

sanwa®

LCR701

DIGITAL LCR METER

INSTRUCTION MANUAL



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[1] SAFETY PRECAUTIONS: Before use, read the following safety precautions

This instruction manual explains how to use your LCR701 digital LCR meter safely. Before use, please read this manual thoroughly to ensure correct and safe use. After reading it, keep it together with the product for reference to it when necessary.

Using this product in ways not specified in this manual may damage its protection function.

The instructions given under the headings of “ WARNING” and “ CAUTION” must be followed to prevent accidental burn and electrical shock.

1-1 Explanation of Warning Symbols

The meaning of the symbols used in this manual and attached to the product is as follows.

 : Very important instruction for safe use.

- The warning messages are intended to prevent accidents to operating personnel such as burn and electric shock.
- The caution messages are intended to prevent incorrect handling which may damage the product.

Symbols attached to the product

 : Refer to the instruction manual before use.

 : High voltage. Do not touch.

 : Double insulation or reinforced insulation

 : Ground

 : Resistance

 : Capacitance

 : Backlight

1-2 Warning Instructions for Safe Use

WARNING

The following instructions are intended to prevent injury such as electric shock and so on. These instructions must be followed.

1. Do not apply any voltage or current to the measuring terminals.
2. Never attempt to repair the instrument by yourself and ask the nearest Sanwa authorized agent, distributor, or service provider for repair.
3. Do not use the instrument if the meter or clip leads look damaged.
4. Never operate the meter with the case or battery lid removed.
5. Remove all lead wires from the instrument when replacing the battery.
6. Do not use any unspecified type of clip leads.
7. Do not touch any measuring terminals.
8. Do not operate the meter when it is wet or with wet hands.
9. Inspect the instrument at least once a year.
10. Use the instrument indoors.
11. Only the specified AC/DC adapter (AD-30-3) can be used with the instrument.

CAUTION

1. Do not apply any voltage or current to the measuring terminals.
2. Discharge before making capacitance measurement.
3. Incorrect measurement may be performed in a ferromagnetic or intense electric field near transformers, high-current circuits, or radio equipments.

[2] APPLICATIONS AND FEATURES

2-1 Applications

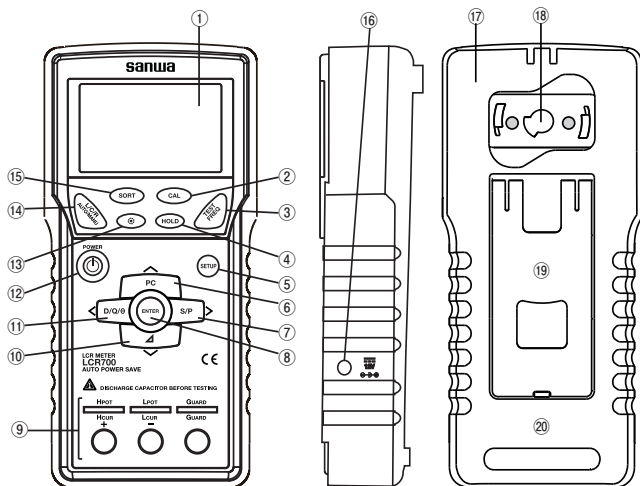
LCR701 is a full-featured high-performance handy LCR meter which rivals the capabilities and options of many of its bench counterparts. This instrument features a device value sorting function, allowing users to quickly sort passive devices in situations such as incoming inspections.

2-2 Features

- 20,000/2,000-count display
- Automatically selectable L/C/R measurement
- Selectable Series/Parallel mode
- Ls/Lp/Cs/Cp measurement with sub parameters (D/Q/θ/ESR)
- resistance DC function (7 ranges: 200.00 Ω ~ 200.0 M Ω)
- 5 different measuring frequencies (100/120/1 k/10 k/100 kHz)
- Measuring signal source level: 0.63 Vrms (Typical)
- Measurable ranges (ex. f=1 kHz)
 - L: 20.000 μ H ~ 20.000 kH
 - C: 200.00 pF ~ 20.00 mF
 - R: 20.000 Ω ~ 200.0 M Ω
- Multi-level low battery indication
- Auto Power Off (approx. 5 min.). *Only when using a battery
- Backlight to allow for easy visibility in low-lit area
- Automatic range selection
- Data hold
- Relative display
- Device Sorting mode to allow users to quickly sort passive devices such as L, C, and R
- Separately available companion software and LCR USB communication unit will allow you to transfer the measured data to your PC with ease.
- Accepts a single standard 9 V battery, and specified AC/DC adapter (AD-30-3) which is separately available.

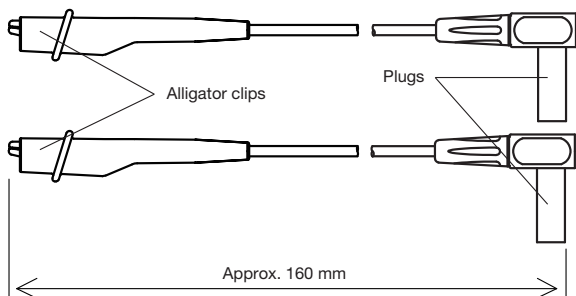
[3] PART IDENTIFICATION

3-1 LCR meter and clipping leads

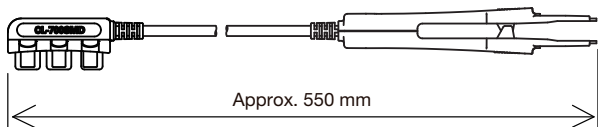


① LCD display	⑧ ENTER button	⑮ Device value sorting function button
② Calibration button	⑨ Measuring terminals	⑯ AC adapter inlet
③ Frequency selecting button	⑩ Relative button	⑰ Holster
④ Hold button	⑪ D/Q/θ/ESR/Rp selector button	⑱ LCR USB communication unit connector
⑤ Sorting mode setting button	⑫ POWER button	⑲ Stand
⑥ PC connection button	⑬ Backlight button	⑳ Battery lid
⑦ Series/Parallel selector button	⑭ LCR AUTO/MANUAL selector button	

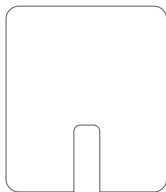
Clipping leads CL-700a (Bundled item)



