Ц437

Combination instrument

Operating instructions

DESIGNATION

The avometer Ц437 is a combination instrument designed for measuring current and voltage in D. C. circuits, D. C. resistance, effective value of sine-shaped voltage in A. C. circuits of 45 to 40000 *c/s* frequencies.

The instrument is produced in two versions: 1) Ц437 for operation at ambient temperature —10 to +40° C and relative humidity up to 80% (at +30° C); 2) Ц437Т for indoor operation both in dry and humid tropical climates at ambient temperature from —5 to +45°C and relative humidity up to 95% (at +35° C).

The instrument Ц437 is intended for use in the course of servicing radio equipment and communication facilities as well as for amateur measurements.

TECHNICAL CHARACTERISTICS

Measurement range:
D. C. intensity: 0.1; 1; 10; 100; 1000 *mA*;
D. C. voltage: 2.5; 10; 50; 250; 500; 1000 *V*;
A. C. voltage: 2.5; 10; 50; 250; 500; 1000 *V*;
D. C. resistance: 0,3; 3; 30; 300 *KΩ*; 3 *MΩ*.

Basic error of instrument:

In measuring D. C. intensity and voltage — not over ±2.5% of the scale maximum value.

In measuring A. C. voltage — not over ±4% of the scale maximum value.

In measuring resistance — not over ±2.5% (in the ×1 range — not over ±4.0% of the scale working portion equal to 71 *mm*).

The working portion of scale "Ω" is the section confined between points "0" and "300".

Power consumed by the instrument:

Full deflection current — 100 *μA* in measuring D. C. and A. C. voltage and 200±50 *μA* in the "∿10 *V*" measurement range.

Drop of voltage across the instrument — not more than 0.5 *V* in measuring D. C. intensity and not more than 0.65 *V* in the 1000 *mA* measurement range.

The instrument frequency range is given in Table 1.

Each instrument Ц437 has been tested for insulation between the electric circuits and the frame by 3 *kV* eff. A. C. at 50 *c/s*.

Down time — not more than 4 *sec*.

Overall dimensions — not more than 212×118×75 *mm*.

Weight of the Ц437 instrument not more than 1.3 *kg* and of Ц437T, not more than 1.56 *kg*.

The normal operating conditions at which the basic error shall not exceed the values given above are as follows:

Horizontal position of the instrument within ±2°.

Table 1

Measurement range, *V*	Frequency, *c/s*	
	Rated	Expanded
2.5	45—10000	10000—40000
10	45—10000	10000—20000
50	45— 1000	1000— 5000
250	45— 200	200— 500
500, 1000	45— 100	100— 200

Ambient temperature +20±5° C for the Ц437 instrument and +27±5° C for the Ц437Т instrument (later on designated as t_a).

In measuring A. C. voltage the frequency shall be within the nominal range (see Table 1) and the voltage curve shall be practically sine-shaped (distortion factor not exceeding 2%).

INFLUENCE OF EXTERNAL FACTORS

Temperature Dependence

Variation of instrument readings due to changes of ambient temperature:

from —10 to +40° C for instrument Ц437 does not exceed ±2.5% for direct current (±1.25 for resistance measurements) and ±4% for alternating current;

from —5 to +45° C for instrument Ц437Т does not exceed ±2% for direct current (±1.25 for resistance measurements) and ±3% for alternating current per each 10° C of temperature change.

The Influence of Frequency

Variation of instrument reading due to change of frequency from the beginning of the nominal range to any value within the adjacent portion of the expanded range (see Table 1) shall not exceed ±4.0% for A. C. measurements.

The Influence of External Magnetic Field

Variation of instrument readings due to constant uniform magnetic field of 400 *A/m* in case of most unfavourable direction of the magnetic field shall not exceed ±5%.

Variation of instrument readings due to uniform magnetic field sinusoidally changing in time (frequency of change being equal to frequency of current passing across the instrument tested) shall not exceed ±5%. Magnetic field intensity for frequencies from 45 *c/s* to f_K inclusive shall be equal to 400 *A/m* and for frequencies from f_K to 40 *kc/s* it is found by the formula:

$$H = 400 \frac{f_K}{f},$$

in which f — frequency in *c/s*;
f_K — frequency 160 *c/s*.

