




INSTRUCTION MANUAL

3532-50

LCR HiTESTER

HIOKI E. E. CORPORATION

Contents


Introduction	i
Shipping Check	ii
Safety	iii
 Points for Attention During Use	v
Layout of This Manual	vi
Chapter 1 Product Overview	1
1.1 Product Overview	1
1.2 Product Features	2
1.3 Names and Functions of Parts	3
Chapter 2 Before Starting Measurement	7
 2.1 Connecting the Power Cord	7
 2.2 Connecting the Test Leads	8
2.2.1 Establishing the Connections	8
2.3 Turning the Power On and Off	10
Chapter 3 Outline of Operation	11
3.1 About the Touch Panel	11
3.2 About the Screen	12
3.2.1 Control Screen Sequence	14
3.3 Basic Measurement	15
3.3.1 Basic Flow up to Testing of the Sample	15
3.3.2 Setting the Test Parameters to be Displayed (Cs, D)	16
3.3.3 Setting the Test Frequency	18
3.3.4 Setting the Constant Voltage Level	21
3.3.5 Setting Open Circuit Compensation	23
3.3.6 Setting Short Circuit Compensation	26
3.3.7 Starting Testing	28
Chapter 4 Detailed Description of Functions	29
4.1 Description of the Screens	29
4.1.1 The Initial Screen	30
4.1.2 The Menu Screen and Application Menu Screen	31
4.2 Setting the Parameters to be Displayed	32
4.2.1 Control Screen Sequence	32
4.2.2 Details of the Setting Process	32
4.2.3 Series Equivalent Circuit Mode and Parallel Equivalent Circuit Mode	34


4.3	Setting the Test Frequency	35
4.3.1	Control Screen Sequence	35
4.3.2	Selecting the Input Method	36
4.3.3	Input Using the Ten Key Screen	37
4.3.4	Input Using the Digit Screen	38
4.4	Setting the Test Signal Level	39
4.4.1	Control Screen Sequence	39
4.4.2	Selecting the Level Type	40
4.4.3	Setting the Open Circuit Voltage (V) Level	42
4.4.4	Setting the Constant Voltage (CV) Level	43
4.4.5	Setting the Constant Current (CC) Level	44
4.5	Setting the Voltage/Current Limit	45
4.5.1	Control Screen Sequence	45
4.5.2	Details of the Setting Process	46
4.6	Setting the Ranging	48
4.6.1	Control Screen Sequence	48
4.6.2	Setting the Ranging	49
4.6.3	Setting AUTO Ranging	49
4.6.4	Setting the Ranging to HOLD	50
4.7	Open Circuit Compensation	52
4.7.1	Control Screen Sequence	52
4.7.2	Setting the Compensation Method	53
4.7.3	ALL Compensation	54
4.7.4	Spot Compensation	56
4.7.5	When an Error Message Appears and Compensation Has Stopped	59
4.7.6	Clearing Compensation Data	59
4.8	Short Circuit Compensation	60
4.8.1	Control Screen Sequence	60
4.8.2	Setting the Compensation Method	61
4.8.3	ALL Compensation	63
4.8.4	Spot Compensation	65
4.8.5	When an Error Message Appears and Compensation Has Stopped	68
4.8.6	Clearing Compensation Data	68
4.9	Open Circuit Compensation and Short Circuit Compensation	69
4.10	Setting the Trigger	71
4.10.1	Control Screen Sequence	71
4.10.2	Details of the Setting Process	72

4.11	Setting the Trigger Delay	74
4.11.1	Control Screen Sequence	74
4.11.2	Details of the Setting Process	75
4.12	Setting Averaging	77
4.12.1	Control Screen Sequence	77
4.12.2	Details of the Setting Process	78
4.13	Setting the Testing Speed	80
4.13.1	Control Screen Sequence	80
4.13.2	Details of the Setting Process	81
4.14	Setting the Measurement Cable Length	82
4.14.1	Control Screen Sequence	82
4.14.2	Details of the Setting Process	83
4.15	Setting and Activating the Comparator	84
4.15.1	Control Screen Sequence	85
4.15.2	Setting the Comparator	85
4.15.3	Returning from Comparator Operation to Normal Testing	88
4.15.4	Choosing How to Set the Upper and Lower Limit Values	88
4.15.5	Setting the Upper or Lower Limit Value as an Absolute Value (ABS)	90
4.15.6	Setting the Upper or Lower Limit Value as a Percentage (%) Relative to a Standard Value	92
4.15.7	Displaying Measurement Values as Deviations from the Reference Value ($\Delta\%$)	95
4.16	Setting and Activating the Scaling	97
4.16.1	Control Screen Sequence	97
4.16.2	Setting Scaling	98
4.16.3	Canceling the Scaling Function	99
4.16.4	Setting the Compensation Coefficient (a, b)	100
4.17	Panel Save Function	102
4.17.1	Control Screen Sequence	102
4.17.2	Details of the Setting Process	103
4.18	Panel Load Function	106
4.18.1	Control Screen Sequence	106
4.18.2	Details of the Setting Process	107
4.19	Setting the Beep Sound	109
4.19.1	Control Screen Sequence	109
4.19.2	Details of the Setting Process	110
4.20	Enlarged Display of Measurement Values	111
4.20.1	Control Screen Sequence	111
4.20.2	Details of the Setting Process	112

4.21	System Reset	113
4.21.1	Control Screen Sequence	113
4.21.2	Details of the Setting Process	114
4.22	Continuous Test Function	116
4.22.1	Control Screen Sequence	116
4.22.2	Details of the Setting Process	117
4.23	Setting the Number of Displayed Digits	120
4.23.1	Control Screen Sequence	120
4.23.2	Details of the Setting Process	121
4.24	Setting for Display	122
4.24.1	Control Screen Sequence	122
4.24.2	Details of the Setting Process	123
4.25	Key Lock Function	124
4.25.1	Turning the Key Lock On and Off	124

Chapter 5 Applications 125

5.1	Example of Comparator Application	125
5.2	Testing High Impedance Elements	127
5.3	Testing an Element in a Circuit	128
5.4	External Interference	129
5.4.1	Countermeasures Against Interference from the Power Supply Line	129
5.4.2	Countermeasures Against Noise from the Test Cables	131
 5.5	The EXT I/O Connector	132
5.5.1	Pinouts for the EXT I/O Connector	132
5.5.2	Signal Lines for the EXT I/O Connector	133
5.5.3	Circuit Construction and Connections for the EXT I/O Connector	135
5.5.4	Electrical Characteristics of the Output Signals	136
5.6	Testing Using EXT I/O	137
5.6.1	Normal Testing	137
5.6.2	Test on the Continuous Test Screen	138
5.7	Supplying DC Bias	140
5.7.1	How to Supply a DC Bias Voltage	141
5.7.2	How to Supply a DC Bias Current	142
5.8	The Residual Charge Protection Function	143

5.9	9442 Printer (option)	144
5.9.1	Preparation	144
5.9.2	Connection Method	146
5.9.3	Control Screen Sequence	147
5.9.4	Returning from Comparator Operation to Normal Testing	148
5.9.5	Screen Copy Mode	149
5.9.6	Auto Print Mode	150
5.9.7	Manual Print Mode	150
Chapter 6 Maintenance, Adjustment, and Disposal		151
6.1	Maintenance and Servicing	151
 6.2	How to Change the Power Supply Fuse and Change the Power Supply Voltage	153
6.3	Shipping the Unit	155
6.4	Troubleshooting	156
6.5	Disposing of the Unit	157
Chapter 7 Specification and Options		159
7.1	General Specification	159
7.2	Testing Parameters and Calculation Equations	164
7.3	Time Taken for Testing	166
7.4	Options	169
7.5	Test Accuracy	172
Index		INDEX 1

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 F1.0AL 20 mm x 5 mm dia.
 - 220 V, 240 V setting: 250 V F0.5AL 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. 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

	<ul style="list-style-type: none"> • 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 (Overvoltage categories)

This instrument complies with CAT I safety requirements.

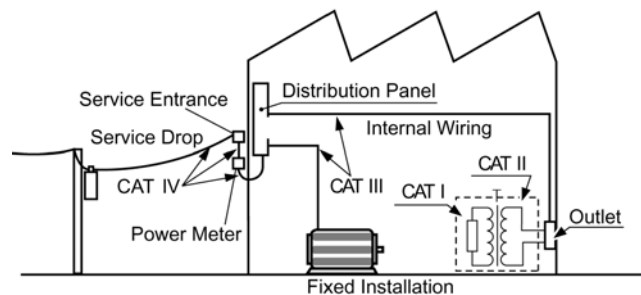
To ensure safe operation of measurement instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT I to CAT IV, and called measurement categories. These are defined as follows.

- CAT I Secondary electrical circuits connected to an AC electrical outlet through a transformer or similar device.
- CAT II Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.)
- 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).

Higher-numbered categories correspond to electrical environments with greater momentary energy. So a measurement device designed for CAT III environments can endure greater momentary energy than a device designed for CAT II.

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.

Never use a CAT I measuring instrument in CAT II, III, or IV environments. The measurement categories comply with the Overvoltage Categories of the IEC60664 Standards.





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 electric shock and ensure safe operation, connect the power cable to a grounded (3-contact) 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°C and 40°C 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°C to 55°C, 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.
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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**
- Index**
-

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.

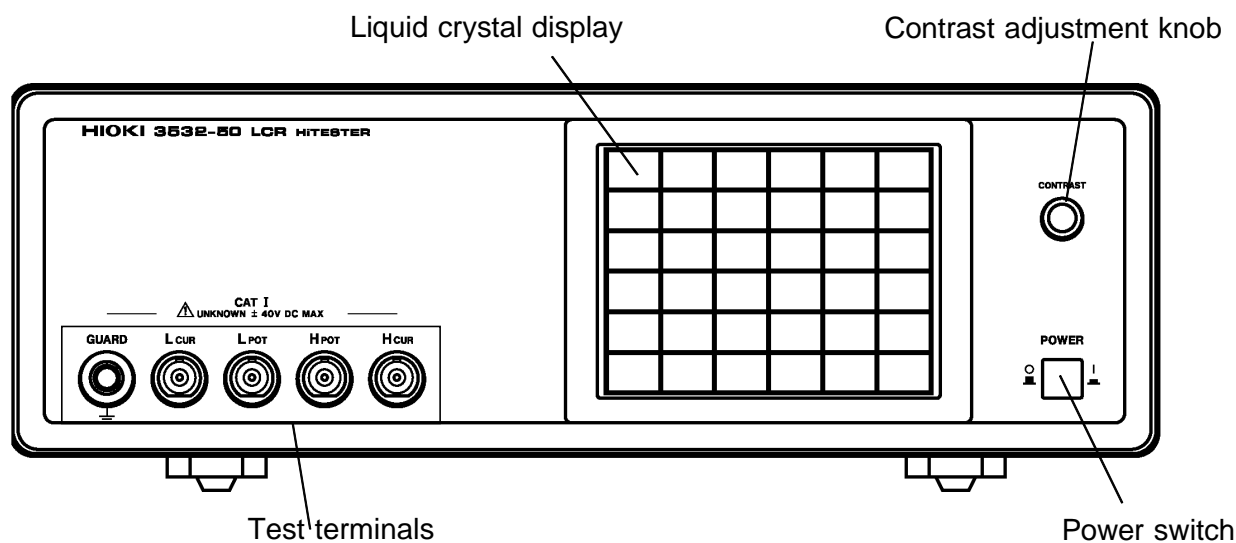
■ Interface

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

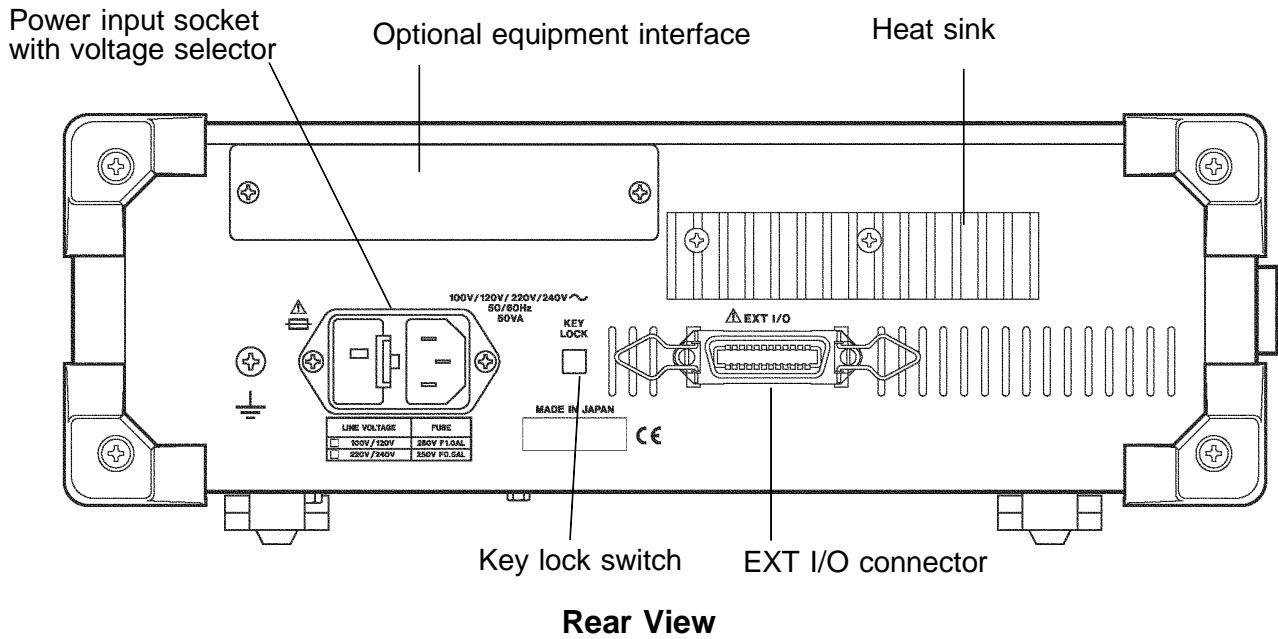
This knob adjusts the screen contrast. Turning it clockwise decreases the contrast, and vice versa.

Test terminals

There are five test terminals:

H _{CUR}	The test signal is supplied to this terminal.
H _{POT}	Detected voltage high terminal
L _{POT}	Detected voltage low terminal
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.

