for years been producing measuring heads that offer great convenience to the user, although at higher expenditure for 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 large number of measurement points.

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

Subsequently, frequency-response correction is carried out. The URV55 multiplies the calculated input voltage with the correction factor for the signal frequency. This frequency is either entered by the user or obtained from a frequency-proportional DC voltage at the DC FREQ input.

This comprehensive error correction technique has 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

These corrective measures, however, do not eliminate all uncertainties. Uncertainties are caused by the way in

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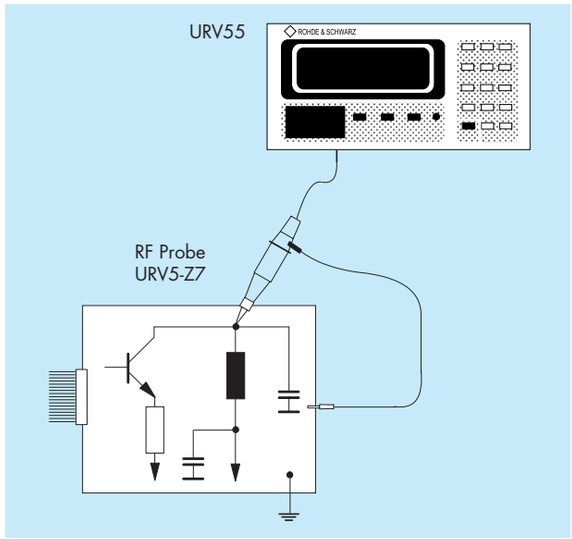
which the voltage is picked up at the DUT, by standing waves when using insertion units, and by the waveform.

Waveform weighting

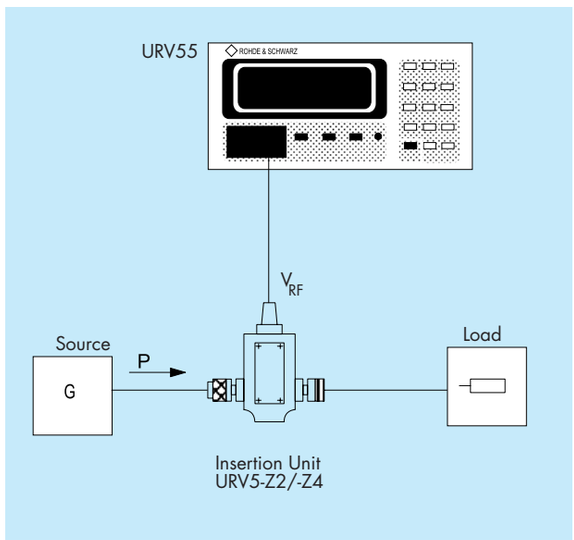
All AC sensors URV5-Z are calibrated so that the rms value is indicated for a sinewave voltage. With other waveforms, eg squarewaves, the peak value is decisive for the type of weighting employed. Below about 30 mV, the RF probe and the 10 V insertion unit measure rms values. Above 1 V, the peak-to-peak value V_{pp} is measured and $V_{pp}/(2\sqrt{2})$ is indicated, which corresponds to the rms value of a sinewave voltage. Between 30 mV and 1 V the type of weighting is determined by the waveform.

The measurement of modulated sinewave voltages follows a pattern similar to that of non-sinusoidal waveforms. Up to a peak value of 30 mV at the envelope´s maximum (corresponding to 10 µW PEP in 50 Ω systems), true rms value is measured. With power indication in W or dBm, the average power is displayed. Above 1 V (10 mW PEP) and with a modulation frequency of at least 10 kHz, peak value is measured again. In the case of power measurements, the peak envelope power PEP is indicated without any calculations being required, and for voltages the value $V_{pp}/(2\sqrt{2})$.

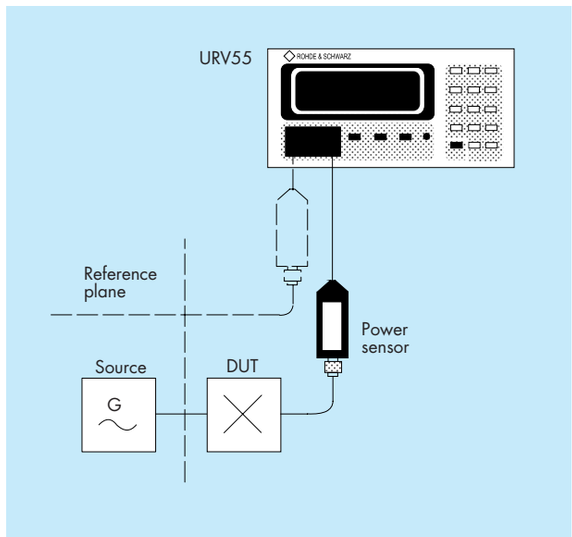
Limit values specified for the 100 V Insertion Unit URV5-Z4 are 20 dB higher than for the 10 V insertion unit, ie by a factor of 10 for voltages and by a factor of 100 for power levels. When a plug-on divider is used with the RF probe, limit values are to be increased by the amount of the preceding attenuation.