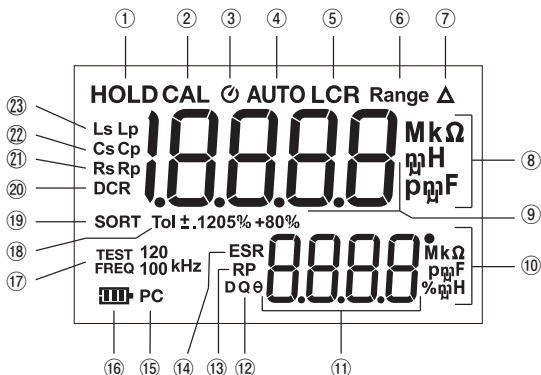
SMD Clipping leads CL-700SMD (Separately available accessory)



Shorting plate (Bundled item)



3-2 Display



①	Data hold indicator	⑬	Equivalent parallel resistance measurement operation indicator
②	OPEN/SHORT calibration mode indicator	⑭	Equivalent series resistance measurement operation indicator
③	Auto Power Off mode indicator	⑮	PC connection indicator
④	Series/Parallel mode automatic detection indicator	⑯	Battery capacity indicator
⑤	L/C/R automatic detection indicator	⑰	Measuring frequency indicator: 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz
⑥	Range setting indicator for the sorting mode	⑱	Tolerance indicator in sorting mode: ±0.25 %, ±0.5 %, ±1 %, ±2 %, ±5 %, ±10 %, ±20 %, -20 ~ +80 %
⑦	Relative display operation indicator	⑲	Sorting mode indicator
⑧	Unit of readings for main display	⑳	Series resistance measurement operation indicator
⑨	Main display	㉑	Resistance measurement operation indicator in series/parallel mode
⑩	Unit of readings for sub display	㉒	Capacitance measurement operation indicator in series/parallel mode
⑪	Sub display	㉓	Inductance measurement operation indicator in series/parallel mode
⑫	Indicator of Dissipation factor (D), Quality factor (Q) or Phase angle (θ) for L / C measurement mode		

[4] DESCRIPTION OF FUNCTIONS

4-1 Power Button

Press the **POWER** button to turn on the meter. All segments of the LCD display will be turned on for 2 seconds after power-on, and then the meter will be ready to use in the Auto LCR mode (described later). Press the **POWER** button again to turn off the meter. **[OFF]** will be indicated for 2 seconds when turning off.

4-2 Auto Power Off

When the meter is powered by the battery, Auto Power Off feature is active and  is shown on the display. The buzzer beeps four times (at approximately 10-second intervals over about 40 seconds) to give a warning. If no activity is made during this period, the buzzer will sound a continuous beep for the fifth time, **[OFF]** will be displayed, and the meter will automatically turn off.

To turn on the meter, press the **POWER** button again.

Note:

When the meter is powered through an AC/DC adapter, the Auto Power Off feature is inactive.

4-3 Buzzer

Whenever an available button is pressed in the function, the buzzer beeps one time to indicate the meter has accepted the command. Pressing an unavailable button makes the buzzer beep two times. The buzzer cannot be disabled.

4-4 Low Battery Indication

The battery condition is continuously indicated.  means that the battery capacity is full.  means that battery power is low and the battery needs to be replaced. Replace the battery with new one. If you use the instrument under "Low battery", it will beep twice and show **[bAtt]**, then turn power off.

4-5 Measuring Mode Selection

4-5-1 Auto LCR Mode

After power-on, the meter is in the Auto LCR mode as a default setting, and shows **[AUTO LCR]** on the display. The meter automatically selects a function, parameter, and series/parallel mode. The function and the sub parameter on the sub display will be selected based on the following conditions.

Conditions for automatic selection of functions and sub parameters.

θ	Functions	Sub parameters	Example
$-11.3^\circ \leq \theta \leq 11.3^\circ$	Resistance	θ	Fig. 4-5-1-1
$\theta > 11.3^\circ$	Inductance	Q	Fig. 4-5-1-2
$\theta < -11.3^\circ$	Capacitance	D	Fig. 4-5-1-3

If $C < 5 \text{ pF}$, R_p is shown on the sub display.

Selection of series/parallel mode depends on the total equivalent impedance measured. (Refer to 4-7)

Note:

S/P button and **D/Q/ θ** button are not available in the Auto LCR mode.



Fig. 4-5-1-1



Fig. 4-5-1-2

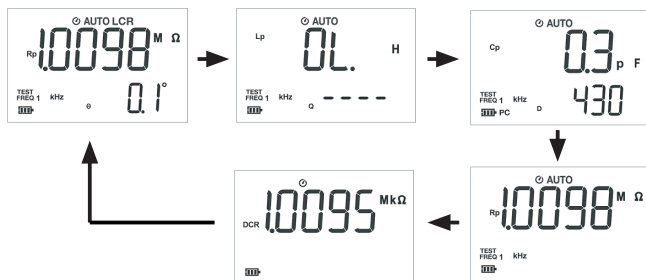


Fig. 4-5-1-3

4-5-2 Manual LCR Mode and DC Resistance Measurement

As already described, the default setting is the Auto LCR mode after power-on, the main function can be switched to the manual LCR mode or DC resistance mode by pressing the **L/C/R AUTO/MANU** button. Pressing this button ($\Rightarrow$) sequentially switches the functions as follows. Auto LCR mode $\Rightarrow$ Ls or Lp function $\Rightarrow$ Cs or Cp function $\Rightarrow$ Rs or Rp function $\Rightarrow$ DCR function $\Rightarrow$ Auto LCR mode

Example of resistance measurement



In the manual LCR mode, the meter automatically selects the series/parallel mode depending on the total equivalent impedance measured similarly to the Auto LCR mode. (Refer to 4-7)

The function of Ls, Lp, Cs, or Cp in the manual LCR mode shows following parameters, being switched by pressing **D/Q/θ** button.

Functions	Selectable parameters
Ls, Cs	Dissipation factor (D), Quality factor (Q), Equivalent series resistance (ESR), and Phase angle (θ)
Lp, Cp	Dissipation factor (D), Quality factor (Q), Equivalent parallel resistance (Rp), and Phase angle (θ)

Note:

- Usually quality factor (Q) is used for inductance measurement. Inductor with higher Q has lower resistance component. Usually dissipation factor (D) is used for capacitance measurement. Capacitor with lower D has lower resistance component.

Quality factor (Q)

= Inductance (L) component / Resistance (R) component

Dissipation factor (D)

= Resistance (R) component / Capacitance (C) component

- ESR is used for measuring equivalent series resistance of a capacitor under a measuring frequency.



Example

4-6 Measuring Frequency Selection

The meter provides 5 different frequencies

(100 Hz/120 Hz/1 kHz/10 kHz/100 kHz)

for more accurate measurement.

The default setting is 1 kHz, and the measuring frequency can be selected by pressing the **TEST FREQ** button as follows.