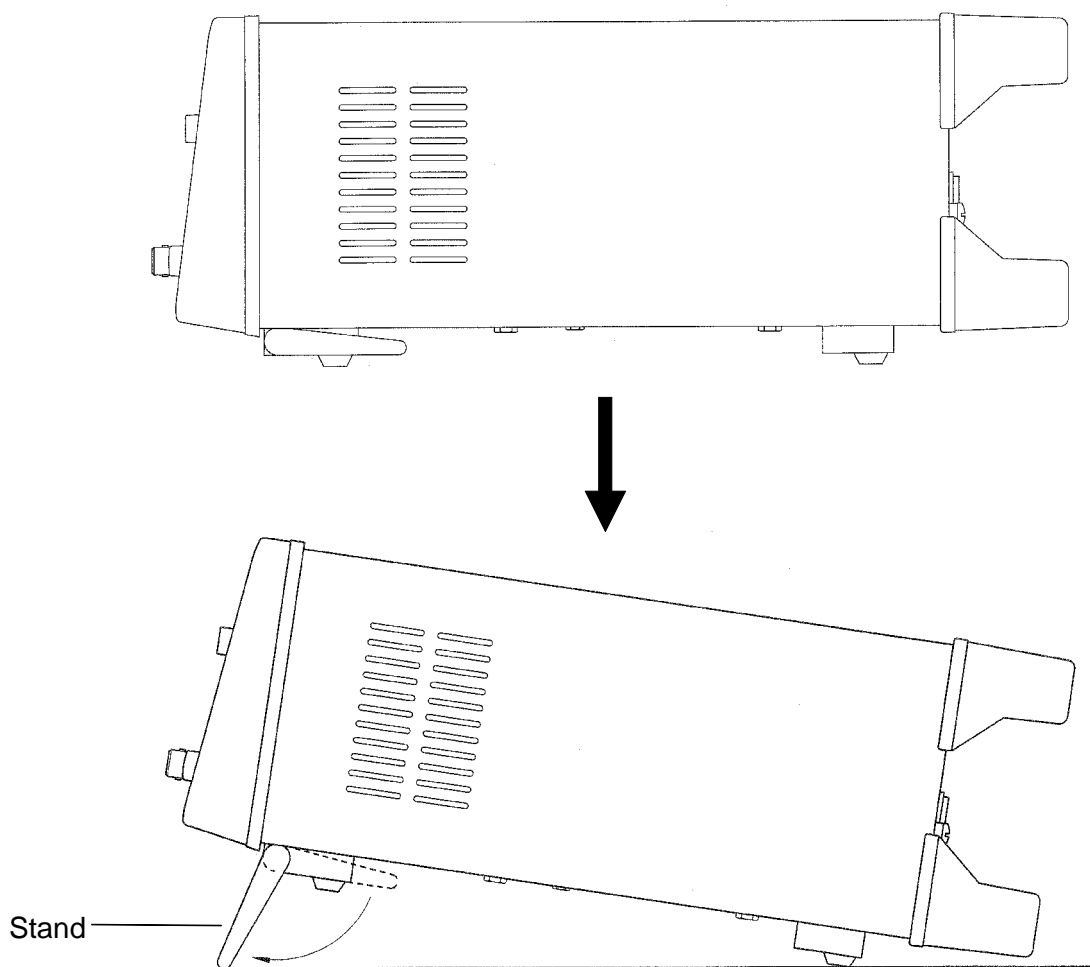


Power input socket (internally fused type) with voltage selector
Connect the supplied power cord here.

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.



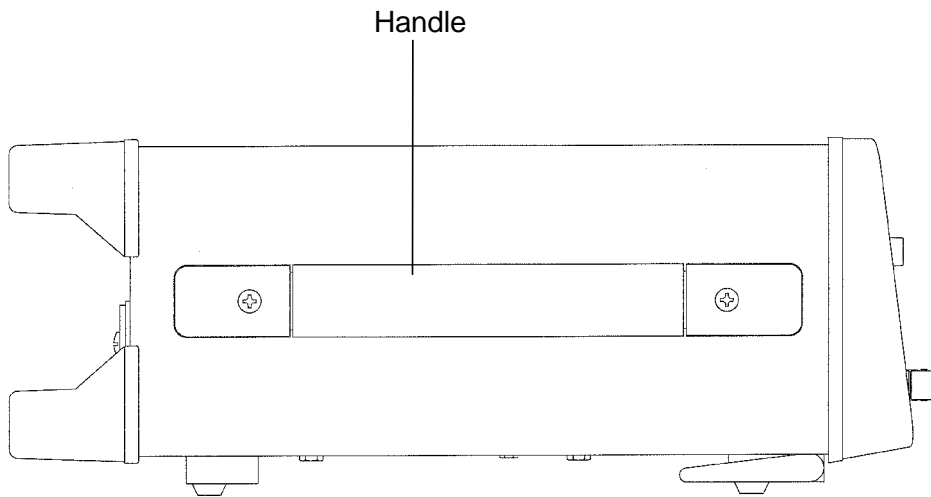
Right View

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

2

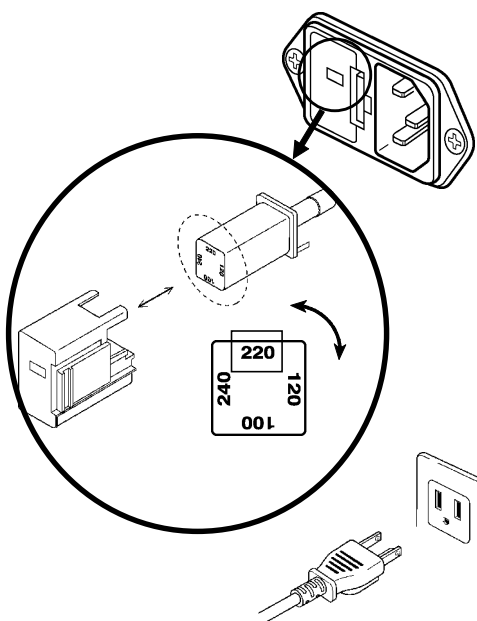
Before Starting Measurement



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 electric shock and ensure safe operation, connect the power cable to a grounded (3-contact) 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.

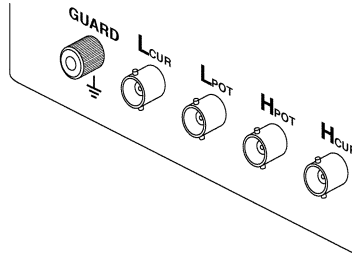
Grounding

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).

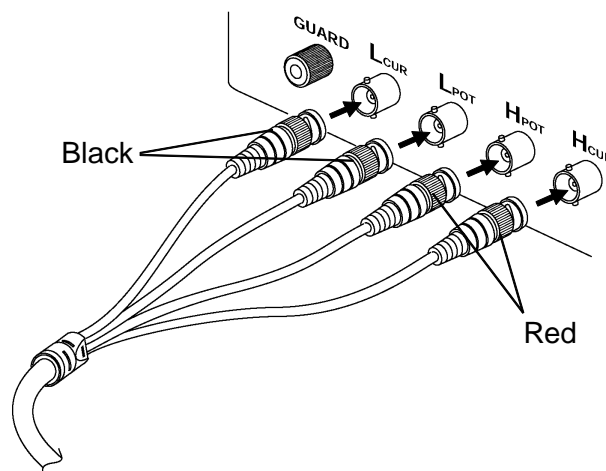


2.2.1 Establishing the Connections

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 H_{CUR} terminal on this unit.
- 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. (For how to apply a DC bias voltage, refer to Section 5.7, "Supplying DC Bias")

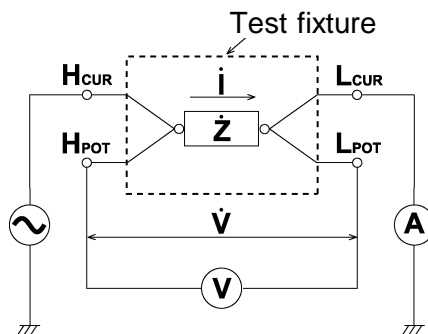
If using a test lead set supplied by HIOKI, connect the red leads to the H_{CUR} terminal and to the H_{POT} terminal, and connect the black leads to the L_{CUR} terminal and to the L_{POT} terminal.



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.

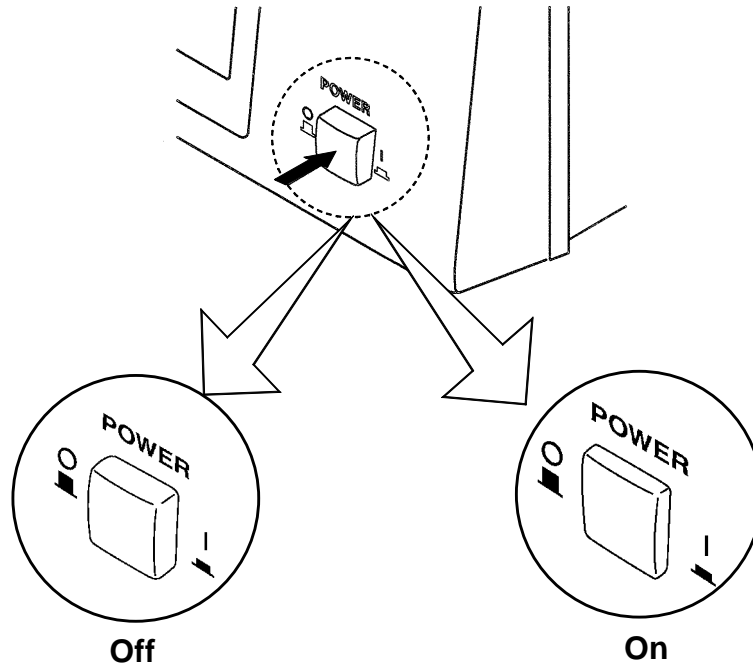


- No test cables are included with the 3532-50 unit. They must be purchased separately. (For details, refer to Section 7.4, "Options")
- If all four terminals are left floating, the numbers which appear on the display are completely meaningless.

2.3 Turning the Power On and Off

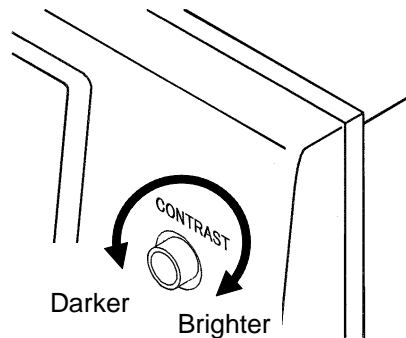
How to turn the power on

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

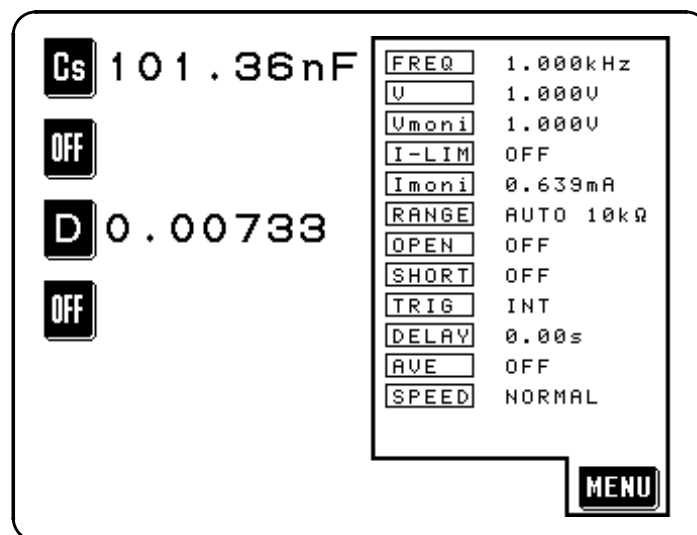
3.1 About the Touch Panel

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.

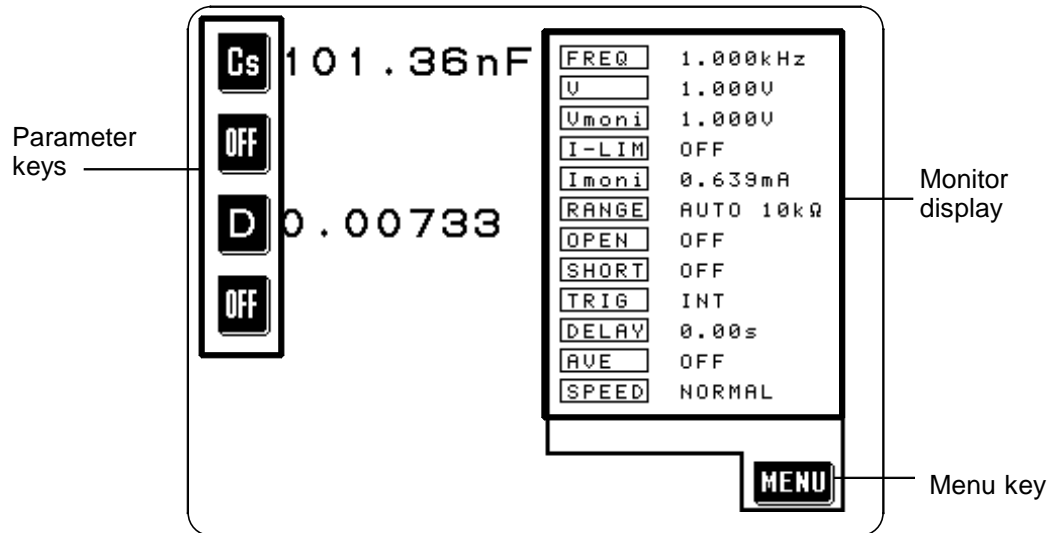


Initial Screen

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.

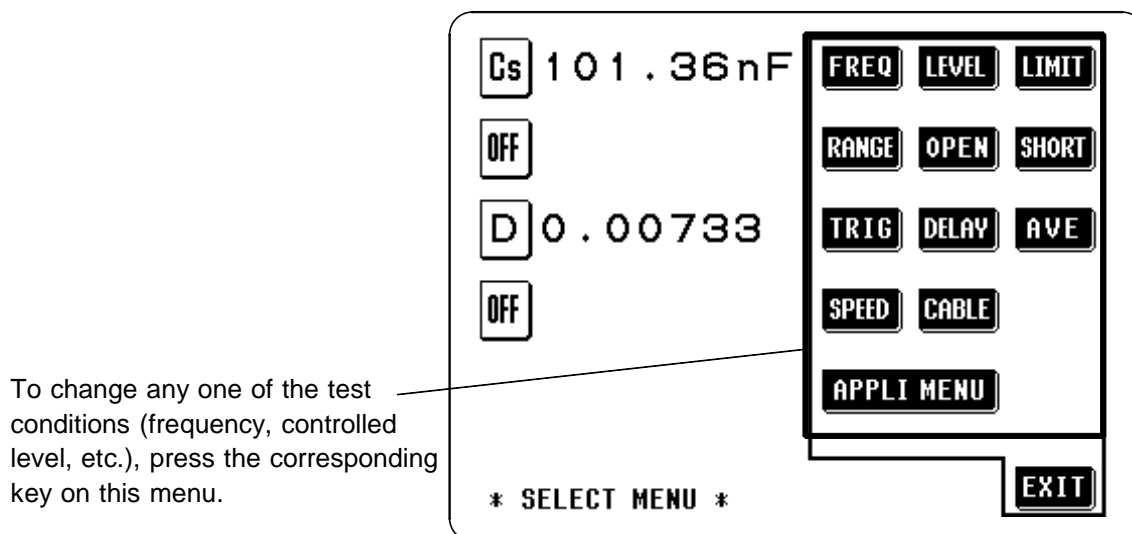


Initial Screen

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.

