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Manual

MILLIVOLTMETER URV 3

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2.1 Legend for Figs. 2 and 3

The values stated hereafter are not guaranteed; only the specifications given in the data sheet are binding.

Ref. No.	Labelling	Function
1	OFF BATT. 30 dBm 10 V 20 dBm 3 V 10 dBm 1 V 0 dBm 0.3 V -10 dBm 100 mV -20 dBm 30 mV -30 dBm 10 mV -40 dBm 3 mV	Rotary switch performing the following functions: switching-on battery check selection of measurement range
2	DC	DC output
3	⏚	Earthing socket for DC output 2.
4	ON	LED; signals when millivoltmeter is switched on.
5	—	Screw for mechanical zero adjustment of instrument.
6	PROBE	Socket for connection of probe or insertion head.
7	0 to 10 V 0 to 3 V -20 to +3 dBm AC-Null Batt.	Moving-coil meter for voltage and level indication, battery check and adjustment of electrical zero.
8	—	Battery box for accommodation of four single cells IEC R20, charger 11 or accumulator 13.
9	ZERO	Potentiometer for adjustment of electrical zero.

Ref. No.	Labelling	Function
10	CHARGER	Socket for charging accumulator 13 by means of charger 11 and connecting cable 12, and for feeding the unit from an external battery.
11	—	Charger (recommended extra); can be inserted into the battery box instead of the battery.
12	—	Cable (accessory delivered with charger) used for charging the accumulator 13 when accommodated in the battery box.
13	—	DRYFIT accumulator (recommended extra); can be inserted into the battery box instead of the batteries and charged with charger 11 and connecting cable 12.
14	—	Lid of battery box.

2.2 Preparation for Use

2.2.1 Setting up the URV 3

In general, the URV 3 is set up in a horizontal position. It is, however, also possible to adjust it into a tilted position after swinging out the carrying handle, which is unlocked by pressing the two joints (arrow in Fig. 1).

2.2.2 Power Supply

The Millivoltmeter URV 3 is designed for universal power supply. The accessories supplied include four single cells IEC R20 which are placed at the bottom of the battery box 8 according to the labelling. The battery box is opened by sliding the lid 14 to the left-hand stop, i.e. in the direction of the charger socket, and removing it. After inserting the single cells, the lid is put on again and the battery voltage checked according to section 2.3.1. The URV 3 is now ready for operation.

The extras recommended are a charger 11 (Fig. 3) with connecting cable 12 and an accumulator 13. Either unit can be accommodated in the battery box 8 instead of the single cells; attention must be paid that the position is in accordance with the labelling at the bottom of the battery box. Charger 11 permits recharging of an accumulator incorporated in the URV 3. To this end, cable 12 must be connected to socket 10. The charging time is about 14 hours.

Buffered operation is possible with accumulator 13 inserted into the URV 3 and charger 11 connected to socket 10 by means of cable 12. In case of AC supply failure, operation is continued by the accumulator.

Power supply is also possible by connecting a DC voltage source to socket 10 (positive pole to contact 4, negative pole to contact 5). Observe this polarity, otherwise the set will not function. The operating voltages are 5 V to 8 V, the current drain is approximately 35 mA.

2.2.3 Connection of Accessory Units

For measurements, a measuring head (probe or insertion unit) is required, which is connected to the three-pole socket 6 (Fig. 2). The measuring heads are fitted with a three-pole plug mating with socket 6. The plug can be inserted into the socket only if the marker line on the plug points towards the top. It is possible to fit the plug to the socket and turn it by applying a slight pressure until it is felt that it has engaged. After the plug has locked in place, it is safeguarded against being pulled out by accident. To pull out the plug, it must be held at the sleeve which is provided with grooves. Pulling at this sleeve unlocks the plug. The DC output voltage is available at the two sockets 2 and 3 (Fig. 2). The open-circuit voltage is

1 V	in the ranges having the final value 1, 10 or 100 with the scale value 10,
3 V	in the ranges having the final value 0.3, 3 or 30 with the scale value 3.