The Influence of Tilt

Variation of instrument readings due to tilting from the normal (horizontal) position through 10° any direction shall not exceed the permissible basic error.

GENERAL INSTRUCTIONS FOR USE

In measuring high voltages accident prevention rules must be observed.

Touching the instrument terminals is dangerous for one's life!

The function switch may be turned to another position only with the instrument disconnected.

To avoid breakage of the braces on which the measuring mechanism frame is secured, escape impacts in transportation and operation of the instrument.

To prolong the service life of the internal power source try to avoid holding the instrument wire free ends for a long time in contact with the resistor tested, as well as shortcircuiting them.

On completing the measurements disconnect the instrument from the circuit checked.

USING THE INSTRUMENT

Measuring D. C. Intensity

Set the function switch to the left position designated "—" (Fig. 1). Insert the plug of one conductor into the receptacle marked "*" and the other conductor plug into the receptacle marked "1000 *mA*". Connect the

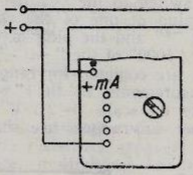

Fig. 1

free ends of both the conductors to the circuit of current measured. If the pointer does not reach 1/10-th of the scale, re-set the plug of the second conductor from the "1000 *mA*" socket to the "100 *mA*" one, repeating this procedure until the pointer appears in the right-hand part of the scale (in case of off-reading in the lower range, return to the previous one). The values are read on the scale marked "—".

Measuring D. C. Voltage

Set the function switch to the position marked "—" (Fig. 2). Insert the plug of one conductor into receptacle "*" (instrument minus) and the other conductor plug into receptacle "1000" of the "—*U*" range. Connect the free ends of both the conductors to the circuit of voltage

measured. If the pointer does not reach the right-hand portion of the scale, reset the second plug from socket "1000" to socket "500", and so on until the pointer is in the scale right-hand part. Read the required value on the scale marked "—".

Measuring A. C. Voltage

Set the function switch to the position marked "~" (Fig. 3). Insert the plug of one of the conductors into the receptacle marked "*" and the plug of the other conductor, into receptacle "1000" of the "~*U*" range (sockets 50, 250, 500 and 1000 are common for ranges "—*U*" and "~ *U*"). Taking measurements in the "~ 2.5 *V*" sub-range, read the values on scale "~2.5 *V*", taking measurements in the other sub-ranges, use should be made of the "~" scale.

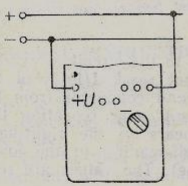

Fig. 2

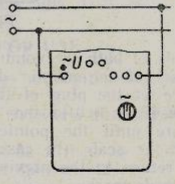

Fig. 3

Measuring D. C. Resistance

1. Set the function switch to the position marked "r_x" (Fig. 4).

2. Insert the plug of one conductor into receptacle "*" and the other conductor plug, into one of the recep-

tacles of the sub-ranges ×1, ×10, ×100, ×1000, ×10000, as required.

3. Short the free ends of the conductors and turning the "уст. 0" (zero adjustment) knob set the pointer to zero of scale "Ω". If the pointer would not set to zero, the power supply should be replaced.

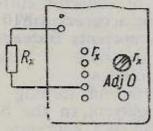

Fig. 4

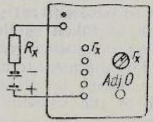

Fig. 5

4. Open the conductor ends and connect them to the outlets of the resistance measured. Record the value of the resistance, multiplying the instrument reading registered on the upper scale, by the factor chosen.

5. Passing over to another measurement range again set the pointer to zero of scale "Ω" as described in item 3. We recommend to test circuits for continuity with factor "×1000", and for shortcircuiting, with factor "×1".

In the "×10000" range the power source used should be a 30 to 42 *V* D. C. supply set connected as in Fig. 5.