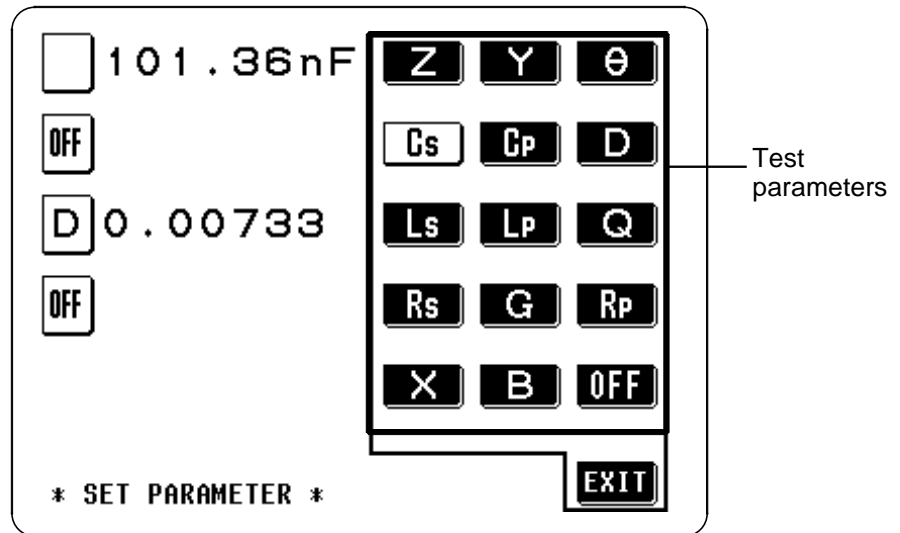


Menu Screen

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

(3) The Parameter setting screen

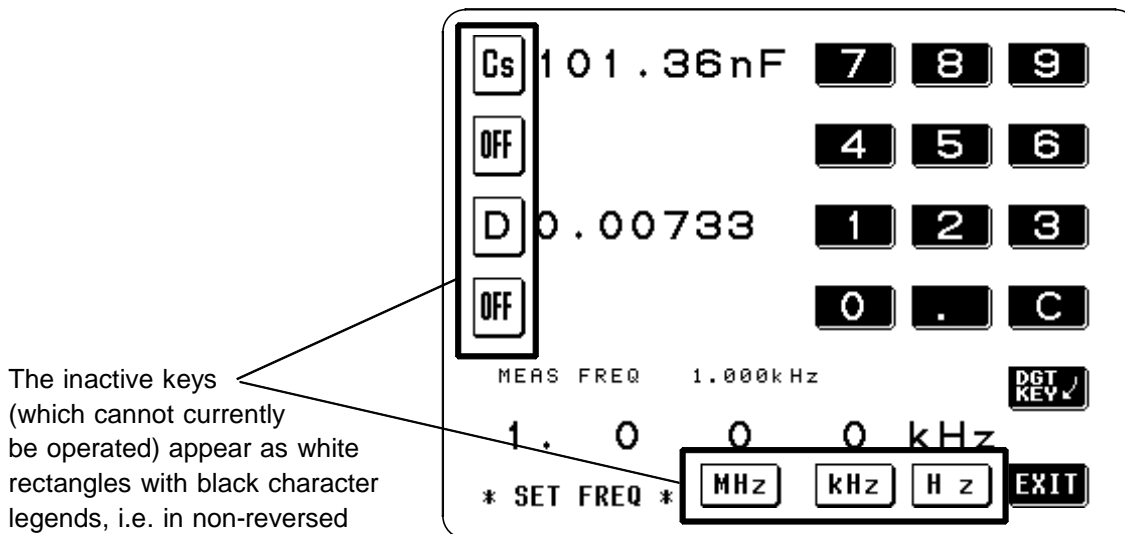
- Pressing a parameter key on the Initial screen causes the Parameter setting screen to be displayed, using which the test parameters to be displayed (up to a maximum of four) are selected.
- By pressing a key for any test parameter, that parameter is set to be displayed, and the unit automatically returns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



Parameter Setting Screen

(4) The Test condition setting screen

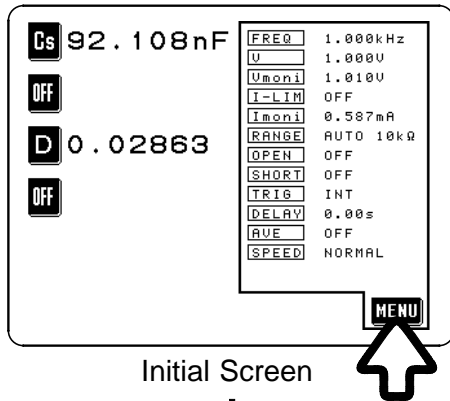
- This screen is for changing a test condition (for example, the test frequency).
- When you have finished setting the test condition, press the **EXIT** key, and the unit will return to displaying the Initial screen again.



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.

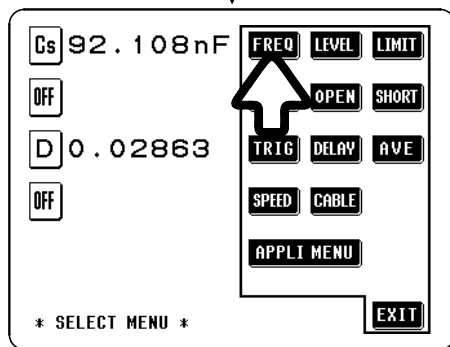


Initial Screen

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:

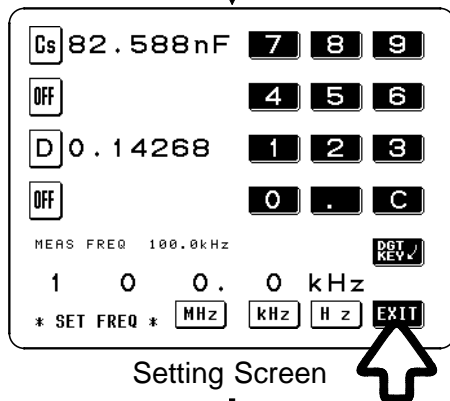
Press the **MENU** soft key, and the Menu screen will be displayed.



Menu Screen

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

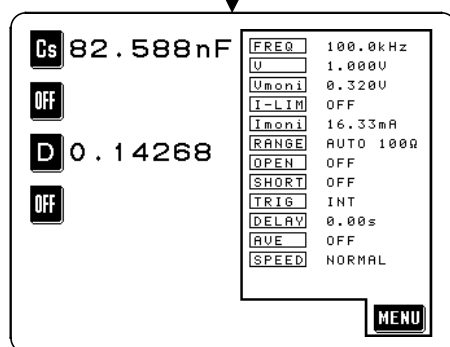
Press the **FREQ** soft key, and the Frequency setting screen will be displayed.



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.



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:

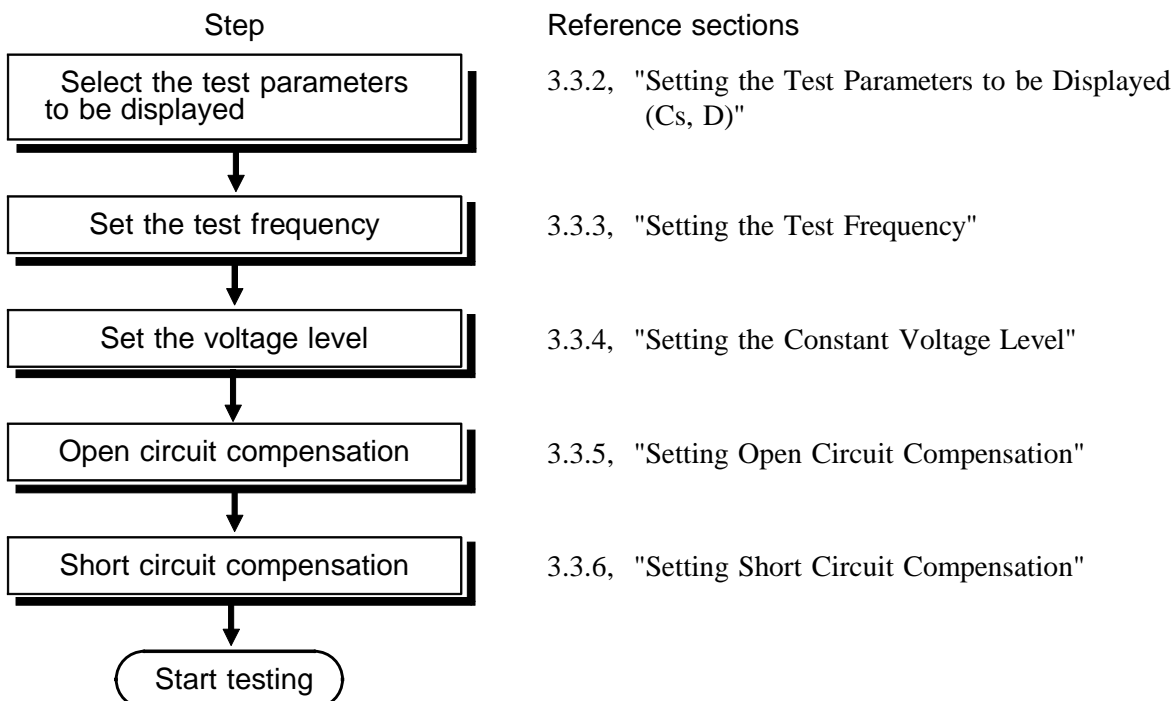
Example	Sample to be tested	
	Capacitor	0.1 μF
	Test conditions	
	Test frequency	100 kHz
	Constant voltage level	0.4 V
	Open circuit compensation setup	ALL compensation
	Short circuit compensation setup	ALL compensation
	Parameters to be displayed	
	Capacitance Cs, Loss coefficient D	

NOTE

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

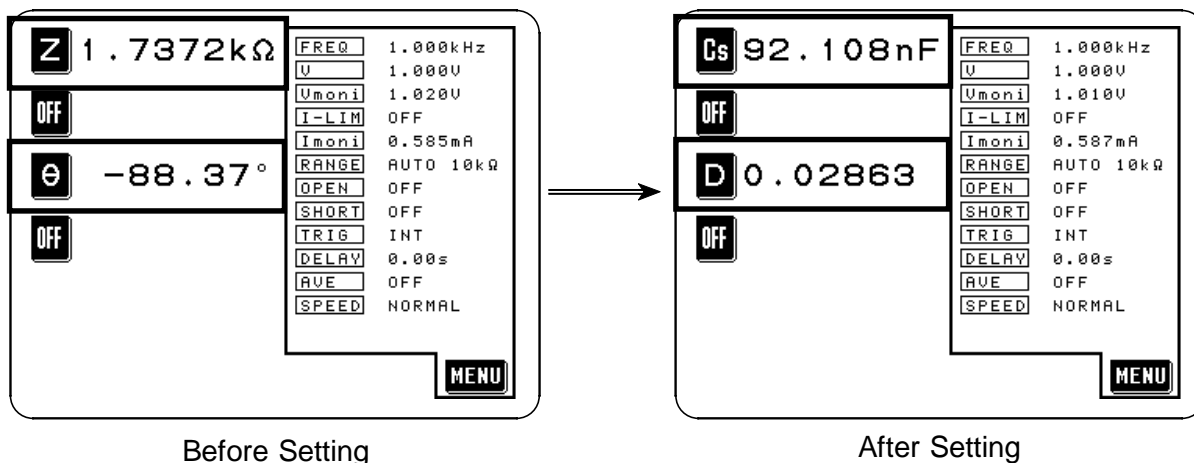
3.3.1 Basic Flow up to Testing of the Sample

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

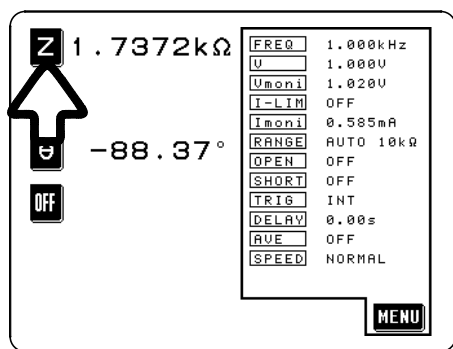


3.3.2 Setting the Test Parameters to be Displayed (Cs, D)

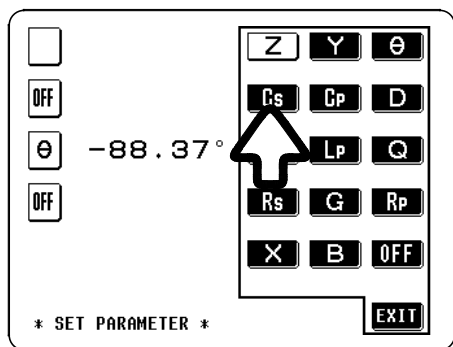
Here the first (i.e., the uppermost) parameter key will be set to capacitance Cs, and the third parameter key will be set to loss coefficient D.



Setting procedure



Initial Screen



Parameter Setting Screen

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

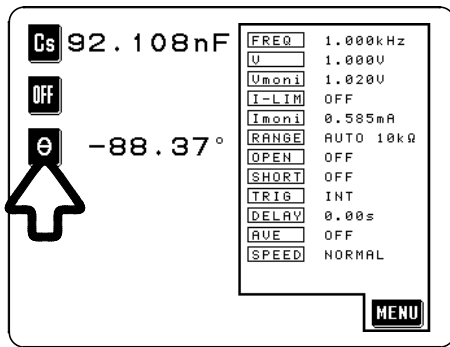
2. The Parameter setting screen is displayed. (The test parameter (currently Z) to which the pressed parameter key currently corresponds is shown in black characters on a white ground, i.e. in non-reversed video).

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.

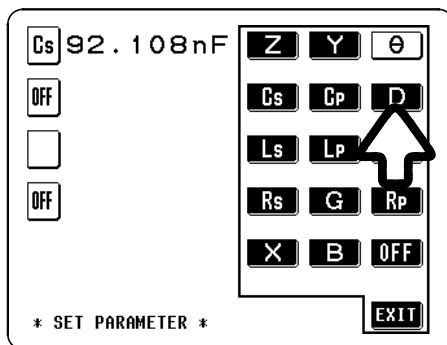
NOTE

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.



Initial Screen

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

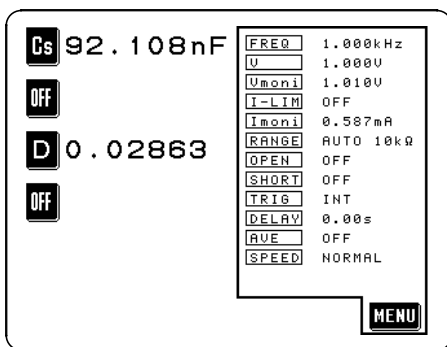


Parameter Setting Screen

- 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.



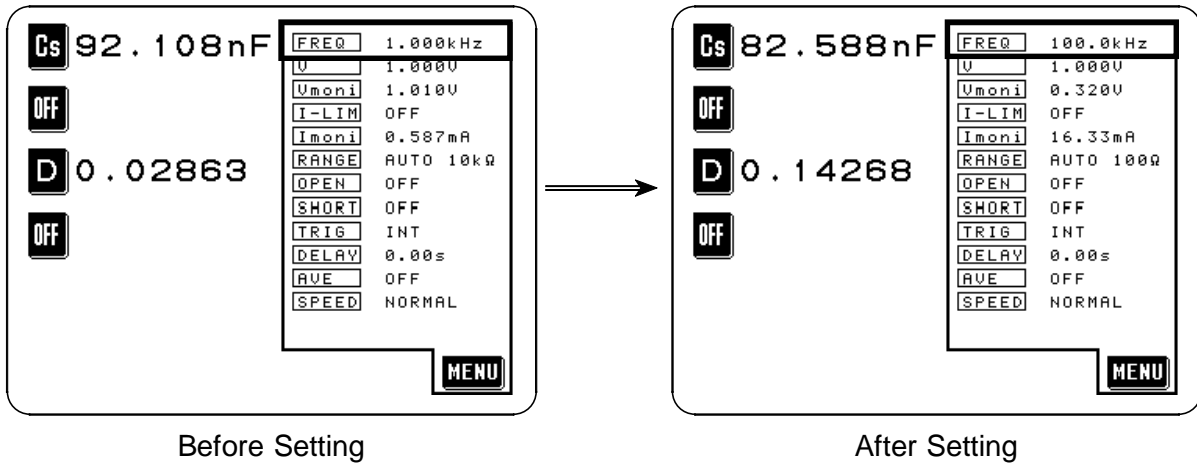
Initial Screen

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

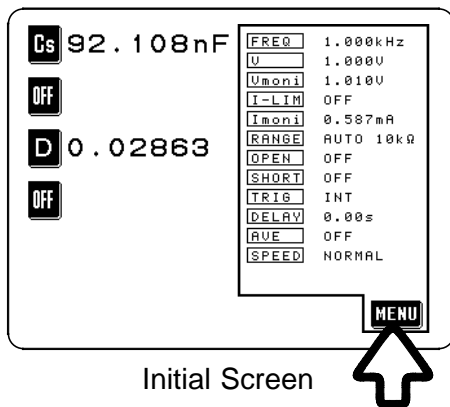
For details, refer to Section 4.2, "Setting the Parameters to be Displayed".

