HIOKI

Instruction Manual

3532-50

LCR HiTESTER

HIOKI E. E. CORPORATION

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60020405A

Contents

Introduction

Thank you for purchasing the HIOKI "3532-50 LCR HiTESTER." To obtain maximum performance from the product, please read this manual first, and keep it handy for future reference.

This manual contains information and points for attention which are necessary for safe operation of the unit and for storing it safely in proper operational condition.

Shipping Check

When you receive the product, 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.

Check the 3532-50 unit and the supplied accessories

Main unit

3532-50 LCR HiTESTER

Supplied accessories

(1) Instruction manual ... 1

(2) Grounded power cord ... 1

(3) Spare fuse for power supply (according to voltage specification) ... 1
100 V, 120 V setting: 250 V T1.0AL 20 mm x 5 mm dia.
220 V, 240 V setting: 250 V T0.5AL 20 mm x 5 mm dia.

NOTE No interface boards and no test cables are supplied with the unit as standard equipment. You should order them separately, according to requirements.

Safety

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

⚠ WARNING

This product 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 product. Using the product 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 product defects.

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

Safety symbols

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

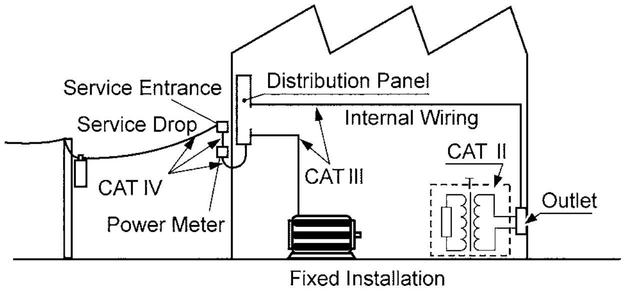
⚠ WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠ CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the product.
NOTE	Advisory items related to performance or correct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

Measurement categories

To ensure safe operation of measurement instruments, 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.



Points for Attention During Use

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

⚠ WARNING

- **Before turning the product on, make sure the source voltage matches that indicated on the product's power connector. Connection to an improper supply voltage may damage the product 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.**
- **To avoid electric shock, do not remove the instrument's case. The internal components of the instrument carry high voltages and may become very hot during operation.**

⚠ CAUTION

- Various connectors are present on the outside of the 3532-50. 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..
- 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.
- This product should be installed and operated between 0℃ and 40℃ and 80% RH or less, and less than 2000 m height.
- The unit should always be stored in a range of temperature and humidity from -10℃ to 55℃, 80% RH or less.
- Do not store or use the product where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the product may be damaged and insulation may deteriorate so that it no longer meets specifications.
- To avoid damage to the product, 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 probes 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.
- Ventilation holes for heat radiation are provided on the side panels of the product. Leave sufficient space around the ventilation holes and install the product with the holes unobstructed. Installation of the product with the ventilation holes obstructed may cause a malfunction or fire.

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.

Layout of This Manual

Chapter 1 **Product Overview**
Describes the product generally, and lists the parts and functions.

Chapter 2 **Before Starting Measurement**
How to connect the power cord etc., and important precautions before operation.

Chapter 3 **Outline of Operation**
Explains the touch panel and basic testing.

Chapter 4 **Detailed Description of Functions**
Detailed explanation of the functions.

Chapter 5 **Detailed Description of Applications**
Various testing applications.

Chapter 6 **Maintenance, Adjustment, and Disposal**

Chapter 7 **Specification and Options**

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Chapter 1
Product Overview

1.1 Product Overview

The HIOKI 3532-50 LCR HiTESTER is an impedance meter which uses a touch panel as the user interface. This interactive touch panel enables extremely easy operation. The test frequency can be set from 42 Hz to 5 MHz at high resolution.

The values of a maximum of any four of the fourteen test 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 voltage setting or a constant current setting.

1.2 Product Features

■ Wide range of test frequencies

The test frequency can be selected from a wide range - 42 Hz to 5 MHz - at high resolution (Three-digit resolution for not more than 100 Hz, and four-digit resolution for not more than 5 MHz). Frequency dependent assessment of electronic components and materials, etc., is possible.

■ Constant voltage and constant current testing

Assessment of dependence upon voltage or 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 test parameters (such as L,C,R, etc.) can be displayed simultaneously.

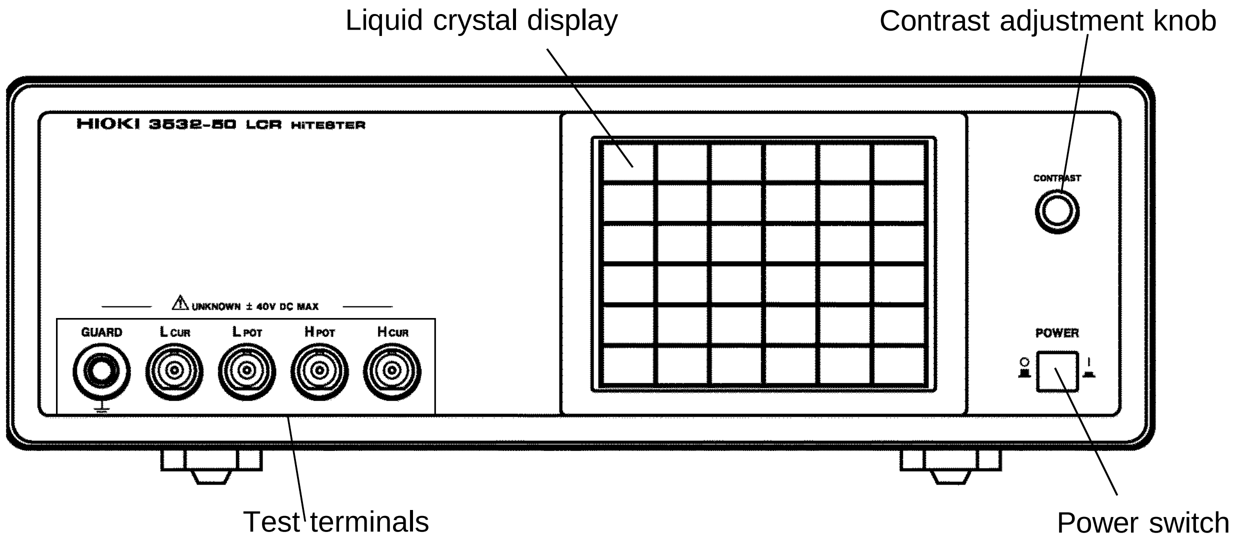
■ Interface

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 View

Liquid crystal display

This is a 5-inch liquid crystal display fitted with a touch panel. It also serves to provide input keys.

Power switch

Turns the power for the unit on and off.

Contrast adjustment knob

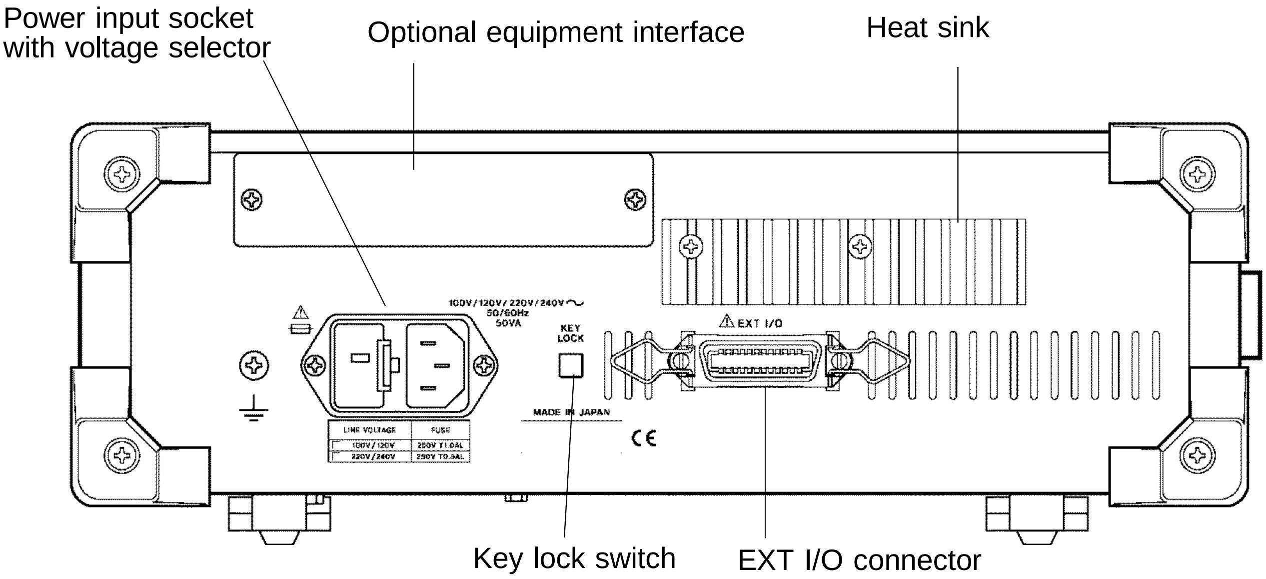
This knob adjusts the screen contrast. Turning it clockwise decreases the contrast, and vice versa.

Test terminals

There are five test terminals:

$\mathrm{H_{CUR}}$	The test signal is supplied to this terminal.
$\mathrm{H_{POT}}$	Detected voltage high terminal
$\mathrm{L_{POT}}$	Detected voltage low terminal
$\mathrm{L_{CUR}}$	Test current detected terminal
GUARD	Guard terminal

These test terminals are designed according to the safety standard; Pollution Degree 2, Measurement category I.



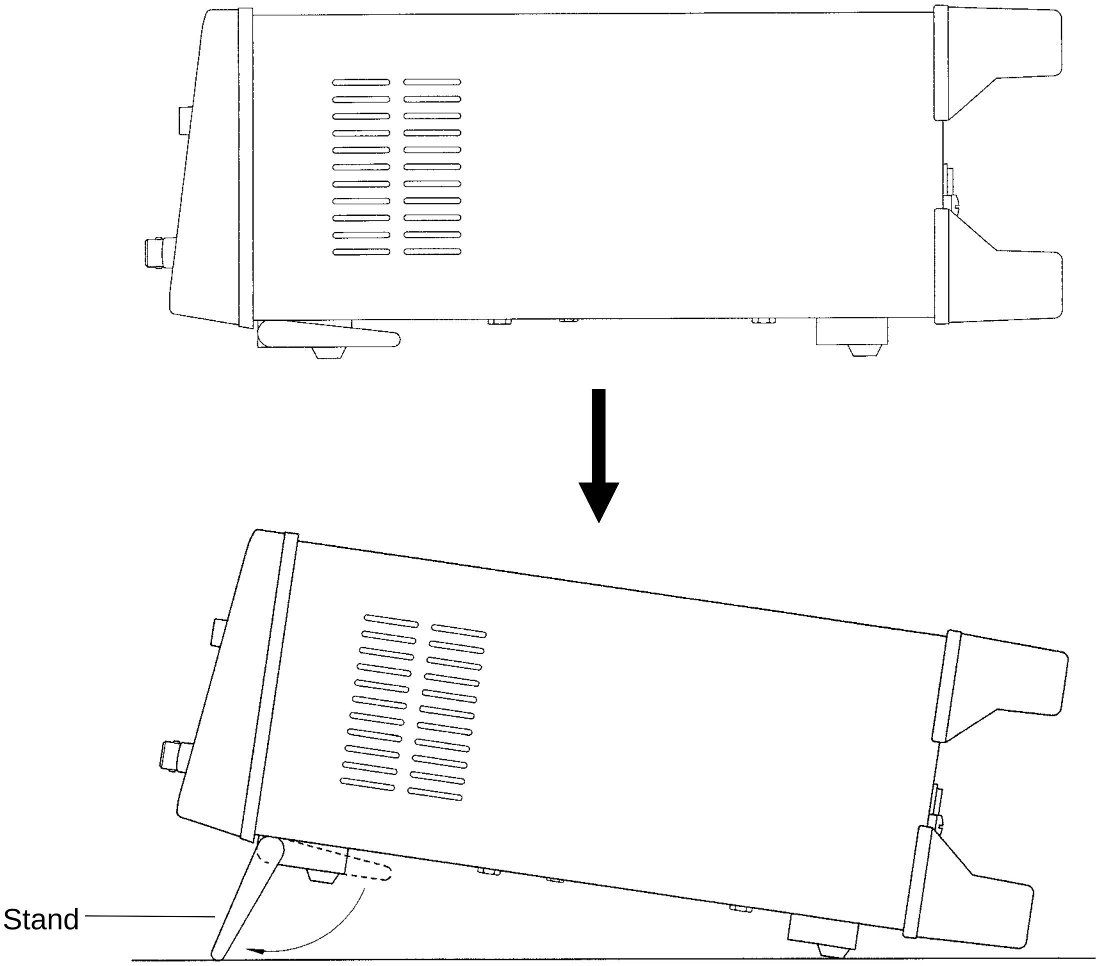
Rear View

Power input socket (internally fused type) with voltage selector
Connect the supplied power cord here.

Optional equipment interface
Optional interface boards are connected here.

EXT I/O connector
For input of an external trigger signal and output of comparator results. Compatible with sequencer connection.

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

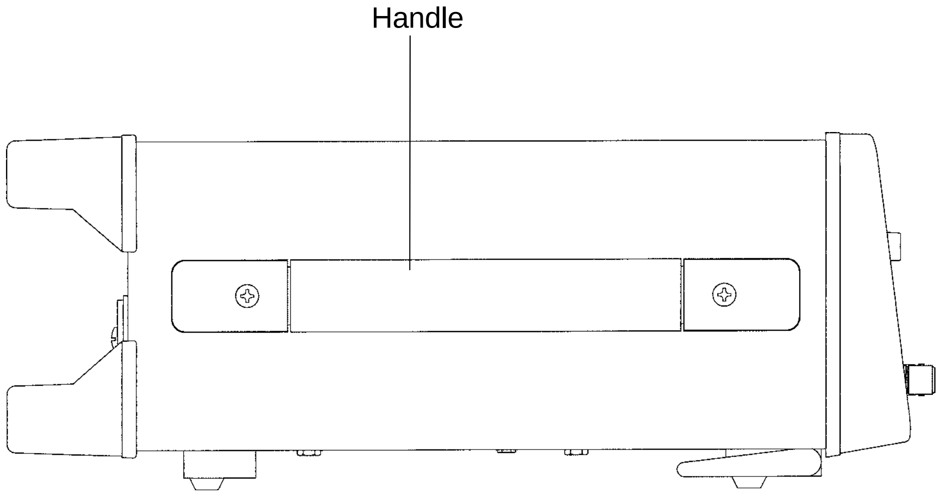


Right View

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.



Left View

Handle
Used when carrying the unit.

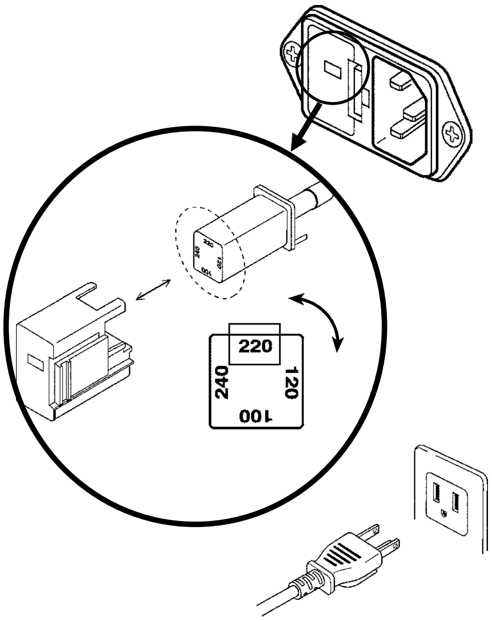
Chapter 2

Before Starting Measurement

2.1 Connecting the Power Cord

⚠ WARNING

- **When a 3532-50 unit is ordered, the supply voltage is set in the factory to the value specified, which can be 100 V, 120 V, 220 V, or 240 V.**
  The maximum rated power (with all options fitted) is 50 VA.
- **Before turning the product on, make sure the source voltage matches that indicated on the product's power connector. Connection to an improper supply voltage may damage the product and present an electrical hazard.**
- **The power supply voltage for this product is switchable. To avoid electrical accidents, check that the voltage selector is set correctly for the supply voltage you are using. (For details, refer to Section 6.2)**
- **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 power cord is connected according to the following procedure.

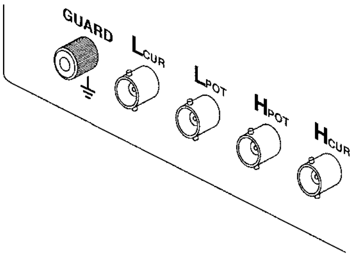
1. Check that the main power switch of the unit is off.
2. Check that the power supply voltage is correct, and connect the proper end of the power cord to the power input socket (with voltage selector) at the rear of the unit.
3. Plug the other end of the power cord into the power supply socket.

Grounding

Use the grounding type (three-wire) power cord supplied. The unit will be grounded automatically.

2.2 Connecting the Test Leads

The 3532-50 has five test terminals: H_{CUR} terminal (to which the test signal is supplied); H_{POT} terminal (detected voltage high terminal); L_{POT} terminal (detected voltage low terminal); L_{CUR} terminal (test current detected terminal), and GUARD terminal (connected to the chassis of the unit).

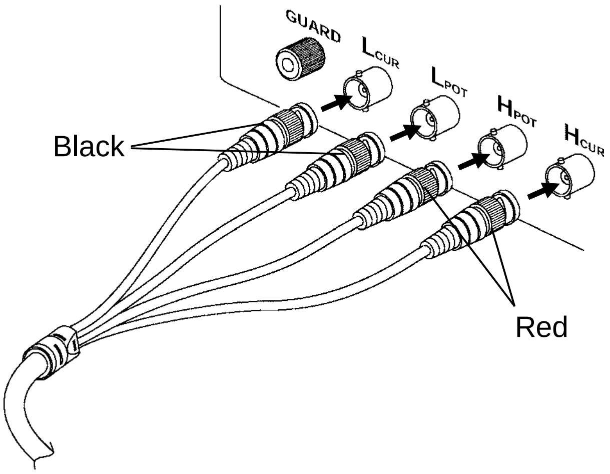


2.2.1 Establishing the Connections

⚠ CAUTION

- Using a low frequency to measure capacitors with a particular polarity (for example, electrolytic capacitors) results in a reverse bias being applied. In some cases this could damage or destroy the capacitor, and therefore a DC bias should always be applied while making the measurements. Also be sure that the positive terminal of the capacitor is connected to the Hcur terminal on this unit.
- When measuring capacitors with a particular polarity (for example, electrolytic capacitors), always apply a DC bias. If the DC bias is not applied, a reverse bias may be applied, damaging or destroying the capacitor.

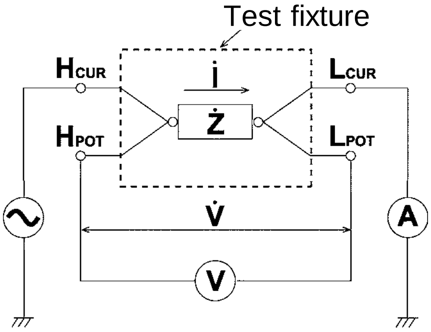
If using a test lead set supplied by HIOKI, connect the red leads to the H_{CUR} terminal and to the H_{POT} terminal, and connect the black leads to the L_{CUR} terminal and to the L_{POT} terminal.



The unit is designed and adjusted for 75 Ω coaxial cable test leads. It is best to use HIOKI test leads.

NOTE

- The connections to the article to be tested are as shown in the following figure.

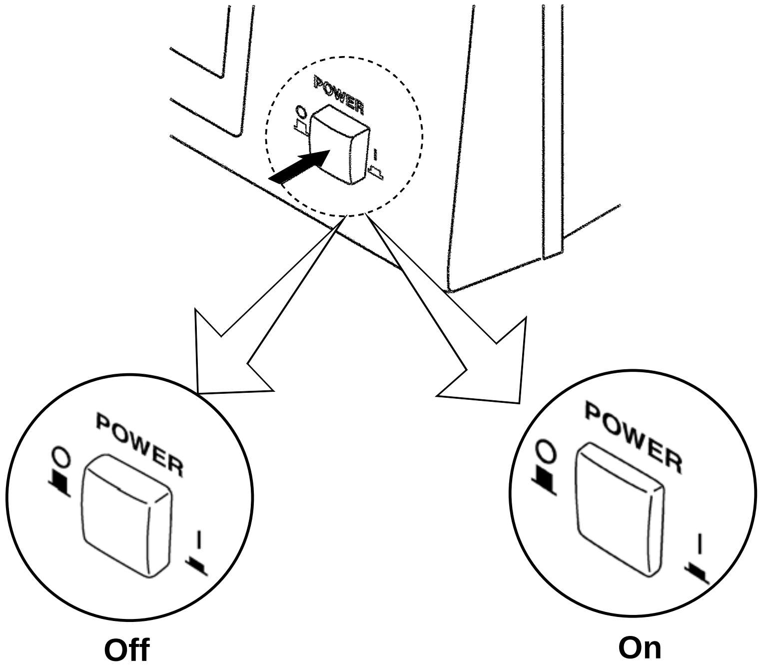


- No test cables are included with the 3532-50 unit. They must be purchased separately. (For details, refer to Section 7.4, "Options")
- If all four terminals are left floating, the numbers which appear on the display are completely meaningless.

2.3 Turning the Power On and Off

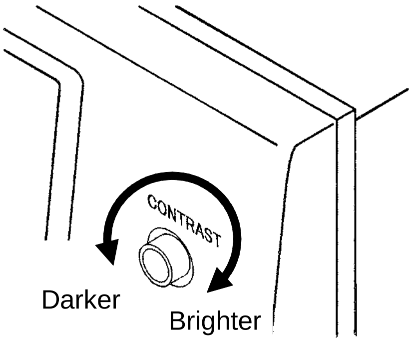
How to turn the power on

1. Turn on the power switch on the front panel. The Initial screen will be displayed on the liquid crystal display.



The test 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.



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

How to turn the power off

Turn off the power switch on the front panel. The test conditions will be preserved.

NOTE

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

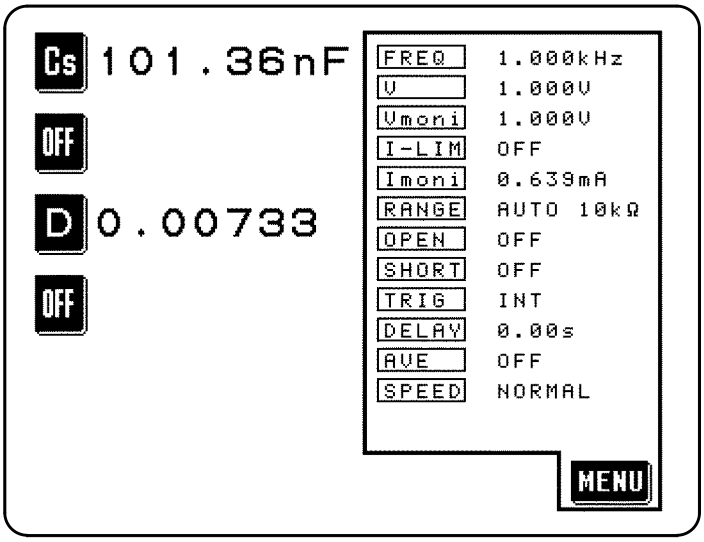
Chapter 3
Outline of Operation

3.1 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 3532-50 uses a touch panel for setting and changing all of the test 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.



Cs 101.36nF
D 0.00733

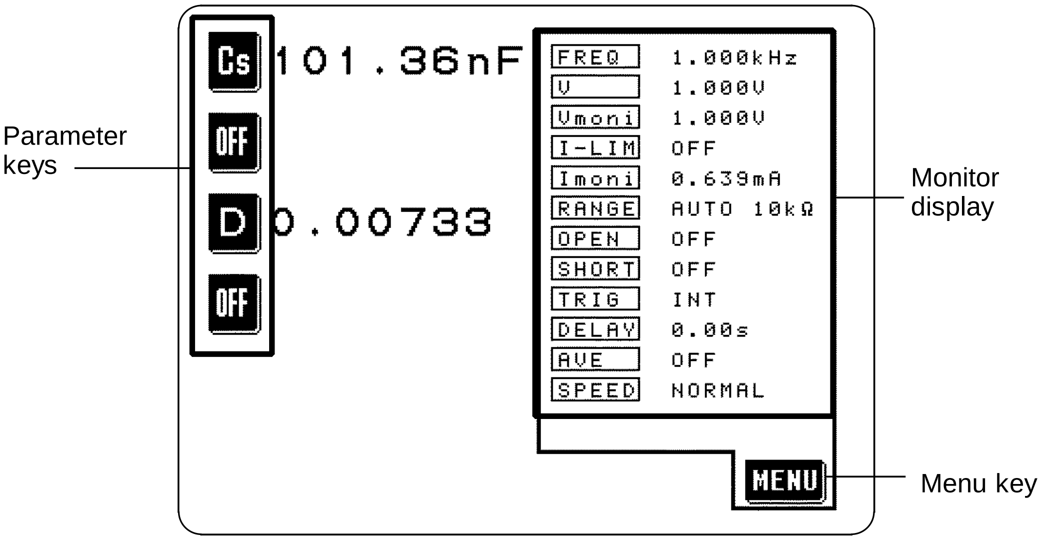
FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

3.2 About the Screen

(1) The Initial screen

- When the power is first turned on, the basic screen for controlling the 3532-50 immediately appears, called the "Initial screen". A maximum of four of the test parameters (L, C, *R*, etc.) can be set for display, and all of the test conditions can be checked, on this Initial screen.
- The Menu screen can be displayed by pressing the MENU key.
- The Parameter setting screen can be displayed by pressing a parameter key.



Cs 101.36nF

D 0.00733

FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Parameter keys

Monitor display

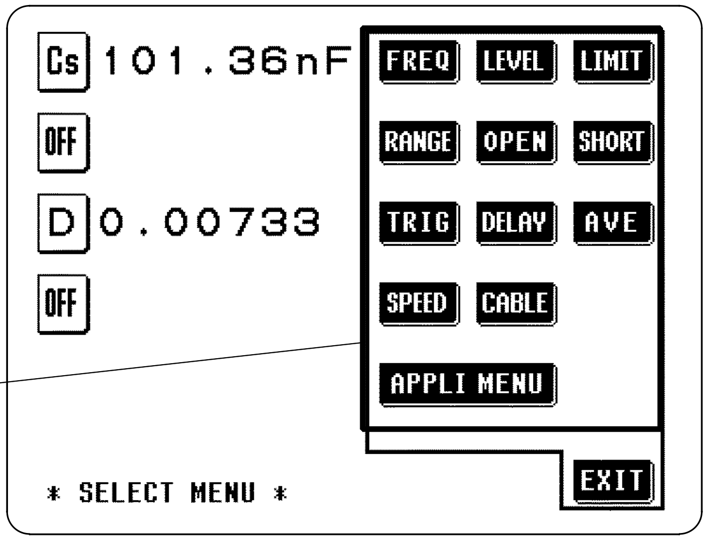
Menu key

Initial Screen

For details, refer to Section 4.1.1, "The Initial Screen."

(2) The Menu screen

The Menu screen is used for selecting whichever of the test conditions you want to change. Pressing one of the keys on this screen changes over the display to the appropriate test condition setting screen.



Cs 101.36nF

D 0.00733

* SELECT MENU *

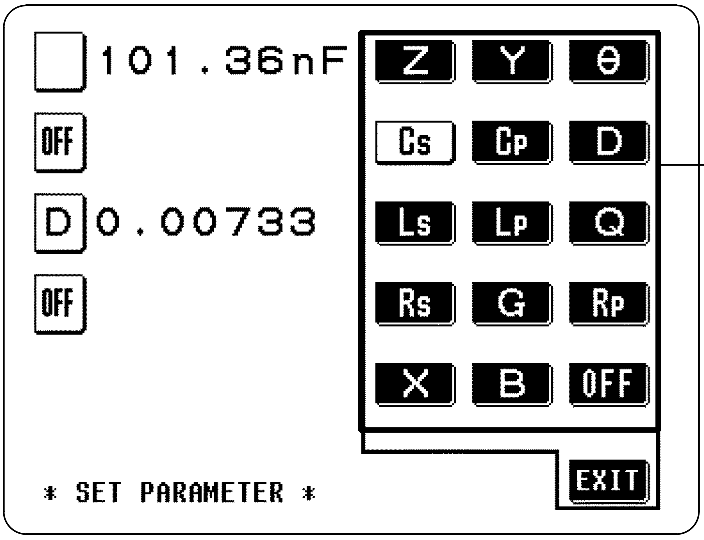
To change any one of the test conditions (frequency, controlled level, etc.), press the corresponding key on this menu.

Menu Screen

For details, refer to Section 4.1.2, "The Menu Screen and Application Menu Screen"

(3) The Parameter setting screen

- Pressing a parameter key on the Initial screen causes the Parameter setting screen to be displayed, using which the test parameters to be displayed (up to a maximum of four) are selected.
- By pressing a key for any test parameter, that parameter is set to be displayed, and the unit automatically returns to displaying the Initial screen again.

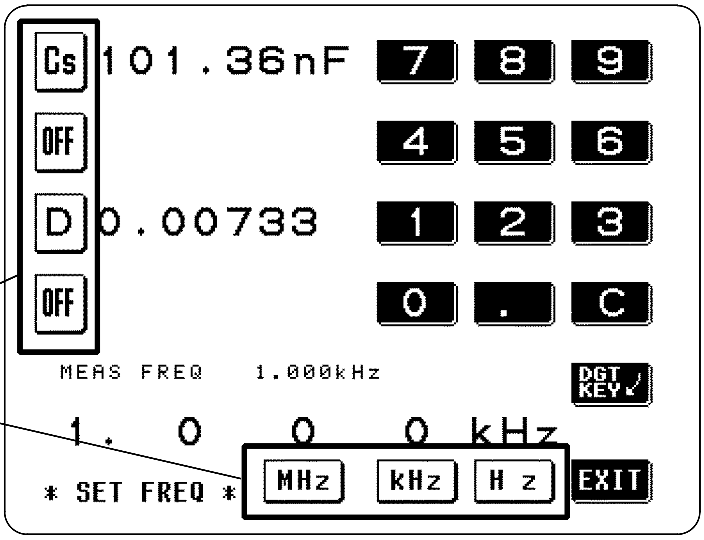


Test parameters

Parameter Setting Screen

(4) The Test condition setting screen

- This screen is for changing a test condition (for example, the test frequency).
- When you have finished setting the test condition, press the EXIT key, and the unit will return to displaying the Initial screen again.

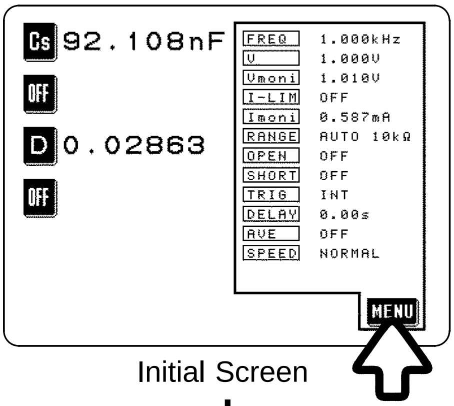


The inactive keys (which cannot currently be operated) appear as white rectangles with black character legends, i.e. in non-reversed video.

Test Condition Setting Screen
(Test frequency setting screen)

3.2.1 Control Screen Sequence

- The basic flow for the change of screens as control operation is performed is as follows.
- The measurement values can be checked in real time on all of the screens.



Cs 92.108nF
D 0.02863

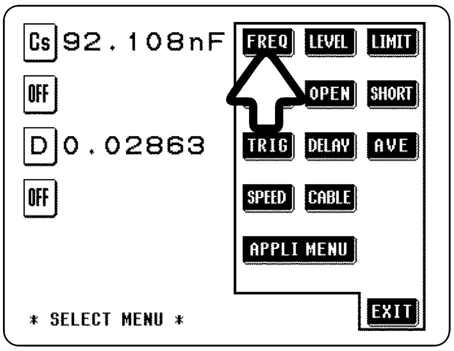
FREQ 1.000kHz
V 1.000V
Vmoni 1.010V
I-LIM OFF
Imoni 0.587mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

The measured values of any of the test parameters can be displayed for checking (up to a maximum of four) and all of the test conditions can be checked on the Initial screen.

To make a change to the test conditions:

Press the MENU soft key, and the Menu screen will be displayed.

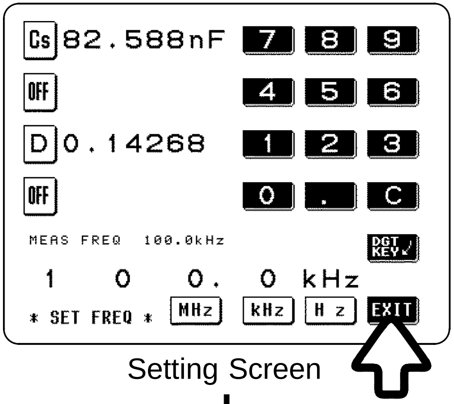


Cs 92.108nF
D 0.02863

Menu Screen

Select the test condition to alter on the Menu screen (for example, when changing the test frequency).

Press the FREQ soft key, and the Frequency setting screen will be displayed.



Cs 82.588nF
D 0.14268

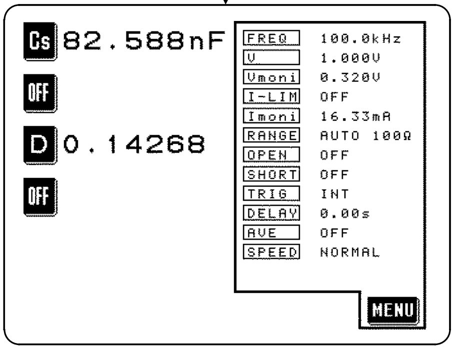
MEAS FREQ 100.0kHz

1 0 0. 0 kHz

Setting Screen

Set or change that test condition on the appropriate Test condition setting screen.

When the test condition setting is complete, press the EXIT soft key, and the display will return to displaying the Initial screen.



Cs 82.588nF
D 0.14268

FREQ 100.0kHz
V 1.000V
Vmoni 0.320V
I-LIM OFF
Imoni 16.33mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

3.3 Basic Measurement

In order to explain the basic operation of the 3532-50 unit, as an example, the procedure will be shown for establishing the following settings:

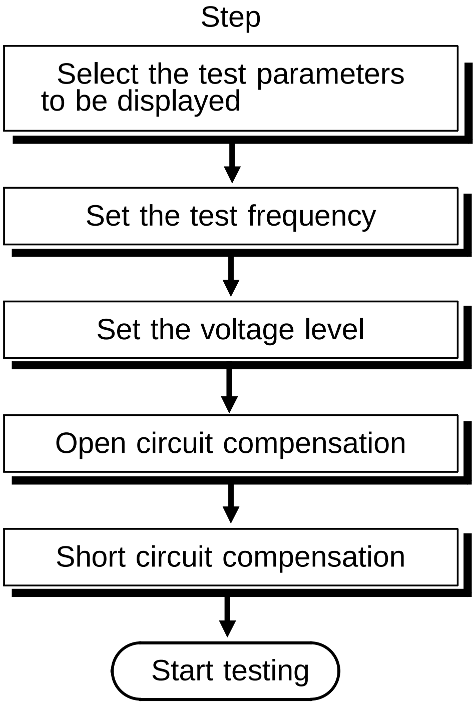
Example

Sample to be tested	
Capacitor	0.1 μF
Test conditions	
Test frequency	100 kHz
Constant voltage level	0.4 V
Open circuit compensation setup	ALL compensation
Short circuit compensation setup	ALL compensation
Parameters to be displayed	
Capacitance Cs, Loss coefficient D	

NOTE The trigger is internal. The 3532-50 unit, when it is dispatched from the factory, is in the internal trigger state.

3.3.1 Basic Flow up to Testing of the Sample

The basic flow up to starting testing of the sample is as shown in the following chart in correspondence to the applicable reference sections:



Reference sections

3.3.2, "Setting the Test Parameters to be Displayed (Cs, D)"

3.3.3, "Setting the Test Frequency"

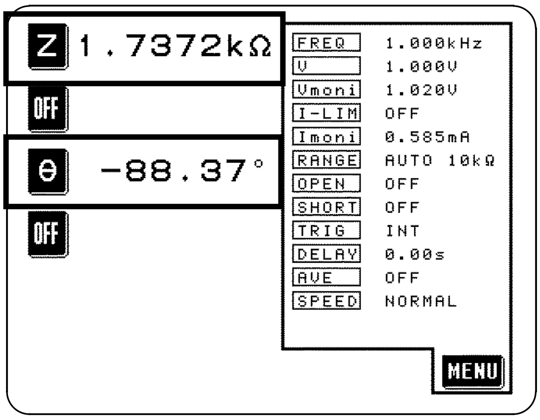
3.3.4, "Setting the Constant Voltage Level"

3.3.5, "Setting Open Circuit Compensation"

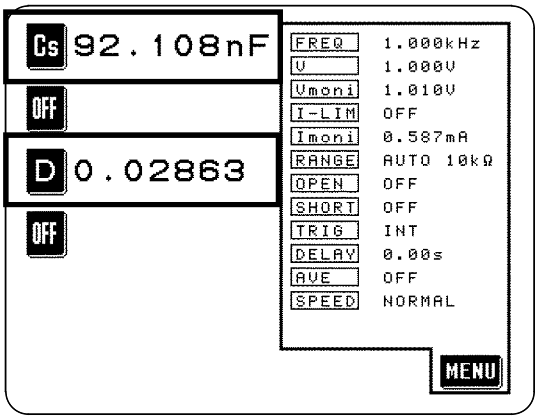
3.3.6, "Setting Short Circuit Compensation"

3.3.2 Setting the Test Parameters to be Displayed (Cs, D)

Here the first (i.e., the uppermost) parameter key will be set to capacitance Cs, and the third parameter key will be set to loss coefficient D.

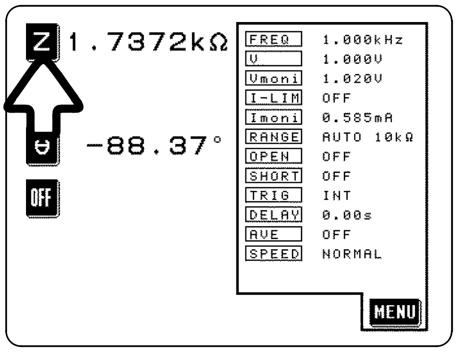

Z 1.7372kΩ
OFF
θ -88.37°
OFF
FREQ 1.000kHz
V 1.000V
Vmoni 1.020V
I-LIM OFF
Imoni 0.585mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Before Setting


Cs 92.108nF
OFF
D 0.02863
OFF
FREQ 1.000kHz
V 1.000V
Vmoni 1.010V
I-LIM OFF
Imoni 0.587mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

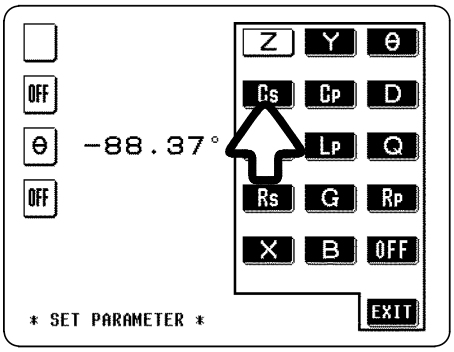
After Setting

Setting procedure


Z 1.7372kΩ
θ -88.37°
OFF
FREQ 1.000kHz
V 1.000V
Vmoni 1.020V
I-LIM OFF
Imoni 0.585mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

1. In order to change the first parameter displayed on the Initial screen, press the first (uppermost) parameter key.



-88.37°
* SET PARAMETER *

Parameter Setting Screen

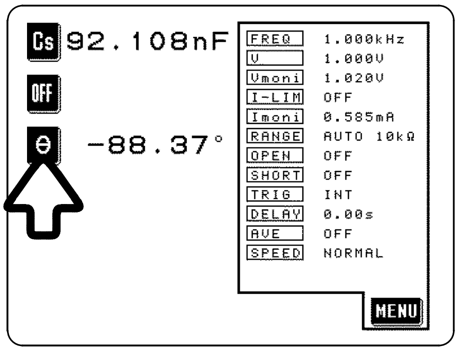
2. The Parameter setting screen is displayed. (The test parameter (currently *Z*) to which the pressed parameter key currently corresponds is shown in black characters on a white ground, i.e. in non-reversed video).

   Press Cs on this screen, and the display will automatically return to displaying the Initial screen, with capacitance Cs being displayed as the first parameter.

   If you press the EXIT key on this screen without pressing Cs , no new setting is performed, and the display just returns to displaying the Initial screen.

NOTE

Any of the test parameters (*Z*, L, C, *R*, etc.) (up to a maximum of four) can be set to correspond to any of the four parameter keys.



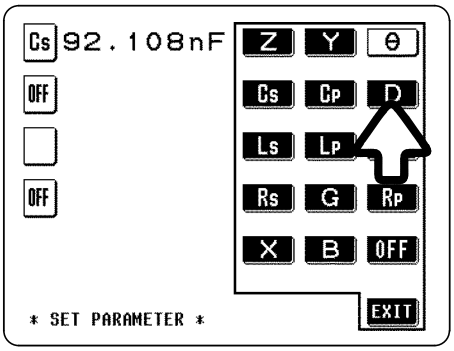
Cs 92.108nF

θ -88.37°

FREQ 1.000kHz
V 1.000V
Vmoni 1.020V
I-LIM OFF
Imoni 0.585mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

3. In order to change the third parameter displayed on the Initial screen, press the third parameter key.



Cs 92.108nF

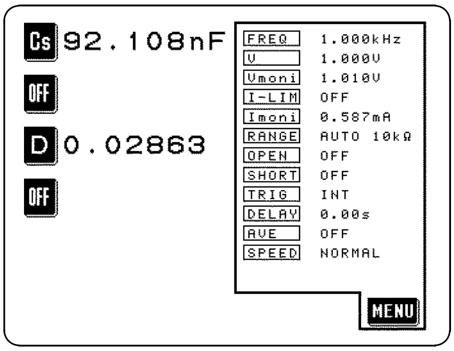
* SET PARAMETER *

Parameter Setting Screen

4. The Parameter setting screen is displayed. Press D on this screen, and the display will automatically return to displaying the Initial screen, with the loss coefficient D being displayed as the third parameter.

NOTE

If you press the OFF key, instead of pressing a soft key corresponding to any one of the test parameters, then the display of the test parameter to which the third parameter key currently corresponds will be canceled.



Cs 92.108nF

D 0.02863

FREQ 1.000kHz
V 1.000V
Vmoni 1.010V
I-LIM OFF
Imoni 0.587mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

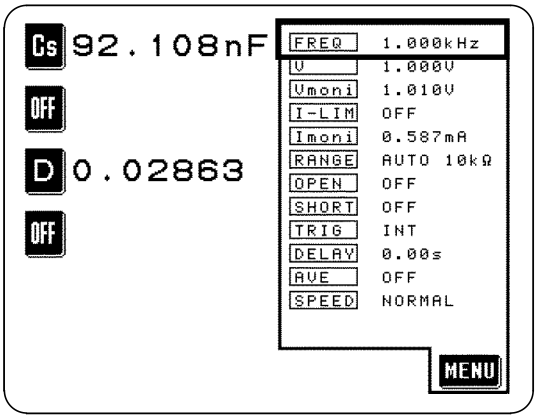
Initial Screen

5. Now the Initial screen is displaying the values of the parameters Cs and D.

For details, refer to Section 4.2, "Setting the Parameters to be Displayed".

3.3.3 Setting the Test Frequency

The following explanation shows how to set the test frequency to 100 kHz, as an example.



Cs 92.108nF

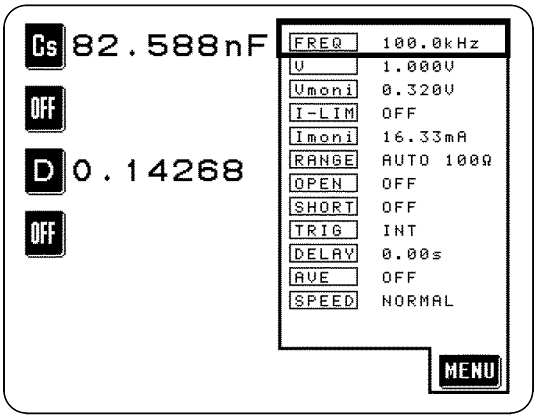
OFF

D 0.02863

OFF

FREQ	1.000kHz
V	1.000V
Vmoni	1.010V
I-LIM	OFF
Imoni	0.587mA
RANGE	AUTO 10kΩ
OPEN	OFF
SHORT	OFF
TRIG	INT
DELAY	0.00s
AVE	OFF
SPEED	NORMAL

Before Setting



Cs 82.588nF

OFF

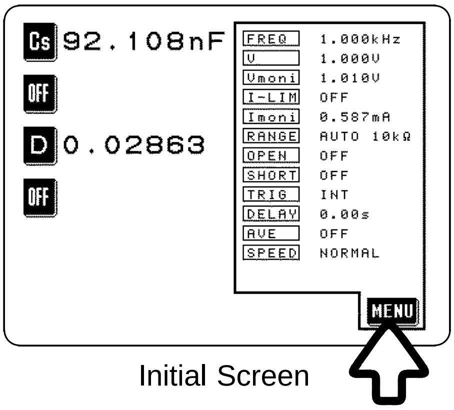
D 0.14268

OFF

FREQ	100.0kHz
V	1.000V
Vmoni	0.320V
I-LIM	OFF
Imoni	16.33mA
RANGE	AUTO 100Ω
OPEN	OFF
SHORT	OFF
TRIG	INT
DELAY	0.00s
AVE	OFF
SPEED	NORMAL

After Setting

Setting procedure



Cs 92.108nF

OFF

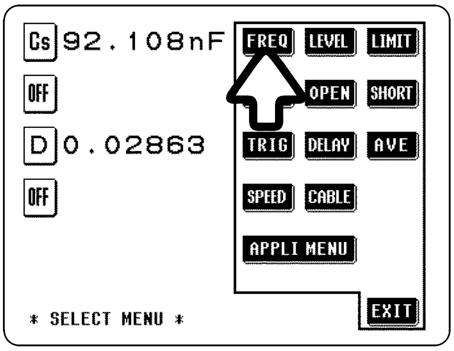
D 0.02863

OFF

FREQ	1.000kHz
V	1.000V
Vmoni	1.010V
I-LIM	OFF
Imoni	0.587mA
RANGE	AUTO 10kΩ
OPEN	OFF
SHORT	OFF
TRIG	INT
DELAY	0.00s
AVE	OFF
SPEED	NORMAL

Initial Screen

1. On the Initial screen, press the MENU key, and the Menu screen will be displayed.



Cs 92.108nF

OFF

D 0.02863

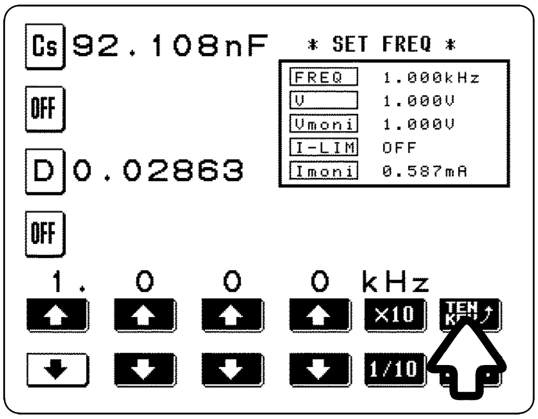
OFF

Menu Screen

2. Press the FREQ key on the Menu screen, and one of the frequency setting screens will be displayed.

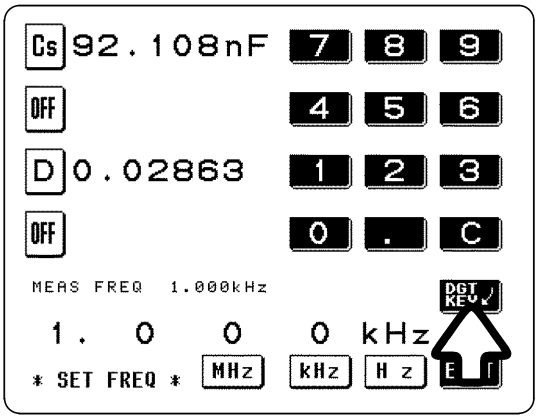
There are actually two frequency setting screens. The display can be switched over between these two screens just by pressing a particular soft key.

The Digit screen	The test frequency is input using the ⬆ and ⬇ digit keys.
The Ten key screen	A numerical value for the test frequency is input directly.



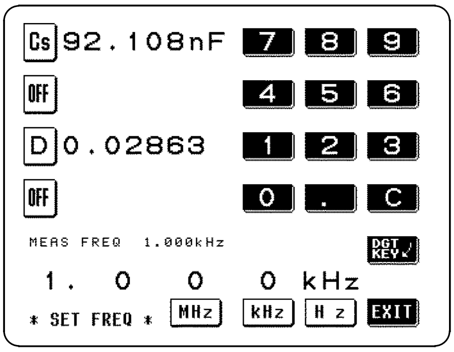
FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.587mA

Digit Screen



MEAS FREQ 1.000kHz

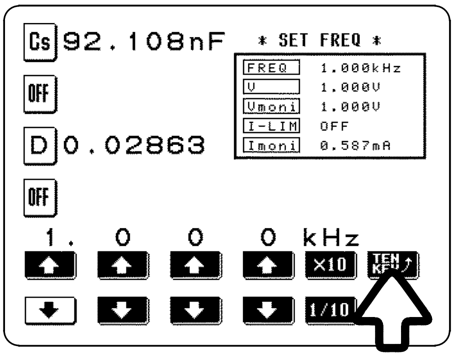
Ten Key Screen



MEAS FREQ 1.000kHz

Ten Key Screen

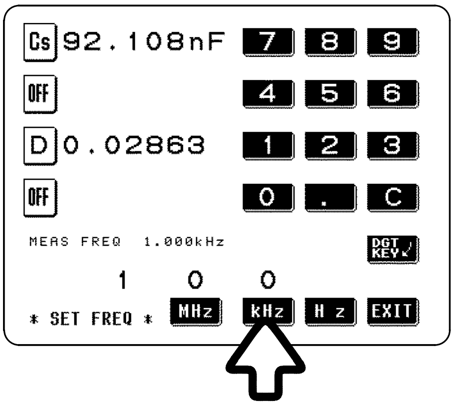
- In this case, because it is desired to input the value 120 Hz for the test frequency directly as a numerical value, the Ten key screen is used.



FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.587mA

Digit Screen

- When the Digit screen is being displayed, pressing the TEN KEY soft key causes the display to switch over to the Ten key screen.



Cs 92.108nF
OFF
D 0.02863
OFF
MEAS FREQ 1.000kHz
1 0 0

Ten Key Screen

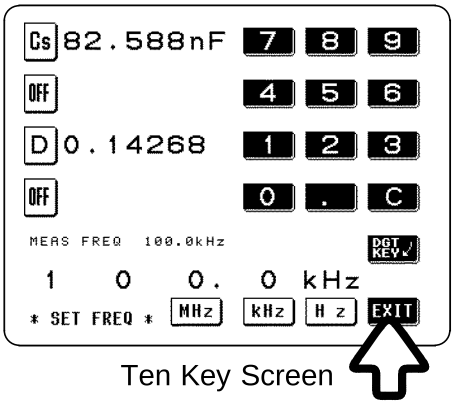
3. Press the keys 1, 0, and 0 in succession on the ten key pad.

If you make a mistake, press the C key to clear the value entered so far, and start again.

Then press the kHz key, and check that the test frequency value input is indeed 100 kHz.

NOTE

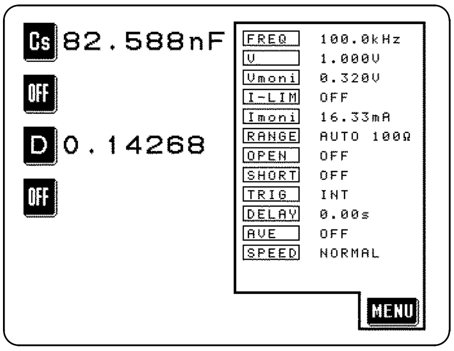
The numerical value input for the test frequency cannot be checked until one of the keys MHz, kHz, and H z has been pressed.
If you press the EXIT key before pressing the H z key, the display will return to displaying the Initial screen with the previously set value for the test frequency still current.



Cs 82.588nF
OFF
D 0.14268
OFF
MEAS FREQ 100.0kHz
1 0 0. 0 kHz

Ten Key Screen

4. When the setting has been established as above, press the EXIT key, and the display will return to the Initial screen.



Cs 82.588nF
OFF
D 0.14268
OFF

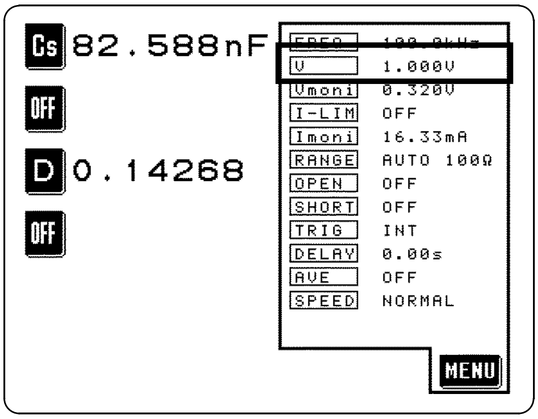
FREQ	100.0kHz
V	1.000V
Vmoni	0.320V
I-LIM	OFF
Imoni	16.33mA
RANGE	AUTO 100Ω
OPEN	OFF
SHORT	OFF
TRIG	INT
DELAY	0.00s
AVE	OFF
SPEED	NORMAL

Initial Screen

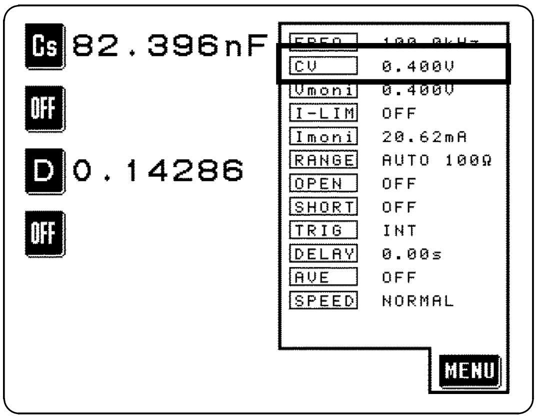
For details, refer to Section 4.3, "Setting the Test Frequency".

3.3.4 Setting the Constant Voltage Level

The following explanation shows, as an example, how to set the value for the constant voltage level to 0.4 V.