RF Probe URV5-Z7 for virtually no-load measurements of AC voltages in high-frequency circuits



Coaxial voltage measurements are ideal and a simple means for measuring signal levels on transmission lines. Under conditions of good matching, the voltage is also a measure for the transmitted power



The URV55 allows attenuation measurements down to 90 dB depending on the measuring head connected

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Photo 39 821

RF Probe URV5-Z7


Photo 43 230

Insertion Unit URV5-Z4


Photo 39 823

Power Sensor NRV-Z1

Probes

URV5-Z7 **395.2615.02**	**RF Probe** 200 µV to 10 V, 20 kHz to 1 GHz	For measurements in RF circuits, with low capacitive and resistive load
with 20 dB plug-on divider*)	2 mV to 100 V, 1 MHz 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 Ω adapter URV-Z50	200 µV 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 Ω up to 1 GHz
with 75 Ω adapter URV-Z3	200 µV to 10 V, 20 kHz to 500 MHz	With integrated termination for power or level measurements in 75 Ω systems such as antenna arrays or video equipment
URV5-Z1 **395.0512.02**	**DC Probe** 1 mV to 400 V, 9 MΩ ll 3 pF	For low-capacitance DC voltage measurements in RF circuits

RF insertion units

URV5-Z2 **395.1019.02**	**10 V Insertion Unit 50 Ω** 200 µV to 10 V, 9 kHz to 3 GHz	Low-load RF voltage measurements in 50 Ω coaxial systems, power measurements on well-matched RF lines
URV5-Z4 **395.1619.02**	**100 V Insertion Unit 50 Ω** 2 mV to 100 V, 100 kHz to 3 GHz	Virtually no-load RF voltage measurements in coaxial 50 Ω systems at higher voltages. Due to minimum insertion loss and reflection coefficient this unit leaves a 50 Ω line practically unaffected

Power sensors

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

*) part of URV-Z6

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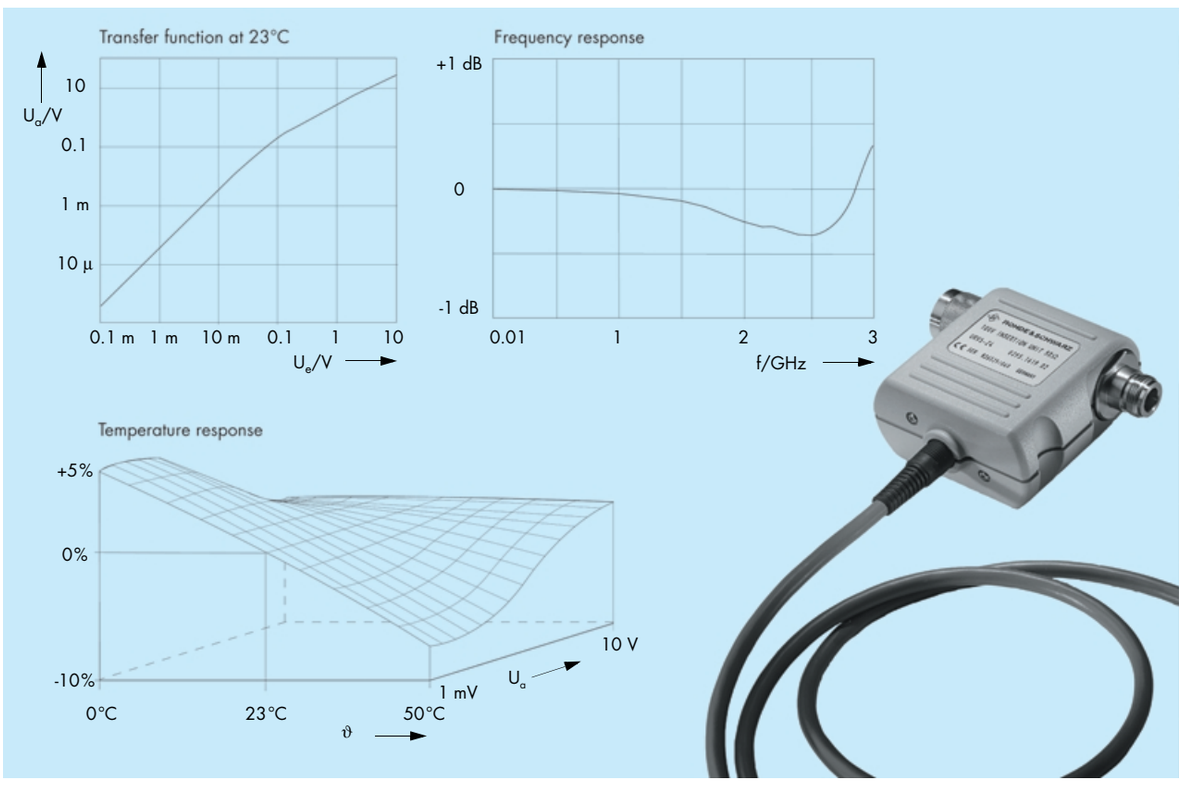
Automatic filter setting depending on measurement range