3.3.3 Setting the Test Frequency

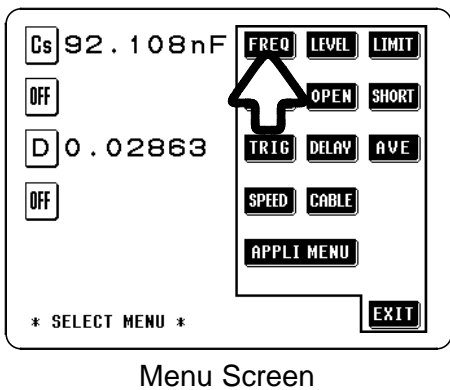
The following explanation shows how to set the test frequency to 100 kHz, as an example.



Setting procedure



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 one of the frequency setting screens will be displayed.

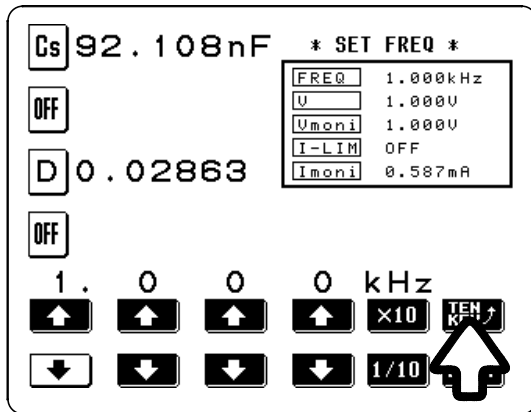
There are actually two frequency setting screens. The display can be switched over between these two screens just by pressing a particular soft key.

The Digit screen

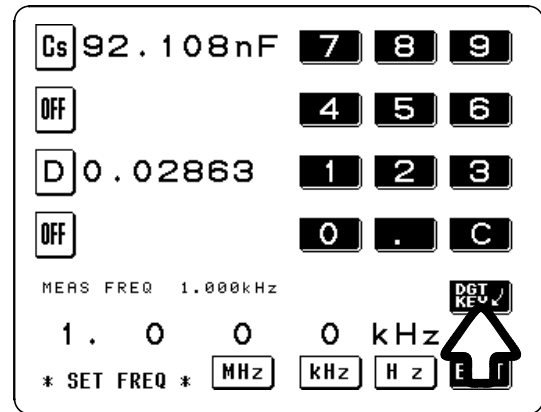
The Ten key screen

The test frequency is input using the  and  digit keys.

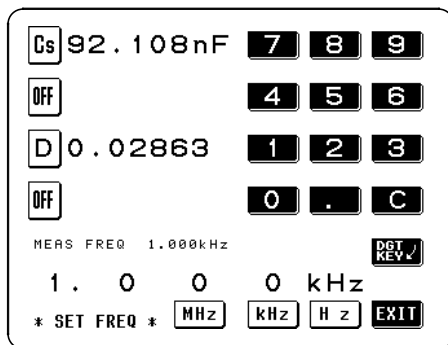
A numerical value for the test frequency is input directly.



Digit Screen

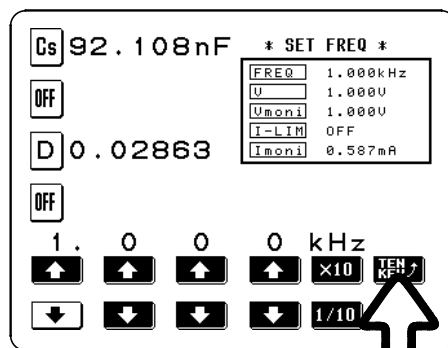


Ten Key Screen




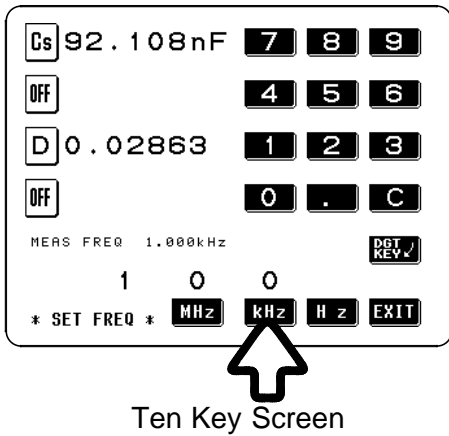
Ten Key Screen

- 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.



Digit Screen

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



Ten Key Screen

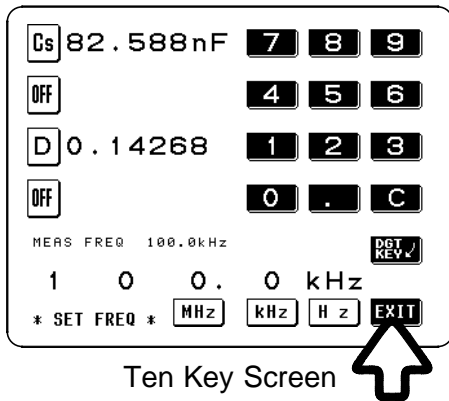
- Press the keys **1**, **0**, and **0** in succession on the ten key pad.

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.

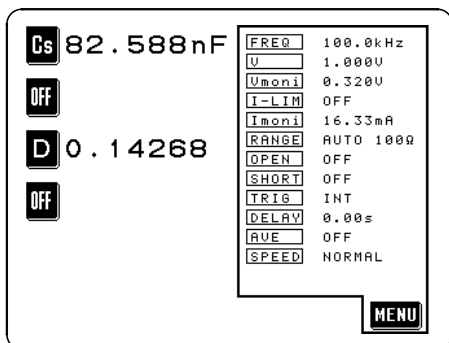
NOTE

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.

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



Ten Key Screen

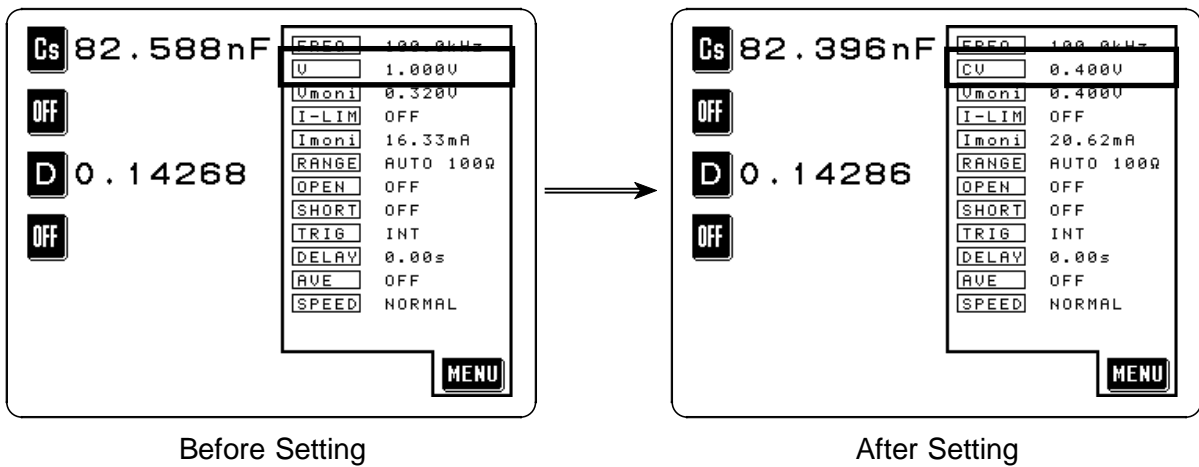


Initial Screen

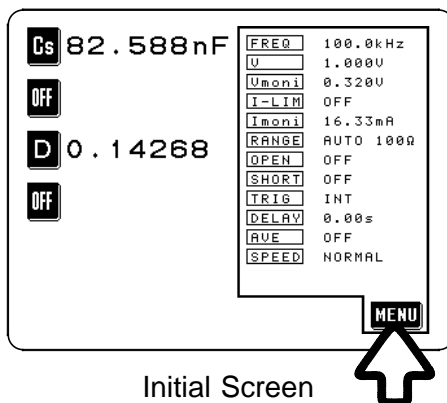
For details, refer to Section 4.3, "Setting the Test Frequency".

3.3.4 Setting the Constant Voltage Level

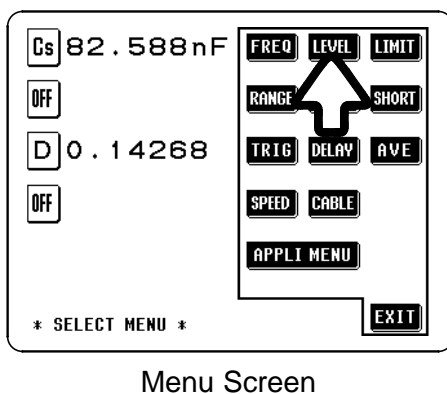
The following explanation shows, as an example, how to set the value for the constant voltage level to 0.4 V.



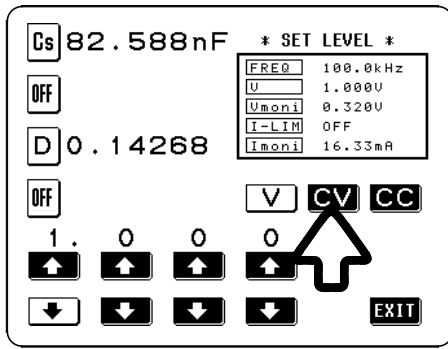
Setting procedure



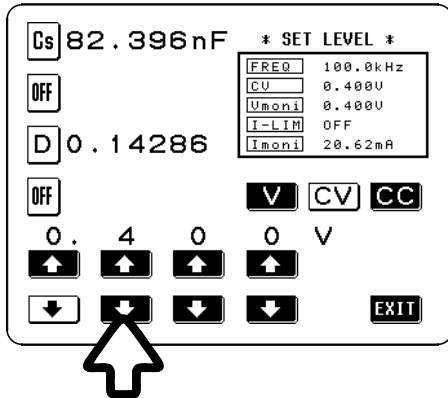
1. On the Initial screen, press the **MENU** key, and the Menu screen will be displayed.



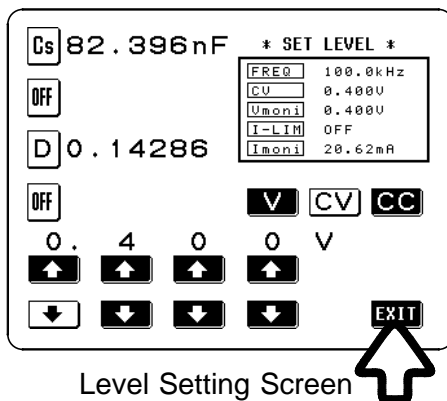
2. Press the **LEVEL** key on the Menu screen, and the Level setting screen will be displayed.



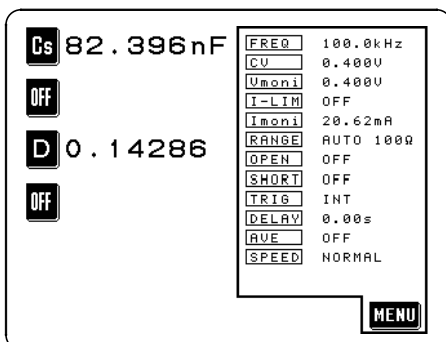
Level Setting Screen



Level Setting Screen



Level Setting Screen



Initial 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.

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.)

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

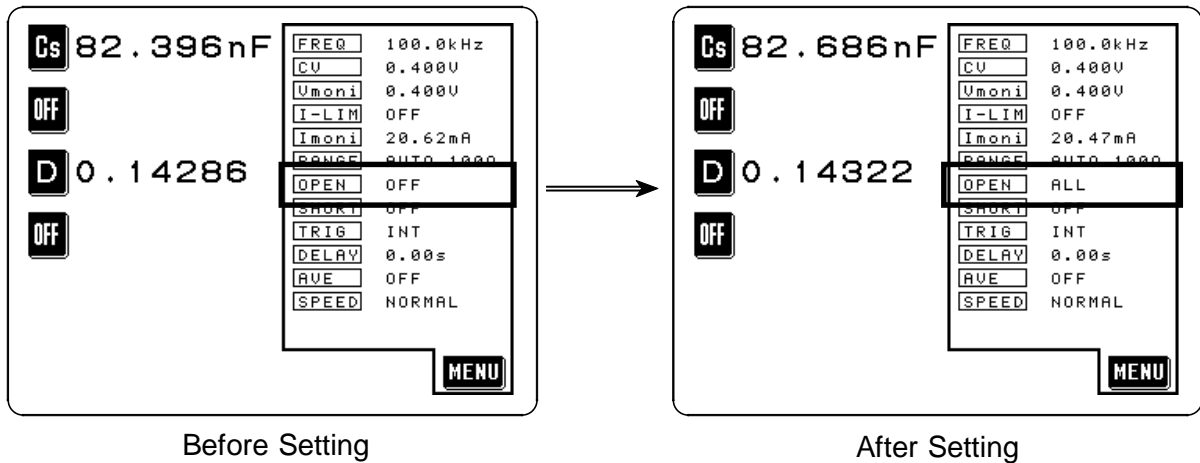
NOTE

- 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)

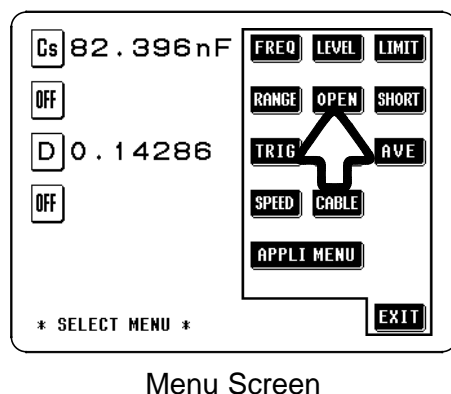
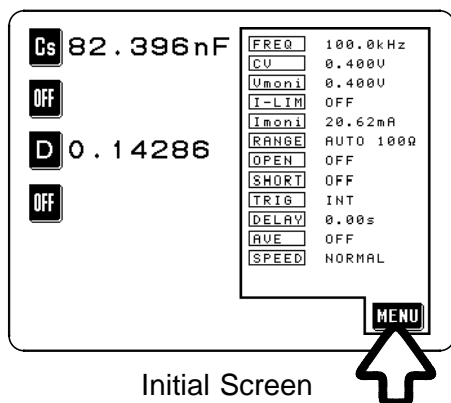
For details, refer to Section 4.4, "Setting the Test Signal Level"

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.



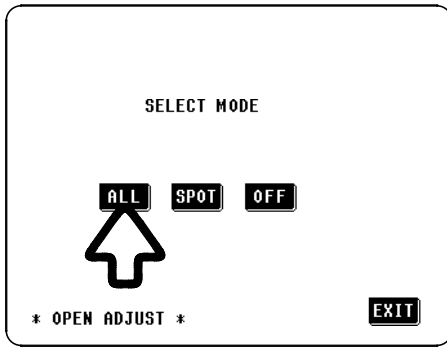
Setting procedure



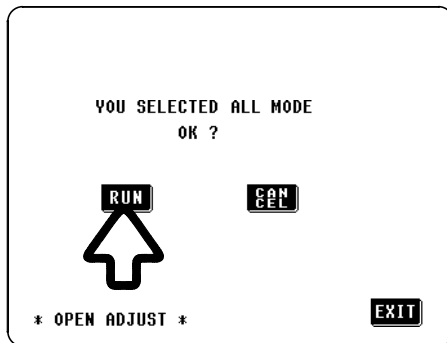
1. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and make sure that the HIGH and LOW leads are not contacted together.