1 kHz $\Rightarrow$ 10 kHz $\Rightarrow$ 100 kHz $\Rightarrow$ 100 Hz $\Rightarrow$ 1 kHz

Note:

The LCR impedance scale ranges and accuracies depend on the measuring frequency.

Refer to the accuracy table in 8-2.

4-7 Series/Parallel Mode

When measuring L/C/R with multiple element in its equivalent circuit, an appropriate measuring mode needs to be selected, assuming actual circuit to be measured.

Select the series mode if a series circuit is assumed, or select the parallel mode if a parallel circuit is assumed.

In the Auto LCR mode or manual LCR mode, the meter automatically selects the series/parallel mode depending on the total equivalent impedance measured. (The display shows **[AUTO]**.)

10 k Ω and lower: Series mode (Ls/Cs/Rs)

Higher than 10 k Ω : Parallel mode (Lp/Cp/Rp)

In the manual LCR mode, pressing **S/P** button manually switches assumed series/parallel mode.

When manually selecting series/parallel mode, the display turns **[AUTO]** off.

4-8 Auto Range Selection

A measuring range in each function will be automatically selected, and cannot be manually selected.

4-9 Data Hold

Press **HOLD** button to freeze present reading for later view. (The display shows **[HOLD]**.) Even if the DUT is disconnected from the measuring terminal, the current reading will remain on the display.

Press the **HOLD** button again to disable the data hold feature and go back to the normal measurement mode. (The display turns **[HOLD]** off.)

Note:

When the reading is indefinite, the data hold feature is not available.

4-10 Relative Display

Relative display allows you to read directly the deviation in % from a reference value.

Pressing the Δ button activates the relative mode, and the display turns **[Δ]** on.

Note:

This function is not available in the Auto LCR mode.

Nor can it be activated when the reading is outside of the meter limits (Ex. **[OL]** is displayed.).

The meter uses the following formula to calculate relative displays.

$$\text{REL\%} = (\text{DCUR} - \text{DREF}) / \text{DREF} * 100\%$$

REL% = Difference in percent

DCUR = Device currently under test

DREF = Device used as a reference

To enter the relative mode, proceed as follows.

1. Perform the OPEN/SHORT calibration. (Refer to 4-11).
 2. Select a function from L, C, R, or DCR.
 3. Connect a device to the measuring terminals as a reference and wait until the readings become stable.
 4. Press the Δ button to save the reading as a reference value.
- Now, the display indicates **[Δ]**, and the sub display shows **[0.0%]**.



5. Remove the reference device, then connect a DUT to the measuring terminals.

The main display shows the value of the DUT and the sub display shows the difference from the reference in %.

Pressing the Δ button again shows the reference value saved in the previous step. You can check the reference value. (**[Δ]** is blinking.)

Pressing the Δ button again allows you to measure in the relative mode.

6. Repeat Step 5 for each DUT.

Note: The range for the difference in percent is -99.9% to 99.9%.

If the DUT falls outside that range, the sub display will show **[OL]**.

7. To exit this mode, press the Δ button for 2 seconds.

4-11 OPEN/SHORT Calibration

The OPEN/SHORT calibration before measurement reduces the parasitic effect of the test fixture to get better accuracy especially for high/low impedance measurement. (For the calibration principle, see 4-15-3.)

Procedure of the OPEN/SHORT calibration

This section explains how to perform the OPEN/SHORT calibration for a measurement using the directly connectable measuring terminals, and one for a measurement using the clipping leads "CL-700a". (Perform the OPEN/SHORT calibration according to each procedure.)

[Measurement using the directly connectable measuring terminals]

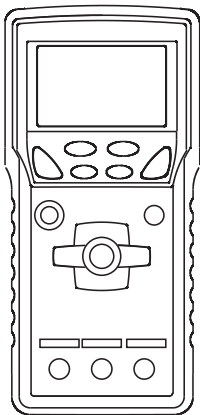
1. Press the **CAL** button for 2 seconds.

The display shows **[OPEN]**.



2. Press the **CAL** button again.

The meter shows a countdown on the display while it performs the OPEN calibration. It takes 30 seconds to complete.



After the countdown is complete, the display should show **[PASS]**.



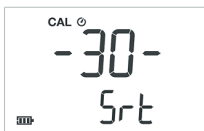
3. Insert the bundled shorting plate to the directly connectable measuring terminals.

4. Press the **CAL** button again.

The display shows **[Srt]**.

5. Press the **CAL** button again.

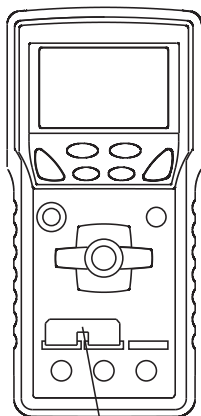
The meter shows a countdown on the display while it performs the SHORT calibration. It takes 30 seconds to complete.



After the countdown is complete, the display should show **[PASS]**.



If the display shows **[FAIL]**, this procedure has to be performed again.

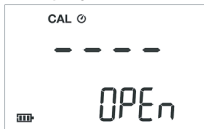


Shorting plate

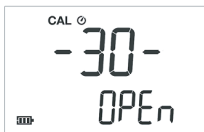
6. Press the **CAL** button once again to exit the OPEN/SHORT calibration mode.

[Measurement using the clipping leads "CL-700a"]

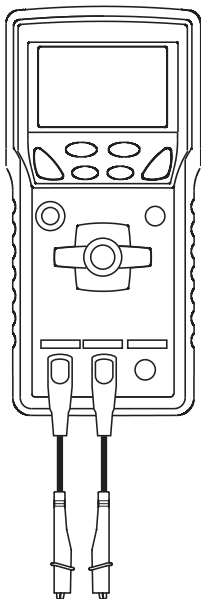
1. Insert the red and black clipping leads into the measuring terminals on the LCR meter as shown in the figure, and leave the clips open.
2. Press the **CAL** button for 2 seconds. The display shows **[OPEn]**.



3. Press the **CAL** button again. The meter shows a countdown on the display while it performs the OPEN calibration. It takes 30 seconds to complete.



After the countdown is complete, the display should show **[PASS]**.



4. Connect the test leads to make a short circuit.
5. Press the **CAL** button again.
The display shows **[Srt]**.
6. Press the **CAL** button again.
The meter shows a countdown on the display while it performs the SHORT calibration. It takes 30 seconds to complete.



After the countdown is complete, the display should show **[PASS]**.

