LCR METER
Z216

INSTRUCTION MANUAL

HUNG CHANG PRODUCTS CO.,LTD.

LCR METER

CONTENTS

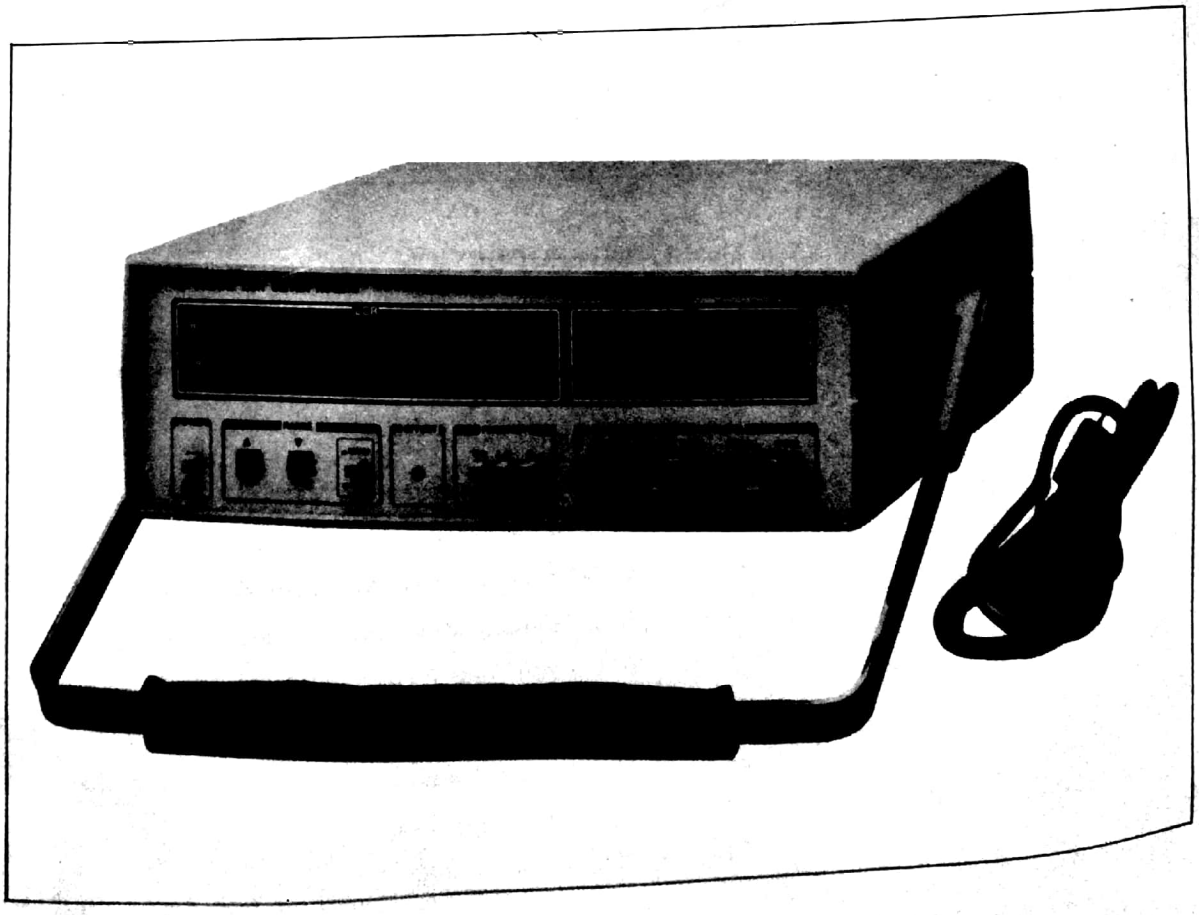
SECTION I
GENERAL INFORMATION

1. INTRODUCTION

This operating manual contains the information required to install and operate the Digital LCR Meter. Figure 1-1 shows the instrument and supplied accessories. This section covers description, specifications, accessories and other basic information.

2. DESCRIPTION

This LCR METER is a general purpose, fully automatic test instrument designed to measure the paramaters of an impedance element with high accuracy and speed. The LCR Meter measures capacitance, inductance, resistance and dissipation factor over a wide range at test frequency of 1KHz employing a five-terminal connection configuration between the component and the instrument. The measuring range for capacitance is from 10 pF to 1999 μF, inductance from 10 μH to 199.9 H, and resistance from 100 mΩ to 1999 KΩ, which are measured with a basic accuracy of 0.3% to 1% depending on the measuring range and measuring equivalent circuit. This LCR Meter is capable of measuring easily and handily the contact resistance of electronic component such as a coil, condenser, resistor as well as switch; relay, etc. and also measuring the internal resistance of battery, the junction capacitance of a semiconductor as well as any kind of elements.