An exception is the measurement range 10 V, in which the output voltage is 10 V instead of 1 V.

A remarkable advantage is the high linearity of the DC output down to 1 mV, permitting the use of this output down to such a low voltage. The URV 3 thus operates as a linear AC/DC converter with a dynamic range of 80 dB and a conversion ratio of 1.

The output is short-circuit-proof and exhibits an output impedance of 1 kΩ.

The connection of the charger or an external DC voltage source is described in section 2.2.2.

2.3 Operating Instructions

2.3.1 Switching-on and Battery Check

If the rotary switch 1 (Fig. 2) is brought to position BATT., the panel meter 7 indicates the operating voltage of the Millivoltmeter. This is also the case when the set is operated from the charger, accumulator or external power supply. The deflection of the pointer must be within the blue range labelled "Batt.". If the deflection is smaller, the batteries have to be replaced according to section 2.2.2.

When switch 1 is set to one of the positions between 10 V and 3 mV, the Millivoltmeter is switched on and the measurement range selected. The on-condition is signalled by the flashing of LED 4.

2.3.2 General Remarks on RF Voltage Measurements

As already mentioned in section 2.2.3, it is possible to connect a probe or an insertion unit to socket 6 (Fig. 2). Measurements can only be made with the aid of a measuring head. The probe permits direct measurement on circuits in the frequency range up to approximately 200 MHz. The earth connection to the probe should be short (e.g. earth socket with solder strip). The screw-on earth cable can only be used for measurements up to about 50 MHz since the measuring error would increase unduly at higher frequencies on account of the length of the cable.

The voltage range with probe is 700 µV to 10.5 V. The maximum permissible AC voltage at the probe is V_{rms} = 15 V. A higher voltage leads to the destruction of the detector diodes. The 20-dB and 40-dB dividers recommended as extras extend the voltage range of the probe to 105 V and 1050 V, respectively.

In measurements with probe and 40-dB divider, the maximum measurable voltage of V_{rms} = 1050 V must not be applied at frequencies above 100 MHz since this would lead to the destruction of the divider on account of the dielectric losses of the divider capacitance. Between 100 MHz and 500 MHz, the permissible voltage decreases inversely with the frequency from 1050 V to 210 V.

With the aid of the BNC adapter, the probe can also be used for measurements on coaxial systems (frequency range 100 kHz to 1 GHz). Use of the reducing sleeve supplied with the set permits the probe to be inserted into the adapter with the divider plugged on to it.

In measurements with the 40-dB divider (frequency range 1 to 500 MHz), the maximum measurable voltage is only limited by the permissible voltage (V_p = 500 V) and the power-handling capacity of the BNC connecting cables. Table 1 lists the power-handling capacity of the BNC cables and the voltage calculated from it as functions of the frequency.

Table 1

f/MHz	1	10	100	200	500
P /W	1300	410	130	82	42
V /V	255	143	81	64	45

Low-frequency insertion units are available for high-accuracy measurements in coaxial systems. The 10-V Insertion Unit URV-Z2 comes with the characteristic impedances 50 and 75 Ω and the 100-V Insertion Unit URV-Z4 with 50 Ω. The 50-Ω insertion units can be fitted with an N plug and an N socket or with Dezifix B. The insertion units with other characteristic impedances can only be fitted with Dezifix B.

2.3.2.1 Input Impedance of Probe

Up to frequencies of approximately 20 MHz, the input impedance of the probe is equivalent to a capacitance of 2.5 pF shunted by an ohmic resistance whose value at room temperature is between 100 kΩ and 1 MΩ depending on the test voltage (Fig. 4; guaranteed value up to 10 MHz > 80 kΩ at room temperature). At higher frequencies, the resistive component of the input impedance decreases as the square of the frequency due to the input capacitance losses (Fig. 5).

The input capacitance is reduced to 1 pF through the 20-dB divider and to 0.5 pF through the 40-dB divider. The resistive component of the input impedance increases to several MΩ with the 20-dB divider and to above 10 MΩ with the 40-dB divider in the frequency range up to 20 MHz. At higher frequencies, the resistive component likewise decreases as the square of the frequency.