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

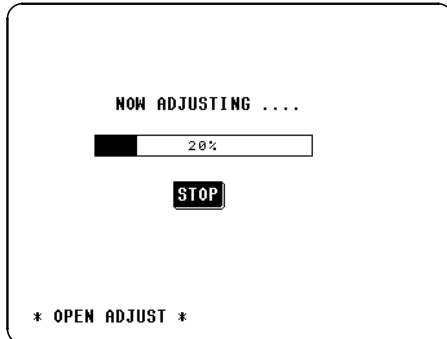
2. On the Initial screen, press the **MENU** key, and the Menu screen will be displayed.
3. Press the **OPEN** key on the Menu screen, and the Open circuit compensation screen will be displayed.



Open Circuit Compensation Screen



Confirmation Screen



Data Determination 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.

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

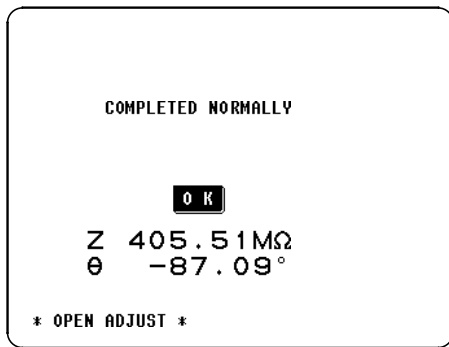
NOTE

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

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.

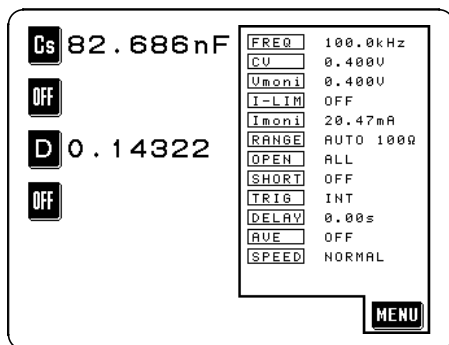


Confirmation Screen

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".)



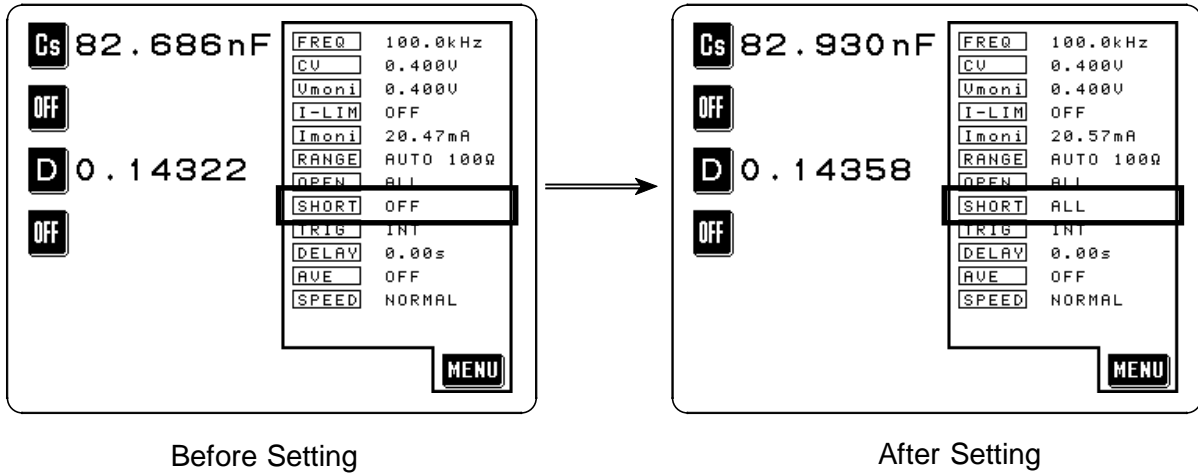
Initial Screen

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

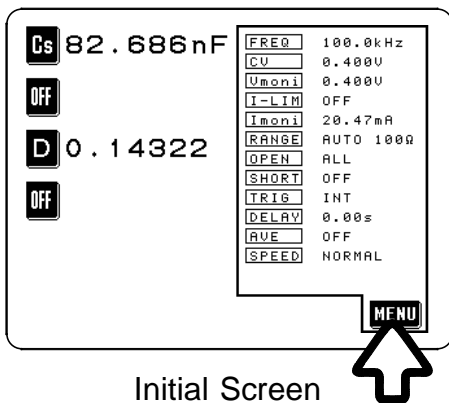
For details, refer to Section 4.7, "Open Circuit Compensation".

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.

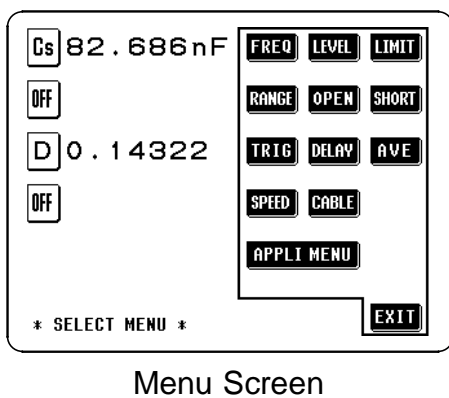


Setting procedure

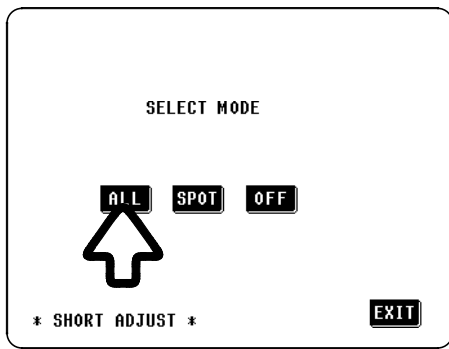


1. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and short circuit together the HIGH and LOW leads using a shorting bar. (Refer to Section 4.8.2 for information about the shorting bar.)

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

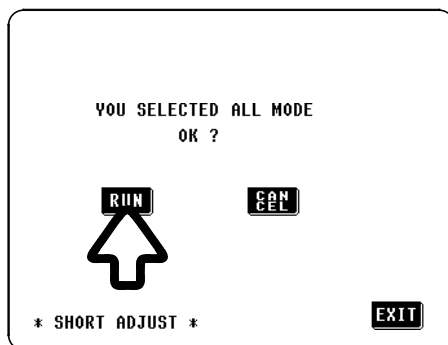


3. Press the **SHORT** key on the Menu screen, and the Short circuit compensation screen will be displayed.



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.

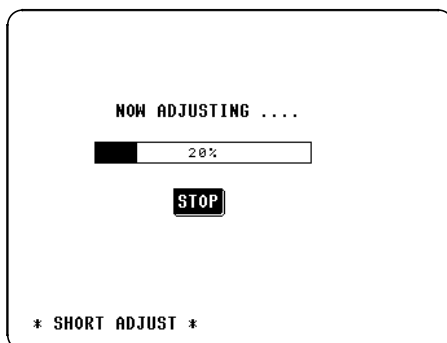


Confirmation Screen

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

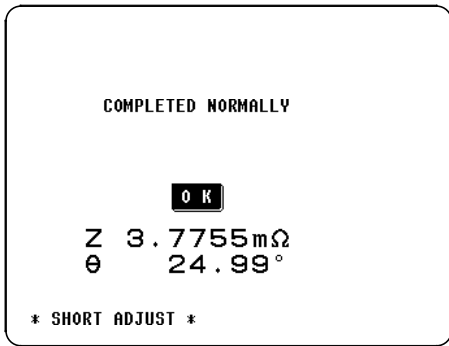
NOTE

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



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.

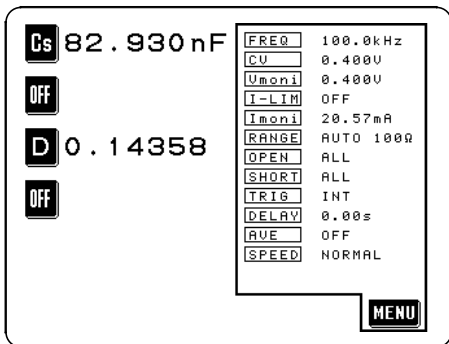


Confirmation Screen

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".)



Initial Screen

8. After checking the short circuit residual component and its phase angle, press the **OK** 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

4.1 Description of the Screens

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

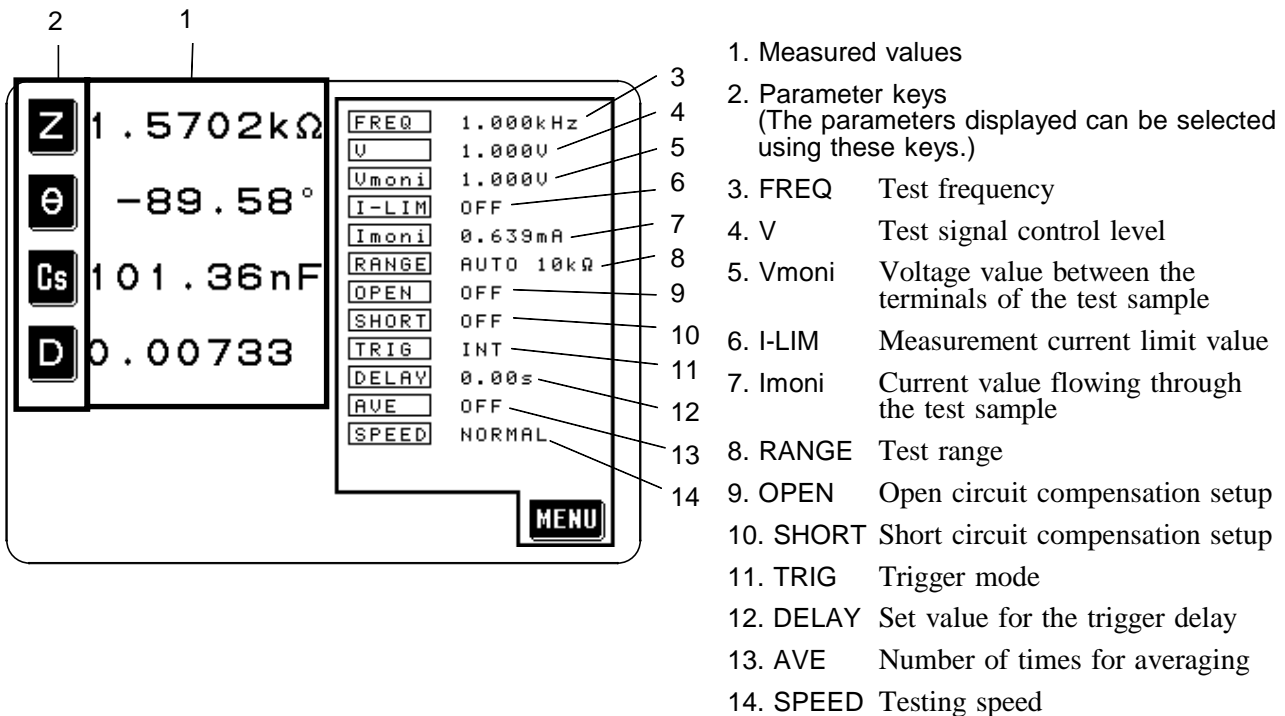
4.1.1 The Initial Screen

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.)

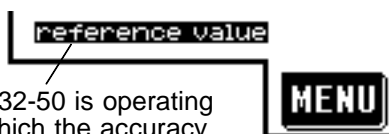
When powering on again, the screen when the power has been turned off on the following screens is displayed.

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



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.

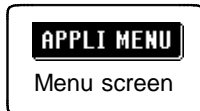
4.1.2 The Menu Screen and Application Menu Screen



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.

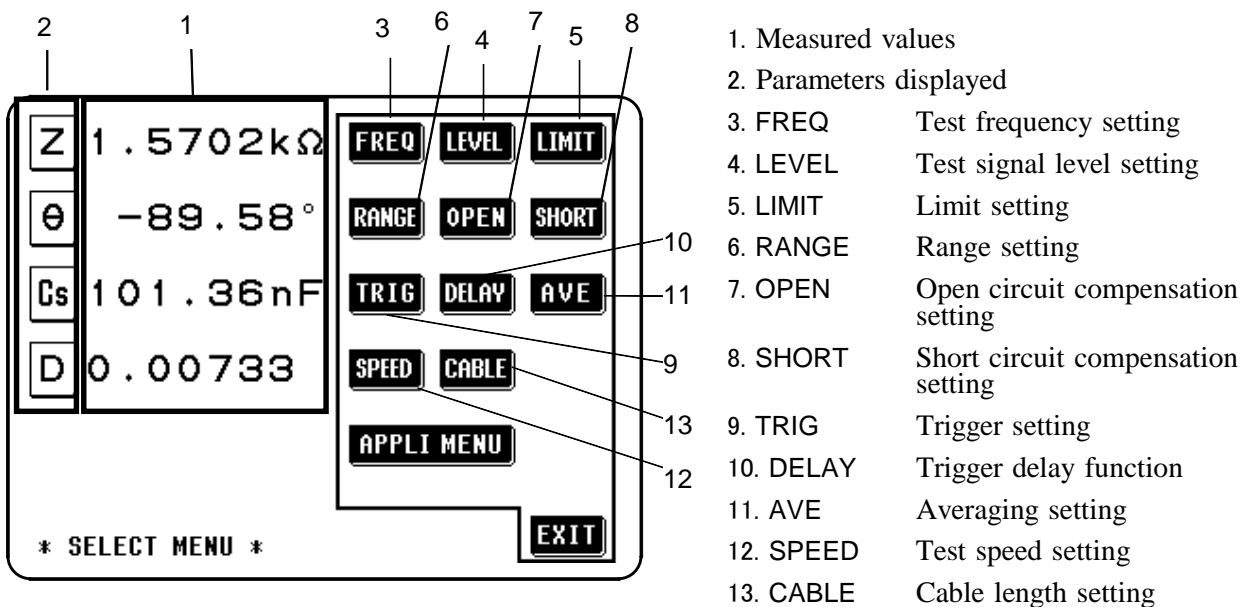


To display the Application screen

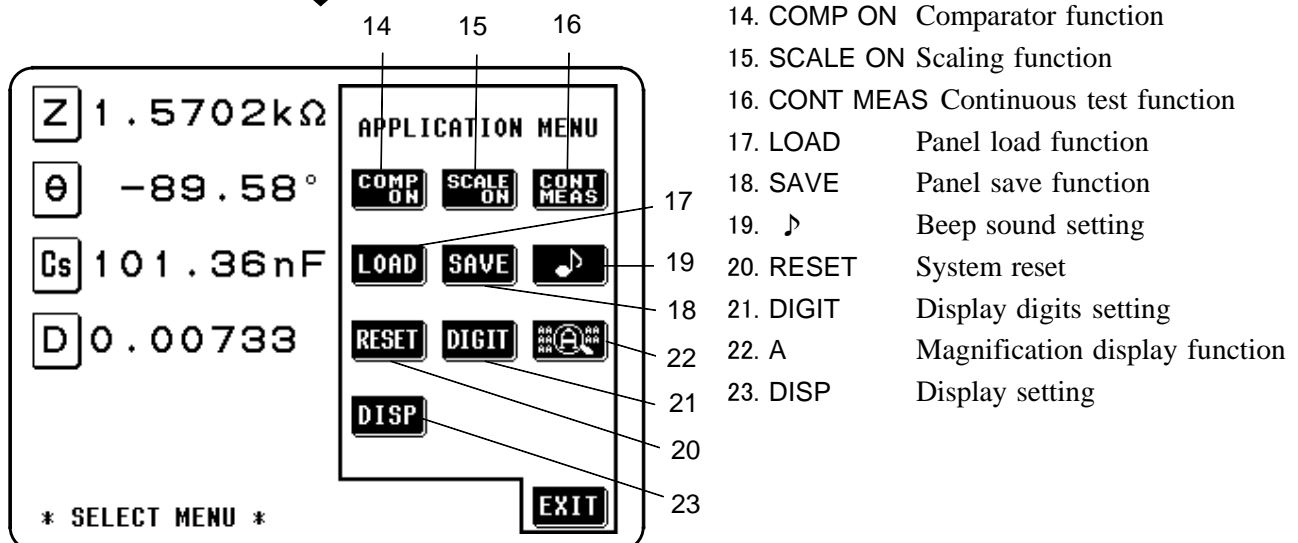
Press the **APPLI MENU** key on the Menu screen.

