HIOKI

Quick Start Manual

3535

LCR HiTESTER

HIOKI E. E. CORPORATION

February 2013 Revised edition 5 3535A981-05 13-02H

600022155

Contents

Introduction

Thank you for purchasing the HIOKI “Model 3535 LCR HiTESTER".
To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.
This manual describes the usage notes, basic operation, and maintenance and service of HIOKI 3535 LCR HiTESTER. See the separate Instruction Manual for more details.

Shipping Check

When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or HIOKI representative.

Checking the contents of the package

- 3535 LCR HiTESTER
- Quick Start Manual
- Instruction Manual
- Power Cord (2-line + ground)

NOTE

No HEAD AMP UNIT and no test fixtures are supplied with the unit as standard equipment. You should order them separately, according to requirements.

Before using the 3535

- Before using the instrument the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or HIOKI representative.

- Before using the instrument, make sure that the insulation on the cables is undamaged and that no bare conductors are improperly exposed. Using the instrument in such conditions could cause an electric shock, so contact your dealer or HIOKI representative for repair.

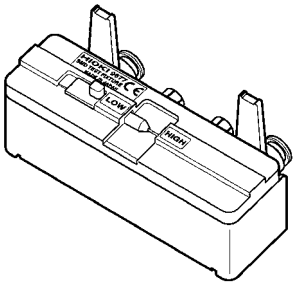
Shipping precautions

Use the original packing materials when reshipping the instrument, if possible.

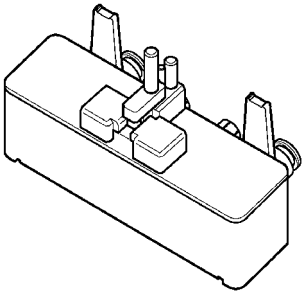
Options

Test Fixture

9677 SMD TEST FIXTURE (no CE marking)



9699 SMD TEST FIXTURE



HEAD AMP UNIT

9700-10 HEAD AMP UNIT (1 kΩ to 100 kΩ range)

Connection Cable

9678 CONNECTION CABLE
(This cable is used when the HEAD AMP UNIT is removed from the 3535 LCR HiTESTER for use.)

9637 RS-232C CABLE (1.8 m, 9pin-9pin)
9638 RS-232C CABLE (1.8 m, 9pin-25pin)

9151-02 GP-IB CONNECTOR CABLE (2 m)
9151-04 GP-IB CONNECTOR CABLE (4 m)

Printers

9442 PRINTER
9443-01 AC ADAPTER (for printer, for Japan)
9443-02 AC ADAPTER (for printer, for EU)
9444 CONNECTION CABLE
1196 RECORDING PAPER (for printer)

Safety Notes

⚠WARNING

This instrument is designed to comply with IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the instrument. Using the instrument in a way not described in this manual may negate the provided safety features. Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from instrument defects.

Safety Symbols

This manual contains information and warnings essential for safe operation of the instrument and for maintaining it in safe operating condition. Before using the instrument, be sure to carefully read the following safety notes.

	In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the instrument. The ⚠ symbol printed on the instrument indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
	Indicates AC (Alternating Current).
	Indicates a grounding terminal.
	Indicates the ON side of the power switch.
	Indicates the OFF side of the power switch.

The following symbols in this manual indicate the relative importance of cautions and warnings.

⚠WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the instrument.
NOTE	Advisory items related to performance or correct operation of the instrument.

Other Symbols

	Indicates the prohibited action.
❖	Indicates the reference.
	Indicates quick references for operation and remedies for troubleshooting.
*	Indicates that descriptive information is provided below.

Accuracy

We define measurement tolerances in terms of f.s. (full scale), rdg. (reading) values, with the following meanings:

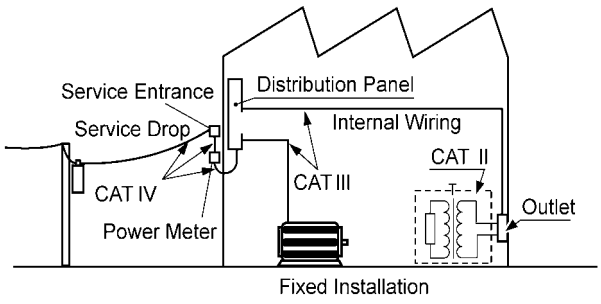
- f.s. (maximum display value or scale length)
  The maximum displayable value or the full length of the scale.
  This is usually the maximum value of the currently selected range.
- rdg. (reading or displayed value)
  The value currently being measured and indicated on the measuring instrument.

Measurement categories

To ensure safe operation of measurement instrument, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT II to CAT IV, and called measurement categories.

CAT II	Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.) CAT II covers directly measuring electrical outlet receptacles.
CAT III	Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.
CAT IV	The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).

Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.
Use of a measurement instrument that is not CAT-rated in CAT II to CAT IV measurement applications could result in a severe accident, and must be carefully avoided.



About the guarantee

You should be aware that HIOKI cannot accept any responsibility directly or indirectly if the unit has been incorporated in some other system, or if it is resold to a third party.

Usage Notes

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

Handling this device

⚠WARNING

- **To avoid electric shock, do not allow the instrument to get wet, and do not use it when your hands are wet.**
- **Never modify the instrument. Only a Hioki service engineer can disassemble or repair the instrument. Failure to observe these precautions may result in fire, electric shock, or injury.**
- **Do not use the instrument where it may be exposed to corrosive or combustible gases. The instrument may be damaged or cause an explosion.**

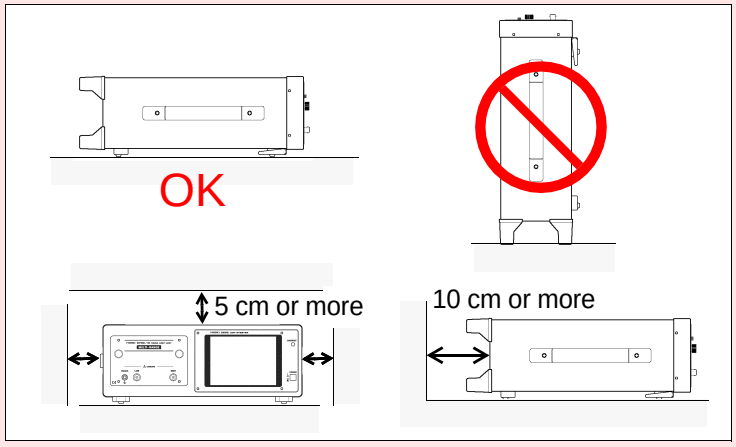
⚠CAUTION

- To avoid damage to the instrument, protect it from vibration or shock during transport and handling, and be especially careful to avoid dropping.
- Do not use excessive force on the touch panel, and do not use sharp objects that could damage the touch screen.
- Before using the instrument, make sure that the insulation on the cables is undamaged and that no bare conductors are improperly exposed. Using the instrument under such conditions could result in electrocution. Replace the cables specified by HIOKI.
- If anything unusual happens during operation of the unit, turn off the power switch immediately and contact any HIOKI service facility for help, advice and service.
- Do not connect or disconnect the 9700-10 HEAD AMP UNIT or 9678 CONNECTION CABLE with the power turned on. This may cause a malfunction.
- Do not apply any voltage to the measurement terminals. This may cause a malfunction in the unit.

Setting up the 3535

⚠CAUTION

- Do not store or use the instrument where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the instrument may be damaged and insulation may deteriorate so that it no longer meets specifications.
- This instrument should be installed and operated indoors only, between 10 and 40°C, 80% RH or less, and at an altitude of 2000 m or less, and also stored in a range of temperature and humidity from -10°C to 55°C, 80% RH or less.
- This instrument is not designed to be entirely water- or dust-proof. To avoid damage, do not use it in a wet or dusty environment.
- Do not use the instrument near a device that generates a strong electromagnetic field or electrostatic charge, as these may cause erroneous measurements.
- Do not install the instrument with any side except the bottom facing down. This may cause a fire or other malfunction in the instrument.
- Ventilation holes for heat radiation are provided on the side and rear panels of the instrument. Leave sufficient space around the ventilation holes and install the instrument with the holes unobstructed. Installation of the instrument with the ventilation holes obstructed may cause a malfunction or fire.



Before connection and powering on

⚠WARNING

- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord provided only to a 3-contact (two-conductor + ground) outlet.**
  ❖ 2.3, "Connecting the Power Cord"(page 19)
- **Before turning the instrument on, make sure the source voltage matches that indicated on the instrument's power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.**
- **Various connectors are present on the outside of the 3535. Never connect any cable to any of these connectors without first turning off the power supply and removing the power cord. Moreover, check the connections carefully in order to avoid any chance of setting up a short-circuit etc.**

Chapter 1 Overview

1.1 Product Overview

The HIOKI 3535 LCR HiTESTER is an impedance meter which uses a touch panel as the user interface. This interactive touch panel enables extremely easy operation. The measurement frequency can be set from 100 kHz to 120 MHz at high resolution.

The values of a maximum of any four of the fourteen measurement parameters, including not only impedance |Z| and phase angle θ, but also L, C, and R etc., can be simultaneously displayed upon the screen.

Moreover, this widely applicable impedance meter can be set, not only to a floating voltage setting, but also to a constant current setting.

1.2 Product Features

Wide range of measurement frequencies

The measurement frequency can be selected from a wide range - 100 kHz to 120 MHz- at high resolution. Frequency dependent assessment of electronic components and materials, etc., is possible.

Constant current measurement

Assessment of dependence upon current is possible.

Outstanding operability

All control operations are initiated via a touch panel on the display. All the keys currently available for use are shown on the display, and can be operated interactively.

Simultaneous display of four parameters

Up to four of the measurement parameters (such as L,C,R, etc.) can be displayed simultaneously.

Interface

Using a computer, any required parameters can be captured.

Changing settings without stopping measurement

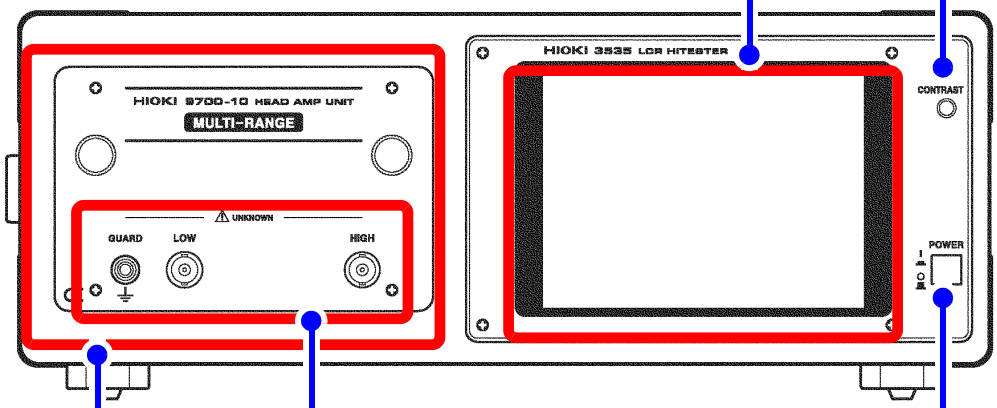
Various background settings can be changed without stopping measurement (when an internal trigger is set).

1.3 Names and Functions of Parts

Front Panel

Display
5-inch LCD display with a touch panel.
❖ 1.4.1, "About the Touch Panel" (page 10)

Contrast adjustment knob
This knob adjusts the screen contrast.
Turn clockwise: The contrast becomes light.
Turn counterclockwise: The contrast becomes dark.



9700-10 HEAD AMP UNIT
Can be detached from the instrument and operated remotely via the 9678 CONNECTION CABLE.

Measurement range:
9700-10 HEAD AMP UNIT
100 mΩ to 300 kΩ

❖ 2.2, "Confirming and Installing the HEAD AMP UNIT" (page 16)

Measurement terminals
There are three measurement terminals:

HIGH HIGH terminal
LOW LOW terminal
GUARD GUARD terminal

❖ 2.5, "Connecting the Test Fixture" (page 21)

POWER switch
Turns the power for the unit on and off.
○ : Power OFF
| : Power ON

❖ 2.4, "Turning the Power On and Off" (page 20)

Rear Panel

Power input socket

Connect the supplied power cord here.