With the auto range and auto mode functions, it is capable of selecting automatically an optimum range for the measuring object with unknown value. Also, as the manual selection of range is possible, time required for the measurement with the change of range can be shortened.

The display unit displays LCR value in 3-1/2 digit and in case of the measuring L or C, the value of D (Dissipation factor) is also displayed in 3-1/2 digit at the same time.

As a direct current voltage proportional to the measured value is output, it is capable of connecting an analog recorder and analog comparator, etc. to this instrument.

3. SPECIFICATION

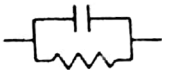
1) Common Specification

Measuring items	:	C (capacitance) and D (dissipation factor) L (inductance) and D (Dissipation factor) R (resistance)
Display	:	in 3-1/2 digit, max. indication 1999
Measuring circuit mode	:	Automatic selection of parallel equivalent circuit and series equivalent circuit.
Measuring terminal	:	Consists of 5 terminals of voltage, current and guard terminal.
Range changeover	:	Aautomatic and manual
Measuring frequency	:	1 KHz ± 5%
External bias	:	0 to 50V DC When measuring capacitance, the external bias can be impressed from the binding post on the rear panel.
Analog output	:	1.999V/1999 count, internal resistance 1 Kohm, LCR and D output are output from the BNC receptacle on the rear panel.
Measuring time	:	less than 1 second until the measured value becomes stable.
Sampling time	:	10-times per second approx.
Time required for automatic ranging	:	100 × n (ms) ("n" stands for the number of range which the automatic ranging circuit steps)

2) General

Operating environment	:	temperature ; 0°C to 40°C humidity ; bellow 85% RH
Power requirements	:	100/120/220V ± 10% 240V + 5%, − 10%, 48 ~ 66Hz
Power Consumption	:	bellow 15VA
Dimensions	:	Approximately 265(W) × 95(H) × 285(D)mm.
Weight	:	Approximately 2.5kg

3)C-D measurement(at 23 deg. C ±5 deg. C)

Measuring range	C	199.9pF	1.999nF	19.99nF	199.9nF	1.999μF	19.99μF	199.9μF	1999μF
	D	0.001~1.999							
Measuring signal level		1V		100mV		150μA	1.5mA	15mA	15mA
Measuring circuit mode		Parallel equivalent circuit 				Series equivalent circuit 			
*1 Accuracy	C	0.5%+2 count+0.2pF				0.5%+2 count			1%+2 count
	*2 D	0.5%+(2+1000/Cx) count				1%+(5+Cx/500)count			

*1. Accuracy: ±(% reading+counts)
*2. Cx is capacitance read out in count.

4) L-D measurement (at 23 deg. C ± 5 deg. C)

Measuring range	L	199.9μH	1.999mH	19.99mH	199.9mH	1.999H	19.99H	199.9H
	D	0.001~1.999						
Measuring signal level		10mA	10mA	1mA	100μA	10μA		1μA
Measuring circuit mode		Series equivalent circuit 						
*1 Accuracy	L	0.8%+2 count+0.2μH						0.5%+2 count
	*2 D	1%+(3+200/Lx)count						

*1. Accuracy: ±(% reading+counts)
*2. Lx is inductance readout in counts.

5) R measurement (at 23 deg. C ± 5 deg. C)

Measuring range	1.999Ω	19.99Ω	199.9Ω	1.999kΩ	19.99kΩ	199.9kΩ	1999kΩ
Measuring signal level	100mA	10mA	1mA	100μA	10μA		1μA *3
Measuring circuit mode	Series equivalent circuit 						
Accuracy *1	0.3%+2 count+2mΩ *2						

*1. Accuracy: ±(% reading+counts)
*2. Max. reading value is 1999KΩ

6) Accessories Available.

(1) TF 100 : Test fixture, direct coupled 5-terminal. Usable on all ranges of the LCR meter.

(2) TF 200 : Test leads with alligator clips, 4-terminal. Usable for low impedance measurements. Measurement range is L $\leqq$ 2H, C $\geqq$ 200 nF and R $\leqq$ 10KΩ

(3) TF 300 : Test leads with alligator clips, 3-terminal. Useable for high impedance measurements. Measurement range is L $\geqq$ 3mH, C $\leqq$ 10μF and R $\geqq$ 200Ω

4. ACCESSORIES SUPPLIED

Figure 1-1 shows the LCR Meter, power cord and fuses.