It is possible to access the various application function setting screens from this screen.

4



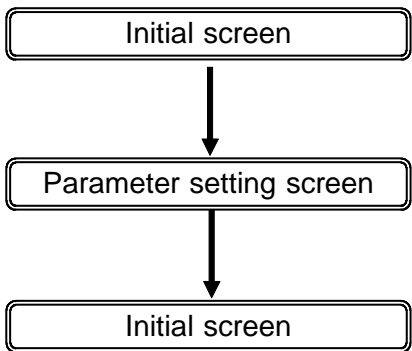
APPLI MENU



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.

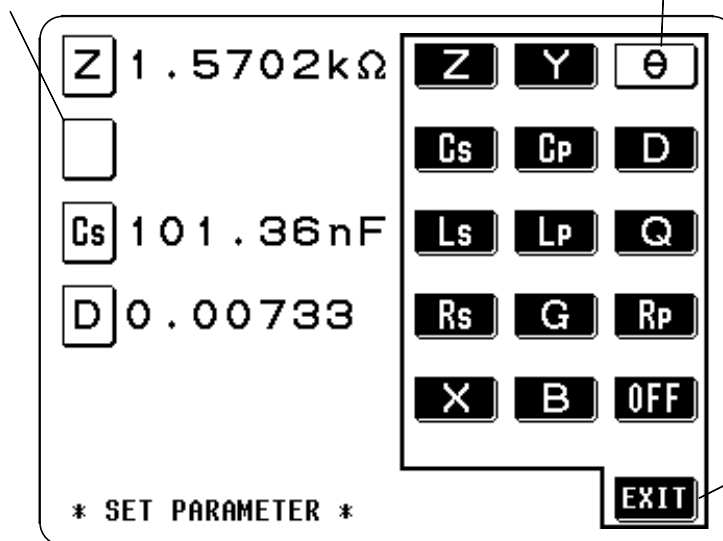
4.2.2 Details of the Setting Process

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).



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 ($^{\circ}$) *1
Cs	static capacitance in series equivalent circuit mode (F)
Cp	static capacitance in parallel equivalent circuit mode (F)
D	loss coefficient= $\tan\delta$
Ls	inductance in series equivalent circuit mode (H)
Lp	inductance in parallel equivalent circuit mode (H)
Q	Q factor
Rs	effective resistance in series equivalent circuit mode (Ω)=ESR
Rp	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 analyses the test sample in terms of a pure inductive component (L), an equivalent circuit construction composed of a pure capacitive component (C), and a pure resistive component (R), and calculates as though these components were connected in series, or alternatively connected in parallel. Therefore, it is possible for the user to select either a series equivalent circuit mode or a parallel equivalent circuit mode for this conceptual connection together of these L , C , and R components.

When the impedance of the sample being tested is relatively high, L_p , C_p , and R_p for the parallel equivalent circuit mode should be selected manually, and when the impedance of the sample being tested is relatively low, L_s , C_s , and R_s for the series equivalent circuit mode should be selected manually. Generally, for a device such as an electrolytic capacitor or the like with a high D value (i.e., a low Q value), the test values obtained when testing using series equivalent circuit mode differ from those obtained when testing using parallel equivalent circuit mode. The greater the resistance component in the sample being tested, the more this difference in the test values appears.

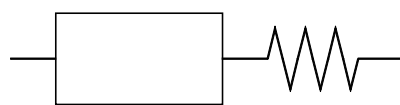
For example, the test values for capacitors of the same capacitance which have different values of D in series equivalent circuit mode and in parallel equivalent circuit mode may be as follows:

	Series equivalent circuit mode	Parallel equivalent circuit mode
$D = 0$	C	C
$D = 0.1$	$1.005C$	$0.995C$
$D = 0.5$	$1.118C$	$0.8944C$

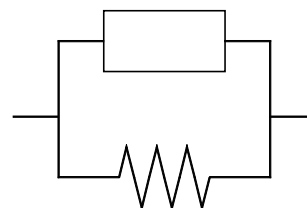
(Where C is the static capacitance)

Therefore it is necessary for the user clearly to understand the setting of this test mode, in order properly to assess test samples.

In general, parallel equivalent circuit mode should be used for elements which have relatively low capacitance and high impedance such as film capacitors and ceramic capacitors, since parallel resistance can cause great loss in this case; while series equivalent circuit mode should be used for elements which have relatively high capacitance and low impedance such as electrolytic capacitors, since series resistance can cause great loss in this case.



Series equivalent circuit



Parallel equivalent circuit

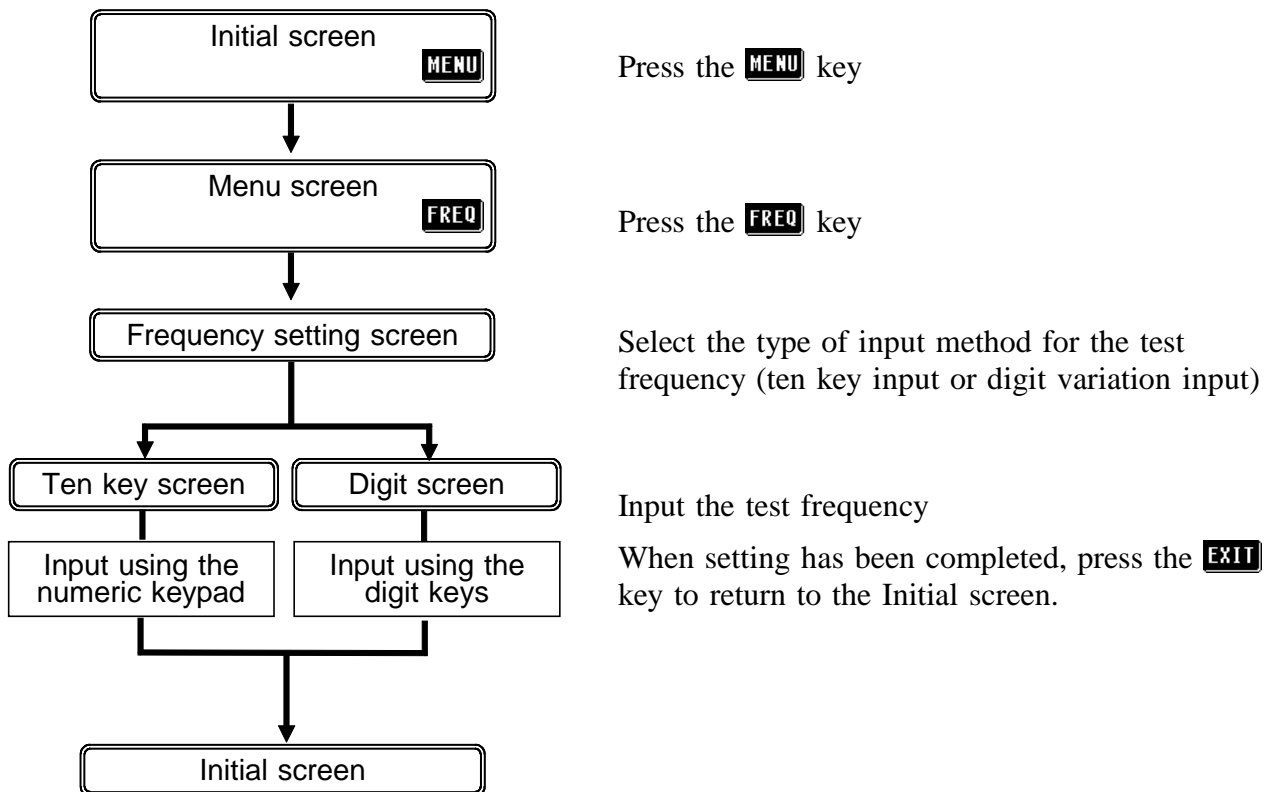
4.3 Setting the Test Frequency

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.

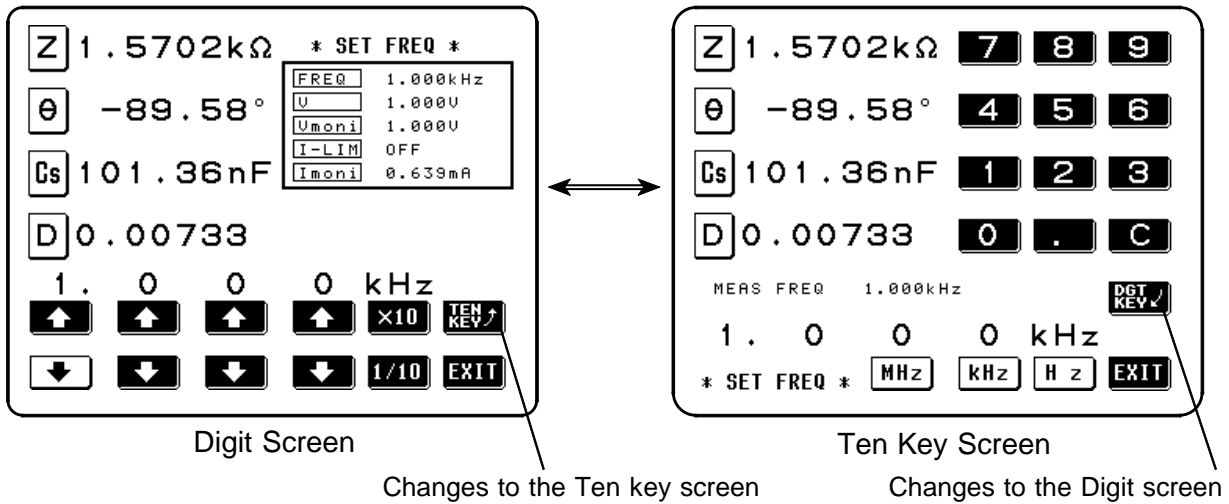
The Ten key screen The numerical value for the test frequency is directly input using the numeric keypad (on the touch panel).
The Digit screen Each digit of the test frequency can be varied by using the appropriate up and down keys.

4.3.1 Control Screen Sequence



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.

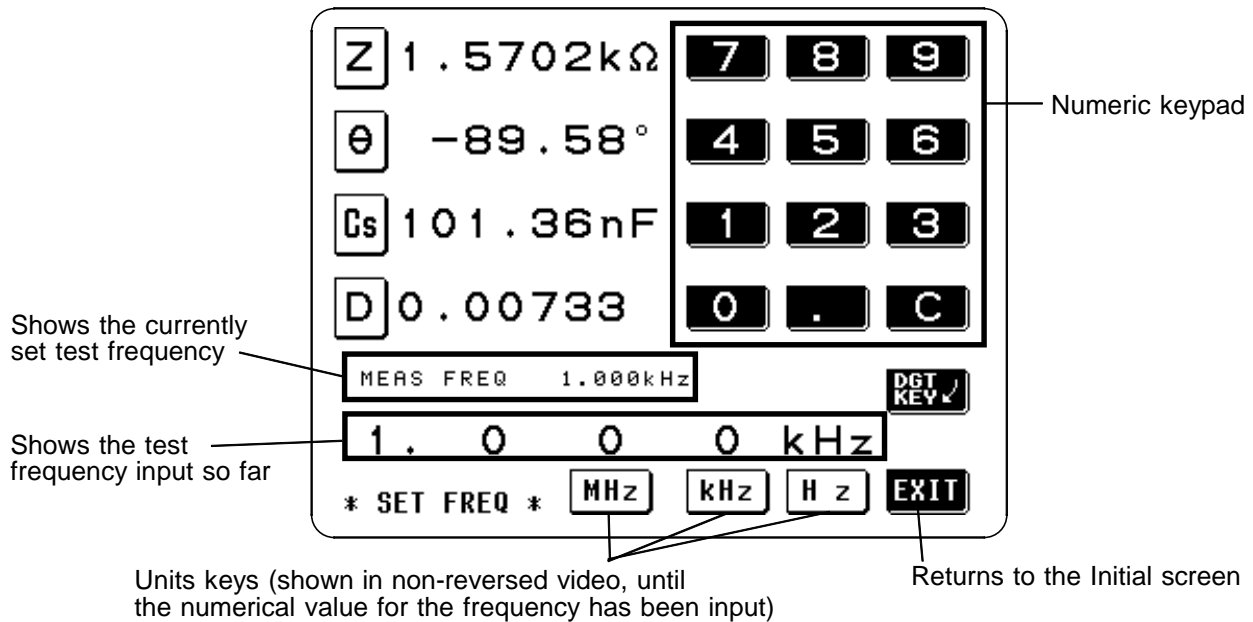


- Some test ranges and test signal levels are unavailable at certain test frequencies. These ranges and levels can be checked using the table below.
- If the test frequency is set to a specific value, the maximum values are automatically selected when the test range and test signal level settings exceed 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.

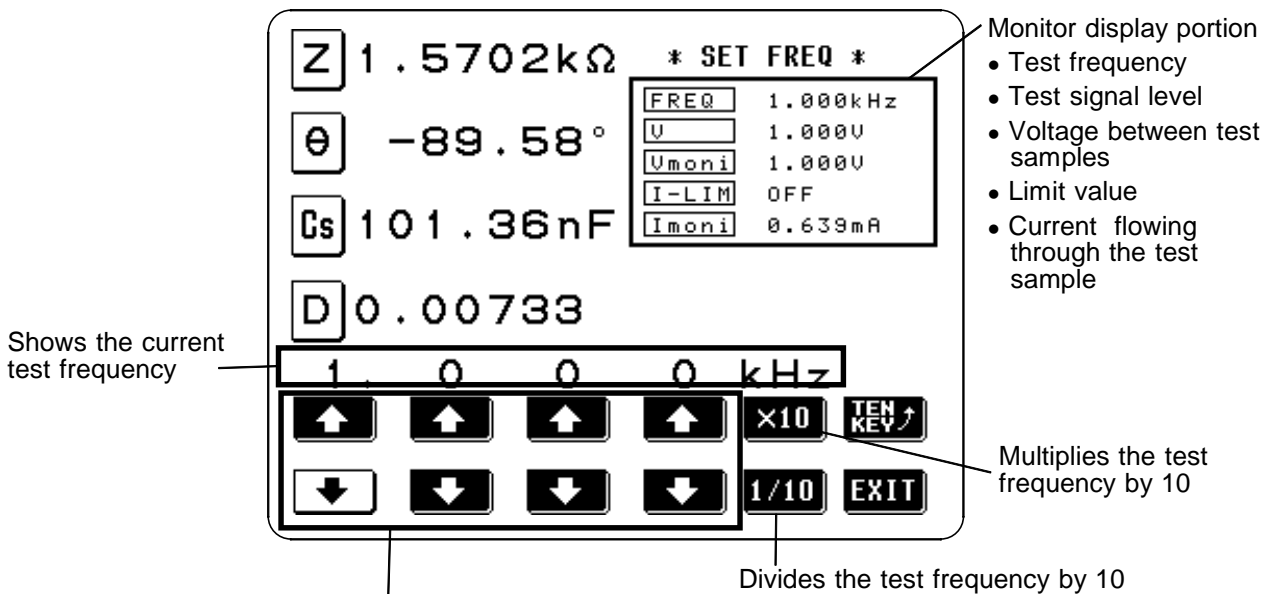
If you attempt to set a test frequency lower than 42 Hz, it will automatically be increased to 42 Hz.

