

MODEL 231A L-C METER

OPERATION MANUAL

印刷表紙使用のこと

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Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.

(Revision should be applied to items indicated by a check mark)

Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

Input fuse

The rating of this product's input fuse is _____ A, _____ VAC, and _____.

WARNING

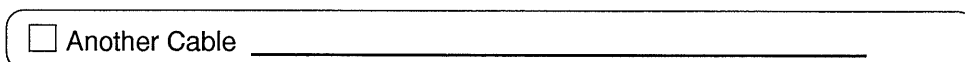
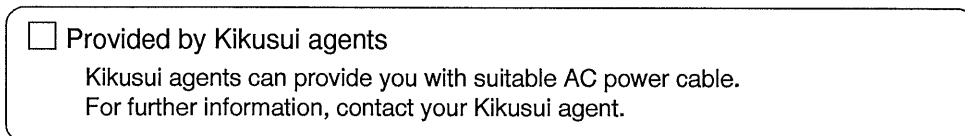
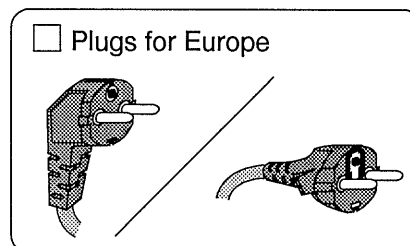
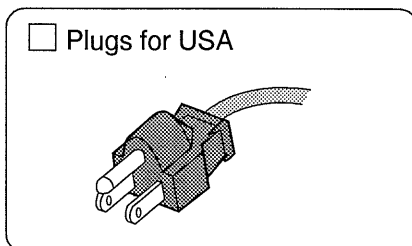
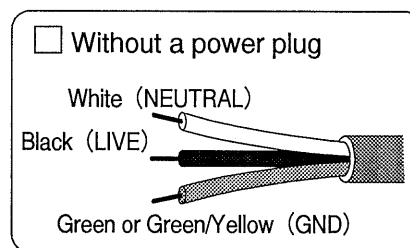
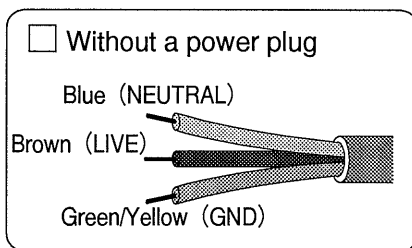
- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

AC power cable

The product is provided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.



The Model 231A L-C Meter is a direct-reading indicator-type inductance-capacitance meter designed for quick measurement of inductances and capacitances from 0 to 300 μ H or pF in 5 ranges, and also, for rapid check of inductances or capacitances upto 10 mH or 0.01 μ F, applying a slight test voltage.

This equipment is also useful to measure interelectrode capacitances of electron tubes and stray capacitances in various electronic circuit utilizing guard terminal provided on the panel, and furthermore, with the aid of Model 931 LCR Standard or Model 932 C Standard, it can be used to measure small capacitances with high accuracy.

SPECIFICATION

Power Requirement	volts, 50 to 60 Hz, approx. 47 VA
Size - Cabinet	170 W x 230 H x 250 D mm
Maximum	175 W x 245 H x 290 D mm
Weight	Approx. 6 kg
Tube Used	1 6CB6
	5 6U8
	1 6BE6
	1 6BQ7A
	1 0A2 or VR-150MT
	1 6X4

Items Supplied with Equipment

1	943 Test Fixture
1	941B Terminal Adaptor
1	Test Lead, equipped with M-type Connector
1	Operation Manual
1	Test Data

Terminals	UHF-type receptacle and GND terminal mounted with a spacing of 19 mm (3/4-inch). UHF-type receptacle accepts UHF-type plug and M-type plug.
Indicator	DC ammeter 200 μ A, length of scale 105 mm
Range	12 ranges: 0 - 3/10/30/100/300 μ H and 0 - 300 - ∞ μ H 0 - 3/10/30/100/300 pF and 0 - 300 - ∞ pF
Accuracy	In ranges 0 - 3/10/30/100/300 μ H or pF Within $\pm 3\%$ of full scale
Test Frequency	132 to 150 kHz
Test Voltage	For capacitance measurement, less than 0.2 volt RMS For inductance measurement, less than 0.05 volt RMS
Stability	For $\pm 10\%$ change in line voltage. Change in indication less than $\pm 1\%$.
Guard Terminal	Output impedance approx. 250 ohms. Maximum stray capacitance to be cancelled 200 pF.

FUNCTIONS OF CONTROLS AND TERMINALS

- POWER** A toggle switch to turn power on or off. Turning this switch on, pilot lamp lights on.
- RANGE** A knob appearing righthand on the panel is a range switch, and is to select any one of 12 ranges; 0 - 3/10/30/100/300 μ H or pF and 300 CENTER μ H or pF.