6. Consumption of power in various D. C. resistance measuring ranges shall be not more than: 100 *mA* for ×1; 10 *mA* for ×10; 1 *mA* for ×100; 0.1 *mA* for ×1000 and ×10000 and the current intensity in the resistance measured shall not exceed consumption of current in the respective measurement sub-ranges.

Measuring Transistor Parameters

With the help of instrument Ц437 measurements may be made of the basic parameters of low-power transistors in the static duty, viz: current gain factor β, collector

junction back current I_{cb}, emitter junction back current I_{eb}, collector initial current I_{ci} in the common emitter circuit.

Measuring β. For the measurement a flash-light battery and a variable resistor are required (the battery built in the Ц437 instrument may be used).

It is known that β is the ratio of collector current gain to base current gain. To sufficient accuracy (±10%) β can be taken as the ratio of these currents instead of the ratio of the current gains.

For the measurement proceed as follows:

1. Hook up the circuit of Fig. 6 and turning the knob of the variable resistor set a current in the base circuit (for instance, 50 μA in the 0.1 *mA* subrange on the "—" scale). Resistance of the variable resistor should not exceed 250 *KΩ*.

2. Connect the Ц437 instrument to the collector circuit (Fig. 7) and read the current intensity in the 10 *mA* sub-range (scale "—"). Full deflection of the pointer will correspond to β=200.

Example: The instrument reads 6.8 *mA* (the pointer deflects through 34 graduations). One graduation corresponds to:

$$\frac{200}{50} = 4 \frac{\text{units } \beta}{\text{graduation}}.$$

Hence, for the given transistor β=4 · 34=136.

Note. If the base current set is 100 μA instead of 50 μA (full deflection of pointer in the 0.1 *mA* sub-range).

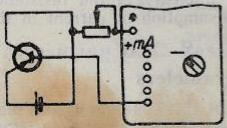

Fig. 6

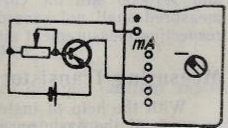

Fig. 7

then, switching the Ц437 instrument to the collector circuit (Fig. 7) the full deflection of pointer in the 10 *mA* sub-range will correspond to $\beta = 100$.

Example: Collector current is 3.1 *mA*, hence,

$$\beta = \frac{3.1 \cdot 10^{-3}}{100 \cdot 10^{-6}} = 31 .$$

Measuring I_{cb}. Collector junction back current is measured as shown in circuit of Fig. 8. The resistor should be 4 *KΩ* so as to protect the instrument in case

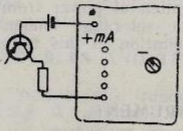

Fig 8

the transistor is disrupted (base connected to collector). Take measurements in the 0.1 *mA* sub-range in which full deflection of pointer corresponds to 100 *μA*. Read the current value on scale "—".

Measuring I_{eb}. Emitter junction back current is measured as shown in circuit of Fig. 9 similarly to measuring I_{cb}.

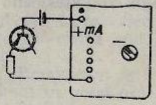

Fig. 9

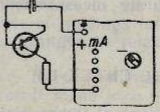

Fig. 10

Measuring I_{ci}. Collector initial current is measured as shown in circuit of Fig. 10 similarly to measuring I_{cb}.

REPLACING POWER SUPPLY SET

To replace the power supply set proceed as follows:

1. Turn off the 4 screws securing the nameplate at the instrument rear side.

2. Take out the waste battery and install a new one type КБС-Л-0,5 into the chamber, fitting the battery terminal plates into the contact springs of corresponding polarity.

3. Re-install the cover and fasten it with screws.

Note. Consumption of power from the supply set operating in the ×1 sub-range amounts to 100 *mA*. Therefore time of operation in this range should be as short as possible.

CARE OF THE INSTRUMENT

Instrument Ц437, like any other precise measuring apparatus, requires accurate and careful handling. If slightly soiled, it should be wiped with a soft cloth, in case of heavy contamination, rubbing with a cloth wetted in ethyl or methyl alcohol will be required.