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.



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:

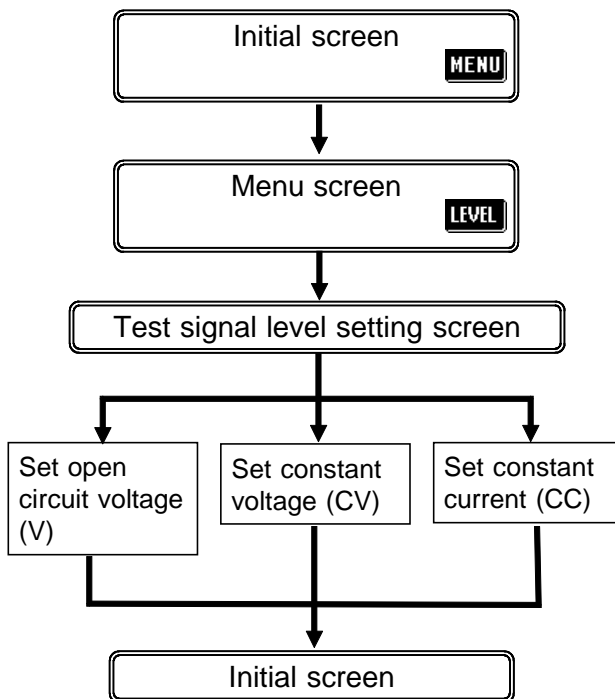
Set open circuit voltage (V)
Set constant voltage (CV)

The value of the open circuit voltage is set.
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.

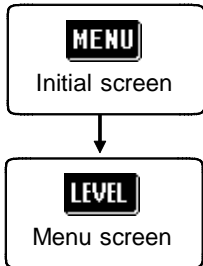
Input the value for the test signal level.

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

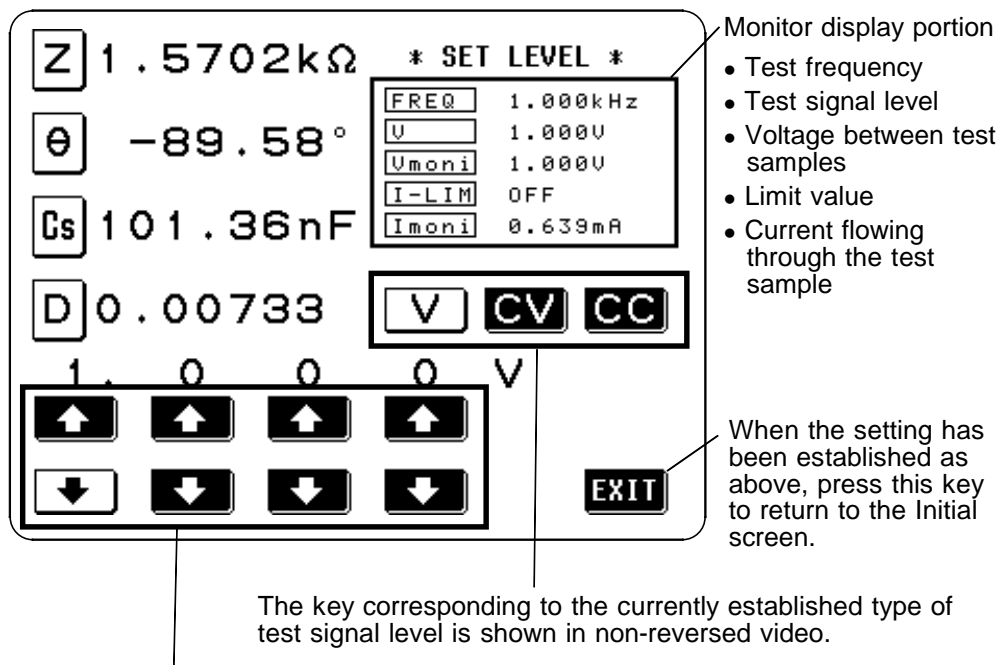
4.4.2 Selecting the Level Type

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.



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.



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.

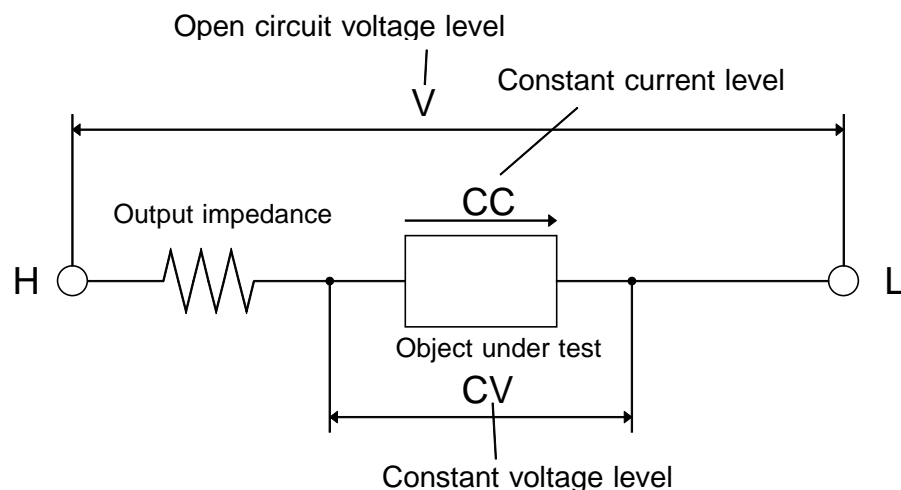
Imoni 1.627mA
reference value

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.

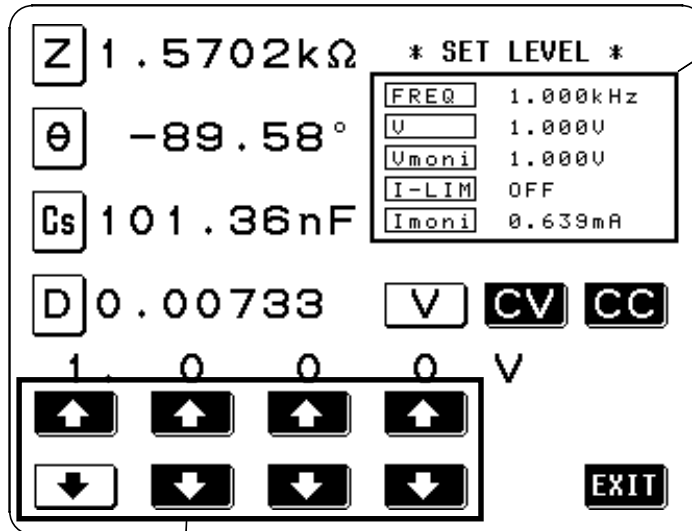
Constant current level (CC)

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



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



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 $\pm 10\% \pm 10$ mV for 42.0 Hz to 1.000 MHz, and $\pm 20\% \pm 10$ mV for 1.001 MHz to 5.000 MHz.

NOTE

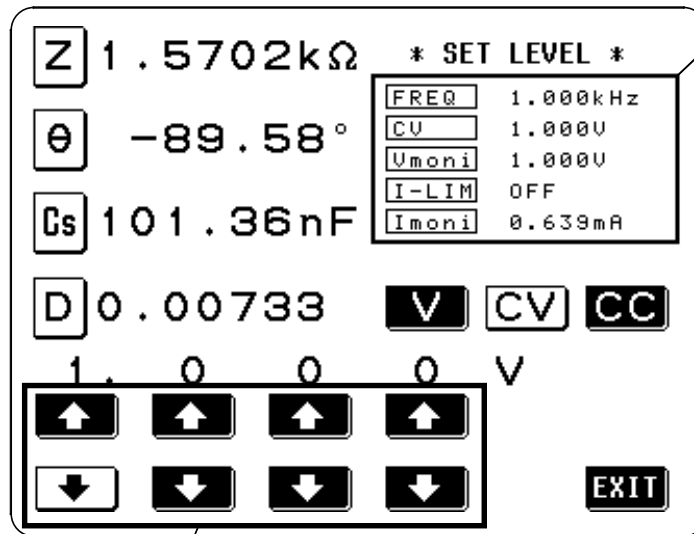
When the test frequency is higher than 1 MHz at an open-circuit voltage of more than 1 V, the voltage is automatically set to 1 V.

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



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



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 $\pm 10\% \pm 10$ mV for 42.0 Hz to 1.000 MHz, and $\pm 20\% \pm 10$ mV for 1.001 MHz to 5.000 MHz.

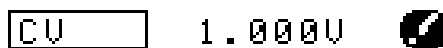
NOTE

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:



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 μ F capacitance is measured at 10 kHz, the CV operation range can be obtained as follows. Sample impedance Z_m becomes as follows:

$$Z_m = R_m + jX_m = 0\Omega - j15.9\Omega \quad X_m = -1/(2\pi fC)$$

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

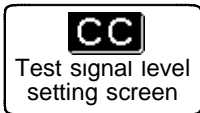
$$Z_m' = R_o + Z_m = 50\Omega - j15.9\Omega \quad R_o: \text{Output resistance (50 } \Omega)$$

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

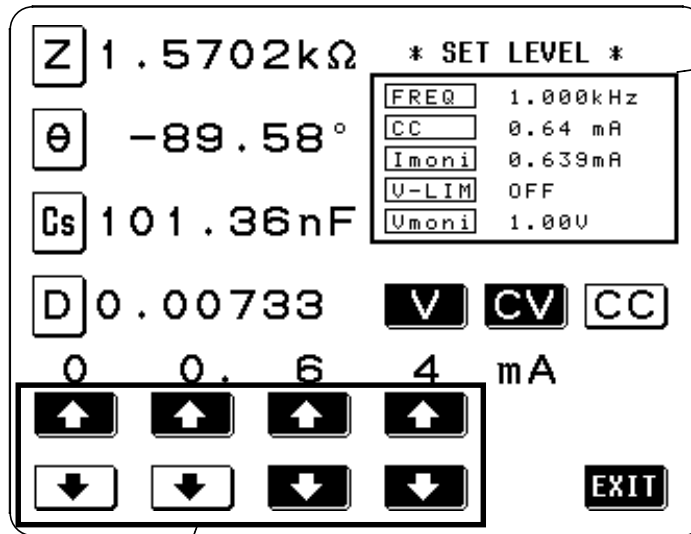
$$V_m = |Z_m| \times V_o / |Z_m'| \quad V_o: \text{generator output} \\ = 15.9\Omega \times V_o / 52.5\Omega$$

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

4.4.5 Setting the Constant Current (CC) Level



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



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 $\pm 10\% \pm 10\mu\text{A}$ for 42.0 Hz to 1.000 MHz, and $\pm 20\% \pm 10\mu\text{A}$ for 1.001 MHz to 5.000 MHz.

NOTE

When the test frequency is higher than 1 MHz at a 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 Z_m becomes as follows:

$$Z_m = R_m + jX_m = 0\Omega + j62.8\Omega \quad X_m: 2\pi fL$$

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

$$Z_m' = R_o + Z_m = 50\Omega + j62.8\Omega \quad R_o: \text{output resistance (50 } \Omega)$$

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

$$I_m = V_o / |Z_m'| = V_o / 80.3\Omega \quad V_o: \text{generator output}$$

Because the generator output voltage range is 10 mV to 5 V for 1 kHz, the CC operation range per the above expression is $I_m = 125 \mu\text{A}$ 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.

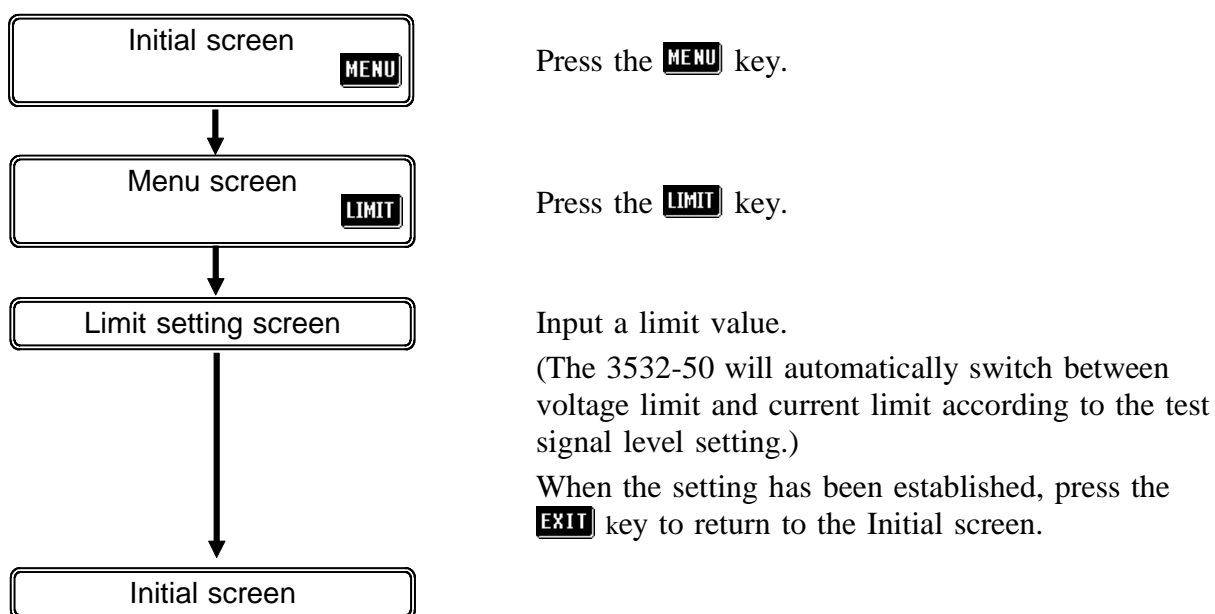
When open circuit voltage (V) or constant voltage (CV) is set:

A current limit can be set.

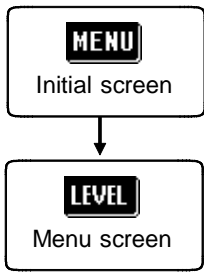
When constant current (CC) is set:

A voltage limit can be set.