2.3.2.2 Waveform Weighting

The URV 3 reads out the rms value in the case of sinusoidal voltages of any magnitude as long as they are within the measurement range of the set. In the case of other waveforms, however, the weighting is dependent on the magnitude of the voltage to be measured since the diode detector has a square-law response only at low voltages up to about 30 mV and consequently measures the true rms value only up to this value independent of the waveform of the test voltage. This range can be expanded to 3 V by means of the dividers supplied, i.e. the true rms value of an AC voltage can be measured over the range from 700 μV to 3 V. Table 2 lists the maximum permissible crest factor as a function of the magnitude of the test voltage at which the error of the measured rms value relative to the true rms value does not exceed 2 or 5%, respectively.

Table 2 Rms value measurement

	Measurement with probe and 10-V insertion unit			Measurement with probe, 20-dB divider and 100-V insertion unit			Measurement with probe and 40-dB divider		
Measured voltage	3 mV	10 mV	30 mV	30 mV	100 mV	300 mV	300 mV	1 V	3 V
Max. crest factor for weighting error of +2%	10	3	1.7	10	3	1.7	10	3	1.7
Max. crest factor for weighting error of +5%	13	4	2	13	4	2	13	4	2

With test voltages above 1 V (above 10 V using 20-dB divider or 100-V insertion unit or above 100 V using 40-dB divider), the diode detector acts as peak-value rectifier. As there is a full-wave rectifier built into the measuring heads, the peak-peak value is measured but the value $(V_{pp}/2) \cdot \sqrt{2}$ is read out. This corresponds to the readout of the rms value in the case of sinusoidal voltages.

Table 3 lists the maximum permissible crest factor for a weighting error of the peak-value rectifier of -2 and -5%, respectively, as a function of the magnitude of the test voltage.

Table 3   Peak value measurement

	Measurement with probe and 10-V insertion unit			Measurement with probe, 20-dB divider and 100-V insertion unit			Measurement with probe and 40-dB divider		
Measured voltage	1 V	3 V	10 V	10 V	30 V	100 V	100 V	300 V	1000 V
Max. crest factor for weighting error of -2%	2.2	4	8	2.2	4	8	2.2	4	8
Max. crest factor for weighting error of -5%	3.8	8	15	3.8	8	15	3.8	8	15

2.3.3 Mechanical Zeroing

When the URV 3 is switched off, the pointer of meter 7 (Fig. 2) must be at the zero mark of the two upper scales; deviations can be corrected with screw 5.

2.3.4 Electrical Zeroing

The electrical zero on the scale of meter 7 (Fig. 2) need only be adjusted if voltages below 10 mV are measured (higher voltages when using dividers).

An unwanted voltage at the input of the amplifier is added to the detected voltage causing an erroneous reading. Since the detected voltage of a diode detector is proportional to the square of the test voltage up to about 30 mV, the influence of this unwanted voltage is dependent on the magnitude of the test voltage. According to the square-law function, the voltage readout is given by

$$V_{readout} = \sqrt{V^2_{test} + V^2_{unwanted}}$$

where V_{test} is the AC voltage to be measured and $V_{unwanted}$ the indication obtained on the meter without test voltage due to inexact zeroing. Thus, an unwanted voltage of, say, 0.2 mV causes an error of about 2% at a test voltage of 1 mV, and an error of about 0.2% when the test voltage is 3 mV. Hence, zeroing is only required when voltages below 10 mV are to be measured; the lower the voltage to be measured, the higher the required accuracy of zero adjustment.

For electrical zeroing of the set, connect a measuring head to socket 6. No voltage must be present at the measuring head (preferably insert probe into BNC adapter to eliminate stray pick-up).

In the case of temperature variations, thermal voltages affecting the electrical zero may temporarily occur in the measuring heads. Therefore, the connected measuring head must have reached thermal equilibrium prior to zero adjustment. This also applies to the measurement of RF voltages in the most sensitive range (3 mV, 40 dBm).

