COMBINATION INSTRUMENT

Ц4324

DESCRIPTION AND OPERATING
INSTRUCTIONS

V/O Mashpriborintorg · USSR · Moscow

1. APPLICATION

Combination instrument Ц4324 is designed for direct measurement of current and voltage in direct- and alternating-current circuits at frequencies ranging from 45 to 20000 Hz, direct-current resistance and transmission level.

Instrument input resistance is 20 kΩ/V in D.C. measurements and 4 kΩ/V in alternating-current measurements.

The instrument finds its application in servicing TV and radio equipment, in radio amateurs' practice, in servicing various domestic appliances as well as under factory and laboratory conditions.

2. TECHNICAL DATA

The basic instrument error is determined at normal values of the effecting factors (Table 1).

In D.C. measurements it does not exceed 2.5%, in A.C.— 4.0%. The basic error is expressed in per cent of the finite scale value (with the instrument switched in via voltmeter or ammeter), and in per cent of the effective scale range in resistance and transmission level measurements.

The effective scale range is not less than: "Ω, dB",— 48 mm; "kΩ" — 52 mm; "~ "— 70 mm.

Table 1

Effecting factor	Normal value
Operating position	Horizontal ±2°
Temperature	From plus 15 to plus 25°C
Ohmmeter supply voltage:	
a) in measurement with finite scale values 0.2; 5; 50, 500 kΩ	From 3.2 to 4.0 V
b) in measurement with finite scale value 5000 kΩ	From 32 to 40 V without built-in supply source
Frequency in A.C. intensity and voltage measurements	Within the rated frequency range
Current or voltage curve shape	Sinusoidal with distortion factor not over 2%

Finite scale values for all types of measurements are indicated in the front nameplate and instrument scale, as well as in the Certificate.

D.C. voltmeter power consumption is 50±2.5 μA; that of A.C. voltmeter — 250±12.5 μA.

Voltage drop across D.C. ammeter jacks does not exceed 0.4 V, across the A.C. ammeter jacks — 1.0 V.

Maximum consumption from supply source and current value in measured resistance when measurement is conducted with an ohmmeter with finite scale values 0.2; 5; 50; 500; 5000 kΩ does not exceed 7; 7; 0.7; 0.07; 0.07 mA respectively.

The rated and expanded frequency ranges of the instrument are indicated in the instrument back nameplate.

Operating climatic conditions for instrument Ц4324 are: ambient temperature from minus 10 to plus 40°C, relative humidity — up to 80% at plus 30°C.

Ultimate climatic conditions for instrument Ц4324 are: ambient temperature from minus 40 to plus 60°C, relative humidity up to 95% at plus 30°C.

Effect of Various Factors

Variations in instrument readings caused by the change of ambient temperature from the normal to any magnitude within the operating range do not exceed ±2.5% (for ohmmeter ±1.25%) in d.c. and ±4% in a.c. per every 10°C of temperature changes.

The changes in the instrument readings, caused by the change in the frequency from the boundary of the rated range to any value in the adjacent part of the expanded frequency range does not exceed ±4%.

Variations in instrument readings due to its deviation to 10° from the horizontal position in any direction do not exceed ±2.5%.

The change in the instrument readings, caused by the deviation of the current or voltage curve shape from the normal (Table 1) under the influence of the 2nd, 3rd or 5th harmonic component equal to 5% of the virtual value of the current and voltage being measured, does not exceed ±4.0%.

The change in the instrument readings under the influence of the constant homogeneous magnetic field of 400 A/m intensity at the most unfavourable direction of the magnetic field does not exceed ±5%.

The change in the instrument readings under the influence of the homogeneous magnetic field, sinusoidally changing in time with the frequency, equal to the frequency of the current which flows through the instrument, does not exceed ±5% at 400 A/m intensity. At the frequency f exceeding $f_K=90$ Hz the magnetic field intensity should be determined by the following equation:

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

3. DESIGN AND OPERATING PRINCIPLE

The circuit elements and measuring mechanism are enclosed in a housing safeguarding them against mechanical damage.

Provision has been made in the instrument design for the change of the supply source without deranging the Manufacturer's seal.

The instrument employs a magnetoelectric measuring mechanism on braces and inside-frame magnet.