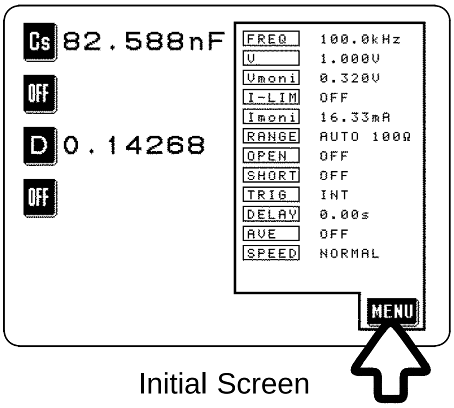

Cs 82.588nF
OFF
D 0.14268
OFF
FREQ 100.0kHz
V 1.000V
Vmoni 0.320V
I-LIM OFF
Imoni 16.33mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Before Setting


Cs 82.396nF
OFF
D 0.14286
OFF
FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.62mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

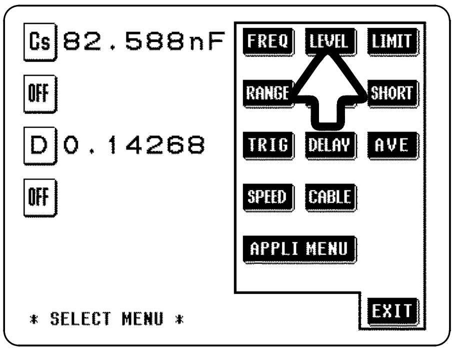
After Setting

Setting procedure


Cs 82.588nF
OFF
D 0.14268
OFF
FREQ 100.0kHz
V 1.000V
Vmoni 0.320V
I-LIM OFF
Imoni 16.33mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

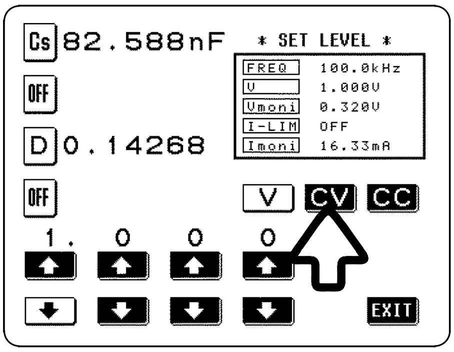
Initial Screen

1. On the Initial screen, press the MENU key, and the Menu screen will be displayed.


Cs 82.588nF
OFF
D 0.14268
OFF
* SELECT MENU *

Menu Screen

2. Press the LEVEL key on the Menu screen, and the Level setting screen will be displayed.



Cs 82.588nF

D 0.14268

* SET LEVEL *

FREQ 100.0kHz

V 1.000V

Vmoni 0.320V

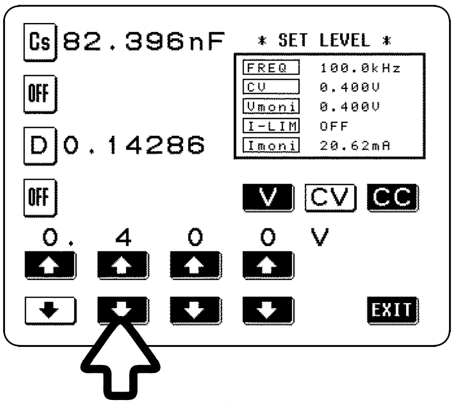
I-LIM OFF

Imoni 16.33mA

1. 0 0 0

Level Setting Screen

3. Because you for example want to set the value for the constant voltage (CV), press the CV key. Then check that the CV key changes to black figures on a white ground (i.e., in non-reversed video), which confirms that constant voltage has been properly selected.



Cs 82.396nF

D 0.14286

* SET LEVEL *

FREQ 100.0kHz

CV 0.400V

Vmoni 0.400V

I-LIM OFF

Imoni 20.62mA

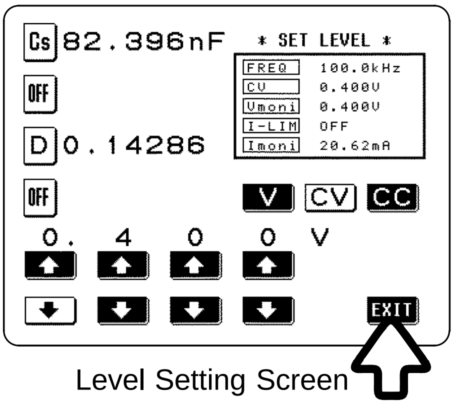
0. 4 0 0 V

Level Setting Screen

4. Using the ▲ and ▼ keys, set the displayed constant voltage value to 0.400.

▲ The corresponding digit is increased. (If you hold this key down continuously, the corresponding digit increments continuously.)

▼ The corresponding digit is decreased. (If you hold this key down continuously, the corresponding digit decrements continuously.)



Cs 82.396nF

D 0.14286

* SET LEVEL *

FREQ 100.0kHz

CV 0.400V

Vmoni 0.400V

I-LIM OFF

Imoni 20.62mA

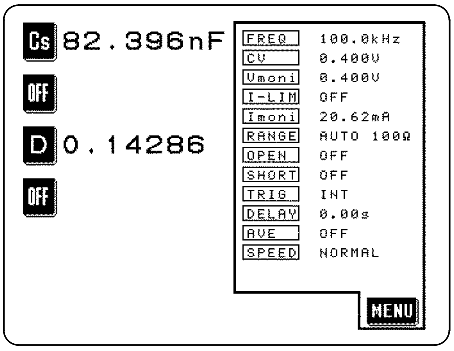
0. 4 0 0 V

Level Setting Screen

5. When the setting has been established as above, press the EXIT key.

NOTE

- With this constant voltage (CV) setting, the testing will be performed with the voltage between the terminals of the sample being tested being kept constant at 0.400 V.
- The accuracy of this constant voltage:
  ±10%±10 mV (42 Hz to 1.000 MHz)
  ±20%±10 mV (1.001 MHz to 5.000 MHz)



Cs 82.396nF

D 0.14286

FREQ 100.0kHz

CV 0.400V

Vmoni 0.400V

I-LIM OFF

Imoni 20.62mA

RANGE AUTO 100Ω

OPEN OFF

SHORT OFF

TRIG INT

DELAY 0.00s

AVE OFF

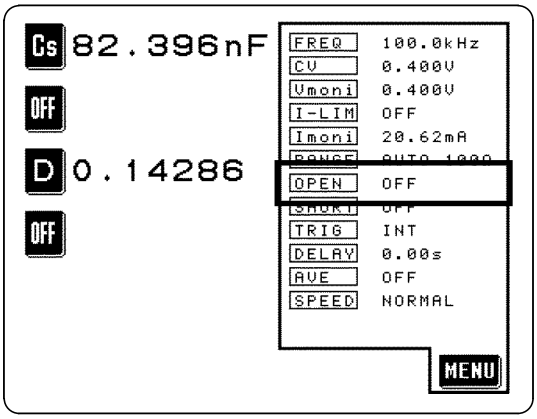
SPEED NORMAL

Initial Screen

For details, refer to Section 4.4, "Setting the Test Signal Level"

3.3.5 Setting Open Circuit Compensation

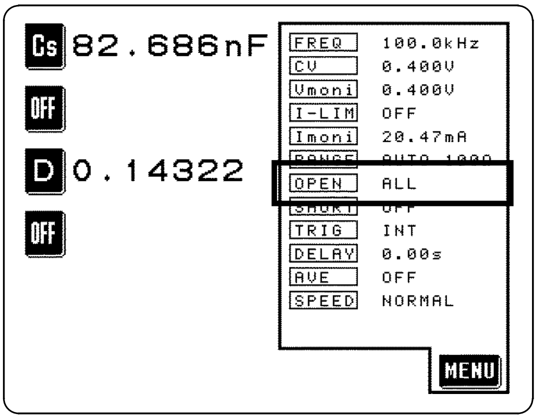
The following explanation shows, as an example, how to set up ALL open circuit compensation, with which open circuit compensation values for all of the test frequencies are determined and adjusted.



Cs 82.396nF
OFF
D 0.14286
OFF

FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.62mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Before Setting

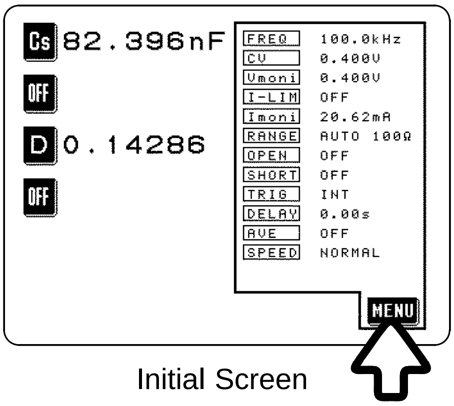


Cs 82.686nF
OFF
D 0.14322
OFF

FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.47mA
RANGE AUTO 100Ω
OPEN ALL
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

After Setting

Setting procedure



Cs 82.396nF
OFF
D 0.14286
OFF

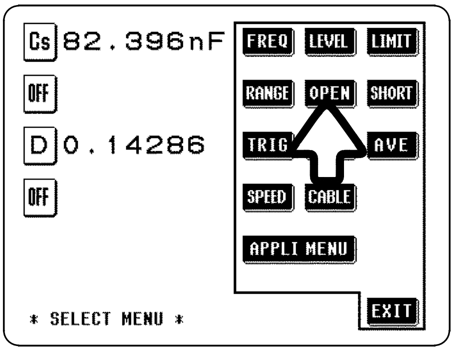
FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.62mA
RANGE AUTO 100Ω
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

1. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and make sure that the HIGH and LOW leads are not contacted together.

For details, refer to Section 4.7.2, "Selecting the Compensation Method".

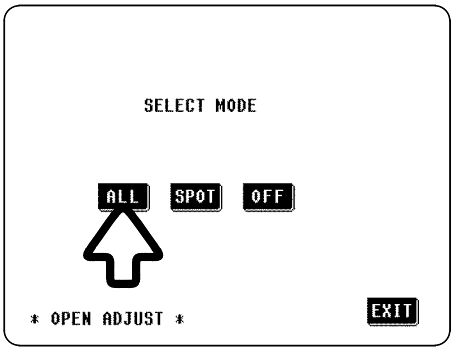
2. On the Initial screen, press the MENU key, and the Menu screen will be displayed.



Cs 82.396nF
OFF
D 0.14286
OFF

Menu Screen

3. Press the OPEN key on the Menu screen, and the Open circuit compensation screen will be displayed.

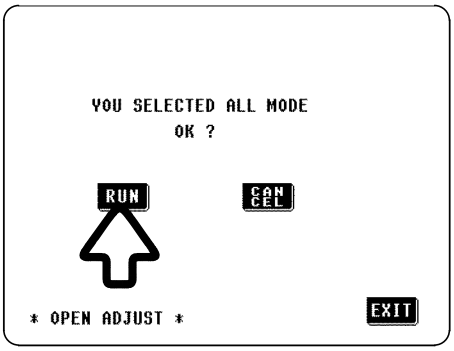


SELECT MODE

* OPEN ADJUST *

Open Circuit Compensation Screen

4. Press the ALL key so as to select ALL compensation, with which open circuit compensation values for all the test frequencies will be determined and adjusted.



YOU SELECTED ALL MODE
OK ?

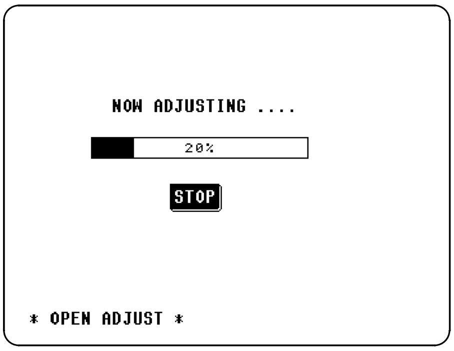
* OPEN ADJUST *

Confirmation Screen

5. A Confirmation screen will be displayed for confirmation of ALL open circuit compensation. If it is OK to proceed, press the RUN key.

NOTE

Check again - are the test leads definitely out of mutual contact ?



NOW ADJUSTING ....

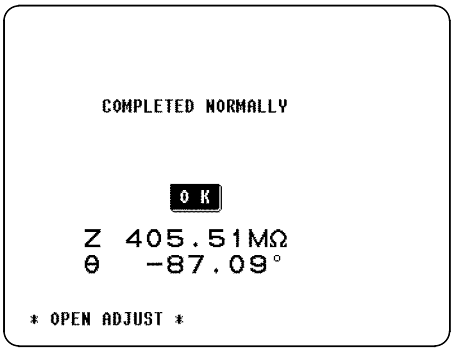
* OPEN ADJUST *

Data Determination Screen

6. When you press the RUN key, the ALL open circuit compensation process starts.

After about 2 minutes, the determination and adjustment of the open circuit compensation values is complete.

If an error message appears, refer to Section 4.7.5.


COMPLETED NORMALLY

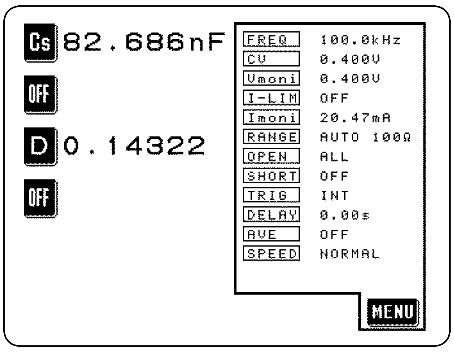
Z 405.51MΩ
θ -87.09°

* OPEN ADJUST *

Confirmation Screen

7. If the compensation process has terminated satisfactorily, a Confirmation screen as shown to the left is displayed.

The residual component at the frequency of 5 MHz with the test cables separated (open circuited), and its phase angle, are shown on the screen. These values are required for use with the test range on HOLD.
(For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)


Cs 82.686nF

D 0.14322

FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.47mA
RANGE AUTO 100Ω
OPEN ALL
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

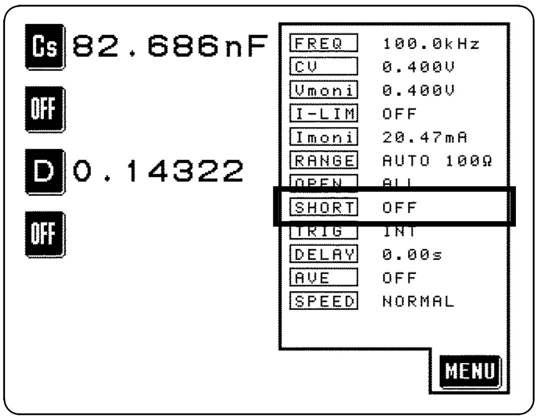
Initial Screen

8. After checking the open circuit residual component and its phase angle, press the O K key, and the display will return to the Initial screen.

For details, refer to Section 4.7, "Open Circuit Compensation".

3.3.6 Setting Short Circuit Compensation

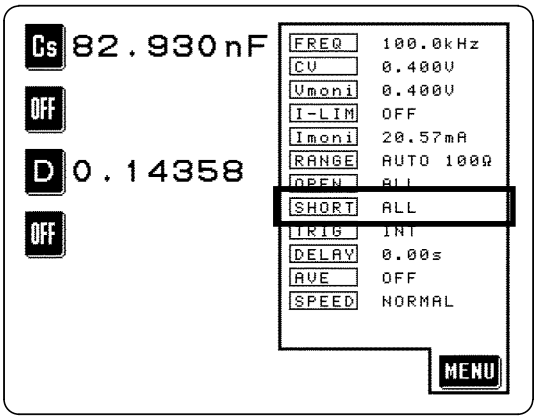
The following explanation shows, as an example, how to set up ALL short circuit compensation, with which short circuit compensation values for all of the test frequencies are determined and adjusted.



Cs 82.686nF
OFF
D 0.14322
OFF

FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.47mA
RANGE AUTO 100Ω
OPEN ALL
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Before Setting

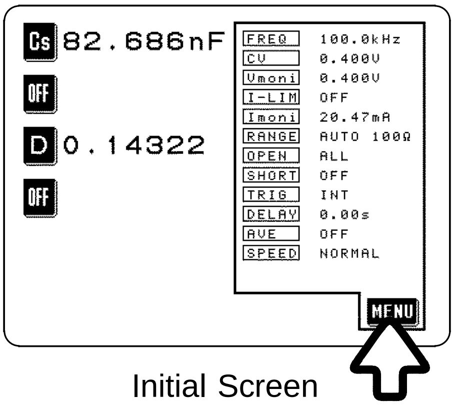


Cs 82.930nF
OFF
D 0.14358
OFF

FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.57mA
RANGE AUTO 100Ω
OPEN ALL
SHORT ALL
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

After Setting

Setting procedure



Cs 82.686nF
OFF
D 0.14322
OFF

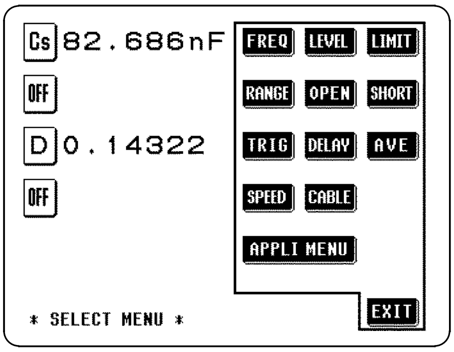
FREQ 100.0kHz
CV 0.400V
Vmoni 0.400V
I-LIM OFF
Imoni 20.47mA
RANGE AUTO 100Ω
OPEN ALL
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

Initial Screen

1. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and short circuit together the HIGH and LOW leads using a shorting bar.

   (Refer to Section 4.8.2 for information about the shorting bar.)

2. On the Initial screen, press the MENU key, and the Menu screen will be displayed.

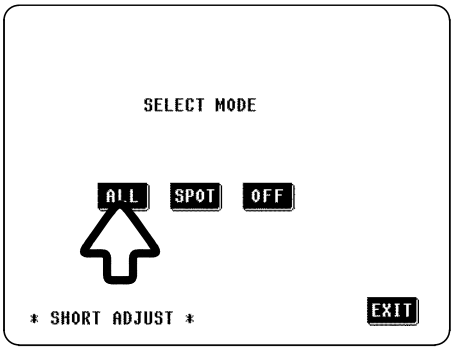


Cs 82.686nF
OFF
D 0.14322
OFF

* SELECT MENU *

Menu Screen

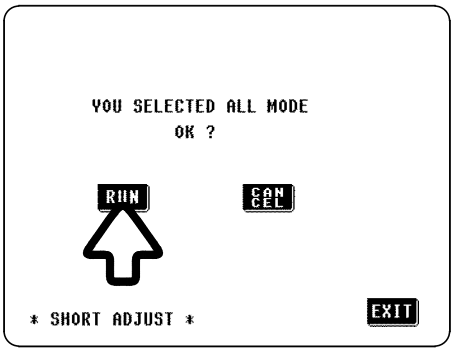
3. Press the SHORT key on the Menu screen, and the Short circuit compensation screen will be displayed.


SELECT MODE

* SHORT ADJUST *

Short Circuit Compensation Screen

4. Press the ALL key so as for example to select ALL compensation, with which short circuit compensation values for all the test frequencies will be determined and adjusted.


YOU SELECTED ALL MODE
OK ?

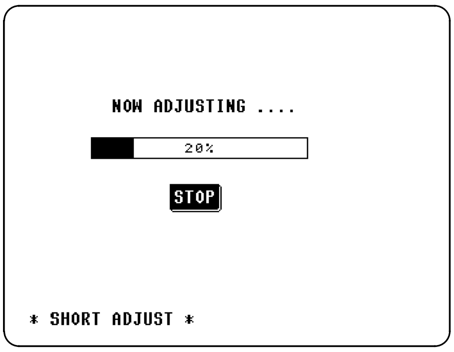
* SHORT ADJUST *

Confirmation Screen

5. A Confirmation screen will be displayed for confirmation of ALL short circuit compensation. If it is OK to proceed, press the RUN key.

NOTE

Check again - are the test leads properly short circuited together by the shorting bar?


NOW ADJUSTING ....

20%

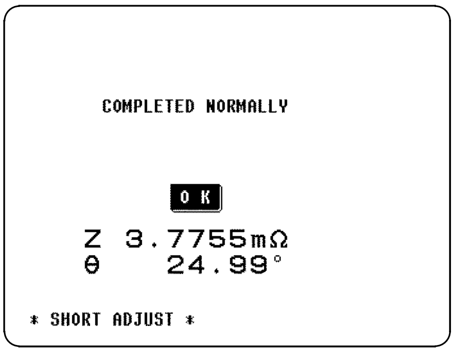
* SHORT ADJUST *

Data Determination Screen

6. When you press the RUN key, the ALL short circuit compensation process starts.

After about 2 minutes, the determination and adjustment of the short circuit compensation values is complete.

If an error message appears, refer to Section 4.8.5.



COMPLETED NORMALLY

Z 3.7755mΩ
θ 24.99°

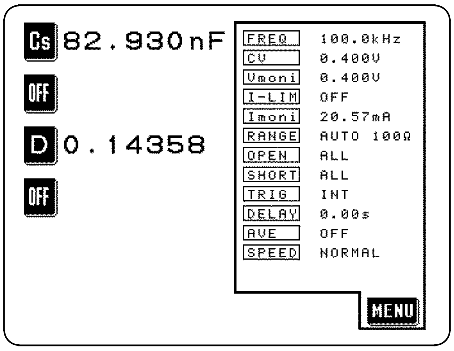
* SHORT ADJUST *

Confirmation Screen

7. If the compensation process has terminated satisfactorily, a Confirmation screen as shown to the left is displayed.

The residual component at the frequency of 5 MHz with the test cables connected together (short circuited), and its phase angle, are shown on the screen.

These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)



Cs 82.930nF

D 0.14358

FREQ	100.0kHz
CV	0.400V
Vmoni	0.400V
I-LIM	OFF
Imoni	20.57mA
RANGE	AUTO 100Ω
OPEN	ALL
SHORT	ALL
TRIG	INT
DELAY	0.00s
AVE	OFF
SPEED	NORMAL

Initial Screen

8. After checking the short circuit residual component and its phase angle, press the **O K** key, and the display will return to the Initial screen.

For details, refer to Section 4.8, "Short circuit compensation"

3.3.7 Starting Testing

When the operations described above have been completed, the test conditions have been for example set as follows:

Test conditions

Frequency	100 kHz
Constant voltage level	0.4 V
Open circuit compensation	ALL compensation
Short circuit compensation	ALL compensation

Parameters displayed
Capacitance Cs, Loss coefficient D

Connect the actual sample to be tested to the test cables, to start testing.

Chapter 4
Detailed Description of Functions

4.1 Description of the Screens

The Initial screen, Menu screen, Application menu screen will be explained.

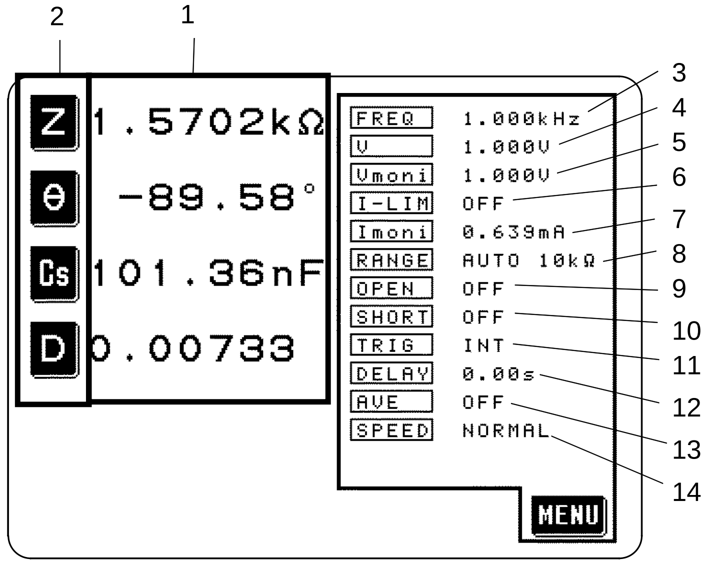
4.1.1 The Initial Screen

The Initial screen is the screen which is initially displayed when the power to the 3532-50 unit is turned on.

The monitor display on this screen enables the user to perform testing while checking the values of all the test conditions. (The monitor display varies according to the test signal level setting.)

When powering on again, the screen when the power has been turned off on the following screens is displayed.

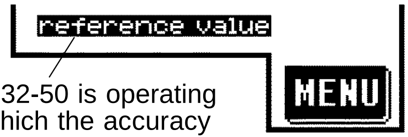
Initial screen, Comparator screen, Scaling screen, Magnification screen, Continuous test screen



1. Measured values
2. Parameter keys
   (The parameters displayed can be selected using these keys.)

3. FREQ	Test frequency
4. V	Test signal control level
5. Vmoni	Voltage value between the terminals of the test sample
6. I-LIM	Measurement current limit value
7. Imoni	Current value flowing through the test sample
8. RANGE	Test range
9. OPEN	Open circuit compensation setup
10. SHORT	Short circuit compensation setup
11. TRIG	Trigger mode
12. DELAY	Set value for the trigger delay
13. AVE	Number of times for averaging
14. SPEED	Testing speed

NOTE Even if the 3532-50 unit is being used outside the limits of its specification, test values are sometimes displayed. In this case, the following type of indication appears on the display.



This means that the 3532-50 is operating outside the range for which the accuracy of the measured values can be assured.

- In this case, you should consider the following possible causes, and you should either change the test conditions while checking the accuracy assured ranges (with reference to Section 7.5, "Test Accuracy"), or you should consider the measured values as values for reference only, because their validity is somewhat doubtful.
- Perhaps the test signal controlled level is too low.
  Increase the test signal level.
- Perhaps the present test range (if ranging is set to HOLD) is not suitable.
  Either set the test range to the most suitable one by using AUTO ranging, or change the test range manually.

4.1.2 The Menu Screen and Application Menu Screen

MENU
Initial screen

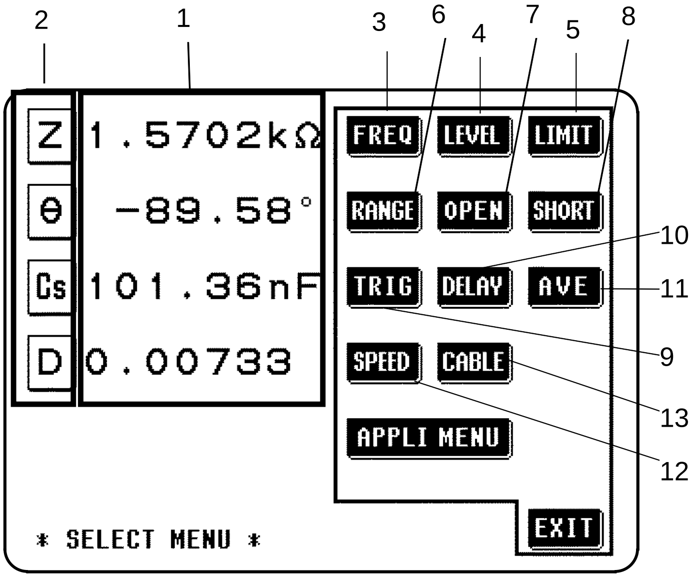
To display the Menu screen

Press this **MENU** key on the Initial screen.
It is possible to access various setting screens for changing the various test conditions from this screen.

APPLI MENU
Menu screen

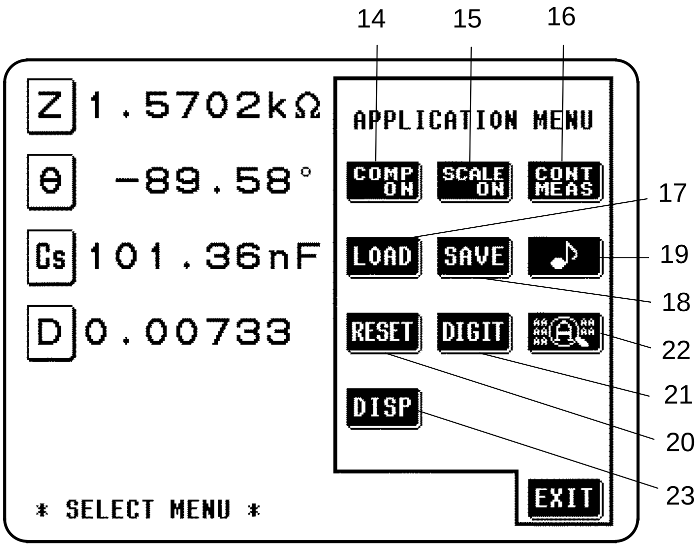
To display the Application screen

Press the **APPLI MENU** key on the Menu screen.
It is possible to access the various application function setting screens from this screen.



1. Measured values	
2. Parameters displayed	
3. FREQ	Test frequency setting
4. LEVEL	Test signal level setting
5. LIMIT	Limit setting
6. RANGE	Range setting
7. OPEN	Open circuit compensation setting
8. SHORT	Short circuit compensation setting
9. TRIG	Trigger setting
10. DELAY	Trigger delay function
11. AVE	Averaging setting
12. SPEED	Test speed setting
13. CABLE	Cable length setting

APPLI MENU

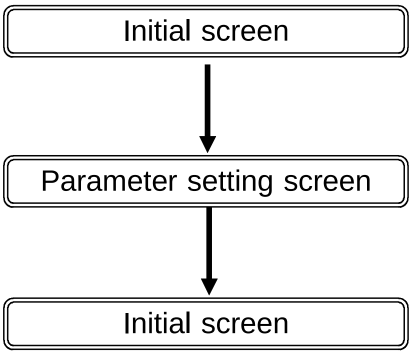


14. COMP ON	Comparator function
15. SCALE ON	Scaling function
16. CONT MEAS	Continuous test function
17. LOAD	Panel load function
18. SAVE	Panel save function
19. ♪	Beep sound setting
20. RESET	System reset
21. DIGIT	Display digits setting
22. A	Magnification display function
23. DISP	Display setting

4.2 Setting the Parameters to be Displayed

From among the total of 14 different test parameters a maximum of four can be selected for their values to be simultaneously displayed on the screen, arranged in any desired order.

4.2.1 Control Screen Sequence



Press the parameter key for which you wish to make the change.

Press the key in the parameter list corresponding to the parameter which you wish to display in that position. The Initial screen will automatically be displayed again.

The parameter displayed in that position will now be the desired one.

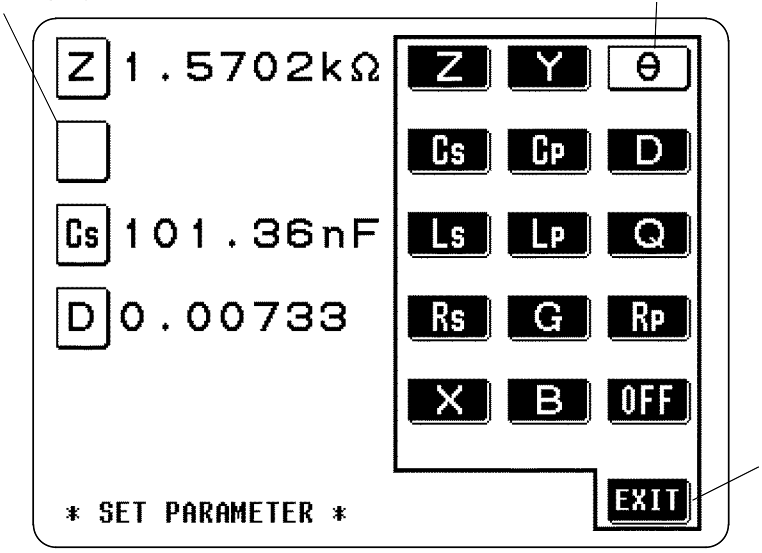
4.2.2 Details of the Setting Process

1. Ensure that the Initial screen is being displayed.

2. Decide in which of the four positions on this Initial screen you wish to change the parameter which is being displayed, and then press the parameter key in the corresponding position.
The Parameter setting screen will be displayed, as follows:

The position in which you wish to change the parameter displayed

The parameter currently being displayed in this position appears in black letters on white (non-reversed video).



Z 1.5702kΩ

Cs 101.36nF

D 0.00733

* SET PARAMETER *

Press this key to abandon the setting process and return to the Initial screen.

The parameters set to be displayed can only be changed by starting from the Initial screen.

3. The parameter which you wish to display in the chosen position can be chosen from the following list by pressing the corresponding key. The screen will then automatically revert to the Initial screen, with the desired new parameter being displayed in the appropriate position.

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 coefficient=tanδ
Ls	inductance in series equivalent circuit mode (H)
Lp	inductance in parallel equivalent circuit mode (H)
Q	Q factor
*R*s	effective resistance in series equivalent circuit mode (Ω)=ESR
*R*p	effective resistance in parallel equivalent circuit mode (Ω)
G	conductance (S)
X	reactance (Ω)
B	susceptance (S)
OFF	display no test parameter in the chosen position

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

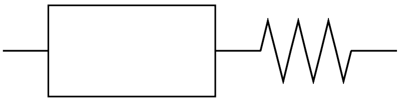
NOTE All parameters excluding the impedance phase angle θ is displayed as absolute value. To check the polarity, confirm the impedance phase angle θ. For details, see Section 7.2, "Testing Parameters and Calculation Equations".

Press the **EXIT** key in order to cancel this setting process and return to the Initial screen with the original parameter still displayed as before.

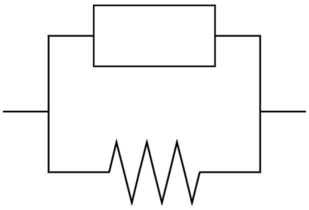
4.2.3 Series Equivalent Circuit Mode and Parallel Equivalent Circuit Mode

The 3532-50 unit obtains the impedance Z and the phase angle θ by measuring the current and voltage across the test sample. The other measurement parameters, like an inductive component L, a capacitive component C, a resistive component R, etc. are calculated based on the Z and θ.
A series-equivalent circuit mode is the mode in which the calculation is performed assuming that resistive components are connected in series to C (or L), while a parallel-equivalent circuit mode is the calculation assuming that resistive components are connected in parallel.
The appropriate selection of the equivalent circuit modes will enable the more accurate calculation results.

Generally, for measurement of a low impedance device (approx. less than 100 Ω) like a large capacitance capacitor or a low inductance, a series-equivalent circuit mode will be selected. While, for a high impedance device (approx. more than 10 kΩ) like a small capacitance capacitor or a high inductance, a parallel-equivalent circuit mode will be selected.
When you are not sure about selection of circuit mode, please ask the parts maker. (ex. a impedance approx. between 100 Ω and 10 kΩ)



Series equivalent circuit



Parallel equivalent circuit

NOTE

Because measurement value in each equivalent circuit mode is obtained through calculation, measurement values of both modes can be displayed. However, please note that the appropriate equivalent circuit depends on the test sample.

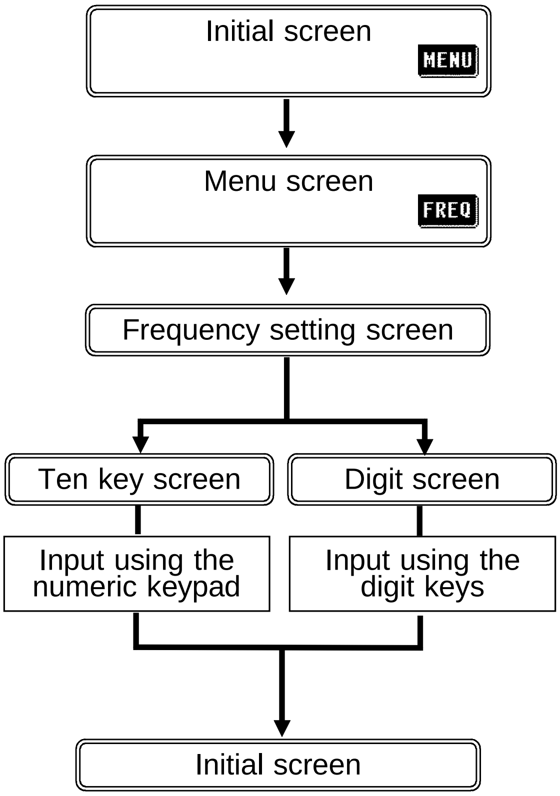
4.3 Setting the Test Frequency

Sometimes the value for the test frequency should be changed according to the type of sample being tested.

There are two types of method for inputting the frequency for testing. Either of two different screens can be selected, according to which of these two input methods is to be used. These two screens are called the Ten key screen and the Digit screen.

The Ten key screen	The numerical value for the test frequency is directly input using the numeric keypad (on the touch panel).
The Digit screen	Each digit of the test frequency can be varied by using the appropriate up and down keys.

4.3.1 Control Screen Sequence



Press the MENU key

Press the FREQ key

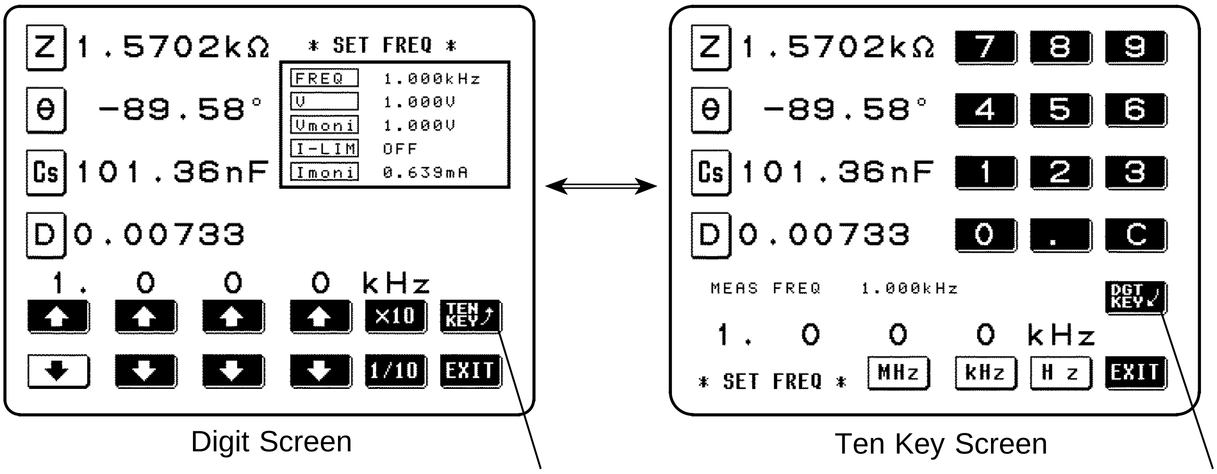
Select the type of input method for the test frequency (ten key input or digit variation input)

Input the test frequency

When setting has been completed, press the EXIT key to return to the Initial screen.

4.3.2 Selecting the Input Method

1. On the Initial screen, press the MENU key, and the Menu screen will be displayed.
2. Press the FREQ key on the Menu screen, and the display will change over to the one of the Frequency setting screens which was previously used.
3. The display can be switched over between these two Frequency setting screens just by pressing the soft keys shown in the figure.



Digit Screen

Ten Key Screen

Changes to the Ten key screen

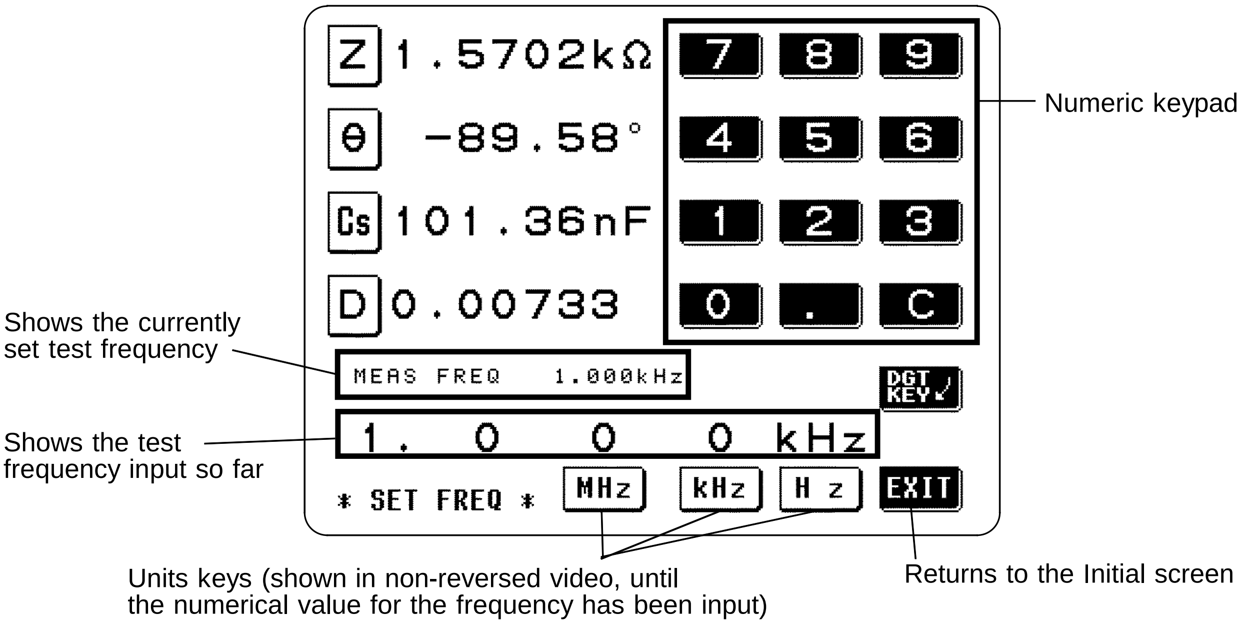
Changes to the Digit screen

- Some test ranges and test signal levels are unavailable at certain test frequencies. These ranges and levels can be checked using the table below.
- If the test frequency is set to a specific value, the maximum values are automatically selected when the test range and test signal level settings exceed the values specified in the table below. For example, when the test frequency is set to 1.001 MHz in a test range of 1 MΩ and a test signal level of 1.5 V, the test range is automatically changed to 100 kΩ and the test signal level to 1 V.

Test frequency (Hz)	Setting range		
	Test range	Test voltage (V, CV)	Test current (CC)
42.0 - 100.0 k	0.1 Ω - 100 MΩ	0.010 V- 5.000 V	0.01 mA - 99.99 mA
100.1 k - 1.000 M	0.1 Ω - 1 MΩ		
1.001 M - 5.000 M	0.1 Ω - 100 kΩ	0.010 V - 1.000 V	0.01 mA - 20.00 mA

4.3.3 Input Using the Ten Key Screen

1. Access to the following Ten key screen.



2. Input the new test frequency directly using the numeric keypad.
Frequency range which can be set: 42.0 Hz to 5.000 MHz

NOTE

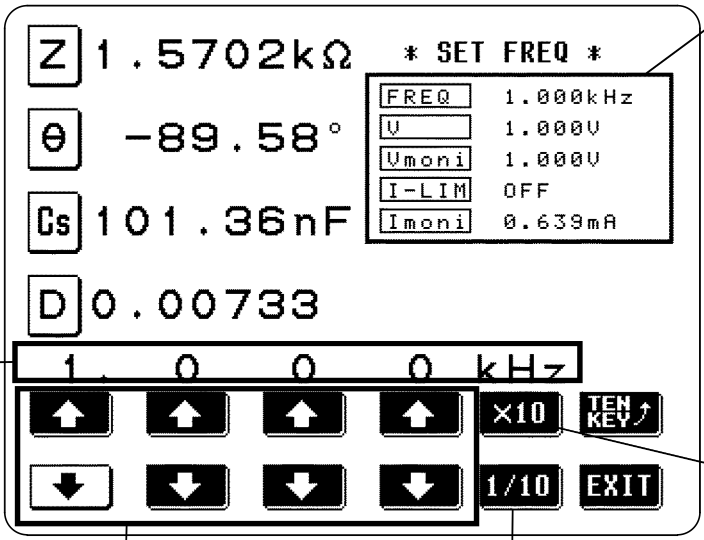
If you attempt to set a test frequency greater than 5 MHz, it will automatically be reduced to 5 MHz.
If you attempt to set a test frequency lower than 42 Hz, it will automatically be increased to 42 Hz.
If you make a mistake during input, press the C key to cancel the input so far, and start again.

3. When you have completed inputting the numerical value for the frequency, press the appropriate units key to confirm the displayed frequency.
If you change screens before confirming the frequency you have set, the frequency will not be changed.
Until the numerical value for the frequency has been input, the units keys cannot be used.

4. When the setting has been established as above, press the EXIT key to return to the Initial screen.

4.3.4 Input Using the Digit Screen

1. Access to the following Digit screen.



Z 1.5702kΩ

θ -89.58°

Cs 101.36nF

D 0.00733

FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA

1. 0 0 0 kHz

Monitor display portion
- Test frequency
- Test signal level
- Voltage between test samples
- Limit value
- Current flowing through the test sample

Shows the current test frequency

Multiplies the test frequency by 10

Divides the test frequency by 10

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

The current situation can be checked using the monitor display.

2. Change the test frequency using the digit keys.
Frequency range which can be set: 42.0 Hz to 5.000 MHz
If you try to go out of this range, the relevant digit key goes into non-reversed video and becomes inactive.

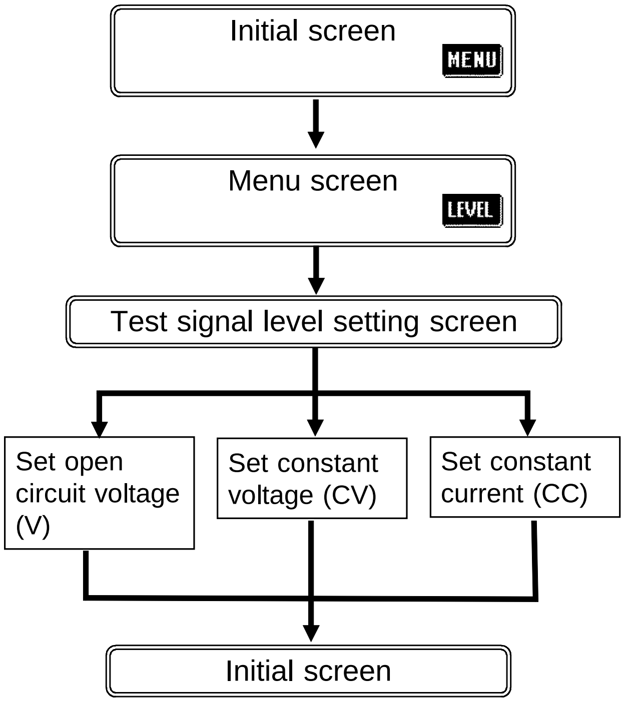
3. When the setting has been established as above, press the **EXIT** key to return to the Initial screen.

4.4 Setting the Test Signal Level

The value of the test signal level may change according to the sample which is being tested. With the 3532-50, it is possible to vary the level of the test signal applied to the object under test over a wide range using the following three methods:

Set open circuit voltage (V)	The value of the open circuit voltage is set.
Set constant voltage (CV)	The value of the voltage between the terminals of the object under test is set.
Set constant current (CC)	The value of the current flowing through the object under test is set.

4.4.1 Control Screen Sequence



Press the MENU key

Press the LEVEL key

Select the type of level for the test signal (open circuit voltage, constant voltage, or constant current) to be set.

Input the value for the test signal level.

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

4.4.2 Selecting the Level Type

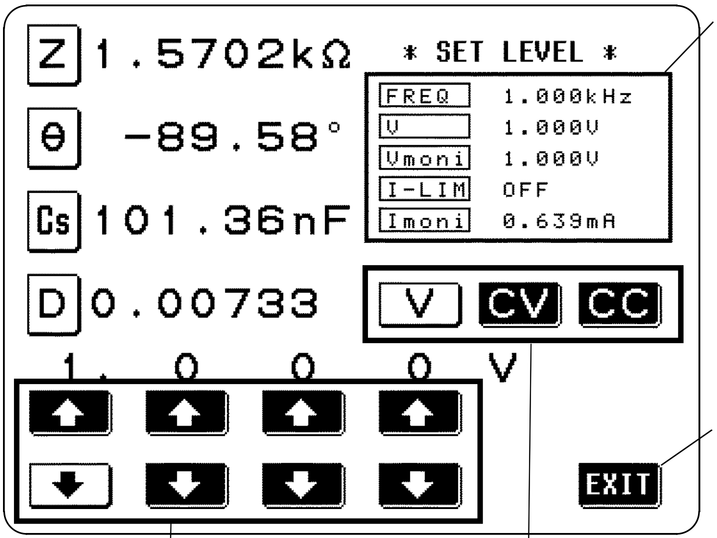
⚠ CAUTION

Be absolutely sure not to change over between constant current (CC) level and constant voltage (CV) level with the test terminals still connected to the sample to be tested. Doing so may damage the test sample.

MENU
Initial screen
↓
LEVEL
Menu screen

1. Press the **MENU** key on the Initial screen to display the Menu screen.

2. Press the **LEVEL** key on the Menu screen to display the Test signal level setting screen.



FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA

Monitor display portion
- Test frequency
- Test signal level
- Voltage between test samples
- Limit value
- Current flowing through the test sample

When the setting has been established as above, press this key to return to the Initial screen.

The key corresponding to the currently established type of test signal level is shown in non-reversed video.

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

The current situation can be checked using the monitor display.

3. The method of control for the test signal level can be selected from the following three:

• Set open circuit voltage (V)	The value of the open circuit voltage is set.
• Set constant voltage (CV)	The value of the voltage between the terminals of the object under test is set.
• Set constant current (CC)	The value of the current flowing through the object under test is set.

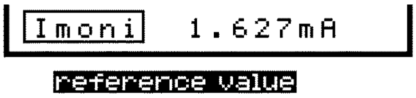
NOTE

The accuracy of testing varies according to the test signal level. Check the accuracy table in Section 7.5.

NOTE

- Even if the 3532-50 unit is being used outside the limits of its specification, test values are sometimes displayed.

  In this case, the following type of indication appears on the display, indicating a value which is not guaranteed.



Imoni 1.627mA

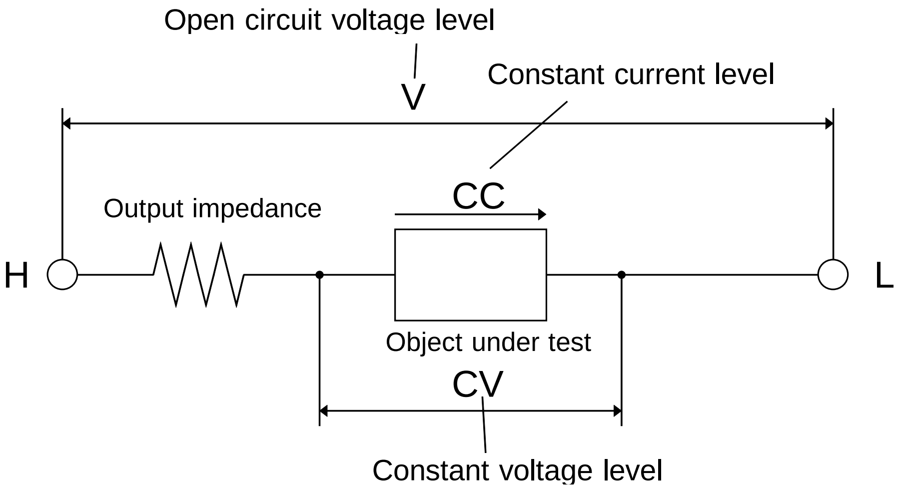
reference value

In this case, you should consider the following possible causes, and you should either change the test conditions while checking the accuracy assured ranges (with reference to Section 7.5, "Test Accuracy"), or you should consider the measured values as values for reference only, because their validity is somewhat doubtful.

- Perhaps the test signal level is too low, increase the test signal level.
- If the current measurement range (during HOLD setting) is not appropriate, set again in the AUTO range, or change the range by manual.

About the test signal level

The relationship between the test signal level for the 3532-50 and the object to be tested is as follows:



Open circuit voltage level (V)

This voltage value is the value which is applied across the two terminals of the series combination of the object which is being tested and the output impedance. As for the voltage which is applied across the terminals of the object which is being tested (by itself), if required, you should either check the monitor voltage value, or select constant voltage (CV) and set a voltage value across these terminals.

Constant voltage level (CV)

You should select this if you wish to set the voltage across the terminals of the object to be tested to a constant value.

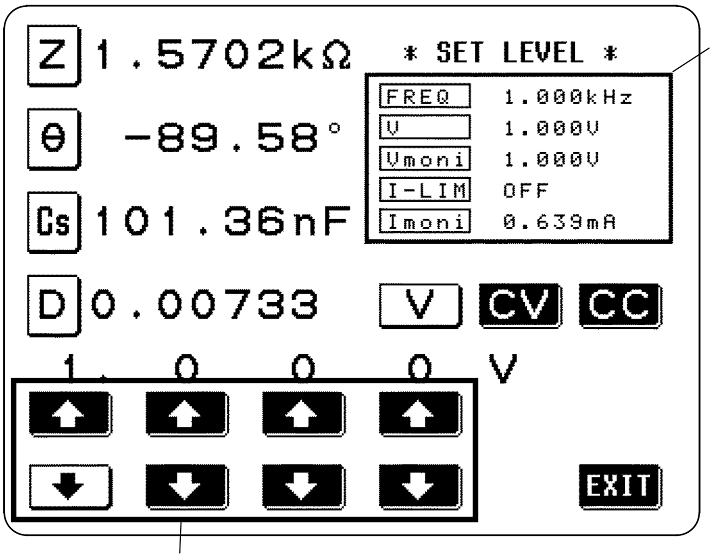
Constant current level (CC)

You should select this if you wish to set the current passing through the object to be tested to a constant value.

4.4.3 Setting the Open Circuit Voltage (V) Level

V
Test signal level setting screen

1. Press this key to set open circuit voltage (V), and the monitor display will change immediately.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733

* SET LEVEL *

FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA

Monitor display portion

- Test frequency
- Open circuit voltage
- Voltage between test samples
- Limit value for the current
- Current flowing through the test sample

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

2. Change the open-circuited voltage value using the digit keys. The definable open-circuit voltage depends on the frequency.

Test frequency (Hz)	Open-circuited voltage
42.0 - 1.000 M	0.010 V- 5.000 V
1.001 M - 5.000 M	0.010 V - 1.000 V

The accuracy of the open-circuit voltage is ±10%±10 mV for 42.0 Hz to 1.000 MHz, and ±20%±10 mV for 1.001 MHz to 5.000 MHz.

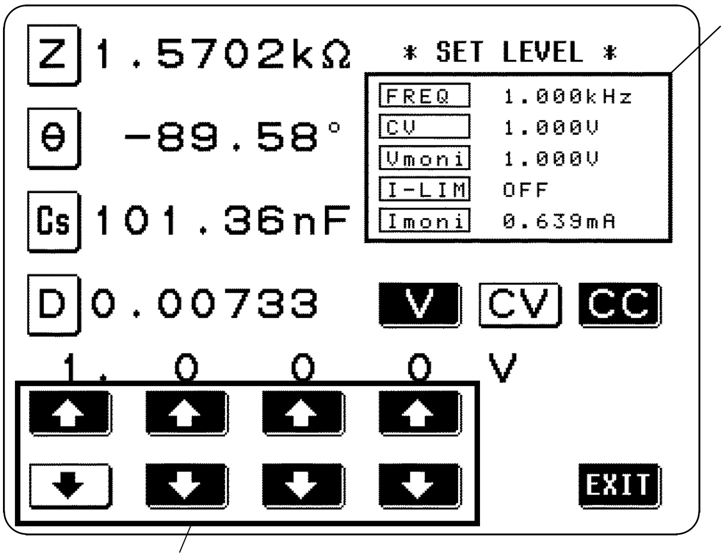
NOTE When the test frequency is higher than 1 MHz at an open-circuit voltage of more than 1 V, the voltage is automatically set to 1 V.

3. When the setting has been established as above, press the **EXIT** key to return to the Initial screen.

4.4.4 Setting the Constant Voltage (CV) Level

CV
Test signal level setting screen

1. Press this key to set constant voltage (CV), and the monitor display will change immediately.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733

* SET LEVEL *

FREQ	1.000kHz
CV	1.000V
Vmoni	1.000V
I-LIM	OFF
Imoni	0.639mA

1.000 V

Monitor display

- Test frequency
- Set value for constant voltage
- Voltage between test samples
- Limit value for the current
- Current flowing through the test sample

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

2. Change the set constant voltage value using the digit keys.
The definable constant voltage depends on the frequency.

Test frequency (Hz)	Constant voltage
42.0 - 1.000 M	0.010 V- 5.000 V
1.001 M - 5.000 M	0.010 V - 1.000 V

The accuracy of the constant voltage is ±10%±10 mV for 42.0 Hz to 1.000 MHz, and ±20%±10 mV for 1.001 MHz to 5.000 MHz.

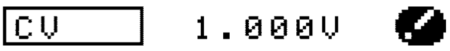
NOTE

When the test frequency is higher than 1 MHz at an open-circuit voltage of more than 1 V, the voltage is automatically set to 1 V.

3. When the setting has been established, press the **EXIT** key to return to the Initial screen.

NOTE

Testing some types of sample is not possible using constant voltage. In this case, the following symbol appears on the display:



CV 1.000V

In such a case, constant voltage testing is not performed. Change the constant voltage level to a value not more than the value being shown as Vmoni.