5. ACCESSORIES AVAILABLE

For effective and easy measurement; three styles of fixture and leads for the measurement of various components are available. These are listed in SPECIFICATIONS. A brief description of each of these fixture and leads is given Table 1-1. Refer to Section III Paragraph '3' for detailed information on these devices.

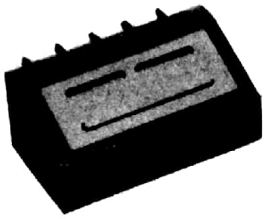
Model	Description
TF 100 	Test fixture (Direct coupled type) for general measurement.
TF 200 	Test leads (with alligator clips) useful for low inducatance, high capacitance. or low resistance (less| than 10KΩ) measurements.
TF 300 	Test leads (with alligator clips) for general component measurement and especially useful for high impedance measurements.

Table 1-1. Accessories Available

SECTION II
INSTALLATION

1. INTRODUCTION

This section provides installation instructions with this LCR Meter. The section also includes information on preparation for using the LCR Meter and storage.

2. PREPARATION FOR USE

1) Power Requirements.

This LCR Meter requires a power source of 100, 120, 220 Volts ac ± 10%, or 240 Volts ac +5% −10%, 48 to 66Hz single phase. Power consumption is approximately 15 watts.

WARNING

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN EXTERNAL AUTO TRANSFORMER FOR VOLTAGE REDUCTION, BE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SUPPLY.

2) Line Voltage and Fuse Selection

CAUTION

BEFORE TURNING THE LCR METER LINE SWITCH TO ON, VERIFY THAT THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SUPPLIED.

Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selection and the proper fuse are factory installed for the voltage appropriate to instrument destination.

CAUTION
USE PROPER FUSE FOR LINE VOLTAGE SELECTED.

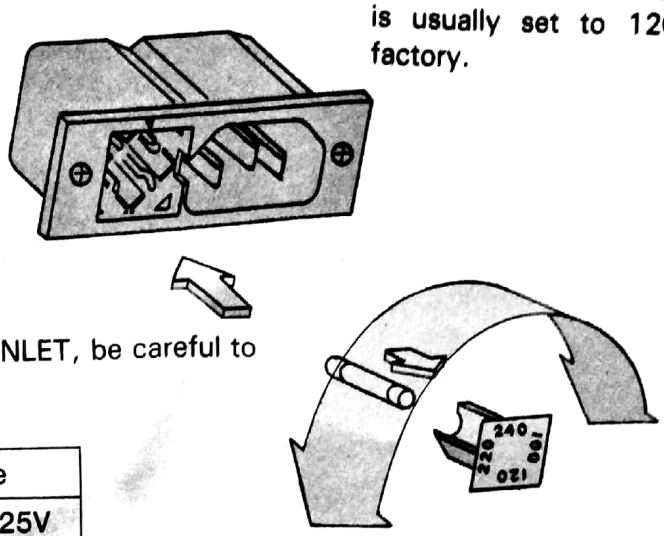
SELECTION OF OPERATING VOLTAGE

1. Disconnect power cable.

2. Pull the fuse holder out.

3. Select operation voltage by orienting Fuse holder to position desired voltage according to '▽' mark on the AC INLET.

Operating voltage is shown on the cover of fuse holder and, is usually set to 120V at factory.



4. Re-insert the fuse holder in AC INLET, be careful to select correct fuse value.

Operating Voltage	Fuse
100 Vac or 120 Vac	0.5A 125V
220 Vac or 240 Vac	0.2A 250V

Fig. 2-1. Voltage and Fuse Selection

CAUTION

MAKE SURE THAT ONLY FUSES FOR THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT.

3) Operating Environment

(1) Temperature. The instrument may be operated in temperatures from 0°C to +40°C.
(2) Humidity. The instrument may be operated in environments with relative humidities to 85% to 40°C. However, the instrument must be protected from temperature extremes which cause condensation within the instrument.

3. STORAGE ENVIRONMENT

The instrument may be stored or shipped in environments within the following limits.

- Temperature : −20°C to +70°C
- Humidity : below 85% RH

SECTION III
OPERATION

1. INTRODUCTION

This section provides the operating information to acquint the user with this LCR Meter. The section includes panel features, measurement procedures for various applications and explain about fixture and test leads.

2. PANEL FEATURES

The front panel and Rear panel are shown in Figure 3-1 and Figure 3-2. Description numbers match the numbers on the figure.