The alternating current is rectified in a full-wave circuit. The instrument measures virtual (effective) value of alternating current or voltage at practically sinusoidal curve shape.

The resistance is measured in a magnetoelectric ohmmeter in-series and parallel circuits.

4. SAFETY PRECAUTIONS AND PREPARATORY PROCEDURES

Using the instrument for measurements in circuits with voltages exceeding 30 V, adhere to all the requirements of safety measures. When conducting measurements in high-voltage circuits it is recommended to connect and disconnect the instrument with the voltage and the circuit being measured cut out.

Measurements in circuits with voltages higher than 200—300 V should be carried out in the presence of other persons. Measurements with a probe should be performed with one hand, the other hand has to be free to avoid electric current shocks through the human body.

To obtain correct measurement results and to prevent possible instrument damage, follow the diagram indicating the layout of controls (Fig. 1) and adhere to the instructions given below:

a) set the instrument into horizontal position;

b) using the corrector, set the instrument pointer to initial scale marks;

c) set the measurement range selector to one of the positions: "—"; "~"; "kΩ"; "Ω";

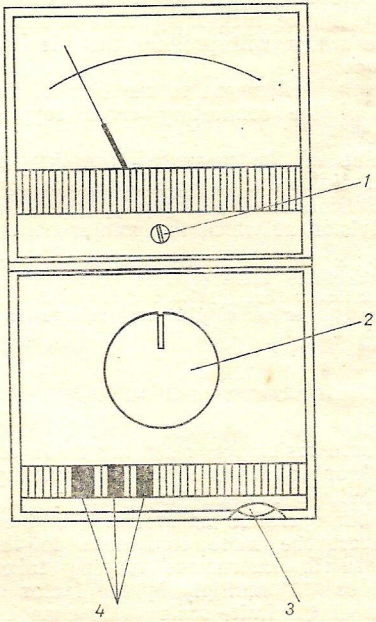


Fig. 1. Arrangement of controls:

1 — corrector; *2* — measurement range selector; *3* — zeroing; *4* — mode switch

d) reset the finite scale value change-over switch to position corresponding to the expected value of the quantity to be measured;

e) measurements with the ohmmeter should be done only with the circuit de-energized. The ohmmeter zeroing and resistance measuring time should be as brief as possible which will prolong the life of the built-in supply source;

connect the instrument to the circuit to be measured by means of the connecting cords supplied with the instrument.

The value of the measured quantity is determined as follows: divide the finite scale value by the number of scale divisions and multiply by the numerical value of scale division at which the pointer has settled.

Example: in the measurement of alternating current voltage at the finite value of scale "~ 300 V" the measuring mechanism indicator has deviated through 21 division in the scale "~". The value of the a.c. voltage is evaluated as follows:

$$U = \frac{300}{30} \cdot 21 = 210 \text{ V}$$

To measure resistance, reset the mode switch, to position "kΩ" or to position "Ω" by pushing simultaneously the buttons marked "kΩ" and "—". Prepare the instrument for operation as indicated in the back nameplate. Connect the loose cord ends to the resistance to be measured. Instrument reading taken from the scale "kΩ" or "Ω" multiply by the factor of the selected position of the finite scale value change-over switch.

In wired communication lines and radio engineering a logorithmic unit—decibel is used to express voltage ratio (amplification or reduction). As absolute a.c. voltage level a voltage is accepted equal to 0.775 V which corresponds to dissipation of 1 mW power across 600 ohm resistance.

In measurements with the final scale value 3 the relative level of the a.c. voltage is read off the scale "dB" directly. Changing over to other finite scale values in a.c. voltage, add to the value read off scale "dB" algebraically the number by which the readings have been increased in accordance with Table 2.

Table 2

Finite scale value	3	6	15	60	150	300	600	900
Increase of scale readings	0	+6	+14	+26	+34	+40	+46	+50

The work over, disconnect the instrument from the measured circuit and reset the instrument switches to position "—" and "1200 V" to prevent instrument damage due to accidental erroneous connections.

5. TECHNICAL SERVICING

At least once a year check the accuracy of instrument readings by comparing them with the readings of reference instruments of not less than 0.5 accuracy class.