Reference

When a 1 μF capacitance is measured at 10 kHz, the CV operation range can be obtained as follows. Sample impedance Zm becomes as follows:

$Zm = Rm + jXm = 0\Omega - j15.9\Omega$ $\quad Xm=-1/(2\pi fC)$

The impedance Zm' observed from the generator is as follows:

$Zm' = Ro + Zm = 50\Omega - j15.9\Omega$ $\quad$ Ro: Output resistance (50 Ω)

Accordingly, the voltage Vm across both leads of the sample is as follows:

$Vm = |Zm| \text{ x } Vo/|Zm'|$ Vo: generator output

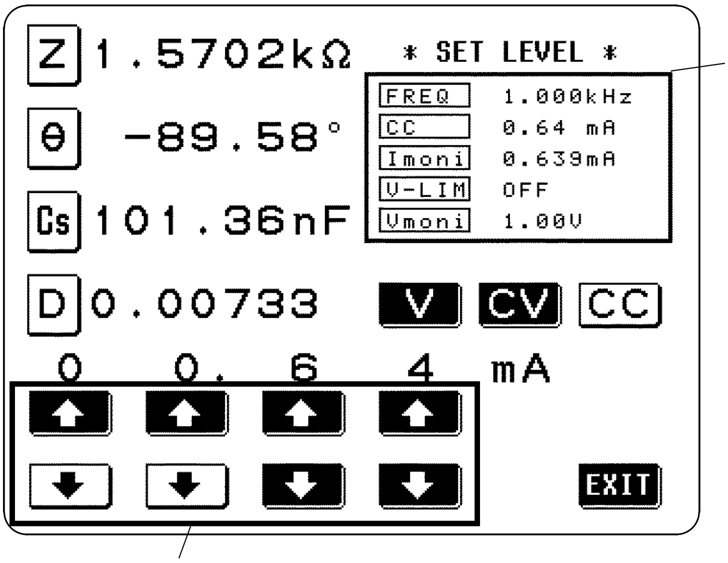
$= 15.9\Omega \text{ x } Vo/52.5\Omega$

Because the generator output voltage range is 10 mV to 5 V for 10 kHz, the CV operation range per the above expression is Vm = 3.03 mV to 1.51 V.

4.4.5 Setting the Constant Current (CC) Level

CC
Test signal level
setting screen

1. Press this key to set constant current (CC), and the monitor display will change immediately.



FREQ 1.000kHz
CC 0.64 mA
Imoni 0.639mA
V-LIM OFF
Vmoni 1.00V

0 0. 6 4 mA

Monitor display

- Test frequency
- Set value for constant current
- Current flowing through the test sample
- Limit value for the voltage
- Voltage between test samples

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

2. Change the set constant current value using the digit keys.
The definable constant current depends on the frequency.

Test frequency (Hz)	Constant current
42.0 - 1.000 M	0.01 mA - 99.99 mA
1.001 M - 5.000 M	0.01 mA - 20.00 mA

The accuracy of the constant current is ±10%±10μA for 42.0 Hz to 1.000 MHz, and ±20%±10μA for 1.001 MHz to 5.000 MHz.

NOTE When the test frequency is higher than 1 MHz at an constant current of more than 20 mA, the current is automatically set to 20 mA.

3. When the setting has been established, press the **EXIT** key to return to the Initial screen.

NOTE Testing some types of sample is not possible using constant current. In this case, the following symbol appears on the display:


CC 20.00mA

In such a case, constant current testing is not performed. Change the constant current level to a value not more than the value being shown as Imoni.

Reference When a 10 mH impedance is measured at 1 kHz, the CC operation range can be obtained as follows. Sample impedance Zm becomes as follows:

$Zm = Rm + jXm = 0\Omega + j62.8\Omega$ Xm: $2\pi fL$

The impedance Zm' observed from the generator is as follows:

$Zm' = Ro + Zm = 50\Omega + j62.8\Omega$ Ro: output resistance (50 Ω)

Accordingly, the current Im across both leads of the sample is as follows:

$Im = Vo/|Zm'| = Vo/80.3\Omega$ Vo: generator output

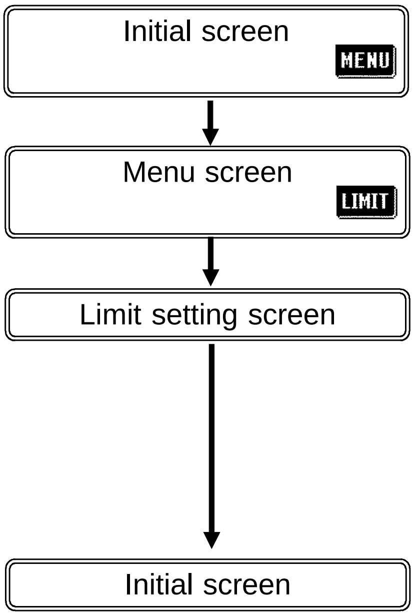
Because the generator output voltage range is 10 mV to 5 V for 1 kHz, the CC operation range per the above expression is Im = 125 μA to 62.3 mA.

4.5 Setting the Voltage/Current Limit

Depending on the test signal level, in some cases it is possible to damage the sample which is being tested by applying to it a voltage or a current greater than its rated value. Using the voltage/current limit function, it is possible to set a limit value which the voltage applied to the sample under test, or alternatively the current flowing through it, should not exceed; and thereafter the 3532-50 unit will limit the voltage, or current, so as keep it below this specified limit value.

When open circuit voltage (V) or constant voltage (CV) is set:
A current limit can be set.
When constant current (CC) is set:
A voltage limit can be set.

4.5.1 Control Screen Sequence



Press the MENU key.

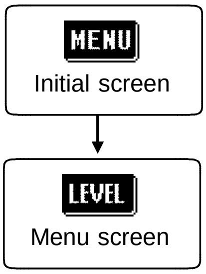
Press the LIMIT key.

Input a limit value.

(The 3532-50 will automatically switch between voltage limit and current limit according to the test signal level setting.)

When the setting has been established, press the EXIT key to return to the Initial screen.

4.5.2 Details of the Setting Process

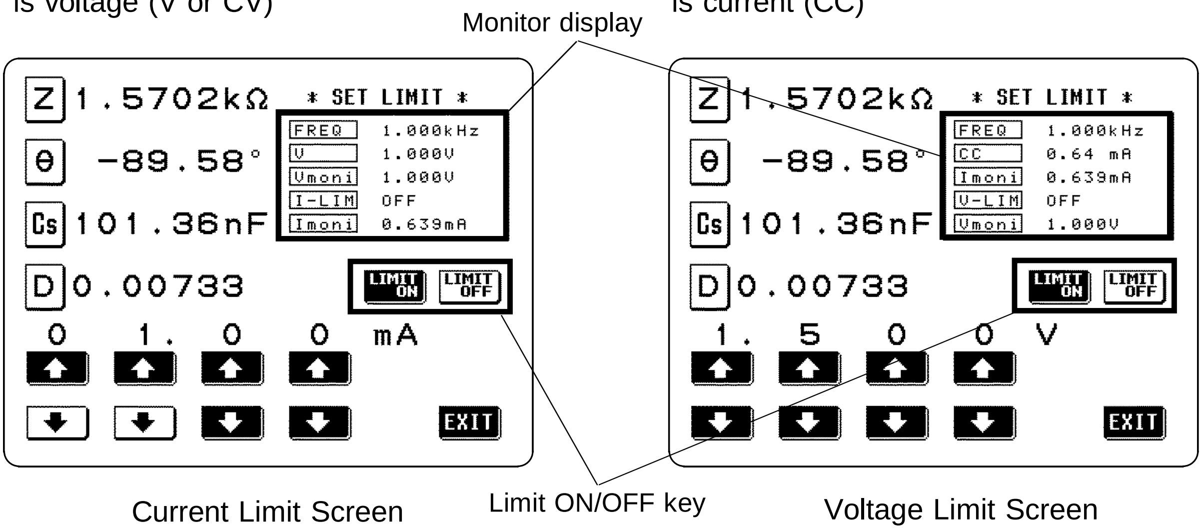


1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the LIMIT key on the Menu screen to display the one of the Limit setting screens.

When the test signal level type is voltage (V or CV)

When the test signal level type is current (CC)



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733
* SET LIMIT *
FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA
LIMIT ON
LIMIT OFF
0 1. 0 0 mA
EXIT

Current Limit Screen

Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733
* SET LIMIT *
FREQ 1.000kHz
CC 0.64 mA
Imoni 0.639mA
V-LIM OFF
Vmoni 1.000V
LIMIT ON
LIMIT OFF
1. 5 0 0 V
EXIT

Voltage Limit Screen

The present situation can be checked using the monitor display.
The monitor display is different for V, CV, and CC.

NOTE

The setting for voltage or current limit changes automatically to current or voltage limit, according to the present Test signal level setting. Therefore, first set the test signal level, and thereafter set the voltage or current limit.
For details of the Test signal level setting, refer to Section 4.4.

3. Input the limit value using the digit keys. The ranges within which the limit values can be set are as follows.

Test signal control level	Limit set	Setting range
V, CV	Current limit	0.01 mA to 99.99 mA
CC	Voltage limit	0.01 V to 5 V

The accuracy of the current limit is ±10%±10μA for 42.0 Hz to 1.000 MHz, and ±20%±10μA for 1.001 MHz to 5.000 MHz.

The accuracy of the voltage limit is ±10%±10 mV for 42.0 Hz to 1.000 MHz, and ±20%±10 mV for 1.001 MHz to 5.000 MHz.
When any digit key would take the limit value outside these ranges, it changes to non-reversed video (black characters upon a white ground).

NOTE

The limit value is not made effective just by setting it, if the limit function is turned off.

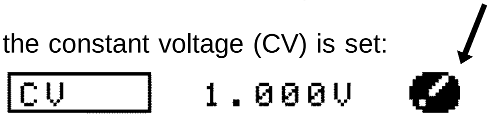
4. The limit function can be turned on and off by pressing the appropriate one of the following keys (The key which has been pressed changes to non-reversed video).
LIMIT ON : The limit function is turned on.
LIMIT OFF : The limit function is turned off.
Whether the limit function is on or off can be checked from the change on the monitor display.

NOTE

When the limit function is on in the following cases, " ⊘ " or " limit " are displayed.

" ⊘ " display
If the voltage or current which is applied to the sample under test exceeds the limit value (the current exceeding the limit value flows through the sample even when the open-circuit voltage is set to minimum value.)

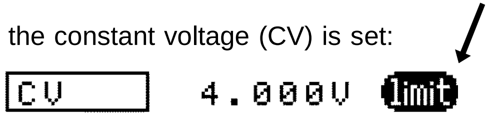
When the constant voltage (CV) is set:



CV 1.000V ⊘

" limit " display
If the test signal level which is being applied to the sample under test exceeds the limit value. Then the test signal level is stopped changing .

When the constant voltage (CV) is set:



CV 4.000V limit

At this time, the voltage or current which exceeds the limit value is not being applied to the sample under test. You should change the test signal level so that it does not exceed the limit value.

5. When the setting has been established as above, press the EXIT key to return to the Initial screen.

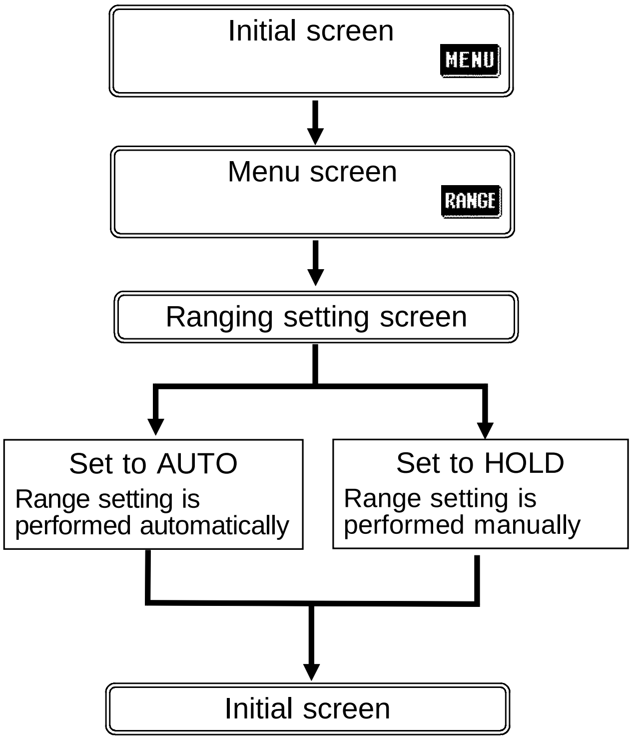
4.6 Setting the Ranging

Using AUTO, the 3532-50 unit can automatically select the most appropriate test range. This is useful when testing a sample whose impedance varies greatly with frequency, or whose nature is unknown. The test range can also be fixed using HOLD, which provides the quickest testing.

AUTO : The most suitable test range is set automatically.
HOLD : The test range is fixed, and may only be altered manually.

NOTE The ranges are all defined in terms of impedance. Therefore, for a parameter other than impedance, the value is obtained by calculating from the measured values of $|Z|$ and θ.

4.6.1 Control Screen Sequence



Press the MENU key.

Press the RANGE key.

Choose the manner in which the range will be set (AUTO or HOLD).

When the ranging setting has been established as above, press the EXIT key to return to the Initial screen.

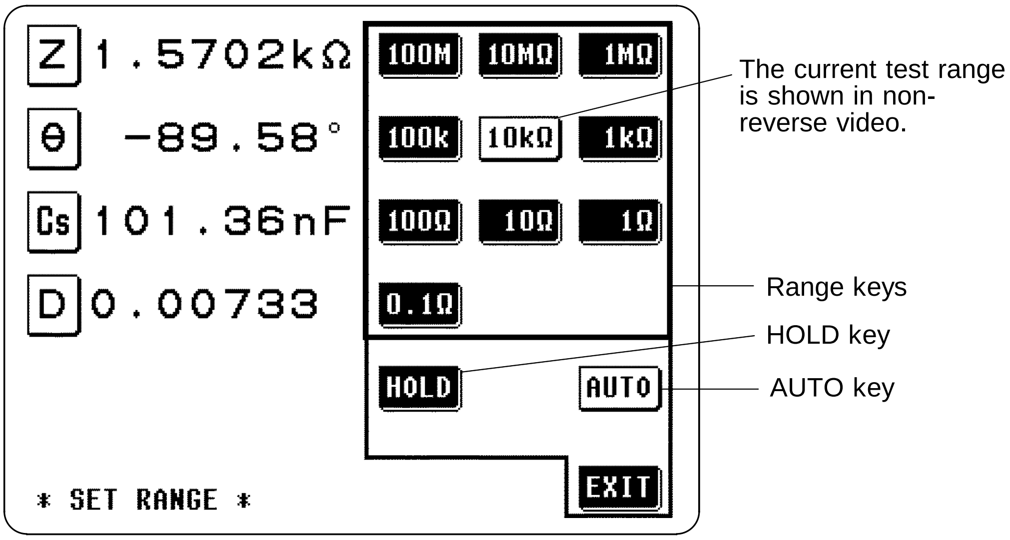
4.6.2 Setting the Ranging

MENU
Initial screen

RANGE
Menu screen

1. Press the **MENU** key on the Initial screen.
The Menu screen will be displayed.

2. Press the **RANGE** key on the Menu screen.
The Ranging setting screen will be displayed.



Ranging Setting Screen

3. The ranging setting can be either of the following:

AUTO : The most suitable test range is set automatically.
HOLD : The test range is fixed, and may only be altered manually.

4.6.3 Setting AUTO Ranging

AUTO
Ranging setting screen

1. Press this key, and the 3532-50 will automatically be set to the most suitable test range. At this time, the AUTO key and the key corresponding to the current test range will be shown in non-reverse video.

2. When the setting has been established as above, press the **EXIT** key to return to the Initial screen.

NOTE

If the 3532-50 unit is being used outside the limits of its specification, the suitable range may not be set in auto ranging function. In this case, check the accuracy assured ranges in Section 7.5, "Test Accuracy" and then change the test conditions.

4.6.4 Setting the Ranging to HOLD

HOLD
Ranging setting screen

1. There are two ways of setting the ranging to HOLD:

1) While AUTO ranging is set, press the **HOLD** key, and then this key will go into non-reverse video, and the currently most suitable range will be held fixed.

2) To select a desired test range directly, just press the key corresponding to that range. Then the **HOLD** key and also this range key will both go into non-reverse video.

Set the test range according to the combined impedance value of the sample to be tested and the test cables.

Test range [Ω]	Range of impedance which can be measured within the accuracy guaranteed [Ω]	- 100 k [Hz]	100.1 k - 1.000 M [Hz]	1.001 M - 5.000 M [Hz]
0.1	10.00 m to 99.99 m	●	●	●
1	80.00 m to 999.99 m	●	●	●
10	0.8000 to 9.9999	●	●	●
100	8.000 to 99.999	●	●	●
1 k	80.00 to 999.99	●	●	●
10 k	0.8000 k to 9.9999 k	●	●	●
100 k	8.000 k to 99.999 k	●	●	●
1 M	80.00 k to 999.99 k	●	●	--
10 M	0.8000 M to 9.9999 M	●	--	--
100 M	8.0000 M to 200.00M	●	--	--

●: settable/ -- cannot be set

NOTE

- The accuracy assured ranges varies according to the measurement level. Check the accuracy assured ranges in Section 7.5, "Test Accuracy."
- The measurement range is determined according to the test range setting. If the display for the measured value shows "OVER FLOW" or "UNDER FLOW", that means that measurement cannot be performed using the currently set test range. Either you should set AUTO ranging so as to select the most suitable test range automatically, or you should set a more suitable test range manually.
- If the test frequency is set to a specific value, the maximum values are automatically selected when the test range setting exceeds the values specified in the table above. For example, when the test frequency is set to 1.001 MHz in a test range of 1 MΩ, the test range is automatically changed to 100 kΩ.

2. When the setting has been established as above, press the EXIT key to return to the Initial screen.

NOTE

- In the case of a test sample whose impedance changes according to the frequency, when testing is being performed with HOLD set, it may happen, when the frequency is changed over, that measurement cannot be continued to be performed upon the same test range. You should change the test range if this happens.
- The test range setting is made according to the combination of the impedances of the sample being tested and the test cables. Therefore it can happen that testing is not possible, if the test range is held with HOLD only upon the basis of the impedance of the sample under test. If this happens, you should change the test range, making reference to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".
- Even if the 3532-50 unit is being used outside the limits of its specification, test values are sometimes displayed.
  In this case, the following type of indication "reference value" appears on the display, indicating a value which is not guaranteed.

In this case, you should consider the following possible cause, and you should either change the test conditions while checking the accuracy assured ranges (with reference to Section 7.5, "Test Accuracy"), or you should consider the measured values as values for reference only, because their validity is somewhat doubtful.

- Perhaps the test signal level is too low, increase the test signal level.
- When the present test range (when HOLD is set) is not suitable:
  Either you should set AUTO ranging so as to select the most suitable test range automatically, or you should set a more suitable test range manually.

4.7 Open Circuit Compensation

With open circuit compensation, it is possible to reduce the influence of the floating impedance of the test cables and thereby to enhance the accuracy of measurement. It is effective for test samples whose impedance is relatively high.

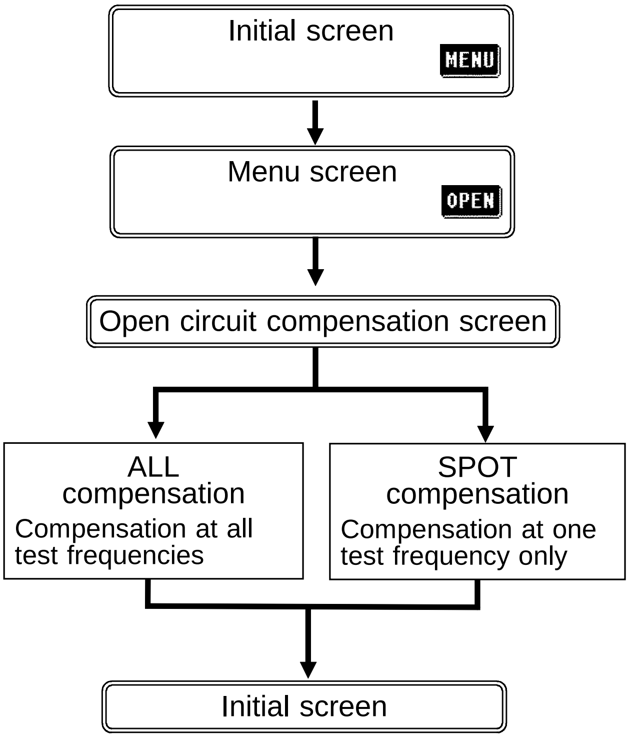
Open circuit compensation may be performed according to either of two methods:
ALL compensation
Compensation is performed at all the test frequencies.

SPOT compensation
Compensation is performed for one specified test frequency only.

NOTE

- Before open circuit compensation, always set the cable length. For details, refer to Section 4.14.
- The testing accuracy specified in the specification of the 3532-50 unit assumes that open circuit compensation and short circuit compensation is being performed, as appropriate.
- When you have changed the test cables, be sure to perform compensation again. Correct test values will not be obtained if you go on testing using the same old compensation values which were obtained before the cable change.
- When performing compensation, make sure that there is no noise source nearby. Noise may cause an error when performing compensation.
  ex. Servo Motor, switching power source, high-voltage cable and etc.
- Perform compensation in the state as close as possible to the actual one in which the test sample will be measured.
- The compensated value is preserved in the memory of the main unit even when power is turned off.

4.7.1 Control Screen Sequence



Press the MENU key.

Press the OPEN key.

Select the compensation method (ALL compensation or SPOT compensation).

If setting has been completed normally, the open circuit residual component and its phase angle are displayed.

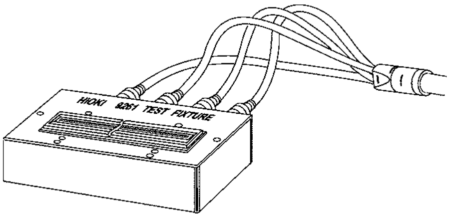
When compensation has been completed, press the O K key to return to the Initial screen.

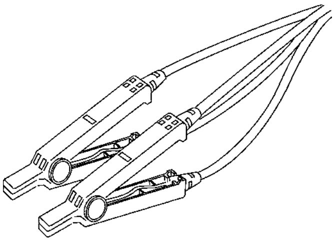
Open circuit compensation has been set.

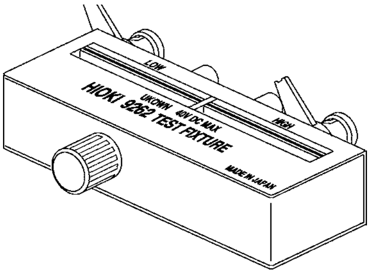
4.7.2 Setting the Compensation Method

1. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and make sure that the HIGH and LOW leads are not contacted together.

2. When the open circuit compensation is performed, execute the guarding process. (For the guarding process, refer to Section 5.2.)

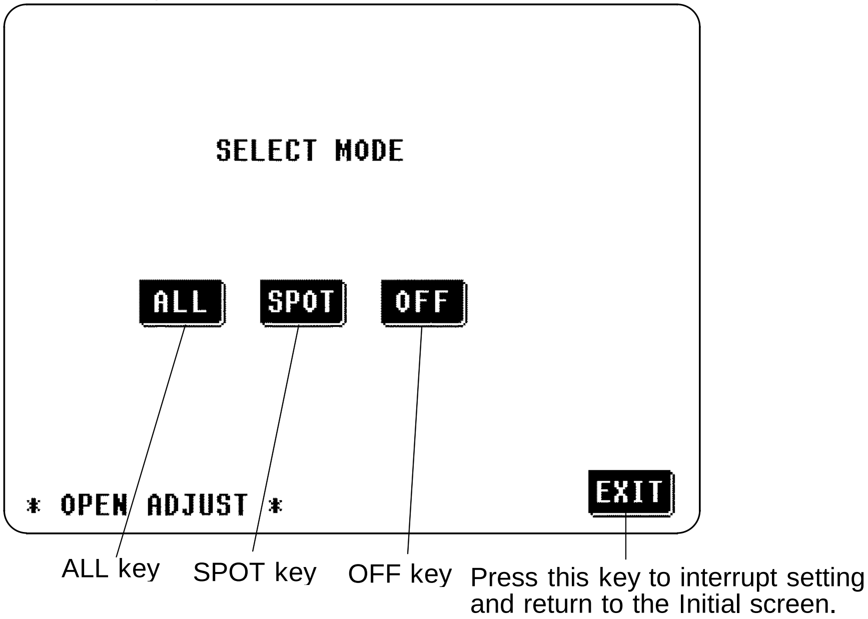






3. On the Initial screen, press the MENU key, and the Menu screen will be displayed.

4. Press the OPEN key on the Menu screen, and the Open circuit compensation screen will be displayed.



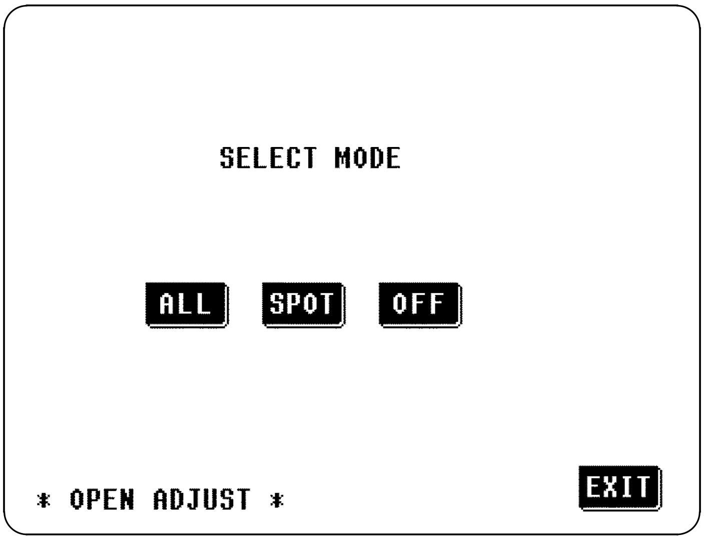
Press this key to interrupt setting and return to the Initial screen.

5. The OPEN circuit compensation method can be set to:
   - ALL : The compensation values are obtained for all test frequencies.
   - SPOT : The compensation values are obtained at the set test frequency only.
   - OFF : The open circuit compensation data are cleared.

4.7.3 ALL Compensation

ALL
Open circuit compensation screen

1. To select ALL compensation, press this key with the Open circuit compensation screen displayed.

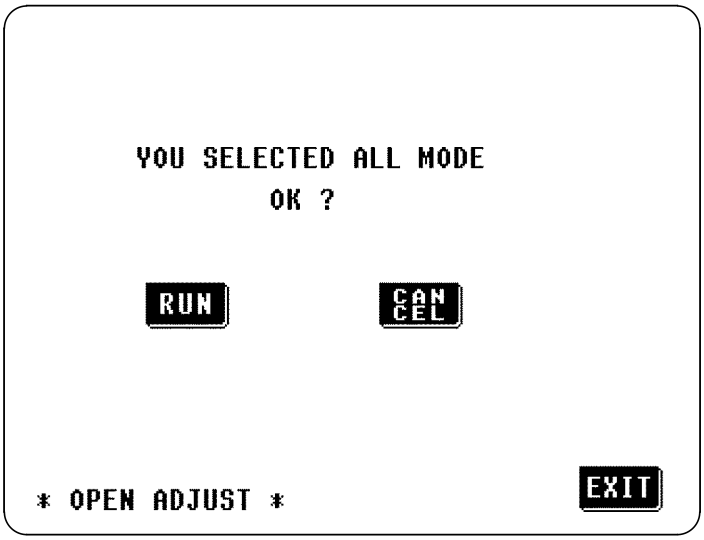


SELECT MODE

* OPEN ADJUST *

Open Circuit Compensation Screen

2. A Confirmation screen will appear for confirmation. If it is OK to proceed, press the RUN key; if not, press the CANCEL key to return to the Open circuit compensation screen.



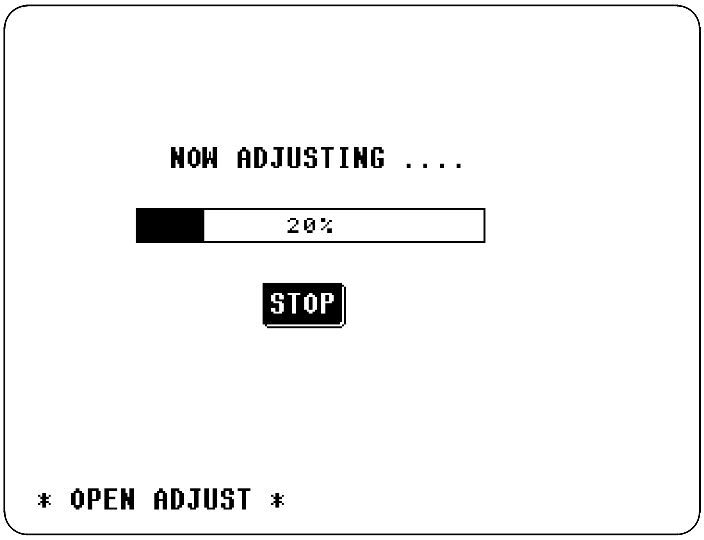
YOU SELECTED ALL MODE
OK ?

* OPEN ADJUST *

NOTE

Check again - are the test leads definitely out of mutual contact?

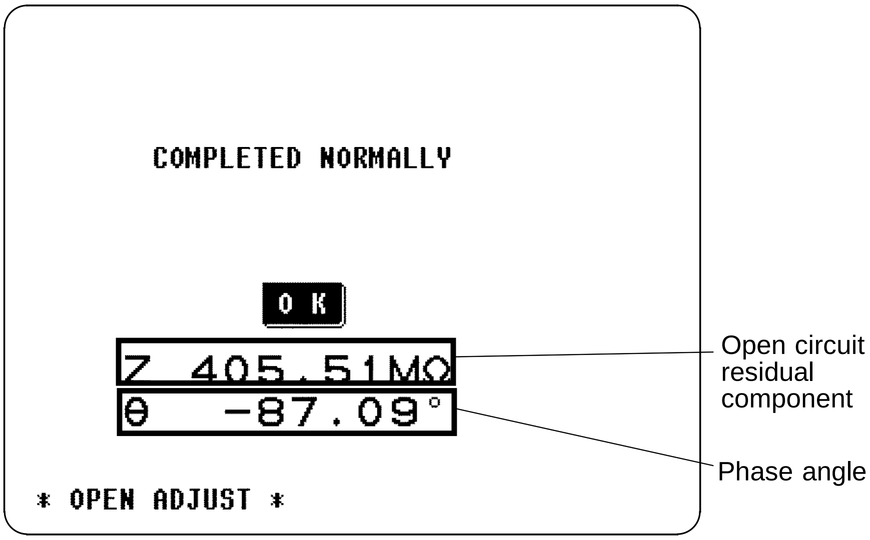
3. When the RUN key is pressed, the ALL open circuit compensation process starts. After about 2 minutes, the determination and adjustment of the open circuit compensation values is complete.


NOW ADJUSTING ....

* OPEN ADJUST *

Interrupting the ALL compensation process:
To interrupt the ALL compensation process, press the STOP key on this screen. The compensation process will stop and the display will revert to the Initial screen. At this time, the compensation values obtained in the previous episode of open circuit compensation will remain valid.

4. If the compensation process has terminated satisfactorily, the following Confirmation screen will be displayed.
The open circuit residual component for the test cables at the frequency of 5 MHz and its phase angle are shown on the screen. (If an error message appears, refer to Section 4.7.5.)


COMPLETED NORMALLY

Z 405.51MΩ
θ -87.09°

* OPEN ADJUST *

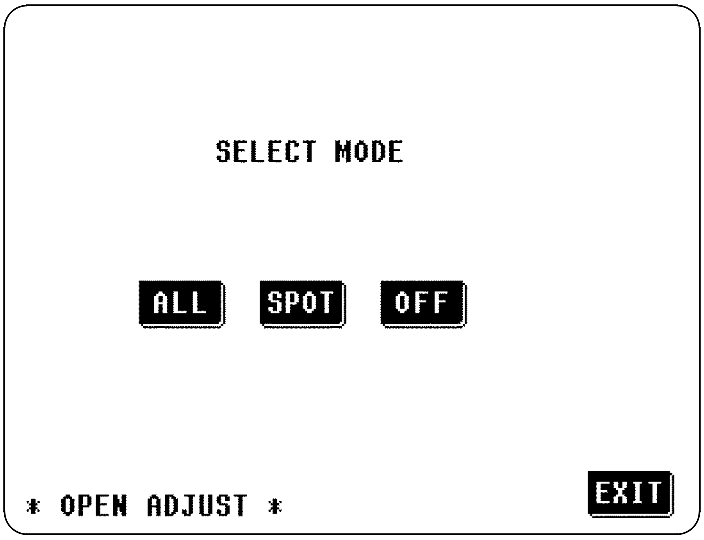
These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)
After checking the open circuit residual component and its phase angle, press the O K key, and the display will return to the Initial screen.

NOTE Compensation can be performed for impedances of at least 1 kΩ.

4.7.4 Spot Compensation

SPOT
Open circuit compensation screen

1. To select SPOT compensation, press this key with the Open circuit compensation screen displayed.

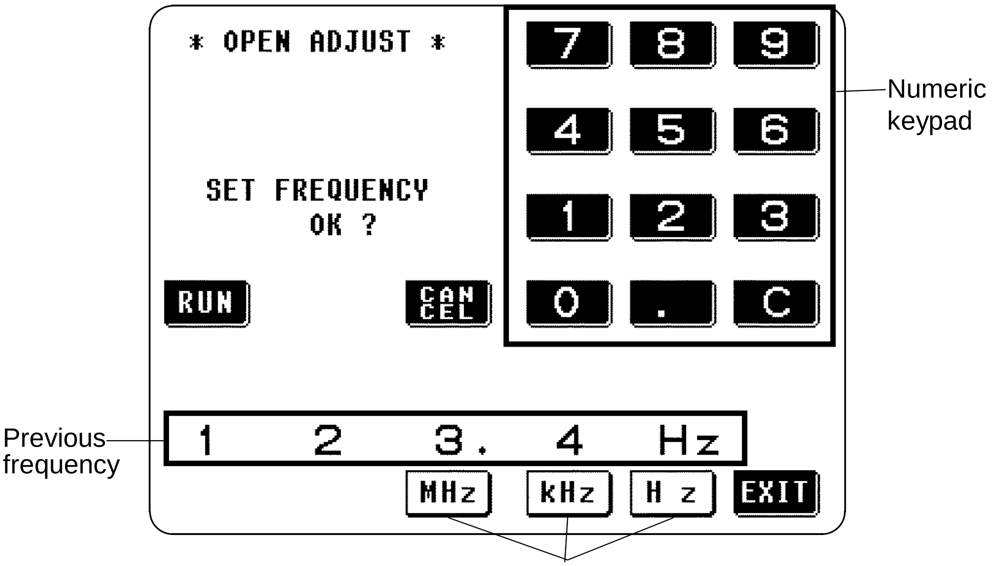


SELECT MODE

* OPEN ADJUST *

Open Circuit Compensation Screen

2. A numeric keypad is displayed for input of the frequency. Until one of these keys is pressed for input of a numerical value, the previous frequency for which SPOT compensation was performed is displayed.



* OPEN ADJUST *

SET FREQUENCY
OK ?

1 2 3. 4 Hz

Units keys (shown in non-reversed video, until a numerical value for the frequency has been input)

SPOT compensation for the same frequency as previously

Just press the RUN key. SPOT compensation will be started using the same frequency which was used for the last episode of SPOT compensation.

SPOT compensation for some new frequency

Input the frequency for compensation using the numeric keypad.

Frequency range which can be set : 42.0 Hz to 5.000 MHz

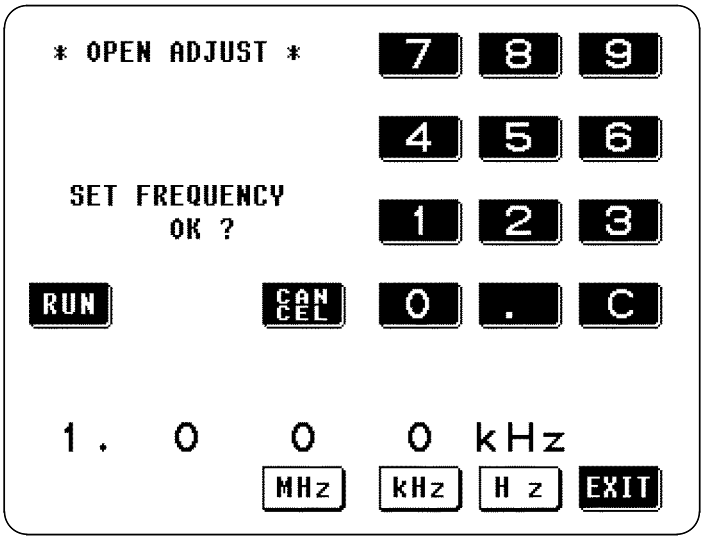
NOTE

If you attempt to set a test frequency greater than 5 MHz, it will automatically be reduced to 5 MHz.

If you attempt to set a test frequency lower than 42 Hz, it will automatically be set to 42 Hz.

- If you make a mistake during input of the numerical value, press the C key to cancel the input so far, and start again.
- When you have completed inputting the numerical value for the frequency, press the appropriate units key MHz, kHz, or H z so as to confirm the displayed frequency for compensation.
- Until the numerical value for the frequency has been input, the units keys cannot be used.

3. After the frequency for SPOT compensation has been input as above, press the RUN key.



* OPEN ADJUST *

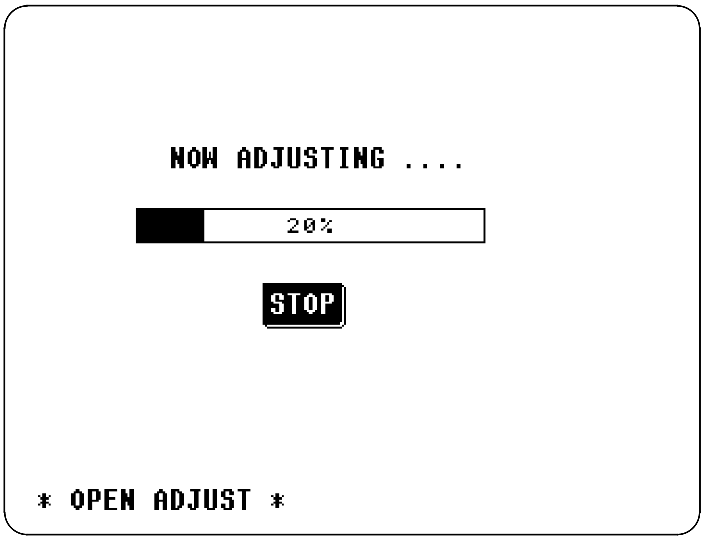
SET FREQUENCY
OK ?

1. 0 0 0 kHz

NOTE

Check again - are the test leads definitely out of mutual contact?

4. When you press the **RUN** key, the SPOT open circuit compensation process starts.



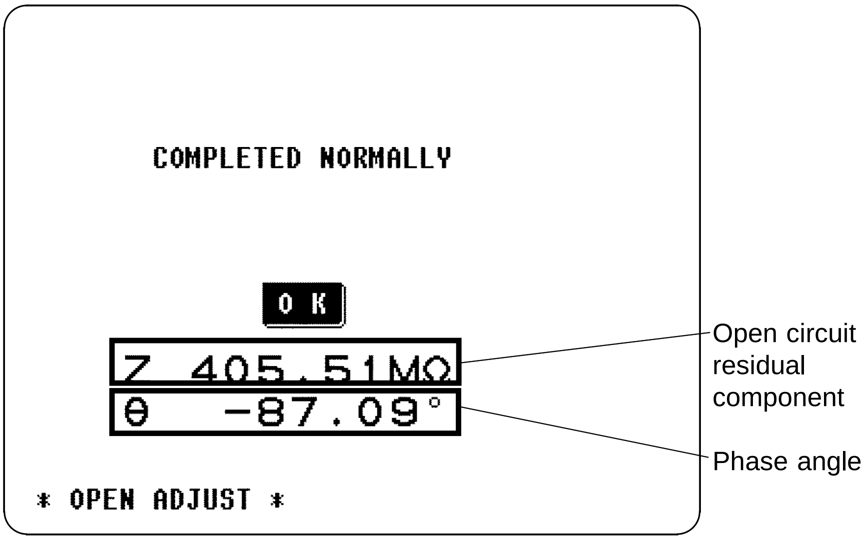
NOW ADJUSTING ....

20%

* OPEN ADJUST *

Interrupting the SPOT compensation process:
To interrupt the SPOT compensation process, press the **STOP** key on this screen. The compensation process will stop and the display will revert to the Initial screen. At this time, the compensation values obtained in the previous episode of open circuit compensation will remain valid.

5. If the compensation process has terminated satisfactorily, the following Confirmation screen will be displayed.
The open circuit residual component for the test cables at the set frequency, and its phase angle, are shown on the screen. (If an error message appears, refer to Section 4.7.5.)



COMPLETED NORMALLY

Z 405.51MΩ

θ -87.09°

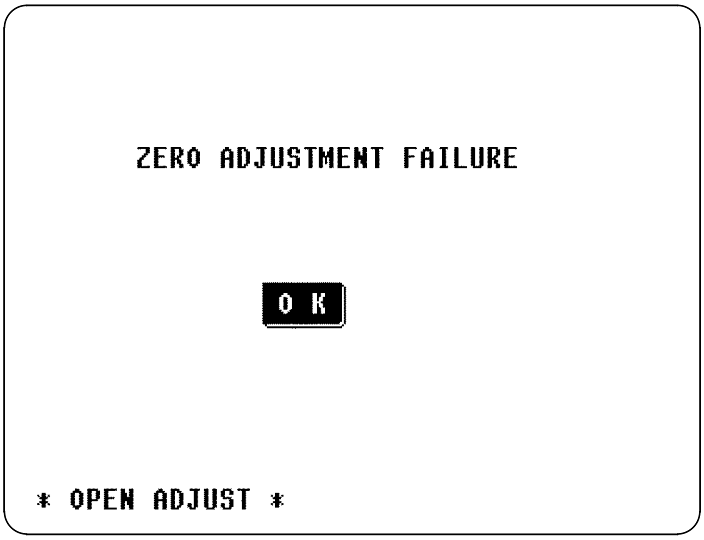
* OPEN ADJUST *

These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)
After checking the open circuit residual component and its phase angle, press the **O K** key, and the display will return to the Initial screen.

NOTE Compensation can be performed for impedances of at least 1 kΩ.

4.7.5 When an Error Message Appears and Compensation Has Stopped

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



ZERO ADJUSTMENT FAILURE

* OPEN ADJUST *

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 cables are properly connected.
- Check that nothing is connected to the test cables. (Open circuit compensation cannot be performed while any test sample is connected to the test cables.)
- Check that the test leads are 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 cables or to move your hand near them.
- Execute the guarding process. (For details, refer to Section 5.2, "Testing High Impedance Elements".)

4.7.6 Clearing Compensation Data

From the Open circuit compensation screen, press the **OFF** key, and the display will revert to the Initial screen with the compensation data cleared.

4.8 Short Circuit Compensation

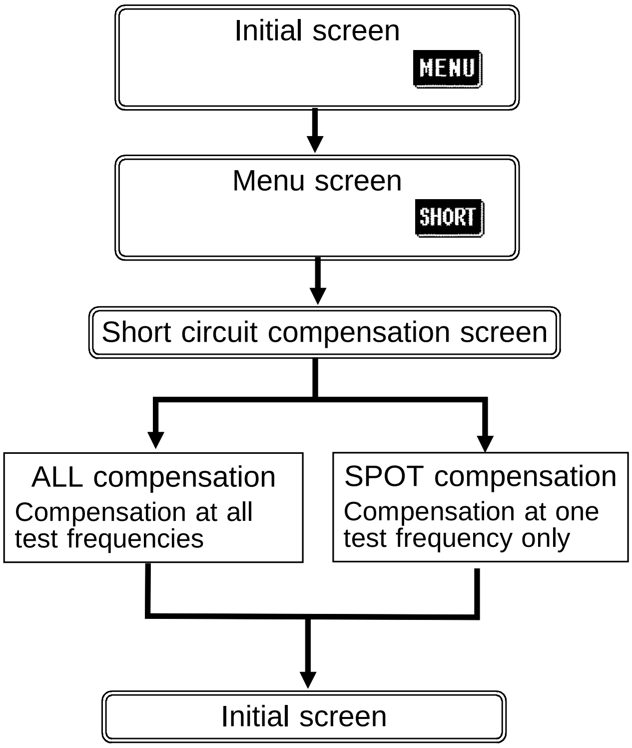
With short circuit compensation, it is possible to reduce the influence of the residual impedance of the test cables and thereby to enhance the accuracy of measurement. It is effective for test samples whose impedance is relatively low. Short circuit compensation may be performed according to either of two methods:

ALL compensation
Compensation is performed at all the test frequencies.
SPOT compensation
Compensation is performed for one specified test frequency only.

NOTE

- Before short circuit compensation, always set the cable length. For details, refer to Section 4.14.
- The testing accuracy specified in the specification of the 3532-50 unit assumes that open circuit compensation and short circuit compensation is being performed, as appropriate.
- When you have changed the test cables, be sure to perform compensation again. Correct test values will not be obtained if you go on testing using the same old compensation values which were obtained before the cable change.
- When performing compensation, make sure that there is no noise source nearby. Noise may cause an error when performing compensation.
  ex. Servo Motor, switching power source, high-voltage cable and etc.
- Perform compensation in the state as close as possible to the actual one in which the test sample will be measured.
- The compensated value is preserved in the memory of the main unit even when power is turned off.

4.8.1 Control Screen Sequence



Press the MENU key.

Press the SHORT key.

Select the compensation method
(ALL compensation or SPOT compensation).

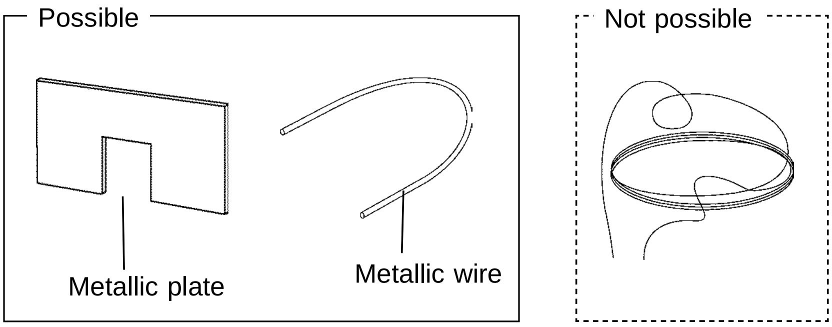
If setting has been completed normally, the short circuit residual component and its phase angle are displayed.

When compensation has been completed, press the OK key to return to the Initial screen.

Short circuit compensation has been set.

4.8.2 Setting the Compensation Method

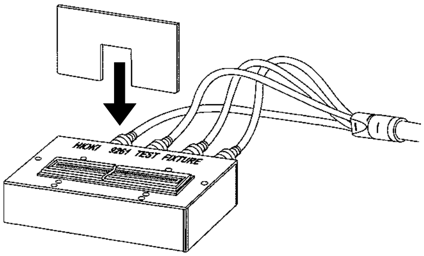
1. A shorting bar is used. This shorting bar is for short circuiting together the ends of the test leads. Use an object whose impedance is as low as possible.

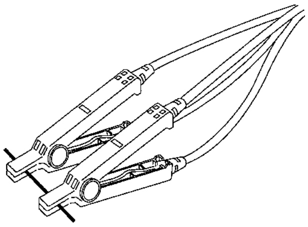


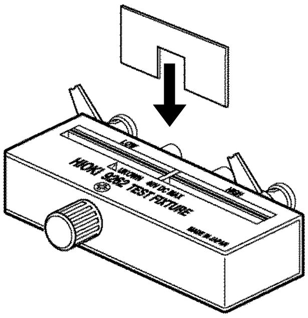
NOTE

If you use a metallic wire or the like as a shorting bar, try to ensure that it is as thick and short as possible.

2. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and short circuit together the HIGH and LOW leads. In order to keep external influences as low as possible, be sure to thrust the shorting bar in all the way.

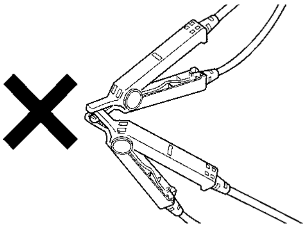






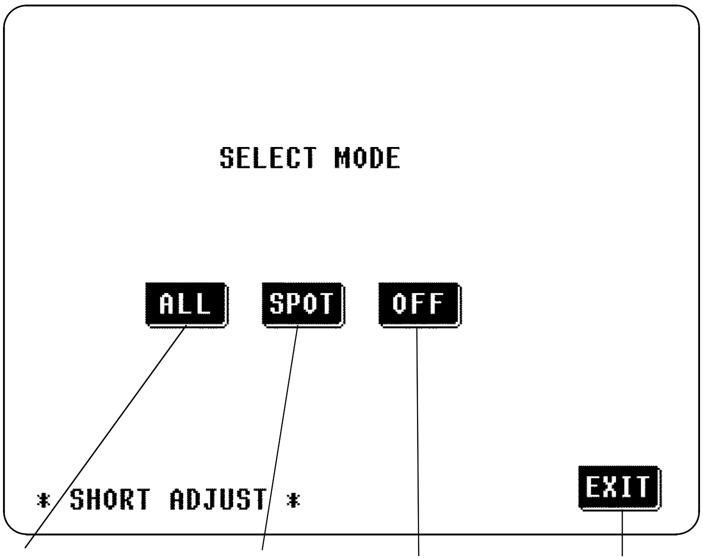
NOTE

If you intend to short circuit between the clamps at the ends of the test leads, clip both clamps onto a short piece of metallic wire as shown.
When using 4-TERMINAL PROBE 9140, please pinch the short wire with both clips. A short circuit state can not be created by pinching clip each other.



3. On the Initial screen, press the MENU key, and the Menu screen will be displayed.

4. Press the SHORT key on the Menu screen, and the Short circuit compensation screen will be displayed.



ALL key

SPOT key

OFF key

Press this key to interrupt setting and return to the Initial screen.

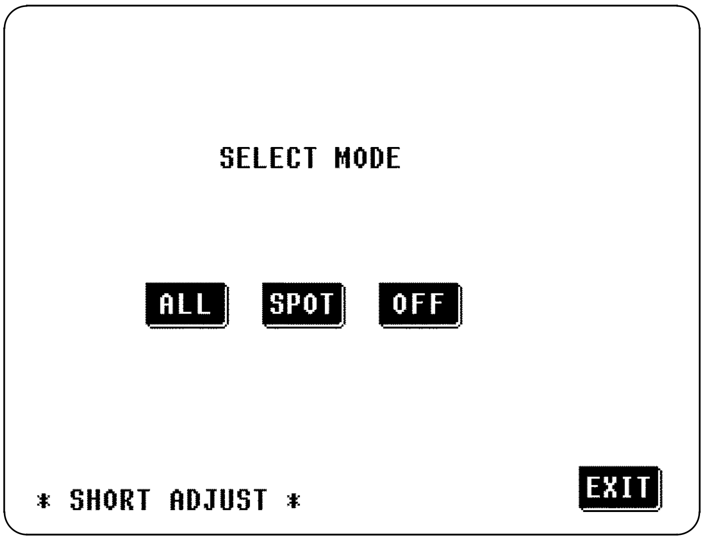
5. The SHORT circuit compensation method can be set to:

ALL : Compensation values are obtained for all test frequencies .
SPOT : Compensation values are obtained at the set test frequency only.
OFF : The short circuit compensation data are cleared.

4.8.3 ALL Compensation

ALL
Short circuit
compensation
screen

1. To select ALL compensation, press this key with the Short circuit compensation screen displayed.

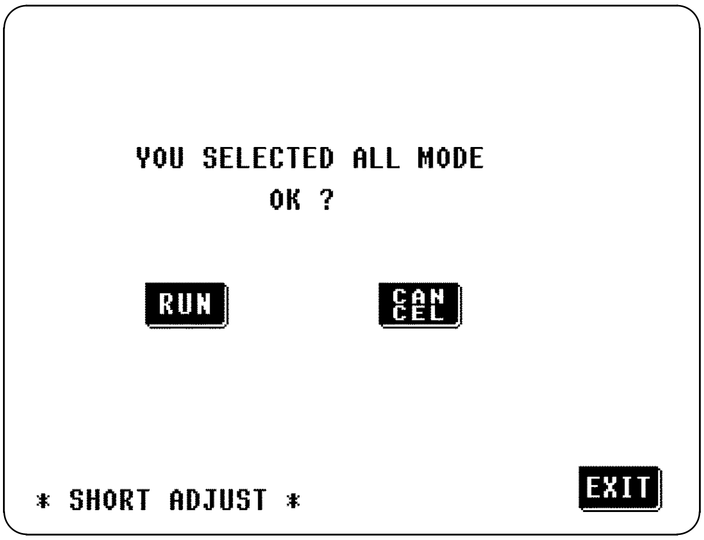


SELECT MODE

* SHORT ADJUST *

Short Circuit Compensation Screen

2. A Confirmation screen will appear for confirmation. To proceed, press the **RUN** key; if not, press the **CANCEL** key to return to the Short circuit compensation screen.

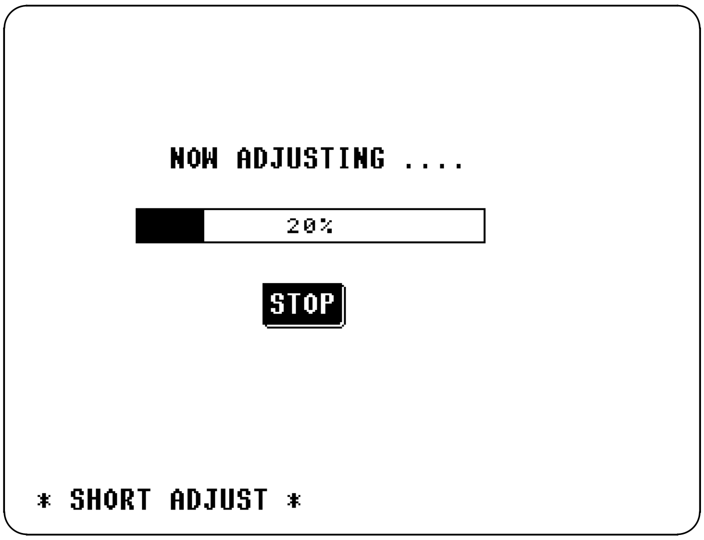


YOU SELECTED ALL MODE
OK ?

* SHORT ADJUST *

NOTE Check again - are the test leads properly shorted together with the shorting bar?

3. When you press the RUN key, the ALL short circuit compensation process starts. After about 2 minutes, the determination and adjustment of the short circuit compensation values is complete.



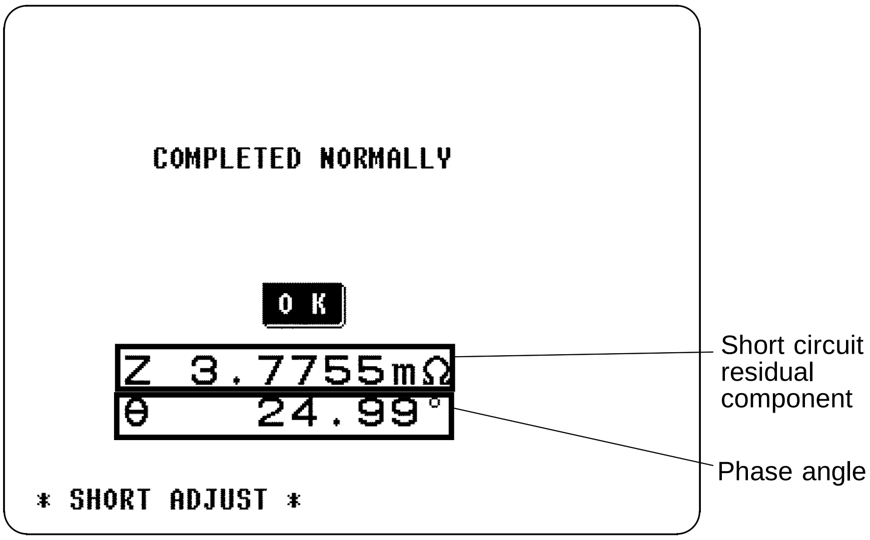
NOW ADJUSTING ....