Particular attention should be paid to cleanliness of the surface between the contact sockets (contamination will result in deterioration of insulation properties, reduction of instrument input resistance, and consequently, in inaccurate measurements of high voltages and resistances).

PERIODIC CHECK-UP

Accuracy of instrument Ц437 readings should be checked at least once a year.

Accuracy of current intensity and voltage measurement is checked comparing the instrument readings with those of standard instruments not worse than 0.5

class of accuracy, both in the direct and alternating current.

The limit values of the standard instrument scale must not exceed the corresponding limit value of the scale of the instrument checked by more than 25%.

To check the instrument in the resistance measuring ranges use should be made of a resistance box of accuracy class not worse than 0.5. The value of the resistance connected to the instrument is taken on the resistance box while the error in indication is read directly off the instrument Ц437.

POSSIBLE TROUBLES AND THEIR REMEDIES

The most characteristic troubles for the instrument are the following: discontinuity of one of the resistors, breakdown of the germanium or silicon rectifiers, breaking of one of the braces type Пл. Ср.-20 М. 0.71 ГОСТ 9444—60.

Loss of conductivity of any coil in the universal shunt circuit will manifest itself by absence of readings in the D. C. upper measurement sub-ranges, while in the lower sub-ranges the readings will be highly inaccurate. Readings of the A. C. voltmeter will be true, as the shunt has nothing to do with them. D. C. voltmeter readings will be too high.

Breaking of the added resistance in the voltage circuit will be revealed by absence of readings in the respective sub-range and higher sub-ranges in relation to this one.

Breakdown of resistance in the ohmmeter circuit (shunt in good order) will result in absence of readings.

Breakdown of rectifiers will result in faulty readings of the A. C. voltmeter in all the sub-ranges.

To remedy the troubles the instrument should be opened by turning off the 4 screws located in the four corners of the base.

Any component of the circuit can be easily found with the use of the electric diagram and the specification to it. If the trouble is not detected by visual examination make tentative measurements with a similar instrument. Suspicious parts should be soldered off and examined in detail. Damaged parts, if not repairable, should be replaced with sound ones.

After repairs entailing change of instrument parameters (replacement of rectifiers, rewinding of the measuring mechanism loop, etc.), the instrument must be completely re-adjusted.

Readjustment should be carried out under normal operating conditions (to avoid additional inaccuracies), and includes the following steps:

1) Adjust all the resistors (excepting the trimming ones) to the values given in the specification remarks column.

2) If the magnetic system of the measuring mechanism has been disassembled, adjust the mechanism full deflection current (deflection to the last division of the scale) to 75 μA by way of magnetization and even demagnetization of the system.

Resistance of the microammeter loop may be within 920 $\Omega \pm 20\%$ while the total resistance of the loop and trimming coil R_{15} must be 1500 $\Omega \pm 3\%$ at temperature t_a.

Adjustment in the "~ 2.5 U" sub-range consists in selection of resistance of resistor R_3, applying 2.5 V current to the instrument.

Adjustment of the instrument in the upper voltage measurement sub-ranges (such as 250, 500 V) consists in selection of resistor R_1+R_2 total resistance, adjustment in the "~ 10 U" sub-range consists in such distribution of the R_1+R_2 total that the standard microammeter reads 200 ± 50 μA.

To finish the adjustment once more check the end marks of the scale in all the A. C. measurement sub-

ranges as well as in the other measurement sub-ranges for accuracy of coincidence.

INSTRUMENT STORAGE

Instrument storage-rooms should be free of dust, gases and vapours causing corrosion. Relative humidity of air in the rooms should not exceed 80%, ambient temperature range for instrument Ц437 from +10 to +35° C and for instrument Ц437Т from −5 to +50° C.