❖ 2.3, "Connecting the Power Cord" (page 19)

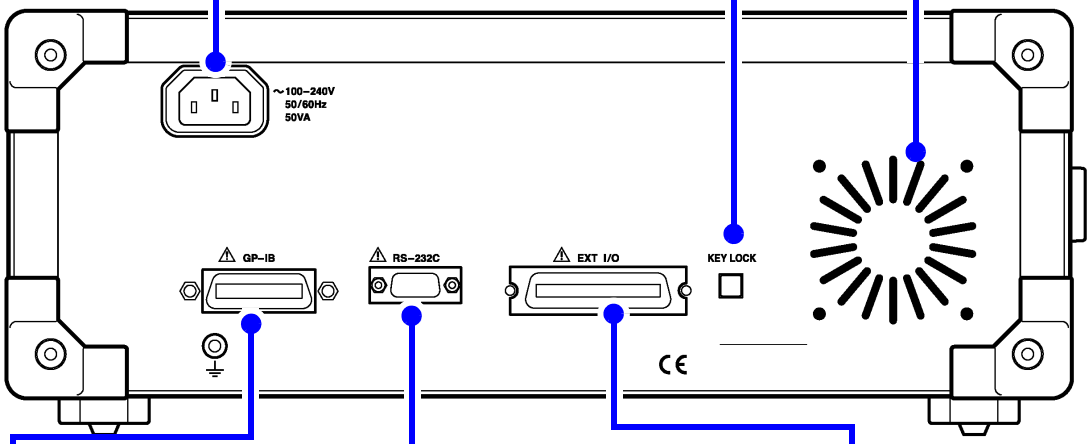
Key lock switch

Puts the touch panel keys into the input-not-accepted state.

❖ Instruction Manual: 4.12, "Key Lock Function"

Ventilation

❖ Setting up the 3535 (page 6)



GP-IB connector

❖ Instruction Manual: Chapter 6, "GP-IB/ RS-232C Interface"

RS-232C connector

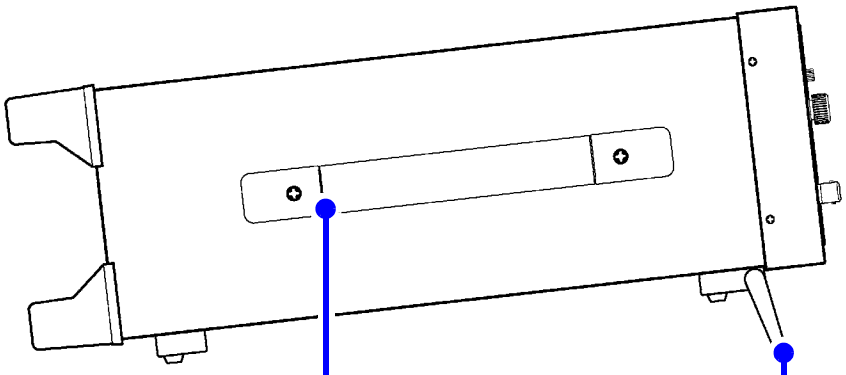
❖ Instruction Manual: Chapter 6, "GP-IB/RS-232C Interface"

EXT I/O connector

For input of an external trigger signal and output of comparator results. Compatible with sequencer connection.

❖ Instruction Manual: 5.3, "Measurements Using EXT I/O"

Left Side



Handle

Used when carrying the unit.

Stand

Can be opened to tilt the unit upwards.

⚠CAUTION

Do not apply strong downward pressure with the stand extended. Damage to the stand will result. Be careful not to get your hands caught under the device.

1.4 Screen Configurations and Operations

1.4.1 About the Touch Panel

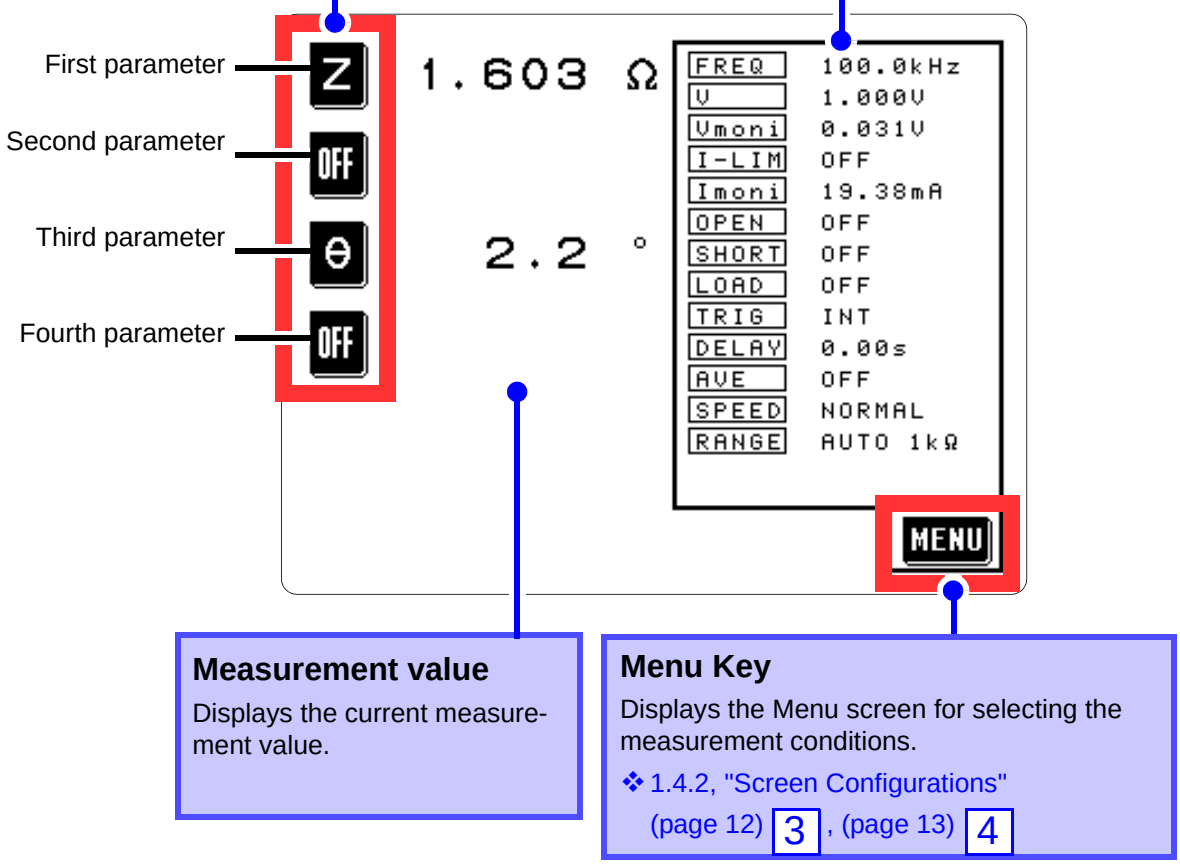
⚠CAUTION

Do not use excessive force on the touch panel, and do not use sharp objects that could damage the touch screen.

The 3535 uses a touch panel for setting and changing all of the measurement conditions. Simply by touching the LCD screen at certain areas - termed soft keys - which appear in reverse video, the items associated with these soft keys, and numerical values, can be selected.
In this manual, lightly touching a soft key area on the screen is termed "pressing" a key.

Parameter Keys
Displays the Parameter setting screen.
❖ 1.4.2, "Screen Configurations" (page 11) 2

Monitor Display and measurement conditions
Displays the currently set measurement conditions.
The monitor display varies according to the measurement signal level setting.
❖ 1.4.2, "Screen Configurations" (page 11) 1

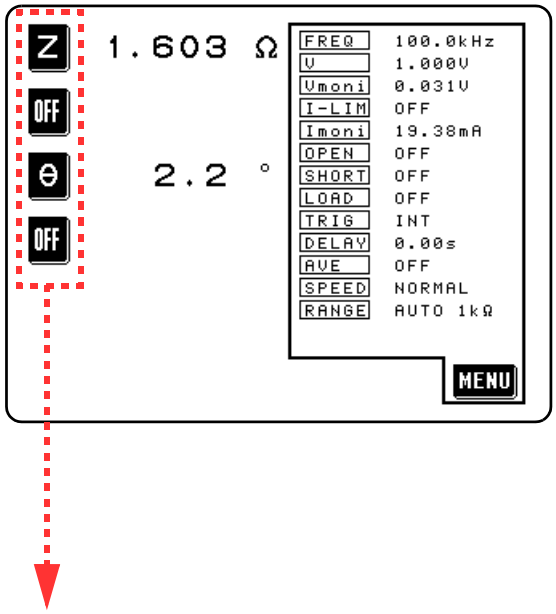


Measurement value
Displays the current measurement value.

Menu Key
Displays the Menu screen for selecting the measurement conditions.
❖ 1.4.2, "Screen Configurations" (page 12) 3, (page 13) 4

1.4.2 Screen Configurations

1 Initial Screen

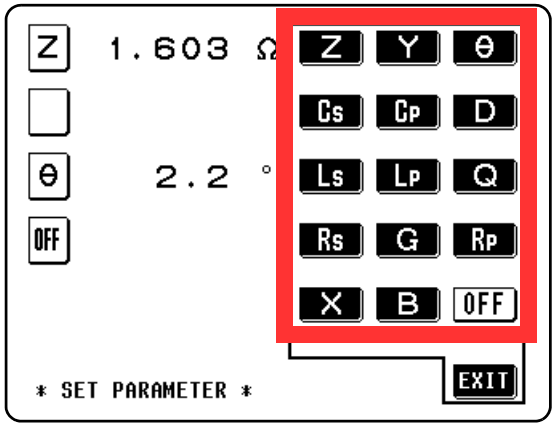


This screen is displayed first after the power is turned on. A maximum of four of the measurement parameters (L, C, R, etc.) can be set for display, and all of the measurement conditions can be checked, on this Initial Screen.

❖ Select any display parameter.(page 23)

FREQ ... Measurement frequency
V ... Measurement signal level
Vmoni ... Voltage value between the terminals
I-LIM ... Measurement current limit value
Imoni ... Current value flowing through the test sample
OPEN ... Open-circuit compensation setup
SHORT ... Short-circuit compensation setup
LOAD ... Load compensation setup
TRIG ... Trigger mode
DELAY ... Setting value for the trigger delay
AVE ... Number of times for averaging
SPEED ... Measurement speed
RANGE ... Measurement range

2 Parameter Setting Screen



Press any parameter key on the Initial Screen to display the Parameter Setting Screen. When you press the key for the parameter to be measured, the selected parameter is set and the Parameter Setting Screen automatically returns to the Initial Screen.

Press EXIT to return to the Initial Screen without setting any parameter.

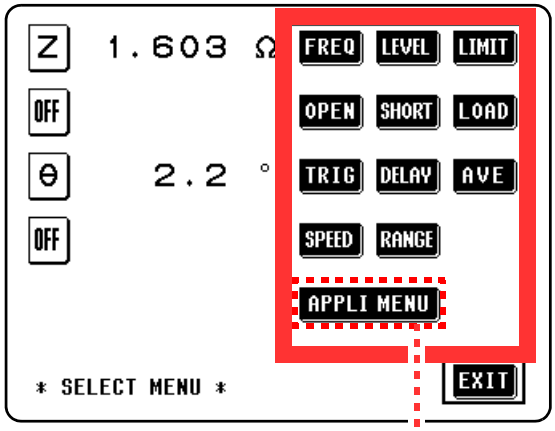
All parameters excluding the impedance phase angle θ is displayed as absolute value. To check the polarity, confirm the impedance phase angle θ.

❖ Instruction Manual; 7.2, "Parameters and Calculation Equations"

*1: The phase angle θ is shown based on the impedance Z. When measuring based on the admittance Y, the sign of the phase angle θ must be reversed.

Z ....Impedance (Ω)
Y ....Admittance (S)
θ ....Impedance phase angle (°) * 1
Cs ....Static capacitance in series-equivalent circuit mode (F)
Cp ....Static capacitance in parallel-equivalent circuit mode (F)
D ....Loss constant = tanδ
Ls ....Inductance in series-equivalent circuit mode (H)
Lp ....Inductance in parallel-equivalent circuit mode (H)
Q ....Q factor
Rs ....Effective resistance in series-equivalent circuit mode = ESR(Ω)
Rp ....Effective resistance in parallel-equivalent circuit mode(Ω)
G ....Conductance (S)
X ....Reactance (Ω)
B ....Susceptance (S)
OFF ....Display no measurement parameter in the chosen position

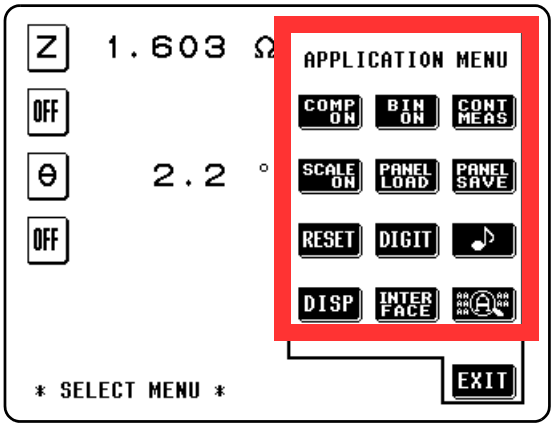
3 Menu Screen



❖ See Chapter 3, "Setting the Menu Screen" in the Instruction Manual for more details.

Press MENU on the Initial Screen to display the Menu Screen.
Select the measurement condition item to be set.
Press the corresponding key to switch to the screen for setting measurement conditions.

