sanwa

LCR700

DIGITAL LCR METER

INSTRUCTION MANUAL CE

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[1] SAFETY PRECAUTIONS

***Before use, read the following safety precautions.**

This instruction manual explains how to use your LCR meter LCR700. Before using, read through this manual to reduce the risk of fire , electric shock, and/or injury. And save it together with the product so that you can refer to the manual as necessary.

Use the instrument only as specified in this manual or the protection provided by the instrument may be impaired.

The instructions given under the headings of " ⚠ WARNING" and must be followed to prevent accidental electric shock and so on.

1-1 Explanation of Warning Symbols

The meanings of the symbols used in this manual and attached to the product are as follows.

⚠ :Extremely-important instructions for safe use

- WARNING identifies conditions and actions that could result in accidental electric shock and so on.
- CAUTION identifies conditions and actions that could cause damage the instrument.

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 adopter (AD-30-2) 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

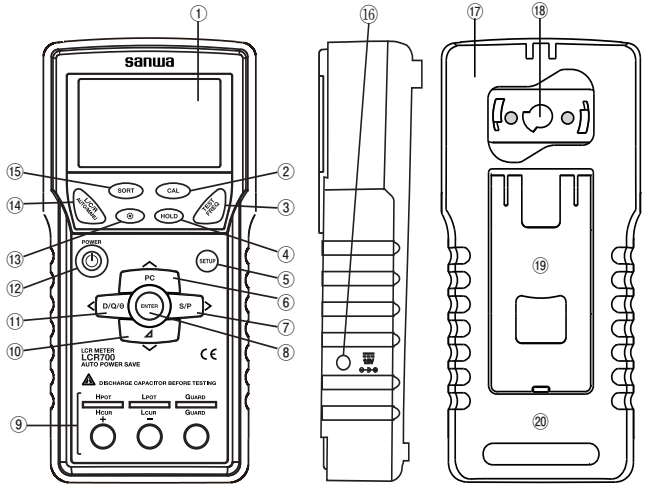
LCR700 is a full-featured high-performance handy LCR meter which rivals the capabilities and options of many of its bench counterparts. This instrument features a device value sorting function, allowing users to quickly sort passive devices in situations such as incoming inspections.

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)
- DC resistance function (7 ranges: 200.00 Ω ~ 200.0 MΩ)
- 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 µH ~ 20.000 kH
  C: 200.00 pF ~ 20.00 mF
  R: 20.000 Ω ~ 200.0 MΩ
- Multi-level low battery indication
- Auto Power Off feature to prevent unexpected battery wearing out
- Backlight to allow for easy visibility in low-lit area
- Automatic range selection
- Data hold
- Relative measurement
- 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 adopter (AD-30-2) which is separately available.

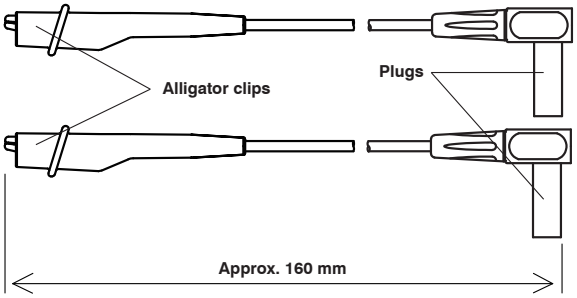
[3] PART IDENTIFICATION

3-1 LCR meter and clipping leads

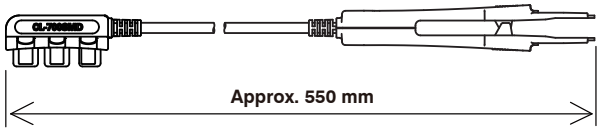


①	LCD display	⑧	ENTER button	⑮	Device value sorting function button
②	Calibration button	⑨	Measuring terminals	⑯	AC adopter inlet
③	Frequency selecting button	⑩	Relative button	⑰	Holster
④	Hold button	⑪	D/Q/θ/ESR/Rp selector button	⑱	Optical communication unit connector
⑤	Sorting mode setting button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