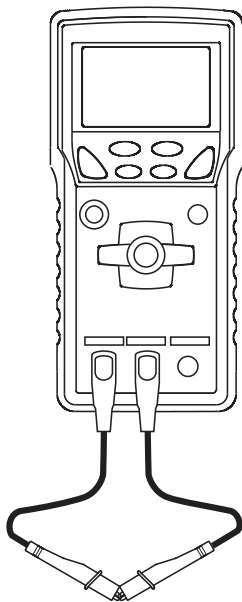


If the display shows **[FAIL]**, this procedure has to be performed again.



7. Press the **CAL** button once again to exit the OPEN/SHORT calibration mode.

For measurement using the SMD clipping leads "CL-700SMD" (separately available accessory), the same procedure as above can be taken to perform the OPEN/SHORT calibration.



4-12 Device Sorting

The meter can sort device values into PASS/FAIL based on resistance, capacitance, or inductance. This feature is useful in situations such as incoming inspections for mass production parts.

Note:

This function is not available in the Auto LCR mode.

Use this function in the manual LCR mode.

For details, refer to 5-5.

4-13 Backlight

To turn the Backlight on, press  button.

To turn it off, press  button again.

The Backlight is disabled automatically after the meter is inactive for 60 seconds.

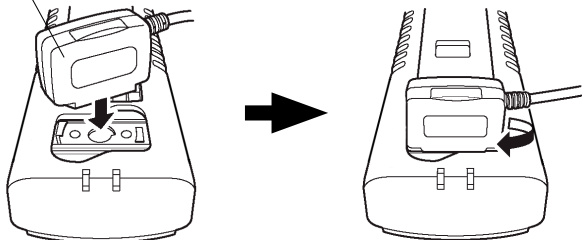
4-14 PC (Personal Computer) Interface

The instrument equips with an IR interface port at the meter back for data communication. LCR-USB or LCR-USB2, LCR USB communication unit for LCR (separately available accessory), and the dedicated software (download for free from our website) allow you to transfer real time readings to your PC and save them.

The connecting procedure is as follows.

1. Snap on LCR-USB or LCR-USB2 and connect the USB plug to your PC on which the dedicated software is running.

LCR USB communication unit
(LCR-USB or LCR-USB2)



LCR USB communication unit connection

The display shows the readings.



2. Press the **PC** button.

The display shows **[PC]** to indicate PC connection is active.



3. To make the PC connection inactive, press **PC** button again.



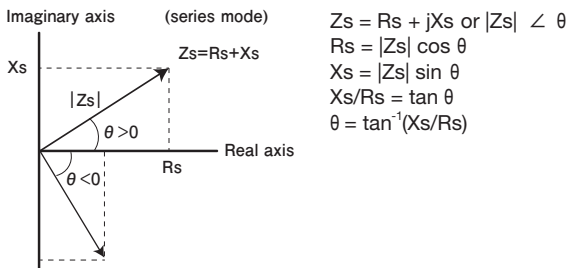
The display turns **[PC]** off to indicate the PC connection is inactive.

4-15 MEASURING PRINCIPLES

4-15-1 What is impedance?

Impedance Z extends the concept of resistance to AC, which is mathematically handled as a vector quantity on a complex plane.

As shown, the impedance vector consists of the real part (the resistance R) and the imaginary part (the reactance X). Series impedance Z_s can be represented as $R_s + jX_s$ in Cartesian form, and also can be represented as $|Z_s| \angle \theta$ (magnitude and phase angle) in the polar form. The figure shows a mathematical relationship between R_s , X_s , $|Z_s|$, θ .



There are two types of reactance. One is inductive reactance X_L , and the other is capacitive reactance X_C .

If $\theta > 0$, the reactance is inductive. If $\theta < 0$, the reactance is capacitive.

The inductive reactance (X_L) and the capacitive reactance (X_C) can be defined as follows.

$$X_L = 2\pi fL$$

$$X_C = 1 / (2\pi fC)$$

where:

L = Inductance

C = Capacitance

f = signal frequency

4-15-2 Impedance measurement

Impedance can be measured in series or in parallel.

In parallel mode, impedance can be represented as reciprocal of admittance (Y).

The admittance can be defined as $Y = G + jB$.

where: G = Conductance B = Susceptance

Series impedance



$$Z = R_s + jX_s$$

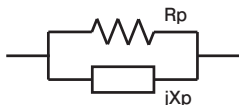
R_s = Series resistance

X_s = Series reactance

C_s = Series capacitance

L_s = Series inductance

Parallel admittance



$$Y = 1/Z = 1/R_p + 1/jX_p = G + jB$$

R_p = Parallel resistance

X_p = Parallel reactance

C_p = Parallel capacitance

L_p = Parallel inductance

	Series	Parallel	Dissipation factor
Capacitance	$C_s = C_p(1+D^2)$	$C_p = C_s/(1+D^2)$	$D = R_s/X_s = \omega C_s R_s$ $D = G/B = G/(\omega C_p) = 1/(\omega C_p R_p)$
Inductance	$L_s = L_p/(1+D^2)$	$L_p = L_s(1+D^2)$	$D = R_s/X_s = R_s/(\omega L_s)$ $D = G/B = \omega L_p G = \omega L_p R_p$
Resistance	$R_s = R_p D^2/(1+D^2)$	$R_p = R_s(1+D^2)$	—
$Q = X_s/R_s = 2\pi f L_s/R_s = 1/2\pi f C_s R_s$ $Q = B/G = R_p/ X_p = R_p/2\pi f L_p = 2\pi f C_p R_p$			

To understand the ratio of resistance and reactance, it is important to consider Quality factor (Q) and Dissipation factor (D). Usually, Q is used when measuring inductance and D is used when measuring capacitance. Q is defined as the reciprocal of D.

$$Q = 1/D = \tan \theta$$

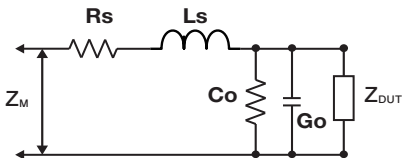
Both R_s and R_p are part of the equivalent circuit of capacitors and inductors.

To measure capacitance and inductance, refer to the settings as shown in the table below.

	Value	Setting
Capacitance	Low	Parallel
	High	Series
Inductance	Low	Series
	High	Parallel

For details, refer to 4-7.

4-15-3 Principle of OPEN/SHORT calibration



Z_M is defined as total impedance measured to a DUT by a test fixture which has some parasitic impedance.

$$Z_M = (R_s + j\omega L_s) + ((G_o + j\omega C_o)^{-1} // Z_{DUT})$$

Z_{DUT} is impedance of the DUT.