1) Front Panel Features

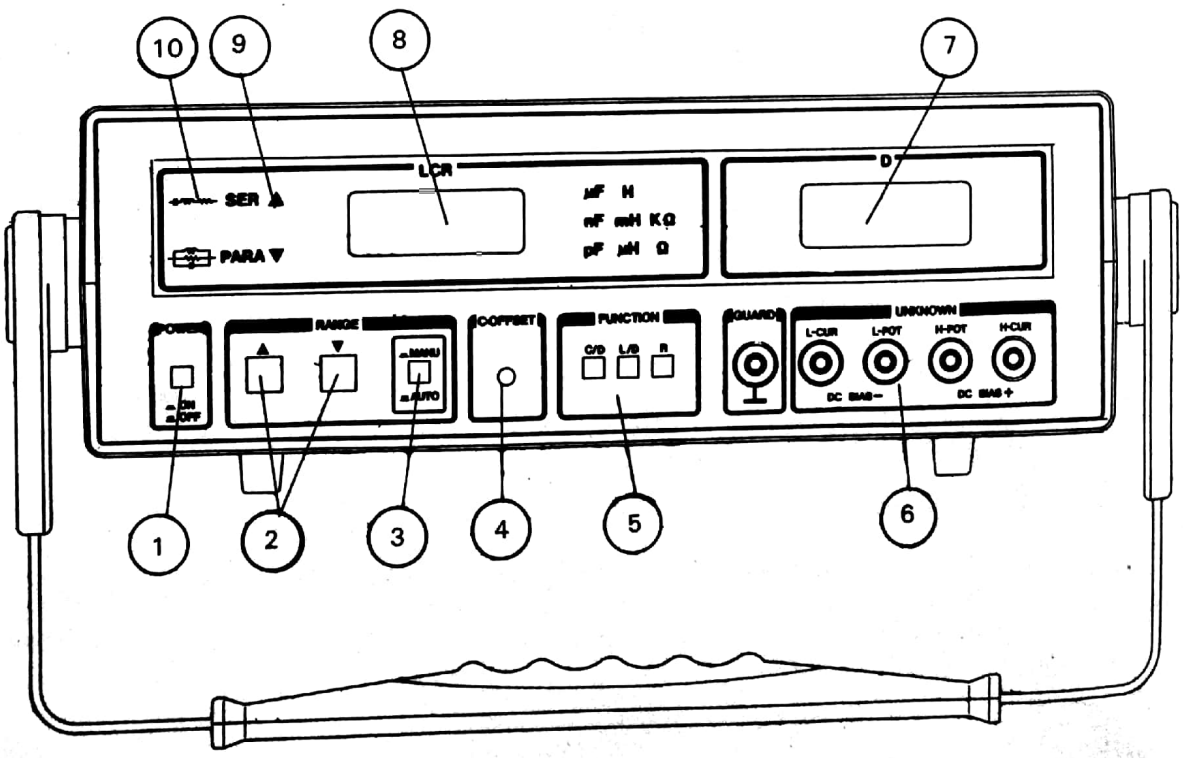


Fig. 3-1. Front Panel Features

(1) Power ON/Off Switch

When the power switch is put on, this unit is in operating condition.

(2) Range Switch

While keeping the range switch put on, the range rises up by one digit with each one push on △ button and falls down by one digit with each one push on ▽ button.

(3) Range Mode (Manual/Auto) Switch

When this switch is put off, the range is automatically selected and when the switch is put on, the range is fixed one that range which is selected at the moment.

(4) C-Offset Adjustment

When capacitance is measured, the stray capacitance of measuring jig, etc. can be erased.

(5) Measuring Parameter Switch (Function Switch)

Measuring circuit parameter selected.

FUNCTION	PARAMETER TO BE MEASURED
C/D	Capacitance and dissipation factor
L/D	Inductance and dissipation factor
R	Resistance

(6) UNKNOWN Terminal (Measuring Terminals)

This is the terminal to which the measuring object is connected. It consists of 4 terminals, H current terminal (H-CUR), H voltage terminal (H-POT), L current terminal (L-CUR) and L voltage terminal (L-POT). When Guard terminal is added, it consists of 5 terminals. Please take note that H-CUR is short-circuited to H-POT with shorting strap and L-CUR to L-POT, thus it consists of 3 terminals when the Meter is delivered from the maufacturer's factory. Therefore, please dis-connect them when you use it for the 4-terminal measurement. Besides, when the external bias is impressed with designated polarity from BIAS terminal on the rear panel + DC bias voltage is impressed on the side of H terminal.

(7) D Display

This displays dissipation factor. This display is blank when resistance is measured and when the count number of inductance or capacitance is below 180. When "D" value overflows, "1999" is displayed.