		Reference pages
FREQ	..Measurement frequency setting	p.43 (1)
LEVEL	..Measurement signal level setting	p.43 (2)
LIMIT	..Limit setting	p.43 (3)
OPEN	..Open-circuit compensation setting	p.43 (4)
SHORT	..Short-circuit compensation setting	p.44 (5)
LOAD	..Load compensation function	p.44 (6)
TRIG	..Trigger setting	p.44 (7)
DELAY	..Trigger delay function	p.44 (8)
AVE	..Averaging setting	p.44 (9)
SPEED	..Measurement speed setting	p.44 (10)
RANGE	..Measurement range setting	p.45 (11)



❖ See Chapter 4, "Setting the Application Menu Screen" in the Instruction Manual for more details.

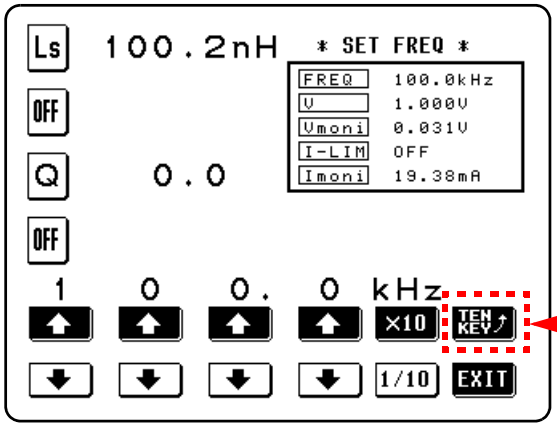
Press APPLI MENU to display the Application Menu Screen.

			Reference pages
COMP ON	COMP OFF	Comparator function	p.45 (12)
BIN ON	BIN OFF	BIN (classification) measurement function	p.45 (13)
CONT MEAS		..Continuous measurement function	p.46 (20)
SCALE ON	SCALE OFF	Scaling function	p.45 (14)
PANEL LOAD		..Panel load function	p.46 (16)
PANEL SAVE		..Panel save function	p.46 (15)
RESET		..System reset	p.46 (19)
DIGIT		..Display digits setting	p.46 (21)
♪		..Beep sound setting	p.46 (17)
DISP		..Display setting	p.47 (22)
INTER FACE		..Interface setting	p.47 (23)
		..Zoom display function	p.46 (18)

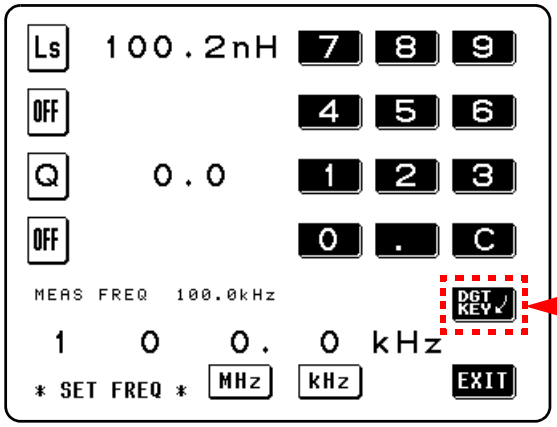
4 Measurement Conditions Setting Screen

(When setting of the measurement frequency)

FREQ



Digit Setting Screen



Numeric Keypad Setting Screen

Select the item to be set in the Menu Screen to set the measurement condition.

Two input methods can be selected for frequency setting.

TEN KEY — Changes to the Numeric keypad setting screen
Input the numeric value directly using the numeric keypad.

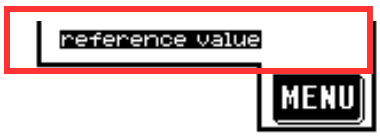
DGT KEY — Changes to the Digit screen
Input the numerical value for each digit.

Set the measurement frequency using the digit keys.

Set the measurement frequency using the numeric keypad.

When the setting process is completed, press EXIT to return to the Initial Screen.

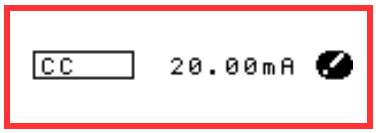
Other Displays



reference value

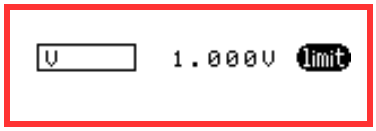
This display appears when the current measurement value is outside of the accuracy guarantee range and when the measurement value is displayed as a reference value.

Cause	Correction
The value is out of the measurement range. ❖ Measurement range: Instruction Manual; 7.4, "Measurement Range and Accuracy"	The range of values that can be measured depends on the selected measurement range, so select the range that suits the value to be measured.
The value is in the non-balanced state. ❖ Instruction Manual ; Appendix 2, "Measurement Principle"	No value can be measured under current measurement conditions. The measurement value should be used as a reference value. A value may be able to be measured by changing the setting of a measurement frequency or voltage.



This display appears when the measurement conditions of the set measurement signal level (V/CC) cannot be satisfied.

Cause	Correction
The voltage or current applied to a sample cannot be suppressed to below the limit set value when the setting of voltage and current limit values is enabled.	Increase the limit set value or decrease the set value of a measurement signal level.
A set current cannot flow in constant current (CC) setting.	Decrease the CC set value.



limit

This display appears when the set value of a measurement signal level is not reached without applying voltage or current exceeding the limit values to a sample while the setting of voltage and current limit values is enabled.

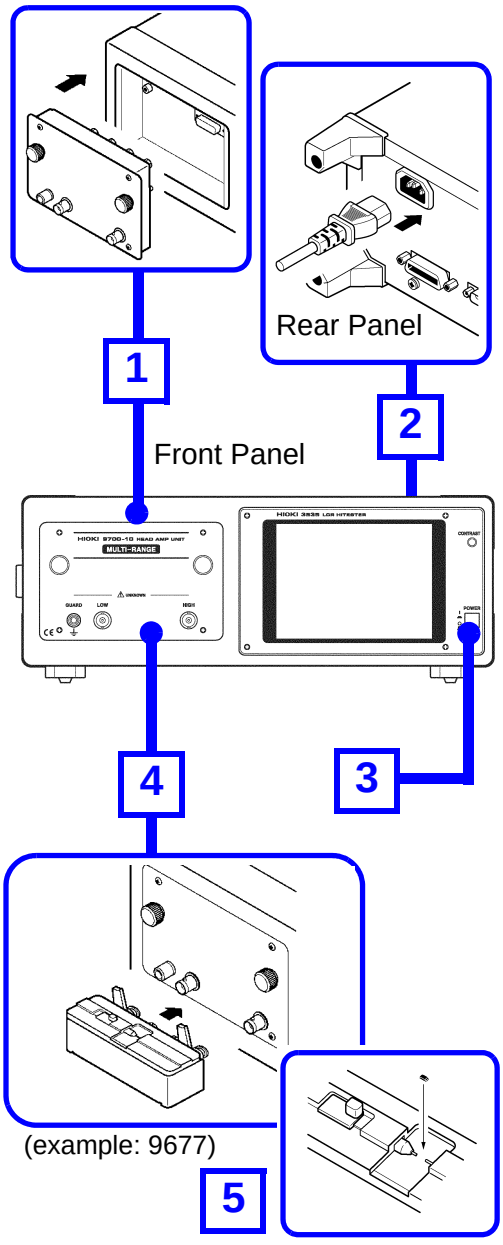
Cause	Correction
The set voltage of open-circuit voltage setting (V) cannot be applied to a sample.	Increase the limit voltage value or decrease the voltage value of open-circuit voltage setting.
The set current of constant current (CC) setting cannot flow through a sample.	Increase the limit current value or decrease the current value of constant current setting.

Measurement Preparations Chapter 2

Please read the Usage Notes (page 5) before setting up this instrument.

2.1 Connection Procedure

Refer to the indicated reference items before installing and connecting.



1 Install the HEAD AMP UNIT.

❖ 2.2, "Confirming and Installing the HEAD AMP UNIT" (page 16)

2 Connect the Power cord.

❖ 2.3, "Connecting the Power Cord" (page 19)

3 Turn the Instrument On.

❖ 2.4, "Turning the Power On and Off" (page 20)

4 Connect the Test Fixture to the measurement terminals.

❖ 2.5, "Connecting the Test Fixture" (page 21)

5 Connect the sample to the Test Fixture.

Settings and Measurements

❖ 3.1, "Basic Operation before Measurement" (page 23)
❖ 3.2, "Measurement" (page 25)

See the Instruction Manual for detailed setting.

2.2 Confirming and Installing the HEAD AMP UNIT

Install the optional 9700-10 HEAD AMP UNIT.

1 kΩ range	100 mΩ to 2 kΩ
10 kΩ range	1 kΩ to 20 kΩ
100 kΩ range	10 kΩ to 300 kΩ

NOTE

- Use the 3535 and HEAD AMP UNITs, which you purchased, in combination when you use the 3535 LCR HiTESTER and multiple HEAD AMP UNITs.
  (The serial number of the HEAD AMP UNIT that can be used is described in the HEAD AMP UNIT installation section of the 3535.)
  When an incompatible HEAD AMP UNIT is installed, the warning message below is displayed after the power is turned on. Operation then stops. In this case, turn the power off at once and replace the HEAD AMP UNIT.

```
HEAD AMP Serial No. is different!

3535     : 123456789
HEAD AMP: 123451234
```

- The warning message below is displayed when the power is turned on with the HEAD AMP UNIT not installed. Operation then stops. In this case, turn off the power at once and install the HEAD AMP UNIT.

```
HEAD AMP UNIT is not connected!
```

- Use an optional 9678 CONNECTION CABLE when removing the HEAD AMP UNIT from the 3535 for measurement.

❖ 2.2.2, "Using the HEAD AMP UNIT away from 3535 LCR HiTESTER" (page 18)

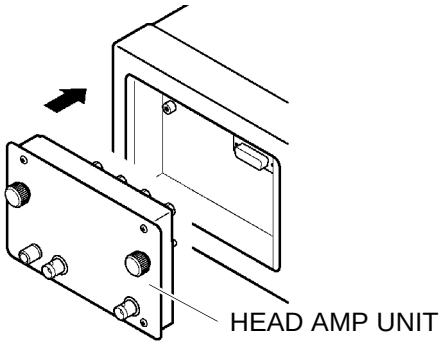
2.2.1 Connecting and Disconnecting the HEAD AMP UNIT

⚠CAUTION

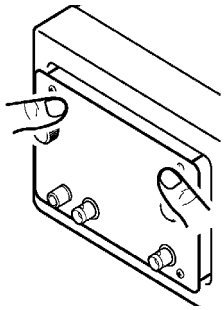
Take note of the following instructions to prevent the 3535 and 9700-10 HEAD AMP UNIT from being damaged.

- Do not connect or disconnect the HEAD AMP UNIT with the power turned on.
- Be sure to disconnect the power cord and test fixture before connecting or disconnecting the HEAD AMP UNIT.
- Do not apply any voltage to the measurement terminals during connecting or disconnecting.
- Handle a connector with care to prevent it from being damaged.

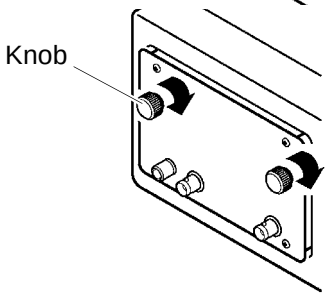
Connecting



1. Push the HEAD AMP UNIT straight into the 3535 while checking each point where it is connected.



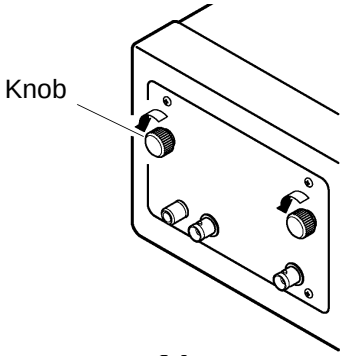
2. Push the upper side of the HEAD AMP UNIT slightly as shown in the figure.



3. Turn both knobs manually to tighten them.

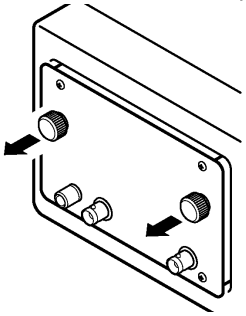
   Tightening the knobs enables the HEAD AMP UNIT to be pushed as far as it will go.
   If the knobs are not engaged, push the HEAD AMP UNIT still more and turn them.

Disconnecting



1. Loosen both knobs of the HEAD AMP UNIT by turning them manually.

   Turn the knobs so that the HEAD AMP UNIT projects.
   Loosen the knobs until they disengage.