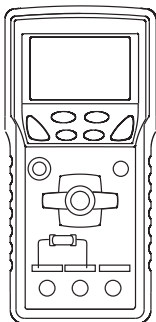
The OPEN/SHORT calibration reduces the effect of $(R_s + j\omega L_s)$ and $(G_o + j\omega C_o)$.

[5] MEASURING PROCEDURE

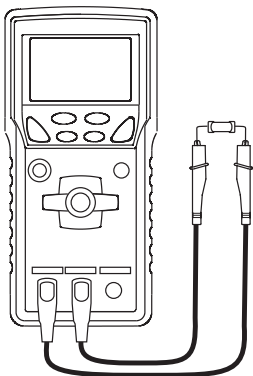
5-1 Connection of DUT (Device Under Test)

DUT's (Devices Under Test) may be connected to the meter as follows.

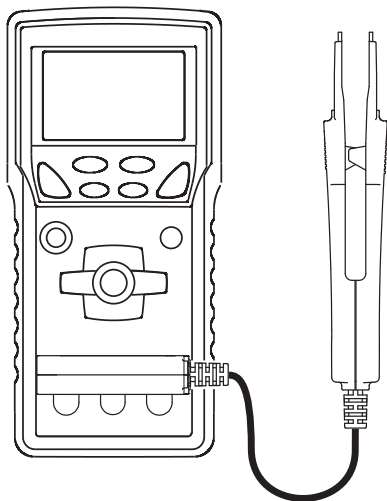
- Directly insert axial or radial component leads to the directly connectable measuring terminals.



- Attach the clipping leads "CL-700a" (bundled item).



- Attach the SMD clipping leads "CL-700SMD" (separately available accessory).



CL-700SMD Electrical Characteristics

Parameter	Measurement Condition	100/120 Hz	1 kHz	10 kHz	100 kHz
Resistance: Rs	Clip opened	< 0.05 Ω	< 0.10 Ω	< 0.10 Ω	< 0.10 Ω
Capacitance: Cp	Clip closed	< 5.0 pF	< 5.0 pF	< 5.0 pF	< 5.0 pF
Inductance: Ls	Clip closed	< 1.0 μ H	< 1.0 μ H	< 0.5 μ H	< 0.5 μ H

- Temperature: 23 $^{\circ}$ C $\pm$ 5 $^{\circ}$ C , Humidity: $\leq$ 80 % R.H.

The guard line provides a shield for DUT, preventing interference when measuring high-impedance devices.

5-2 Pre-operational Check

WARNING

1. Do not use the instrument if the meter or the clipping leads look damaged.
2. Make sure the clipping leads are not broken.

CAUTION

- Make sure the battery condition is good after power-on. Replace the battery with new one if the battery power is low.
- The directly connectable measuring terminals accept axial or radial component leads up to 1.0 mm in diameter. Inserting thicker leads may damage the measuring terminals.

Perform the OPEN/SHORT calibration before measurement to ensure the safety and the accuracy.

For details, refer to 4-11.

5-3 Auto LCR Mode Measurement

WARNING

1. Do not apply any voltage or current to the measuring terminals.
2. Measuring live circuit may damage the meter.
3. Do not touch any metal part of the clipping leads nor the leads of the DUT while measuring.

CAUTION

- Discharge the capacitor before any measurement.

1) Measuring ranges

L: 20.000 μ H $\sim$ 2000 H (auto-range)

C: 200.00 pF $\sim$ 20.00 mF (auto-range)

R: 20.000 Ω $\sim$ 200.0 M Ω (auto-range)

2) Measuring procedure

- ① Press the POWER button to turn the meter on.
- ② Press the **TEST FREQ** button to select a measuring frequency.
- ③ Connect a DUT to the measuring terminals.
- ④ Read the display.

Note: D/Q/ θ /ESR/Rp button is not available.



Examples

5-4 Manual LCR Mode measurement

WARNING

1. Do not apply any voltage or current to the measuring terminals.
2. Measuring live circuit may damage the meter.
3. Do not touch any metal part of the clipping leads nor the leads of the DUT while measuring.

CAUTION

- Discharge the capacitor before any measurement.

The meter will be in Auto LCR mode after power-on.

Pressing the **L/C/R AUTO/MANU** button switches to Manual LCR mode and this button allows you to select the L/C/R as follows.

Auto LCR mode $\Rightarrow$ Ls or Lp $\Rightarrow$ Cs or Cp $\Rightarrow$ Rs or Rp $\Rightarrow$ DCR
 $\Rightarrow$ Auto LCR mode

(Above each function except Auto LCR mode is in Manual mode.)

5-4-1 Inductance (L) measurement

1) Measuring ranges

L: 20.000 μ H $\sim$ 2000 H (auto-range)

2) Measuring procedure

- ① Press the **L/C/R AUTO/MANU** button to select Ls or Lp function.
- ② Press the **TEST FREQ** button to select a measuring frequency.
- ③ Press the **S/P** button to select Ls or Lp.
- ④ Connect a DUT to the measuring terminals.
- ⑤ Press the **D/Q/ θ /ESR/Rp** button to select a sub parameter.

The sub parameter in the Ls function includes Q, ESR, θ , and D.

The sub parameter in the Lp function includes Q, Rp, θ , and D.

- ⑥ Read the display.



Example

5-4-2 Capacitance (C) measurement

1) Measuring ranges

C: 200.00 pF ~ 20.00 mF (auto-range)

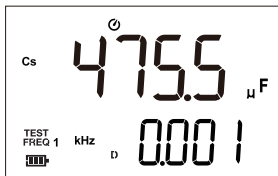
2) Measuring procedure

- ① Press the **L/C/R AUTO/MANU** button to select Cs or Cp function.
- ② Press the **TEST FREQ** button to select a measuring frequency.
- ③ Press the **S/P** button to select Cs or Cp.
- ④ Connect a DUT to the measuring terminals.
- ⑤ Press the **D/Q/θ/ESR/Rp** button to select a sub parameter.

The sub parameter in the Cs function includes D, Q, ESR, and θ .

The sub parameter in the Cp function includes D, Q, Rp, and θ .

- ⑥ Read the display.



Example

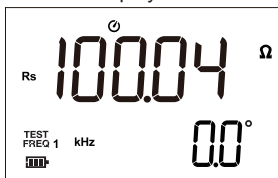
5-4-3 Resistance (R) measurement

1) Measuring ranges

R: 20.000 Ω ~ 200.0 M Ω (auto-range)

2) Measuring procedure

- ① Press the **L/C/R AUTO/MANU** button to select Rs or Rp function.
- ② Press the **TEST FREQ** button to select a measuring frequency.
- ③ Press the **S/P** button to select Rs or Rp.
Any sub parameter will not be shown.
- ④ Connect a DUT to the measuring terminals.
- ⑤ Read the display.