20%

* SHORT ADJUST *

Interrupting the ALL compensation process:
To interrupt the ALL compensation process, press the STOP key on this screen. The compensation process will stop and the display will revert to the Initial screen. At this time, the compensation values obtained in the previous episode of short circuit compensation will remain valid.

4. If the compensation process has terminated satisfactorily, the following Confirmation screen will be displayed.
The short circuit residual component for the test cables at the frequency of 5 MHz and its phase angle are shown on the screen. (If an error message appears, refer to Section 4.8.5.)



COMPLETED NORMALLY

Z 3.7755mΩ

θ 24.99°

* SHORT ADJUST *

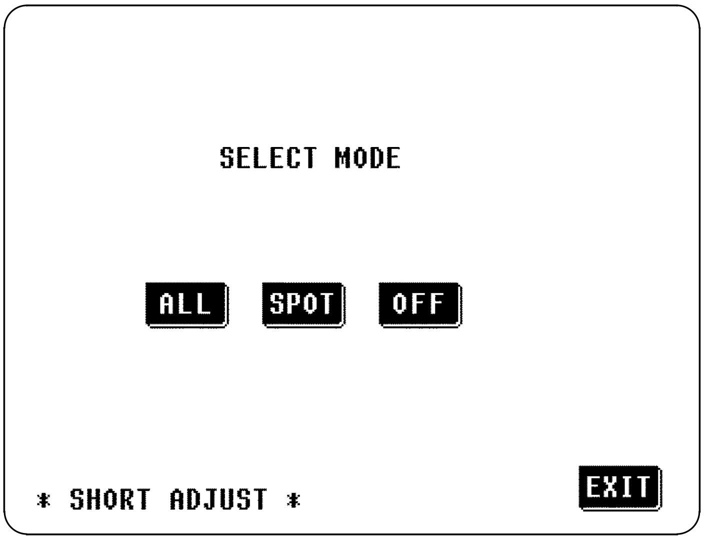
These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)
After checking the short circuit residual component and its phase angle, press the O K key, and the display will return to the Initial screen.

NOTE Compensation can be performed for impedances less than 1 kΩ

4.8.4 Spot Compensation

SPOT
Short circuit compensation screen

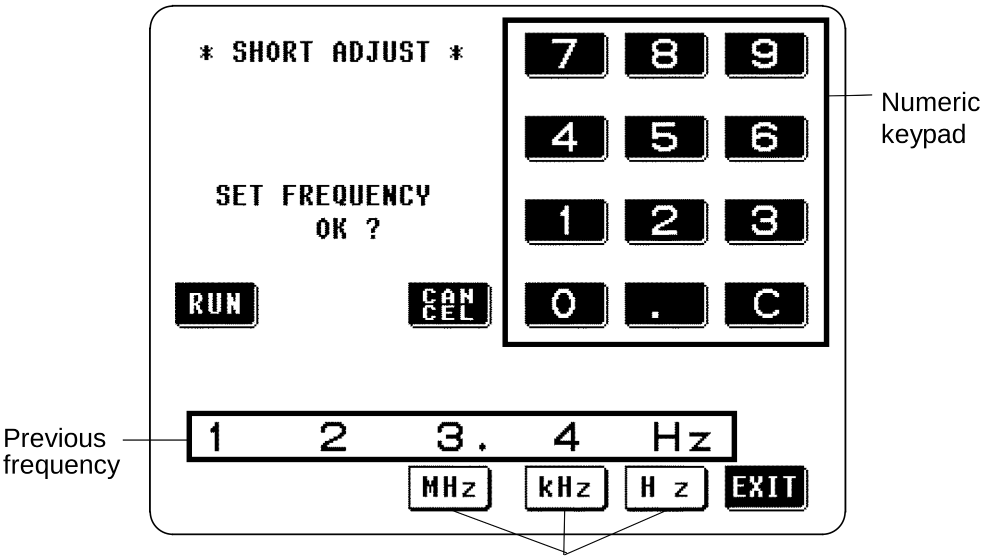
1. To select SPOT compensation, press this key with the Short circuit compensation screen displayed.


SELECT MODE

* SHORT ADJUST *

Short Circuit Compensation Screen

2. A numeric keypad is displayed for input of the frequency. Until one of these keys is pressed for input of a numerical value, the previous frequency for which SPOT compensation was performed is displayed.


* SHORT ADJUST *

SET FREQUENCY
OK ?

1 2 3. 4 Hz

Units keys (shown in non-reversed video, until a numerical value for the frequency has been input)

SPOT compensation for the same frequency as previously:
Just press the RUN key. SPOT compensation will be started using the same frequency which was used for the last episode of SPOT compensation.

When compensation is to be performed for some new frequency:

Input the frequency for compensation using the numeric keypad.

Frequency range which can be set : 42.0 Hz to 5.000 MHz

NOTE

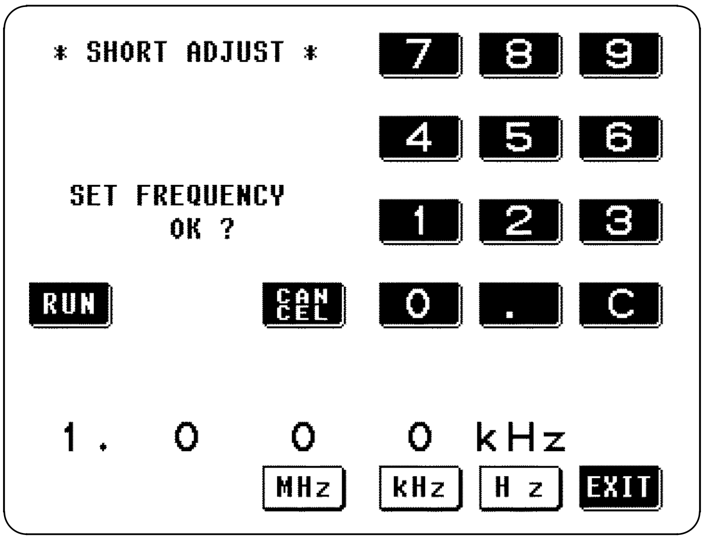
If you attempt to set a test frequency greater than 5 MHz, it will automatically be reduced to 5 MHz.

If you attempt to set a test frequency lower than 42 Hz, it will automatically be increased to 42 Hz.

If you make a mistake during input of the numerical value, press the **C** key to cancel the input so far, and start again.

- When you have completed inputting the numerical value for the frequency, press the appropriate units key **MHz**, **kHz**, or **H z** so as to confirm the displayed frequency for compensation.
- Until the numerical value for the frequency has been input, the units keys cannot be used.

3. After the frequency for SPOT compensation has been input as above, press the **RUN** key.



* SHORT ADJUST *

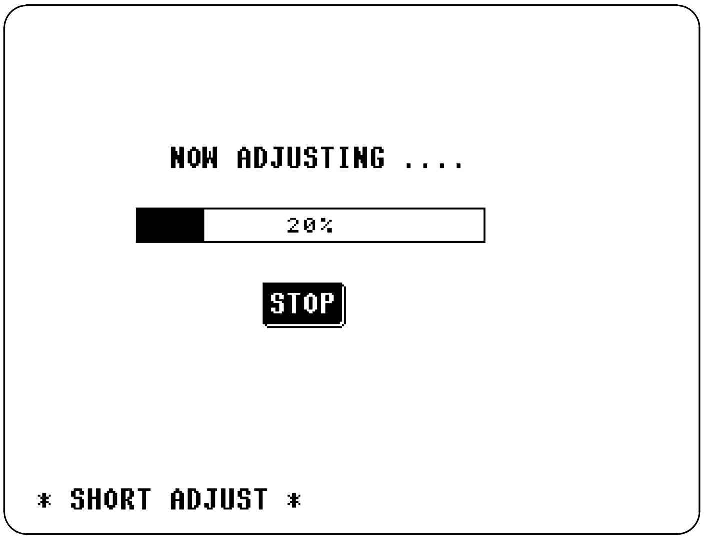
SET FREQUENCY
OK ?

1.000 kHz

NOTE

Check again - are the test leads properly shorted together with the shorting bar?

4. When you press the RUN key, the SPOT short circuit compensation process starts.

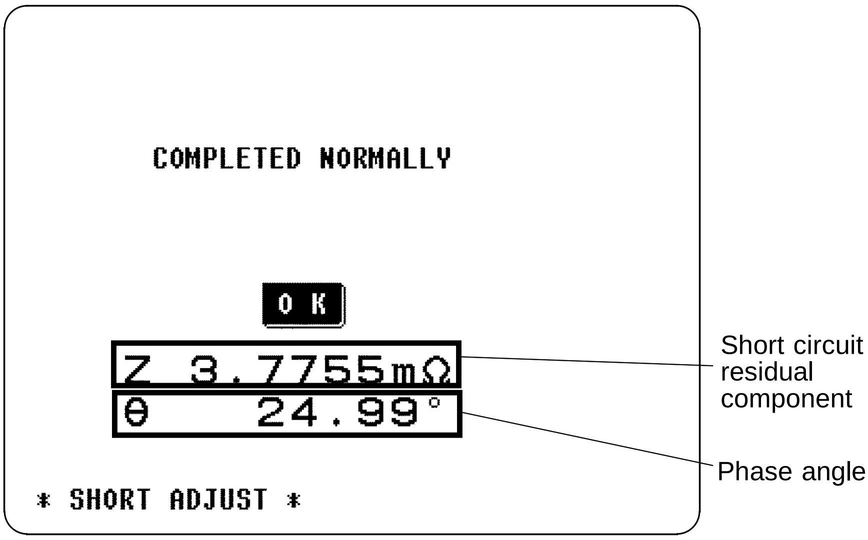


NOW ADJUSTING ....

* SHORT ADJUST *

Interrupting the SPOT compensation process:
To interrupt the SPOT compensation process, press the STOP key on this screen. The compensation process will stop and the display will revert to the Initial screen. At this time, the compensation values obtained in the previous episode of short circuit compensation will remain valid.

5. If the compensation process has terminated satisfactorily, the following Confirmation screen will be displayed.
The short circuit residual component for the test cables at the set frequency, and its phase angle, are shown on the screen. (If an error message appears, refer to Section 4.8.5.)



COMPLETED NORMALLY

Z 3.7755mΩ
θ 24.99°

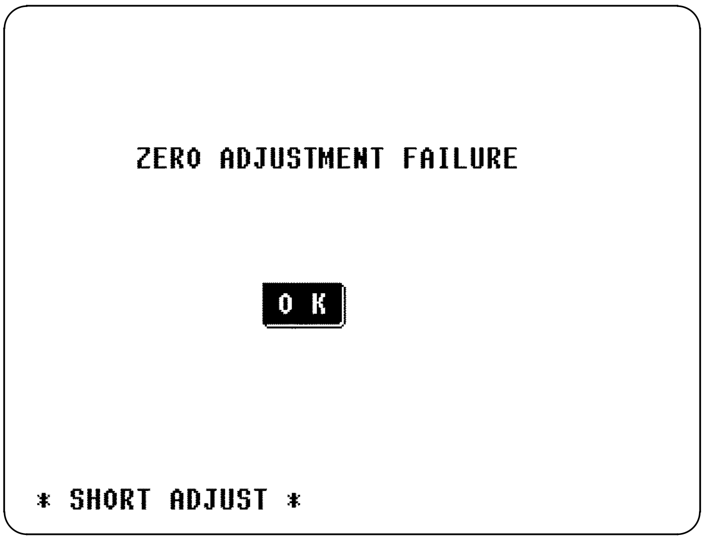
* SHORT ADJUST *

These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)

After checking the short circuit residual component and its phase angle, press the O K key, and the display will return to the Initial screen.

4.8.5 When an Error Message Appears and Compensation Has Stopped

When an error message appears and compensation has stopped, short circuit compensation is turned off.



ZERO ADJUSTMENT FAILURE

* SHORT ADJUST *

Check the following points before starting the short circuit compensation process again:

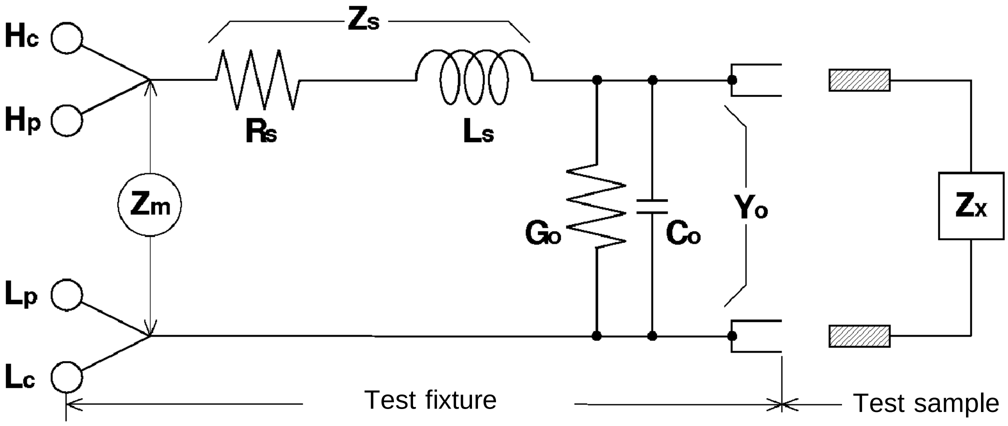
- Check that the test cables are properly connected.
- Check that the test cables are properly shorted together with the shorting bar. (Short circuit compensation cannot be performed while any test sample is connected to the test cables.)
- Check that the test leads are arranged as closely as possible to their configuration in which measurement will be performed.
- During the compensation process, be sure not to disturb the test cables or to move your hand near them.

4.8.6 Clearing Compensation Data

From the Short circuit compensation screen, press the OFF key, and the display will revert to the Initial screen with the compensation data cleared.

4.9 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
Ls : residual inductance
Co : floating capacitance value
Yo : open circuit residual component

Rs : residual resistance
Go : residual conductance
Zs : short circuit residual component
Zm : measured value

In this case, for the measured value Zm:

$$Zm = Zs + \frac{1}{Yo + \frac{1}{Zx}}$$

The residual components can be determined in the following manner:

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.

NOTE

The determination of test range is performed according to the measured value Zm for impedance. Therefore it may happen that testing cannot be performed, when HOLD is on, if the test range is determined merely according to the value of impedance of the sample under test. In this case, you should set the test range in consideration both of the impedance of the test sample and also of the residual impedance components of the test fixture.

Deviations in the measured values can become comparatively large in the following cases:

- If only short circuit compensation has been performed.
  With short circuit compensation only having been performed, since no compensation can be performed in terms of the open circuit residual component Yo (which is not available), thereby deviation in the resultant values will become large if the value of that open circuit residual component Yo is relatively large.

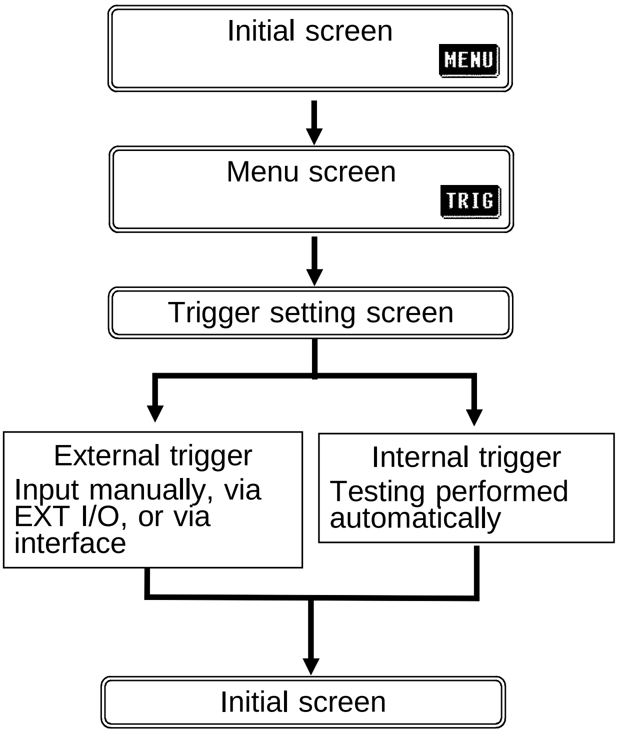
- If only open circuit compensation has been performed.
  With open circuit compensation only having been performed, since no compensation can be performed in terms of the short circuit residual component Zs (which is not available), thereby deviation in the resultant values will become large if the value of that short circuit residual component Zs is relatively large.

In order to avoid this sort of thing, be sure always to perform both short circuit compensation and also open circuit compensation.

4.10 Setting the Trigger

The trigger can either be set to internal trigger, when continuous testing is performed while automatically generating an internal trigger signal, or external trigger, when a trigger signal is input from the outside either manually or automatically.

4.10.1 Control Screen Sequence



Press the MENU key.

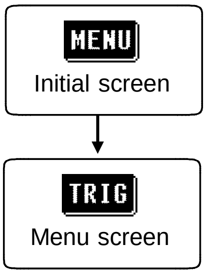
Press the TRIG key.

Select the type of trigger (external trigger or internal trigger).

When the setting has been established as above, press the EXIT key to return to the Initial screen.

The trigger has been set.

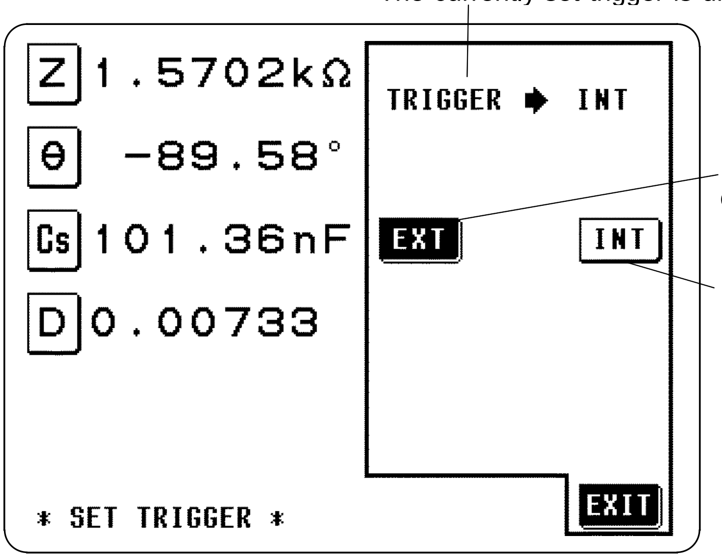
4.10.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the TRIG key on the Menu screen to display the Trigger setting screen.

The currently set trigger is displayed here.


Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733
TRIGGER ➧ INT

* SET TRIGGER *

Press to select external trigger.

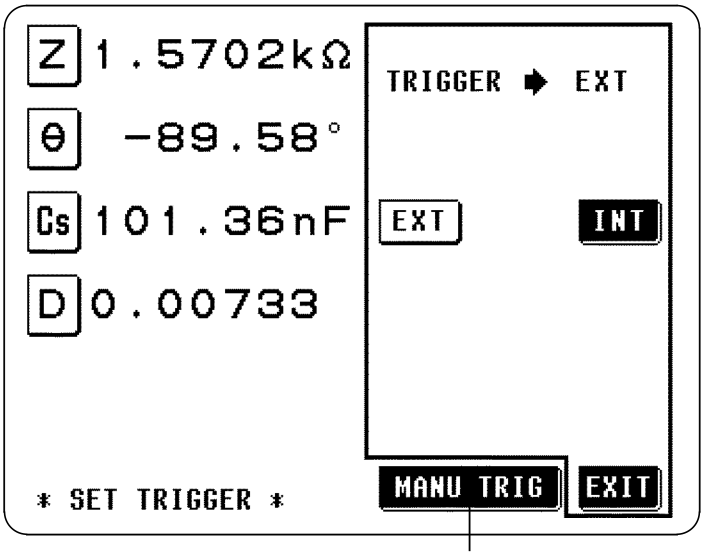
Press to select internal trigger.

Trigger Setting Screen

INT (internal trigger)
Testing is performed continuously.

EXT (external trigger)
The trigger is input manually, via EXT I/O, or via interface.

The external trigger can be input manually, via the EXT I/O connector, or via interface.
When external trigger is selected, MANU TRIG appears as shown in the following figure, and a manual trigger signal can be input by pressing this key.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733

TRIGGER ➧ EXT

* SET TRIGGER *

Press this key to perform testing once.

When inputting the trigger signal through the EXT I/O connector:
Testing is performed once, each time a negative sense pulse signal is supplied to the EXT I/O connector on the rear panel of the 3532-50. (For details, refer to Section 5.5, "The EXT I/O Connector")

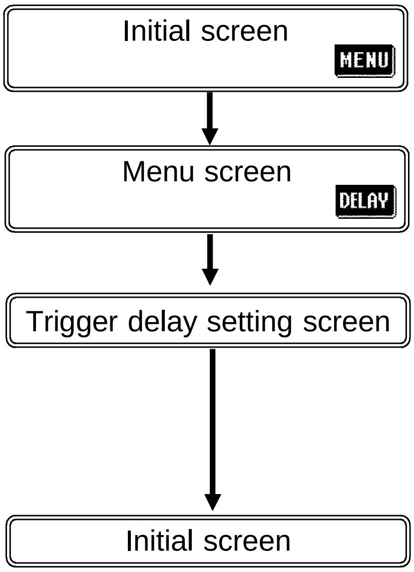
When inputting the trigger signal through the interface:
Testing is performed once, when the "*TRG" command is transferred from the interface. (For details, see the "Command Reference" of the Instruction Manuals for the interface.

3. When the setting has been established as above, press the EXIT key to return to the Initial screen.

4.11 Setting the Trigger Delay

The delay time period from input of the trigger signal to reading of the test data can be set. The value of the trigger delay period can be set from 10 ms to 9.99 s, with a resolution of 10 ms. With this function it is possible to ensure that testing is started after the connection condition of the object being tested and the test cables has stabilized.

4.11.1 Control Screen Sequence



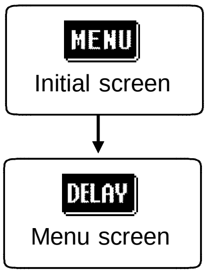
Press the MENU key.

Press the DELAY key.

Set the trigger delay time.
When the setting has been established, press the EXIT key to return to the Initial screen.

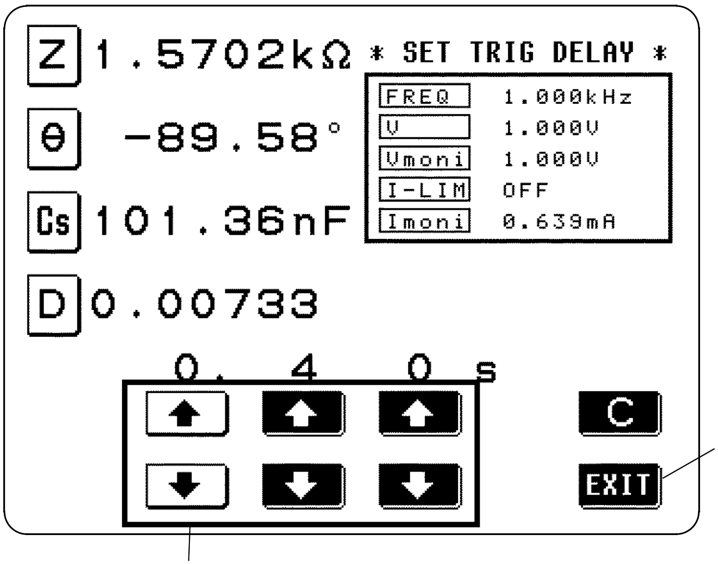
The setting has been performed.

4.11.2 Details of the Setting Process



1. Press the MENU key on the Initial screen.
The Menu screen will be displayed.

2. Press the DELAY key on the Menu screen.
The Trigger delay setting screen will be displayed.



Z 1.5702kΩ

θ -89.58°

Cs 101.36nF

D 0.00733

* SET TRIG DELAY *

FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA

0. 4 0 s

Press this key when setting is completed to return to the Initial screen.

The digit keys (If held down continuously, the corresponding digit increments or decrements continuously.) (If the limit for the corresponding digit is reached, these keys change to non-reversed video and become inactive.)

3. Set the desired value for the delay time period using the digit keys.

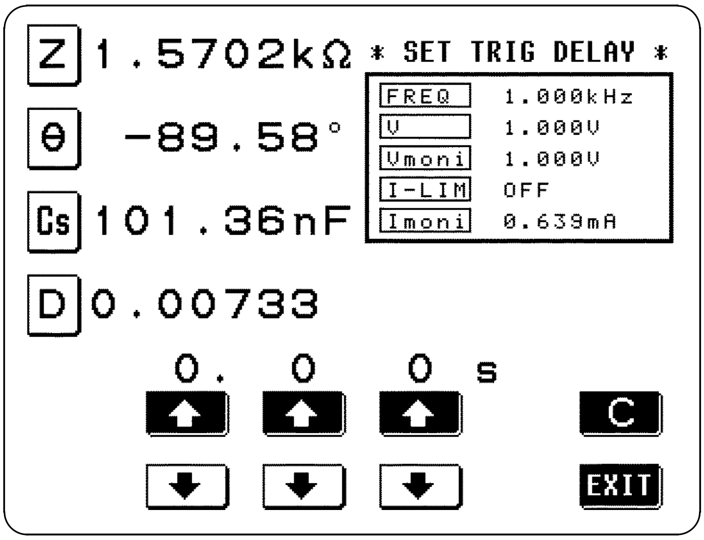
The range over which the delay time period can be set :
10 ms to 9.99 s, with a resolution of 10 ms

The other keys, which cannot be used, are shown in non-reversed video.

4. When the setting has been established as above, press the EXIT key to return to the Initial screen.

Canceling the trigger delay function

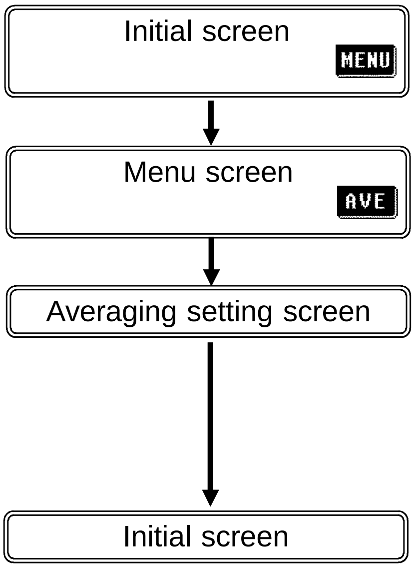
Press the C key to set the trigger delay period to 0.00 s. This will cancel the trigger delay function.



4.12 Setting Averaging

With the averaging function, the measured values can be averaged. Using this function, it is possible to reduce fluctuations in the measured value display.
The averaging can be performed over 2, 4, 8, 16, 32, or 64 times that measurement is performed.

4.12.1 Control Screen Sequence



Press the MENU key.

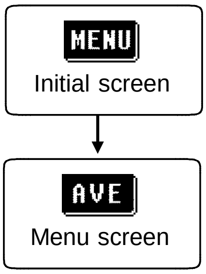
Press the AVE key.

Set the number of measurement times for averaging.

When the setting has been established, press the EXIT key to return to the Initial screen.

The setting has been made.

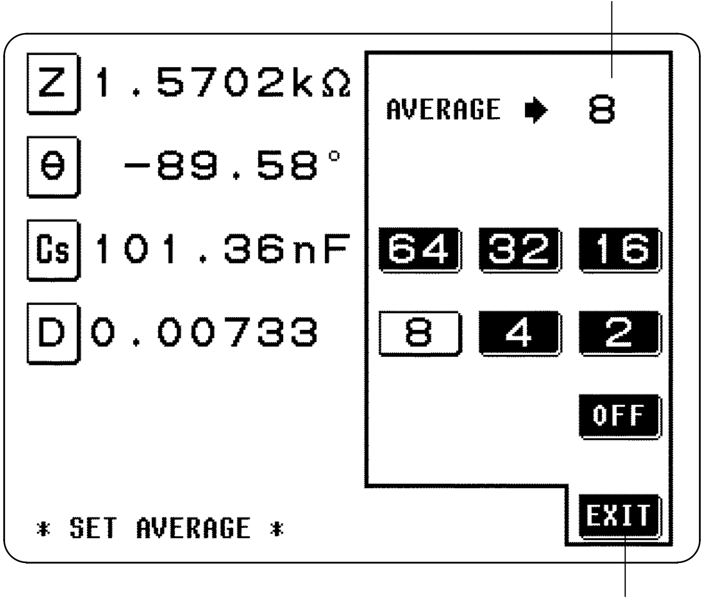
4.12.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the AVE key on the Menu screen to display the Averaging setting screen.

The selected number is displayed, and averaging is set.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733
AVERAGE ➧ 8
* SET AVERAGE *

When the setting is completed, press this key to return to the Initial screen.

Averaging Setting Screen

3. Press the key corresponding to the desired number of times for averaging.
The number of times for averaging which can be selected : 2, 4, 8, 16, 32, or 64.
The key which is pressed goes into non-reversed video, and this number is set as the number of times for averaging.

NOTE

The way in which averaging is performed varies, depending upon the trigger setting.

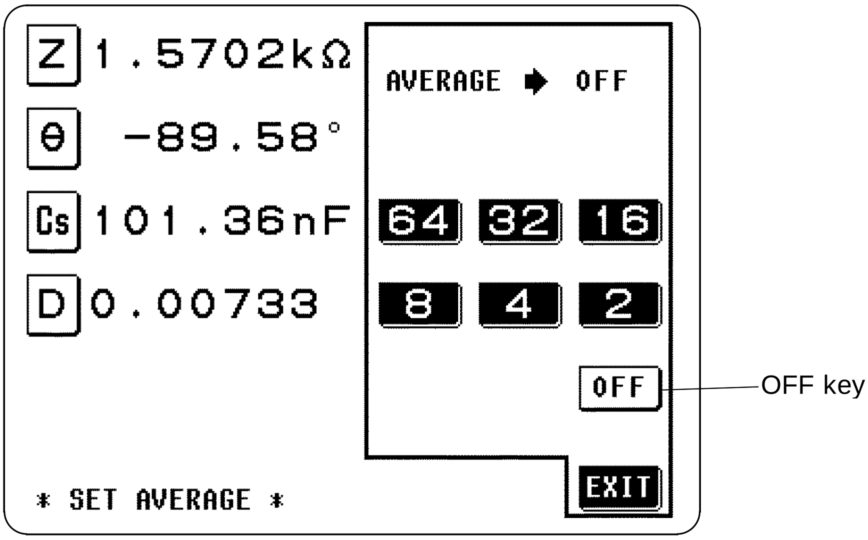
With internal trigger:
A rolling average of the tested values over the set number of times for averaging is always calculated backwards from the present.
When the sample to be tested is changed over, it takes a little time for a certain stabilization time period until the results is reliable.

With external trigger:
An average of the test values is calculated over the set number of times for averaging forwards from when the trigger is input.

4. When the setting has been established as above, press the EXIT key to return to the Initial screen.

Stopping the averaging function

On the Averaging setting screen, press the OFF key. This key will go into non-reversed video, and the averaging function will be terminated.

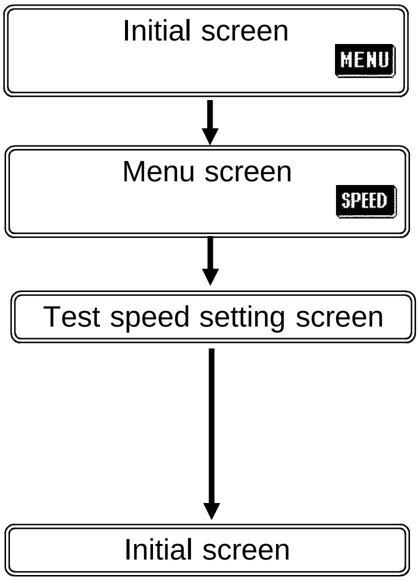


4.13 Setting the Testing Speed

The testing speed can be set. The slower the testing speed is, the more accurate are the results.
The testing speed can be set to one of three values:

FAST	low accuracy testing is performed at high speed
NORM	the speed used for normal testing
SLOW	high accuracy testing is performed slowly
SLOW2	high accuracy testing is performed slowly

4.13.1 Control Screen Sequence



Press the MENU key.

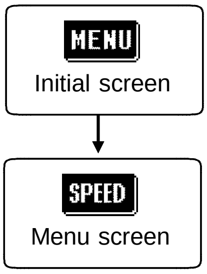
Press the SPEED key.

Select the speed for testing.

When the setting has been established, press the EXIT key to return to the Initial screen.

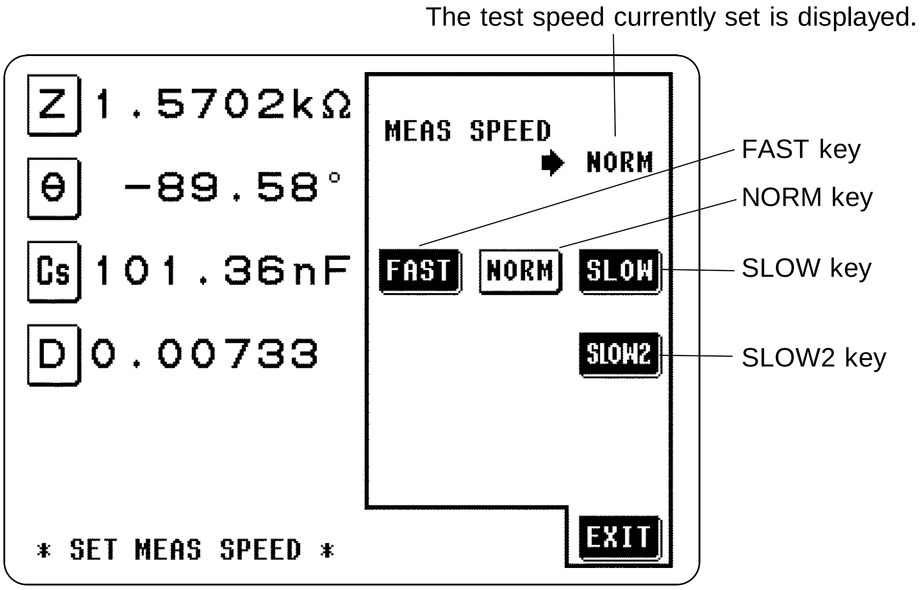
The setting has been made.

4.13.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the SPEED key on the Menu screen to display the Test speed setting screen.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733

MEAS SPEED
➡ NORM

* SET MEAS SPEED *

The test speed currently set is displayed.

Test Speed Setting Screen

3. Select the desired new speed for testing from among the following options. The key corresponding to the currently selected testing speed appears in non-reversed video (black letters upon a white ground).

Testing speeds (typical)

FAST	5 ms ±2 ms	Low accuracy testing at high speed
NORM	21 ms ±2 ms	This speed used for normal testing
SLOW	72 ms ±2 ms	High accuracy slow testing
SLOW2	140 ms ±2 ms	High accuracy slow testing

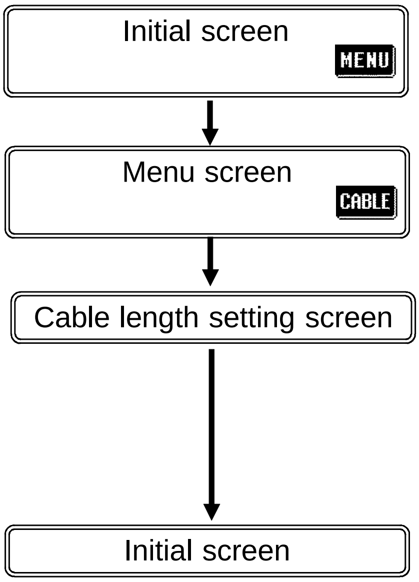
The testing speed varies according to the number of parameters being displayed, and according to their type. The speeds given in the table relate to the case of |Z| only being displayed. For details, refer to Section 7.3, "Time Taken for Testing."

4. When the setting has been established as above, press the EXIT key to return to the Initial screen.

4.14 Setting the Measurement Cable Length

In measuring harmonics, the cable has a large influence on the measurement error. Making the cable length setting enables the measurement error to be reduced.

4.14.1 Control Screen Sequence



Press the MENU key.

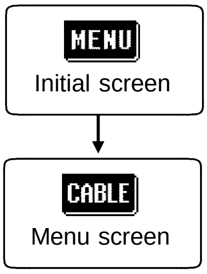
Press the CABLE key.

Set the cable length.

When the setting has been established, press the EXIT key to return to the Initial screen.

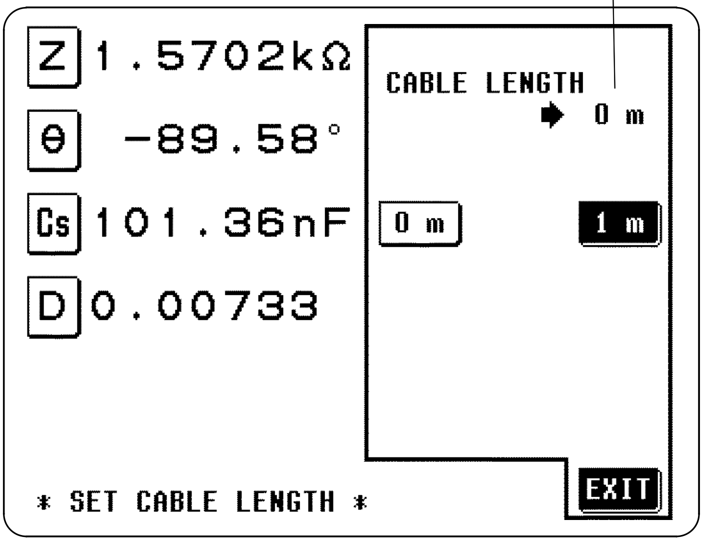
The setting has been made.

4.14.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the CABLE key on the Menu screen to display the Cable length setting screen.


The specified cable length is displayed.

Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733

CABLE LENGTH
➡ 0 m

Cable Length Setting Screen

3. Select the desired cable length.
When the following test fixture probe is used, set the cable length shown below.

0 m : When using the 9262 TEST FIXTURE or 9263 SMD TEST FIXTURE

1 m : When using the 9140 4-TERMINAL PROBE, 9143 PINCHER PROBE, or 9261 TEST FIXTURE

4. When the setting has been established, press the EXIT key to return to the Initial screen.

4.15 Setting and Activating the Comparator

Using the comparator function an upper limit value and a lower limit value can be set, and the result of measurement then can be compared with these two limit values, so as to give a result expressed as HI (greater than the upper limit value), IN (between the lower limit value and the upper limit value), or LO (less than the lower limit value). Moreover, a corresponding signal can be output via the EXT I/O connector on the rear panel of the 3532-50 unit.
The following setting methods are available on the comparator:

Absolute value setting method (ABS)

The upper limit value and the lower limit value are set as absolute numerical values. The measurement values displayed are the same as those of the measurement parameters.

Percentage setting method (%)

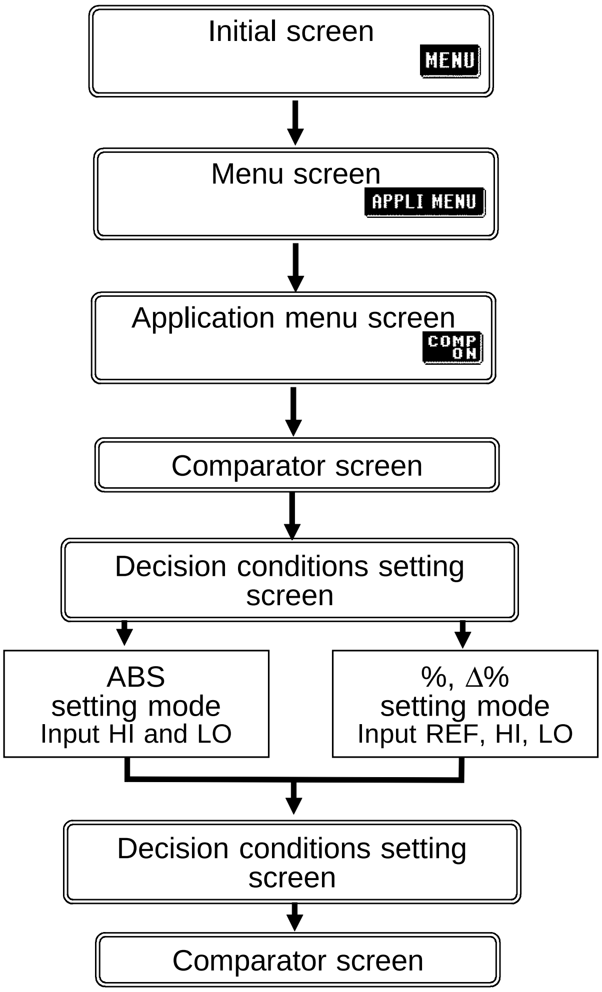
A reference value is input, and the upper-limit and lower-limit values are set as percentages relative to the reference value. The measurement values displayed are the same as those of the measurement parameters.

Setting of the deviation percentage (Δ%)

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.

The comparator can deal with two test values at the most. "ABS", "%", and "Δ%" can be selected for each of these values individually.
After powering off on the Comparator setting screen, the screen is displayed when the power is turned on again.

4.15.1 Control Screen Sequence



Press the MENU key.

Press the APPLI MENU key.

Press the COMP ON key.

Activate the comparator.

To change the comparator settings, press the LMT key.

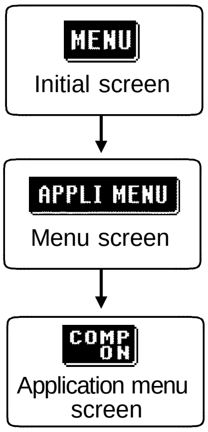
Choose the comparator setting method (ABS, %, or Δ%)

Input the decision conditions.

When the input is complete, press the ENTER key to return to the Decision conditions setting screen.

When the setting has been established as above, press the EXIT key to return to the Comparator screen.

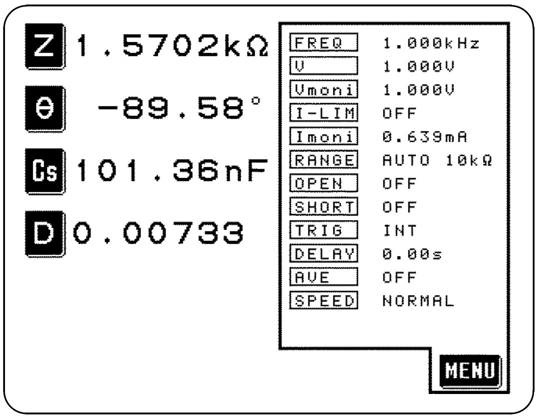
4.15.2 Setting the Comparator



1. Press the MENU key on the Initial screen to display the Menu screen.

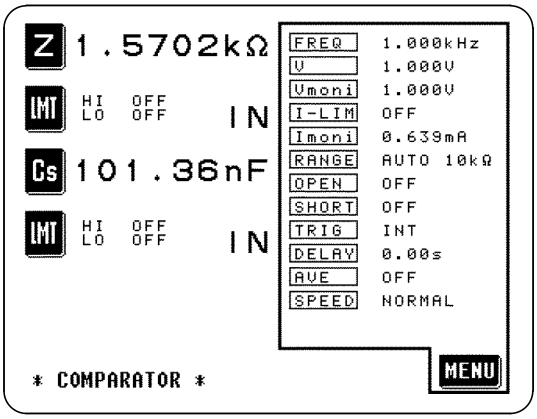
2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the COMP ON key on the Application menu screen to display the Comparator screen. At the same time, the comparator will be started.



```
Z  1.5702kΩ      FREQ    1.000kHz
                 V       1.000V
θ   -89.58°      Vmoni   1.000V
                 I-LIM   OFF
Cs 101.36nF      Imoni   0.639mA
                 RANGE   AUTO 10kΩ
D  0.00733       OPEN    OFF
                 SHORT   OFF
                 TRIG    INT
                 DELAY   0.00s
                 AVE     OFF
                 SPEED   NORMAL
                                MENU
```

Initial Screen

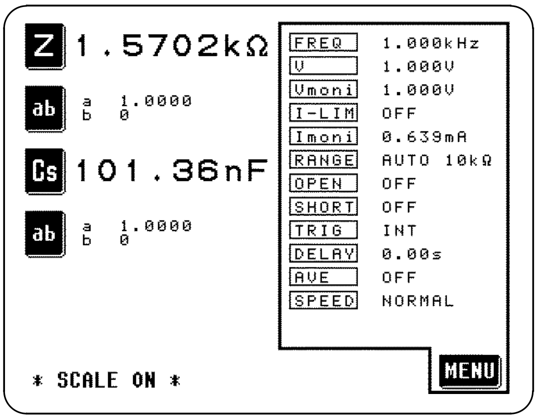


```
Z   1.5702kΩ       FREQ    1.000kHz
                   V       1.000V
LMT HI  OFF        Vmoni   1.000V
    LO  OFF   IN   I-LIM   OFF
                   Imoni   0.639mA
Cs  101.36nF       RANGE   AUTO 10kΩ
                   OPEN    OFF
LMT HI  OFF        SHORT   OFF
    LO  OFF   IN   TRIG    INT
                   DELAY   0.00s
                   AVE     OFF
                   SPEED   NORMAL
* COMPARATOR *                    MENU
```

Comparator Screen

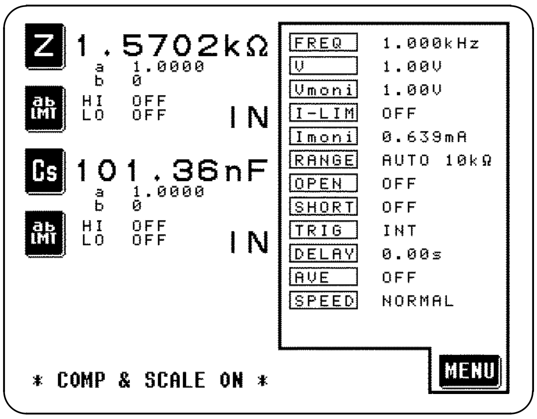
NOTE On the Scaling screen, the Comparator scaling screen can be also accessed by same key operations. The comparator is activated for the scaling measured value.

For the scaling function, refer to Section 4.16.



```
Z  1.5702kΩ      FREQ    1.000kHz
                 V       1.000V
ab a 1.0000      Vmoni   1.000V
   b 0           I-LIM   OFF
                 Imoni   0.639mA
Cs 101.36nF      RANGE   AUTO 10kΩ
                 OPEN    OFF
ab a 1.0000      SHORT   OFF
   b 0           TRIG    INT
                 DELAY   0.00s
                 AVE     OFF
                 SPEED   NORMAL
* SCALE ON *                    MENU
```

Scaling Screen



```
Z      1.5702kΩ       FREQ    1.000kHz
       a  1.0000      V       1.00V
       b  0           Vmoni   1.00V
ab     HI  OFF        I-LIM   OFF
LMT    LO  OFF   IN   Imoni   0.639mA
                      RANGE   AUTO 10kΩ
Cs     101.36nF       OPEN    OFF
       a  1.0000      SHORT   OFF
       b  0           TRIG    INT
ab     HI  OFF        DELAY   0.00s
LMT    LO  OFF   IN   AVE     OFF
                      SPEED   NORMAL
* COMP & SCALE ON *                  MENU
```

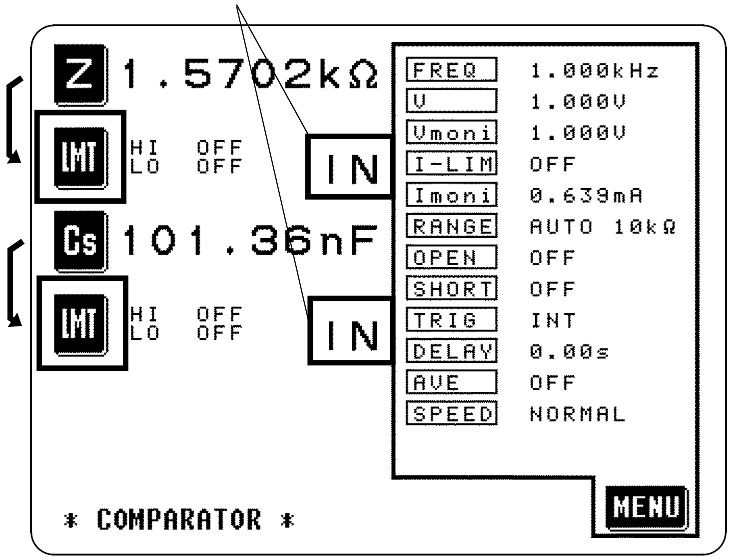
Comparator Scaling Screen

4. Set the first and third parameters to be the two parameters which you wish to measure. (Refer to the section on display parameter setting for details upon how to make the setting.)

Shows the results of the decisions made by the comparator.

Shows the first decision condition setting.

Shows the third decision condition setting.



1.5702kΩ

HI OFF
LO OFF

101.36nF

HI OFF
LO OFF

FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

* COMPARATOR *

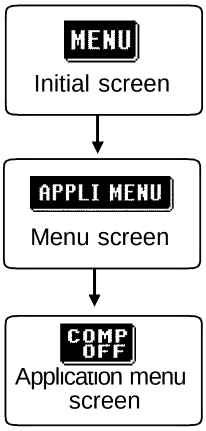
The Conditions setting screen is accessed by pressing the LMT key.

5. The Menu screen can be displayed from the Comparator screen display by pressing the MENU key, in the same manner as from the Initial screen, and then the values for the various test conditions can be changed. (For details, refer to the explanation of setting the appropriate test condition.)

NOTE

- When the trigger is internal, testing starts at the time point at which the comparator mode is started, and the results of the decisions will be output through the EXT I/O terminal.
- The test conditions during comparator operation and normal operation are compatible.

4.15.3 Returning from Comparator Operation to Normal Testing



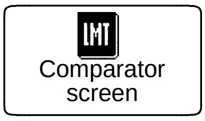
1. Press the MENU key on the Comparator screen or the Comparator scaling screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the COMP OFF key on the Application menu screen to return the Initial screen or the Scaling screen.
   - The test conditions during comparator operation and normal operation are compatible.
   - On the Initial screen, the second and fourth display parameter positions LMT will revert to displaying the parameters which they were displaying before the comparator mode was started. On the Scaling screen, they will revert to displaying ab .

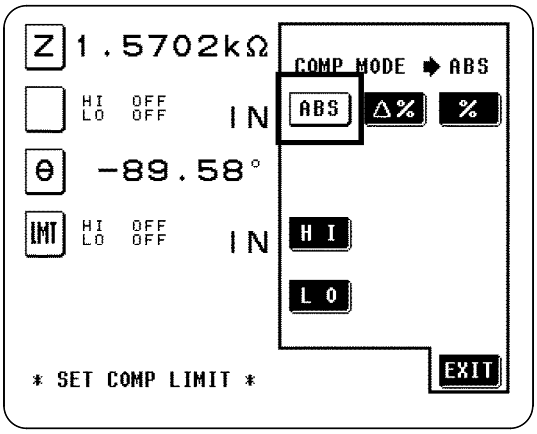
NOTE The comparator is active until the display returns to showing the Initial screen or Scaling screen.

4.15.4 Choosing How to Set the Upper and Lower Limit Values



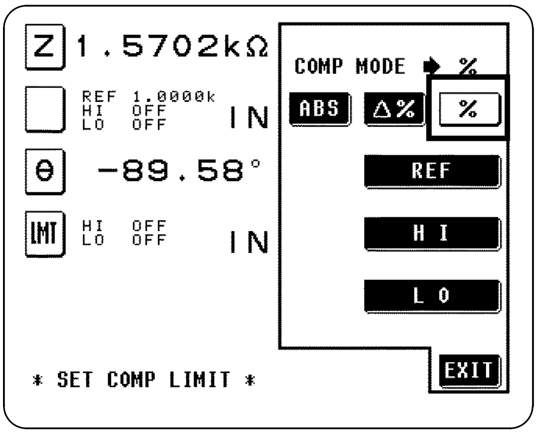
1. Access the Comparator screen.
2. On this screen, press the LMT key which corresponds to the upper or lower limit value to set or change. The Conditions setting screen is displayed.
3. Select the method for setting the limit value and press the following corresponding key ABS or %:

- Absolute value setting method (ABS)
  The upper limit value and the lower limit value for the test parameter are set as absolute numerical values. The measurement values displayed are the same as those of the measurement parameters.
- Percentage setting method (%)
  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.
- Setting of the deviation percentage (Δ%)
  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.



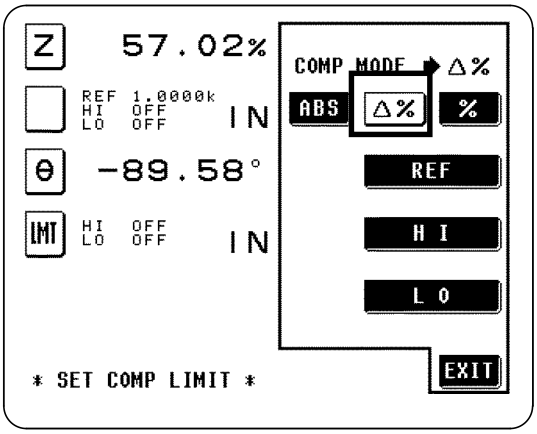
COMP MODE ➡ ABS

Absolute Value (ABS) Setting Screen



COMP MODE ➡ %

Percentage (%) Setting Screen



COMP MODE ➡ Δ%

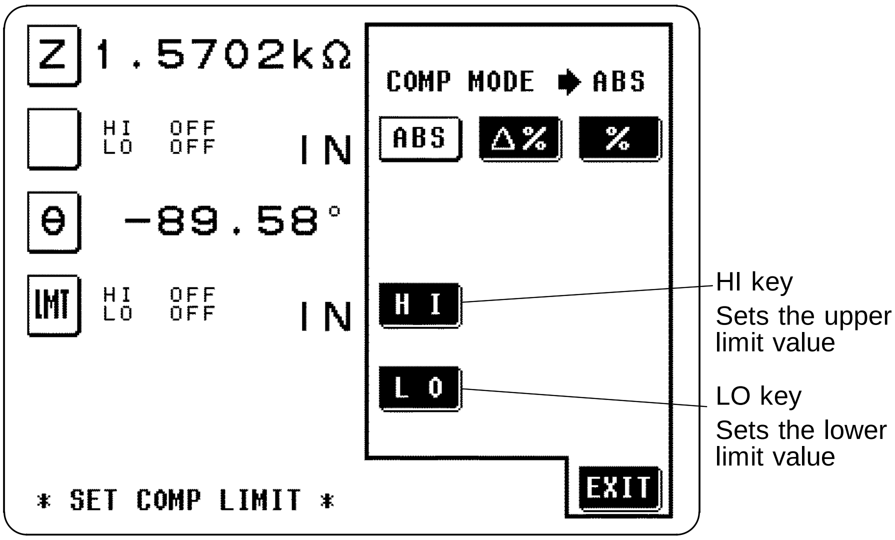
Deviation Percentage (Δ%) Setting Screen

4.15.5 Setting the Upper or Lower Limit Value as an Absolute Value (ABS)

ABS
Condition setting screen

1. Press this key on the Conditions setting screen displayed to select the absolute value setting mode.

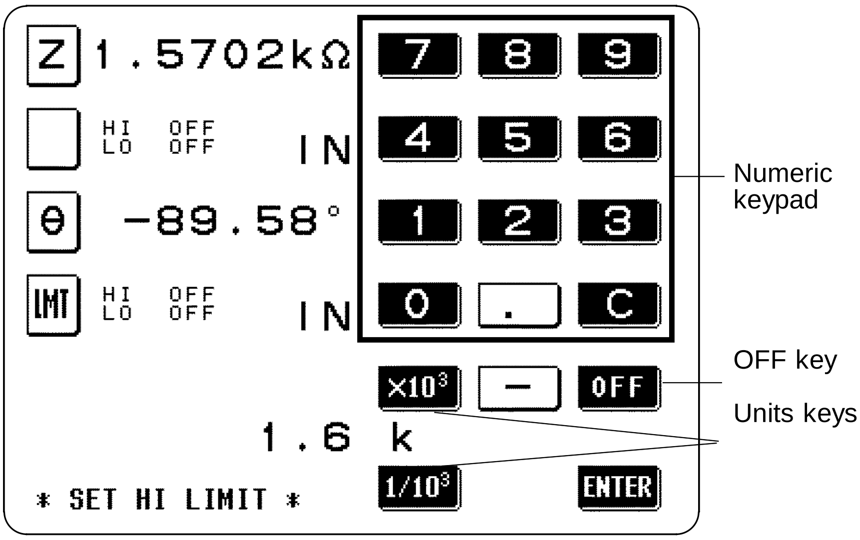
   At this time the ABS key will go into non-reversed video, and simultaneously HI and LO keys will appear for setting the upper and lower limit values.