2. Pull both knobs toward you and pull out the HEAD AMP UNIT from the 3535.

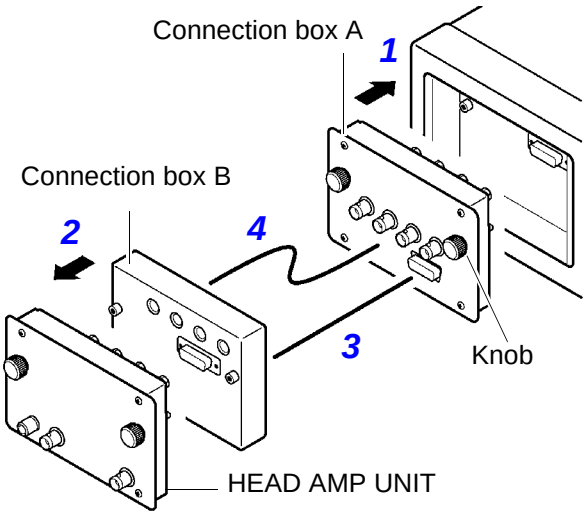
2.2.2 Using the HEAD AMP UNIT away from 3535 LCR HiTESTER

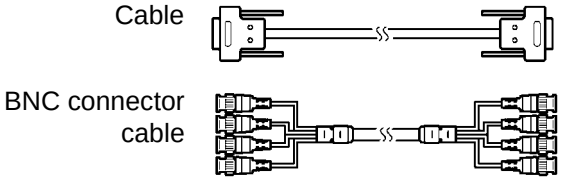
⚠CAUTION

When disconnecting the BNC connector, be sure to release the lock before pulling the connectors apart. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.

The HEAD AMP UNIT can be used away from the 3535 with the 9678 CONNECTION CABLE (optional) connected.

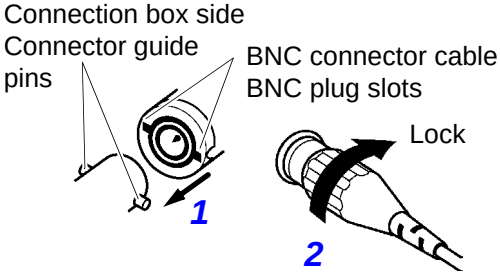
Connection





1. Push connection box A of a 9678 CONNECTION CABLE straight into the 3535 and tighten both knobs by turning them manually.
2. Insert connection box B of a 9678 CONNECTION CABLE into the HEAD AMP UNIT and tighten both knobs by turning them manually.
3. Connect a cable to connection boxes A and B.
4. Connect a BNC connector cable to the same color pins of connection boxes A and B.

Connection of BNC connector:



Align the slots in the BNC plug with the guide pins on the connector at the instrument side, then push and turn the plug clockwise.

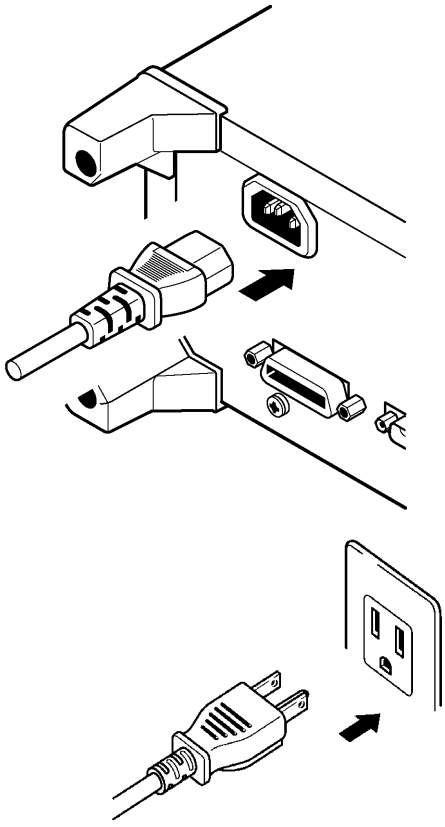
To unplug the connector, push the plug and turn it counterclockwise before pulling it apart.

2.3 Connecting the Power Cord

⚠WARNING

- **Before turning the instrument on, make sure the source voltage matches that indicated on the instrument's power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.**
- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord provided only to a 3-contact (two-conductor + ground) outlet.**
- **The maximum rated power is 50 VA.**

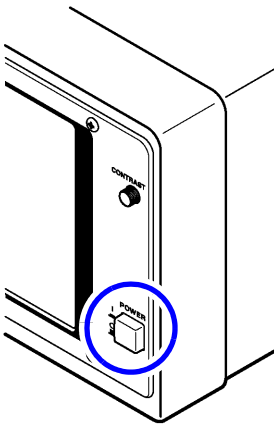
Connection



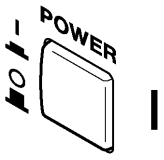
1. Check that the main power switch of the unit is off.
2. Check that the power supply voltage is correct, and connect the end of the power cord to the power input socket at the rear of the unit.
3. Plug the power cord into the AC mains outlet.

Insert the plug into the outlet.

2.4 Turning the Power On and Off



Powering On



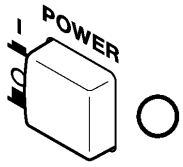
1. Turn the POWER switch ON (|).

The Initial Screen will be displayed on the liquid crystal display.
The measurement conditions will start off the same as they were when last the power was turned off.

2. Adjust the contrast knob so as to make the display as easy to see as possible.

Wait for 60 minutes after turning on the power before starting measurement, so as to allow the unit to warm up fully.

Powering Off



Turn the POWER switch OFF(○).

The measurement conditions will be preserved.

Even if the power supply is interrupted because of a power failure or the like, the measurement conditions (settings) will not be lost; when the power is turned on again, the unit will return to its state just before the interruption.

2.5 Connecting the Test Fixture

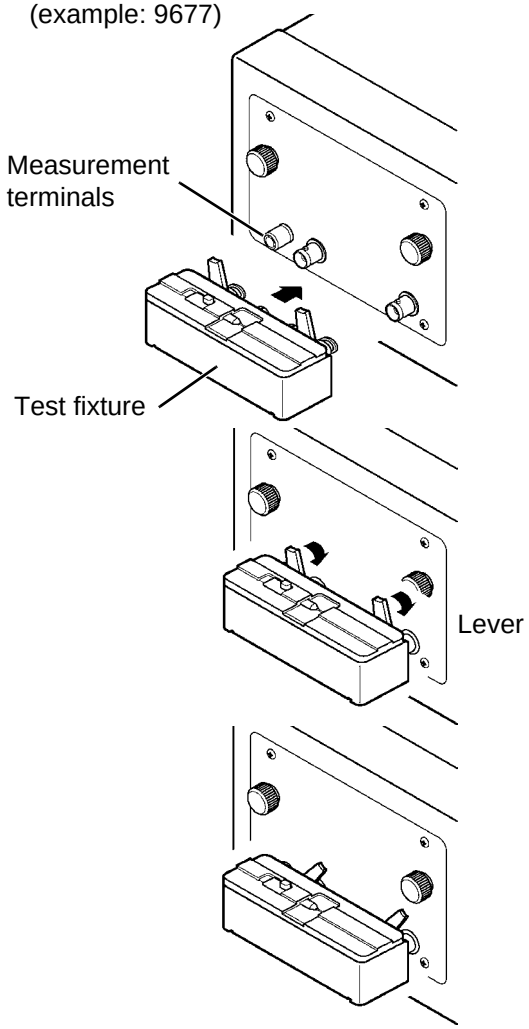
.

⚠CAUTION

- Do not apply any voltage to the measurement terminals. This may cause a malfunction in the unit.
- Use HIOKI's optional fixture as a test fixture.

Connection

(example: 9677)



1. Insert the test fixture directly into the measurement terminals of the connected unit with the surface, on which the type name is printed, up.

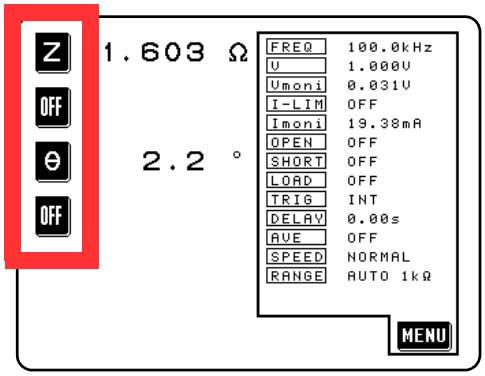
2. Position and fix the test fixture using right and left levers.

Setting and Measurement Chapter 3

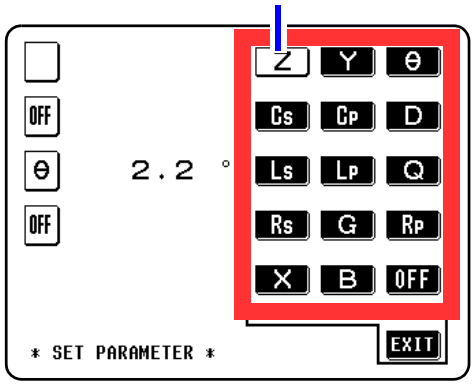
3.1 Basic Operation before Measurement

See the Instruction Manual for instructions on how to set each item.

1 Select any display parameter.



The displayed parameters are highlighted.



Initial Screen

On the Initial Screen, press the parameter key to be set.
A maximum of four parameters can be displayed.

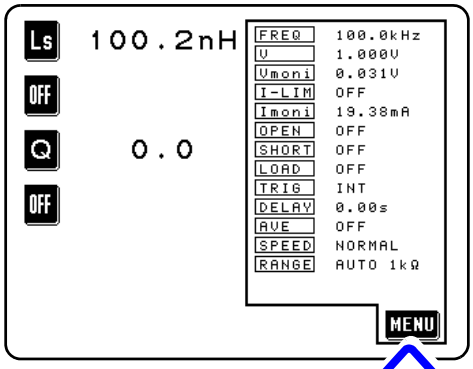
Parameter Setting Screen

Select any parameter.
The selected parameter is set, and the Parameter Setting Screen automatically returns to the Initial Screen.

Press EXIT to return to the Initial Screen without setting any parameter.

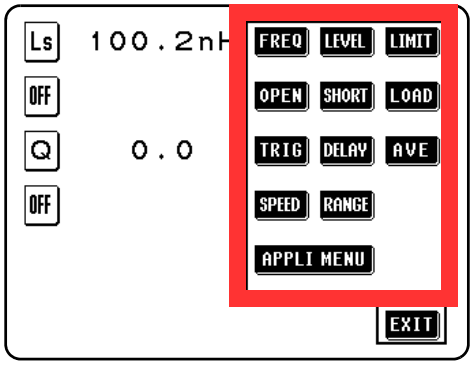
❖ Description of keys:1.4.2, "Screen Configurations", Parameter Setting Screen (page 11)

2 Select the measurement condition item to be set.



Initial Screen

Press **MENU** on the Initial Screen.

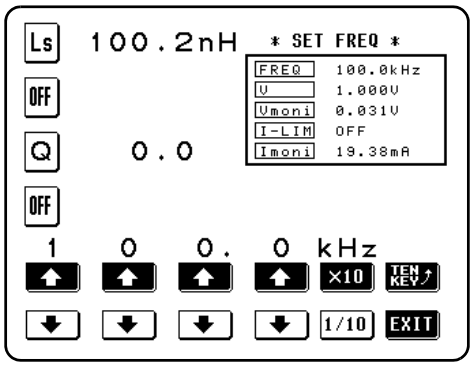


Menu Screen

Select the measurement condition item to be set.

❖ Description of keys:1.4.2, "Screen Configurations", Measurement Conditions Setting Screen (page 13)

3 Set the measurement conditions.



Measurement Conditions Setting Screen

Set the measurement condition.

Press **EXIT** after the measurement conditions are set.

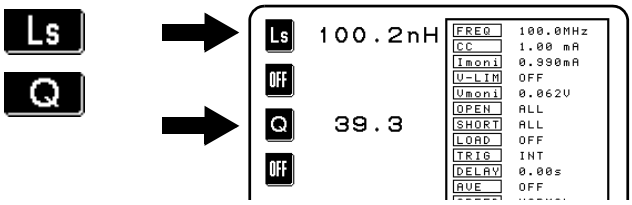
3.2 Measurement

Please read , "Usage Notes" (page 5) and Chapter 2, "Measurement Preparations" (page 15) before measurement.

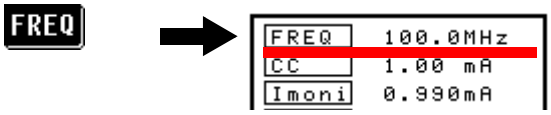
Example: Measure an inductor.