Example

5-4-4 DC Resistance measurement

1) Measuring ranges

R: 200.00 Ω ~ 200.0 M Ω (auto-range)

2) Measuring procedure

- ① Press the **L/C/R AUTO/MANU** button to select DCR function.
- ② Connect a DUT to the measuring terminals.
- ③ Read the display.



Example

5-5 Device Value Sorting

1) Measuring ranges

L: 20.000 μ H $\sim$ 2000 H (auto-range)

C: 200.00 pF $\sim$ 20.00 mF (auto-range)

R: 20.000 Ω $\sim$ 200.0 M Ω (auto-range)

2) Setting and Measuring procedure

① Perform the OPEN/SHORT calibration.

For details, refer to 4-11.

(The OPEN/SHORT calibration is recommended for more accurate measurement.)

② Press **L/C/R AUTO/MANU** button to select an appropriate manual measurement function.

This button allows you to select it as follows.

Auto LCR mode $\Rightarrow$ Ls or Lp $\Rightarrow$ Cs or Cp $\Rightarrow$ Rs or Rp $\Rightarrow$ DCR
 $\Rightarrow$ Auto LCR mode

Note:

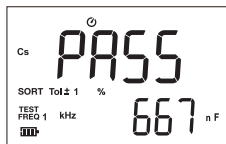
- The sorting mode is not available in the Auto LCR mode.
- **S/P** button allows you to select the series mode (Ls/Cs/Rs) or the parallel mode (Lp/Cp/Rp).

The TEST FREQ button allows you to select the measuring frequency.

③ Connect a device to the measuring terminals as a reference.

After the reading has stabilized, press the **SORT** button to activate the sorting mode, and the reading will be saved as a reference.

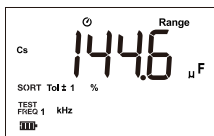
[PASS] will be indicated as shown below.



Note:

If you press the **SORT** button while the meter is reading outside limits (OL) or while the reading is less than 200 counts, the sorting mode is not available.

④ To set the decimal point, range, or tolerance against the reference value, press the **SETUP** button. The saved reference value will be shown on the display.

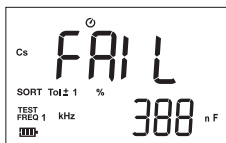
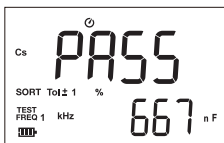


The following shows how to set up the details of the sorting mode.

- Use < button (D/Q/θ/ESR/Rp button) or > button (S/P button) to adjust the position of the decimal point as necessary. Press the **ENTER** button when finished.
- Use the <, ^ (PC button), ∇ (Δ button), and > buttons to adjust the digits of the reference value (setting range: 0002 to 1999) as necessary. Press the **ENTER** button when finished.
- Use < and/or > keys to adjust the tolerance as necessary. The tolerance options will be indicated sequentially as follows.
±0.25 %, ±0.5 %, ±1 %, ±2 %, ±5 %, ±10 %, ±20 %, -20 % ~ +80 %
Press the **ENTER** button when finished.

Now, the devices can be sorted.

- The main display will show either **[PASS]** or **[FAIL]** as each device is measured. The sub display will show the value of the measured component, as shown in the examples below.



Examples

- L/C/R AUTO/MANU button, D/Q/θ/ESR/Rp button, Δ button, S/P button, and **HOLD** button will be unavailable while the instrument is in the sorting mode.

- To exit the sorting mode, press the **SORT** button.

LCR-USB or LCR-USB2, LCR USB communication unit for LCR (separately available accessory), and the dedicated software allow you to record the test results in your PC.

[6] MAINTENANCE



WARNING

1. This section is very important for safety. Read and understand the following descriptions thoroughly and maintain your instrument properly.
2. The instrument must be calibrated and inspected at least once a year to maintain the safety and accuracy.

6-1 Maintenance and Inspection

1) Appearance:

Is the instrument not damaged due to falling or other cause?

2) Test leads:

Are the test leads not damaged or the core wires not exposed from the test leads?

If any of the above problems exists, stop using the instrument and request for repair.

6-2 Calibration

For more information, please contact Sanwa's authorized agent / distribution service provider, listed on our website. (See 7-3.)

6-3 Cleaning and Storage



CAUTION

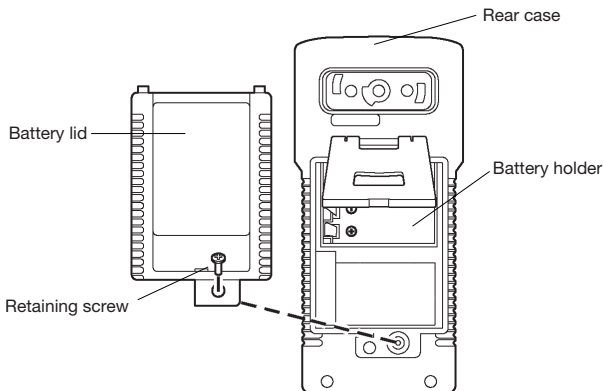
1. The main unit is not resistant to volatile solvent and must not be cleaned with thinner or alcohol. For cleaning, use dry, soft cloth and wipe it lightly.
2. The main unit is not resistant to heat. Do not place it near heat-generating devices.
3. Do not store the instrument in a place where it may be subjected to vibration or where it may fall.
4. Do not store the instrument in places under direct sunlight, or hot, cold or humid places or places where condensation is anticipated.
5. If the instrument will not be used for a long time, be sure to remove the battery.

6-4 Battery Replacement

WARNING

1. To avoid electric shock, do not remove the battery lid while an input is applied to the measured terminal or during measurement.
2. Make sure that the POWER button is set to OFF before replacing the battery.

- ① Remove the holster and loosen the battery lid retaining screw (x 1) with a Phillips screwdriver.
- ② When the battery lid lifts up, remove it from the unit.
- ③ Replace the battery in the battery holder with a new one while paying attention the polarity.
- ④ Attach the battery lid and retaining screw in the original positions.



[7] AFTER-SALE SERVICE

7-1 Warranty and Provision

Sanwa offers comprehensive warranty services to its end-users and to its product resellers. Under Sanwa's general warranty policy, each instrument is warranted to be free from defects in workmanship or material under normal use for the period of one (1) year from the date of purchase.

This warranty policy is valid within the country of purchase only, and applied only to the product purchased from a Sanwa authorized agent or distributor.