For electrical zeroing, set switch 1 to the 3-mV range. Adjust potentiometer 9 on the rear panel (Fig. 3) so that the pointer of meter 7 remains within the blue range "AC-Null".

NOTE: Only a positive deviation from zero is indicated. In the case of a negative deviation - regardless of its magnitude - the indication stays on the zero point even though it also causes a measuring error.

After some time, the electrical zero may slightly shift again; however, according to the explanations given at the beginning of this section, the measurement accuracy is not considerably affected by such displacement.

2.3.5 Range Selection

Switch 1 serves for setting the individual subranges (Fig. 2). The labelling refers to voltage measurement by means of the RF probe without divider or with the aid of the 10-V insertion unit. When using the probe with the 20-dB divider or the 100-V insertion unit, the indicated value is to be multiplied by 10 or increased by +20 dB. The probe with the 40-dB divider requires multiplication by 100 or addition of +40 dB to the readout.

3. Maintenance

The values mentioned in this section are not guaranteed; only the values stated in the data sheet are binding.

3.1 Measuring Instruments and Auxiliary Equipment Required

The equipment required for maintenance is listed in Table 7 (appendix).

3.2 Checking the Rated Specifications

The following underlined reference numbers for operating controls and terminals comply with those indicated in section 2 "Preparation for Use and Operating Instructions" and in Fig. 2.

The set reaches the rated specifications after a warm-up period of 10 minutes and at operating voltages that cause the pointer of meter 7 to deflect within the blue range designated with "Batt.", switch 1 being in position BATT.

Prior to performance checking adjust the mechanical zero according to section 2.3.3 and the electrical zero as described in section 2.3.4. The measuring instruments required for performance checking are listed in Table 7.

3.2.1 Absolute-value Calibration

Note: Since the test signal is processed in the measuring head, the absolute-value calibration is slightly dependent on the measuring head used. An appreciable indicating error may be caused by a fault in the set itself or in the measuring head. At any rate, a correctly operating measuring head must be used for absolute-value calibration.

The test setup shown in Fig. 6 is recommended for checking the absolute-value calibration. When using the equipment listed in Table 7, it is possible to check the absolute-value calibration up to test voltages of 1 V. Test setup Fig. 7 is suitable for test voltages up to 10 V.

Before measuring, the test setup is calibrated with a DC voltage. To this end, the thermal power meter must be DC-voltage coupled.

Measuring procedure with test setup according to Fig. 6 (up to 1 V)

a) Connect a DC voltage source instead of the generator and adjust for a DC voltage (approx. 2 V) so that the power meter indicates 20 mW.

b) Connect the test input of the digital ratiometer to the inner conductor of the BNC adapter.

c) Set the attenuator to 0 dB.

d) Adjust the divider at the DC output in such a manner that the readout on the ratiometer is 1.000.

e) Cut off the DC voltage and insert the URV probe into the BNC adapter.

f) Connect the generator and apply an AC voltage at f_I = 10 MHz, thus producing a reading of approx. 20 mW on the power meter.

g) Adjust the attenuation values on the attenuator and the measurement ranges on the URV 3 in the order given in Table 4 and take the reading on the ratiometer.

The values must not exceed the specified limits.

Table 4

Test voltage	Attenuation	Measurement range	Max. deviation from 1.000
1 V	0 dB	1 V	±3%
100 mV	20 dB	100 mV	±3%
10 mV	40 dB	10 mV	±5%
1 mV	60 dB	3 mV	±9%

Measuring procedure with test setup according to Fig. 7 (up to 10 V)

a) Replace the generator by a DC voltage source, feed in a voltage of 10.00 V ±10 mV and read the value on the power meter.

b) Connect the generator and apply an AC voltage at f = 10 MHz with an amplitude causing the same readout as the 10.00 V DC.

c) Read the value indicated on meter 7 (Fig. 2).
The deviation from 10.00 V may be ±3%.

3.2.2 Measurement of Frequency Response of Probe

Note: Particular care should be taken when measuring the frequency response on account of the bandwidth and sensitivity of the URV 3. Short, matched connections are very important.