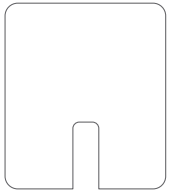
Clipping leads CL-700a (Bundled item)



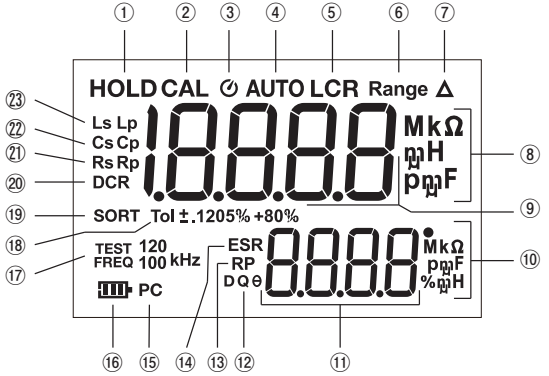
SMD Clipping leads CL-700SMD (Separately available accessory)



Shorting plate (Bundled item)



3-2 Display



①	Data hold indicator	⑬	Indicator of AC resistance in parallel mode
②	OPEN/SHORT calibration mode indicator	⑭	Equivalent series resistance mode 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 mode indicator	⑲	Sorting mode indicator
⑧	Unit of readings for main display	⑳	DC resistance mode indicator
⑨	Main display	㉑	Indicator of AC resistance in series or parallel mode
⑩	Unit of readings for sub display	㉒	Indicator of capacitance in series or parallel mode
⑪	Sub display	㉓	Indicator of inductance in series or 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 Switch

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 terning 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 three times (approx. for 15 sec.) to remind the user after approx. 5 minutes of no activity. If no activity is made before beeping finishes, the meter will show **[OFF]** and automatically turn its power off.
To turn on the meter, press the **POWER** button again.
Note:
When the meter is powered through an AC/DC adopter, 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 2 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° ≦ θ ≦ 11.3°	Resistance	θ	Fig. 4-5-1-1
θ > 11.3°	Inductance	Q	Fig. 4-5-1-2
θ < -11.3°	Capacitance	D	Fig. 4-5-1-3

If C < 5 pF, Rp 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

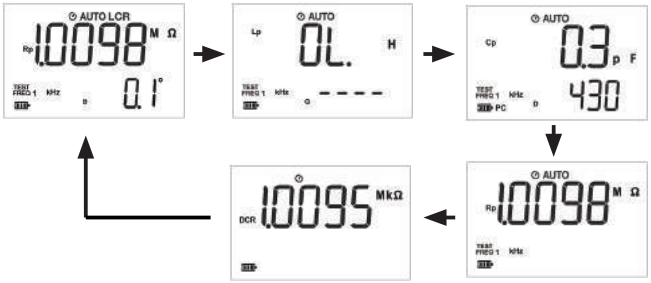
Fig. 4-5-1-2

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 (⇒) sequentially switches the functions as follows. Auto LCR mode ⇒ Ls or Lp function ⇒ Cs or Cp function ⇒ Rs or Rp function ⇒ DCR function ⇒ 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 ⇒ 10 kHz ⇒ 100 kHz ⇒ 100 Hz ⇒ 1 kHz

Note:

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

Refer to the accuracy table in Chapter 9.

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 kΩ and lower: Series mode (Ls/Cs/Rs)

Higher than 10 kΩ: 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 Measurement

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

Pressing the ⊿ 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 measurements.

REL% = (DCUR – DREF) / 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 the section 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 ⊿ 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 ⊿ button again shows the reference value saved in the previous step. You can check the reference value. (**[Δ]** is blinking.)
   Pressing the ⊿ 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 ⊿ button for 2 seconds.