Sanwa reserves the right to inspect all warranty claims to determine the extent to which the warranty policy shall apply. This warranty shall not apply to disposables batteries, or any product or parts, which have been subject to one of the following causes:

1. A failure due to improper handling or use that deviates from the instruction manual.
2. A failure due to inadequate repair or modification by people other than Sanwa service personnel.
3. A failure due to causes not attributable to this product such as fire, flood and other natural disaster.
4. Non-operation due to a discharged battery.
5. A failure or damage due to transportation, relocation or dropping after the purchase.

7-2 Repair

Customers are asked to provide the following information when requesting services:

1. Customer name, address, and contact information
2. Description of problem
3. Description of product configuration
4. Model Number
5. Product Serial Number
6. Proof of Date-of-Purchase
7. Where you purchased the product

Please contact a Sanwa authorized agent / distributor / service provider, listed in our website, in your country with above

information. An instrument sent to a Sanwa / agent / distributor without above information will be returned to the customer.

Note:

- 1) Prior to requesting repair, please check the following:
Capacity of the built-in battery, polarity of installation and discontinuity of the test leads.
- 2) Repair during the warranty period:
The failed meter will be repaired in "7-1 Warranty and Provision" conditions stipulated in 8-1 Warranty and Provision.
- 3) Repair after the warranty period has expired:
In some cases, repair and transportation cost may become higher than the price of the product. Please contact a Sanwa authorized agent / service provider in advance.
The minimum retention period of service functional parts is six (6) years after the discontinuation of manufacture. This retention period is the repair warranty period. Please note, however, if such functional parts become unavailable for reasons of discontinuation of manufacture, etc., the retention period may become shorter accordingly.
- 4) Precautions when sending the product to be repaired:
To ensure the safety of the product during transportation, place the product in a box that is larger than the product 5 times or more in volume and fill cushion materials fully and then clearly mark "Repair Product Enclosed" on the box surface. The cost of sending and returning the product shall be borne by the customer.

7-3 SANWA Website

<http://www.sanwa-meter.co.jp>

E-mail: exp_sales@sanwa-meter.co.jp

[8] SPECIFICATIONS

8-1 General Specifications

LCD display (with Backlight)	Main display	20,000 counts: Ls / Lp / Cs / Cp / Rs / Rp / DCR
	Sub display	2,000 counts: D/Q/θ/ESR/RP
Over-range indication	While the meter is reading outside limits, numeric part of the display indicates [OL] .	
Battery power indication	4 levels	
Measurable parameters	Ls / Lp / Cs / Cp / Rs / Rp / DCR (including D/Q/θ/ESR/RP)	
Measuring mode	Series / Parallel	
Range selection	Automatic	
Measuring terminals	4 terminals plus guard shielding Accepts the plugs of the clipping leads.	
Auto LCR measurement ranges	L: 20.000 μ H ~ 20.000 kH C: 200.00 pF ~ 20.00 mF R: 20.000 Ω ~ 200.0 M Ω	
DCR measurement ranges	R: 200.00 Ω ~ 200.0 M Ω	
Measuring frequencies	100 Hz / 120 Hz / 1 kHz / 10 kHz / 100 kHz	
Measurement rate	1.2 times / second (LCR mode) 0.5 times / second (DCR mode)	
Selectable tolerances	± 0.25 %, ± 0.5 %, ± 1 %, ± 2 %, ± 5 %, ± 10 %, ± 20 %, -20 % ~ $+80$ %	
Measuring signal level	0.63 Vrms (nominal), 0.9 Vdc (nominal)	
Operating conditions	Altitude: < 2,000 m Pollution degree: II	
Specification guaranteed temperature/ humidity	18 ~ 28 $^{\circ}$ C < 80 % RH	

Temperature coefficient	[0.15 x (specified accuracy)] / °C 0 ~ 18 °C , 28 ~ 50 °C	
Operating temperature/humidity	0 ~ 50 °C < 80 % RH	
Storage temperature/humidity	-20 ~ 60 °C < 80 % RH	
EMC directive, RoHS directive	IEC61326-1(EMC), EN50581(RoHS) Under a condition field strength CS 3 V (0.15-80 MHz): The following shows a total accuracy of the DC resistance measurement. Total accuracy = specified accuracy ± 150 dgt In other ranges or a condition which is worse than the above-described condition, the accuracy is not specified	
Power source	Single alkaline 9 V battery 6LF22, single manganese 9 V battery 6F22, or external AC/DC adapter (separately available: AD-30-3)	
Auto Power Off	5 minutes after the last operation	
Power consumption	Approx. 100 mW	
Battery life	Alkaline 9 V battery 6LF22: 40 hours Manganese 9 V battery 6F22: 18 hours (Auto LCR Mode, 1 kHz)	
Dimensions	without holster	Approx. L175 mm × W80 mm × H40 mm
	with holster	Approx. L184 mm × W87 mm × H45 mm
Mass	without holster	Approx. 320 g
	with holster	Approx. 400 g
Accessories	Clipping leads (CL-700a), Holster (H-701) Shorting plate for the directly connectable measuring terminals Instruction manual	
Separately available accessories	AC/DC adapter (AD-30-3), SMD clipping leads (CL-700SMD) LCR USB communication unit (LCR-USB/LCR-USB2) Dedicated software (LCR Link is available for free download from our website.)	

8-2 Measuring Range and Accuracy

Accuracy: $\pm(\% \text{ rdg} + \text{dgt})$ " % + d " is an abbreviation.

rdg: reading

dgt: least significant digit

Temperature: 23 °C $\pm$ 5 °C

Humidity: $\leq$ 80 % R.H.

($\leq$ 60 % R.H. for the range of 2 M Ω , 20 M Ω , and 200 M Ω)

The accuracy when using the dedicated accessory CL-700a or CL-700SMD after OPEN / SHORT calibration is shown below.

" - ": the accuracy is not guaranteed.