Instrument Ц4324 should be stored in its case in rooms with ambient temperature from plus 10 to plus 35°C and relative humidity up to 80% at plus 30°C. The surroundings should not contain harmful admixtures liable to cause corrosion.

To change the supply source, take down the back nameplate of the instrument. Installing the nameplate in place, do not forget to put in the cardboard gasket — it enhances electric strength of the instrument during measurements of high voltages.

6. TROUBLE SHOOTING

Trouble	Cause	Remedy
No readings in the corresponding range and in the higher ranges as regards the former during voltage measurements	Loss of conductivity or unsoldered one of the resistors in voltmeter circuit	Using an ohmmeter, locate the break and repair it
In a.c. voltage measurement instrument readings are almost half the required	One of the germanium diodes faulty	Unsolder the diodes, locate the faulty diode by means of an ohmmeter and replace it by a similar new one; after diode replacement the instrument must be adjusted in the alternating current
No readings in all the ranges during a.c. voltage measurements	Faulty diodes in the rectifying bridge or loss of conductivity of resistors *R24, R23*	Replace faulty diodes or resistor by new ones, adjust the instrument

Too high instrument readings during alternating and direct current voltage measurements. No readings in the corresponding range and in higher range as regards the former range during direct and alternating current measurements	Break in the universal shunt circuit	Using an ohmmeter, locate faulty wire-wound resistor and remedy the defect
No readings in the corresponding range during resistance measurements. In other ranges the instrument operates normally	Loss of multiplier conductivity in this range in ohmmeter circuit	Locate and repair the faulty resistor
Instrument fails to operate in all ranges	Break in measurer *R23* tuning coil, break in measurer frame winding or broken brace	These defects are to be repaired at a repair shop or at the Manufacturing Plant

To remedy a defect, open the instrument as follows: remove the back nameplate, turn out screws in the instrument base, take off the cover carrying the instrument wiring. Following the electric circuit diagram (Supplement 1), parts layout diagram (Fig. 2) and the Specifications (Supplement 2), any circuit components can be easily located. Should it prove impossible to locate the defect by visual inspection, carry out ap-

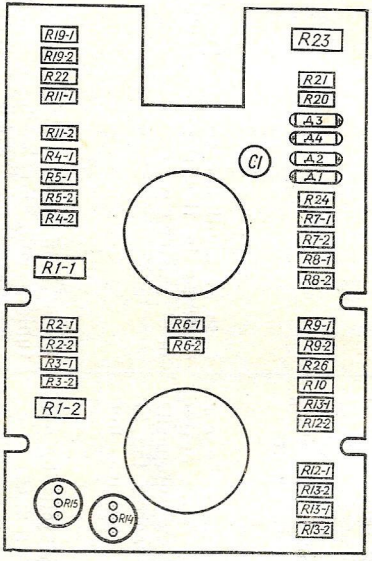


Fig. 2. Parts layout diagram: resistor *R27* is soldered on directly to the lobes of measurement range selector

proximate measurements of circuit components. Faulty parts are to be unsoldered and replaced by new ones.

After repairs involving the change of instrument parameters (replacement of rectifiers, rewinding of the measuring mechanism frame, etc.) the instrument has to be re-adjusted.

The re-adjustment has to be carried out at normal conditions (Table 1) to avoid additional errors.

All resistors, except adjusting ones *R24* and *R23*, are to be adjusted to values indicated in specifications. If the repair of the measuring instrument involved dismantling of the magnetic system, its full deflection current has to be adjusted to 37.5 μA by magnetizing and gradually demagnetizing the system. Total resistance of the measuring instrument and resistor *R23* is to be adjusted to 1000±6 Ω. If the adjustment has been carried out at a temperature other than the normal, the value of total resistance to be obtained by the adjustment is to be evaluated by the following equation:

$$R_{mm} + R23 = 1000 + 0.004 \quad (t - 20) \quad R_{mm} \pm 6 \ \Omega,$$

where t — temperature at which the adjustment has been performed, °C.