- Sample to be measured:
  Inductor100 nH
- Parameters to be displayed:
  InductanceLs
  Q factorQ
- Measurement conditions:
  Measurement frequency ..... 100 MHz
  Constant current level ..... 1.00 mA
  Measurement range..... 1 kΩ
  Open-circuit compensation setup ... ALL
  Short-circuit compensation setup.... ALL

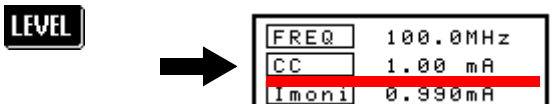
1 Select the measurement parameters (page 26)



2 Set the measurement frequency (page 28)



3 Set the constant current level (page 30)



4 Set the Measurement range (page 32)

5 Open-circuit compensation (page 34)

6 Short-circuit compensation (page 36)

7 Connect the sample to be measured (page 38)

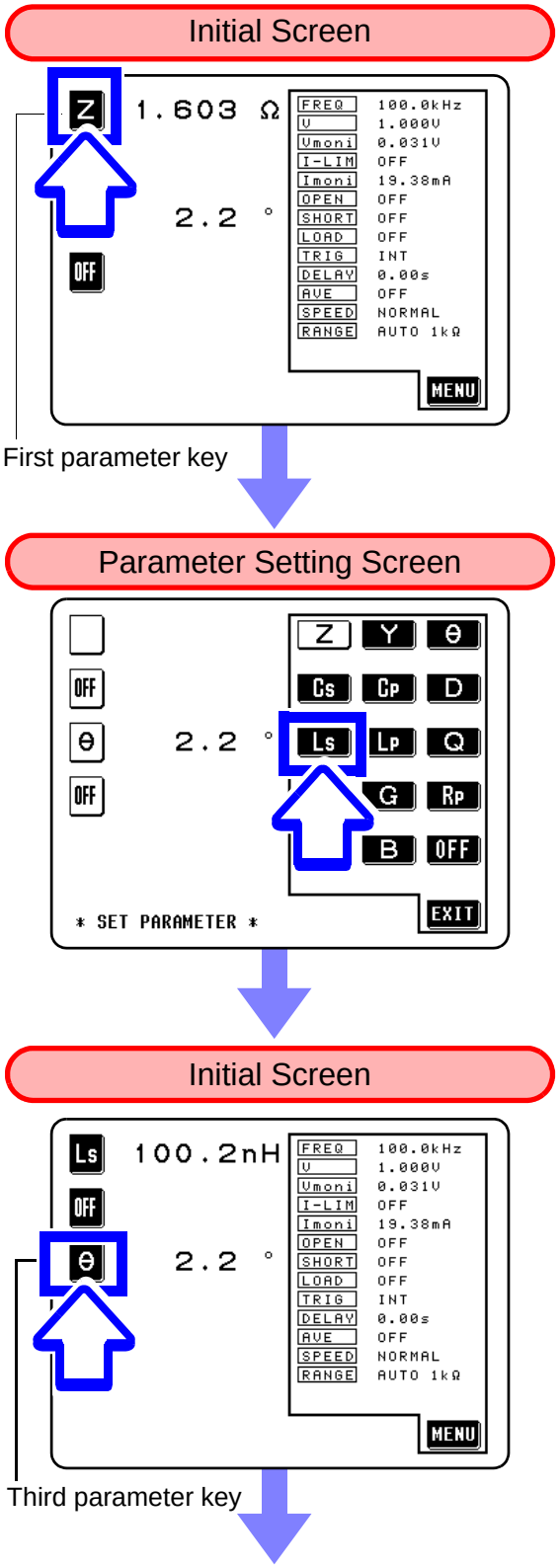
Start measurement

See the Instruction Manual for more details.

3.2.1 Setting the Measurement Parameters to be Displayed

(Example)

Set the first parameter key to inductance (Ls), and the third parameter key to Q factor (Q).



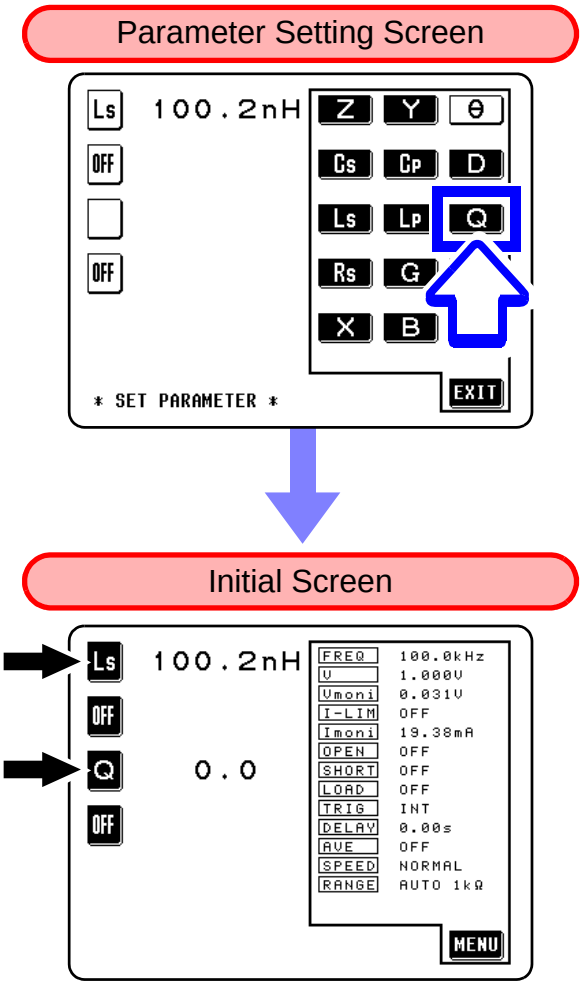
1. Press the first parameter key on the Initial Screen.

The Initial Screen is switched to the Parameter Setting Screen and the set parameter is highlighted.)

2. Press **Ls** (inductance).

The Parameter Setting Screen automatically returns to the Initial Screen.

3. Press the third parameter key.



4. Press **Q** (Q factor).

The Parameter Setting Screen automatically returns to the Initial Screen.

5. Set other parameters to **OFF**.

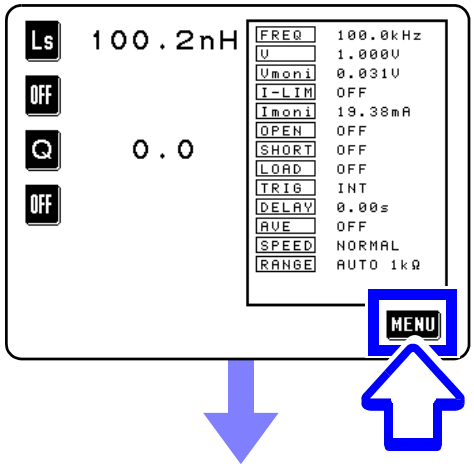
Ls and Q are set to each parameter.

3.2.2 Setting the Measurement Frequency

(Example)

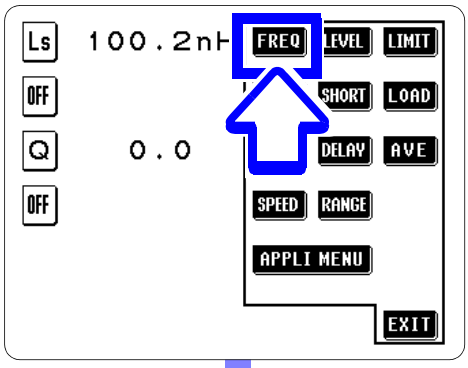
Set the measurement frequency to 100 MHz.

Initial Screen



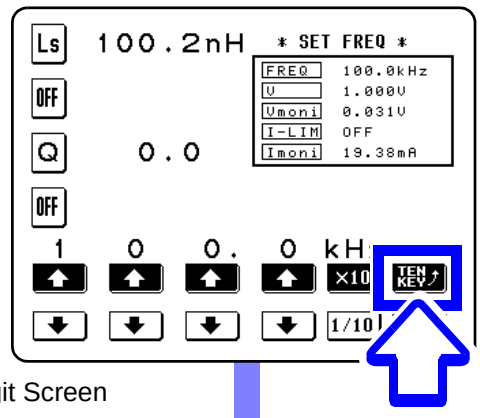
1. On the Initial Screen, press **MENU**, and the Menu Screen will be displayed.

Menu Screen



2. Press **FREQ** (frequency), and the Measurement Conditions Setting Screen will be displayed.

Measurement Conditions Setting Screen



Digit Screen

3. Set the measurement frequency.

There are actually two frequency setting screens.

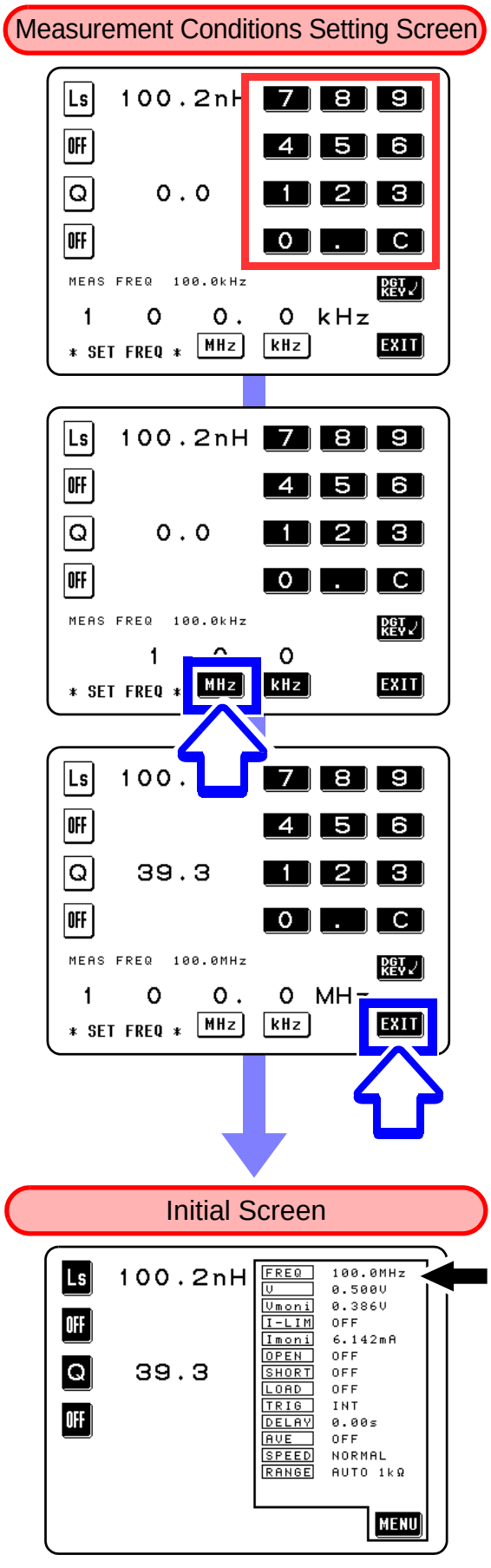
- Set the numeric value for each digit.

  DGT KEY ..... Digit Screen

- Input the numeric value directly.

  TEN KEY .... Numeric keypad setting screen

Input the numeric value directly using the numeric keypad. Press **TEN KEY** when the Numeric keypad setting screen is not displayed.



4. Press the numeric keypad **1**, **0**, and **0** sequentially.

If you make a mistake, press **C** and input the numeric value again.

5. Press **MHz** and register the setting.

The setting is not registered until you press the unit key.

Press **EXIT** before registration when returning to the Initial Screen to keep the previous setting.

6. Press **EXIT** after the setting is registered.

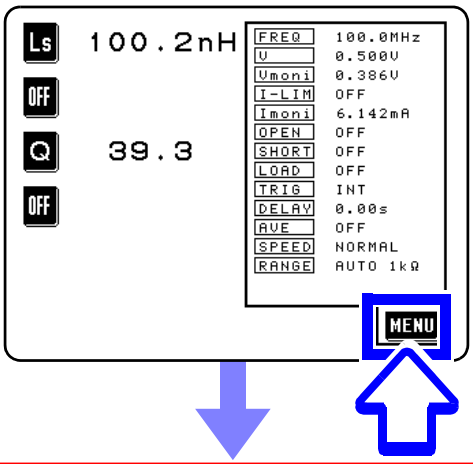
For details, see the Instruction Manual (3.1 "Setting the Measurement Frequency").

3.2.3 Setting the Constant Current Level

(Example)

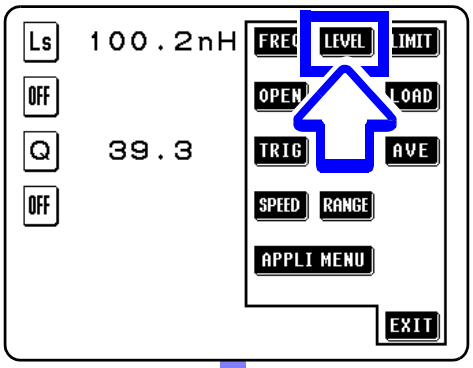
Set the value for the constant current level to 1 mA.