(8) LCR Display

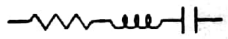
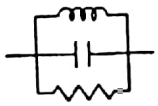
This displays inductance value, capacitance value and resistance value. These values are displayed with the decimal point and measuring unit in 3-1/2 digit. This display is blank when the count number is above 1999 or below 180 in case of the series mode (1.999μF range-1999μF range) for C/D measurement.

(9) Range Changeover Display

This displays the direction of range selection with manual range. When the optimum range is selected, neither △ nor ▽ lights up. When △ lights up, please raise the range up and when ▽ lights up, lower the range down. When △ lights up with automatic range, it indicates the over-range.

10) Measuring Mode Display

this displays measuring equivalent circuit.

SER		Series capacitance Series inductance Series resistance
PARA		Parallel capacitance

2) Rear Panel Features

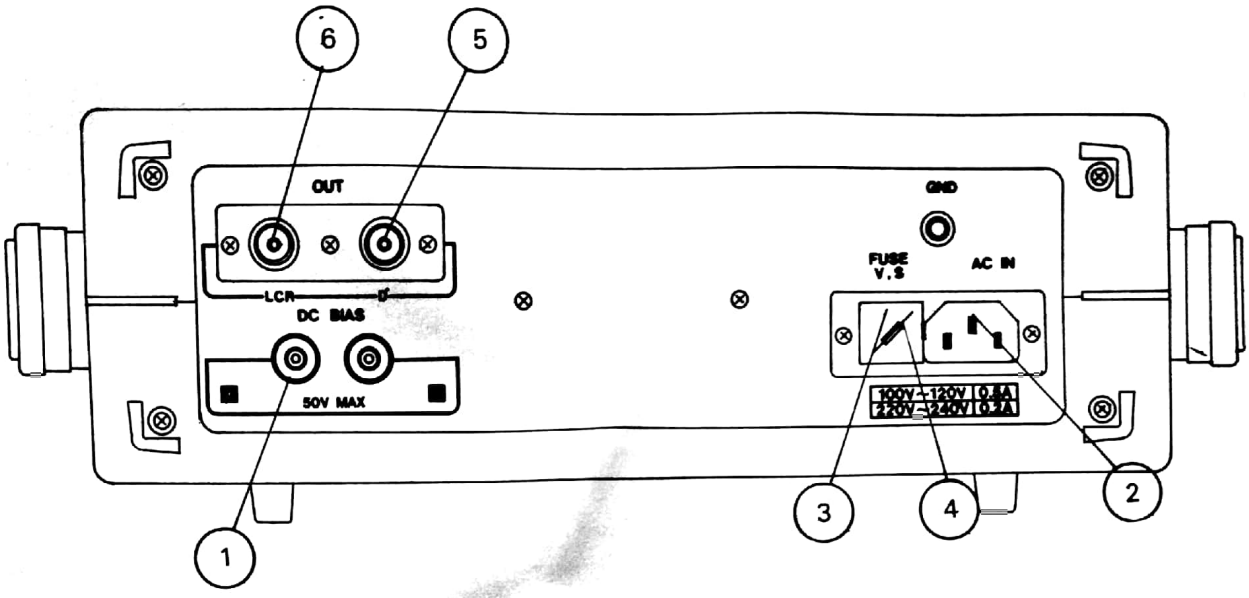


Fig. 3-2. Rear Panel Features.

(1) DC BIAS Terminal
The external DC voltage bias upto 50V is impressed on the measuring object through this terminal.

(2) Power Receptacle
AC 100V/120V/220V/240V is supplied through this connector.

(3) AC Line Voltage selector
It is possible to select AC supply voltage, 100V/120V/220V/240V.

(4) Fuse Holder
Please use 0.5A fuse for AC100V, 120V and 0.2A fuse for AC220V, 240V.

(5) D Analog DC Voltage Output
DC voltage proportional to D display is output.
(1.999/1999 count approx.)

(6) LC R Analog DC Voltage Output
DC voltage proportional to L, C or R display is output. (1.999/1999 count approx.)

3. MEASURING FIXTURE AND TEST LEADS

1) Connection of DUT. (Device Under Test)

The LCR Meter Unknown terminals consists of five binding post (type) connectors: HCUR, HPOT, LCUR, LPOT, and GUARD. By connecting the stationary shorting straps to appropriate terminals, the UNKNOWN terminals can be adopted for the desired measurement terminal configuration: the two, three, four or five terminal method.

2) 2-Terminal Method

For measurements of samples having a medium order of impedance (100Ω to 10kΩ), the convenient two terminal method is suited to measurement requirements for good accuracy as well as for ease in connecting the sample. When converting to two terminals, shorting straps are attached to the UNKNOWN HCUR and HPOT terminals, and LCUR and LPOT terminals, respectively.