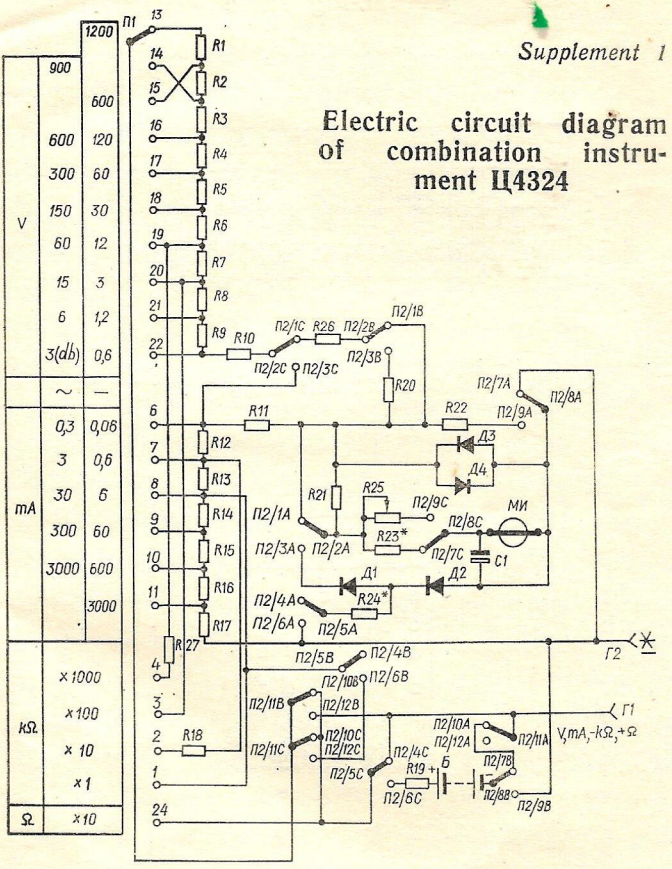
The moving part of the measuring mechanism is secured on braces Type Пл. Ср-20 with antagonistic moment 0.32 at tension of 65±5 gf. The measuring mechanism being put in place, check the matching of finite scale marks at all finite d.c. scale values.

After repairs the instrument scale does not have to be changed, except for the case when the diodes have been replaced. Following the replacement of diodes the instrument has to be adjusted in the alternating current. This is done by connecting the instrument at one of the finite scale values in the alternating current or voltage to a.c. supply, 50 Hz, and by the aid of the reference instrument, the current or voltage value in the

instrument circuit being adjusted, is brought up to the selected finite scale value.

The value of resistor *R24* is to be so selected that at the indicated conditions the pointer would deviate to the finite scale mark; after that the intermediate numbered a.c. scale marks are checked for correspondence. In case of discrepancies over 4.0% from the finite value of scale "~" and from the effective part of scale "dB", the scales have to be re-calibrated (re-plotted) or the diodes replaced once more.

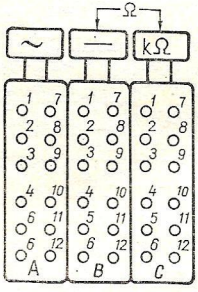
Electric circuit diagram of combination instrument Ц4324



Contacting Table

Mode of operation	Numbers of face contacts of switch П2																							
	A												B											
	1-2	2-3	4-5	5-6	7-8	8-9	10-11	11-12	1-2	2-3	4-5	5-6	7-8	8-9	10-11	11-12	1-2	2-3	4-5	5-6	7-8	8-9	10-11	11-12
~	X						X		X						X			X			X		X	
—		X				X				X				X			X			X		X		
kΩ		X			X					X			X					X			X			
Ω	X			X							X								X			X		

Switch П2 contact numbering diagram



Supplement 2

Specification to Circuit Diagram of Instrument Ц4324

Ref. No.	Item	Rating and type	Q-ty	Notes
R1	Resistor	6.8 MΩ МЛТ-0.5±5%	1	Total resistance
	Resistor	5.1 MΩ МЛТ-0.5±5%	1	12±0.06 MΩ
R2	Resistor	4.7 MΩ МЛТ-0.5±5%	1	Total resistance
	Resistor	3.6 MΩ МЛТ-0.5±5%	1	8.4±0.042 MΩ
R3	Resistor	680 kΩ МЛТ-0.5±5%	1	Total resistance
	Resistor	510 kΩ МЛТ-0.5±5%	1	1.2±0.006 MΩ
	Resistor	680 kΩ МЛТ-0.5±5%	1	Total resistance
R4	Resistor	510 kΩ МЛТ-0.5±5%	1	1.2±0.006 MΩ
R5	Resistor	300 kΩ МЛТ-0.5±5%	2	Total resistance 600±3 kΩ
R6	Resistor	180 kΩ МЛТ-0.5±5%	2	Total resistance 360±1.8 kΩ