Initial Screen



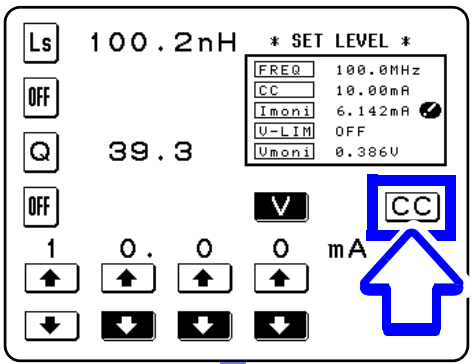
1. On the Initial Screen, press **MENU**, and the Menu Screen will be displayed.

Menu Screen



2. Press **LEVEL** (Measurement signal level), and the Measurement Conditions Setting Screen will be displayed.

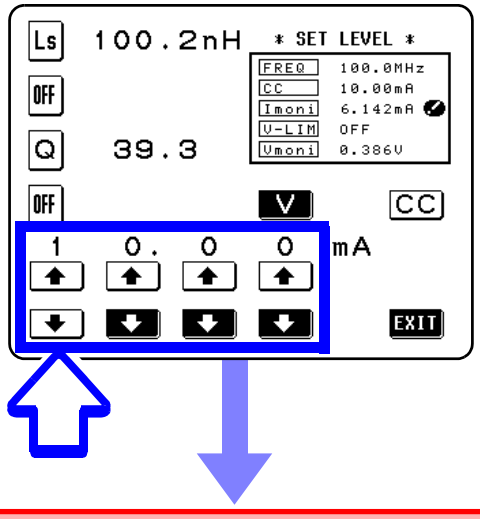
Measurement Conditions Setting Screen



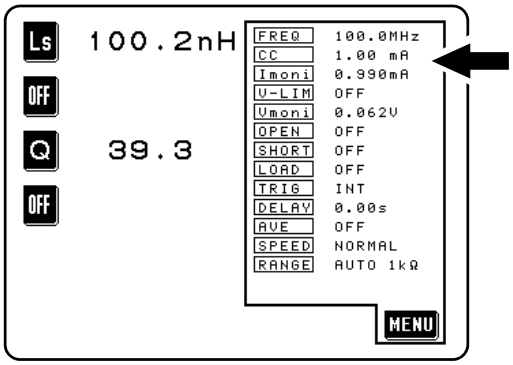
3. Press **CC** (constant current).

CC is highlighted.

Measurement Conditions Setting Screen



Initial Screen



4. Using ▲ / ▼ , set to "**01.00**".

▲ The numeric character increases by one.

▼ The numeric character decreases by one.

Continuously pressing the keys enables the numerical value to be increased or decreased continuously.

5. After setting, press EXIT to register the setting.

The Measurement Condition Setting Screen returns to the Initial Screen.

- During constant current (CC) setting, the unit operates so that the current between sample pins is constant (1.00 mA).
- The accuracy of this constant current:
  ±(10% + 50 μA) x (2 + log f)
  (f: measurement frequency [MHz])

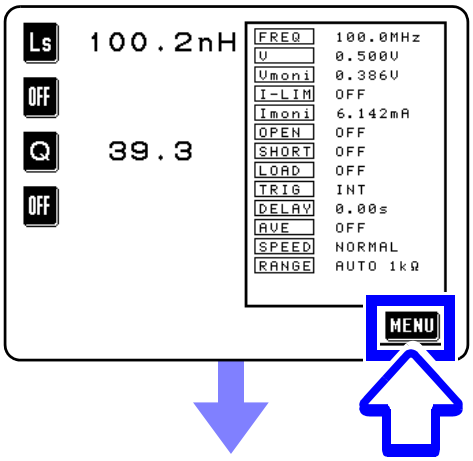
For details, see the Instruction Manual (3.2 "Setting the Measurement Signal Level").

3.2.4 Setting the Measurement Range

(Example)

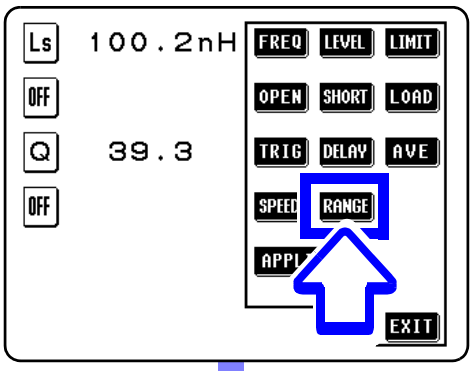
Set the measurment range to 1 kΩ.

Initial Screen



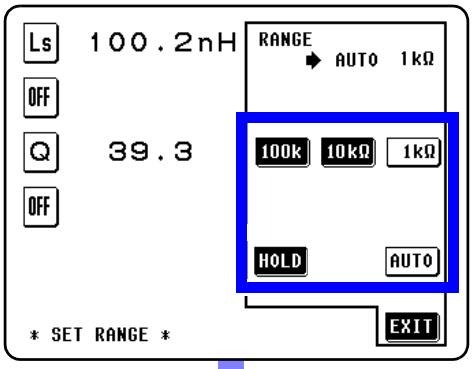
1. On the Initial Screen, press **MENU**, and the Menu Screen will be displayed.

Menu Screen



2. Press **RANGE** (Measurement range), and the Measurement Conditions Setting Screen will be displayed.

Measurement Conditions Setting Screen



3. When "1 kΩ" is selected (1 kΩ is highlighted):

Press **HOLD**.

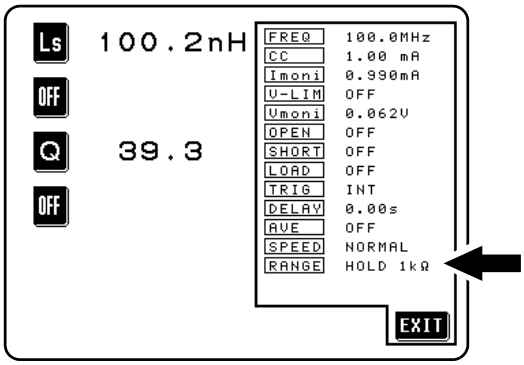
HOLD is highlighted.

When "1 kΩ" is not selected:

Press **1kΩ**.

4. After setting, press **EXIT** to register the setting.

Initial Screen



The Measurement Condition Setting Screen returns to the Initial Screen.

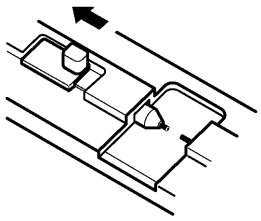
For details, see the Instruction Manual (3.11 "Setting the Measurement Range").

3.2.5 Setting Open-circuit Compensation

(Example)

Set up ALL open-circuit compensation, with which open-circuit compensation values for all of the measurement frequencies are determined and adjusted.

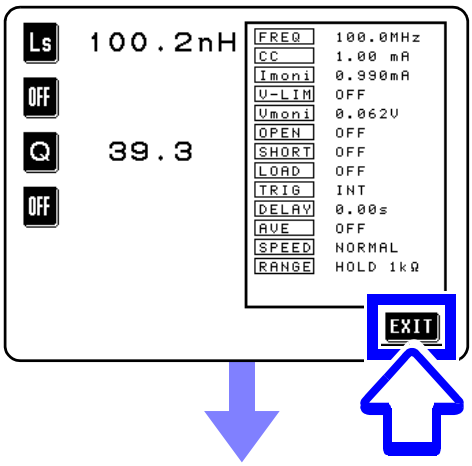
When using the 9677



1. Open the high and low levels of the test fixture.

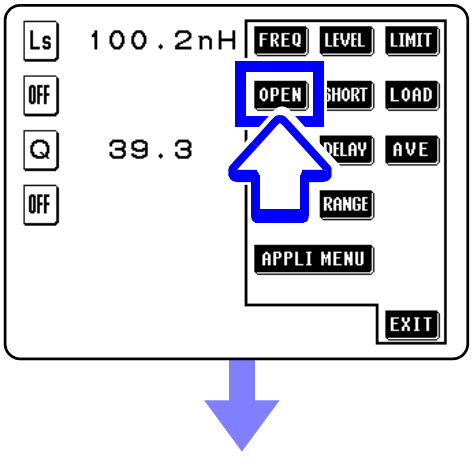
❖ For details, see the Instruction manual of the test fixture.

Initial Screen



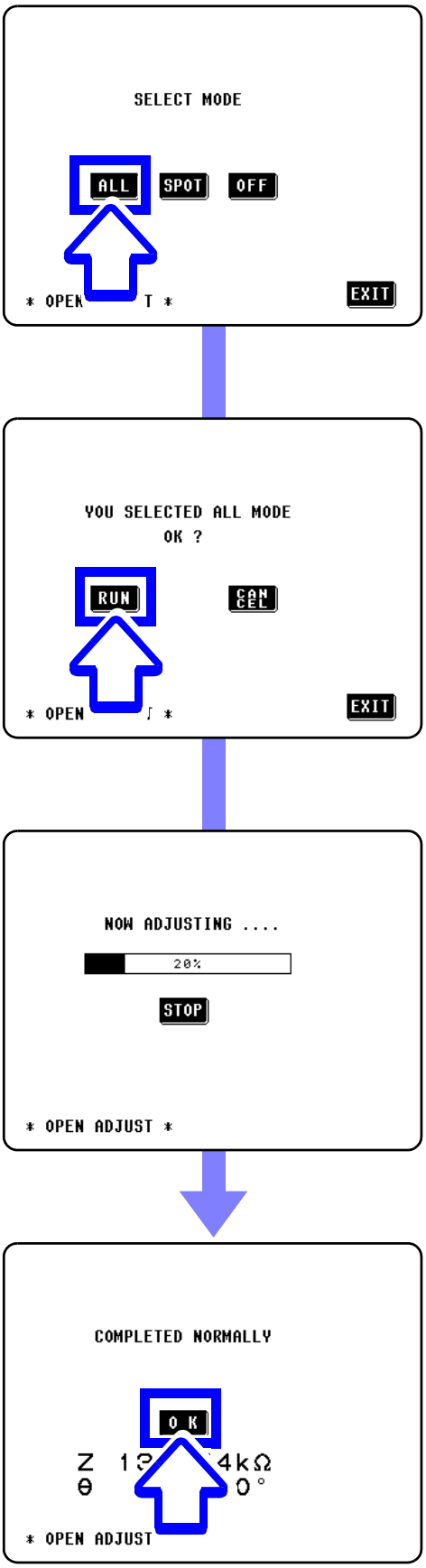
2. On the Initial Screen, press **MENU** , and the Menu Screen will be displayed.

Menu Screen



3. Press **OPEN** (open-circuit compensation), and the Measurement Conditions Setting Screen will be displayed.

Measurement Conditions Setting Screen



4. Press **ALL** (ALL compensation).

ALL compensation:
The compensation values are obtained for all measurement frequencies.

5. Confirm that the test fixture is in the open state and press **RUN**.

(Data loading)

After about 5 minutes, the determination and adjustment of the open-circuit compensation values (for ALL) is complete.

❖ When an Error Message Appears: (page 47)

The open-circuit residual component of a test fixture in a frequency of 120 MHz and its phase angle are displayed when the determination and adjustment are completed normally.

These values are required for use with the measurement range on HOLD.

❖ Open-circuit Compensation and Short-circuit Compensation (page 48)

6. After checking the open-circuit residual component and its phase angle, press **OK**, and the display will return to the Initial Screen.

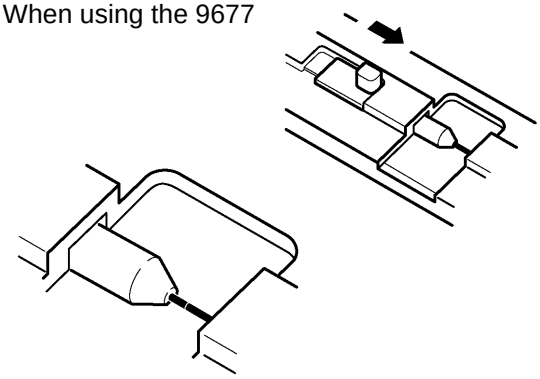
For details, see the Instruction Manual (3.4 "Open Circuit Compensation").

3.2.6 Setting Short-circuit Compensation

(Example)

Set up ALL short-circuit compensation, with which short-circuit compensation values for all of the measurement frequencies are determined and adjusted.

