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
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.

Readout

Measurement results, units and various items of information are displayed on a large 4 ½-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.

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.
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.

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...
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 $\mu$W PEP in 50 $\Omega$ 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.
Probes

<table>
<thead>
<tr>
<th>URV5-Z7</th>
<th>RF Probe 200 μV to 10 V, 20 kHz to 1 GHz</th>
<th>For measurements in RF circuits, with low capacitive and resistive load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>with 20 dB plug-on divider *)</td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td>with 40 dB plug-on divider *)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with 50 Ω adapter URV-Z50</td>
<td>With integrated termination for power or level measurements in test items with a source impedance of 50 Ω up to 1 GHz</td>
</tr>
<tr>
<td></td>
<td>with 75 Ω adapter URV-Z3</td>
<td>With integrated termination for power or level measurements in 75 Ω systems such as antenna arrays or video equipment</td>
</tr>
<tr>
<td>URV5-Z1</td>
<td>DC Probe 1 mV to 400 V, 9 Ω 8 3 pF</td>
<td>For low-capacitance DC voltage measurements in RF circuits</td>
</tr>
</tbody>
</table>

RF insertion units

<table>
<thead>
<tr>
<th>URV5-Z2</th>
<th>10 V Insertion Unit 50 Ω 200 μV to 10 V, 9 kHz to 3 GHz</th>
<th>Low-load RF voltage measurements in 50 Ω coaxial systems, power measurements on well-matched RF lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>URV5-Z4</td>
<td>100 V Insertion Unit 50 Ω 2 mV to 100 V, 100 kHz to 3 GHz</td>
<td>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</td>
</tr>
</tbody>
</table>

Power sensors

<table>
<thead>
<tr>
<th>NRV-Z1</th>
<th>Diode Power Sensor 50 Ω 10 MHz to 18 GHz, 200 pW to 20 mW</th>
<th>Power measurements of highest sensitivity up to 18 GHz in 50 Ω systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRV-Z2</td>
<td>Diode Power Sensor 50 Ω 10 MHz to 18 GHz, 20 mW to 500 mW</td>
<td>Power measurements with minimum mismatch, for high powers in 50 Ω systems</td>
</tr>
<tr>
<td>NRV-Z3</td>
<td>Diode Power Sensor 75 Ω 1 kHz to 2.5 GHz, 100 pW to 13 mW</td>
<td>Power measurements in 75 Ω systems</td>
</tr>
<tr>
<td>NRV-Z4</td>
<td>Diode Power Sensor 50 Ω 100 kHz to 6 GHz, 100 pW to 20 mW</td>
<td>Power measurements of highest sensitivity in the frequency range 100 kHz to 6 GHz, very large dynamic range</td>
</tr>
<tr>
<td>NRV-Z5</td>
<td>Diode Power Sensor 50 Ω 100 kHz to 6 GHz, 10 mW to 500 mW</td>
<td>Like NRV-Z4, but for high powers and minimum mismatch</td>
</tr>
<tr>
<td>NRV-Z6</td>
<td>Diode Power Sensor 50 Ω 50 MHz to 26.5 GHz, 400 pW to 20 mW</td>
<td>Power measurements up to 26.5 GHz with high sensitivity in 50 Ω systems (PC 3.5)</td>
</tr>
<tr>
<td>NRV-Z15</td>
<td>Diode Power Sensor 50 Ω 50 MHz to 400, 400 pW to 20 mW</td>
<td>Power measurements up to 40 GHz with high sensitivity in 50 Ω systems (PC 3.5)</td>
</tr>
<tr>
<td>NRV-Z31</td>
<td>Peak Power Sensor 50 Ω 30 MHz to 6 GHz, 1 μW to 20 mW</td>
<td>Power measurements, pulse width ≥2 (200) μs, pulse repetition rate ≥10 (100) Hz, 3 models</td>
</tr>
<tr>
<td>NRV-Z32</td>
<td>Peak Power Sensor 50 Ω 30 MHz to 6 GHz, 100 μW to 2(4) W</td>
<td>Peak power measurements, pulse width ≥2 (2000) μs, pulse repetition rate ≥23 (100) Hz, 2 models</td>
</tr>
<tr>
<td>NRV-Z33</td>
<td>Peak Power Sensor 50 Ω 30 MHz to 6 GHz, 1 mW to 20 W</td>
<td>Peak power measurements up to 20 W, pulse width ≥2 (2000) μs, pulse repetition rate ≥100 Hz, 2 models</td>
</tr>
<tr>
<td>NRV-Z31</td>
<td>Thermal Power Sensor 50 Ω DC to 18 GHz, 1 μW to 100 mW</td>
<td>High-precision power measurement also with non-sinusoidal or modulated signals, N connector</td>
</tr>
<tr>
<td>NRV-Z51</td>
<td>Thermal Power Sensor 50 Ω DC to 26.5 GHz, 1 μW to 100 mW</td>
<td>Same as NRV-Z31, but with FC 3.5 connector for measurements up to 26.5 GHz</td>
</tr>
<tr>
<td>NRV-Z32</td>
<td>Thermal Power Sensor 50 Ω DC to 26.5 GHz, 1 μW to 100 mW</td>
<td>Same as NRV-Z31, but with FC 3.5 connector for measurements up to 26.5 GHz</td>
</tr>
<tr>
<td>NRV-Z33</td>
<td>Thermal Power Sensor 50 Ω DC to 18 GHz, 100 μW to 10 W</td>
<td>High-power measurements up to 10 W also with non-sinusoidal or modulated signals</td>
</tr>
<tr>
<td>NRV-Z34</td>
<td>Thermal Power Sensor 50 Ω DC to 18 GHz, 300 μW to 30 W</td>
<td>High-power measurements up to 30 W also with non-sinusoidal or modulated signals</td>
</tr>
<tr>
<td>NRV-Z35</td>
<td>Thermal Power Sensor 50 Ω DC to 40 GHz, 1 μW to 100 mW</td>
<td>Same as NRV-Z31, but with 2.92 mm connector for measurements up to 40 GHz</td>
</tr>
</tbody>
</table>