When power switch is turned on or turned off, it is good practice that this switch is positioned at 300 μ H or pF or 300 CENTER μ H or pF.

ZERO ADJ

Two knobs, regular size and small size, appearing lefthand on the panel are used for adjustment of zero point or infinite point. Regular size knob is for coarse adjustment and small size knob is for fine adjustment. These controls can compensate additional external capacitance accrued owing to test leads upto 100 pF. Figures 0, 50, and 100 around coarse adjustment knob and -5 and +5 around fine adjustment knob indicate capacitances of internal compensating variable capacitor in pF, and when nothing is connected to measuring terminal, zero point is obtained roughly at 100 position.

To obtain zero point accurately, fine adjustment knob is set at 0, then, coarse adjustment knob is set so that meter pointer indicates roughly zero. Then, increasing meter sensitivity by stepping down range switch, fine adjustment knob is adjusted so that meter pointer indicates accurately zero.

UNKNOWN LC

A UHF-type receptacle to connect component to be measured. This receptacle accepts Type 943 Test Fixture, Type 941B Terminal Adaptor, or test lead, as necessarily. External conductor of receptacle is connected to the chassis of the equipment.

GUARD VOLTAGE

In measurement of capacitances, this terminal supplies a voltage which is same as test voltage

in both amplitude and phase, and allows to cancel by connecting as shown in Figure 1. (However, this function does not work when range switch is positioned at 300 CENTER pF.)

OPERATION

Measurement of Capacitances

In ranges 0 - 3/10/30/100/300 pF, meter indication should first be accurately adjusted to zero using ZERO ADJ knobs. Then, unknown capacitance is connected to measuring terminal. Capacitance can then be read directly on the meter scale corresponding to the range positioned. In range 300 CENTER pF, measuring terminal or tips of test lead are first short circuited and meter indication is adjusted to infinite position by ZERO ADJ knobs. Then, unknown capacitance is connected and capacitance is read on the scale 0 - 300 $\rightarrow \infty$.

The meter reading however includes stray capacitance (C_0) which develops in parallel to unknown capacitance. Therefore, the meter reading when unknown capacitance is removed (this capacitance is equal to C_0) should be subtracted from the original reading.

Measurement of Inductances

In ranges 0 - 3/10/30/100/300 μ H, measuring terminal or tips or test lead are first short circuited and zero point is adjusted using ZERO ADJ knobs. Then, unknown inductance is connected. Inductance can then be read directly on the meter scale corresponding to the range positioned. In this case, the use of test leads having large stray capacitance should be avoided so as to reduce the measuring error.

In range 300 CENTER μ H, zero point is also adjusted in the same manner

as above, and inductance is read on the scale 0 - 300 - ∞ . It should be noted however that there might be some discrepancy between zero point for inductance measurement and for capacitance measurement.

Measurement of Small Capacitance and Inductance

When using 3 pF or 3 μ H range, the equipment should be warmed up at least for 10 minutes in order to avoid fluctuation or zero point.

In measurement of so small value as less than 1 pF or 1 μ H, after zero point is obtained as noted above, fine ZERO ADJ knob is turned clockwise to indicate 1 pF or 1 μ H. Upon measurement, then, 1 pF or 1 μ H is subtracted from the meter reading. By doing so, difficulty of reading due to fluctuation of meter pointer could be reduced.

In measurement of small inductances, in order to avoid the error accrued from test leads, it is recommended that zero point is obtained by short circuiting measuring terminal. Then, inductance of test leads measured by short circuiting their tips, and upon measurement of unknown inductance, inductance of test leads is subtracted from the measured inductance value.

Comparison of Capacitances

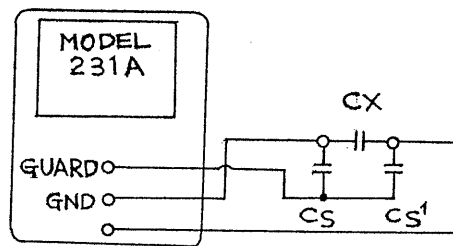
In comparison of number of capacitances, it is possible to magnify the difference using this equipment at high sensitivity range and shifting zero point. The meter indication is first adjusted to zero point as noted above, then, ZERO ADJ knobs are turned counterclockwise till meter pointer indicates an arbitrary capacitance value. This indication means that, if such capacitance is connected, the indication would become zero. Following is an example.