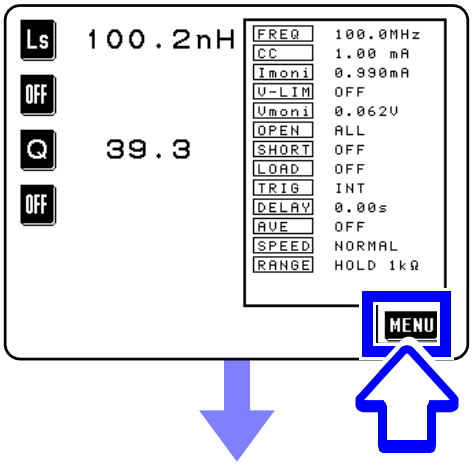
When using the 9677



1. Short-circuit the high and low levels of the test fixture.

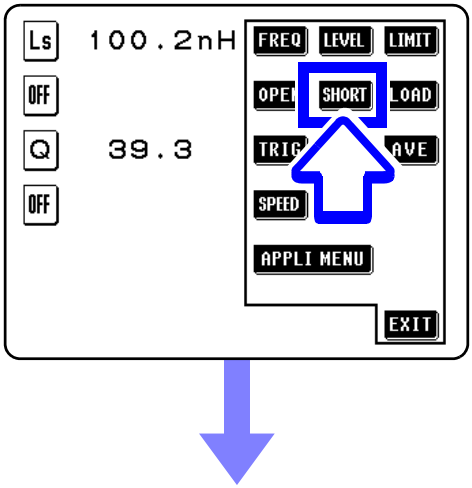
❖ For details, see the Instruction manual of the test fixture.

Initial Screen



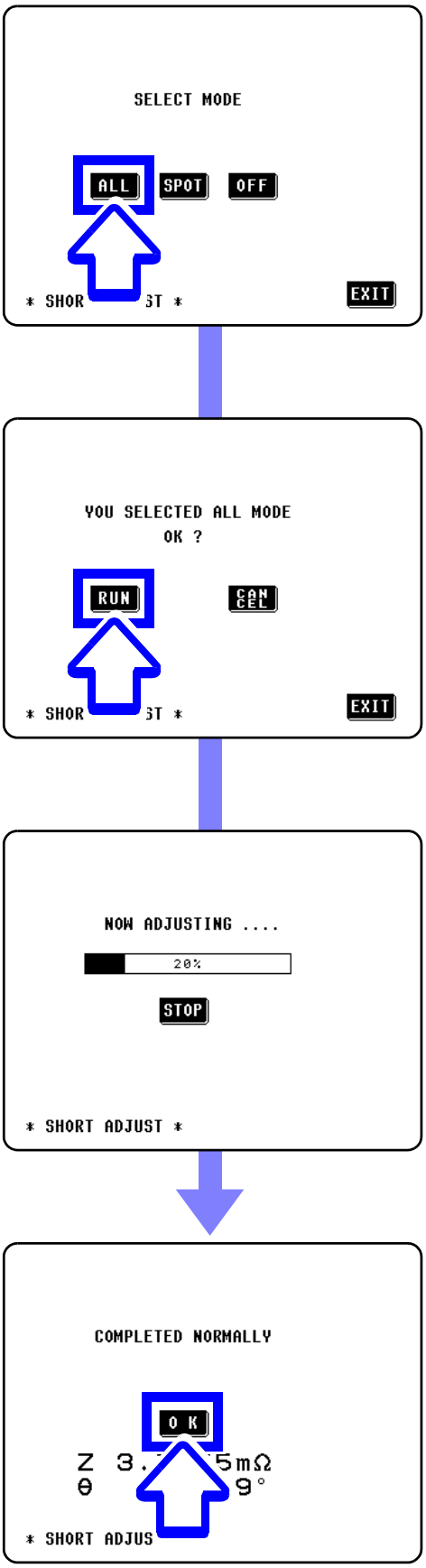
2. On the Initial Screen, press **MENU** , and the Menu Screen will be displayed.

Menu Screen



3. Press **SHORT** (short-circuit compensation), and the Measurement Conditions Setting Screen will be displayed.

Measurement Conditions Setting Screen



4. Press **ALL** (ALL compensation).

ALL compensation:
The compensation values are obtained for all measurement frequencies.

5. Confirm that the high and low levels of a test fixture are short-circuited and press **RUN**.

(Data loading)

After about 5 minutes, the determination and adjustment of the short-circuit compensation values (for ALL) is complete.

❖ When an Error Message Appears: (page 47)

The short-circuit residual component of a test fixture in a frequency of 120 MHz and its phase angle are displayed when the determination and adjustment are completed normally.

These values are required for use with the measurement range on HOLD.

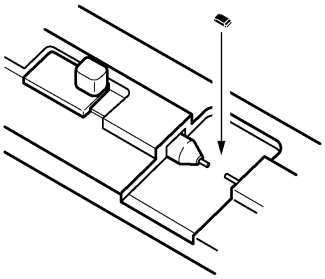
❖ Open-circuit Compensation and Short-circuit Compensation (page 48)

6. After checking the short-circuit residual component and its phase angle, press **OK**, and the display will return to the Initial Screen.

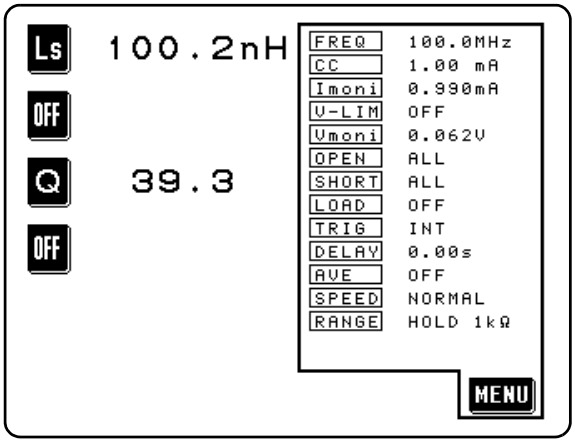
For details, see the Instruction Manual (3.5 "Short Circuit Compensation").

3.2.7 Starting the Measurement

When using the 9677

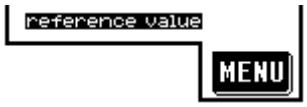


Under the set conditions, insert an inductor (100 nH) into a test fixture and start the measurement.



3.2.8 Measurement Value

In the 3535, the measurement value may be displayed even if it is out of the accuracy guarantee range. The comment (reference value) below is then displayed on the screen.



In this case, the following possible cause is considered.
Confirm the accuracy guarantee range and change the measurement conditions or use the measurement value as a reference value.

❖ Accuracy guarantee range: Instruction Manual, 7.4, "Measurement Range and Accuracy"

- The range of values that can be measured depends on the selected measurement range, so select the range that suits the value to be measured.
- The value is in the non-balanced state. It may be put into the balanced state by changing the setting of a measurement frequency or voltage.

❖ Instruction Manual Appendix 2, "Measurement Principle"

- The screen displayed when the power is turned off is activated when, on the screens below, the power is turned off and then turned on again.
  Initial Screen, Comparator Screen, BIN Screen, Scaling Screen, Zoom Display Screen, Continuous Measurement Screen

Maintenance and Service

Chapter 4

4.1 Checking, Repair, and Cleaning

In order to use the 3535 safely, the following maintenance and checking procedures should be executed at the proper intervals.

⚠WARNING

Never modify the instrument. Only a HIOKI service engineer can disassemble or repair the instrument. Failure to observe these precautions may result in fire, electric shock, or injury.

⚠CAUTION

If damage is suspected, check the "Troubleshooting" section before contacting your dealer or HIOKI representative.

If operation is interrupted in the following kinds of situation, remove the power cord, and get into contact with an approved HIOKI service facility:

- The unit is clearly damaged.
- Even when you try, measurement is not possible.
- The unit has remained subject to high temperature or high humidity conditions for a long time period.
- The unit has been subjected to stress due to rough transportation.
- When the unit is wet with water or other liquids or soiled with oil or dust
  Getting the unit wet or letting oil or dust enter inside its casing will certainly damage it, and is quite likely to cause an electric shock accident or a dangerous conflagration.

In the following case, contact a HIOKI service facility.

- When no measurement conditions can be saved
  A lithium battery is used in the 3535 for powering the backup memory. When this battery becomes unfit for service, it is no longer possible to preserve the measurement conditions.
  The average life of a backup battery is approximately five years during normal operation.

Shipping

NOTE

- Pack the instrument carefully so that it will not be damaged during shipment, and include a detailed written description of the problem. HIOKI cannot be responsible for damage that occurs during shipment.
- Use the original packing materials when reshipping the instrument, if possible.

Troubleshooting

Symptom	Check Items	Countermeasure
Although you have turned on the power switch, the screen display does not appear.	Is the power cord disconnected?	Reconnect the power cord.
	Is the contrast on the LCD panel turned down to minimum?	Adjust the LCD panel contrast.
Keys do not operate.	Is the unit in the key locked state?	Release the key lock state.
	Is the unit remotely controlled from the outside using GP-IB?	Set GP-IB to local.
	Is the unit remotely controlled from the outside using RS-232C?	Set RS-232C to local.
Measurement value is incorrect.	Were open and short-circuit compensations performed?	Perform open and short-circuit compensations. ❖ 3.2.5, "Setting Open-circuit Compensation" (page 34) ❖ 3.2.6, "Setting Short-circuit Compensation" (page 36)

Cleaning

⚠CAUTION

- To clean the instrument, wipe it gently with a soft cloth moistened with water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners or gasoline, as they can deform and discolor the case.
- Wipe the LCD gently with a soft, dry cloth.

4.2 Instrument Disposal

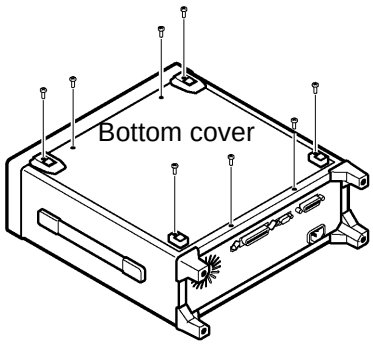
The instrument contains a lithium battery for recording measurement conditions.

⚠WARNING

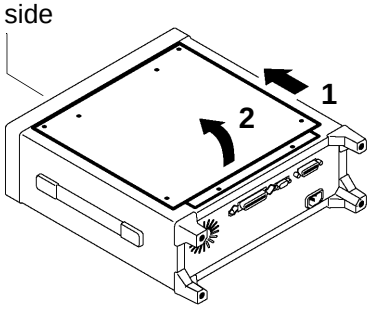
- **To avoid electrocution, turn off the power switch and disconnect the power cord before removing the lithium battery.**
- **When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.**

Required tools:

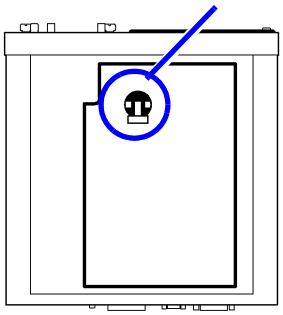
- Phillips screwdriver...1
- Tweezers (Sharp-pointed tool)...1

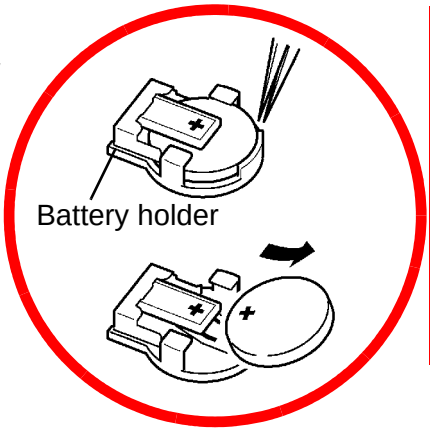


Front side



Lithium battery





1. Turn the 3535 over.
2. Remove the eight screws at the back of the unit.
3. Slide the bottom panel into the front side and remove it.
4. Insert a pointed tool, such as the tip of a tweezers, between the battery and the battery holder, and lift the battery to remove it.

⚠CAUTION

Be careful not to short-circuit the + and – sides.
This may cause sparking.

CALIFORNIA, USA ONLY
This product contains a CR Coin Lithium Battery which contains Perchlorate Material - special handling may apply.
See www.dtsc.ca.gov/hazardouswaste/perchlorate

Appendix

Quick Reference

Settings *:See Notes (page 47)	Procedure ([ ]: Set as required.)
(1) Measurement frequency *1 ❖ Instruction Manual; 3.1	MENU ▶ FREQ ▶ [TEN KEY / DGT KEY] ▶ Numerical value setting ▶ EXIT
(2) Measurement signal level *1 ❖ Instruction Manual; 3.2	MENU ▶ LEVEL ▶ V / CC ▶ Numerical value setting ▶ EXIT V: Set the value of the open-circuit voltage. CC: Set the value of the current flowing through the object under measurement.
(3) Voltage/ Current limit *1 ❖ Instruction Manual; 3.3	MENU ▶ LIMIT ▶ Numerical value setting ▶ LIMIT ON / LIMIT OFF ▶ EXIT This display appears when the set value of a measurement signal level is not reached. limit: This display appears when the set value of a measurement signal level is not reached without applying the voltage or current exceeding limit values to a sample. <Remedy> Set the limit values again or change the measurement signal level so that the voltage or current does not exceed the limit values.
(4) Compensation value loading (open-circuit compensation) *2,*3 ❖ Instruction Manual; 3.4	Open circuit state ▶ MENU ▶ OPEN ▶ ALL / SPOT ▶ Numerical value setting + Unit selection ▶ RUN ▶ O K ▶ EXIT ALL: Compensation is performed at all the measurement frequencies. SPOT: Compensation is performed for one specified measurement frequency only. OFF: Open-circuit compensation data is invalidated.