Resistance: Rp, Rs

Range	Resolution	DCR	100/120 Hz	1 kHz	10 kHz	100 kHz
20 Ω	0.01 Ω	-	0.7 % + 8 d	-	-	-
	0.001 Ω	-	-	0.7 % + 8 d	0.7 % + 8 d	0.7 % + 8 d
200 Ω	0.01 Ω	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.5 % + 5 d
2 k Ω	0.0001 k Ω	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.5 % + 5 d
20 k Ω	0.001 k Ω	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.7 % + 8 d
200 k Ω	0.01 k Ω	0.5 % + 5 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.9 % + 10 d
2 M Ω	0.0001 M Ω	0.5 % + 5 d	0.5 % + 5 d	0.5 % + 5 d	2.0 % + 10 d	-
20 M Ω	0.001 M Ω	2.0 % + 8 d	2.0 % + 10 d	3.0 % + 20 d	-	-
	0.01 M Ω	-	-	-	5.0 % + 80 d	-
200 M Ω	0.1 M Ω	5.0 % + 80 d	5.0 % + 80 d	-	-	-

Capacitance: Cp, Cs (When D < 0.1)

Range	Resolution	100/120 Hz	1 kHz	10 kHz	100 kHz
*200 pF	0.01 pF	-	-	0.8 % + 10 d	2.0 % + 10 d
2000 pF	1 pF	0.5 % + 5 d	-	-	-
	0.1 pF	-	0.5 % + 5 d	0.5 % + 5 d	1.5 % + 10 d
20 nF	0.001 nF	0.5 % + 5 d	0.3 % + 3 d	0.5 % + 5 d	0.7 % + 10 d
200 nF	0.01 nF	0.3 % + 3 d	0.5 % + 5 d	0.5 % + 5 d	0.7 % + 10 d
2000 nF	0.1 nF	0.3 % + 3 d	0.3 % + 3 d	0.5 % + 5 d	3.5 % + 10 d
20 μ F	0.001 μ F	0.3 % + 3 d	0.3 % + 3 d	1.0 % + 10 d	-
200 μ F	0.01 μ F	0.3 % + 3 d	0.8 % + 10 d	-	-
	0.1 μ F	-	-	3.5 % + 10 d	-
2000 μ F	0.1 μ F	2.0 % + 10 d	-	-	-
	1 μ F	-	1.5 % + 10 d	-	-
20 mF	0.01 mF	1.5 % + 10 d	-	-	-

* Accuracy is not guaranteed under 50 pF.

• Accuracy when $D \geq 0.1$: $Ae \times \sqrt{1 + D^2}$

Ae means an accuracy of rdg in the main display.

Inductance: Lp, Ls (When D < 0.1)

Range	Resolution	100/120 Hz	1 kHz	10 kHz	100 kHz
20 μ H	0.001 μ H	-	-	-	1.0 % + 10 d
200 μ H	0.01 μ H	-	-	0.8 % + 10 d	1.0 % + 10 d
2000 μ H	0.1 μ H	-	0.8 % + 10 d	0.5 % + 5 d	0.8 % + 10 d
20 mH	0.001 mH	0.8 % + 10 d	0.3 % + 3 d	0.5 % + 5 d	0.8 % + 10 d
200 mH	0.01 mH	0.5 % + 5 d	0.5 % + 5 d	0.8 % + 10 d	-
2000 mH	0.1 mH	0.3 % + 3 d	0.5 % + 5 d	0.8 % + 10 d	-
20 H	0.001 H	0.3 % + 3 d	0.3 % + 3 d	5.0 % + 20 d	-
200 H	0.01 H	0.5 % + 5 d	0.8 % + 10 d	-	-
2000 H	0.1 H	0.8 % + 10 d	3.0 % + 20 d	-	-
20 kH	0.001 kH	5.0 % + 20 d	-	-	-

- Accuracy when $D \geq 0.1$: $Ae \times \sqrt{1+D^2}$

Ae means an accuracy of rdg in the main display.

* With the CL-700a, accuracy 2000 mH/ 10 kHz is 1.00 % rdg + 100 dgt.

Accuracy of Θ θ_e : $\theta_e = \pm(180/\pi) \times A_e$ (deg)

A_e means an accuracy of rdg in the main display.

Unit: °

Display range: -90.0 ° to 90.0 °

• In the capacitance measurement

Range	100/120 Hz	1 kHz	10 kHz	100 kHz
200 pF	-	-	±0.46	±1.15
2000 pF	±0.29	±0.29	±0.29	±0.86
20 nF	±0.29	±0.17	±0.29	±0.40
200 nF	±0.17	±0.29	±0.29	±0.40
2000 nF	±0.17	±0.17	±0.29	±2.01
20 µF	±0.17	±0.17	±0.57	-
200 µF	±0.17	±0.46	±2.01	-
2000 µF	±1.14	±0.86	-	-
20 mF	±0.86	-	-	-

• In the inductance measurement

Range	100/120 Hz	1 kHz	10 kHz	100 kHz
20 µH	-	-	-	±0.57
200 µH	-	-	±0.46	±0.57
2000 µH	-	±0.46	±0.29	±0.46
20 mH	±0.46	±0.17	±0.29	±0.46
200 mH	±0.29	±0.29	±0.46	-
2000 mH	±0.17	±0.29	±0.46	-
20 H	±0.17	±0.17	±2.87	-
200 H	±0.29	±0.46	-	-
2000 H	±0.46	±1.72	-	-
20 kH	±2.87	-	-	-

Accuracy of D value De: $De = \pm Ae$

Display range: 0.000 to 1999

Ae means an accuracy of rdg in the main display.

Ex. Capacitor to be measured: 180 nF

Measuring frequency: 1 kHz

Measuring accuracy: $\pm(0.3 \%rdg + 3 \text{ dgt})$

Ae = 0.3 %rdg

Calculation for De (Accuracy of D value):

De = ± 0.003

Accuracy of ESR: $Re = \pm Z_M \times Ae(\Omega)$

Display range: 00.00 to 199.9 M Ω

Calculation for Z_M : $1/(2\pi fC)$ or $2\pi fL$

Ex. Capacitor to be measured: 180 nF

Measuring frequency: 1 kHz

Measuring accuracy: $\pm(0.3 \%rdg + 3 \text{ dgt})$

Ae = 0.3 %rdg

$Z_M = 1/(2 \times 3.14 \times 1000 \times 180 \times 10^{-9})$

= 884.6 Ω

Re = $\pm 0.003 \times 884.6$

= $\pm 2.65 \Omega$

Accuracy of Q value Q_e : $Q_e = \pm \frac{Q^2 \cdot D_e}{1 - Q \cdot D_e}$

Display range: 0.000 to 1999

Condition: $Q \cdot De < 1$

Ex. Inductor to be measured: 180 μH

Measuring frequency: 10 kHz

Measuring accuracy: $\pm(0.5 \%rdg + 3 \text{ dgt})$

Assumption: $De = Ae = \pm 0.005$

Measured Q value: 20

$Q_e = \pm 20 \times 20 \times 0.005 / (1 - 20 \times 0.005)$

= 2.22

4-terminal measurement with guard shielding:

The DUT measuring leads are implemented by 4-terminal measurement. It is necessary to perform the OPEN/SHORT calibration to obtain the accuracy shown above.

The product specifications and its appearance described in this manual are subject to change without prior notice for improvements or other reasons.

< MEMO >

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This manual employs soy ink.

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