4-11 OPEN/SHORT Calibration

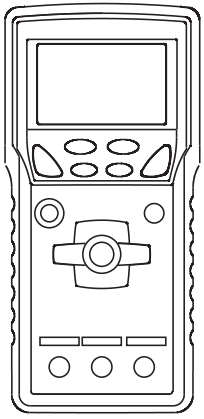
The OPEN/SHORT calibration before measurement reduces the parasitic effect of the test fixture to get better accuracy especially for high/low impedance measurement. (For the calibration principle, see 4-15-3.)

Procedure of the OPEN/SHORT calibration

This section explanations 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]

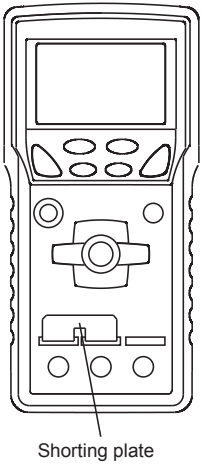
1. Press the **CAL** button for 2 seconds.
   The display shows **[OPEn]**.



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.

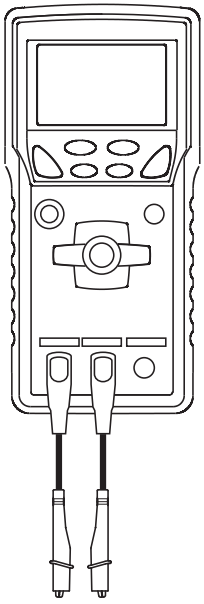
6. Press the **CAL** button once again to exit the OPEN/SHORT calibration mode.

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

1. Make sure the leads are completely disconnected.
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.

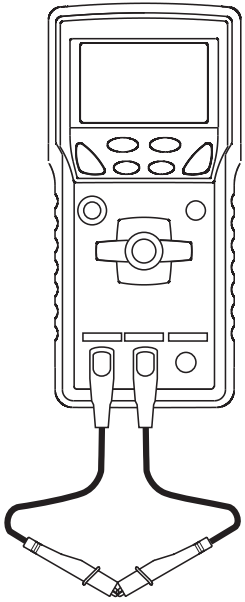
   After the countdown is complete, the display should show **[PASS]**.



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 measaurement 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 the section 5-5.

4-13 Backlight

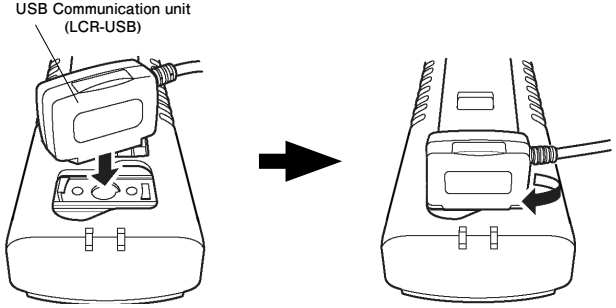
To turn the Backlight on, press ☼ button.
To turn it off, press ☼ button again.
The Backlight is disabled automatically after the meter is inactive for 60 seconds.

4-14 PC (Personal Computer) Interface

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

The connecting procedure is as follows.

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



USB Communication unit connection

The display shows the readings.

2. Press the **PC** button.
   The display shows **[PC]** to indicate PC connection is active.

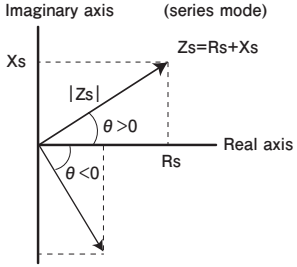
3. To make the PC connection inactive, press **PC** button again.

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 Zs can be represented as Rs + jXs in Cartesian form, and also can be represented as $|Zs| \angle \theta$ (magnitude and phase angle) in the polar form. The figure shows a mathematical relationship between Rs, Xs, |Zs|, θ.