How about to sort a batch of 50 pF capacitors within a tolerance of ± 5 pF. As usual, zero point is first adjusted, and range switch is

set in 100 pF position. Then, ZERO ADJ knob is turned counterclockwise so as to shift the indication to 45 pF (that is $50 - 5$ pF), and range switch is set in 10 pF position (then indication over scales). Next, an accurate known capacitance ($45 + x$) pF is connected and fine adjustment knob is re-set so as to indicate x pF accurately. The equipment is now ready for sorting of capacitors, and capacitances 50 ± 5 pF will now be indicated as 0 - 10 pF on the scale. However, it should be cautioned that there are always two values of capacitance for one indication. In this example, both 50 pF and 40 pF appear as 5 pF on the scale. Using coarse adjustment knob, capacitance can be shifted up to 100 pF, however, actually limited less than 100 pF due to stray capacitance of the test leads.

Warning

If capacitor of more than 300 pF or inductor of more than 300 μ H is connected in ranges 0 - 3/10/30/100/300 pF or μ H, the meter might indicate exceptionally low value or the indication might be unstable or at times does not work. It is therefore recommended that unknown components are once checked in 0 - 300 - ∞ range prior to the measurement.



Cx - Capacitance to be measured.
Cs and Cs' - Capacitances to be cancelled.

Figure 1 Guard voltage is used to cancel stray capacitance

MAINTENANCE AND ADJUSTMENT

Similarly to handling of ordinary test equipment, this equipment should always be kept away from severe shock or vibration, high temperatures over 40°C, low temperatures below 0°C, direct subject to sun-light, or dusty place. In operation, line voltage should be maintained within $\pm 5\%$ of rated voltage.

How To Remove Side Board

Side board can be removed simply by unlocking two screw type locks appearing on the upper corner of the side board using a screw driver. These locks can be unlocked by turning counter clockwise approximately one rotation.

In mounting, screw-type locks are first turned counterclockwise approximately by 1/4 rotation, and bottom edge of the side board is put inside of bottom board. Then, placing side board in position, screw-type locks are fastened.

Adjustment

The equipment is supplied properly adjusted and calibrated at the factory. However, re-adjustment may be necessary when tubes or other parts are replaced, or when some deviation is recognized after long period of use due to aging of the equipment. In adjustment, minimum warm-up time of 10 minutes should be allowed.

Adjustment of T3 -- This transformer serves to oscillate a fixed frequency. A frequency meter is connected to pin #7 of V6, and ferrite core of T3 is adjusted to obtain a frequency of exactly 150 kHz.

Adjustment of T2 -- In adjustment of T2, Model 931 LCR Standard is connected to measuring terminal. With the knob on the Standard placed

in 0 pF position, and the range selector of the equipment placed in 3 pF position, zero point is accurately obtained. Then, the knob on the Standard is placed in 300 pF position, and the range switch is placed at 300 pF position, and the meter indication is recorded.

Followingly, the knob of the Standard is placed at 0Ω position, and zero point is adjusted at 3 μH range. Then, switchin Standard at 300 μH position, the meter indication is recorded in 300 μH range. If this indication is higher (or lower) than the indication of 300 pF, ferrite core of T2 is turned so as to decrease (or increase) the meter indication. This procedure is repeated several times so that the meter indications at 300 pF and 300 μH become equal.

Adjustment of R31. In this adjustment, zero point is first shifted to full scale point, and screw-driver adjustment R31 is turned fully clockwise. In this condition, a voltage across load resistor R39 for pentode section of V7 is recorded. Then, R31 is turned counterclockwise so as to the voltage drops down to $\frac{1}{2}$ of the recorded value.

Adjustment of R43 -- Connecting Model 931 LCR Standard, and its switch set in 300 pF or 300 μH position and range switch set also in 300 pF or 300 μH position, this resistor is adjusted so as to give exactly 300 pF or 300 μH indication. Because this resistor governs overall sensitivity, if this resistor is adjusted, sensitivity should be re-adjusted in all ranges.