Absolute Value Setting Mode

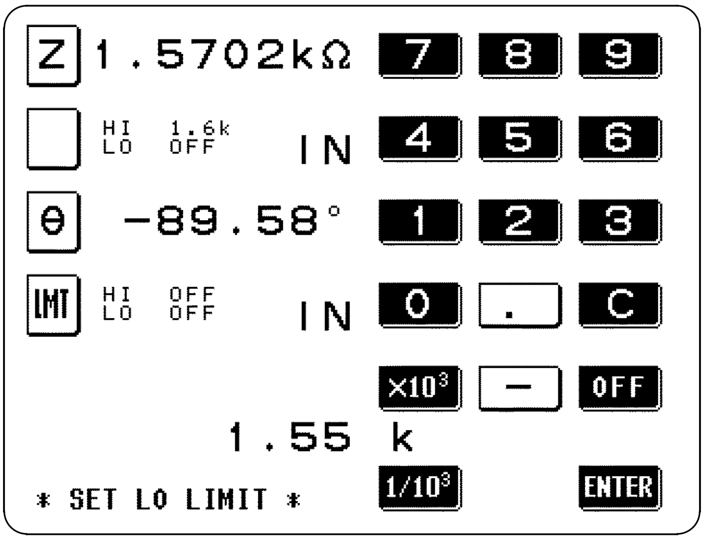
2. To set the upper limit value (for example), press the HI key, and a screen will appear for upper limit value setting. Use the numeric keypad to input the desired value for the upper limit.

   In order to set no upper limit value, press the OFF key.



The setting can be made in the range : -200.00M to +200.00M
To return to the previous screen without making any change to the set value, press the ENTER key when the screen is in the state with nothing being displayed (the state after pressing the C key).

3. Select the units using one of the units keys:
   $\times 10^3$: step the units up
   $1/10^3$: step the units down
   p -- n -- µ -- m -- (none) -- k -- M
   <= Units down Units up =>
   Pressing the ENTER key causes the upper limit value to be set and the screen display to return to the Conditions setting screen.
4. The lower limit value is set in a manner identical to the upper limit value, mutatis mutandis.



Z 1.5702kΩ

HI 1.6k
LO OFF IN

θ -89.58°

LMT HI OFF
LO OFF IN

1.55 k

* SET LO LIMIT *

The setting can be made in the range : -200.00M to +200.00M

5. When the setting for the upper or lower limit value has been established as above, press the EXIT key on the Condition setting screen to return to the Comparator screen.

NOTE

The comparator decisions are made in the following order:

1) If the measured value is "OVER FLOW", HI is displayed, and the value is "UNDER FLOW", LO is displayed.
2) Is the measured value greater than the lower limit value or not?
   If not (NG decision result), then LO is displayed.
3) Is the measured value lower than the upper limit value or not?
   If not (NG decision result), then HI is displayed.
4) If both 2) and 3) give an affirmative result, then IN is displayed.

No test 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.

4.15.6 Setting the Upper or Lower Limit Value as a Percentage (%) Relative to a Standard Value

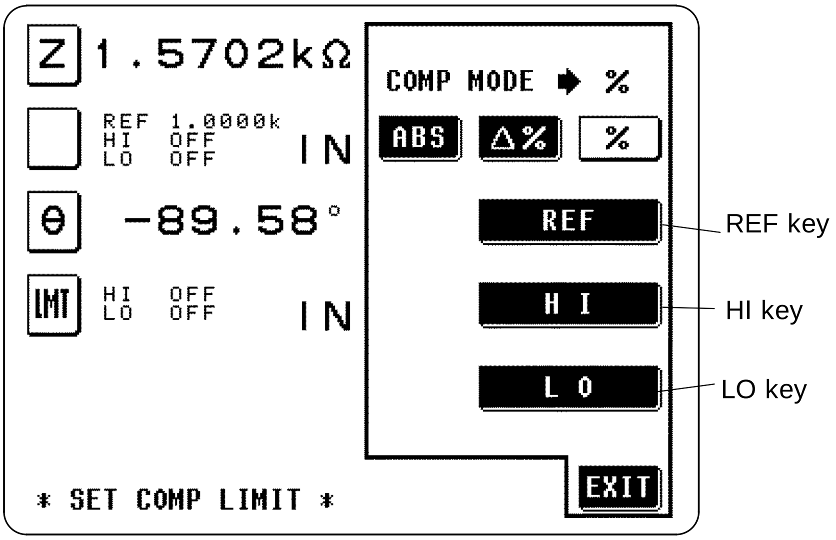
%
Condition setting screen

1. Press this key on the Conditions setting screen to select the percentage value setting mode.

   At this time the % key will go into non-reversed video, and simultaneously a REF key will appear for inputting the reference value, and H I and L O keys will appear for the upper and lower limit values.

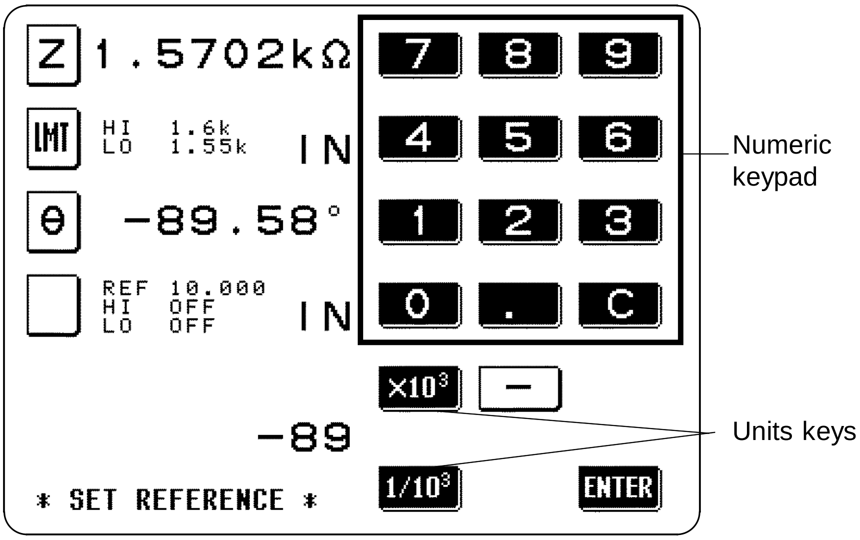
NOTE

The settings of the reference value and the upper- and lower-limit values are common to both the percentage mode and deviation percentage mode.



Percentage Value Setting Mode

2. Press the REF key, and a screen will appear for setting the reference value. This reference value is necessary for setting the limit values in terms of percentages.

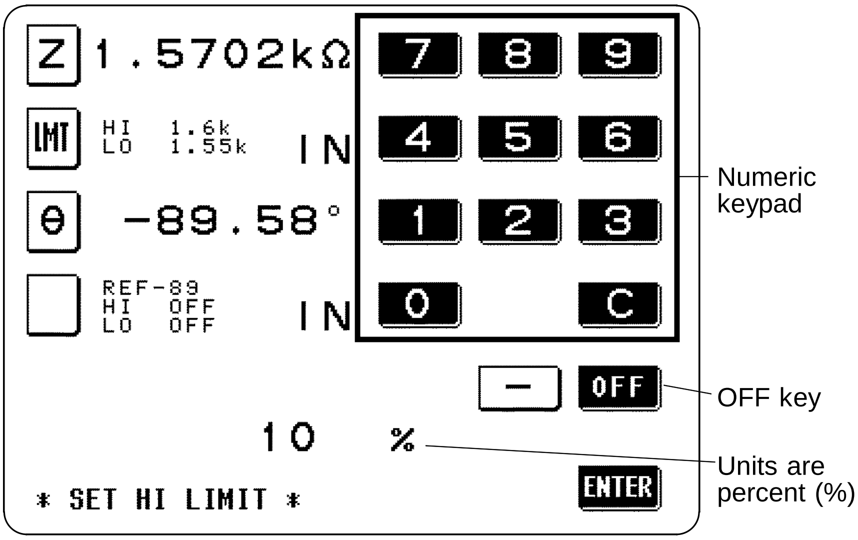


The setting can be made in the range : -200.00M to +200.00M

To return to the previous screen without making any change to the set reference value, press the ENTER key when the screen is in the state with nothing being displayed (the state after pressing the C key).

3. Select the units using one of the units keys:
×10³ : step the units up
1/10³ : step the units down
p -- n -- µ -- m -- (none) -- k -- M
<= Units down Units up =>
Pressing the ENTER key causes the upper limit value to be set and the screen display to return to the Conditions setting screen.

4. When the HI key is pressed, a screen for setting the upper limit value will appear. Use the numeric keypad to input the upper limit value as a percentage relative to the reference value.
In order to set no upper limit value, press the OFF key.



The setting can be made in the range : -999.99% to +999.99%

When the setting has been established as above, press the ENTER key to return to the Conditions setting screen with the upper limit value set.

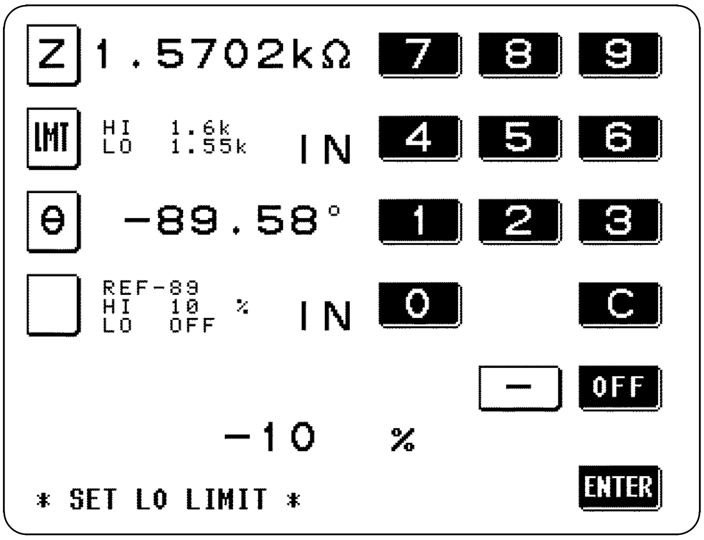
NOTE

The actual internal operation consists of calculating the upper-limit value of comparison using the equation given below, and comparing it to the measurement value to enable a decision to be made.

$$\text{Upper-limit comparison value} = \text{Reference value} + |\text{Reference value}| \times \frac{\text{Percentage set value}}{100}$$

| |: Denotes an absolute value

5. The lower limit value is set in a manner identical to the upper limit value, mutatis mutandis.



```
Z   1.5702kΩ
LMT HI 1.6k
    LO 1.55k      IN
θ   -89.58°
    REF-89
    HI  10  %
    LO  OFF       IN
        -10  %
* SET LO LIMIT *
```

The setting can be made in the range : -999.99% to +999.99%

NOTE

The actual internal operation consists of calculating the lower-limit value of comparison using the equation given below, and comparing it to the measurement value to enable a decision to be made.
If a value smaller than the reference value is to be set, the percentage set value must be an absolute value.

$$\text{Lower-limit comparison value} = \text{Reference value} + |\text{Reference value}| \times \frac{\text{Percentage set value}}{100}$$

| |: Denotes an absolute value

If the value is lower than the reference value, a minus sign is necessary.

6. When the setting for the upper or lower limit value has been established as above, press the EXIT key on the Condition setting screen to return to the Comparator screen.

NOTE

The comparator decisions are made in the following order:

1) If the measured value is "OVER FLOW", HI is displayed, and the value is "UNDER FLOW", LO is displayed.
2) Is the measured value greater than the lower limit value or not? If not (NG decision result), then LO is displayed.
3) Is the measured value lower than the upper limit value or not? If not (NG decision result), then HI is displayed.
4) If both 2) and 3) give an affirmative result, then IN is displayed.

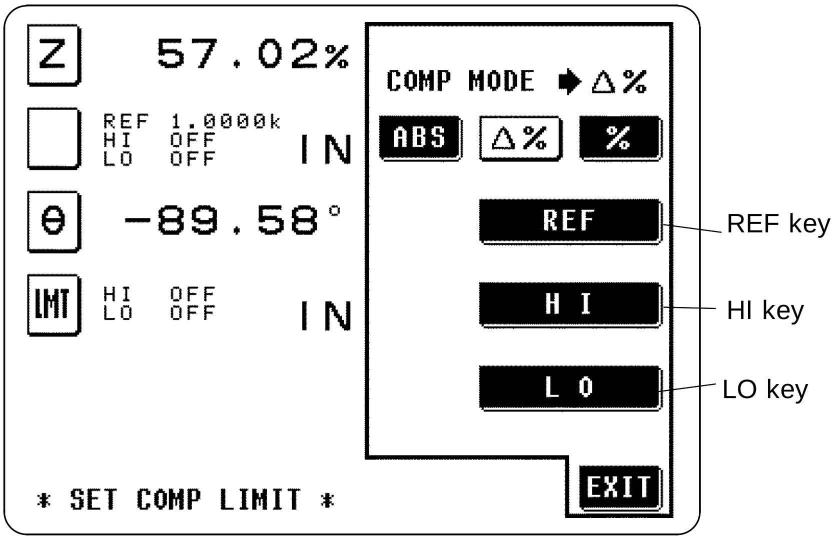
No test is performed in order to ensure that the upper limit value is greater than the lower limit value. Therefore no error message will be displayed even if you mistakenly interchange the settings for the desired upper limit value and the desired lower limit value. However, be careful that the decision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

4.15.7 Displaying Measurement Values as Deviations from the Reference Value（Δ%）

Δ%
Condition setting screen

1. Press this key on the Conditions setting screen to select the deviation percentage mode.

   At this time the **Δ%** key will go into non-reversed video, and simultaneously a **REF** key will appear for inputting the reference value, and **H I** and **L O** keys will appear for the upper and lower limit values.



Deviation Percentage Mode

The setting can be made in the range : -999.99% to +999.99%
In the deviation percentage mode, the measurement value is displayed as a deviation (Δ%) from the reference value. The reference value and upper- and lower-limit values are set in the same manner as in the percentage mode. For the setting method, refer to "4.15.6."

NOTE

The settings of the reference value and the upper- and lower-limit values are common to both the percentage mode and deviation percentage mode.

The Δ% value is calculated using the following equation:

$$\Delta\% = \frac{\text{Measurement value - Reference value}}{|\text{Reference value}|} \text{ x } 100$$

| |: Denotes an absolute value

If the result of the calculation exceeds 999.99, "999.99" will be indicated, and if the result is less than -999.99, "-999.99" will be displayed.

NOTE

The comparator decisions are made in the following order:

1) If the measured value is "OVER FLOW", HI is displayed, and the value is "UNDER FLOW", LO is displayed.
2) Is the measured value greater than the lower limit value or not?
   If not (NG decision result), then LO is displayed.
3) Is the measured value lower than the upper limit value or not?
   If not (NG decision result), then HI is displayed.
4) If both 2) and 3) give an affirmative result, then IN is displayed.

No test 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.

4.16 Setting and Activating the Scaling

Scaling applies a correction function to the measurement value. This function can be used to provide compatibility among measurement devices. Set the compensation coefficient a and b for the measurement values of the first and third parameters to compensate by the following expression.

Y = a x X + b

X: the first or third parameter measurement value
Y: the last measurement value
a: integration value of the measured value X
b: the value added to measured value X

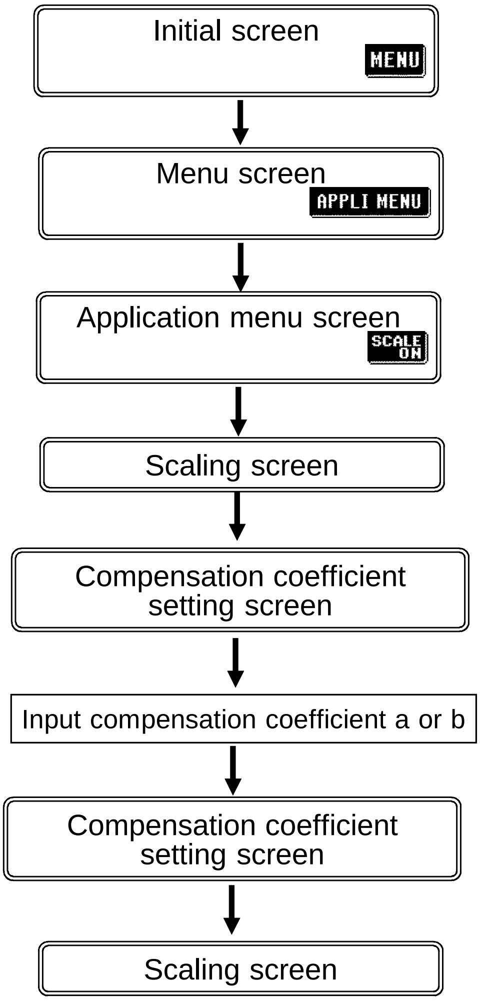
Here, when the parameter corresponding to X is either D or Q, the scaling is applied to θ as follows:

θ' = a x θ + b

This gives a new value θ', from which D or Q is obtained.

After powering off on the Scaling screen, the same screen is displayed when the power is turned on again.

4.16.1 Control Screen Sequence



Press the MENU key.

Press the APPLI MENU key.

Press the SCALE ON key.

Activate the scaling function.

To change the compensation coefficient, press the ab key.

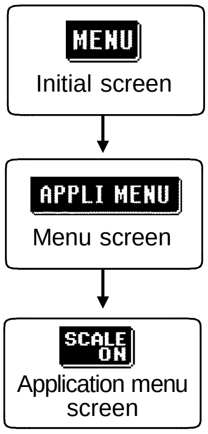
Choose the compensation coefficient (a or b).

Input the compensation coefficients.

When the input is complete, press the ENTER key to return to the Decision conditions setting screen.

When the setting has been established as above, press the EXIT key to return to the Scaling screen.

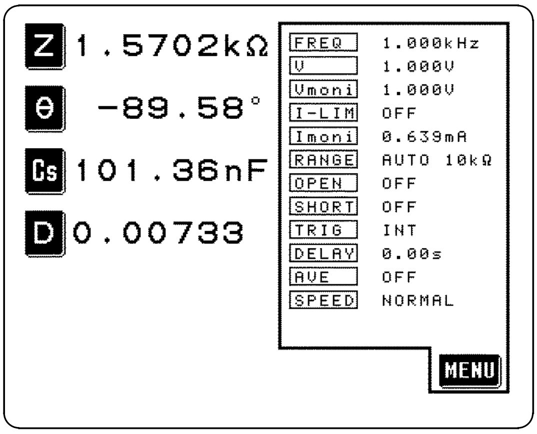
4.16.2 Setting Scaling



1. Press the MENU key on the Initial screen to display the Menu screen.

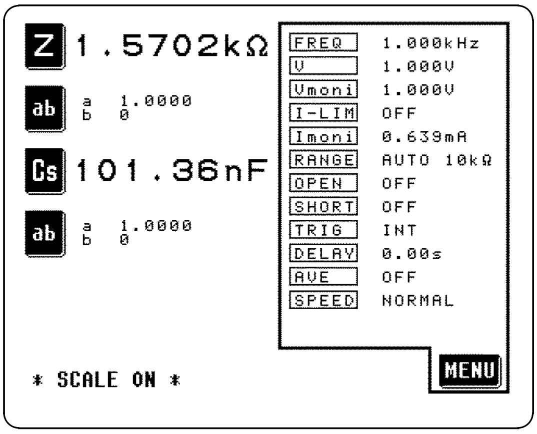
2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the SCALE ON key on the Application menu screen to display the Scaling screen. At the same time, the comparator will be started.



```
Z  1.5702kΩ     FREQ   1.000kHz
                V      1.000V
θ   -89.58°     Vmoni  1.000V
                I-LIM  OFF
                Imoni  0.639mA
Cs 101.36nF     RANGE  AUTO 10kΩ
                OPEN   OFF
                SHORT  OFF
D  0.00733      TRIG   INT
                DELAY  0.00s
                AVE    OFF
                SPEED  NORMAL

                           MENU
```

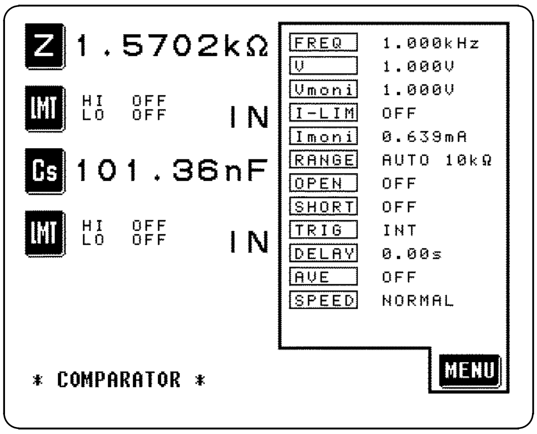
Initial Screen



```
Z  1.5702kΩ     FREQ   1.000kHz
                V      1.000V
ab a 1.0000     Vmoni  1.000V
   b 0          I-LIM  OFF
                Imoni  0.639mA
Cs 101.36nF     RANGE  AUTO 10kΩ
                OPEN   OFF
                SHORT  OFF
ab a 1.0000     TRIG   INT
   b 0          DELAY  0.00s
                AVE    OFF
                SPEED  NORMAL

* SCALE ON *               MENU
```

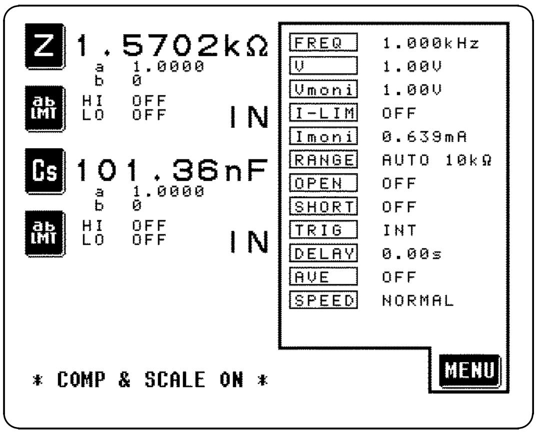
Scaling Screen

NOTE On the Comparator screen, the Comparator scaling screen can be also accessed by the same key operations. For details on the comparator, see Section 4.15.



```
Z  1.5702kΩ     FREQ   1.000kHz
                V      1.000V
LMT HI OFF      Vmoni  1.000V
    LO OFF  IN  I-LIM  OFF
                Imoni  0.639mA
Cs 101.36nF     RANGE  AUTO 10kΩ
                OPEN   OFF
                SHORT  OFF
LMT HI OFF      TRIG   INT
    LO OFF  IN  DELAY  0.00s
                AVE    OFF
                SPEED  NORMAL

* COMPARATOR *             MENU
```

Comparator Screen



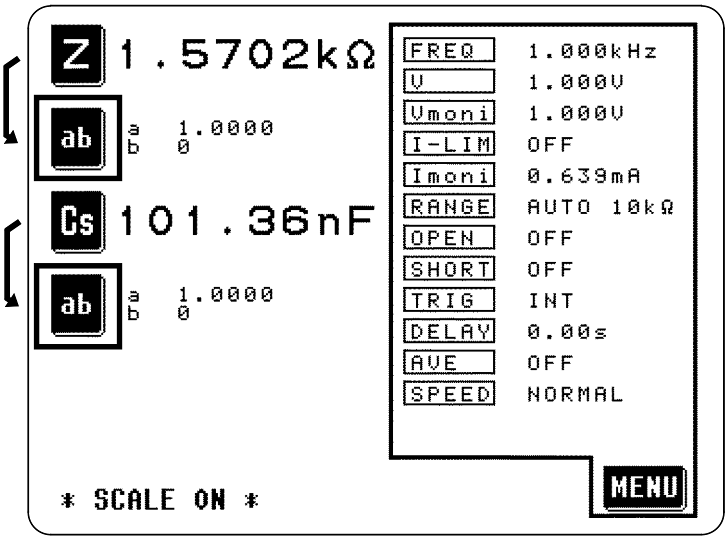
```
Z  1.5702kΩ     FREQ   1.000kHz
    a 1.0000    V      1.00V
    b 0         Vmoni  1.00V
ab  HI OFF      I-LIM  OFF
LMT LO OFF  IN  Imoni  0.639mA
Cs 101.36nF     RANGE  AUTO 10kΩ
    a 1.0000    OPEN   OFF
    b 0         SHORT  OFF
ab  HI OFF      TRIG   INT
LMT LO OFF  IN  DELAY  0.00s
                AVE    OFF
                SPEED  NORMAL

* COMP & SCALE ON *        MENU
```

Comparator Scaling Screen

4. Set the first and third parameters to be the two parameters which you wish to measure. (Refer to the section on display parameter setting for details upon how to make the setting.)

Shows the first compensation coefficient setting.

Shows the third compensation coefficient setting.



Z 1.5702kΩ

ab a 1.0000
b 0

Cs 101.36nF

ab a 1.0000
b 0

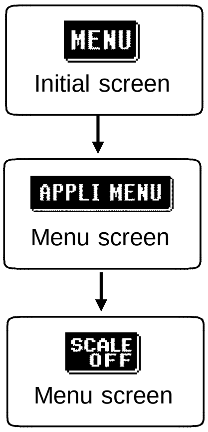
FREQ 1.000kHz
V 1.000V
Vmoni 1.000V
I-LIM OFF
Imoni 0.639mA
RANGE AUTO 10kΩ
OPEN OFF
SHORT OFF
TRIG INT
DELAY 0.00s
AVE OFF
SPEED NORMAL

* SCALE ON *

The Conditions setting screen is accessed by pressing the ab key.

5. The Menu screen can be displayed from the Comparator screen display by pressing the MENU key, in the same manner as from the Initial screen, and then the values for the various test conditions can be changed. (For details, refer to the explanation of setting the appropriate test condition.)

4.16.3 Canceling the Scaling Function



1. Press the MENU key on the Scaling screen or the Comparator scaling screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

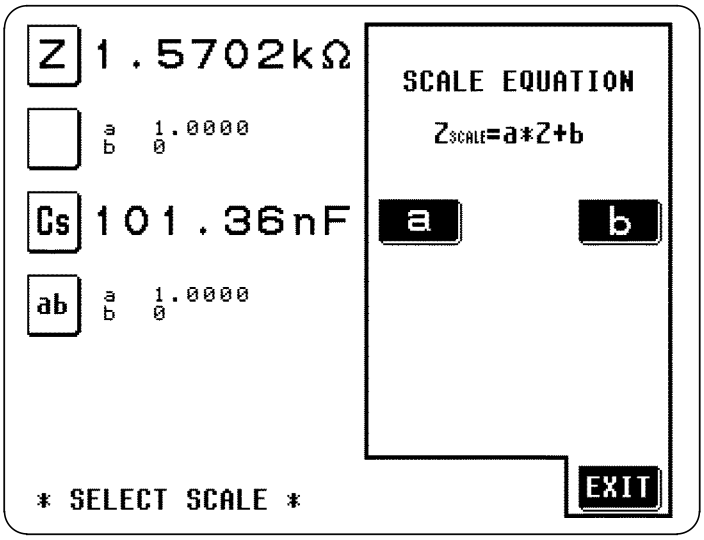
3. Press the SCALE OFF key on the Application menu screen to return the Initial screen or the Scaling screen.

On the Initial screen, the second and fourth display parameter positions ab will revert to displaying the parameters which they were displaying before the comparator mode was started. On the Comparator screen, they will revert to displaying LMT .

4.16.4 Setting the Compensation Coefficient (a, b)

1. Access the Scaling screen.

2. On the Scaling screen, press the ab key which you wish to change. The Conditions setting screen will be displayed.


Z 1.5702kΩ

a 1.0000
b 0

Cs 101.36nF

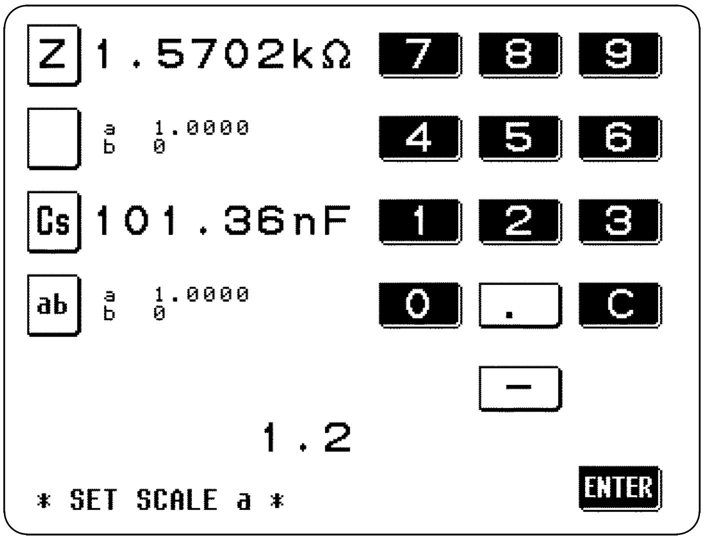
ab a 1.0000
b 0

SCALE EQUATION

$Z_{SCALE}=a*Z+b$

* SELECT SCALE *

3. Press the a key, and a screen will appear for setting the compensation coefficient a. Use the numeric keypad to input the desired value.


Z 1.5702kΩ

a 1.0000
b 0

Cs 101.36nF

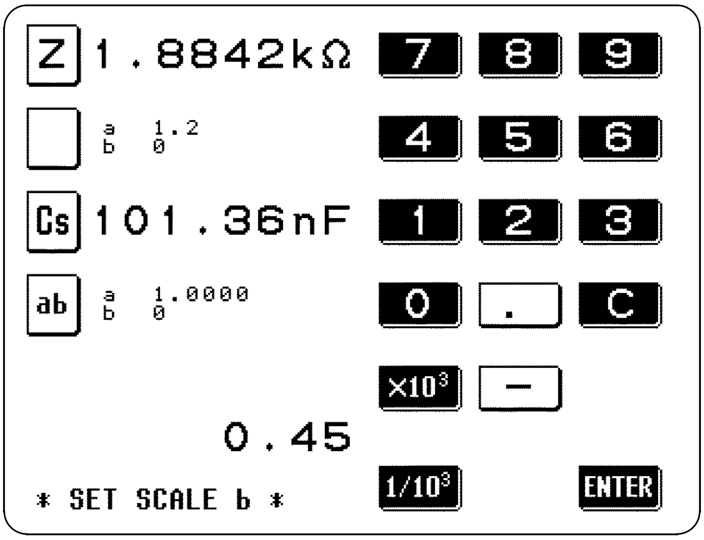
ab a 1.0000
b 0

1.2

* SET SCALE a *

The setting can be made in the range : -999.99 to +999.99
To return to the previous screen without making any change to the set value, press the ENTER key when the screen is in the state with nothing being displayed (the state after pressing the C key).

4. Set the compensation coefficient b as the same way.



Z 1.8842kΩ

a 1.2
b 0

Cs 101.36nF

ab
a 1.0000
b 0

0.45

* SET SCALE b *

The setting can be made in the range : -200.00M to +200.00M

$\times10^3$: step the units up

$1/10^3$: step the units down

p -- n -- µ -- m -- (none) -- k -- M

<= Units down Units up =>

5. When the compensation coefficient setting has been established, press the EXIT key on the Compensation coefficient setting screen to return to the Scaling screen.

NOTE

- The scaled measurement value has no effect on other measurement values. Therefore, even if the same parameter is set for the first and third parameters, the scaling is carried out with the respective compensation coefficients.
- The calculation result of scaling for θ is as follows.
  When exceeding 180° , "180.00° " is displayed.
  When below -180° , "-180.00° " is displayed.

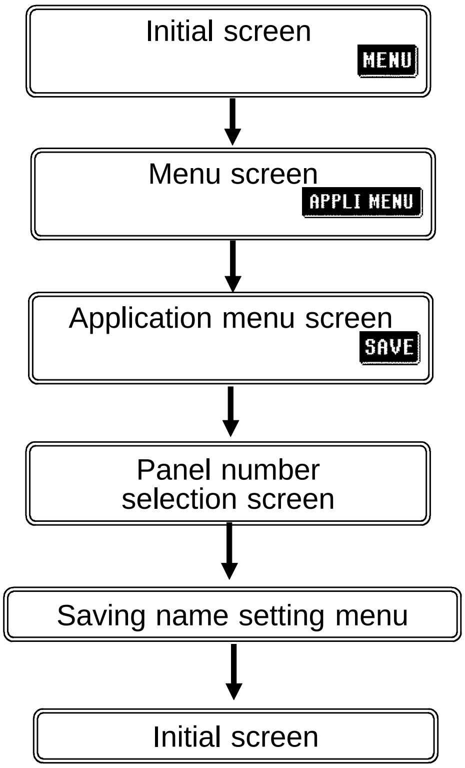
4.17 Panel Save Function

All of the test conditions can be saved as a "panel", up to a maximum of 30 such stored panels (i.e., sets of stored test conditions).

The test conditions which are saved are:

- Display parameters
- Test range
- Set value for averaging
- Test frequency
- Open and short circuit compensation values
- Set value for test speed
- Test signal level
- Setting for trigger value
- Beep sound setting
- Voltage and current limit values
- Set value for trigger delay
- Comparator setting
- Scaling setting
- Display digits setting
- Cable length setting
- Display setting

4.17.1 Control Screen Sequence



Press the MENU key.

Press the APPLI MENU key.

Press the SAVE key.

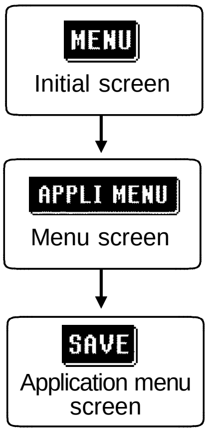
Select the panel number under which settings will be saved.

Set the saving name.

When the saving has been completed, the system returns automatically to the Initial screen.

The saving has been performed.

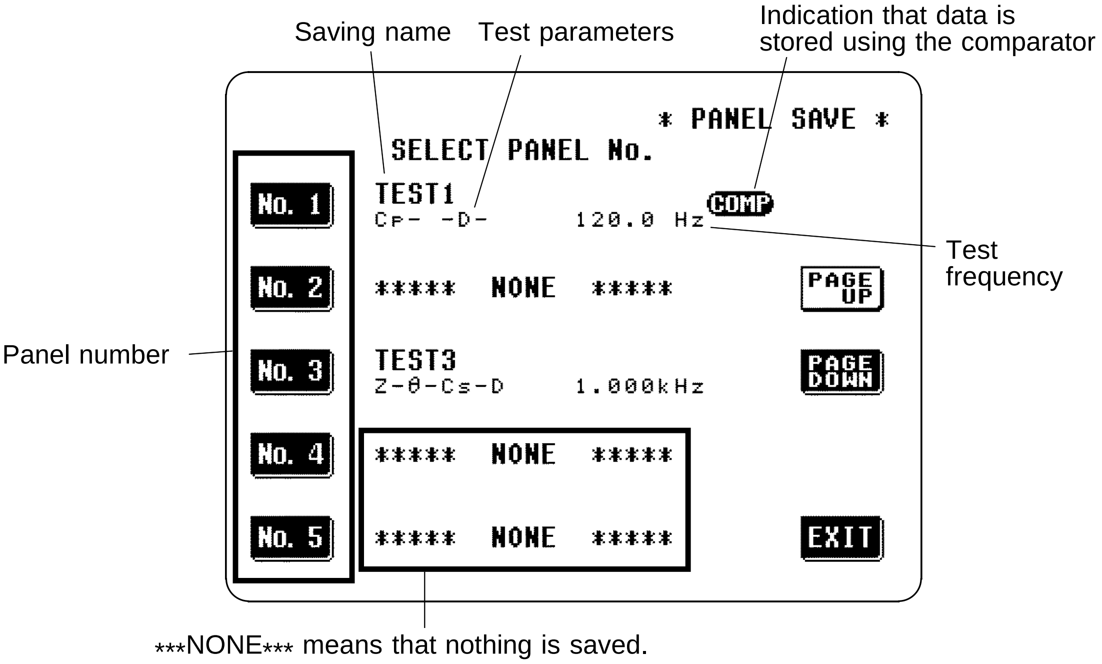
4.17.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the SAVE key on the Application menu screen to display the Panel number selection screen.



* PANEL SAVE *

SELECT PANEL No.

TEST1
Cp- -D- 120.0 Hz

***** NONE *****

TEST3
Z-θ-Cs-D 1.000kHz

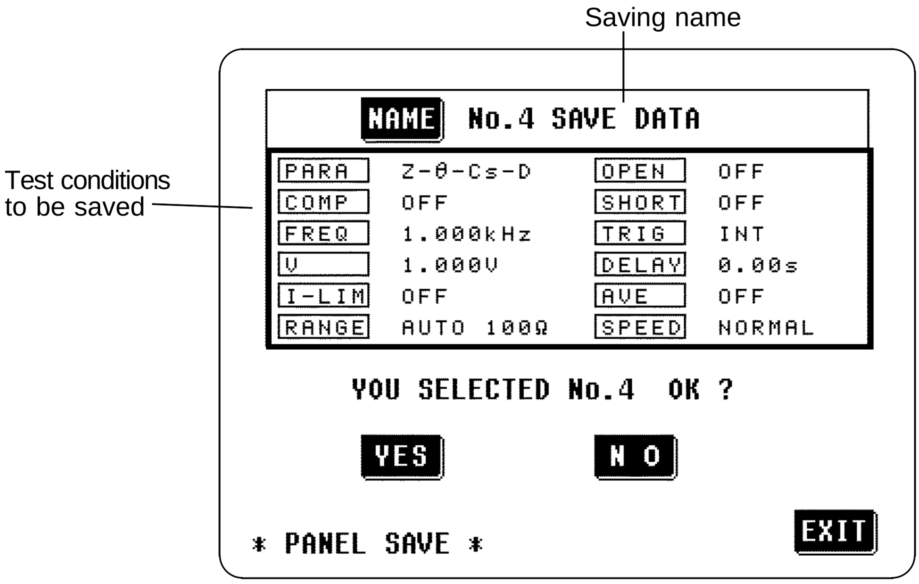
***** NONE *****

***** NONE *****

Panel Number Selection Screen

EXIT : cancel the saving, and the display reverts to the Initial screen.
PAGE UP, PAGE DOWN : change the position of the panel number

4. When you have decided upon the panel number under which the present test conditions will be saved, press the corresponding panel number key to select it.



No.4 SAVE DATA

PARA	Z-θ-Cs-D	OPEN	OFF
COMP	OFF	SHORT	OFF
FREQ	1.000kHz	TRIG	INT
V	1.000V	DELAY	0.00s
I-LIM	OFF	AVE	OFF
RANGE	AUTO 100Ω	SPEED	NORMAL

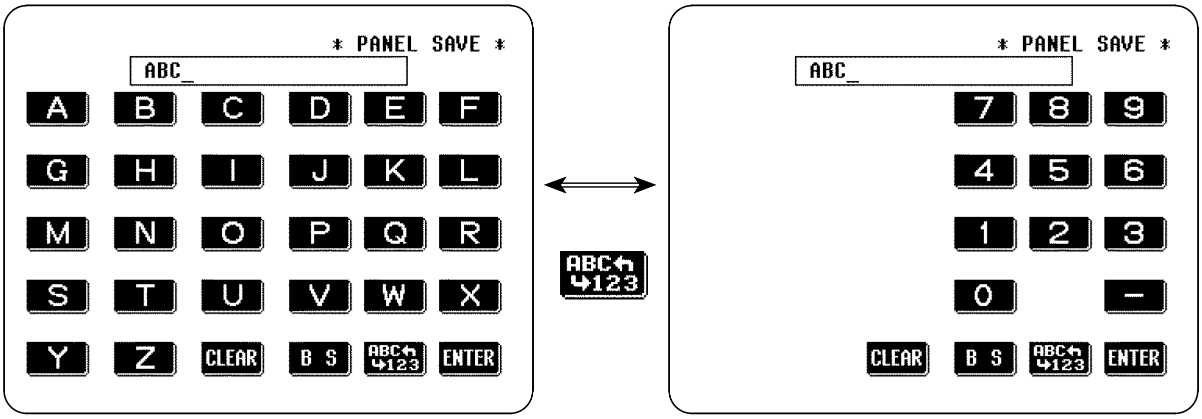
YOU SELECTED No.4 OK ?

* PANEL SAVE *

YES : save the current test conditions with the saving name, and the display automatically reverts to the Initial screen.

N O : change the panel number, and the previous screen will be displayed again.

5. To change the saving name, press the NAME key, and the screen for name input will be displayed. Input the saving name (up to 20 characters).



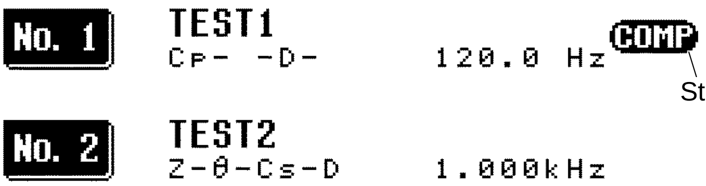
ABC↰↳123 : Toggles between the alphabet input screen and numerical input screen.
B S : Back space
CLEAR : Clears the input character.

6. After input, press the ENTER key to return the Saving confirmation screen.

7. Press the YES key on the Saving confirmation screen to save the test conditions. The display automatically reverts to the Initial screen.

NOTE

- If the comparator mode is set, then when the test conditions are saved, as well as the saved test conditions, the following mark is displayed:



```
No. 1  TEST1
       Cp- -D-       120.0 Hz COMP
No. 2  TEST2
       Z-θ-Cs-D      1.000kHz
```

Stored using the comparator mod

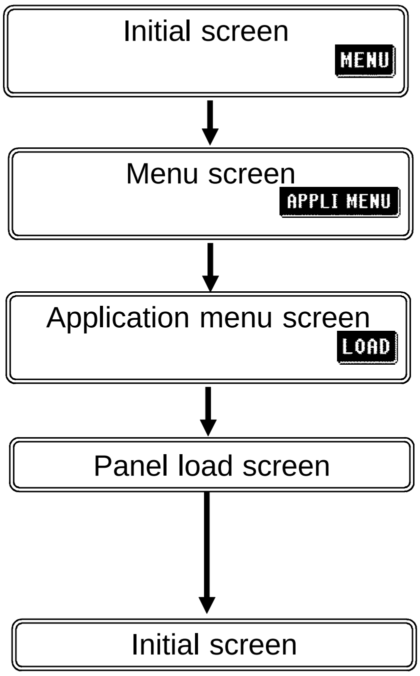
- Under normal conditions of use, the average life of the backup battery is about 10 years.
- If the internal battery becomes exhausted, it is no longer possible to save the test conditions. You should have the battery changed by an approved HIOKI service facility (which is chargeable).

4.18 Panel Load Function

Using the panel load function, saved test conditions can be loaded.

The test conditions which are saved:
- Display parameters
- Test range
- Set value for averaging
- Test frequency
- Open and short circuit compensation values
- Set value for test speed
- Test signal level
- Setting for trigger value
- Beep sound setting
- Voltage and current limit values
- Set value for trigger delay
- Comparator setting
- Scaling setting
- Display digits setting
- Cable length setting
- Display setting

4.18.1 Control Screen Sequence



Press the MENU key.

Press the APPLI MENU key.

Press the LOAD key.

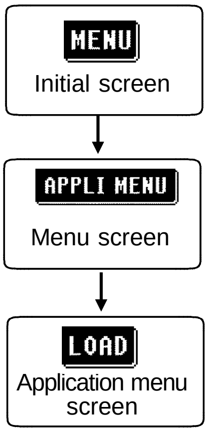
Select the panel number which you wish to load.

When the loading has been completed, the system returns automatically to the Initial screen.

The loading has been performed.

Testing starts with the new test conditions.

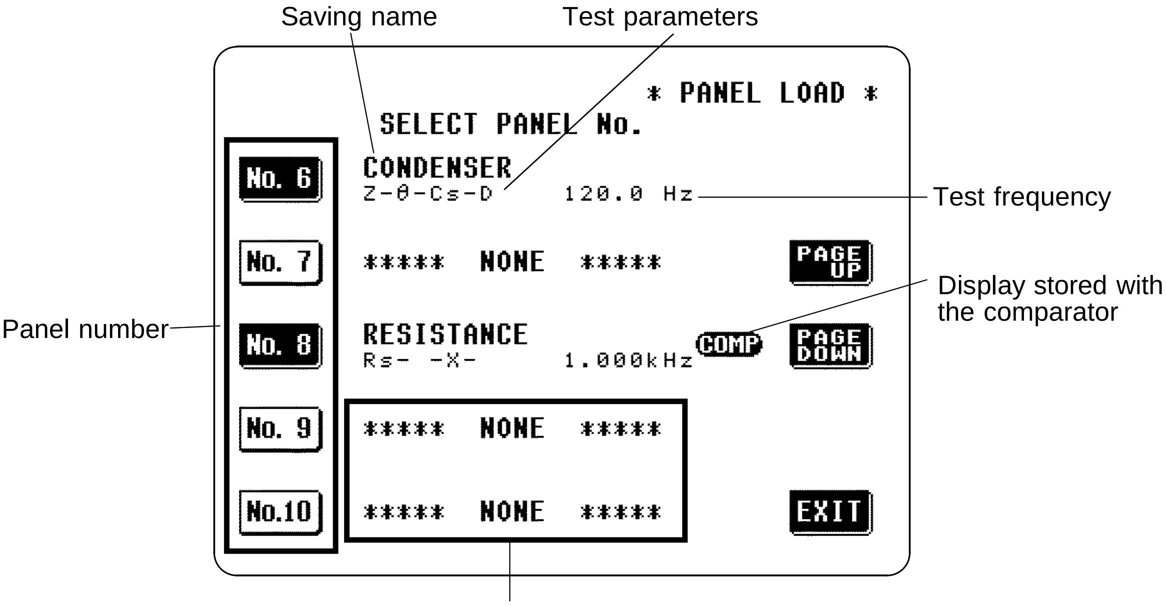
4.18.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the LOAD key on the Application menu screen to display the Panel load screen.



* PANEL LOAD *

SELECT PANEL No.

No. 6 CONDENSER
Z-θ-Cs-D 120.0 Hz

No. 7 ***** NONE *****

No. 8 RESISTANCE
Rs- -X- 1.000kHz

No. 9 ***** NONE *****

No.10 ***** NONE *****

NONEmeans that nothing is saved.

Panel Load Screen

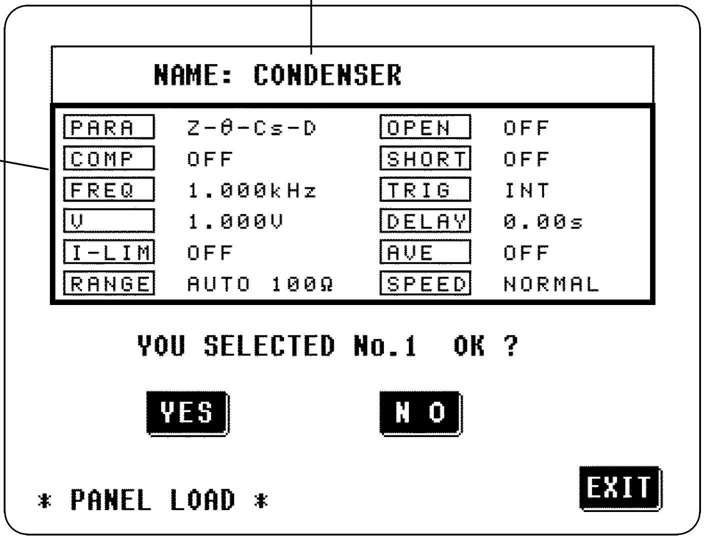
4. For each panel number, some of the values currently saved are shown on the Panel load screen. Check these stored values and then select the panel number for which the stored test conditions will be loaded.

PAGE UP, PAGE DOWN : change the position of the panel number

5. When you have decided upon the panel number for which the stored test conditions will be loaded, press the corresponding panel number key to select it.

To cancel the panel load process, press the EXIT key. The present test conditions will not be altered, and the display will revert to the Initial screen.

6. A message requesting confirmation will be displayed. To continue, press the YES key. The test conditions saved under the panel number which was selected will be loaded in place of the present test conditions.



Saving name

Test conditions to be loaded

NAME: CONDENSER

PARA	Z-θ-Cs-D	OPEN	OFF
COMP	OFF	SHORT	OFF
FREQ	1.000kHz	TRIG	INT
V	1.000V	DELAY	0.00s
I-LIM	OFF	AVE	OFF
RANGE	AUTO 100Ω	SPEED	NORMAL

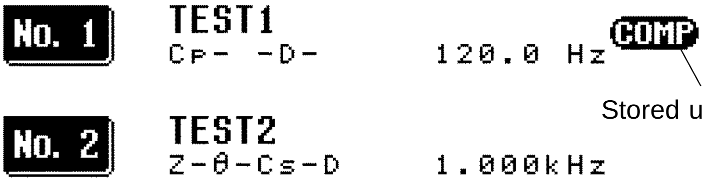
YOU SELECTED No.1 OK ?

* PANEL LOAD *

To change the panel number for the load, press the N O key, and the previous screen will be displayed again.
When the new test conditions have been loaded, the display automatically reverts to the Initial screen, on which the panel number from which the newly loaded test conditions just came is displayed.

NOTE

- For test conditions saved with the comparator mode, the following mark is displayed:



No. 1 TEST1 Cp- -D- 120.0 Hz COMP

No. 2 TEST2 Z-θ-Cs-D 1.000kHz

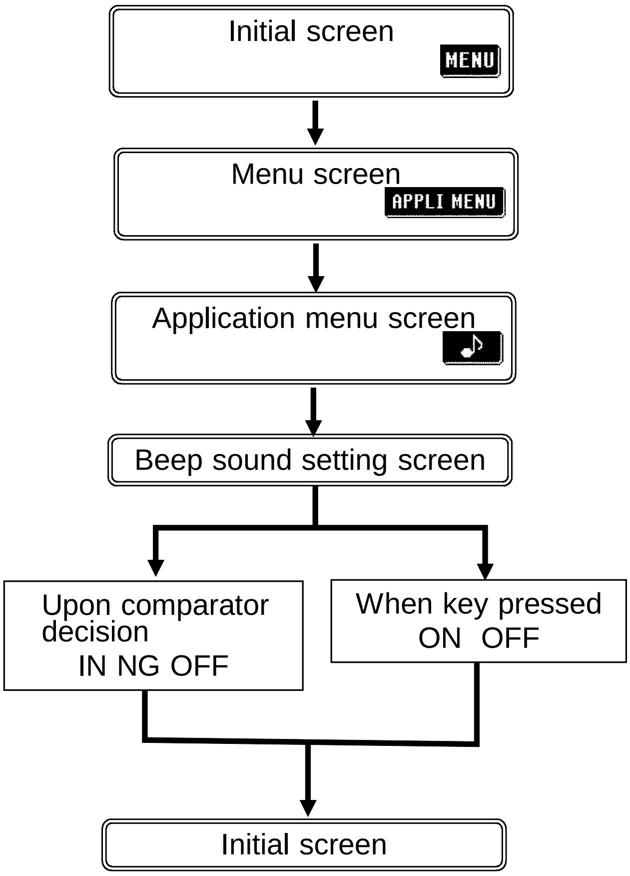
Stored using the comparator mode

- Under normal conditions of use, the average life of the backup battery is about 10 years.
- If the internal battery becomes exhausted, it is no longer possible to save the test conditions. You should have the battery changed by an approved HIOKI service facility (which is chargeable).

4.19 Setting the Beep Sound

The beep sound which is produced each time that a soft key is pressed, and the beep sound which is produced when the comparator makes decisions, can be turned on and off individually.

4.19.1 Control Screen Sequence



Press the MENU key.

Press the APPLI MENU key.

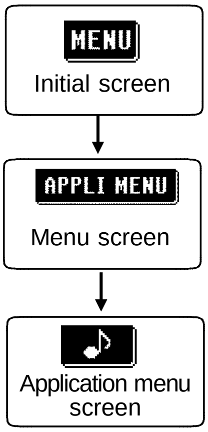
Press the ♪ key.

Set the beep sound for the comparator and for key input.

When the setting has been established, press the EXIT key to return to the Initial screen.

The setting has been performed.

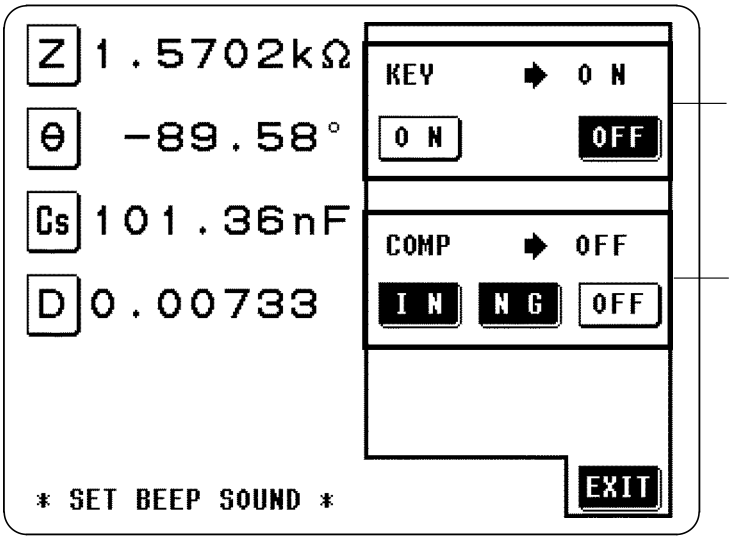
4.19.2 Details of the Setting Process



1. Press the **MENU** key on the Initial screen to display the Menu screen.

2. Press the **APPLI MENU** key on the Menu screen to display the Application menu screen.

3. Press the **♪** key on the Application menu screen to display the Beep sound setting screen.



Z 1.5702kΩ
θ -89.58°
Cs 101.36nF
D 0.00733
KEY ➡ ON
ON OFF
COMP ➡ OFF
IN NG OFF
EXIT
* SET BEEP SOUND *

Beep sound setting for when a key is pressed

Beep sound setting for when the comparator makes decisions

Setting the beep sound produced each time a key is pressed:

ON : A beep sound for key input is emitted.
OFF : No beep sound for key input is emitted.

Setting the beep sound produced when the comparator makes decisions:

- When the comparator makes a single decision:
  - **IN** : When the comparator result is IN, a beep sound is emitted.
  - **NG** : 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:
  - **IN** : When both of these comparator results are IN, a beep sound is emitted.
  - **NG** : 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.

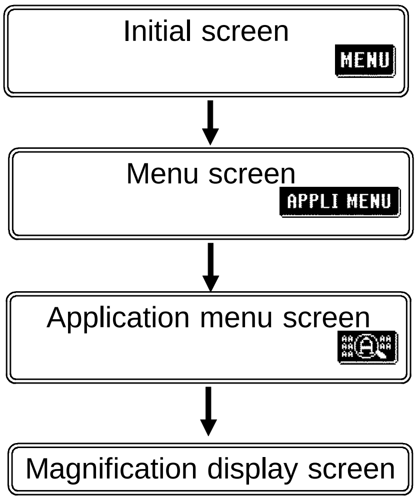
3. When the setting has been established as above, press the **EXIT** key to return to the Initial screen.

4.20 Enlarged Display of Measurement Values

The measurement values and comparator decision results can be displayed in enlarged form. This function is convenient when the unit is used under constant measurement conditions.

After powering off on the Magnification display screen, the same screen is displayed when the power is turned on again.

4.20.1 Control Screen Sequence

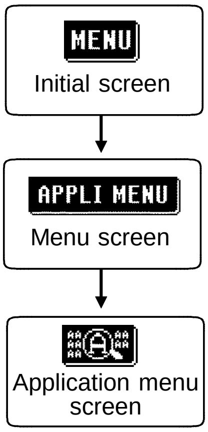


Press the MENU key.