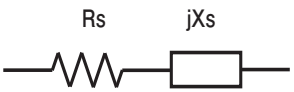
$Zs = Rs + jXs$ or $|Zs| \angle \theta$
$Rs = |Zs| \cos \theta$
$Xs = |Zs| \sin \theta$
$Xs/Rs = \tan \theta$
$\theta = \tan^{-1}(Xs/Rs)$

There are two types of reactance. One is inductive reactance X_L, and the other is capacitive reactance X_C.
If θ > 0, the reactance is inductive. If θ < 0, the reactance is capacitive.
The inductive reactance (XL) and the capacitive reactance (XC) can be defined as follows.
$X_L = 2\pi f L$
$X_C = 1 / (2\pi f C)$
where:
L = Inductance
C = Capacitance
f = signal frequency

4-15-2 Impedance measurement

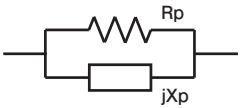
Impedance can be measured in series or in parallel.
In parallel mode, impedance can be represented as reciprocal of admittance (Y).
The admittance can be defined as Y = G + jB.
where: G = Conductance B = Susceptance

Series impedance



$Z = Rs + jXs$

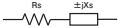
Parallel admittance



$Y = 1/Z = 1/Rp + 1/jXp = G+jB$

Rs = Series resistance
Xs = Series reactance
Cs = Series capacitance
Ls = Series inductance

Rp = Parallel resistance
Xp = Parallel reactance
Cp = Parallel capacitance
Lp = Parallel inductance

	Series	Parallel	Dissipation factor
			
Capacitance	$Cs=Cp(1+D^2)$	$Cp=Cs/(1+D^2)$	$D=Rs/Xs=\omega CsRs$ $D=G/B=G/(\omega Cp)=1/(\omega CpRp)$
Inductance	$Ls=Lp/(1+D^2)$	$Lp=Ls(1+D^2)$	$D=Rs/Xs=Rs/(\omega Ls)$ $D=G/B=\omega LpG=\omega Lp/Rp$
Resistance	$Rs=RpD^2/(1+D^2)$	$Rp=Rs(1+1/D^2)$	—
$Q = Xs/Rs = 2\pi f\, Ls/Rs = \frac{1}{2}\pi f\, CsRs$ $Q = B/G = Rp/\lvert Xp \rvert = Rp/2\pi f\, Lp = 2\pi f\, CpRp$			

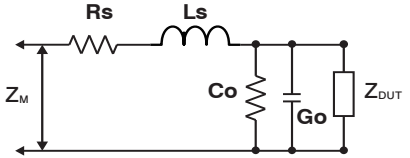
To understand the ratio of resistance and reactance, it is important to consider Quality factor (Q) and Dissipation factor (D). Usually, Q is used when measuring inductance and D is used when measuring capacitance. Q is defined as the reciprocal of D.
$Q = 1 / D = \tan \theta$

Both Rs and Rp 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 the section 4-7.

4-15-3 Principle of OPEN/SHORT calibration



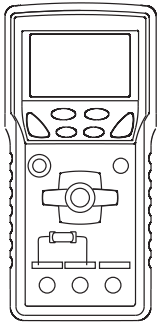
Z_M is defined as total impedance measured to a DUT by a test fixture which has some parasitic impedance.
$Z_M = (Rs + j\omega Ls) + ((Go + j\omega Co)^{-1} // Z_{DUT})$
Z_{DUT} is impedance of the DUT.

The OPEN/SHORT calibration reduces the effect of (Rs + jωLs) and (Go + jωCo).

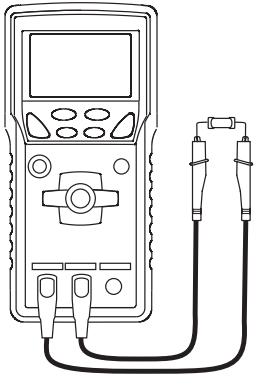
[5] MEASURING PROCEDURE

5-1 Connection of DUT (Device Under Test)
DUT's (Devices Under Test) may be connected to the meter as follows.