*) part of URV-Z6
Automatic filter setting depending on measurement range

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Filter number</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH 0.001 dB</td>
<td>11  9  7  7  7  7  7</td>
</tr>
<tr>
<td>MEDIUM 0.01 dB</td>
<td>9  7  3  3  3  3  3</td>
</tr>
<tr>
<td>LOW 0.1 dB</td>
<td>7  3  0  0  0  0  0</td>
</tr>
</tbody>
</table>

URV5-Z2, -Z7

- 1 mV
- 10 mV
- 100 mV
- 1 V
- 10 V

URV5-Z4

- 0.065
- 0.07
- 0.08
- 0.10
- 0.20
- 0.38
- 0.72
- 1.45
- 2.8
- 5.5
- 11
- 22
- 44

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

<table>
<thead>
<tr>
<th>Filter number</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>URV5-Z2, -Z4, -Z7</td>
<td>0.065</td>
<td>0.07</td>
<td>0.08</td>
<td>0.10</td>
<td>0.20</td>
<td>0.38</td>
<td>0.72</td>
<td>1.45</td>
<td>2.8</td>
<td>5.5</td>
<td>11</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>URV5-Z4</td>
<td>0.045</td>
<td>0.05</td>
<td>0.06</td>
<td>0.08</td>
<td>0.15</td>
<td>0.27</td>
<td>0.49</td>
<td>0.93</td>
<td>1.85</td>
<td>3.6</td>
<td>7.2</td>
<td>14.5</td>
<td>28.5</td>
</tr>
<tr>
<td>NRV-Z1 to -Z15</td>
<td>0.045</td>
<td>0.05</td>
<td>0.06</td>
<td>0.08</td>
<td>0.15</td>
<td>0.27</td>
<td>0.49</td>
<td>0.93</td>
<td>1.85</td>
<td>3.6</td>
<td>7.2</td>
<td>14.5</td>
<td>28.5</td>
</tr>
<tr>
<td>NRV-Z31</td>
<td>0.14</td>
<td>0.15</td>
<td>0.15</td>
<td>0.17</td>
<td>0.23</td>
<td>0.34</td>
<td>0.54</td>
<td>0.94</td>
<td>1.77</td>
<td>3.4</td>
<td>6.6</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>NRV-Z34</td>
<td>0.135</td>
<td>0.44</td>
<td>0.45</td>
<td>0.47</td>
<td>0.53</td>
<td>0.64</td>
<td>0.84</td>
<td>1.24</td>
<td>2.07</td>
<td>3.7</td>
<td>6.9</td>
<td>14</td>
<td>27</td>
</tr>
</tbody>
</table>

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.
**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: 9 kHz to 3 GHz, 200 µV to 1000 V
- for power measurements: 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 V, dB, µV, W, dBm
- Relative %V, dB or %W referred to stored reference value

**Analog display**
- automatic or with selectable scale

**Resolution of digital display**
- 4½ 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: 0.017 dB (0.2%) ± 1 digit
  - 0 °C to 50 °C: 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 623/EIEE interface, interface functions: SH1, AH1, T6, I4, SR1, RL1, DC1, DT1, PPO

**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 (EMP) proportional to deflection of analog display, scale value: left 0 V, right +3 V, additional setting time 250 ms, error ±3 mV, ripple typ. 5 mV (V_rms)

**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. (1.3% RSS) at 0 °C to 50 °C, for 1 year in each case

**General data**
- Temperature range: to DIN IEC 68-2-1/68-2-2
  - Operating: 0 °C to +50 °C
  - Storage: -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 S
- Random vibration: 10 Hz to 500 Hz, 1.9 g rms to DIN IEC 68-2-36
- Shock: 40 g shock spectrum to MILSTD810 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 MILSTD-461 C, RE 02, CE 03, RS 03, CS 02
- Safety: to EN 61010-1
- Power supply: 115 V +15/–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