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**
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	–
NRV-Z1, -Z3, -Z4, -Z6, -Z15	10 nW	100 nW	1 µW	10 µW	100 µW	1 mW	20 mW
NRV-Z2, -Z5	1 µW	10 µW	100 µW	1 mW	10 mW	100 mW	500 mW
NRV-Z31	–	1 µW	10 µW	100 µW	1 mW	20 mW	–
NRV-Z32	–	100 µW	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 µW	100 µW	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	–	–

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

Filter number		0	1	2	3	4	5	6	7	8	9	10	11	12
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
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 NRV-Z32	Mod. 03/04 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

The individual calibration data for transfer function, temperature and frequency response are stored in a non-volatile memory in the connector of each measuring head



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Specifications

Measurement functions	DC and AC voltage, average power, pulse power, max. envelope power (depending on measuring head)
Frequency and level range for voltage measurements for power measurements	 9 kHz to 3 GHz, 200 µV to 1000 V DC to 40 GHz, 100 pW to 30 W
Measuring heads	all voltage and power sensors URV5-Z and NRV-Z
Display	LCD for figures, units, user prompting and analog display
Readout Absolute Relative	 V, dBµV, W, dBm %V, dB or %W referred to stored reference value
Analog display	automatic or with selectable scale
Resolution of digital display	$4\frac{1}{2}$ digits max., resolution adjustable in 3 modes: HIGH: 12000 steps or 0.001 dB MEDIUM: 1200 steps or 0.01 dB LOW: 120 steps or 0.1 dB
Averaging filter	over 1 to 512 readings for reducing display noise; manual or automatic setting depending on measurement range and resolution (see table page 6)
Display noise	see data sheet of measuring heads
Measurement rate	see table page 6
Error limits of voltage readout (excluding measuring head) 18 °C to 28 °C 10 °C to 40 °C 0 °C to 50 °C	 0.017 dB (0.2%) + 1 digit 0.039 dB (0.45%) + 1 digit 0.060 dB (0.7%) + 1 digit
Zero adjustment	manually 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 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	numeric entry via keyboard or IEC/IEEE bus, or use of stored measured value
Reference impedance	for conversion between voltage and power, automatic readout of reference impedance from data memory in 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; interface functions: SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, PP0
DC control input for frequency response correction	BNC female, ±12 V, linear with selectable scale, input impedance 9 MΩ, max. input voltage 50 V
DC output	BNC female, source impedance 1 kΩ, output voltage (EMF) proportional to deflection of analog display, scale value: left 0 V, right +3 V, additional settling time 250 ms, error ≤5 mV, ripple typ. 5 mV (V_{pp})
Sensor Check Source NRVS-B1 (option)	
Frequency	50 MHz, crystal-stabilized
Power	1.00 mW; factory-set to ±0.7% (traceable to PTB)
Deviation from nominal	1.2% max. (0.9% RSS) at 10°C to 40°C or 1.6% max. (1.2% RSS) at 0°C to 50°C, for 1 year in each case
SWR	1.05
RF connector	N female (at rear panel); N male/SMA female adapter for NRV-Z6/-Z52/ -Z15/-Z55 included

General data

Temperature range Operating Storage	to DIN IEC 68-2-1/68-2-2 0°C to +50°C –40°C to +70°C
Permissible humidity	max. 80%, without condensation
Sinusoidal vibration	5 Hz to 55 Hz, max. 2 g; 55 Hz to 150 Hz, 0.5 g cont. (to DIN IEC 68-2-6, IEC 1010-1, MIL-T-28800 D, class 5)
Random vibration	10 Hz 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)
EMC	to EN 50081-1 and 50082-1, EMC directive of EC (89/336/EEC) and EMC law of Federal Republic of Germany; to MIL-STD-461 C, RE 02, CE 03, RS 03, CS 02
Safety	to EN 61010-1
Power supply	115 V +15/–22% (–15%), 47 Hz to 63 (440) Hz, 230 V +15/–22%, 47 Hz to 63 Hz, 13 VA, power transformer with thermal overload protection
Dimensions (W x H x D)	219 mm x 103 mm x 350 mm
Weight	3.2 kg

Ordering information

Order designation	RF Millivoltmeter URV55 1029.1701.02	
Option		
Sensor Check Source	NRVS-B1	1029.2908.02
Recommended extras		
Rack Adapter	ZZA-97	827.4527.00
Transit Case for URV55, sensors and accessories	UZ-24	1029.3379.02
Service Kit	NRVS-S1	1029.2708.02

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