Circuit Diagram for Instrument Ц437

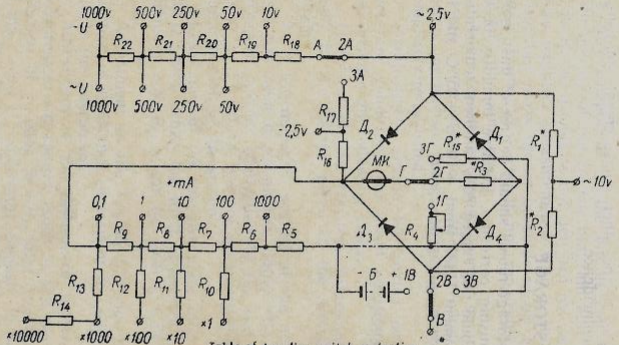

Table of function switch contacting

Kind of work	Numbers of contacts							
	1A	2A	3A	1B	2B	3B	1Г	2Г	3Г
—			X						X
~							X		X
r_x			X	X					X

* Selected at adjustment

Specification

Designation as per diagram	Description and type	Ratings	Q'ty, *pc*	Remarks
R_1	Resistor МЛТ-0.5	80—120 *KΩ*	1	Trimming
R_2	Resistor МЛТ-0.5	50—70 *KΩ*	1	Trimming
R_3	Resistor МЛТ-0.5	15—25 *KΩ*	1	Trimming
R_4	Resistor СП 1 ОС-5-32А 2 *W*	5 *KΩ*	1	
R_5	Coil	0.45±0.0022 Ω	1	
R_6	Coil	4.05±0.020 Ω	1	
R_7	Coil	40.5±0.20 Ω	1	
R_8	Coil	405±2.0 Ω	1	
R_9	Coil	4050±20 Ω	1	
R_{10}	Coil	26.5±0.13 Ω	1	
R_{11}	Resistor БЛП-0.1	283 Ω	1	
R_{12}	Resistor БЛП-0.1	2.84 *KΩ*	1	
R_{13}	Resistor БЛП-0.1	30.7 *KΩ*	1	
R_{14}	Resistor МЛТ-0.5	150 *KΩ*	2	Total resistance 300±1.5 *KΩ*
R_{15}	Coil	Up to 750 Ω	1	Trimming
R_{16}	Resistor МЛТ-0.5	12 *KΩ*	2	Total resistance 23.9±0.12 *KΩ*

Continued

Designation as per diagram	Description and type	Ratings	Q'ty, *pc*	Remarks
R_{17}	Resistor МЛТ-0.5	2 $K\Omega$	1	Total resistance
	Resistor МЛТ-0.5	3 $K\Omega$	1	5±0.025 $K\Omega$
R_{18}	Resistor МЛТ-0.5	43 $K\Omega$	1	Total resistance
	Resistor МЛТ-0.5	27 $K\Omega$	1	70±0 35 $K\Omega$
R_{19}	Resistor МЛТ-0.5	200 $K\Omega$	2	Total resistance 400±2 $K\Omega$
R_{20}	Resistor МЛТ-0.5	1 $M\Omega$	2	Total resistance 2±0.01 $M\Omega$
R_{21}	Resistor МЛТ-0.5	1.2 $M\Omega$	1	Total resistance
	Resistor МЛТ-0.5	1.3 $M\Omega$	1	2.5±0.012 $M\Omega$
R_{22}	Resistor МЛТ-0.5	2 $M\Omega$	1	Total resistance
	Resistor МЛТ-0.5	3 $M\Omega$	1	5±0.025 $M\Omega$
$Д_1$ $Д_2$	Diode Д9М		2	Д9А, Д9Д can be used instead
$Д_3$ $Д_4$	Diode Д103А		2	
$Б$	Battery КБС-Л-0.50		1	
$МИ$	Measuring mechanism	920±100 Ω n=675.5 turns of ПЭЛ wire dia. 0.03	1	Full deflection current 75 μA

Notes: 1. Items R_{11}—R_{22} (for Ц437) can be made either from one or several resistors (МЛТ, МТ, ОМЛТ, УЛИ, УЛМ, БЛП, МТП, ВС, etc.) so as to obtain the resistance value given in the specification.

2. Items R_{11}—R_{13} (for Ц437) should be made either from one or several resistors МЛТ.

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