Press the APPLI MENU key.

Press the 🔍 key.

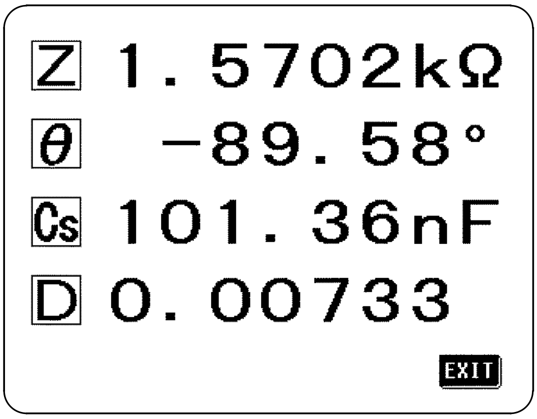
4.20.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

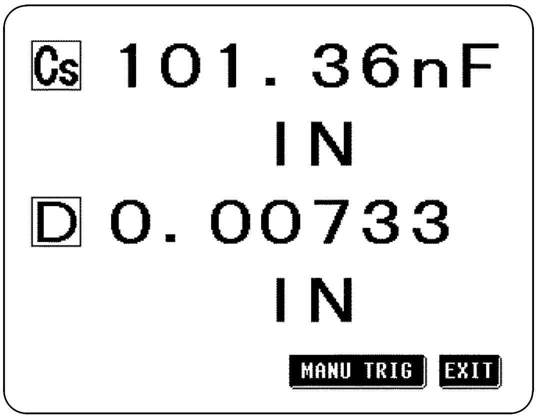
2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the 🔍 key on the Application menu screen to display the Magnification display screen.



```
Z  1.5702kΩ
θ   -89.58°
Cs 101.36nF
D  0.00733
```

Normal Screen



```
Cs 101.36nF
      IN
D  0.00733
      IN
```

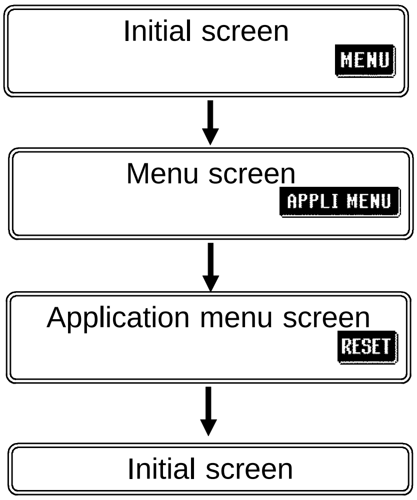
Comparator Screen

EXIT : return the Initial screen
MANU TRIG (during the external trigger setting): measure once
On the Magnification display screen, only EXIT and MANU TRIG keys are displayed.

4.21 System Reset

All of the settings will revert to the factory original settings.

4.21.1 Control Screen Sequence

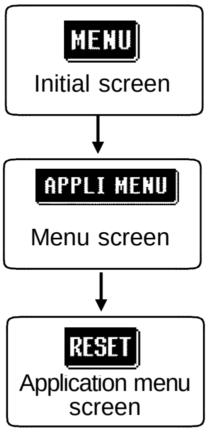


Press the MENU key.

Press the APPLI MENU key.

Press the RESET key.

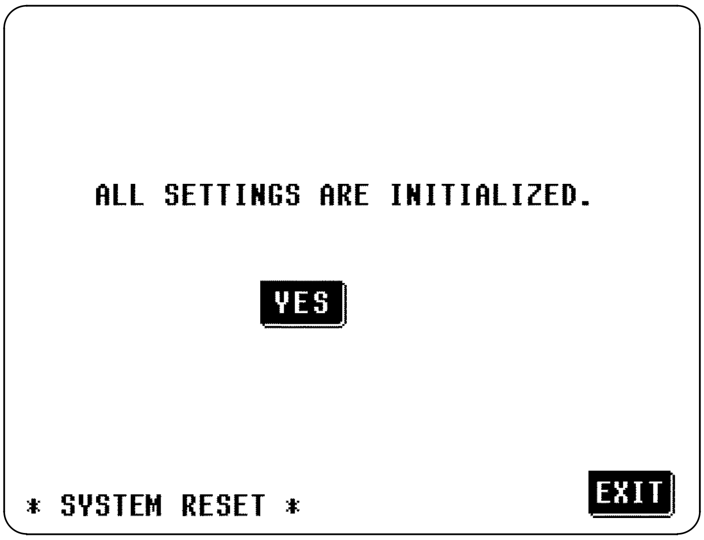
4.21.2 Details of the Setting Process



1. Press the **MENU** key on the Initial screen to display the Menu screen.

2. Press the **APPLI MENU** key on the Menu screen to display the Application menu screen.

3. Press the **RESET** key on the Application menu screen to display the System reset screen.


ALL SETTINGS ARE INITIALIZED.

* SYSTEM RESET *

YES : reverts to the factory settings and the Initial screen is displayed.
EXIT : halts settings and reverts to the Initial screen.

The settings established at the factory are as follows:

Test parameters	$\lvert Z \rvert$, θ
Test frequency	1 kHz
Test signal level	Open circuit voltage (V) setting
Open circuit voltage (V) set value	1.000 V
Constant voltage (CV) set value	1.000 V
Constant current (CC) set value	10.00 mA
Limit function	OFF
Voltage limit set value	5.000 V
Current limit set value	50.00 mA
Test range	AUTO range
Open circuit compensation	OFF
Short circuit compensation	OFF
Trigger setting	Internal trigger
Trigger delay setting	0 s
Averaging	OFF
Test speed setting	NORMAL
Cable length setting	0 m
Beep sound setting	ON for key input, OFF for comparator
Panel save, panel load	All contents clear
Comparator	
Comparator setting	Both first and third parameters set to absolute value.
Absolute value set values	Upper and lower limit values for the first and third parameters both OFF
Percent set values	First parameter reference value: 1000 Upper and lower limit values for first parameter both OFF Third parameter reference value: 10 Upper and lower limit values for third parameter both OFF
Scaling setting value	Compensation coefficient a for the first and third parameters: 1.0000 Compensation coefficient b for the first and third parameters: 0
Display digits setting	All five digits for first to 4th parameters
Display setting	LCD display: ON Voltage and Current monitor: ON

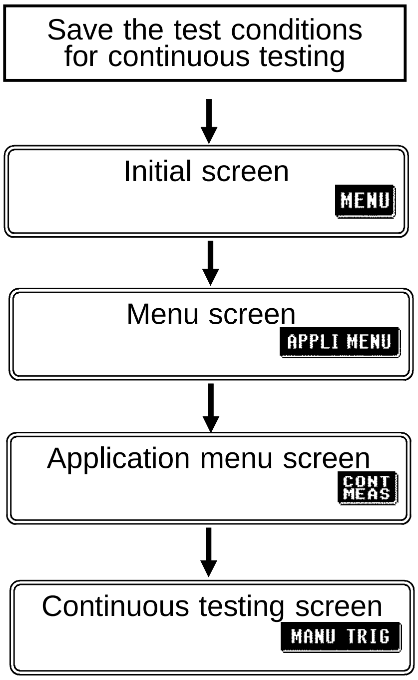
4.22 Continuous Test Function

It is possible to read in order test conditions which have been saved using the panel save function, and to perform continuous testing.
Up to five panel numbers can be selected in a page for the continuous testing.

Page	Panel numbers
1	1 - 5
2	6 - 10
3	11 - 15
4	16 - 20
5	21 - 25
6	26 - 30

After powering off on the Continuous test screen, the same screen is displayed when the power is turned on again.

4.22.1 Control Screen Sequence



Section 4.17, "Panel Save Function"

Press the MENU key.

Press the APPLI MENU key.

Press the CONT MEAS key.

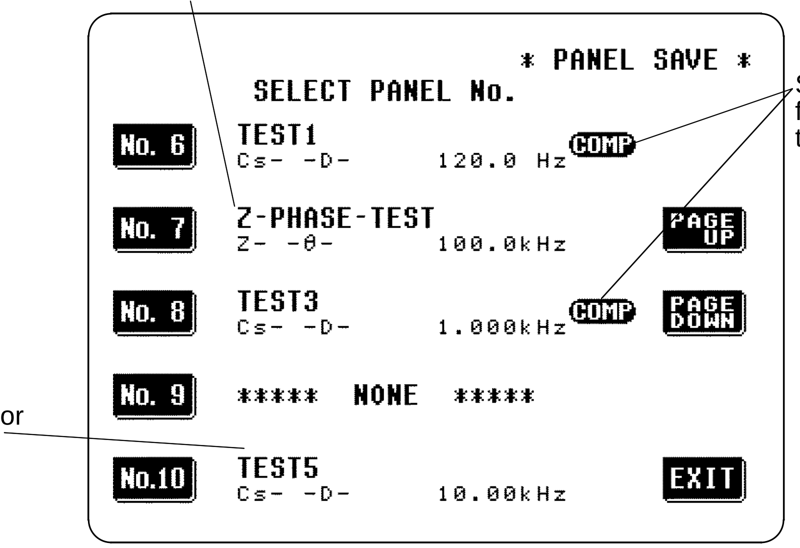
Select the panel number which you wish to test.
Press the MANU TRIG key to start test.

4.22.2 Details of the Setting Process

This section describes procedure when performing continuous testing with panel numbers 6, 8, and 10 for example.

1. Save the continuous testing conditions on panel numbers 6, 8, and 10 using the panel save function. The continuous testing is performed for the first and third parameters which have been saved.

For details on panel save function, see Section 4.17.



Test conditions for some other test sample are already saved here

Saves conditions for comparator test.

Saves conditions for normal test.

* PANEL SAVE *

SELECT PANEL No.

No. 6 TEST1 Cs- -D- 120.0 Hz COMP

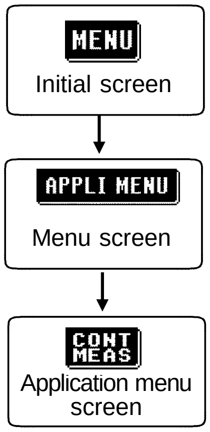
No. 7 Z-PHASE-TEST Z- -θ- 100.0kHz

No. 8 TEST3 Cs- -D- 1.000kHz COMP

No. 9 ***** NONE *****

No.10 TEST5 Cs- -D- 10.00kHz

Panel Save Screen

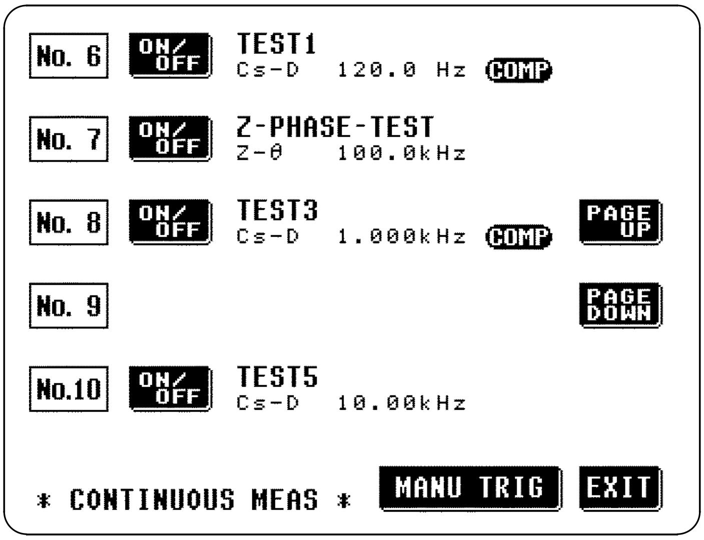


2. Press the MENU key on the Initial screen to display the Menu screen.

3. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

4. Press the CONT MEAS key on the Application menu screen to display the Continuous test screen.

5. Using the PAGE UP and PAGE DOWN keys, make a display of panel numbers which are previously saved.



No. 6 TEST1 Cs-D 120.0 Hz

No. 7 Z-PHASE-TEST Z-θ 100.0kHz

No. 8 TEST3 Cs-D 1.000kHz

No. 9

No.10 TEST5 Cs-D 10.00kHz

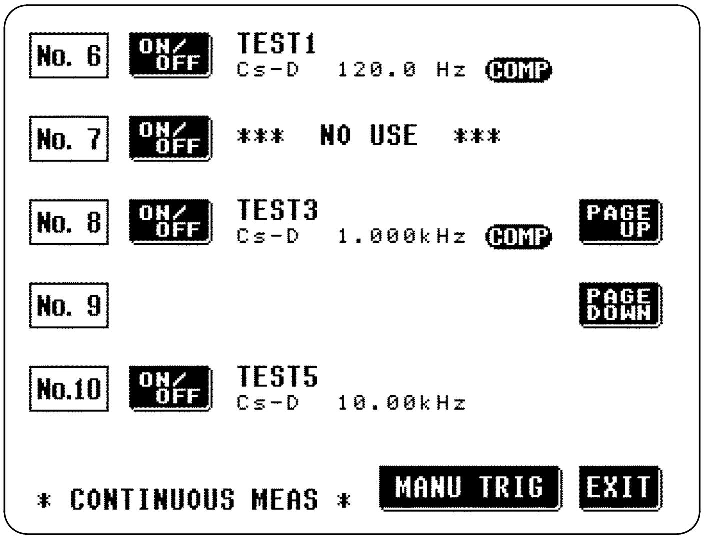
* CONTINUOUS MEAS *

Continuous Test Screen

NOTE The panel numbers which are not saved or which are invalid even if saved (when the both first and third parameters are off) are not displayed.

6. Set whether testing of each panel number is executed or not.

When the saving conditions of the panel or previous test result is displayed, the testing is executed. However, when "∗∗∗ NO USE ∗∗∗" is displayed, the testing is not executed. In this example, make a setting not to test for the panel number 7.



No. 6 TEST1 Cs-D 120.0 Hz

No. 7 *** NO USE ***

No. 8 TEST3 Cs-D 1.000kHz

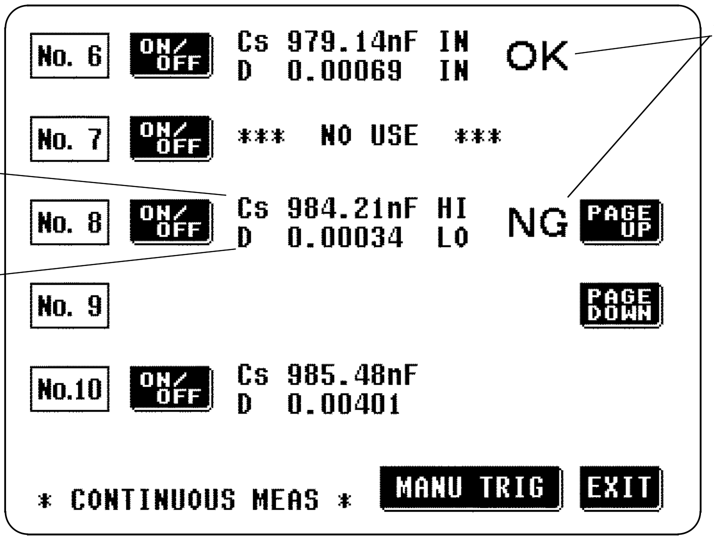
No. 9

No.10 TEST5 Cs-D 10.00kHz

* CONTINUOUS MEAS *

NOTE When changing a page, the all panel number displayed will be tested.

7. Press the MANU TRIG to start test. The test result is displayed when the tests of each panel numbers are terminated.



```
No. 6  ON/OFF  Cs 979.14nF  IN
               D  0.00069   IN    OK

No. 7  ON/OFF  ***  NO USE  ***

No. 8  ON/OFF  Cs 984.21nF  HI
               D  0.00034   LO    NG  PAGE UP

No. 9                                 PAGE DOWN

No.10  ON/OFF  Cs 985.48nF
               D  0.00401

* CONTINUOUS MEAS *   MANU TRIG   EXIT
```

The first parameter test result

The third parameter test result

When the comparator test, individual decision result and AND result are displayed.

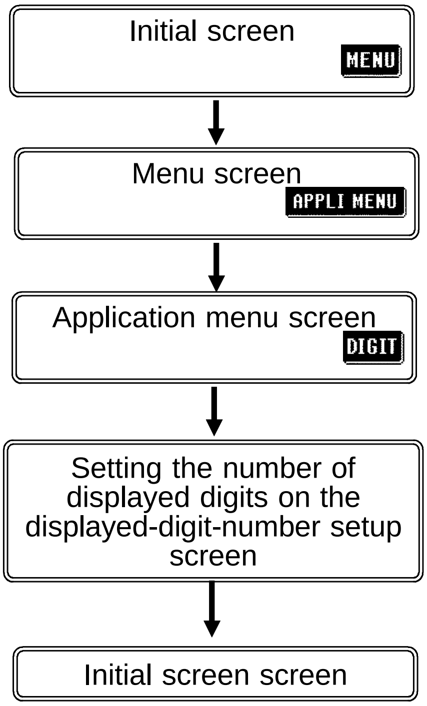
NOTE If the displaying page is switched to other page after test completed, the displays of the test result are disappear.

8. To exit from the continuous test, press the EXIT key to return the Initial screen.
The continuous test can be executed from the EXT I/O connector. For details, see Section 5.6, "Testing Using EXT I/O."

4.23 Setting the Number of Displayed Digits

The number of effective digits for measurement can be set on a parameter-by-parameter basis.

4.23.1 Control Screen Sequence



Press the MENU key.

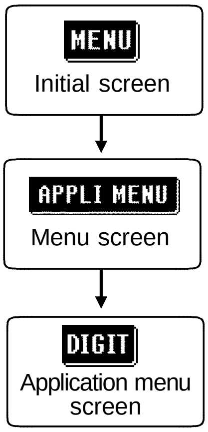
Press the APPLI MENU key.

Press the DIGIT key.

Set the number of digits to be displayed.

When the setting is completed, press the EXIT key to return to the Initial screen.

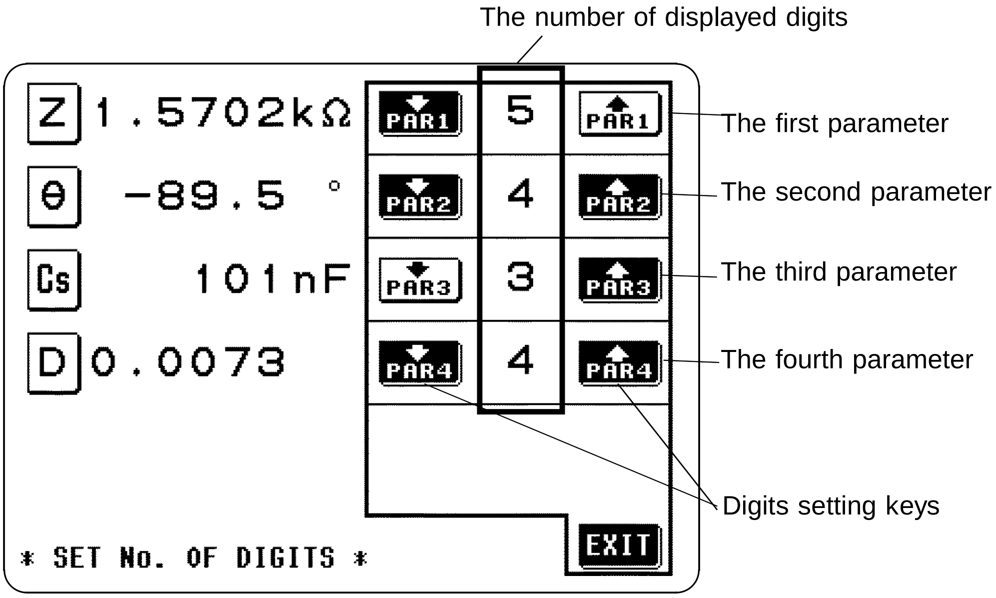
4.23.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the DIGIT key on the Application menu screen to display the Setting the displayed digits screen.



Press ▼PAR and ▲PAR for each parameter to set the number of displayed digits. While the definable set values are 3, 4, and 5, the value is actually selected according to the parameter type, as shown in the table below.

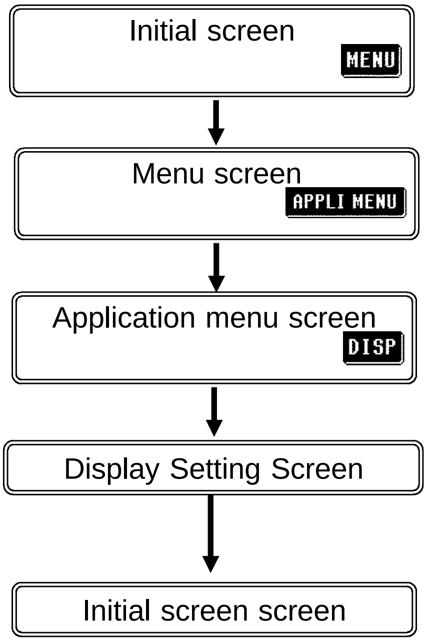
Parameter Setting value	θ, Q Comparator Δ% setting	D	Others
5	Up to the second decimal place	Up to the fifth decimal place	Up to 5 digits
4	Up to the first decimal place	Up to the fourth decimal place	Up to 4 digits
3	No decimal place	Up to the third decimal place	Up to 3 digits

4. To exit from this mode, press the EXIT key to return the Initial screen.

4.24 Setting for Display

In some applications, such as on a production line or where EXT I/O or interfaces are used, it may not be necessary to display measurement values. This unit allows ON/OFF settings of the display and voltage/current monitors (Vmoni, Imoni) to be made.
Turning off the LCD display helps save power, as the LCD display and backlight remain off. Moreover, the measurement time is reduced due to the fact that measurement values and Vmoni and Imoni indications need not be displayed. When the voltage and current monitors are turned off, the measuring time is also reduced due to the fact that the Vmoni and Imoni indications are not required.

4.24.1 Control Screen Sequence



Press the MENU key.

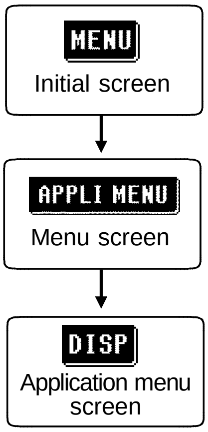
Press the APPLI MENU key.

Press the DISP key.

Set ON or OFF of the display.

When the setting is completed, press the EXIT key to return to the Initial screen.

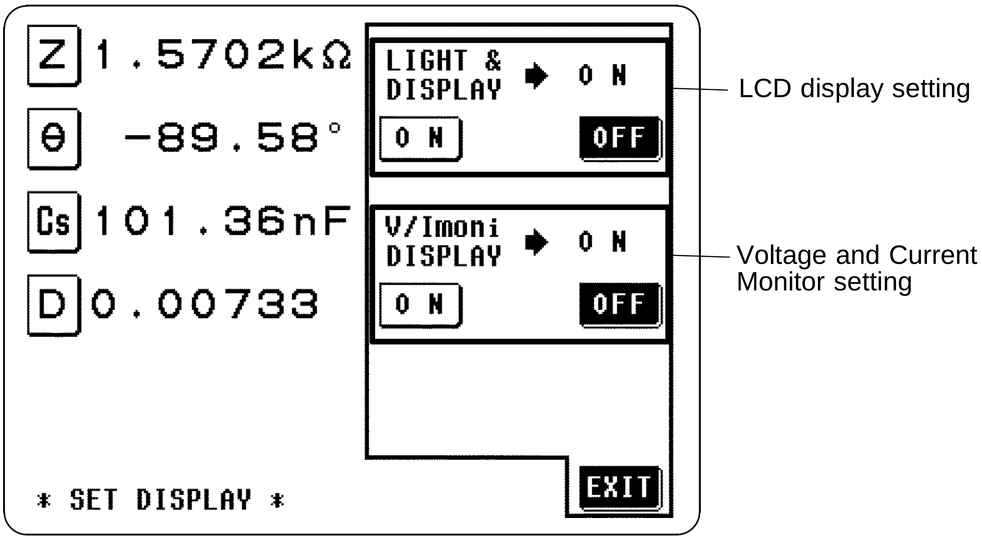
4.24.2 Details of the Setting Process



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the DISP key on the Application menu screen to display the Display Setting Screen.



Setting for LCD Display

O N :The LCD display and backlight remain on permanently.
OFF :The LCD display and backlight remain off permanently.

When OFF is selected, the LCD display and backlight go out approximately 10 seconds after the touch panel is last touched. When the touch panel is touched after the display and backlight have gone out, they will come on again. When the display and backlight are off, the measurement time is reduced, as Vmoni and Imoni do not display indications.

Setting for Voltage and Current Monitors (Vmoni, Imoni)

O N :The voltage and current monitors display indications.
OFF :The voltage and current monitors do not display indications.

When OFF is selected, the measurement time is reduced, as Vmoni and Imoni do not display indications. For the measurement time, refer to "7.3 Time Taken for Testing."

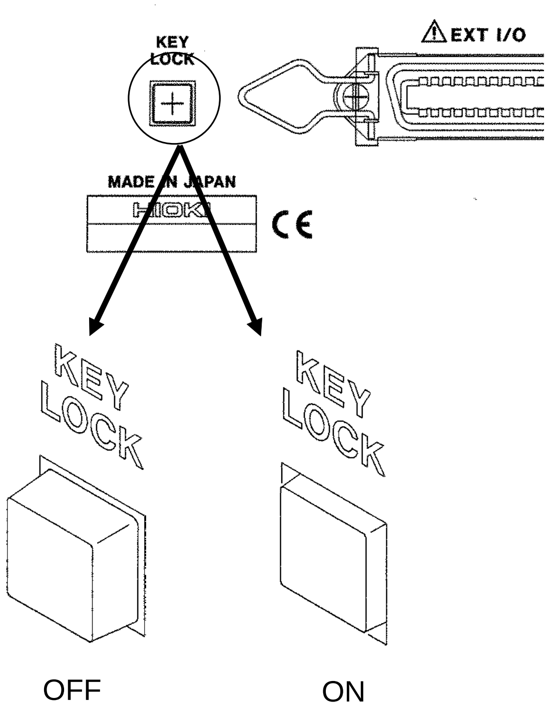
4. To exit from this mode, press the EXIT key to return the Initial screen.

4.25 Key Lock Function

When the key lock function is turned on, all of the keys become inoperative, so that no control via the touch panel is possible, and the values of the settings are all frozen and preserved.

4.25.1 Turning the Key Lock On and Off

- This function is activated using the key lock switch on the rear panel of the 3532-50 unit.
- The key lock function can only be used when the screen is displaying the Initial screen, Comparator screen, Scaling screen, Magnification display screen, or Continuous test screen.



NOTE

- In the case of external triggering, the key lock does not apply to the **MANU TRIG** button.
- Even if the power supply is interrupted, the key lock function is not canceled.
- The key lock function can be turned on and off via the EXT I/O connector. For details, see Section 5.5, "The EXT I/O Connector."

Chapter 5
Applications

5.1 Example of Comparator Application

Making decisions for two items simultaneously (ABS and % settings).

Example First parameter: static capacitance Cp and third parameter: phase angle θ will be set as follows:

First parameter (ABS setting)
Upper limit value 110 nF
Lower limit value 100 nF

Third parameter (% setting)
Reference value -85°
Upper limit value 5% (i.e., -80.75°)
Lower limit value -5% (i.e., -89.25°)

The results of the decisions with these settings are as shown in the following table:

Comparator decisions

Third parameter	Lower limit value	Upper limit value	
First parameter	LO	IN	HI
HI	HI/LO	HI/IN	HI/HI
Upper limit value			
IN	IN/LO	IN/IN	IN/HI
Lower limit value			
LO	LO/LO	LO/IN	LO/HI

In this manner, two decisions can be made simultaneously. Further, it is possible to check the decision results for two different parameters at the same time, and thereby to determine what quality zone the object which is being tested falls into.

Sorting a single item into five bands (% setting).
Two decisions can be made relating to the same item, so as to obtain five different combinations of results.

Example First parameter and third parameter: impedance *Z*, will be set as follows:

First parameter

Reference value	3.0 kΩ
Upper limit value	10%
Lower limit value	5%

Third parameter

Reference value	3.0 kΩ
Upper limit value	-5%
Lower limit value	-10%

The results of the decisions with these settings are as shown in the following table:

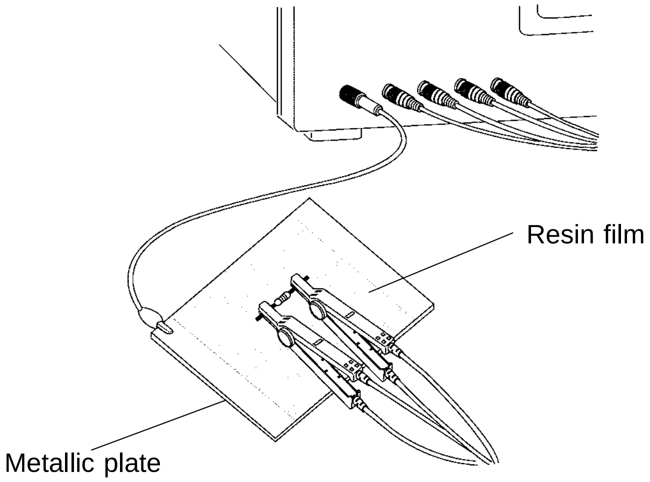
	Comparator decisions	
	Parameter 1 result	Parameter 3 result
Band 1	HI	HI
First parameter upper limit value 10% (3.3 kΩ)		
Band 2	IN	HI
First parameter lower limit value 5% (3.15 kΩ)		
Band 3	LO	HI
Third parameter upper limit value -5% (2.85 kΩ)		
Band 4	LO	IN
Third parameter lower limit value -10% (2.7 kΩ)		
Band 5	LO	LO

It is possible to sort the objects under test into five bands according to the results of the decisions relating to the first and the third parameter. (This can also be done using the ABS setting.)

Various other possibilities can be used for the settings, according to requirements.

5.2 Testing High Impedance Elements

The measured value obtained when testing a high impedance element (such as, for example, a resistor with resistance higher than 100 kΩ) is sometimes unreliable, because such an element is vulnerable to the effects of external interference and the like. In this case, reliable testing can be performed by the use of guarding, that is, connecting a metallic plate to the GUARD terminal and carrying out the measurement on the metallic plate.



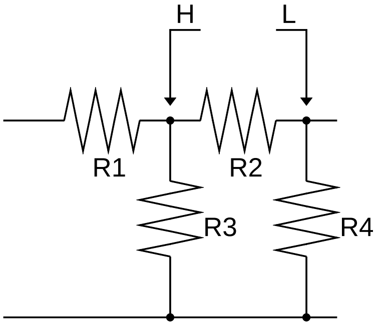
When testing against a metallic plate, the surface of the plate should be covered by a film of resin or the like, in order to prevent short circuiting together the terminals.

NOTE When the open circuit compensation is performed always execute the guarding process because of high impedance elements testing. If not, the compensation values do not stabilize. It is not possible to obtain the reliable measured value.

5.3 Testing an Element in a Circuit

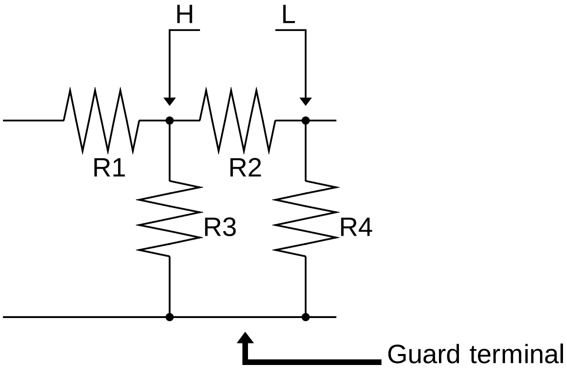
Testing an element in a circuit is not possible without guarding.

- Referring to the following figure, when measuring a resistance value for the resistor R_2, even if the tips of the two probes are contacted against the ends of the resistor R_2, considering the sum of the current flowing through the resistor R_2 and the current flowing through the resistors R_3 and R_4, what is obtained is the resistance value for the parallel combination:



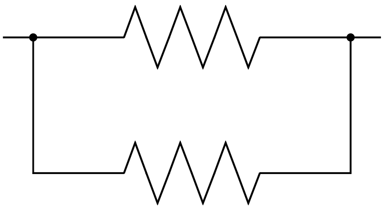
$$\mathrm{R} = \mathrm{R}_2 \cdot \frac{\mathrm{R}_3 + \mathrm{R}_4}{\mathrm{R}_2 + \mathrm{R}_3 + \mathrm{R}_4}$$

- If as shown in the next figure a guard terminal is used, the current flowing through the resistors R_3 (not flowing through R_4) is absorbed by this guard terminal, so that the resistance value for the resistor R_2 is accurately measured.

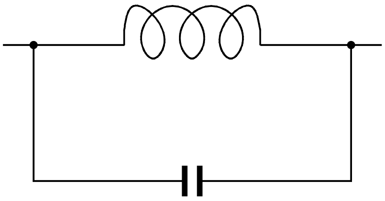


NOTE

The accuracy of measurement will not be improved in cases where for example
$R_2 >> R_3$ and R_3 is close to zero.
As shown in the figure below, it is not possible to use this type of separation process for testing of the impedance values of two resistors or other elements of identical types which are connected in parallel, or for testing of the impedance values of a coil and a capacitor which are connected in parallel.



Two resistors in parallel



Coil and capacitor in parallel

5.4 External Interference

The 3532-50 is designed to be resistant to errors caused by interference from the test cables or the power supply line. However, if the level of the interference is particularly large, this can cause measurement errors or faulty operation.
Refer to the examples given below for examples of countermeasures which can be taken against interference which has caused faulty operation etc.

5.4.1 Countermeasures Against Interference from the Power Supply Line

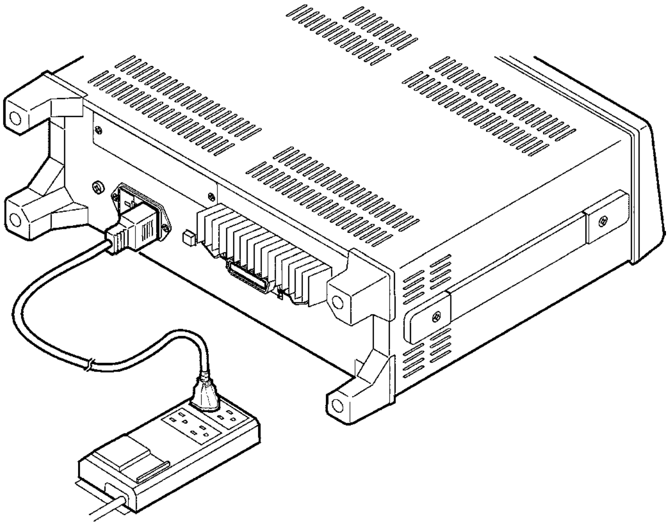
If noise is present in the power supply line, its influence can be moderated by the following countermeasures:

Grounding by using a protective ground wire
The 3532-50 unit is constructed so as to be provided with protective grounding via the ground lead in the power cord.

This protective grounding serves the important function, not only of avoiding the possibility of electric shock to the operator, but also of eliminating noise from the power supply line by the provision of an internal filter.

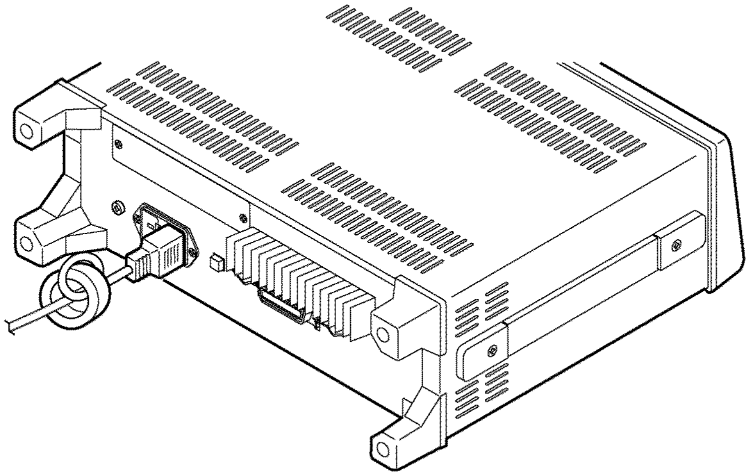
Be sure to connect the 3532-50 unit to a properly 3-wire power supply socket, using the grounded power cord which is supplied with the unit.

Inserting a noise filter in the power supply line
Any excessive noise present in the power supply line can be suppressed by purchasing a socket type noise filter (generally available commercially) which can be inserted into the power supply socket, with the 3532-50 unit connected to the output of the noise filter.
Various types of such socket type noise filters are readily available from specialist manufacturers.



Fitting an anti-interference ferrite core on the power cord

Pass the power cord through a commercially available anti-interference ferrite core, and fix it on the power cord as close as possible to the AC power inlet of the 3532-50 unit, so as to suppress noise from the power supply line. Further benefit can often be obtained by fitting another anti-interference ferrite core on to the power cord at its other end, as close as possible to the plug which connects to the power supply outlet.
Moreover, if the internal diameter of the ferrite core allows, winding the power cord several times around the ferrite core may further reduce the amount of noise. Various types of such anti-interference ferrite cores or ferrite beads are readily available in the market from specialist manufacturers.

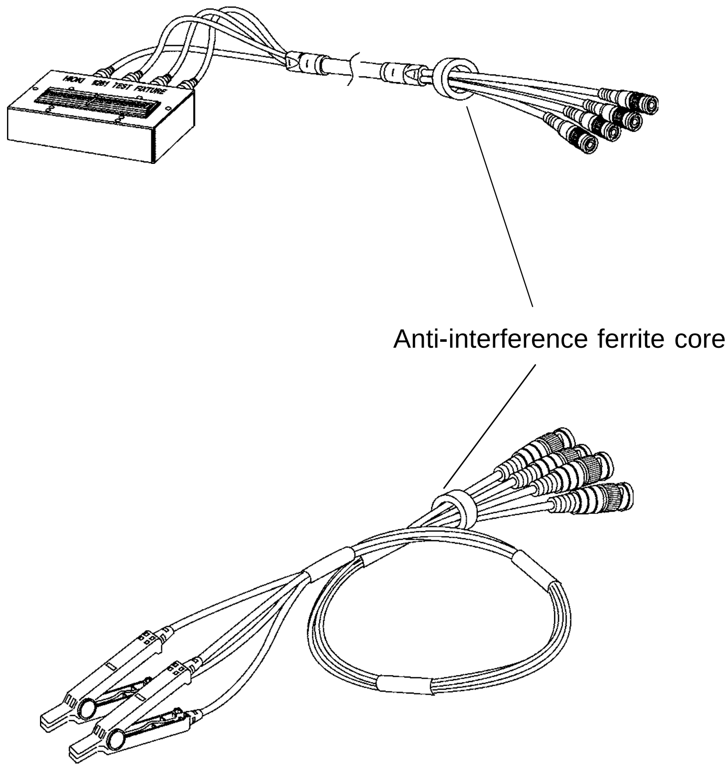


5.4.2 Countermeasures Against Noise from the Test Cables

If interference is producing noise in the test cables, its influence can be moderated by the following countermeasure.

Fitting an anti-interference ferrite core on the test cables
Pass the test cables through a commercially available anti-interference ferrite core, and fix it close to the test terminals, so as to suppress noise from the test cables.

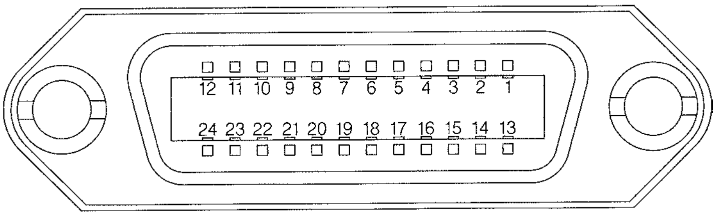
Moreover, if the internal diameter of the ferrite core allows, winding the test cables several times around the ferrite core (as with the power cord as described above) may further reduce the amount of noise.



5.5 The EXT I/O Connector

This is a connector for output of comparator result signals, of a measurement finished signal (EOM), and of an analog measurement finished signal (INDEX), and for input of an external trigger signal, and a signal for performing selection of the number of the panel to be loaded.

Connector used	Hirose type RC10(F)-24R-LW 24-pin receptacle
Compatible connector	Hirose type RC30-24P 24-pin receptacle



EXT I/O Connector Pin Numbering
(seen from 3532-50)

5.5.1 Pinouts for the EXT I/O Connector

Pin number	Signal line name	Input/output	Pin number	Signal line name	Input/output
1	INT.DCV	Output	13	INT.GND	Output
2	EXT.DCV	Input	14	EXT.COM	Input
3	EXT.DCV	Input	15	EXT.COM	Input
4	$\overline{\text{TRIG}}$	Input	16	$\overline{\text{M-HI}}$	Output
5	$\overline{\text{LOCK}}$	Input	17	$\overline{\text{M-IN}}$	Output
6	$\overline{\text{LD1}}$	Input	18	$\overline{\text{M-LO}}$	Output
7	$\overline{\text{LD2}}$	Input	19	$\overline{\text{S-HI}}$	Output
8	$\overline{\text{LD3}}$	Input	20	$\overline{\text{S-IN}}$	Output
9	$\overline{\text{LD4}}$	Input	21	$\overline{\text{S-LO}}$	Output
10	$\overline{\text{LD5}}$	Input	22	$\overline{\text{AND}}$	Output
11	Unused	———	23	$\overline{\text{INDEX}}$	Output
12	Unused	———	24	$\overline{\text{EOM}}$	Output

All input and output terminals excluding the power supply are all negative logic.

5.5.2 Signal Lines for the EXT I/O Connector

NOTE All input signals are all negative logic.

(1) $\overline{\text{M-HI}}$, $\overline{\text{M-IN}}$, $\overline{\text{M-LO}}$ (Output signal of comparator result)

These lines output the comparator result for the first parameter.

(2) $\overline{\text{S-HI}}$, $\overline{\text{S-IN}}$, $\overline{\text{S-LO}}$ (Output signal of comparator result)

These lines output the comparator result for the third parameter.

(3) $\overline{\text{AND}}$ (Output signal of comparator result)

This signal is used to comprehensively evaluate the decision results for the first and third parameters.

This signal is output only if both the first parameter comparator result and the third parameter comparator result are IN.

(4) $\overline{\text{EOM}}$ (End of measurement signal)

This signal is continuously output during measurement. When this signal is HI, the most recent comparator result is used for the evaluation. The next trigger signal can also be input.

(5) $\overline{\text{INDEX}}$ (Signal during analog measurement)

Output during analog measurement. When this signal is HI, the object under test can be changed.

NOTE $\overline{\text{INDEX}}$ signal is output at each time of retest. Therefore, when the object under test is changed, the settings of the test signal level, current and voltage limits, test range, and average are specified as followings.

Test signal level	Open-circuit voltage (V) setting
Current and voltage limits	OFF
Test range	HOLD range
Average	OFF

For the settings other than above, change the object under test referring to $\overline{\text{EOM}}$.

(6) EXT.DCV, EXT.COM

These are terminals for supplying a power supply voltage from an external device. This enables the 3532-50 unit to be connected to an external device while maintaining the isolation. The range of power voltage which can be connected is from +5 to +24 volts DC.

(7) INT.DCV, INT.GND

These lines output +5 VDC and COM from the 3532-50 unit.

(8) $\overline{\text{TRIG}}$

When the external trigger is enabled for the 3532-50, measurement is begun when this signal is input.

(9) $\overline{\text{LD1}}$ to $\overline{\text{LD5}}$

This signal is used to select panel numbers stored using the panel save function. When a panel number has been selected using this signal at the input of a trigger signal, the 3532-50 loads the measurement conditions for the panel number and then begins measurement. The table below shows the selectable panel numbers.

L: low level input, H: high level input

Panel number	$\overline{\text{LD}}$					Panel number	$\overline{\text{LD}}$					Panel number	$\overline{\text{LD}}$				
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
1	L	H	H	H	H	11	L	L	H	L	H	21	L	H	L	H	L
2	H	L	H	H	H	12	H	H	L	L	H	22	H	L	L	H	L
3	L	L	H	H	H	13	L	H	L	L	H	23	L	L	L	H	L
4	H	H	L	H	H	14	H	L	L	L	H	24	H	H	H	L	L
5	L	H	L	H	H	15	L	L	L	L	H	25	L	H	H	L	L
6	H	L	L	H	H	16	H	H	H	H	L	26	H	L	H	L	L
7	L	L	L	H	H	17	L	H	H	H	L	27	L	L	H	L	L
8	H	H	H	L	H	18	H	L	H	H	L	28	H	H	L	L	L
9	L	H	H	L	H	19	L	L	H	H	L	29	L	H	L	L	L
10	H	L	H	L	H	20	H	H	L	H	L	30	H	L	L	L	L
												Invalid	H	H	H	H	H
													L	L	L	L	L

(10) LOCK (Key lock signal)

This signal activates the key lock function. If the key lock switch of the 3532-50 has been turned on, the key lock is not deactivated even if the key lock function is turned off using this signal.

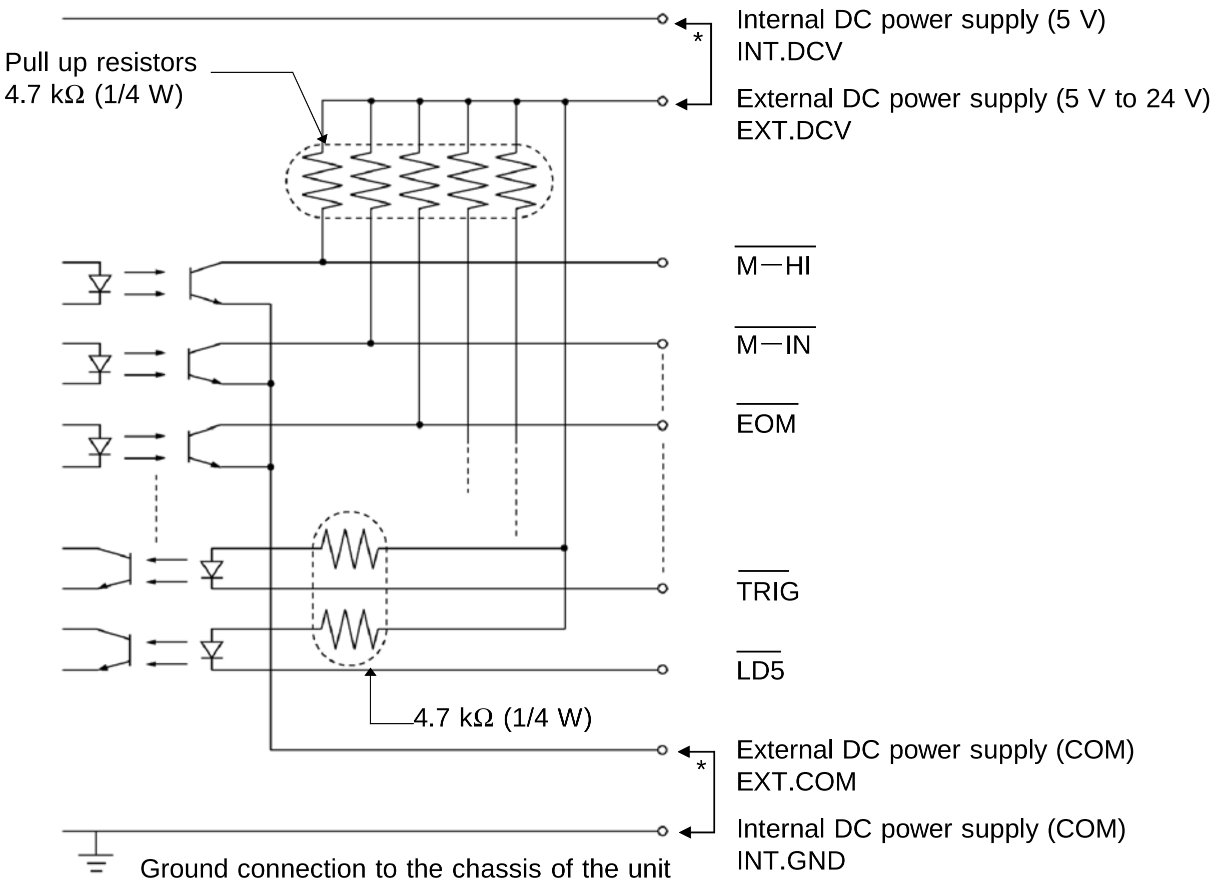
5.5.3 Circuit Construction and Connections for the EXT I/O Connector

⚠ CAUTION

- The insulation of the signal lines is for eliminating mutual influences between the signals. Any device which is connected to the 3532-50 unit should always be properly protectively grounded. If proper connection to a protective ground is not established, there is a danger of damage to the insulation.
- The voltage of the external DC power supply to be connected to the EXT DCV and EXT COM terminals should be from 5 V to 24 V. Do not supply DC voltage greater than 24 V. If you do, there is a danger of damage to the unit.
  Moreover, for driving the circuitry, connect any device which is capable of providing an output current of more than 200 mA.

The circuit construction for the EXT I/O connector is shown in the figure.

Except for the power supply lines, all of the input and output signal lines are insulated by photocouplers.



Circuit Construction

* Connect when using the internal 5V power supply.

NOTE

- The internal DC power supply of 5 VDC is provided between INT DCV and INT GND. The maximum current capacity is 100 mA. Do not connect any external circuit whose current consumption is greater than 100 mA.
- INT GND is grounded to the chassis of the 3532-50 unit.
- When using the EXT I/O connector, be sure always to supply power to the external DC power supply.
- The output signal low level output current is a maximum of 30 mA. If a current greater than this is required, you should connect a transistor circuit using a current amplifier driven by an external power source or the like externally.

5.5.4 Electrical Characteristics of the Output Signals

The output signals are the collector outputs of the photocouplers, and are connected to the external DC power supply (EXT. DCV) via 4.7 kΩ pull-up resistors provided internally to the 3532-50 unit.

The relationship between the external DC power supply voltage, the voltage of the output signals, and the current, is as shown in the following table:

External DC power supply voltage	Output signals (internal pull-up resistors 4.7 kΩ)		
	High level	Low level (Output current)	
		10 mA	30 mA
5 V	5V	0.9 V	1.1 V
12 V	12 V	0.9 V	1.1 V
24 V	24 V	0.9 V	1.1 V

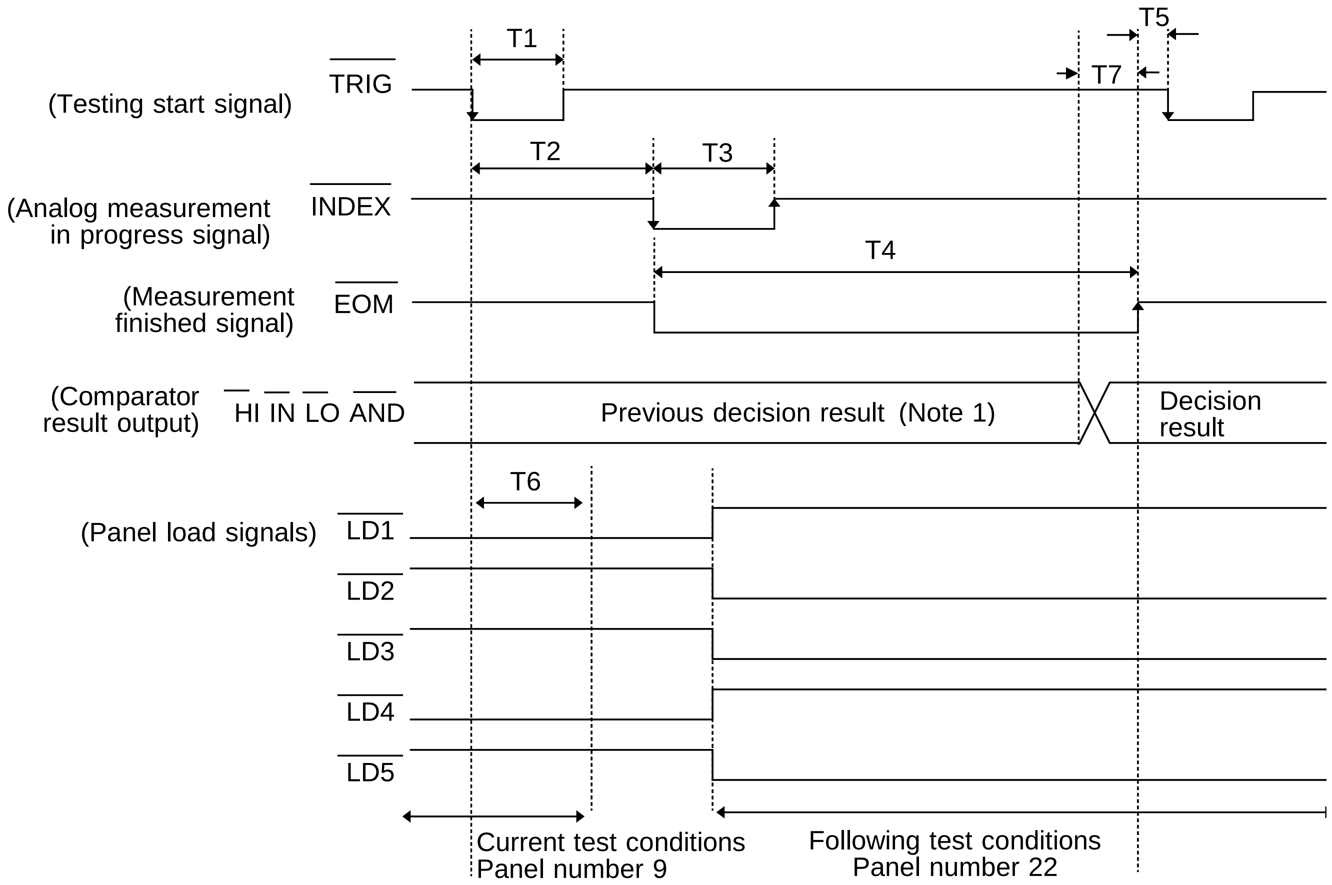
The above value is for reference only, and not a guaranteed value.
Direct connection of a circuit whose input voltage V_{IL} is regulated to a maximum of 0.8 V or the like is not possible.

In such a case, keep V_{IL} below 0.8 V by incorporating a transistor or a drive capable buffer circuit or the like.

5.6 Testing Using EXT I/O

5.6.1 Normal Testing

With the test conditions for testing by the comparator having been set (with the trigger setting set to external trigger), when in this state a trigger signal is input via the EXT I/O connector, or when on the screen the **MANU TRIG** soft key is pressed, then the decision result is output on the comparator result output signal line of the EXT I/O connector.
When a panel number has been selected using the panel load signal at the input of a trigger signal via the EXT I/O connector, the 3532-50 loads the measurement conditions for the panel number and then begins measurement.
An example of testing timing is as follows:



NOTE You can use a communication command (:IO:RESult:RESet) to select whether the judgment results for comparator measurement are reset when the start-of-measurement signal is input or updated when measurement ends.

Note1: Reset at the same time as TRIG: HIGH
Not reset at the same time as TRIG: Last judgment result remains
(Initial setting)

	Meaning	Timing (approximate)
T1	Minimum time period for trigger signal recognition	100 µs
T2	Time period from trigger to circuit response	300 µs + α (α depends on the sample under test and the trigger delay)
T3	Analog measurement time; chucking switching on INDEX (HIGH) possible (Note 1)	1 ms (Note 2)
T4	Time period for testing	5 ms (Note 2)
T5	Minimum time period from end of testing to next trigger	0 s
T6	Time period from trigger input to panel load signal recognition. After this length of time has elapsed, the LD signal can be changed.	300 µs
T7	From Comparator judgement result output to EOM (LOW): Setting value for Delay Time.	10 µs (Note 3)

Note1: The chuck can be switched using the $\overline{\text{INDEX}}$ signal only when the test signal level, current and voltage limits, test range, and average are set as specified below:
Test signal level: Open circuit voltage (V) setting
Current and voltage limits: OFF
Test range: HOLD range
Average: OFF

Note2: Reference value with the following conditions; test frequency:1 kHz, testing speed:FAST, averaging:OFF, and when measuring |*Z*|.
For the test time, refer to Section 7.3, "Time Taken for Testing."