Continued

Ref. No.	Item	Rating and type	Q-ty	Notes
R7	Resistor	91 kΩ МЛТ-0.5±5%	2	Total resistance 180±0.9 kΩ
R8	Resistor	18 kΩ МЛТ-0.5±5%	2	Total resistance 36±0.18 kΩ
R9	Resistor	6.8 kΩ МЛТ-0.5±5%	1	Total resistance
	Resistor	МЛТ-0.5±5%	1	12±0.06 kΩ
R10	Resistor	3.3 kΩ МЛТ-0.5±5%	1	Total resistance 10.5±0.05 kΩ
R11	Resistor	200 Ω МЛТ-0.5±5%	1	Total resistance
	Resistor	300 Ω МЛТ-0.5±5%	1	500±2.5 Ω
R12	Resistor	1.1 kΩ МЛТ-0.5±5%	2	Total resistance 2.25±0.0115 kΩ
R13	Resistor	100 Ω МЛТ-0.5±5%	1	Total resistance
	Resistor	120 Ω МЛТ-0.5±5%	1	225±0.1 Ω
R14	Coil	22.5±0.1 Ω ПЭМС Ø 0.2 mm	1	

R15	Coil	2.25±0.01 Ω ПЭМС ∅ 0.4 mm	1	
R16	Shunt	0.2±0.001 Ω МНМЦ-3-12 ∅ 1.2	1	
R17	Shunt	0.05±0.00025 Ω МНМЦ-3-12 ∅ 1.5	1	
R18	Resistor	2.4 kΩ МЛТ-0.5±5%	1	Total resistance
	Resistor	2.2 kΩ МЛТ-0.5±5%	1	4.56 kΩ±0.03 kΩ
	Resistor	270 Ω МЛТ-0.5±5%	1	Total resistance
R19	Resistor	220 Ω МЛТ-0.5±5%	1	490±2.45 Ω
R20	Resistor	750 Ω МЛТ-0.5±5%	1	
R21	Resistor	1 kΩ МЛТ-0.5±5%	1	
R22	Resistor	1 kΩ МЛТ-0.5±5%	1	Total resistance
R23	Coil	up to 520 Ω	1	with mm 1000±6 Ω at $t=+20°C$
R24	Resistor	1+2 kΩ МЛТ-0.5±5%	1	To be selected during adjustment
MИ	Measuring mechanism	600±120 Ω ПЭВ-1 ∅ 0.03 mm — 660 turns	1	

Continued

Ref. No.	Item	Rating and type	Q-ty	Notes
R25	Resistor	СП-3-9a-16-2.2 k±20%	1	
R26	Resistor	МЛТ-0.5±5%-7.5 kΩ	1	Total with *R10* 10.5±0.05 kΩ
R27	Resistor	МЛТ-0.5±5%-270 kΩ	1	
Д1	Germanium diode	Д9Д	2	Permissible relacement by Д9М
Д2				
Д3; *Д4*	Silicon diode	Д103	2	Permissible Д220
Б	Chemical current source	ЗРЦ-63 (ЗРЦ-53)	1	Permissible storage battery Д-0.1 — 3 cells *
C1	Capacitor	К50-6-6-50±20% 50 μF	1	

* If the ohmmeter circuit of your instrument is supplied from three cells Д-0.1, it is recommended to charge them, if necessary, by 12 mA current at 1.3 V for 15 hours.

Cells Д-0.1 withstand 150 cycles of charge and discharge.

Important!

Do not use the instrument without studying its Certificate.

Negligible changes in instrument design and circuit may not be reflected in this manual.

Комбинированный прибор Ц4324.
Техническое описание и инструкция по эксплуатации
на английском языке.

Vneshtorgizdat, 297У/73 (3756)