3) 3-Terminal Method

High impedance samples (greater than 1kΩ)—which includes low capacitance, high inductance and high resistance—should be measured by the three terminal method to eliminate the effects of stray capacitances on the measurements. For this purpose, the guard conductor of the sample is connected to the instrument GUARD terminal.

4) 4-Terminal Method

In the measurement of low impedance samples (less than 1kΩ), efforts should be made to eliminate the effects of contact resistance, lead resistance, residual inductance and other residual parameters in the measuring apparatus. Four terminal configuration measurements allow stable, accurate measurement of high capacitance, low inductance and low resistance samples at minimum incremental errors in the measurement of low impedance samples. In the four terminal method, the shorting straps are disconnected to separate potential leads from current leads. Thereby, the characteristics of the sample can be precisely determined by the instrument irrespective of the various residual parameters present in the measuring signal current path. To ensure the best accuracy, the potential leads should be connected near to the sample.

5) 5-Terminal Method

The five terminal method, which adds the guard conductor to the four terminal configuration, expands the applicable measurement range into the higher impedance regiions. Thus, this method covers a broad range of measurements from low to high impedance samples.

6) Useable Test Fixture and Leads

When test fixture and test leads used have a shielding conductor and are designed to consider residual impedance, the measurement limitations described above for the individual terminal configurations can vary to some extent depending on the particular characteristics of the fixture and connections. Three accessories, the TF 100 Test Fixture, the TF 200 Test Leads, and the TF 300 Test Leads are available. The characteristics of these accessories and applicable measurement ranges are outlined in Figure 3-3. These accessories make it easy to construct the desired terminal configuration.

IMPORTANT!

FOR CERTAIN TERMINAL MEASUREMENT CONFIGURATIONS, THE HCUR TERMINAL MUST BE CONNECTED TO HPOT TERMINAL AND THE LCUR TERMINAL CONNECTED TO THE LPOT TERMINAL. OTHERWISE, THE DISPLAYS WILL HAVE NO MEANING AND THE LIFE OF THE RELAYS USED IN THE INSTRUMENT WILL SOMETIMES BE SHORTENED.

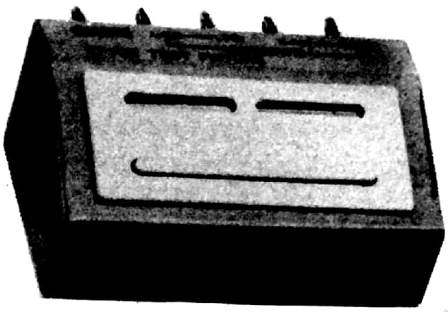
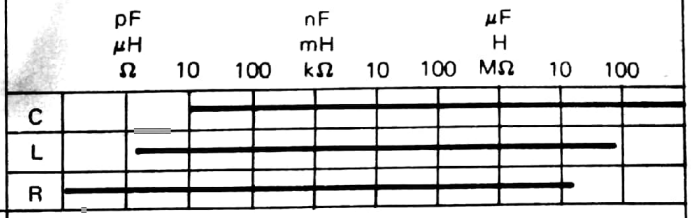
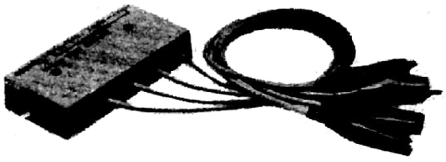
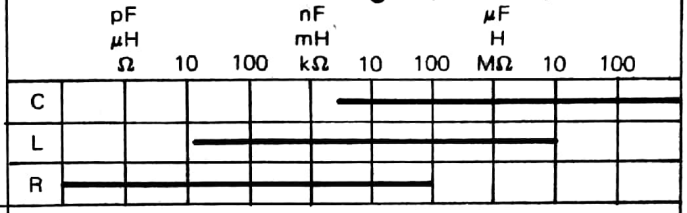
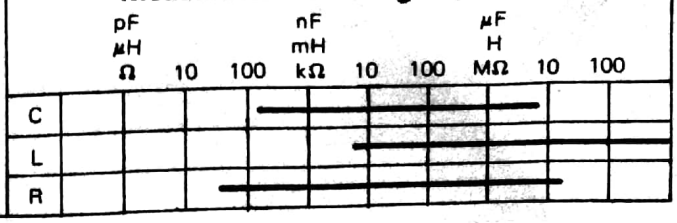
Accessory Model	Characteristics
TF 100 Text Fixture  Five terminal construction test fixture.	This fixture facilitates easy measurement of general type components with axial or vertical leads. To install fixture, disconnect shorting bars between high terminals and between low terminals. **DUT range (at 1kHz)** 
TF 200 Test Leads  Test Leads for four terminal measurement (Does not contain guard conductor).	The TF 200 is especially useful when measuring low impedances. DUT values measurable with the TF 200 are diagrammed below. If the measuring sample is more than approx. 300μF at 1kHz or less than approx. 100μH at 1kHz, it is recommended that the respective potential leads and current leads be twisted together. **Measurable DUT ranges (at 1kHz)** 
TF 300 Test Leads  Coaxial test leads with guard conductor for three terminal measurement.	The TF 300 is particularly useful when measuring high impedances. Dut Values measurable with the TF 300 are diagrammed below. This test lead set is not intended to be used for the accurate measurement of small capacitances (less than approx. 100pF) due to the residual capacitance of the leads. **Measurable DUT ranges (at 1kHz)** 