Settings *:See Notes (page 47)	Procedure ([ ]: Set as required.)
(5) Compensation value loading (short-circuit compensation) ***2,*3** ❖ Instruction Manual; 3.5	Short circuit state ▶ MENU ▶ SHORT ▶ ALL / SPOT ▶ Numerical value setting + Unit selection ▶ RUN ▶ O K ▶ EXIT ALL: Compensation is performed at all the measurement frequencies. SPOT: Compensation is performed for one specified measurement frequency only. OFF: Short-circuit compensation data is invalidated.
(6) Load compensation ❖ Instruction Manual; 3.6	MENU ▶ LOAD ▶ Compensation condition number selection ▶ Compensation condition selection ▶ Mode selection / Numerical value setting + Unit selection ▶ O K ▶ RUN ▶ EXIT Compensation condition selection: FREQ: Compensation frequency setting MODE: Input mode setting of reference value REF1: Set the reference value 1 (Z/Cs/Cp/Rs/Ls/Lp) REF2: Set the reference value 2 (θ/D/X/Q)
(7) Trigger ❖ Instruction Manual; 3.7	MENU ▶ TRIG ▶ EXT / INT ▶ EXIT EXT: External trigger (The trigger is input manually, via EXT I/O, or via interface.) INT: Internal trigger (Measurement is performed continuously)
(8) Trigger delay (Time required from trigger generation to loading start) ❖ Instruction Manual; 3.8	MENU ▶ DELAY ▶ Numerical value setting ▶ EXIT **Cancel:** C
(9) Average (Averaging measurement value) ❖ Instruction Manual; 3.9	MENU ▶ AVE ▶ Numerical value setting ▶ EXIT
(10)Measurement speed ❖ Instruction Manual; 3.10	MENU ▶ SPEED ▶ FAST / NORM / SLOW2 / SLOW ▶ EXIT FAST: Low accuracy measurement is performed at high speed (6 ms±1 ms) NORM: The speed used for normal measurement (8 ms±1 ms) SLOW: High accuracy measurement is performed slowly (55 ms±1 ms) SLOW2: High accuracy measurement is performed slowly (668 ms±1 ms)

Settings *:See Notes (page 47)	Procedure ([ ]: Set as required.)

(11)Measurement range

❖ Instruction Manual; 3.11

MENU ▶ RANGE ▶ 1kΩ / 10kΩ / 100k / HOLD / AUTO ▶ EXIT

1kΩ	Measurement range:100 mΩ to 2 kΩ
10kΩ	Measurement range:1 kΩ to 20 kΩ
100k	Measurement range:10 kΩ to 300 kΩ
HOLD	Fix (hold) the currently selected measurement range.
AUTO	Automatically select the most suitable range.

(12)Comparator *4

❖ Instruction Manual; 4.1

MENU ▶ APPLI MENU ▶ COMP ON ▶ Parameter selection ▶ LMT ▶

▶ ABS / Δ% / % ▶ H I / L O / REF (% only) ▶

▶ Numerical value setting + Unit selection ▶ ENTER ▶ EXIT

ABS	Absolute value setting (The upper limit value and the lower limit value are set as absolute numerical values.)
%	Percentage setting (A reference value is input, and the upper-limit and lower-limit values are set as percentages relative to the reference value. The measurement values displayed are the same as those of the measurement parameters.)
Δ%	Deviation percentage setting (A reference value is input, and the upper-limit and lower-limit values are set as percentages relative to the reference value. The measurement values are displayed in deviations (Δ%) from the reference value.)

Exiting comparator mode:

MENU ▶ APPLI MENU ▶ COMP OFF

(13)BIN measurement

❖ Instruction Manual; 4.2

MENU ▶ APPLI MENU ▶ BIN ON ▶ BIN LIST ▶

Move to the mode/reference value/upper- and lower-limit value set items.

▶ ↑ / ↓ / ← / → ▶ SELECT ▶ Setting ▶ ENTER ▶ EXIT

Selecting mode: ABS / % / Δ%

Setting of the reference value, upper and lower limit values:

Numeric keypad + ×10³ 1/10³

Exiting BIN measurement mode: MENU ▶ APPLI MENU ▶ BIN OFF

(14)Scaling

❖ Instruction Manual; 4.3

MENU ▶ APPLI MENU ▶ SCALE ON ▶ Parameter selection ▶ ab ▶

▶ a / b ▶ Numerical value setting + Unit selection ▶ ENTER ▶ EXIT

Exiting scaling mode:

MENU ▶ APPLI MENU ▶ SCALE OFF

Settings *:See Notes (page 47)	Procedure ([ ]: Set as required.)
(15)Panel save *5 ❖ Instruction Manual; 4.4	MENU ▶ APPLI MENU ▶ PANEL SAVE ▶ [PAGE UP / PAGE DOWN] ▶ Panel number selection ▶ NAME ▶ Name setting ▶ ENTER ▶ YES **Setting the saving name:** ABC↔123 Toggles between the alphabet input screen and numerical input screen. B S Back space CLEAR Clears the input character.
(16)Panel load *5 ❖ Instruction Manual; 4.5	MENU ▶ APPLI MENU ▶ PANEL LOAD ▶ [PAGE UP / PAGE DOWN] ▶ Panel number selection ▶ YES
(17)Beep sound ❖ Instruction Manual; 4.6	MENU ▶ APPLI MENU ▶ ♪ ▶ O N / OFF ▶ Setting during comparator judgment ▶ EXIT **When the comparator makes a single decision:** I N When the comparator result is IN, a beep sound is emitted. N G When the comparator result is LO or HI, a beep sound is emitted. OFF No beep sound is emitted when the comparator operates. **When the comparator makes two decisions:** I N When both of these comparator results are IN, a beep sound is emitted. N G When either of these comparator result is LO or HI, a beep sound is emitted. OFF No beep sound is emitted when the comparator operates.
(18)Zoom display ❖ Instruction Manual; 4.7	MENU ▶ APPLI MENU ▶ ▶ EXIT
(19)System reset ❖ Instruction Manual; 4.8	MENU ▶ APPLI MENU ▶ RESET ▶ YES
(20)Continuous measurement ❖ Instruction Manual; 4.9	Panel saving ▶ MENU ▶ APPLI MENU ▶ CONT MEAS ▶ [PAGE UP / PAGE DOWN] ▶ Panel number selection ▶ ON/OFF ▶ MANU TRIG Displays • Measurement conditions are displayed: Measurement is executed. • *** **NO USE** ***: Not measured.
(21)Display digits ❖ Instruction Manual; 4.10	MENU ▶ APPLI MENU ▶ DIGIT ▶ Display digits setting ▶ EXIT

Settings *:See Notes (page 47)	Procedure ([ ]: Set as required.)

(22)Display monitor

❖ Instruction Manual; 4.11

MENU ▶ APPLI MENU ▶ DISP ▶ ON / OFF ▶ EXIT

Backlight setting (LIGHT&DISPLAY)

ON	Lights at all times.
OFF	Goes off.

Voltage/ Current monitor setting (V/I moni DISPLAY)

ON	Displayed.
OFF	Not displayed.

(23)Interface

❖ Instruction Manual; 5.4
❖ Instruction Manual; 6.3.2

MENU ▶ APPLI MENU ▶ INTERFACE ▶ GP-IB / RS 232C / 9442 PRINT ▶

Communication conditions/mode selection ▶ EXIT

GP-IB	Address setting	▲ / ▼
	Terminator setting	LF / CR+LF
RS 232C	Transfer rate	19200 / 9600
9442 PRINT	Printing method	SCR COPY / MANU / AUTO

Notes:

***1** Measurement Accuracy:
The measurement accuracy varies depending on the measurement conditions.

❖ Instruction Manual: 7.4, "Measurement Range and Accuracy"

***2** When an Error Message Appears:

"ZERO ADJUSTMENT FAILURE"

When an error message appears and compensation has stopped, open-circuit compensation is turned OFF.

Open-circuit compensation:

The open-circuit compensation process is quite sensitive to noise - both noise originating externally and induced noise. Therefore, if open-circuit compensation has been interrupted with a fault, you should check the following points before starting the compensation process again:

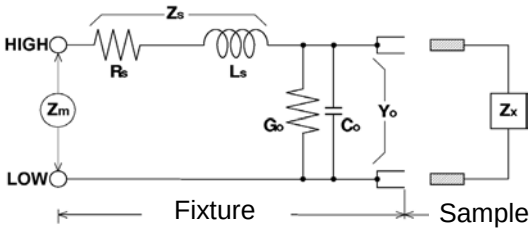
- Check that the test fixture is properly connected.
- Check that nothing is connected to the test fixture. (Open-circuit compensation cannot be performed while any measurement sample is connected to the test fixture.)
- Check that the test fixture is arranged as closely as possible to their configuration in which measurement will be performed.
- During the compensation process, be sure not to disturb the test fixture or to move your hand near them.

Short-circuit compensation:

- Check that the test fixture is properly connected.
- During the compensation process, be sure not to disturb the test fixture or to move your hand near them.

*3 Open-circuit Compensation and Short-circuit Compensation

The residual impedance component of the test fixture can be considered in terms of an equivalent circuit as shown in the figure. Further, because the measured value Zm for impedance includes this residual component, therefore, in order to obtain the genuine impedance value, it is necessary to compensate the measured value in terms of the open-circuit impedance residual component and the short-circuit residual component, which accordingly must be obtained.



Zx: true value Rs: residual resistance
Ls: residual inductance Go: residual conductance
Co: floating capacitance value
Zs : short-circuit residual component
Yo: open-circuit residual component
Zm: measured value
Zm = Zs + 1/(Yo + 1/Zx)

How to obtain residual components

Open-circuit compensation:
The terminals of the test fixture are left separated (open-circuited). Because the short-circuit residual component Zs is now zero, therefore the open-circuit residual component Yo can be determined.

Short-circuit compensation:
The terminals of the test fixture are connected together (short-circuited). Because the open-circuit residual component Yo is now zero, therefore the short-circuit residual component Zs can be determined.

These residual components thus obtained are recorded as compensation values, and the compensation process may then be performed by substituting them into the above equation. For details, see the Instruction Manual.

*4 Judgment of comparator

Criterion	Display
1. If the measured value is "OVERFLOW" If the measured value is "UNDERFLOW"	**HI** **LO**
2. If it is judged whether the measured value is higher than a lower-limit value and the result is NG.	**LO**
3. If it is judged whether the measured value is lower than an upper-limit value and the result is NG.	**HI**
4. If both 2 and 3 give an affirmative result	**IN**

No measurement is performed in order to ensure that the upper limit value is greater than the lower limit value. Therefore no error message will be displayed even if you mistakenly interchange the settings for the desired upper limit value and the desired lower limit value. However, be careful that the decision process will not operate properly.

*5 Panel Save/ Panel Load Function

The marks below are displayed when measurement conditions are saved and loaded in the following state.

- Comparator mode: COMP
- BIN measurement: BIN

MEMO

MEMO

HIOKI

HIOKI E. E. CORPORATION

Headquarters
81 Koizumi, Ueda, Nagano 386-1192, Japan
TEL +81-268-28-0562 FAX +81-268-28-0568 E-mail: os-com@hioki.co.jp
URL http://www.hioki.com/
(International Sales and Marketing Department)

HIOKI USA CORPORATION
6 Corporate Drive, Cranbury, NJ 08512, USA
TEL +1-609-409-9109 FAX +1-609-409-9108 E-mail: hioki@hiokiusa.com
URL http://www.hiokiusa.com

HIOKI (Shanghai) Sales & Trading Co., Ltd.
1608-1610, Shanghai Times Square Office 93 Huaihai Zhong Road Shanghai,
P.R.China POSTCODE: 200021
TEL +86-21-63910090 FAX +86-21-63910360 E-mail: info@hioki.com.cn
URL http://www.hioki.cn

HIOKI INDIA PRIVATE LIMITED
Khandela House, 24 Gulmohar Colony Indore 452 018 (M.P.), India
TEL +91-731-6548081 FAX +91-731-4020083 E-mail: info@hioki.in
URL http://www.hioki.in

HIOKI SINGAPORE PTE. LTD.
33 Ubi Avenue 3, #03-02 Vertex Singapore 408868
TEL +65-6634-7677 FAX +65-6634-7477 E-mail: info@hioki.com.sg

1205

- For regional contact information, please go to our website at http://www.hioki.com.
- The Declaration of Conformity for instruments that comply to CE mark requirements may be downloaded from the HIOKI website.
- All reasonable care has been taken in the production of this manual, but if you find any points which are unclear or in error, please contact your supplier or the International Sales and Marketing Department at Hioki headquarters.
- In the interests of product development, the contents of this manual are subject to revision without prior notice.
-

Edited and published by Hioki E.E. Corporation Printed in Japan