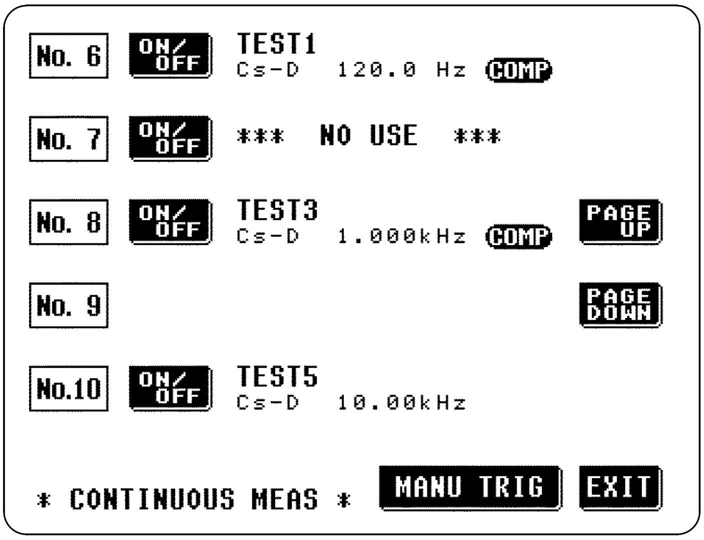
Note3: There is an approximate error of 40 µs in the display time entered for Judgement Result ↔ $\overline{\text{EOM}}$ for the setting value. When the setting value is 0.0 s, the display time is approximately 10 µs

NOTE

- When the selected panel number is not stored, the 3532-50 begins measurement without loading the measurement conditions.
- When the measurement conditions are loaded, the external trigger is always set.
- The rise time speed of signal line for comparator judgement result output (Pins 16 to 22) depends on the circuit structure connected to the EXT I/O. Because of this, the comparator judgement result level immediately after $\overline{\text{EOM}}$ output may cause measurement error. To prevent this, it is possible to set the command of delay time between comparator judgement result output and $\overline{\text{EOM}}$. In addition, when the Command setting for judgement result signal line in EXT I/O (:IO:RESult:RESet) is enabled (ON) and forcibly moved to HIGH level simultaneously with $\overline{\text{TRIG}}$, LOW → HIGH transfer will not occur when evaluation result is outputted immediately after measurement has finished. As a result, the delay time between the judgement result output and $\overline{\text{EOM}}$ can be minimized. However, take note that the evaluation result confirmation range is valid until the following triggers are accepted.
- During measurement, a trigger input from EXT /IO or communicating by interface may lead to a bigger dispersion of delay time between comparator judgement result output and $\overline{\text{EOM}}$. As far as possible, try not to control from external sources when carrying out measurement.

5.6.2 Test on the Continuous Test Screen

On the Continuous test screen, when a trigger signal is input via the EXT I/O connector, or when on the screen the **MANU TRIG** soft key is pressed, then the decision result is output on the comparator result output signal line of the EXT I/O connector after testing is completed for all the panel numbers that must be tested on the screen according to the setting.
When performing continuous testing with panel numbers 6, 8, and 10 for example.



No. 6 ON/OFF TEST1
Cs-D 120.0 Hz COMP

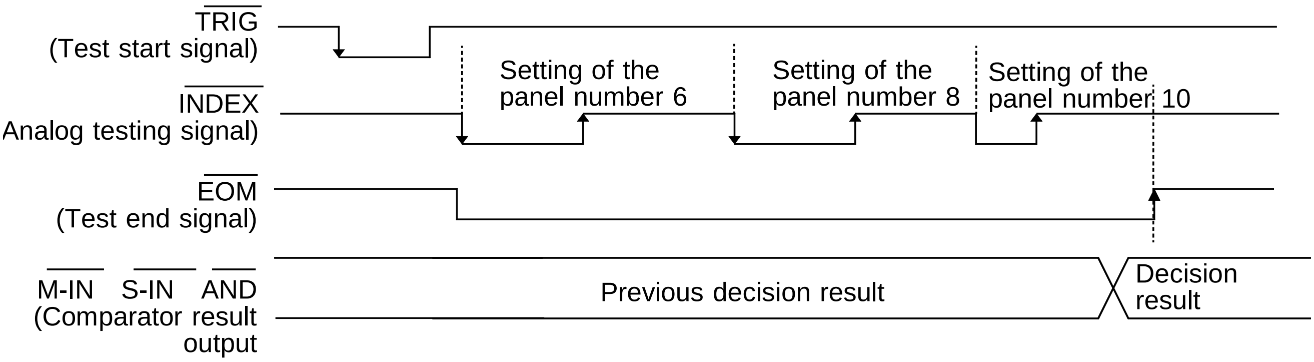
No. 7 ON/OFF *** NO USE ***

No. 8 ON/OFF TEST3
Cs-D 1.000kHz COMP PAGE UP

No. 9 PAGE DOWN

No.10 ON/OFF TEST5
Cs-D 10.00kHz

* CONTINUOUS MEAS * MANU TRIG EXIT



$\overline{\text{AND}}$ If all of the decision results are IN, then LO is output.

$\overline{\text{M-IN}}$ If all of the decision results of the first parameters are IN, then LO is output.

$\overline{\text{S-IN}}$ If all of the decision results of the third parameters are IN, then LO is output.

$\overline{\text{M-HI}}$, $\overline{\text{M-LO}}$, $\overline{\text{S-HI}}$, $\overline{\text{S-LO}}$: No output

NOTE

On the continuous testing screen, the panel load signals (LD1 to LD5) cannot be used.

For details on continuous testing, see Section 4.22, "Continuous Test Function."

5.7 Supplying DC Bias

⚠ CAUTION

The maximum voltage which can be applied to the test terminals of the 3532-50 unit is 40 V DC. If a DC voltage greater than this is applied continuously, the unit may be damaged.

Supplying DC bias means that a DC voltage is supplied as a bias to a sample for test whose characteristics are voltage dependent, such as an electrolytic capacitor or a ceramic capacitor.

Further, a DC current can be supplied as a bias to a sample for test whose characteristics are current dependent, such as a choke coil.

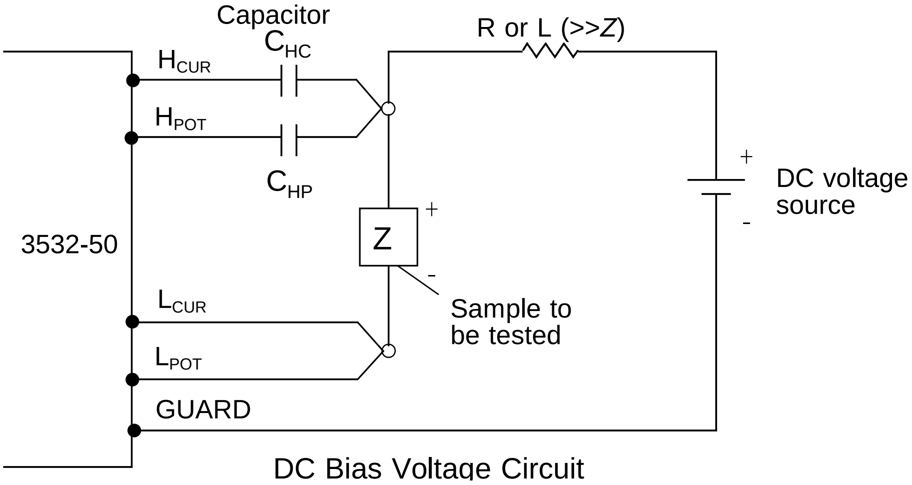
Since the 3532-50 unit has no DC bias input terminals, a DC bias must be supplied in the manner described in the following sections.

5.7.1 How to Supply a DC Bias Voltage

⚠ CAUTION

- In order to avoid electric shock accident, be absolutely sure not to touch the test terminals while the DC bias voltage is being supplied to them.
- If you disconnect the sample under test from the test terminals with the DC bias voltage still being supplied, then the test sample is left charged, which is very dangerous. In order to avoid electric shock accident, be absolutely sure to discharge the test sample.
- Do not short circuit between the clips of the test probes with the DC bias voltage still being supplied. Doing so may damage the probes or cause a short circuit accident.
- When measuring the element whose DC resistance is not high enough, DC current will flow to the main unit and the measurement will not be performed properly.

To supply a DC bias voltage to a capacitor or the like, proceed as follows.
Use the optional 9268 DC BIAS VOLTAGE UNIT (Maximum input current DC40 V).
For details on using the 9268, refer to the Instruction Manual of the 9268.
(Depending on the test frequency, test signal level, and test range, the 9268 cannot be used.)
If the 9268 is not used, refer to the following.



DC Bias Voltage Circuit

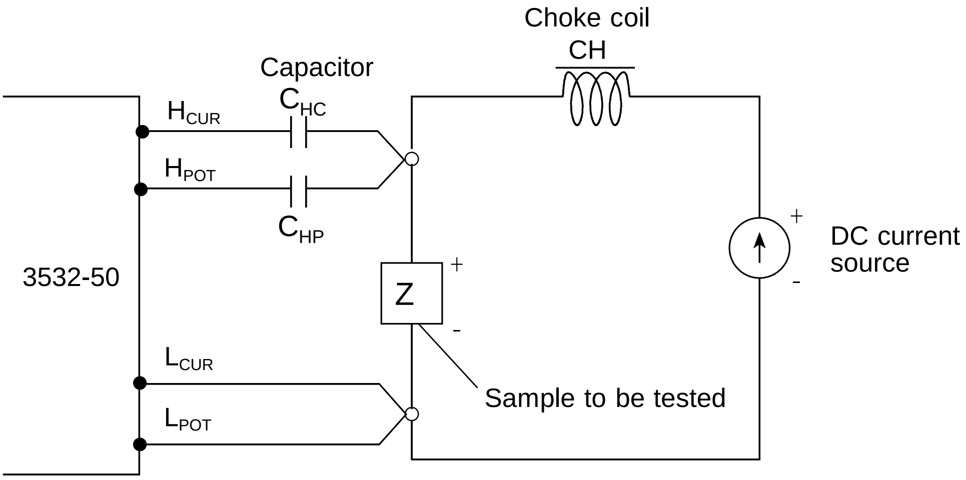
- Use a resistance (*R*) or inductance (L) which has a large enough impedance with reference to the sample under test (*Z*).
- A Hcur side capacitor must have a small enough impedance (i.e. a large enough capacitance) relative to the output resistance (50Ω) while a Hpot capacitor must have a small enough impedance to the input resistance (10kΩ).
- Be careful about the polarity when connecting together the probes, the sample to be tested, and the DC voltage source.
- It takes a little time for the DC voltage which is being supplied to the sample under test to reach the set voltage, so you should wait for a certain stabilization time period (which depends upon the sample) before performing testing. Be careful, because if you perform testing before this stabilization time period has elapsed, the results will not be reliable.
- After testing is completed, drop the voltage of the DC voltage source to zero, and remove the sample under test from the probes after having discharged any electric charge which may have built up.
- If you have removed the sample under test from the probes without first having discharged the accumulated electric charge, you should be careful to do so immediately.

5.7.2 How to Supply a DC Bias Current

⚠ CAUTION

- In order to avoid electric shock accident, be absolutely sure not to touch the test terminals while the DC bias is being supplied to them.
- Due to the inductance of the coil and the sample, counter electromotive force is generated when the sample is removed or inserted with the DC bias supplied. This may result in damage to the 3532-50 or to the DC source.
- When measuring the element whose DC resistance is high (incl. open state), a high voltage occurred on the H side may cause damage on the main unit.

To supply a DC bias, use the optional 9269 DC BIAS CURRENT UNIT (Maximum input current DC2 A).
For details on using the 9269, refer to the Instruction Manual of the 9269. (Depending on the test frequency, test signal level, and test range, the 9269 cannot be used.)
If the 9269 is not used, refer to the followings.
To supply a DC bias current to a transformer or a choke coil or the like, construct an external bias circuit as follows.



DC Bias Current Circuit

- Connect the sample to the measuring probe and then gradually raise the voltage of the DC source to the specified DC bias level. To disconnect the sample, gradually reduce the voltage of the DC source until the DC bias supplied to the sample is decreased to zero. You may disconnect the sample after this is achieved.
- Use a choke coil (CH) which has a large enough impedance with reference to the sample under test (*Z*).
- A Hcur side capacitor must have a small enough impedance (i.e. a large enough capacitance) relative to the output resistance (50Ω) while a Hpot capacitor must have a small enough impedance to the input resistance (10kΩ).
- Be careful about the polarity when connecting together the probes, the sample to be tested, and the DC current source.
- Be careful not to magnetically saturate the choke coil (CH) with the DC bias current.
- It takes a little time for the DC current which is being supplied to the sample under test to reach the set value, so you should wait for a certain stabilization time period (which depends upon the sample) before performing testing. Be careful, because if you perform testing before this stabilization time period has elapsed, the results will not be reliable.

5.8 The Residual Charge Protection Function

⚠ CAUTION

- The quoted maximum voltage from which the unit can be protected by this function is for reference purposes only, and is not a guaranteed value. There may be danger of damage to the 3532-50 unit, depending upon the operational circumstances and upon how often such charged capacitors are connected. In general, you should not rely upon this protection function; be sure to discharge charged capacitors properly before connecting them to the test terminals.
- The residual charge protection function is for protection of the 3532-50 unit against the discharge of voltage present in charged capacitors, and is not capable of protecting the unit against DC voltage which is constantly applied such as a superimposed DC voltage. (The maximum voltage for supply to the test terminals of the 3532-50 unit is 40 VDC.) If this is done, there is a danger of damage to the unit. (For how to supply a DC bias voltage, refer to Section 5.7, "Supplying DC Bias".)

The 3532-50 has been enhanced by the incorporation of a residual charge protection function. If by mistake a charged capacitor is connected to the test terminals, this function protects the internal circuitry of the unit from discharge of such residual charge.
The maximum voltage from which the unit can be protected by this function is determined from the capacitance value of the sample under test by the following equation:

$$V = \sqrt{\frac{1}{C}}$$

V: voltage (volts) (maximum 400 VDC)
C: capacitance (farads)

5.9 9442 Printer (option)

Using with the optional 9593-01 RS-232C INTERFACE, 9442 PRINTER, and 9446 CONNECTION CABLE, the test values and screen display copy can be printed out.

5.9.1 Preparation

(1) Using of the printer

Use the 9442 PRINTER, the 9443-01 AC ADAPTER, and the 1196 RECORDING PAPER.
To connect the main unit and printer, use the 9593-01 RS-232C INTERFACE and the 9446 CONNECTION CABLE. (All are options)
9442
9443-01 (for Japan)
9443-02 (for EU)

(2) Setting of the 9442 PRINTER communication condition

Change the settings of the software dip switches (DIP SW) to use the 9442 for the 3532-50.

⚠ CAUTION

- The 9442 is shipped with the function settings for use with the HIOKI 3166 CLAMP ON POWER HiTESTER. Before using, always change the settings of the DIP switches.
- For details on the operations and handling of the printer, refer to the operation manual supplied to the printer.
- For the printer, use the 1196 RECORDING PAPER (thermal paper, 10 rolls) or an equivalent.

1. Turn off the power.
2. Turn on the power while pressing the ON LINE button. Release the button after a list of the current settings starts printing out.
3. The print out of the current settings is followed by the prompt:
   "Continue? :Push 'On-line SW'", "Write?:Push 'Paper feed SW'".
   Press the ON LINE button to change the settings.

4. "Dip SW-1" is printed to make a settings for switch number 1 to 8 of DIP SW 1. Refer to the next table.

Software DIP SW1

▨ Use these settings for the 3532-50

Switch No.	Function	ON (ON LINE)	OFF (FEED)
1	Input method	Parallel	▨ Serial
2	Printing speed	▨ High	Low
3	Auto loading	▨ Enable	Off
4	CR function	Carriage return and line feed	▨ Carriage return
5	DIP SW setting command	▨ Enable	Disable
6	Printing density (set to 100%)		▨ OFF
7		▨ ON	
8		▨ ON	

To set to ON, press the ON LINE button once and to set to OFF, press the FEED button once.
The setting is printed out after the ON LINE or FEED button is pressed to allow to confirm the new setting. To change the settings, repeat from step 1.
When the setting for switch number 8 is made, the printer once again prompts with "Continue? :Push 'On-line SW'", "Write?:Push 'Paper feed SW'".

5. Set the switch number 1 to 8 of DIP SW 2 and 3 in the same way from step 3 referring to the following tables.

Software DIP SW2

Switch No.	Function	ON (ON LINE)	OFF (FEED)
1	Print mode	▨ Normal printing (40 columns)	Condensed printing (80 columns)
2	User-defined characters back-up	▨ Enable	Disable
3	Character type	▨ Ordinary characters	Special characters
4	Zero font	▨ 0	0
5	International character set	▨ ON	
6		▨ ON	
7		▨ ON	
8		▨ ON	

Software DIP SW3

Switch No.	Function	ON	OFF
1	Data bit length	▨ Eight bits	Seven bits
2	Parity permission	▨ Without	With
3	Parity condition	▨ Odd	Even
4	Flow control	▨ H/W BUSY	XON/XOFF
5	Baud rate (19200bps)		▨ OFF
6		▨ ON	
7		▨ ON	
8			▨ OFF

6. After setting for the switch number 8 of DIP SW 3 is made, press the ON LINE or FEED switch to complete settings.
   "Dip SW setting complete!!" is printed out.

(3) Setting of the 9593-01 RS-232C INTERFACE

Set the communication setting switch on the left of the RS-232C connector to ON.

5.9.2 Connection Method

⚠ WARNING

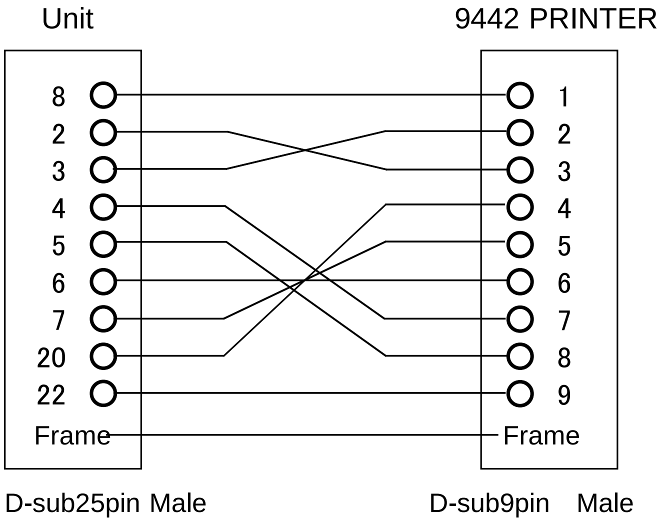
To avoid electrocution, turn off the power to all devices before plugging or unplugging any cables or peripherals.

Set the 9442 PRINTER and the 9593-01 RS-232C INTERFACE referring to Section 5.9.1.

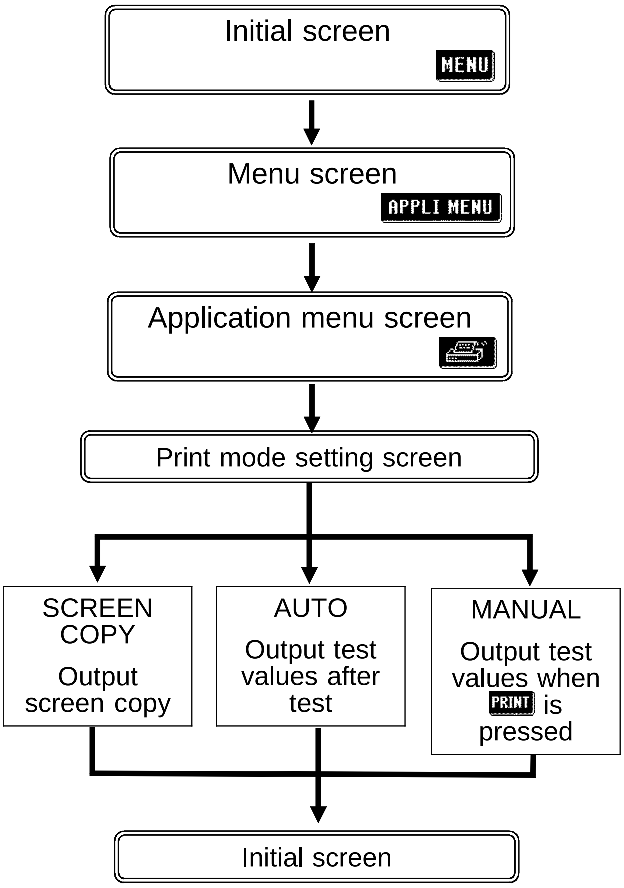
1. Turn off the power of the main unit and printer.

2. Install the 9593-01 RS-232C INTERFACE to the main unit.
(For details on installing, see the 9593-01 Instruction Manual.)

3. Connect the 9446 CONNECTION CABLE between the main unit and the printer.



5.9.3 Control Screen Sequence



Press the MENU key.

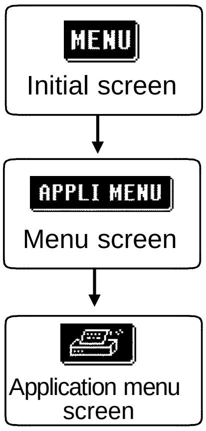
Press the APPLI MENU key.

Press the 🖨 key.

Select the print type.

When the setting has been established as above, press the EXIT key to return to the Initial screen.

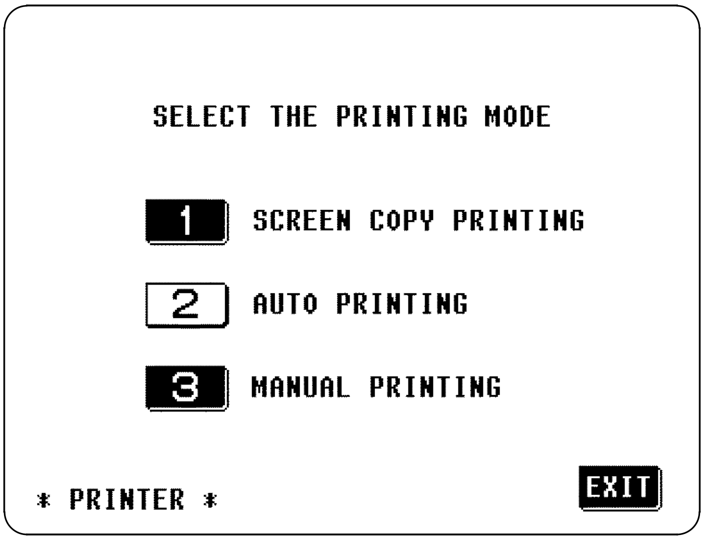
5.9.4 Returning from Comparator Operation to Normal Testing



1. Press the MENU key on the Initial screen to display the Menu screen.

2. Press the APPLI MENU key on the Menu screen to display the Application menu screen.

3. Press the 🖨 key on the Application menu screen to display the Print mode setting screen.



Print mode setting screen

4. Select the one of the following print mode. The key selected changes to non-reversed video. For details on print mode, see Section 5.9.5 to 5.9.7.

1: Screen copy printing	Prints out the Initial screen copy.
2: Auto printing	Prints out the test values after test.
3: Manual printing	Prints out the test values only when the PRINT key key on the Initial screen is pressed.

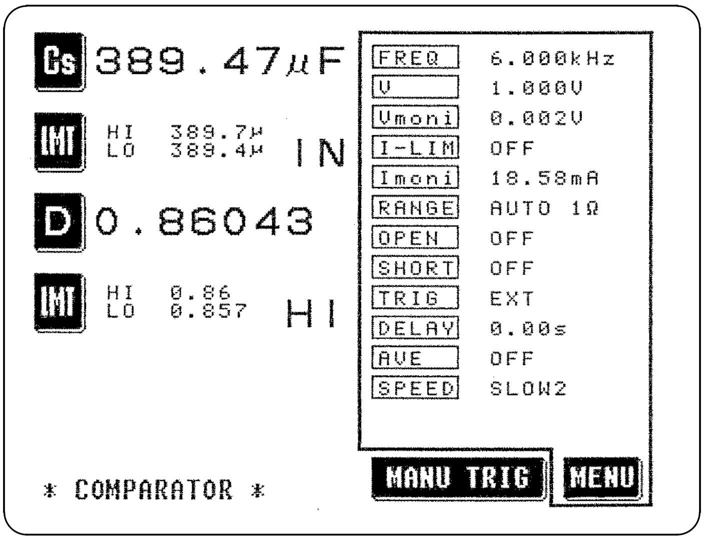
5. When the setting is completed, press the EXIT key to return the Initial screen.

5.9.5 Screen Copy Mode

Prints out the screen copy of the Initial screen.

- Pressing the PRINT key on the Initial screen starts printing.
- During printing, the PRINT key is not displayed, and all keys are invalid.
- When the printer is not operated for 10 seconds or more after pressing the key, such as case of disconnecting the printer, it stops printing after beep sounds.

Example of printing



Cs 389.47µF

LMT HI 389.7µ LO 389.4µ IN

D 0.86043

LMT HI 0.86 LO 0.857 HI

FREQ	6.000kHz
V	1.000V
Vmoni	0.002V
I-LIM	OFF
Imoni	18.58mA
RANGE	AUTO 1Ω
OPEN	OFF
SHORT	OFF
TRIG	EXT
DELAY	0.00s
AVE	OFF
SPEED	SLOW2

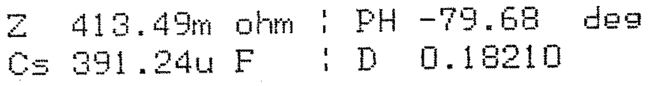
* COMPARATOR *

5.9.6 Auto Print Mode

The test values are printed out when the test is completed.
When the continuous test is performed, the test values are printed out when each test for the panel number is completed.

Example of printing

Normal test

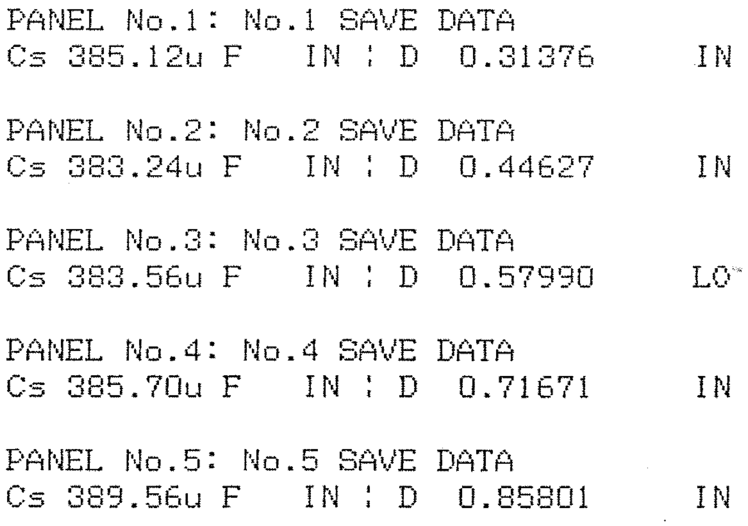


```
Z  413.49m ohm ; PH -79.68  deg
Cs 391.24u F   ; D  0.18210
```

Comparator executing

```
Cs 391.34u F   HI ; D  0.18174     HI
```

Continuous test



```
PANEL No.1: No.1 SAVE DATA
Cs 385.12u F   IN ; D  0.31376     IN

PANEL No.2: No.2 SAVE DATA
Cs 383.24u F   IN ; D  0.44627     IN

PANEL No.3: No.3 SAVE DATA
Cs 383.56u F   IN ; D  0.57990     LO

PANEL No.4: No.4 SAVE DATA
Cs 385.70u F   IN ; D  0.71671     IN

PANEL No.5: No.5 SAVE DATA
Cs 389.56u F   IN ; D  0.85801     IN
```

5.9.7 Manual Print Mode

Regardless of the trigger settings, the test values are printed out when the PRINT key on the Initial screen is pressed.

- When the test value is not stabilized because of changing the range by auto-ranging, "OVER FLOW" may be printed out.
  Press the PRINT key after the test value is stabilized.
- The examples of the output results are same as a and b of the auto print mode.

Chapter 6
Maintenance, Adjustment, and Disposal

6.1 Maintenance and Servicing

In order to use the 3532-50 safely, the following maintenance and checking procedures should be executed at the proper intervals.

- Be sure to read assiduously the various items highlighted in this manual for attention, in order to use the unit correctly.
- If damage is suspected, check the "Troubleshooting" section before contacting your dealer or Hioki representative.
- Getting the 3532-50 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. If the unit has gotten seriously wet, oily, or dusty, stop using it and send it for service at an approved HIOKI service facility.
- Periodic calibration is necessary in order to maintain and authenticate the accuracy of this testing device. When such calibration is necessary, you should utilize the services of an approved HIOKI calibration facility.
- A lithium battery is used in the 3532-50 for powering the backup memory. When this battery becomes unfit for service, it is no longer possible to preserve the testing conditions. Therefore, when it is not possible to preserve the testing conditions, you should dispatch the unit to an approved HIOKI service facility for the lithium battery to be changed.

NOTE HIOKI intend to maintain the supply of spare parts for maintenance and service of the 3532-50 unit for a minimum of seven years after the cessation of production.

Cleaning the unit

- To clean the product, 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.

6.2 How to Change the Power Supply Fuse and Change the Power Supply Voltage

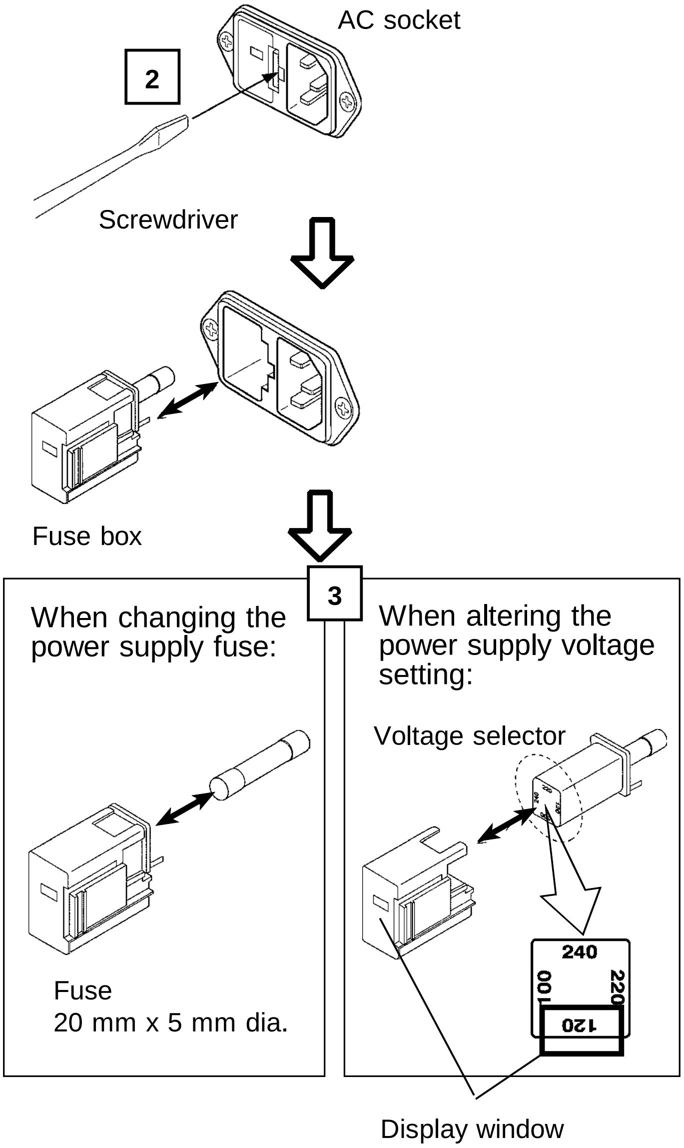
The power supply fuse for the 3532-50 unit, and the power supply voltage selector, are housed in the power input socket on the rear panel.

⚠ WARNING

- **When changing the power supply fuse or changing the power supply voltage, in order to avoid the risk of electric shock accident, be quite sure first to turn the main switch of the 3532-50 unit off, and then to remove the power cord.**
  Moreover, after finishing any operation, before reconnecting the power cord to the unit, be sure to check that the power supply voltage value indicated on the voltage selector housed in the power input socket on the rear panel is in agreement with the actual voltage value of the power supply line to which you intend to connect the unit.
  (The voltage indication is upside down.)
- **Replace the fuse only with one of the specified characteristics and voltage and current ratings. Using a non-specified fuse or shorting the fuse holder may cause a life-threatening hazard.**
  Fuse type:
  100 V, 120 V settings: 250 V T1.0 AL 20 mm × 5 mm dia.
  220 V, 240 V settings: 250 V T0.5 AL 20 mm × 5 mm dia.
- **Before the 3532-50 is dispatched from the factory, it is set to the power supply voltage used at the destination specified for shipping, and the specified fuse for that power supply voltage is fitted, along with an identical spare fuse. If for any reason you intend to power the unit from a power supply whose voltage is different, be sure to change the fuse as well as altering the voltage selector setting.**
- **If you intend to use a power supply of a voltage other than the specified ones for powering the unit, use a fuse and voltage selector setting as follows:**

  Actual power supply voltage 110 V : use settings for 120 V
  Actual power supply voltage 200 V : use settings for 220 V
  Actual power supply voltage 230 V : use settings for 240 V

Changing the power supply fuse and the power supply voltage:



1. Turn the power switch off, and then remove the power cord.

2. Using a slot head screwdriver or the like, bias sideways the catch which holds the fuse box into the power input socket as shown in the figure, and then remove the fuse box.

3. When changing the power supply fuse:
Change the power supply fuse for a new one of the same rating and specification.

When altering the power supply voltage setting:

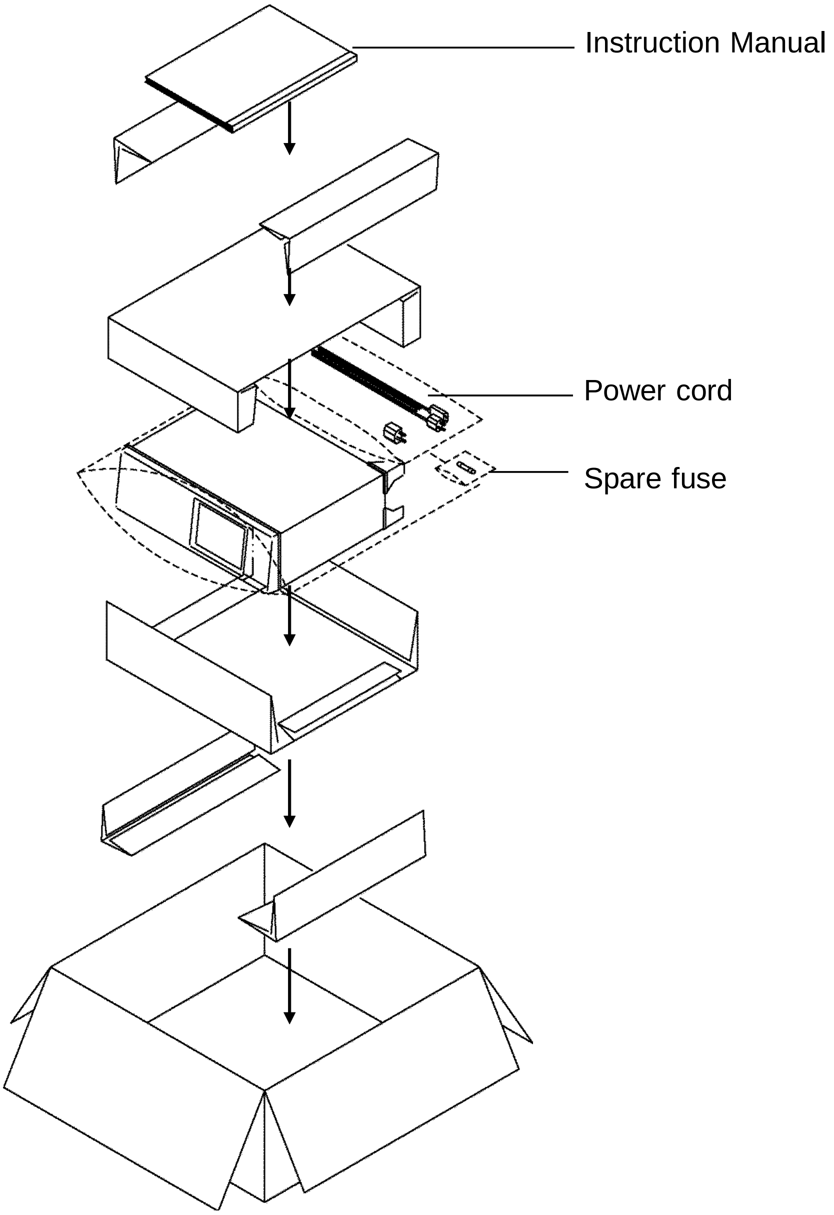
1) Remove the voltage selector from the fuse box, and reinsert it after having rotated it so that the desired new power supply voltage setting appears in the display window as shown in the figure.
Then recheck the setting value shown in the window. (The voltage display is upside down and backwards.).

2) Change the power supply fuse for a new one whose rating and specification are appropriate for the new power supply setting.

4. Replace the fuse box by reinserting it into the power input socket.

6.3 Shipping the Unit

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



6.4 Troubleshooting

If the 3532-50 unit appears to be faulty, check the following possibilities before sending the unit for service:

Symptom	Cause	Treatment
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.
	Has the fuse blown?	Change the fuse.
Key input is not effective.	Is the unit in the key locked state?	Release the key lock state.
	If both GP-IB and RS-232C are in use, has remote been externally set?	Set both GP-IB and RS-232C to local.

If none of these is applicable, or if you have no idea of the problem, try resetting the system.
All of the settings will revert to the factory original settings. You must reset them again.
For the method of system reset, see Section 4.21 "System Reset."

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

- The unit is clearly damaged.
- Even when you try, testing 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.

6.5 Disposing of the Unit

A lithium battery is used in the 3532-50 as a power source for recording test conditions.

⚠ WARNING

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

⚠ CAUTION

If the protective functions of the instrument are damaged, either remove it from service or mark it clearly so that others do not use it inadvertently.

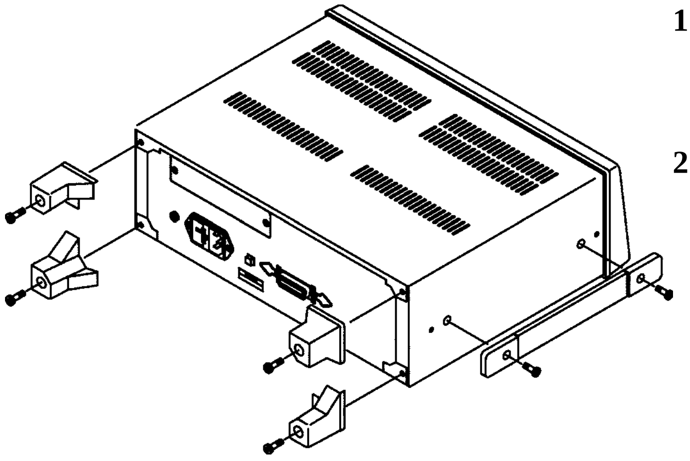
Tools required for dismantling

• Phillips screwdriver	1
• Pair of tweezers	1

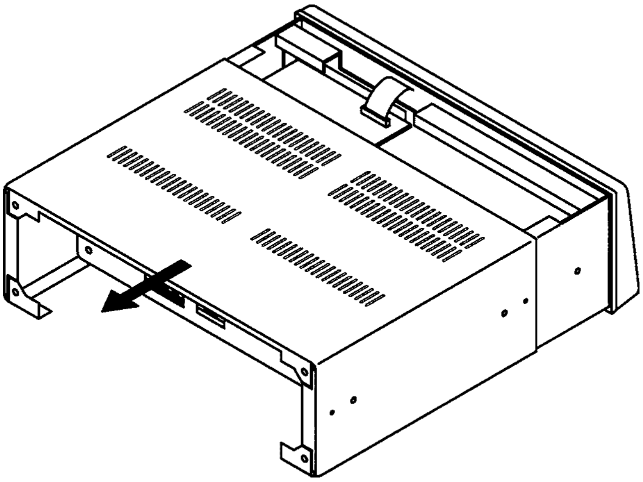
How to dismantle the unit

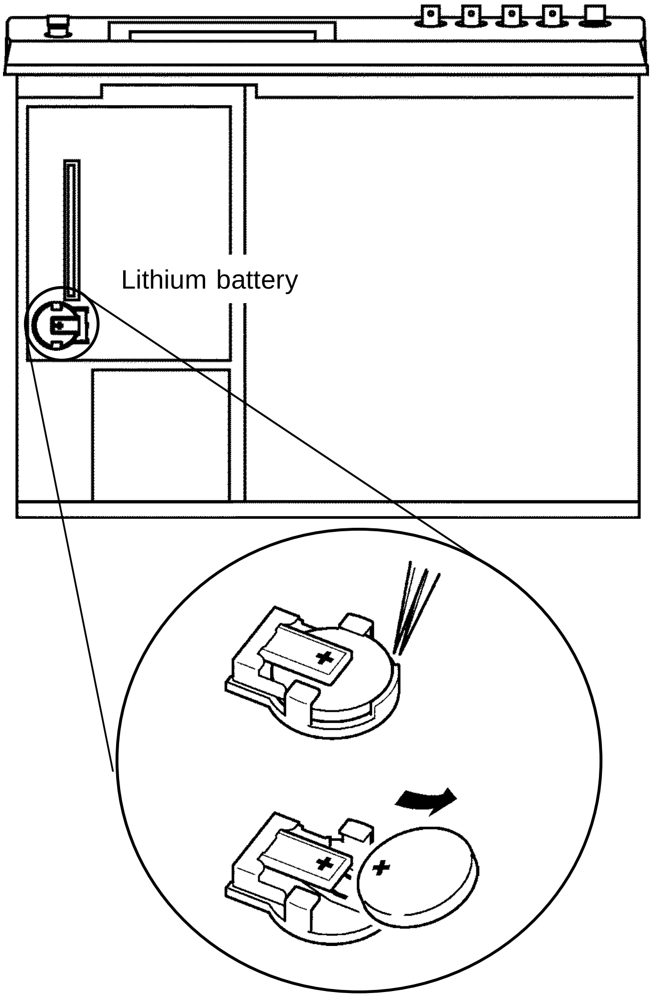
1. Turn off the power switch, and disconnect the power cord and other cables.

2. Remove the four screws at the back of the unit and the two screws which hold on the carrying handle, as shown.



3. Pull off the case in the direction shown by the arrows in the figure.





4. The battery holder is located in the position illustrated on the left. 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.

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

Chapter 7
Specification and Options

7.1 General Specification

1. Test parameters

|*Z*|	Impedance
|*Y*|	Admittance
θ	Phase angle
Cs	Series-equivalent static capacitance
Cp	Parallel-equivalent static capacitance
D	Loss coefficient = tan δ (δ = delta)
Ls	Series-equivalent inductance
Lp	Parallel-equivalent inductance
Q	Q factor (Q = 1/D)
*R*s	Series-equivalent resistance = ESR
*R*p	Parallel-equivalent resistance
G	Conductance
X	Reactance
B	Susceptance

2. Test frequencies 42 Hz to 5.000 MHz

Setting resolution

Frequency (Hz)	Step (Hz)
42.0 to 999.9	0.1
1.000 k to 9.999 k	1
10.00 k to 99.99	10
100.0 k to 999.9	100
1.000 M to 5.000 M	1 k

Test frequency accuracy ±0.005% or less

3. Output impedance 50 Ω±10 Ω

4. Test signal levels

Open circuit voltage (V) mode and Constant voltage (CV) mode	Range	10 mV to 5 V, 100 mA max. (1.000 MHz or less) 10 mV to 1 V, 20 mA max. (1.001 MHz or more)
	Resolution	1 mV steps
	Accuracy	±10%±10 mV (1.000 MHz or less) ±20%±10 mV (1.001 MHz or more)
Constant current (CC) mode	Range	10 μA to 100 mA, 5 V max. (1.000 MHz or less) 10 μA to 20 mA, 1 V max. (1.001 MHz or more)
	Resolution	10 μA steps
	Accuracy	±10%±10 μA (1.000 MHz or less) ±20%±10 μA (1.001 MHz or more)
Monitor function		
Voltage monitor (Vmoni)	Range	0.000 V to 5.000 V
	Accuracy	±10%±10 mV (1.000 MHz or less) ±20%±10 mV (1.001 MHz or more)
Current monitor (Imoni)	Range	0.000 mA to 100.0 mA
	Accuracy	±10%±10 μA (1.000 MHz or less) ±20%±10 μA (1.001 MHz or more)
Limit function		
Current limit (I-LIM) (V, CV mode)	Range	0.01 mA to 99.99 mA
	Accuracy	±10%±10 μA (1.000 MHz or less) ±20%±10 μA (1.001 MHz or more)
Voltage limit (V-LIM) (CC mode)	Range	0.010 V to 5.000 V
	Accuracy	±10%±10 mV (1.000 MHz or less) ±20%±10 mV (1.001 MHz or more)

5. Residual charge protection	400 V max (for reference only) Where: $V = \sqrt{\frac{1}{C}}$ {C: capacitance of the sample under test in farads}
6. Test ranges (RANGE)	The test range is determined according to impedance and phase angle. The values of the other test parameters are calculated from |*Z*|.
Ranges	100 mΩ, 1 Ω, 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, and 100 MΩ (10 ranges, can be set either automatically or manually)
|*Z*| display range	10.00 mΩ to 200.00 MΩ (5 digits)
θ display range	+180.00° to -180.00° (5 digits)

7. Display ranges

The measurement range varies according to the test frequency.
( ): impedance

Y, G, B	99.999 S (100 mΩ) to 5.0000 nS (200 MΩ)	5 digits
R, X	10.00 mΩ to 200.00 MΩ	5 digits
L	38.000 μH(100mΩ) to 750.00 kH(200MΩ) (at 42 Hz, θ =90°) 32.000 nH(10Ω) to 3.2000 mH(100kΩ) (at 5 MHz, θ =90°)	5 digits 5 digits
C	19.000 pF(200MΩ) to 370.00 mF(100mΩ) (at 42 Hz, θ = 90°) 0.3200 pF(100kΩ) to 32.000 nF(10Ω) (at 5 MHz, θ =90°)	5 digits 5 digits
D	0.00001 to 9.99999	6 digits
Q	0.01 to 999.99	5 digits

NOTE: The test range of L and C varies depending on the test frequency and value of θ.

8. Display

78.4 mm x 107.2 mm LCD display with backlight

9. Testing speed

Processing method: taken as the average of the waveform detected by the measurement circuit.

When measuring open-circuit terminal voltage (V) (minimum times with test frequency 1 kHz, Z display, initial screen)

The values depend on the measurement frequency, display parameter types, open-circuit and short-circuit compensation, and whether or not the comparator is being used.

FAST	5 ms ±2 ms
NORMAL	21 ms ±2 ms
SLOW	72 ms ±2 ms
SLOW2	140 ms ±2 ms

Constant voltage (CV) and constant current (CC) settings

Constant voltage/constant current measurement after connecting a measurement sample

Maximum of 5 times measurement speed setting

10. Averaging function

Setting of the number of averaging

OFF, 2, 4, 8, 16, 32, or 64

Processing

Internal trigger	moving average of setting times
External trigger	moving average of setting times

11. Trigger function

Manual setting of the Internal trigger (INT) or external trigger (EXT)
Trigger delay function (DELAY): 0.01 s to 9.99 s, setting resolution 0.01 s

12. Zero compensation

Open circuit compensation (OPEN)

Correction of residual admittance between the measurement terminals of the fixture
Operation is possible when, with the terminals open-circuit, the impedance is at least 1 kΩ.

Short circuit compensation (SHORT)

Correction of residual impedance between the measurement terminals of the fixture
Operation is possible when, with the terminals short-circuit, the impedance is less than 1 kΩ.

Spot compensation (SPOT)/Continuous correction (ALL)

For both open-circuit and short-circuit correction, a selection can be made for correction either at the set frequency only, or correction to be made over the entire frequency range.

13. Cable length setting function

Can be set to 0 m or 1 m

14. Comparator function (COMP)	
Comparator function setting and using	For the touch panel, GP-IB, and/or RS-232C, comparator settings can be made and execution carried out for two parameters.
Upper and lower limit value settings (LIM)	For ABS (absolute values) setting Upper and lower limit values (HI, LO) are set. For % (percentages) setting Set a reference value (REF) and upper- and lower-limit values (HI, LO). For Δ% (deviation percentages) setting Set a reference value (REF) and upper- and lower-limit values (HI, LO). The measurement values are displayed as deviations from the reference value (Δ%).
Comparator result output (HI, IN, LO)	EXT I/O connector (HI, IN, LO, AND output of two parameters, INDEX, EOM signal outputs, TRIG, LOCK, LOAD signal inputs, internal 5 V, GND output, external power supply, GND input)
15. Scaling function	Test value compensation is possible by setting the compensation coefficients a and b to the following equation. [test value after compensation] = a×[test value] + b When the parameter is D or Q, calculate from compensation value for θ.
16. Magnification display function	The test values and comparator decision results can be displayed in enlarged form
17. Continuous test function	Continuous testing of the conditions which have been saved
18. Display digits	The values 3, 4, and 5 can be set as the number of displayed digits. The actual number of displayed digits, however, depends on the parameter used.

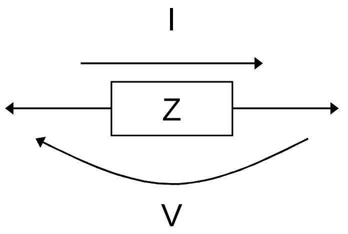
Parameter Setting value	θ, Q Comparator Δ% setting	D	Others
5	Up to the second decimal place	Up to the fifth decimal place	Up to 5 digits
4	Up to the first decimal place	Up to the fourth decimal place	Up to 4 digits
3	No decimal place	Up to the third decimal place	Up to 3 digits

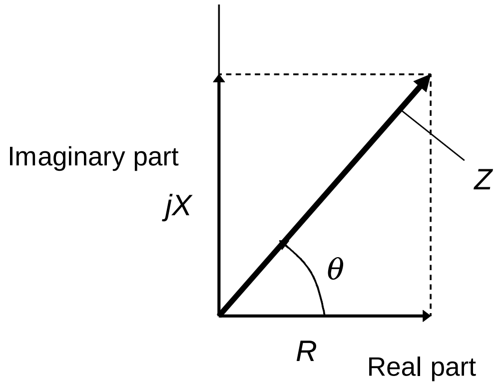
19. Display-setting function	A setting can be made to turn on/off the indications of the LCD display and voltage/current monitors.
20. System reset	All of the settings will revert to the factory settings.
21. Key lock function (KEY LOCK)	This disables the operation of keys on the panel, by means of either the special-purpose switch or EXT I/O connector on the rear panel.
22. Panel save (SAVE) and load (LOAD) function	A maximum of 30 sets of complete measurement conditions can be saved and recalled.
23. Beep sound setting (BEEP)	There are settings corresponding to key input and to the comparator results.
24. Interfaces	Touch panel settings 9518-01 GP-IB INTERFACE or 9593-01 RS-232C INTERFACE options can be selected (separate package) EXT I/O connector (standard)
25. Temperature range for use	0 to 40℃ (32 to 104℉), up to 80% relative humidity, no condensation.
26. Temperature range for storage	-10 to 55℃ (14 to 131℉), up to 80%RH, no condensation.

27. Operating environment	Indoors, altitude up to 2000 m (6562 feet), Pollution Degree 2
28. Power supply	Rated supply voltage 100/120/220/240 V AC (switchable)(Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) Rated supply frequency 50/60 Hz Maximum rated power 50 VA (with options installed)
29. Guaranteed accuracy period	6 months
30. Dimensions and mass	Approx. 348W mm x 113H mm x 273D mm (13.70"W x 4.45"H x 10.75"D), Approx. 5.7 kg (201.1 oz.)
31. Accessories supplied	Instruction Manual 1 Power cord 1 (selected according to shipping destination) Spare fuse for power supply 1 (selected according to shipping destination) (100/120 V: 250 V T1.0 AL, 200/240 V: 250 V T0.5 AL)
32. Component replacement	Power supply fuse (refer to above)
33. Options	9140 4-TERMINAL PROBE 9143 PINCHER PROBE 9261 TEST FIXTURE 9262 TEST FIXTURE (direct connection type) 9263 SMD TEST FIXTURE (direct connection type) 9268 DC BIAS VOLTAGE UNIT 9269 DC BIAS CURRENT UNIT 9165 CONNECTION CORD (for 9268, 9269/ BNC-BNC/ 1.5 m) 9166 CONNECTION CORD (for 9268, 9269/ BNC-clip/ 1.5 m) 9518-01 GP-IB INTERFACE 9151-02 GP-IB CONNECTOR CABLE (2 m) 9151-04 GP-IB CONNECTOR CABLE (4 m) 9593-01 RS-232C INTERFACE 9442 PRINTER(DPU-414 Seiko Instruments Inc.) 9443-01 AC ADAPTER (for printer, for Japan) 9443-02 AC ADAPTER (for printer, for EU) 9446 CONNECTION CABLE (for printer) 1196 RECORDING PAPER (for printer) Note: Only one of the 9518-01 GP-IB INTERFACE and the 9593-01 RS-232C INTERFACE can be installed. To use the 9442 printer, 9593-01 is necessary.
34. Applicable Standards	EMC EN61326 EN61000-3-2 EN61000-3-3 Safety EN61010
35. Withstand voltage	1.62 kV AC for 60s, between power and ground

7.2 Testing Parameters and Calculation Equations

Normal circuit elements etc. are assessed with regard to their characteristics in terms of their impedance Z. The 3532-50 for subjects such circuit components to an alternating current signal at a certain test frequency, measures their voltage and current vectors, and from these values obtains the impedance Z and the phase angle θ. It is then possible to obtain the following quantities from the impedance Z by displaying it upon the complex plane.



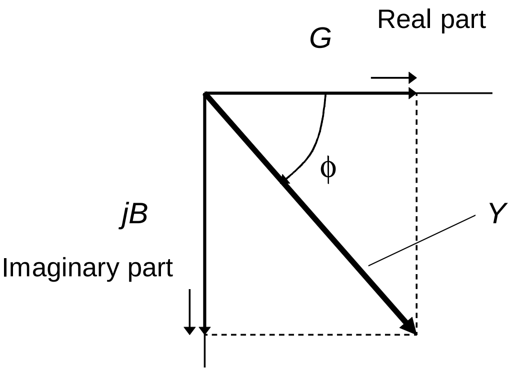


$$Z = R + \mathrm{j}X$$
$$\theta = \tan^{-1} \ (X/R)$$
$$|Z| = \sqrt{R^2 + X^2}$$

Z : impedance (Ω)
θ: phase angle (degrees)
R : resistance (Ω)
X : reactance (Ω)
$|Z|$: absolute value of impedance (Ω)

Moreover, it is possible to use the admittance Y, which as a characteristic of a circuit component is the reciprocal of the impedance Z.

By displaying the admittance Y upon the complex plane (just as was done for the impedance Z) the following quantities can be obtained:



$$Y = G + \mathrm{j}B$$
$$\phi = \tan^{-1} \ (B/G)$$

Y : admittance (S)
G : conductance (S)
B : susceptance (S)
$|Y|$: absolute value of admittance (S)

From the voltage V which is applied between the terminals of the sample under test, the current I which flows through the test sample at this time, the phase angle θ between this voltage V and this current I, and the angular velocity ω which corresponds to the test frequency, the 3532-50 can calculate the following components by using the calculation equations shown:

NOTE

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

Quantit	Series equivalent circuit mode	Parallel equivalent circuit mode
Z	$\lvert Z\rvert = \frac{V}{I}\left(= \sqrt{R^2 + X^2}\right)$	
Y	$\lvert Y\rvert = \frac{1}{\lvert Z\rvert}\left(= \sqrt{G^2 + B^2}\right)$	
R	$Rs = ESR = \lvert\lvert Z\rvert \cos\theta\rvert$	$Rp = \left\lvert \frac{1}{\lvert Y\rvert\cos\phi} \right\rvert \left(= \frac{1}{G}\right)*$
X	$X = \lvert\lvert Z\rvert \sin\theta\rvert$	______________
G	______________	$G = \lvert\lvert Y\rvert\cos\phi\rvert$ *
B	______________	$B = \lvert\lvert Y\rvert\sin\phi\rvert$ *
L	$L_s = \frac{X}{\omega}$	$L_p = \frac{1}{\omega B}$
C	$C_s = \frac{1}{\omega X}$	$C_p = \frac{B}{\omega}$
D	$D = \left\lvert\frac{1}{\tan\theta}\right\rvert$	
Q	$Q = \lvert\tan\theta\rvert\left(= \frac{1}{D}\right)$	

* ϕ: phase angle of admittance Y ($\phi = -\theta$)

Ls, *R*s, Cs : The measured values of L, C, and *R* in series equivalent circuit mode.