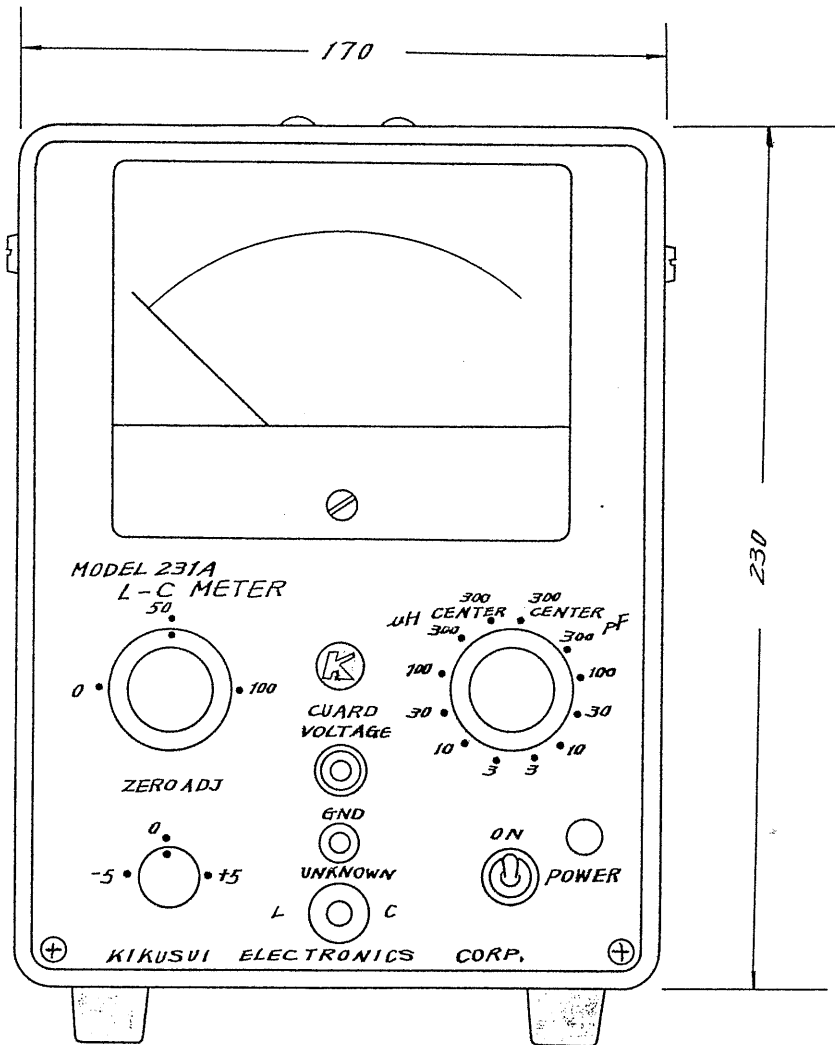
Adjustment of R47 through R50 -- These screw adjustments are for adjustments of sensitivities in ranges 3/10/30/100 pF or μH , and these are adjusted using Model 931 LCR Standard. If T2 is properly adjusted as noted above, adjustment of pF ranges also completes adjustment or μH ranges.

Adjustment of C13 -- C13 is provided so as to minimize the error in

meter indication due to the dielectric loss of the unknown capacitance. Connecting Model 931 LCR Standard and with its switch positioned at $1\text{ M}\Omega$, zero point is shifted to indicate the center of scale at 10 pF range. Then, the switch of Standard is set in $100\text{ K}\Omega$ position, and C13 is adjusted for minimum difference in indications at $1\text{ M}\Omega$ and $100\text{ K}\Omega$ positions.

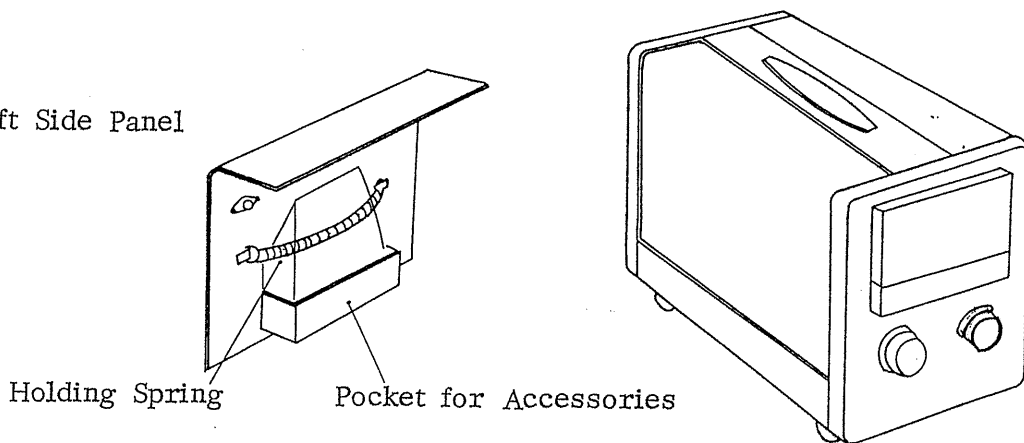
Adjustment of L1 -- After completion of above noted adjustments, range selector is placed in $300\text{ }\mu\text{H}$ CENTER position, and zero point is adjusted. Then, ferrite core of L1 is turned so that the meter pointer indicates ∞ .

Front View



Accessory Pocket

Left Side Panel



The accessories are kept in the pocket inside the case. Remove the left side panel by rotating the two screws about one turn. The accessories should be held by the spring.