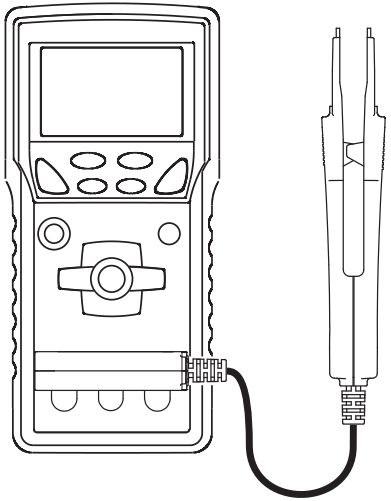
- Directly insert axial or radial component leads to the directly connectable measuring terminals.



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



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



CL-700SMD Electrical Characteristics

Parameter	Test 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 μH	< 1.0 μH	< 0.5 μH	< 0.5 μH

• Temperature: 23 ℃ ±5 ℃ , Humidity: ≦ 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 the section 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 μH ～ 2000 H (auto-range)
   C: 200.00 pF ～ 20.00 mF (auto-range)
   R: 20.000 Ω ～ 200.0 MΩ (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 ⇒ Ls or Lp ⇒ Cs or Cp ⇒ Rs or Rp ⇒ DCR ⇒ 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 μH ～ 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)

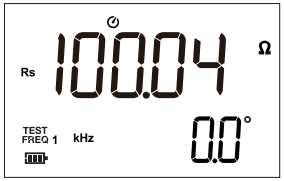
2) Measuring procedure
   ①Press the **L/C/R AUTO/MANU** button to select Cs or Cp function.
   ② Press the **TEST FREQ** button to select a measuring frequency.
   ③ Press the **S/P** button to select Cs or Cp.
   ④ Connect a DUT to the measuring terminals.
   ⑤ Press the **D/Q/θ/ESR/Rp** button to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

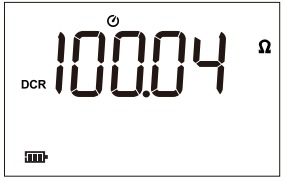


Example

5-4-4 DC Resistance measurement

1) Measuring ranges
R: 200.00 Ω ～ 200.0 MΩ (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

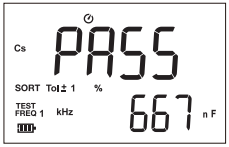
5-5 Device Value Sorting

1) Measuring ranges
L: 20.000 μH ～ 2000 H (auto-range)
C: 200.00 pF ～ 20.00 mF (auto-range)
R: 20.000 Ω ～ 200.0 MΩ (auto-range)

2) Setting and Measuring procedure
① Perform the OPEN/SHORT calibration.
For details, refer to the section of "OPEN/SHORT calibration". (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 ⇒ Ls or Lp ⇒ Cs or Cp ⇒ Rs or Rp ⇒ DCR ⇒ Auto LCR mode

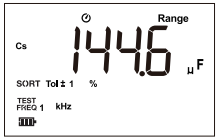
Note:
- The sorting mode is not available in the Auto LCR mode.
- **S/P** button allows you to select the series mode (Ls/Cs/Rs) or the parallel mode (Lp/Cp/Rp).

③ Connect a device to the measuring terminals as a reference.
After the reading has stabilized, press the **SORT** button to launch 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.

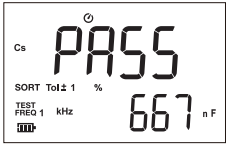


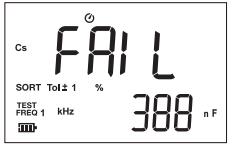
The following shows how to set up the details of the sorting mode.

a. Use < and/or > keys to adjust the position of the decimal point as necessary. Press the **ENTER** button when finished.
b. Use <, ∨, ∧, and/or > keys to adjust each digit as necessary. Press the **ENTER** button when finished.
c. 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.