Lp, *R*p, Cp : The measured values of L, C, and *R* in parallel equivalent circuit mode.

7.3 Time Taken for Testing

The time taken for testing varies according to the test conditions.
The following values may be used for reference.

NOTE These values are all for reference only. Do not rely upon them absolutely, because the actual time taken for testing depends upon many operational conditions.

Analog testing signal (INDEX)

The output time (T3) of the analog testing signal (INDEX) taken according to the testing speed:

Tf(s) = 1/ test frequency

Test frequency [Hz]	Calculation time (Allowance ±2 ms)			
	FAST	NORM	SLOW	SLOW2
42.0 to 99.9	Tf	Tf x 4	Tf x 8	Tf x 16
100.0 to 300.0	Tf	Tf x 16	Tf x 32	Tf x 64
300.1 to 1.000 k	Tf	Tf x 16	Tf x 64	Tf x 128
1.001 k to 3.000 k	Tf	Tf x 32	Tf x 128	Tf x 256
3.001 k to 30.00 k	10 ms	160 ms	320 ms	640 ms
30.01 k to 5.000 M	1 ms	16 ms	64 ms	128 ms

Testing finished signal (EOM)

For the output time (T4) of the testing finished signal (EOM), the following time periods A through E should be added to the output time of the analog testing signal <T3>:

T4 = T3+A+B+C+D+E

The time taken for calculation varies according to A to E.

<A>

The time taken for calculation varies according to the display parameters:

Test frequency [Hz]	Calculation time (Allowance ±2 ms)			
	FAST	NORM	SLOW	SLOW2
42.0 to 99.9	8 ms	10 ms	12 ms	16 ms
100.0 to 300.0	5 ms	7 ms	9 ms	14 ms
300.1 to 1.000 k	4 ms	5 ms	8 ms	12 ms
1.001 k to 3.000 k	4 ms	5 ms	7 ms	10 ms
3.001 k to 30.00 k	5 ms	7 ms	9 ms	14 ms
30.01 k to 5.000 M	5 ms	6 ms	8 ms	12 ms

<B>

The time taken for test varies according to the display state (display ON/OFF):

Display setting	Test time
LCD display and backlight :OFF	-2.3 ms
Voltage and current monitors:OFF	-1.4 ms
LCD display and backlight :ON Voltage and current monitors:ON	0 ms

(Allowance ±1 ms)

<C>

The time taken for calculation varies according as to whether or not both open circuit compensation and also short circuit compensation are performed:

Open/short circuit compensation	Calculation time
Open and/or short circuit compensation performed	1.5 ms
Not performed	0 ms

(Allowance ±1 ms)

<D>

The time taken for calculation varies according as to whether or not the comparator is operating:

Comparator operating	Calculation time
Normal testing	0 ms
When the comparator is operating	0.7 ms

(Allowance ±1 ms)

<E>

The time taken for calculation varies according as to whether or not the comparator is operating:

Scaling execution	Calculation time
Normal testing	0 ms
When the scaling is executed	0.8 ms for a parameter

(Allowance ±1 ms)

Wait time for changing test conditions

When the test conditions are changed, the time taken for the internal processing is necessary according to the following factors (1) to (3), before testing.

(1) When the test frequency is changed:
Changing to the frequency in another range Wait time: 300 ms

Range	Frequency
1	42 Hz to 99.9 Hz
2	100.0 Hz to 300.0 Hz
3	300.1 Hz to 1.000 kHz
4	1.001 kHz to 3.000 kHz
5	3.001 kHz to 10.00 kHz
6	10.01 kHz to 30.00 kHz
7	30.01 kHz to 100.0 kHz
8	100.1 kHz to 1.000 MHz
9	1.001 MHz to 5.000 MHz

(2) When the test signal level is changed:
Changing to the test signal level in another range Wait time: 300 ms

Range	Test signal level
1	0.010 V to 0.100 V
2	0.101 V to 0.500 V
3	0.501 V to 1.000 V
4	1.001 V to 5.000 V

Note When the test signal level setting is CV/CC or the setting of voltage and current limit is ON, the test signal level is automatically changed.

(3) When the test range is changed:
Wait time: 300 ms

7.4 Options

■ 9518-01 GP-IB INTERFACE

Compliance standard: IEEE-488.1 (1987)

Reference standard: IEEE-488.2 (1987)

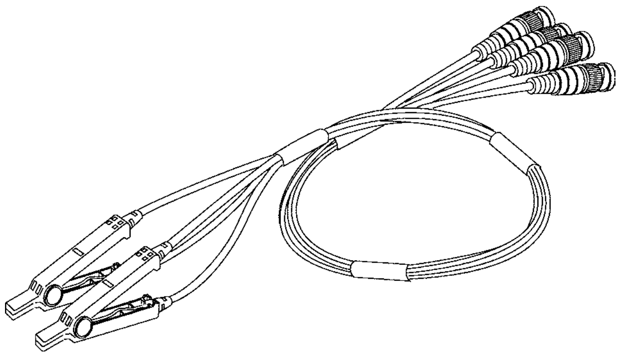
For explanation of how to fit the 9518-01 GP-IB INTERFACE BOARD and for a detailed description of its commands etc., reference should be made to the user manual supplied with the 9518-01.

■ 9593-01 RS-232C INTERFACE

Compliance standard: EIA RS-232C

For explanation of how to fit the 9593-01 RS-232C INTERFACE BOARD and for a detailed description of its commands etc., reference should be made to the user manual supplied with the 9593-01.

■ 9140 4-TERMINAL PROBE



This is a crocodile clip type of test probe.

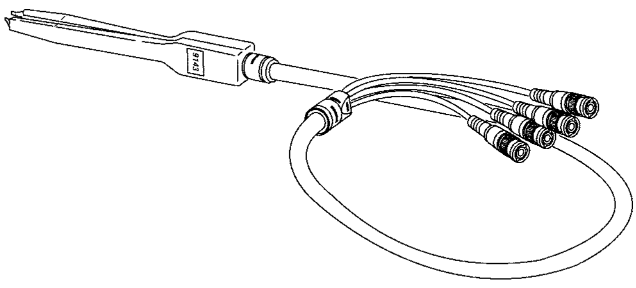
This type of probe is very convenient for connection to a wide range of wires, from comparatively thin wires to comparatively thick ones.

Range of frequencies which can be used is from DC to 100 kHz

NOTE

Open and close by holding the clip part of the 9140. If you hold the cable when opening or closing the clip, too much stress may be added to the cable, causing it to break.

■ 9143 PINCHER PROBE



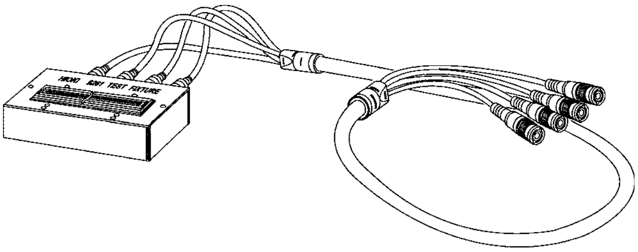
This tweezer type probe is very convenient for testing samples such as chips. The impedance range which can be measured by the 3532-50 using this probe varies according to the frequencies.

The range of test frequency which can be used is from DC to 5 MHz.

NOTE

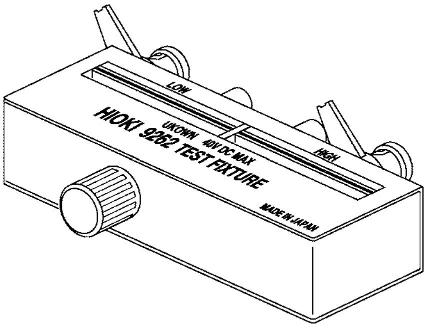
When using a probe, it may happen that the values obtained vary because the contact resistance is altering due to alterations in the pinch pressure exerted. Therefore it is necessary to keep the pinch pressure as constant as possible.

■ 9261 TEST FIXTURE

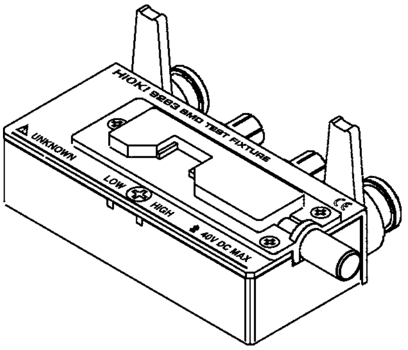


Samples to be tested can be comparatively easily loaded into and removed from this type of fixture. The range of test frequency which can be used is from DC to 5 MHz.

■ 9262 TEST FIXTURE

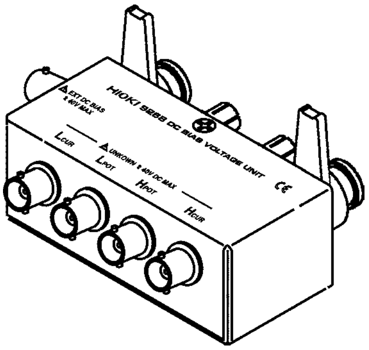


■ 9263 SMD TEST FIXTURE



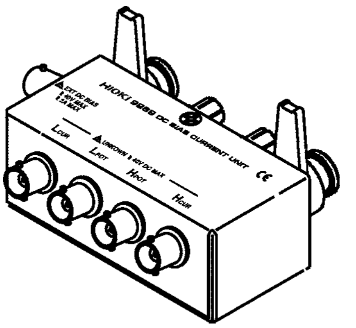
This is very convenient for testing samples such as chips.
The range of test frequency which can be used is from DC to 5 MHz.

■ 9268 DC BIAS VOLTAGE UNIT



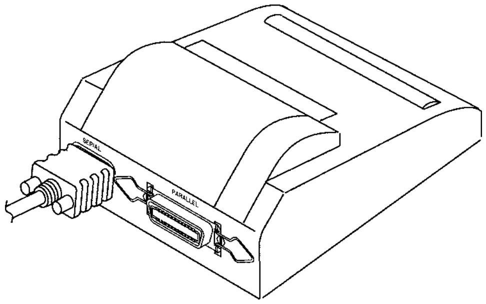
Maximum input voltage: 40 VDC

9269 DC BIAS CURRENT UNIT



Maximum input current: 2 A

9442 PRINTER



The screen copy and test values can be printed out. To use the printer, the following optional unit is necessary.

9593-01	RS-232C INTERFACE
9443	AC ADAPTER
9446	CONNECTION CABLE
1196	RECORDING PAPER

7.5 Test Accuracy

The test accuracy is calculated from a basic accuracy, which is based on the accuracy for impedance Z (%) and phase angle θ (°), and the following coefficients.

Test accuracy = Basic accuracy x C x D + E

C: Test speed coefficient
D: Cable length coefficient
E: Temperature coefficient

1. Basic accuracy

The basic accuracy is calculated from a value A and B from the accuracy coefficient table, which is based on the measurement frequency (*1), the measurement range, and the measurement signal level (*2).

(*1): When the measurement frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.

(*2): In CV or CC mode, the accuracy varies according to the test signal level.

(1 kΩ range or more)

$$\text{Basic accuracy } Z(\%) \text{ or } \theta(^\circ) = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

(100 Ω range or less)

$$\text{Basic accuracy } Z(\%) \text{ or } \theta(^\circ) = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range }[\Omega]}\right)$$

*Z*x: sample of |*Z*|

The impedance of the measurement sample (Zx) is taken to be either the measured value, or the value calculated from the following expressions (refer to "Conversion Table from C and L to |*Z*|").

$$
\begin{aligned}
|Zx|\ (\Omega) &\fallingdotseq \omega L\ (H)\ (\theta \fallingdotseq 90^\circ)\\
&\fallingdotseq 1/\omega C\ (F)\ (\theta \fallingdotseq -90^\circ)\\
&\fallingdotseq R\ (\Omega)\ (\theta \fallingdotseq 0^\circ)
\end{aligned}
$$

Basic accuracy conditions:

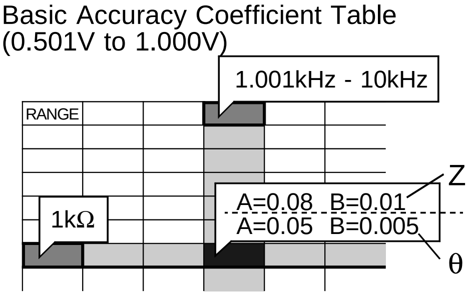
- Using the 9262 TEST FIXTURE
- Test speed: SLOW2
- Cable length coefficient: 0 m
- Temperature and humidity: 23±5℃, 80 %RH or less
- Operation 60 minutes after the power is turned on
- Open circuit compensation and short circuit compensation both being performed

If the test condition is different from above, the coefficients corresponding to the following settings are calculated from each table and must be multiplied (C, D) or added (E) to the basic accuracy.

Example calculation

1. Impedance (Z=500 Ω) basic accuracy

Measurement conditions: test frequency = 10 kHz, signal level = 1 V, speed = SLOW2, range = 1 kΩ



From Basic Accuracy Coefficient Table (0.501V to 1.000V) on the following pages), basic Z accuracy coefficients A=0.08, B=0.01.

Inserting these in the calculation expression yields:

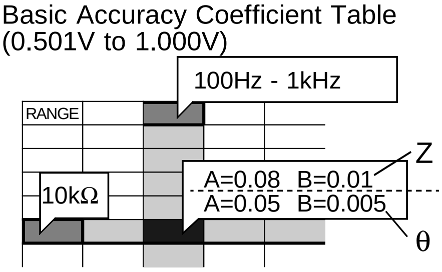
$$\text{Z accuracy} = \pm(0.08 + \frac{0.01 \text{ x } |10 \text{ x } 500 - 1 \text{ x } 10^3|}{1 \text{ x } 10^3}) = \pm 0.12\%$$

Similarly for θ basic accuracy coefficients A = 0.05, B=0.005, and thus:

$$\theta \text{ accuracy} = \pm(0.05 + \frac{0.005 \text{ x } |10 \text{ x } 500 - 1 \text{ x } 10^3|}{1 \text{ x } 10^3}) = \pm 0.07^\circ$$

2. Capacitance(Cs=160 nF) basic accuracy

Measurement conditions: test frequency = 1 kHz, signal level = 1 V, speed = SLOW2



Test Z and θ.
Measurement range: AUTO

When Z = 1.0144 kΩ, θ = -78.69° , test range is 10 kΩ

From Basic Accuracy Coefficient Table (0.501V to 1.000V) on the following pages), basic Z accuracy coefficients A=0.08, B=0.01.

Inserting these in the calculation expression yields:

$$\text{Z accuracy} = \pm(0.08 + \frac{0.01 \text{ x } |10 \text{ x } 1.0144 \text{ x } 10^3 - 10 \text{ x } 10^3|}{10 \text{ x } 10^3}) \fallingdotseq \pm 0.08\%$$

Similarly for θ basic accuracy coefficients A = 0.05, B=0.005, and thus:

$$\theta \text{ accuracy} = \pm(0.05 + \frac{0.005 \text{ x } |10 \text{ x } 1.0144 \text{ x } 10^3 - 10 \text{ x } 10^3|}{10 \text{ x } 10^3}) \fallingdotseq \pm 0.05^\circ$$

From the basic accuracy, find ranges that each of Z and θ can take.

Zmin = 1.0144 kΩ × (1 - 0.08/100) ≒ 1.0136kΩ
Zmax = 1.0144 kΩ × (1 + 0.08/100) ≒ 1.0152kΩ
θmin = 78.69 - 0.05 = 78.64 ° (θ: |θ| absolute value)
θmax = 78.69 + 0.05 = 78.74 °

From the ranges of Z and θ, determine ranges of Cs can take.

Csmin = 1/(Zmax x ω x sinθmax) ≒ 159.85 nF .... -0.09%
Csmax = 1/(Zmin x ω x sinθmin) ≒ 160.15 nF .... +0.09%
ω = 2 x π x f
f: frequency [Hz]

Hence the accuracy of Cs is ±0.009

2. Test speed coefficient (C)

Test speed	FAST	NORMAL	SLOW	SLOW2
C	5	2	1.5	1

3. Test cable length coefficient (D) (When using a 1.5C-V coaxial cable)

Cable length	0 m	1 m
D	1	(100 kHz max) 1.5 + 0.015×f [kHz]
		(100.1 kHz min) 1.5 + 0.3×f [MHz]

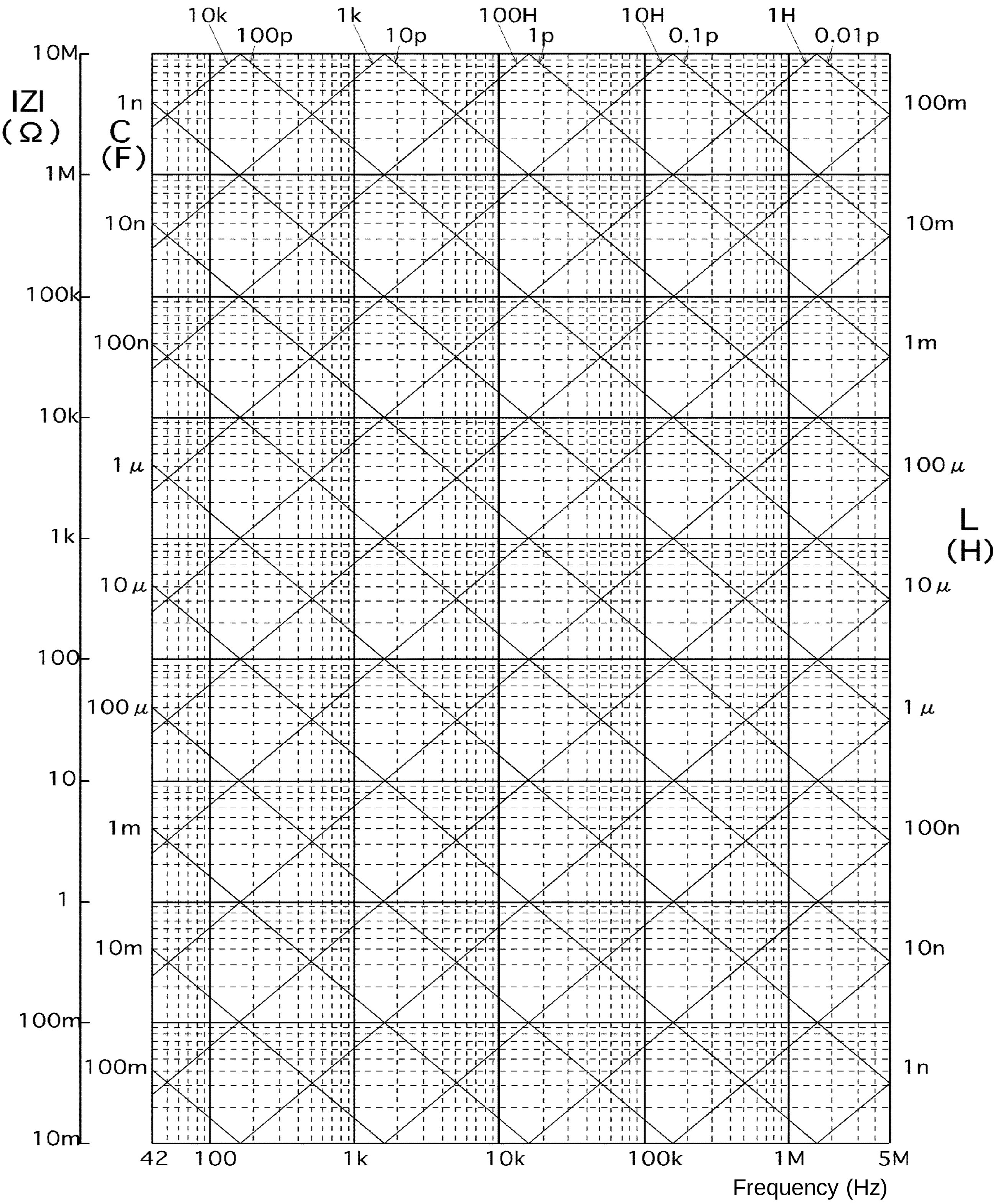
f: measurement frequency

4. Temperature coefficient (E)

Temperature	Operating temperature = T ℃
E	0.1× basic accuracy× |T-23|

Note The above mesurment specification was determined using a 1.5C-2V coaxial cable with an established cable length for the unit. Using a cable other than a 1.5C-2V, or a cable that not an established length for the unit in question increases the chance of measurement inaccuracy. A large capacitance between the H terminal and grounding capacitance (GND) or the L terminal and GND may result in mesurement inaccuracy. Please set the GND to 10pF or less.

Conversion Table from C and L to |*Z*|



Basic Accuracy Coefficient Table 1 (0.010 V to 0.049 V)

1 kΩ range or more

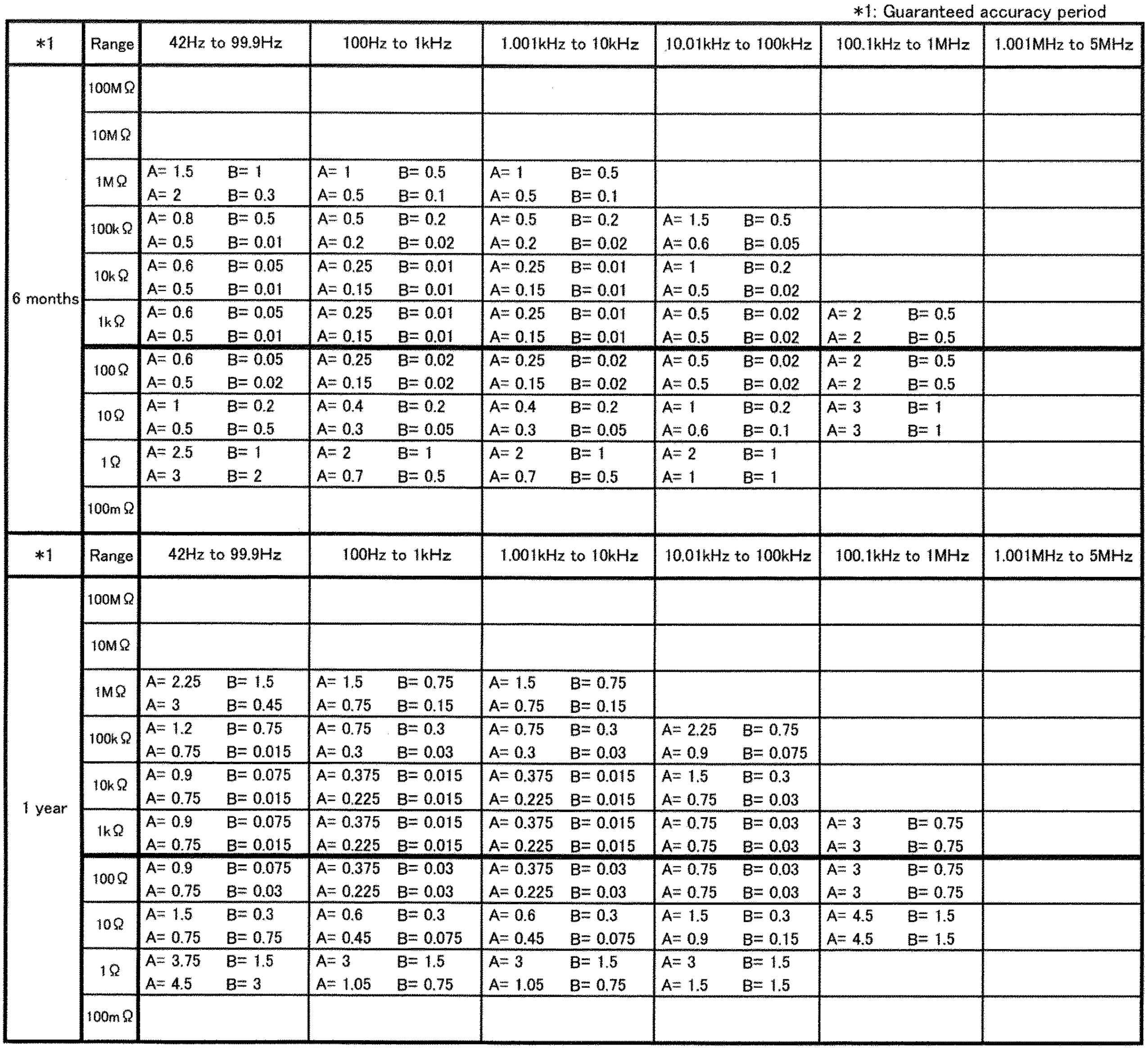
$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range }[\Omega]}\right)$$

Zx: sample of impedance
A, B: basic accuracy coefficient
Accuracy coefficient for Z (%): upper values in the following table
Accuracy coefficient for θ (°): lower values in the following table

When the frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.



*1: Guaranteed accuracy period

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
6 months	100MΩ						
	10MΩ						
	1MΩ	A= 1.5 B= 1 A= 2 B= 0.3	A= 1 B= 0.5 A= 0.5 B= 0.1	A= 1 B= 0.5 A= 0.5 B= 0.1			
	100kΩ	A= 0.8 B= 0.5 A= 0.5 B= 0.01	A= 0.5 B= 0.2 A= 0.2 B= 0.02	A= 0.5 B= 0.2 A= 0.2 B= 0.02	A= 1.5 B= 0.5 A= 0.6 B= 0.05		
	10kΩ	A= 0.6 B= 0.05 A= 0.5 B= 0.01	A= 0.25 B= 0.01 A= 0.15 B= 0.01	A= 0.25 B= 0.01 A= 0.15 B= 0.01	A= 1 B= 0.2 A= 0.5 B= 0.02		
	1kΩ	A= 0.6 B= 0.05 A= 0.5 B= 0.01	A= 0.25 B= 0.01 A= 0.15 B= 0.01	A= 0.25 B= 0.01 A= 0.15 B= 0.01	A= 0.5 B= 0.02 A= 0.5 B= 0.02	A= 2 B= 0.5 A= 2 B= 0.5	
	100Ω	A= 0.6 B= 0.05 A= 0.5 B= 0.02	A= 0.25 B= 0.02 A= 0.15 B= 0.02	A= 0.25 B= 0.02 A= 0.15 B= 0.02	A= 0.5 B= 0.02 A= 0.5 B= 0.02	A= 2 B= 0.5 A= 2 B= 0.5	
	10Ω	A= 1 B= 0.2 A= 0.5 B= 0.5	A= 0.4 B= 0.2 A= 0.3 B= 0.05	A= 0.4 B= 0.2 A= 0.3 B= 0.05	A= 1 B= 0.2 A= 0.6 B= 0.1	A= 3 B= 1 A= 3 B= 1	
	1Ω	A= 2.5 B= 1 A= 3 B= 2	A= 2 B= 1 A= 0.7 B= 0.5	A= 2 B= 1 A= 0.7 B= 0.5	A= 2 B= 1 A= 1 B= 1		
	100mΩ						

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
1 year	100MΩ						
	10MΩ						
	1MΩ	A= 2.25 B= 1.5 A= 3 B= 0.45	A= 1.5 B= 0.75 A= 0.75 B= 0.15	A= 1.5 B= 0.75 A= 0.75 B= 0.15			
	100kΩ	A= 1.2 B= 0.75 A= 0.75 B= 0.015	A= 0.75 B= 0.3 A= 0.3 B= 0.03	A= 0.75 B= 0.3 A= 0.3 B= 0.03	A= 2.25 B= 0.75 A= 0.9 B= 0.075		
	10kΩ	A= 0.9 B= 0.075 A= 0.75 B= 0.015	A= 0.375 B= 0.015 A= 0.225 B= 0.015	A= 0.375 B= 0.015 A= 0.225 B= 0.015	A= 1.5 B= 0.3 A= 0.75 B= 0.03		
	1kΩ	A= 0.9 B= 0.075 A= 0.75 B= 0.015	A= 0.375 B= 0.015 A= 0.225 B= 0.015	A= 0.375 B= 0.015 A= 0.225 B= 0.015	A= 0.75 B= 0.03 A= 0.75 B= 0.03	A= 3 B= 0.75 A= 3 B= 0.75	
	100Ω	A= 0.9 B= 0.075 A= 0.75 B= 0.03	A= 0.375 B= 0.03 A= 0.225 B= 0.03	A= 0.375 B= 0.03 A= 0.225 B= 0.03	A= 0.75 B= 0.03 A= 0.75 B= 0.03	A= 3 B= 0.75 A= 3 B= 0.75	
	10Ω	A= 1.5 B= 0.3 A= 0.75 B= 0.75	A= 0.6 B= 0.3 A= 0.45 B= 0.075	A= 0.6 B= 0.3 A= 0.45 B= 0.075	A= 1.5 B= 0.3 A= 0.9 B= 0.15	A= 4.5 B= 1.5 A= 4.5 B= 1.5	
	1Ω	A= 3.75 B= 1.5 A= 4.5 B= 3	A= 3 B= 1.5 A= 1.05 B= 0.75	A= 3 B= 1.5 A= 1.05 B= 0.75	A= 3 B= 1.5 A= 1.5 B= 1.5		
	100mΩ						

Basic Accuracy Table 2 (0.050 V to 0.100 V)

1 kΩ range or more

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range}\ [\Omega]}\right)$$

Zx: sample of impedance
A, B: basic accuracy coefficient
Accuracy coefficient for Z (%): upper values in the following table
Accuracy coefficient for θ (°): lower values in the following table

When the frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.

*1: Guaranteed accuracy period

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
6 months	100MΩ						
	10MΩ						
	1MΩ	A= 1 B= 0.2 A= 1.5 B= 0.2	A= 0.5 B= 0.05 A= 0.25 B= 0.05	A= 0.5 B= 0.05 A= 0.25 B= 0.05	A= 1 B= 0.2 A= 1 B= 0.1		
	100kΩ	A= 0.5 B= 0.01 A= 0.35 B= 0.01	A= 0.2 B= 0.01 A= 0.15 B= 0.01	A= 0.25 B= 0.01 A= 0.15 B= 0.01	A= 0.5 B= 0.05 A= 0.3 B= 0.05	A= 3.5 B= 2 A= 1.5 B= 1	
	10kΩ	A= 0.5 B= 0.01 A= 0.35 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.3 B= 0.02 A= 0.2 B= 0.02	A= 0.8 B= 0.2 A= 1 B= 0.3	
	1kΩ	A= 0.5 B= 0.01 A= 0.35 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.3 B= 0.02 A= 0.2 B= 0.02	A= 0.6 B= 0.05 A= 0.4 B= 0.05	A= 2.5 B= 0.4 A= 2 B= 0.2
	100Ω	A= 0.5 B= 0.02 A= 0.35 B= 0.02	A= 0.2 B= 0.02 A= 0.1 B= 0.02	A= 0.2 B= 0.02 A= 0.1 B= 0.02	A= 0.3 B= 0.02 A= 0.2 B= 0.02	A= 0.6 B= 0.05 A= 0.4 B= 0.05	A= 2.5 B= 0.2 A= 2 B= 0.2
	10Ω	A= 0.6 B= 0.1 A= 0.4 B= 0.2	A= 0.35 B= 0.04 A= 0.2 B= 0.05	A= 0.35 B= 0.04 A= 0.2 B= 0.05	A= 0.35 B= 0.04 A= 0.3 B= 0.05	A= 1 B= 0.5 A= 1 B= 0.3	A= 4 B= 1.5 A= 3.5 B= 1
	1Ω	A= 1.5 B= 1 A= 2.2 B= 0.5	A= 0.7 B= 0.5 A= 0.5 B= 0.3	A= 0.7 B= 0.5 A= 0.5 B= 0.3	A= 1 B= 1 A= 0.8 B= 0.5		
	100mΩ						

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
1 year	100MΩ						
	10MΩ						
	1MΩ	A= 1.5 B= 0.3 A= 2.25 B= 0.3	A= 0.75 B= 0.075 A= 0.375 B= 0.075	A= 0.75 B= 0.075 A= 0.375 B= 0.075	A= 1.5 B= 0.3 A= 1.5 B= 0.15		
	100kΩ	A= 0.75 B= 0.015 A= 0.525 B= 0.015	A= 0.3 B= 0.015 A= 0.225 B= 0.015	A= 0.375 B= 0.015 A= 0.225 B= 0.015	A= 0.75 B= 0.075 A= 0.45 B= 0.075	A= 5.25 B= 3 A= 2.25 B= 1.5	
	10kΩ	A= 0.75 B= 0.015 A= 0.525 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.45 B= 0.03 A= 0.3 B= 0.03	A= 1.2 B= 0.3 A= 1.5 B= 0.45	
	1kΩ	A= 0.75 B= 0.015 A= 0.525 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.45 B= 0.03 A= 0.3 B= 0.03	A= 0.9 B= 0.075 A= 0.6 B= 0.075	A= 3.75 B= 0.6 A= 3 B= 0.3
	100Ω	A= 0.75 B= 0.03 A= 0.525 B= 0.03	A= 0.3 B= 0.03 A= 0.15 B= 0.03	A= 0.3 B= 0.03 A= 0.15 B= 0.03	A= 0.45 B= 0.03 A= 0.3 B= 0.03	A= 0.9 B= 0.075 A= 0.6 B= 0.075	A= 3.75 B= 0.3 A= 3 B= 0.3
	10Ω	A= 0.9 B= 0.15 A= 0.6 B= 0.3	A= 0.525 B= 0.06 A= 0.3 B= 0.075	A= 0.525 B= 0.06 A= 0.3 B= 0.075	A= 0.525 B= 0.06 A= 0.45 B= 0.075	A= 1.5 B= 0.75 A= 1.5 B= 0.45	A= 6 B= 2.25 A= 5.25 B= 1.5
	1Ω	A= 2.25 B= 1.5 A= 3.3 B= 0.75	A= 1.05 B= 0.75 A= 0.75 B= 0.45	A= 1.05 B= 0.75 A= 0.75 B= 0.45	A= 1.5 B= 1.5 A= 1.2 B= 0.75		
	100mΩ						

Basic Accuracy Table 3 (0.101 V to 0.500 V)

1 kΩ range or more

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range }[\Omega]}\right)$$

Zx: sample of impedance
A, B: basic accuracy coefficient
Accuracy coefficient for Z (%): upper values in the following table
Accuracy coefficient for θ (°): lower values in the following table

When the frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.

*1: Guaranteed accuracy period

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
6 months	100MΩ	A= 4.5 B= 4 A= 3.5 B= 2	A= 2.5 B= 2 A= 2 B= 1.5	A= 2.5 B= 2 A= 2 B= 1.5			
	10MΩ	A= 1 B= 1 A= 2 B= 0.2	A= 0.7 B= 0.5 A= 0.3 B= 0.2	A= 0.7 B= 0.5 A= 0.3 B= 0.2	A= 1.2 B= 1 A= 1.2 B= 0.5		
	1MΩ	A= 0.45 B= 0.05 A= 0.35 B= 0.2	A= 0.3 B= 0.05 A= 0.2 B= 0.02	A= 0.3 B= 0.05 A= 0.2 B= 0.02	A= 0.5 B= 0.08 A= 0.5 B= 0.08		
	100kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.3 B= 0.04 A= 0.25 B= 0.03	A= 2 B= 1.5 A= 1 B= 0.5	
	10kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.5 B= 0.05 A= 0.7 B= 0.3	A= 2 B= 1 A= 1.5 B= 0.5
	1kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.5 B= 0.03 A= 0.2 B= 0.05	A= 2 B= 0.2 A= 1.5 B= 0.2
	100Ω	A= 0.4 B= 0.02 A= 0.3 B= 0.01	A= 0.15 B= 0.02 A= 0.08 B= 0.01	A= 0.15 B= 0.02 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.5 B= 0.03 A= 0.2 B= 0.05	A= 2 B= 0.2 A= 1.5 B= 0.2
	10Ω	A= 0.5 B= 0.1 A= 0.35 B= 0.2	A= 0.3 B= 0.04 A= 0.15 B= 0.03	A= 0.3 B= 0.04 A= 0.15 B= 0.03	A= 0.3 B= 0.04 A= 0.2 B= 0.03	A= 0.6 B= 0.1 A= 0.6 B= 0.1	A= 2.5 B= 1.5 A= 3 B= 1
	1Ω	A= 1.4 B= 1 A= 2 B= 0.5	A= 0.5 B= 0.3 A= 0.4 B= 0.2	A= 0.5 B= 0.3 A= 0.4 B= 0.2	A= 0.5 B= 0.3 A= 0.4 B= 0.2		
	100mΩ						

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
1 year	100MΩ	A= 6.75 B= 6 A= 5.25 B= 3	A= 3.75 B= 3 A= 3 B= 2.25	A= 3.75 B= 3 A= 3 B= 2.25			
	10MΩ	A= 1.5 B= 1.5 A= 3 B= 0.3	A= 1.05 B= 0.75 A= 0.45 B= 0.3	A= 1.05 B= 0.75 A= 0.45 B= 0.3	A= 1.8 B= 1.5 A= 1.8 B= 0.75		
	1MΩ	A= 0.675 B= 0.075 A= 0.525 B= 0.3	A= 0.45 B= 0.075 A= 0.3 B= 0.03	A= 0.45 B= 0.075 A= 0.3 B= 0.03	A= 0.75 B= 0.12 A= 0.75 B= 0.12		
	100kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.45 B= 0.06 A= 0.375 B= 0.045	A= 3 B= 2.25 A= 1.5 B= 0.75	
	10kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 0.75 B= 0.075 A= 1.05 B= 0.45	A= 3 B= 1.5 A= 2.25 B= 0.75
	1kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 0.75 B= 0.045 A= 0.3 B= 0.075	A= 3 B= 0.3 A= 2.25 B= 0.3
	100Ω	A= 0.6 B= 0.03 A= 0.45 B= 0.015	A= 0.225 B= 0.03 A= 0.12 B= 0.015	A= 0.225 B= 0.03 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 0.75 B= 0.045 A= 0.3 B= 0.075	A= 3 B= 0.3 A= 2.25 B= 0.3
	10Ω	A= 0.75 B= 0.15 A= 0.525 B= 0.3	A= 0.45 B= 0.06 A= 0.225 B= 0.045	A= 0.45 B= 0.06 A= 0.225 B= 0.045	A= 0.45 B= 0.06 A= 0.3 B= 0.045	A= 0.9 B= 0.15 A= 0.9 B= 0.15	A= 3.75 B= 2.25 A= 4.5 B= 1.5
	1Ω	A= 2.1 B= 1.5 A= 3 B= 0.75	A= 0.75 B= 0.45 A= 0.6 B= 0.3	A= 0.75 B= 0.45 A= 0.6 B= 0.3	A= 0.75 B= 0.45 A= 0.6 B= 0.3		
	100mΩ						

Basic Accuracy Table 4 (0.501 V to 1.000 V)

1 kΩ range or more

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range}\ [\Omega]}\right)$$

Zx: sample of impedance
A, B: basic accuracy coefficient
Accuracy coefficient for Z (%): upper values in the following table
Accuracy coefficient for θ (°): lower values in the following table

When the frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.

*1: Guaranteed accuracy period

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
6 months	100MΩ	A= 4 B= 4 A= 2.5 B= 2	A= 2 B= 2 A= 1 B= 1.5	A= 2 B= 2 A= 1 B= 1.5			
	10MΩ	A= 0.8 B= 0.4 A= 1 B= 0.2	A= 0.4 B= 0.2 A= 0.25 B= 0.1	A= 0.4 B= 0.2 A= 0.25 B= 0.1	A= 1 B= 0.5 A= 1 B= 0.5		
	1MΩ	A= 0.4 B= 0.05 A= 0.3 B= 0.1	A= 0.15 B= 0.05 A= 0.15 B= 0.02	A= 0.15 B= 0.05 A= 0.15 B= 0.02	A= 0.3 B= 0.08 A= 0.3 B= 0.08	A= 3 B= 1 A= 3 B= 0.5	
	100kΩ	A= 0.35 B= 0.01 A= 0.25 B= 0.01	A= 0.08 B= 0.01 A= 0.05 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.25 B= 0.04 A= 0.15 B= 0.02	A= 0.4 B= 0.3 A= 0.3 B= 0.3	A= 2 B= 0.5 A= 2 B= 0.3
	10kΩ	A= 0.35 B= 0.01 A= 0.25 B= 0.005	A= 0.08 B= 0.01 A= 0.05 B= 0.005	A= 0.08 B= 0.01 A= 0.05 B= 0.005	A= 0.2 B= 0.02 A= 0.08 B= 0.02	A= 0.3 B= 0.03 A= 0.15 B= 0.02	A= 1.5 B= 0.2 A= 1 B= 0.2
	1kΩ	A= 0.35 B= 0.01 A= 0.25 B= 0.005	A= 0.08 B= 0.01 A= 0.05 B= 0.005	A= 0.08 B= 0.01 A= 0.05 B= 0.005	A= 0.2 B= 0.02 A= 0.08 B= 0.02	A= 0.3 B= 0.03 A= 0.15 B= 0.02	A= 1.5 B= 0.2 A= 1 B= 0.2
	100Ω	A= 0.35 B= 0.02 A= 0.25 B= 0.01	A= 0.08 B= 0.02 A= 0.05 B= 0.01	A= 0.08 B= 0.02 A= 0.05 B= 0.01	A= 0.2 B= 0.02 A= 0.08 B= 0.02	A= 0.3 B= 0.03 A= 0.15 B= 0.02	A= 1.5 B= 0.2 A= 1 B= 0.2
	10Ω	A= 0.4 B= 0.04 A= 0.3 B= 0.1	A= 0.2 B= 0.03 A= 0.1 B= 0.02	A= 0.2 B= 0.03 A= 0.1 B= 0.02	A= 0.2 B= 0.03 A= 0.15 B= 0.02	A= 0.4 B= 0.1 A= 0.3 B= 0.05	A= 2 B= 1 A= 2 B= 0.5
	1Ω	A= 0.7 B= 0.4 A= 1 B= 0.2	A= 0.4 B= 0.3 A= 0.25 B= 0.2	A= 0.4 B= 0.3 A= 0.25 B= 0.2	A= 0.4 B= 0.3 A= 0.25 B= 0.2	A= 1 B= 1 A= 0.7 B= 0.5	
	100mΩ	A= 4 B= 4 A= 2.5 B= 2	A= 3 B= 2 A= 2 B= 1	A= 3 B= 2 A= 2 B= 1	A= 3 B= 2 A= 2 B= 1		
*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
1 year	100MΩ	A= 6 B= 6 A= 3.75 B= 3	A= 3 B= 3 A= 1.5 B= 2.25	A= 3 B= 3 A= 1.5 B= 2.25			
	10MΩ	A= 1.2 B= 0.6 A= 1.5 B= 0.3	A= 0.6 B= 0.3 A= 0.375 B= 0.15	A= 0.6 B= 0.3 A= 0.375 B= 0.15	A= 1.5 B= 0.75 A= 1.5 B= 0.75		
	1MΩ	A= 0.6 B= 0.075 A= 0.45 B= 0.15	A= 0.225 B= 0.075 A= 0.225 B= 0.03	A= 0.225 B= 0.075 A= 0.225 B= 0.03	A= 0.45 B= 0.12 A= 0.45 B= 0.12	A= 4.5 B= 1.5 A= 4.5 B= 0.75	
	100kΩ	A= 0.525 B= 0.015 A= 0.375 B= 0.015	A= 0.12 B= 0.015 A= 0.075 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.375 B= 0.06 A= 0.225 B= 0.03	A= 0.6 B= 0.45 A= 0.45 B= 0.45	A= 3 B= 0.75 A= 3 B= 0.45
	10kΩ	A= 0.525 B= 0.015 A= 0.375 B= 0.0075	A= 0.12 B= 0.015 A= 0.075 B= 0.0075	A= 0.12 B= 0.015 A= 0.075 B= 0.0075	A= 0.3 B= 0.03 A= 0.12 B= 0.03	A= 0.45 B= 0.045 A= 0.225 B= 0.03	A= 2.25 B= 0.3 A= 1.5 B= 0.3
	1kΩ	A= 0.525 B= 0.015 A= 0.375 B= 0.0075	A= 0.12 B= 0.015 A= 0.075 B= 0.0075	A= 0.12 B= 0.015 A= 0.075 B= 0.0075	A= 0.3 B= 0.03 A= 0.12 B= 0.03	A= 0.45 B= 0.045 A= 0.225 B= 0.03	A= 2.25 B= 0.3 A= 1.5 B= 0.3
	100Ω	A= 0.525 B= 0.03 A= 0.375 B= 0.015	A= 0.12 B= 0.03 A= 0.075 B= 0.015	A= 0.12 B= 0.03 A= 0.075 B= 0.015	A= 0.3 B= 0.03 A= 0.12 B= 0.03	A= 0.45 B= 0.045 A= 0.225 B= 0.03	A= 2.25 B= 0.3 A= 1.5 B= 0.3
	10Ω	A= 0.6 B= 0.06 A= 0.45 B= 0.15	A= 0.3 B= 0.045 A= 0.15 B= 0.03	A= 0.3 B= 0.045 A= 0.15 B= 0.03	A= 0.3 B= 0.045 A= 0.225 B= 0.03	A= 0.6 B= 0.15 A= 0.45 B= 0.075	A= 3 B= 1.5 A= 3 B= 0.75
	1Ω	A= 1.05 B= 0.6 A= 1.5 B= 0.3	A= 0.6 B= 0.45 A= 0.375 B= 0.3	A= 0.6 B= 0.45 A= 0.375 B= 0.3	A= 0.6 B= 0.45 A= 0.375 B= 0.3	A= 1.5 B= 1.5 A= 1.05 B= 0.75	
	100mΩ	A= 6 B= 6 A= 3.75 B= 3	A= 4.5 B= 3 A= 3 B= 1.5	A= 4.5 B= 3 A= 3 B= 1.5	A= 4.5 B= 3 A= 3 B= 1.5		

Basic Accuracy Table 5 (1.001 V to 5.000 V)

1 kΩ range or more

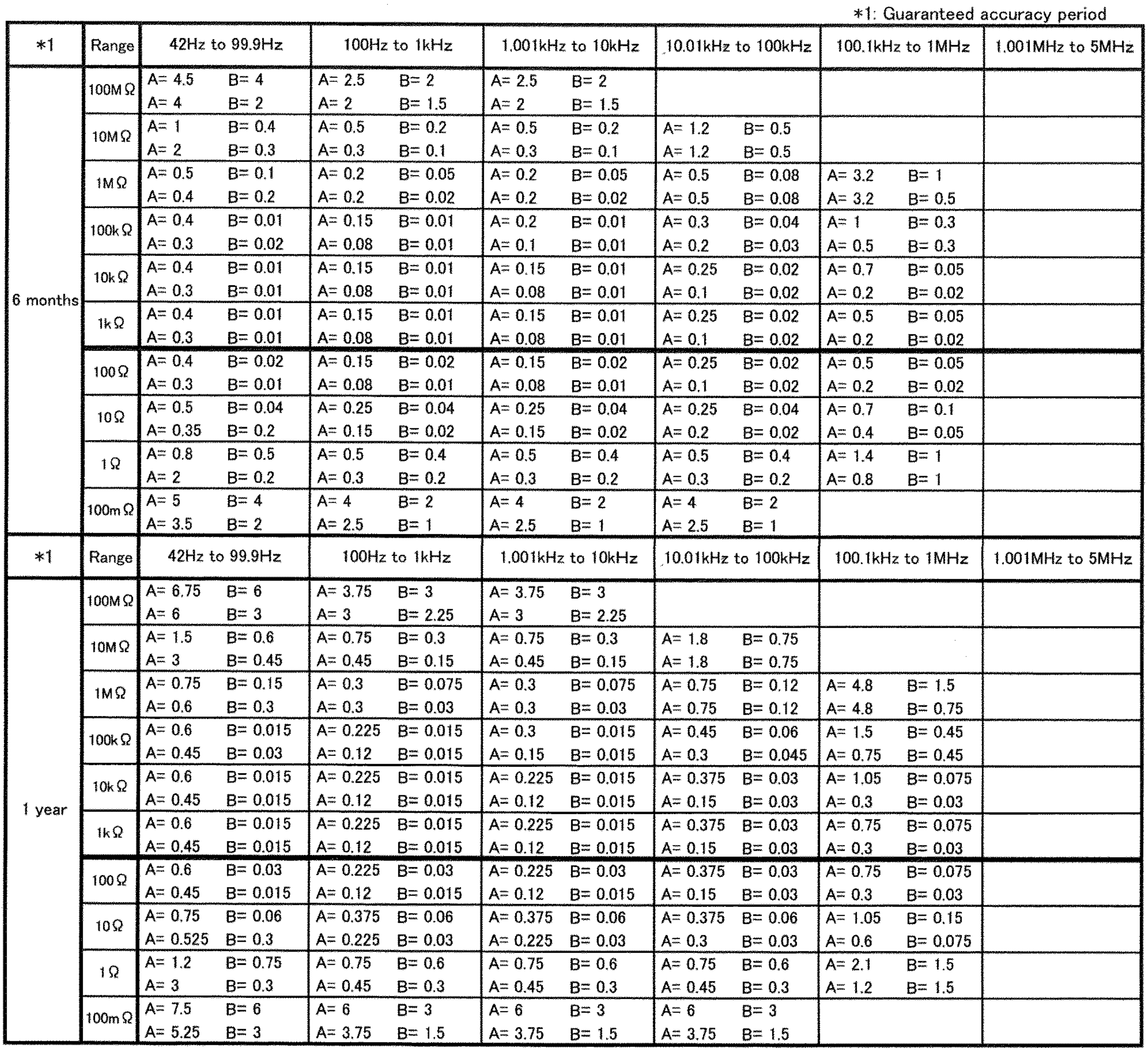
$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |10 \times Zx[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]}\right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm\left(A + \frac{B \times |\text{Range}[\Omega] - Zx[\Omega]| \times 10}{\text{Range }[\Omega]}\right)$$

Zx: sample of impedance
A, B: basic accuracy coefficient
Accuracy coefficient for Z (%): upper values in the following table
Accuracy coefficient for θ (°): lower values in the following table

When the frequency is 1.001 MHz or more, (f [MHz] +3)/4 must be multiplied to the basic accuracy.



*1: Guaranteed accuracy period

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
6 months	100MΩ	A= 4.5 B= 4 A= 4 B= 2	A= 2.5 B= 2 A= 2 B= 1.5	A= 2.5 B= 2 A= 2 B= 1.5			
	10MΩ	A= 1 B= 0.4 A= 2 B= 0.3	A= 0.5 B= 0.2 A= 0.3 B= 0.1	A= 0.5 B= 0.2 A= 0.3 B= 0.1	A= 1.2 B= 0.5 A= 1.2 B= 0.5		
	1MΩ	A= 0.5 B= 0.1 A= 0.4 B= 0.2	A= 0.2 B= 0.05 A= 0.2 B= 0.02	A= 0.2 B= 0.05 A= 0.2 B= 0.02	A= 0.5 B= 0.08 A= 0.5 B= 0.08	A= 3.2 B= 1 A= 3.2 B= 0.5	
	100kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.02	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.2 B= 0.01 A= 0.1 B= 0.01	A= 0.3 B= 0.04 A= 0.2 B= 0.03	A= 1 B= 0.3 A= 0.5 B= 0.3	
	10kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.7 B= 0.05 A= 0.2 B= 0.02	
	1kΩ	A= 0.4 B= 0.01 A= 0.3 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.15 B= 0.01 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.5 B= 0.05 A= 0.2 B= 0.02	
	100Ω	A= 0.4 B= 0.02 A= 0.3 B= 0.01	A= 0.15 B= 0.02 A= 0.08 B= 0.01	A= 0.15 B= 0.02 A= 0.08 B= 0.01	A= 0.25 B= 0.02 A= 0.1 B= 0.02	A= 0.5 B= 0.05 A= 0.2 B= 0.02	
	10Ω	A= 0.5 B= 0.04 A= 0.35 B= 0.2	A= 0.25 B= 0.04 A= 0.15 B= 0.02	A= 0.25 B= 0.04 A= 0.15 B= 0.02	A= 0.25 B= 0.04 A= 0.2 B= 0.02	A= 0.7 B= 0.1 A= 0.4 B= 0.05	
	1Ω	A= 0.8 B= 0.5 A= 2 B= 0.2	A= 0.5 B= 0.4 A= 0.3 B= 0.2	A= 0.5 B= 0.4 A= 0.3 B= 0.2	A= 0.5 B= 0.4 A= 0.3 B= 0.2	A= 1.4 B= 1 A= 0.8 B= 1	
	100mΩ	A= 5 B= 4 A= 3.5 B= 2	A= 4 B= 2 A= 2.5 B= 1	A= 4 B= 2 A= 2.5 B= 1	A= 4 B= 2 A= 2.5 B= 1		

*1	Range	42Hz to 99.9Hz	100Hz to 1kHz	1.001kHz to 10kHz	10.01kHz to 100kHz	100.1kHz to 1MHz	1.001MHz to 5MHz
1 year	100MΩ	A= 6.75 B= 6 A= 6 B= 3	A= 3.75 B= 3 A= 3 B= 2.25	A= 3.75 B= 3 A= 3 B= 2.25			
	10MΩ	A= 1.5 B= 0.6 A= 3 B= 0.45	A= 0.75 B= 0.3 A= 0.45 B= 0.15	A= 0.75 B= 0.3 A= 0.45 B= 0.15	A= 1.8 B= 0.75 A= 1.8 B= 0.75		
	1MΩ	A= 0.75 B= 0.15 A= 0.6 B= 0.3	A= 0.3 B= 0.075 A= 0.3 B= 0.03	A= 0.3 B= 0.075 A= 0.3 B= 0.03	A= 0.75 B= 0.12 A= 0.75 B= 0.12	A= 4.8 B= 1.5 A= 4.8 B= 0.75	
	100kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.03	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.3 B= 0.015 A= 0.15 B= 0.015	A= 0.45 B= 0.06 A= 0.3 B= 0.045	A= 1.5 B= 0.45 A= 0.75 B= 0.45	
	10kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 1.05 B= 0.075 A= 0.3 B= 0.03	
	1kΩ	A= 0.6 B= 0.015 A= 0.45 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.225 B= 0.015 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 0.75 B= 0.075 A= 0.3 B= 0.03	
	100Ω	A= 0.6 B= 0.03 A= 0.45 B= 0.015	A= 0.225 B= 0.03 A= 0.12 B= 0.015	A= 0.225 B= 0.03 A= 0.12 B= 0.015	A= 0.375 B= 0.03 A= 0.15 B= 0.03	A= 0.75 B= 0.075 A= 0.3 B= 0.03	
	10Ω	A= 0.75 B= 0.06 A= 0.525 B= 0.3	A= 0.375 B= 0.06 A= 0.225 B= 0.03	A= 0.375 B= 0.06 A= 0.225 B= 0.03	A= 0.375 B= 0.06 A= 0.3 B= 0.03	A= 1.05 B= 0.15 A= 0.6 B= 0.075	
	1Ω	A= 1.2 B= 0.75 A= 3 B= 0.3	A= 0.75 B= 0.6 A= 0.45 B= 0.3	A= 0.75 B= 0.6 A= 0.45 B= 0.3	A= 0.75 B= 0.6 A= 0.45 B= 0.3	A= 2.1 B= 1.5 A= 1.2 B= 1.5	
	100mΩ	A= 7.5 B= 6 A= 5.25 B= 3	A= 6 B= 3 A= 3.75 B= 1.5	A= 6 B= 3 A= 3.75 B= 1.5	A= 6 B= 3 A= 3.75 B= 1.5		

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