Fig. 3-3 Test Fixture and Leads.

4. BAGIC OPERATION

1) C/D Measurement

(1) Function switch (Measuring Parameter Switch) should be set on C/D.

(2) Under the condition that the measuring object is not connected to the measusring terminal, please adjust C-OFFSET with – driver so that LCR Display shows 00.0pF

(3) When the measurement is made with the external DC BIAS voltage is being impressed, please supply DC voltage to DC BIAS terminal on the rear panel after having confirmed the designated polarity. Please make sure that the external DC BIAS voltage more than 50V or with reverse polarity should never be impressed. Please be careful not to damage the instrument.

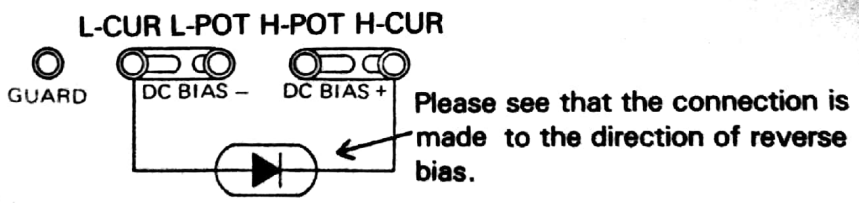
(4) When the measuring object is connected to the measuring terminal, LCR Display displays capacitance value and unit and D Display displays dissipation factor value.

(5) In case of C/D measurement, the range of 199.9pF-199.9nF is measured in parallel equivalent circuit mode and the range of 1.999μF-1999μF in series equivalent circuit mode. When the number of count is over 1999 with parallel equivalent circuit mode and below 180 or over 1999 with series equivalent circuit mode, both LCR Display and D Display are blank.

(6) When D Display is '1999' even if LCR Display is shown, LCR Display (capaciatance value) is void. In this case, Auto range is unstable and the phenomenon like the breakdown may be observed but the instrument is not out of order.

(7) When a big capacitance is measured with the external DC BIAS voltage being impressed, it takes time for the voltage on the measuring object to reach the impressed voltage. Unit the voltage on the measuring object becomes stable, the displayed value is unstable and the display flickers. So, please read the value after the display has become stable.

(8) For the measurement of junction capacitance of semiconductor the measurement should be made under the condition that bias voltage above DC 1V is impressed through the external bias terminal.

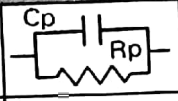
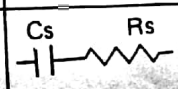


(9) When almost equal capacitance is measured continuously, you can save time for the change of range if you fix the range by putting on Range Mode Switch while the first measuring object is being measured.

(10) When the equivalent circuit of measuring mode is different, the measured value displays different value. For example, parallel capacitance (Cp) 1000pF with dissipation factor (D) 0.5 is equivalent to series capacitance (Cs) 1250pF at 1KHz.

When dissipation factor (D) is smaller than 0.01, the value of paraallel equivalent is almost equal to the value of series equivalent. Dissipation factor of a certain measuring object is same regardless of parallel equivalent and series equivalent provided that the frequency is fixed.

Conversion Equation for other mode:

Circuit Mode		Dissipation Factor	Conversion equation for Other Mode
Cp mode		$D = \frac{1}{2\pi fCpRp} \left(= \frac{1}{Q}\right)$	$Cs = (1 + D^2) \cdot Cp$, $Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Cs mode		$D = 2\pi fCsRs \left(= \frac{1}{Q}\right)$	$Cp = \frac{1}{1 + D^2} \cdot Cs$, $Rp = \frac{1 + D^2}{D^2} \cdot Rs$

f: Frequency of testing signal

The reciprocal of dissipation factor (D) is Q. Also D is sometimes expressed in the tan δ of dissipation angle.