⑤ 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, ⊿ button, **S/P** button, and **HOLD** button will be unavailable while the instrument is in the sorting mode.

⑥ To exit the sorting mode, press the **SORT** button.

LCR-USB, dedicated USB optical 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. The followings are important to safety. Read this manual throughly to maintain the instrument.
2. Calibrate and inspect the instrument at least once a year to ensure safety and maintain its accuracy.

6-1 Simple Examination

1) Appearance
   - Check for damaged appearance by dropping down and so on.

2) Measuring terminals/Clipping leads
   - Check for loose contacts between the measuring sockets and the DUT, or between the measuring terminals and the plugs.
   - Check for damaged clipping lead wires.
   - Check for exposed core wire anywhere on the clipping leads.

If you find any problem on the above items, stop using immediately and ask us to repair it.
Check for the clipping leads without breaking wires, referring to the section 4-11.

6-2 Battery Replacement

⚠WARNING

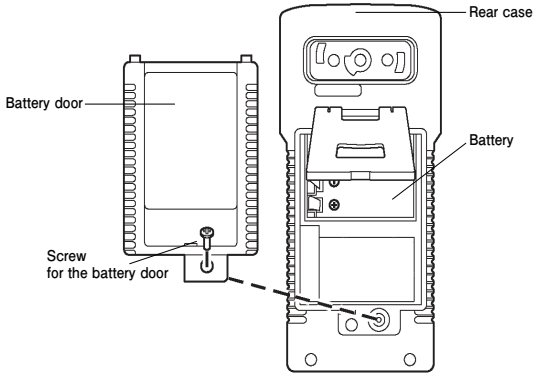
Make sure the meter power is OFF, before starting the replacement.

Pre-installed battery

Since the pre-installed battery is for monitoring, it may not be durable as typically expected.
*The purpose of the battery for monitoring is to check for the functions and performances of the product.

Replacement procedure

① Remove the holster and loosen the Philips-head screw fixing the battery door using appropriate screw driver.
② Remove the battery door and replace the battery with new one.
Caution: Observe correct polarity.
③ Re-fasten the screw and set the holster again.



6-3 Storage

⚠CAUTION

1. The panel and case are not resistant to volatile solvents. Do not wipe out with solvents or isopropyl alcohol. Clean the instrument up with a dry soft cloth.
2. The panel and case are not resistant to heat. Keep it away from heat-generating devices such as solder irons.
3. Do not save the instrument into vibratory places or where the instrument may fall off.
4. Do not expose the instrument to direct sunlight and do not save it into any places with extreme temperature, humid, or condensation.
5. Remove the battery for saving the instrument over a long period of time.

Save the instrument into an appropriate place, according to the precautions above. (Refer to the section 8-1.)

[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 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 SANWA authorized agent / distributor / service provider, listed in our website, in your country with above

information. An instrument sent to 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 accordance with the 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 SANWA authorized agent / service provider in advance.
   The minimum retention period of service functional parts is 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 web site

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 µH ～ 20.000 kH C: 200.00 pF ～ 20.00 mF R: 20.000 Ω ～ 200.0 MΩ	
DCR measurement ranges	R: 200.00 Ω ~ 200.0 MΩ	
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 ℃ < 80 % RH	

Temperature coefficient	[0.15 x (specified accuracy)]/℃ 0 ～ 18 ℃ , 28 ～ 50 ℃	
Operating temperature/ humidity	0 ～ 50 ℃ < 80 % RH	
Storage temperature/ humidity	-20 ～ 60 ℃ < 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 6LR61(IEC6LF22, NEDA1604A) or an external AC/DC adopter (separately available: AD-30-2)	
Auto Power Off	5 minutes after the last operation	
Power consumption	Approx. 110 mW	
Battery life	Approx. 35 hours (Auto LCR Mode, 1 kHz)	
Dimensions	without holster	Approx. L 175 mm × W 80 mm × H 40 mm
	with holster	Approx. L 184 mm × W 87 mm × H 45 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 adopter (AD-30-2), SMD clipping leads (CL-700SMD) LCR USB communication unit (LCR-USB) (PC communication sftware bundled)	

8-2 Measuring Range and Accuracy

Accuracy: ±(% rdg + dgt) " % + d " is an abbreviation.
rdg: reading
dgt: least significant digit
Temperature: 23 ℃ ±5 ℃
Humidity: ≦ 80 % R.H.
(≦ 60 % R.H. for the range of 2 MΩ, 20 MΩ, and 200 MΩ)
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 kΩ	0.0001 kΩ	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.5 % + 5 d
20 kΩ	0.001 kΩ	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.7 % + 8 d
200 kΩ	0.01 kΩ	0.5 % + 5 d	0.3 % + 3 d	0.3 % + 3 d	0.3 % + 3 d	0.9 % + 10 d
2 MΩ	0.0001 MΩ	0.5 % + 5 d	0.5 % + 5 d	0.5 % + 5 d	2.0 % + 10 d	-
20 MΩ	0.001 MΩ	2.0 % + 8 d	2.0 % + 10 d	3.0 % + 20 d	-	-
	0.01 MΩ	-	-	-	5.0 % + 80 d	-
200 MΩ	0.1 MΩ	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 µF	0.001 µF	0.3 % + 3 d	0.3 % + 3 d	1.0 % + 10 d	-
200 µF	0.01 µF	0.3 % + 3 d	0.8 % + 10 d	-	-
	0.1 µF	-	-	3.5 % + 10 d	-
2000 µF	0.1 µF	2.0 % + 10 d	-	-	-
	1 µF	-	1.5 % + 10 d	-	-
20 mF	0.01 mF	1.5 % + 10 d	-	-	-

* Accuracy is not guaranteed under 50 pF.
• Accuracy when D ≧ 0.1: Ae× $\sqrt{1+D^2}$
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 µH	0.001 µH	-	-	-	1.0 % + 10 d
200 µH	0.01 µH	-	-	0.8 % + 10 d	1.0 % + 10 d
2000 µH	0.1 µH	-	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 ≧ 0.1: Ae× $\sqrt{1+D^2}$
Ae means an accuracy of rdg in the main display.

Accuracy of Θ θe: θe=±(180/π) × Ae (deg)
Ae 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 = ±Ae

Display range: 0.000 to 1999

Ae means an accuracy of rdg in the main display.

Ex. Capacitor to be measured: 180 nF
Test frequency: 1 kHz
Measuring accuracy: ±(0.3 %rdg + 3 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 MΩ
Calculation for Z_M: 1/(2πfC) or 2πfL
Ex. Capacitor to be measured: 180 nF
Test frequency: 1 kHz
Measuring accuracy: ±(0.3 %rdg + 3 dgt)
Ae = 0.3 %rdg
Z_M = 1/(2 x 3.14 x 1000 x 180 x 10^{-9})
= 884.6 Ω
Re = ±0.003 x 884.6
= ± 2.65 Ω

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

Display range: 0.000 to 1999
Condition: Q・De < 1
Ex. Inductor to be measured: 180 μH
Test frequency: 10 kHz
Measuring accuracy: ±(0.5 %rdg + 3 dgt)
Assumption: De = Ae = ±0.005
Measured Q value: 20
Qe = ±20 x 20 x 0.005 / (1- 20 x 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 >

sanwa®
三和電気計器株式会社
本社=東京都千代田区外神田2-4-4・電波ビル
郵便番号=101-0021・電話=東京(03)3253－4871㈹
大阪営業所=大阪市浪速区恵美須西2－7－2
郵便番号=556-0003・電話=大阪(06)6631－7361㈹
SANWA ELECTRIC INSTRUMENT CO.,LTD.
Dempa Bldg., 4-4 Sotokanda2-Chome Chiyoda-Ku,Tokyo,Japan

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