(11) If a condenser to be measured is charged with voltage and the measurement is made on such a condenser, the LCR meter may be damaged. So, please discharge the voltage from a condenser prior to the measurement.

2) L/D Measurement

(1) Function Switch (Measuring Parameter Switch) should be set on L/D.

(2) When the measuring object with unknown value is measured. Range Mode Switch should be set on AUTO and the object be connected to the measuring terminal. Then the optimum range is automatically selected and inducatance value and D value are displayed.

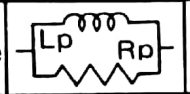
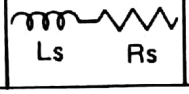
(3) When almost equal inductance is measured continuously, you can save time for the change of range if you fix the range by putting on Range Mode Switch while the first measuring object is being measured.

(4) When Function Switch is set improperly (for instance, in case of measuring capacitance of the object at L/D position), LCR Display shows "—". In this case, LCR Display and D Display are void. However, when LCR Display shows "—" about "000", it is normal.

(5) When D Display is 1999 even if LCR Display is shown, LCR Display (inductance value) is void. In this case, Auto range is unstable and the phenomenon like the breakdown may be observed but the instrument is not out of order.

(6) The measuring mode for L/D measurement is series equivalent circuit and if the equivalent circuit is different, the measured value displays different value. Please calculate the value of parallel equivalent circuit according to the equation below.

Conversion Equation for other mode:

Circuit Mode		Dissipation Factor	Conversion equation for Other Mode
Lp mode		$D = \frac{2\pi f Lp}{Rp} \left(= \frac{1}{Q}\right)$	$Ls = \frac{1}{1+D^2} \cdot Lp,\ Rs = \frac{D^2}{1+D^2} \cdot Rp$
Ls mode		$D = \frac{Rs}{2\pi fLs} \left(= \frac{1}{Q}\right)$	$Lp = (1+D^2) \cdot Ls,\ Rp = \frac{1+D^2}{D^2} \cdot Rs$

f: Frequency of testing signal

(7) With regard to an object like inductor with iron core which the measured value varies according to the measuring current, the measured value may be different from the value measured with other measuring instrument. So, please be careful about measuring condition. Besides, when such an object is measured with "Auto" of Range Mode Switch and the selection of range is made repeatedly and unsteadily, please set the optimum measuring range for the object with "MANU" of Range Mode Switch

(8) In case of L/D measurement, please make sure that the external BIAS voltage never be impressed.

3) R Measurement

(1) Function Switch should be set on R.

(2) When an object with unknown value is measured, Range Mode Switch should be set on AUTO and the object be connected to the measuring terminal. Then, the optimum range is automatically selected and resistance value is displayed on LCR Display. In this case, D Display is blank.

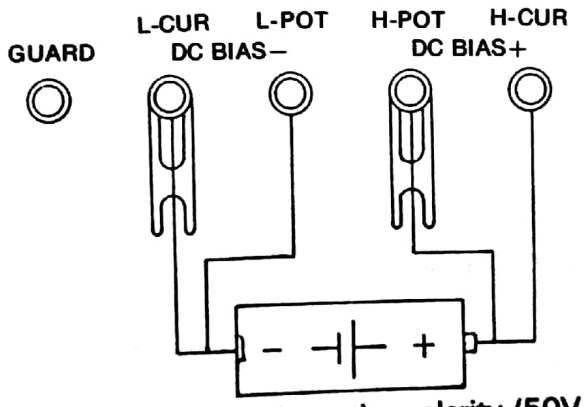
(3) When almost equal resistance is measured continuously, you can save time for the change of range if you fix the range by putting on Range Mode Switch to MANU while the first measuring object is being measured.

(4) Series resistance of electrolytic condenser, inductor and transformer can be measured with R measuring mode. In this case, it may happen that displayed number of digit is lessened. This resistance can also be measured with C/D or L/D mode and be calculated with the following equation.

$$Rs = D/wCs \quad \text{(Cs-D measurement)}$$
$$Rs = wLs \cdot D \quad \text{(Ls-D measurement)}$$

(5) When series resistance of inductor with iron core is measured, the range is unstable with AUTO of Range Mode Switch and the phenomenon like MANU of Range Mode Switch or calculate Rs according to the afore-mentioned equation in 3), 4) Measuring the resistance with L/D mode.

(6) When the internal resistance of an object having electromotive force like battery and cell is measured under the condition of non load, please be careful about the polarity and the connection should be made as per the following drawing. The measurement of an object having electromotive force of more than 50V may damage the instrument and cannoat be made. (In this case, Please make open BIAS connector on the back panel.)



Remarks: Be careful about the polarity (50V)

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