4.5.1 Control Screen Sequence



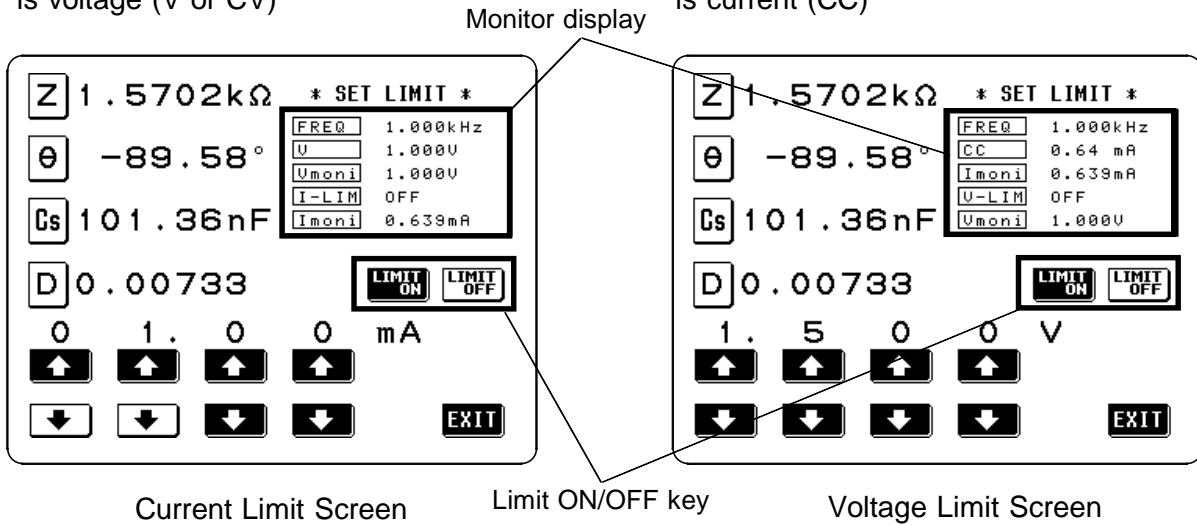
4.5.2 Details of the Setting Process



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)



NOTE

The present situation can be checked using the monitor display. The monitor display is different for V, CV, and CC. 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 $\pm 10\% \pm 10\mu\text{A}$ for 42.0 Hz to 1.000 MHz, and $\pm 20\% \pm 10\mu\text{A}$ for 1.001 MHz to 5.000 MHz.


The accuracy of the voltage limit is $\pm 10\% \pm 10\text{ mV}$ for 42.0 Hz to 1.000 MHz, and $\pm 20\% \pm 10\text{ mV}$ 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).


 : The limit function is turned on.

 : 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 "" 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:

 1.0000V 


"" 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:

 4.0000V 

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  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.

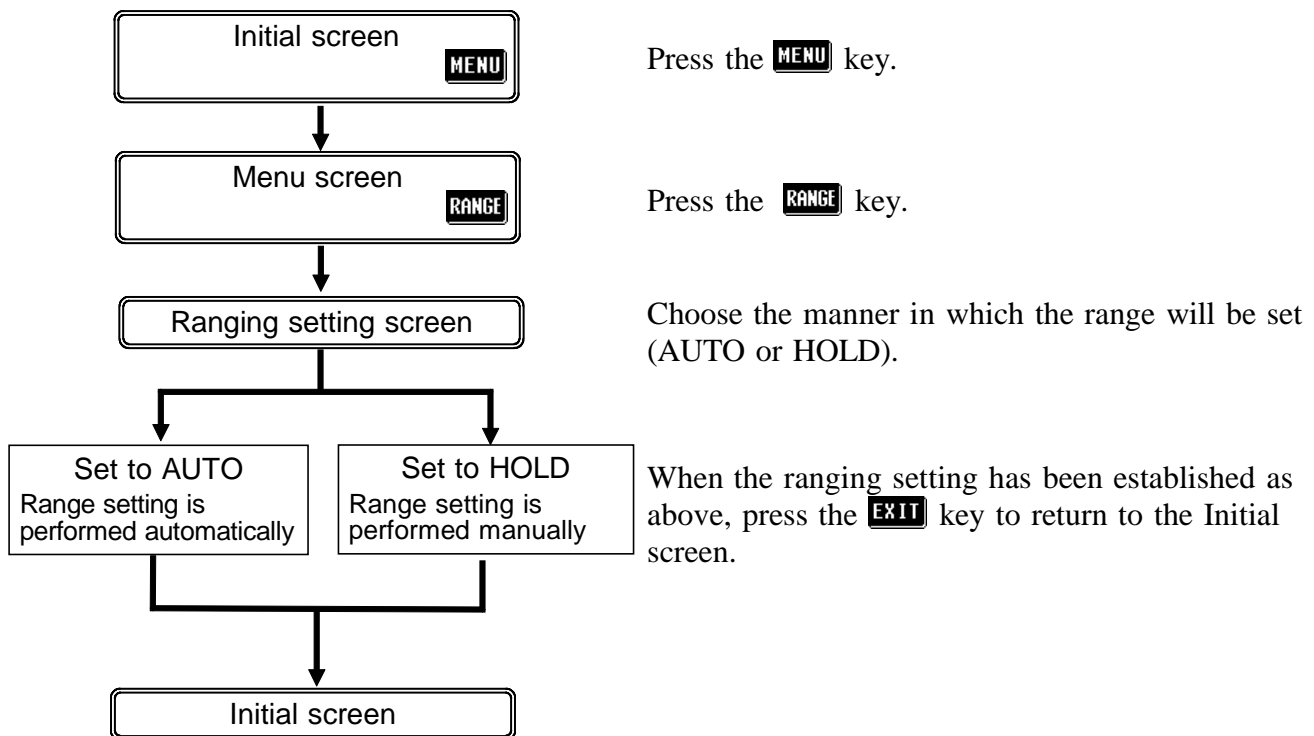
AUTO : The most suitable test range is set automatically.

HOLD : The test range is fixed, and may only be altered manually.

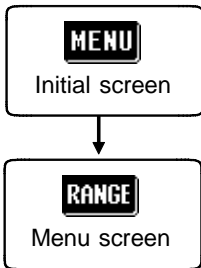
NOTE

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 .

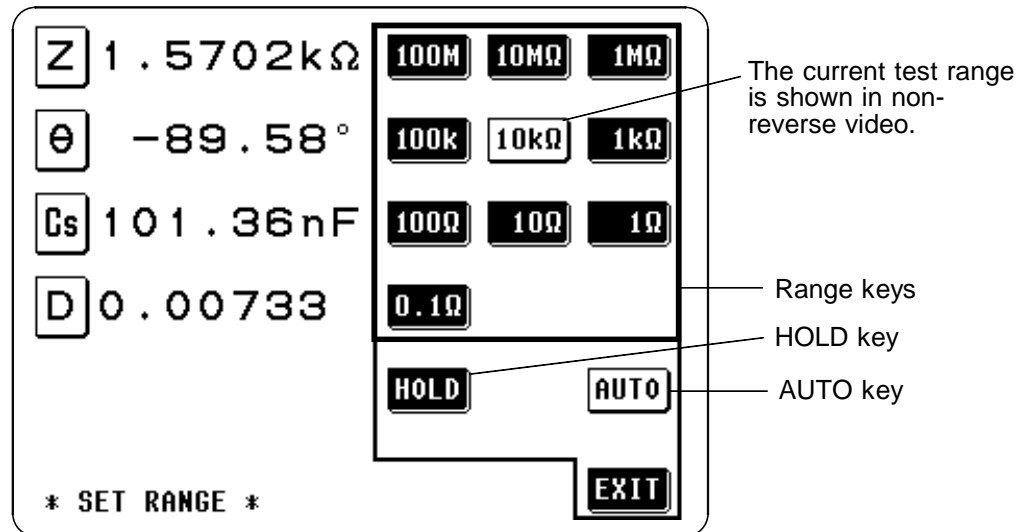
4.6.1 Control Screen Sequence



4.6.2 Setting the Ranging



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



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



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

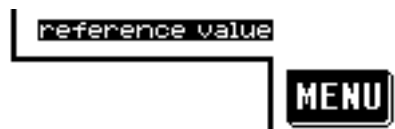
NOTE

- 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.

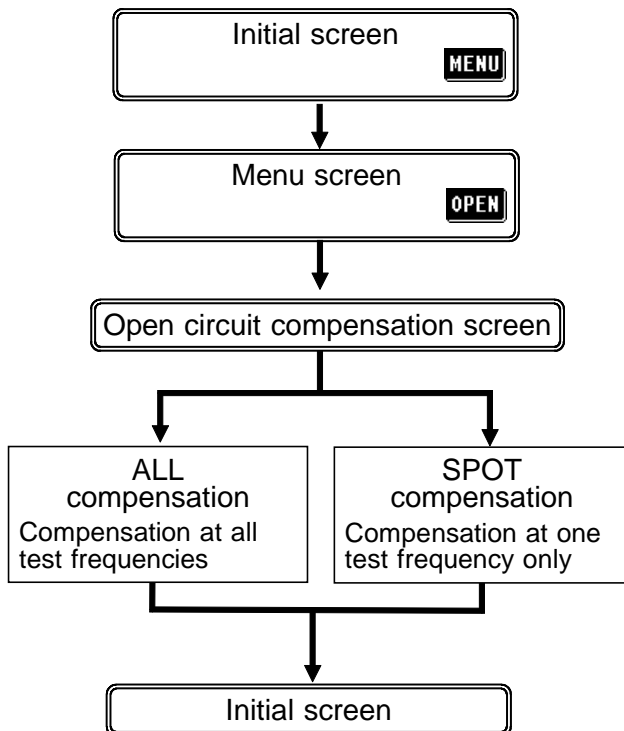
SPOT compensation

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.

4.7.1 Control Screen Sequence



Press the **MENU** key.

Press the **OPEN** key.

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

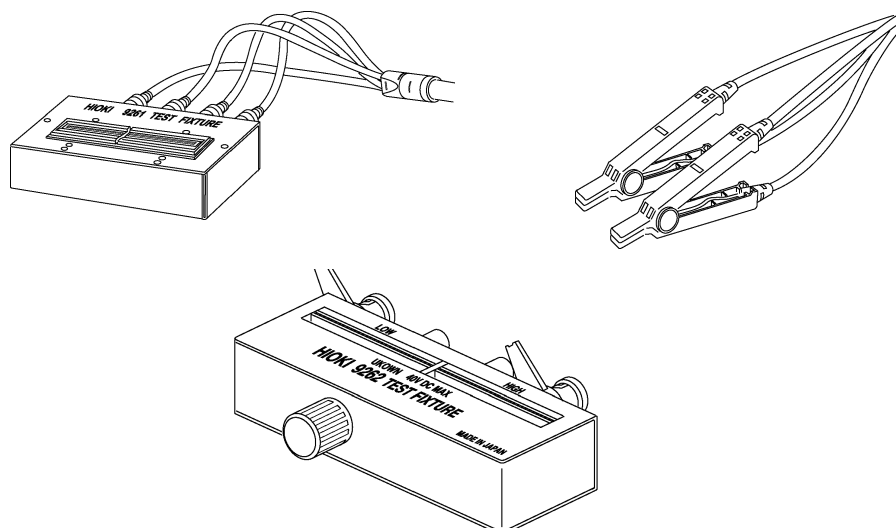
If setting has been completed normally, the open circuit residual component and its phase angle are displayed.

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

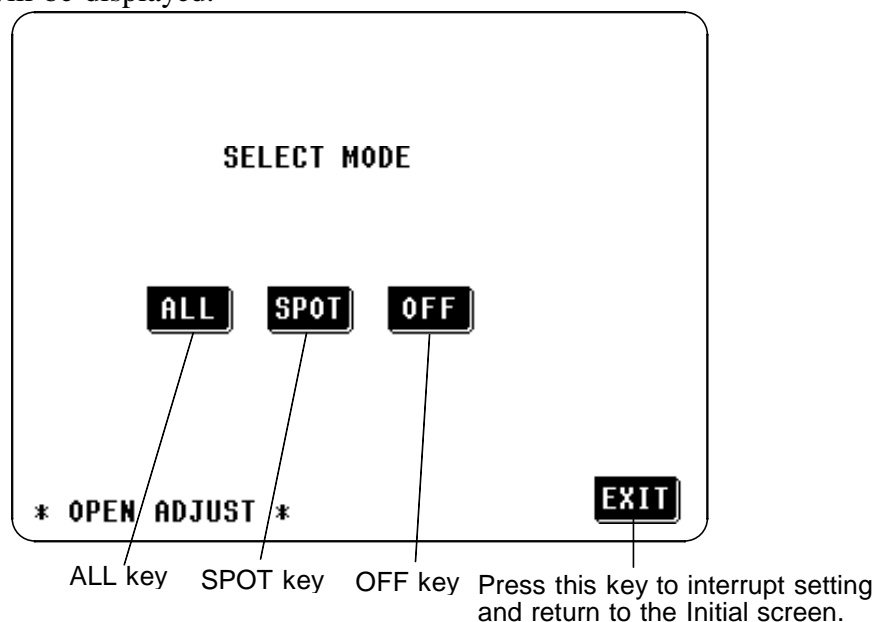
Open circuit compensation has been set.

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.)

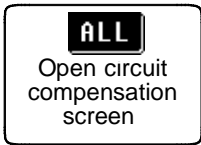


3. On the Initial screen, press the **MENU** key, and the Menu screen will be displayed.
4. Press the **OPEN** key on the Menu screen, and the Open circuit compensation screen will be displayed.

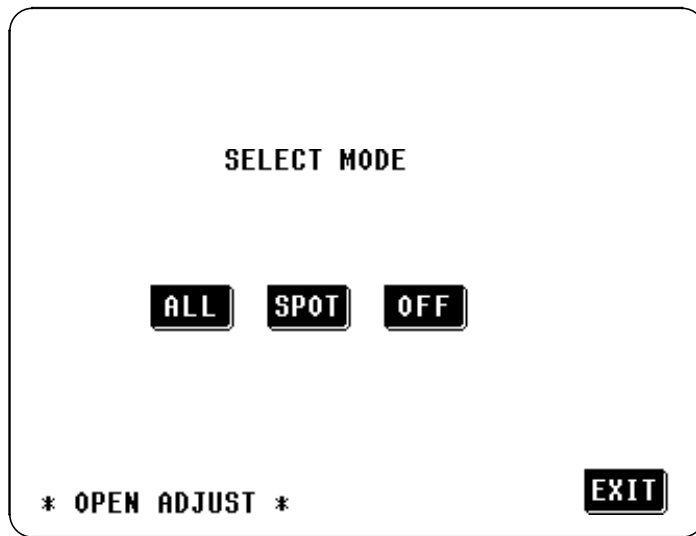


5. The OPEN circuit compensation method can be set to:
 - ALL** : The compensation values are obtained for all test frequencies.
 - SPOT** : The compensation values are obtained at the set test frequency only.
 - OFF** : The open circuit compensation data are cleared.

4.7.3 ALL Compensation



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



Open Circuit Compensation Screen

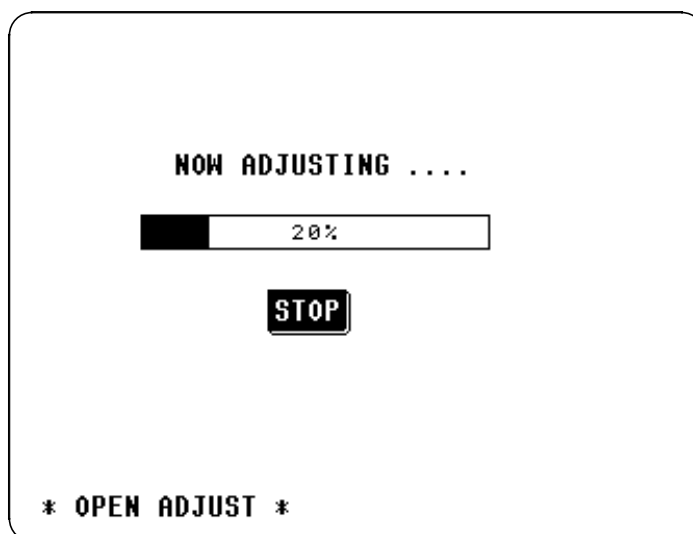
2. A Confirmation screen will appear for confirmation. If it is OK to proceed, press the **RUN** key; if not, press the **CANCEL** key to return to the Open circuit compensation screen.



NOTE

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

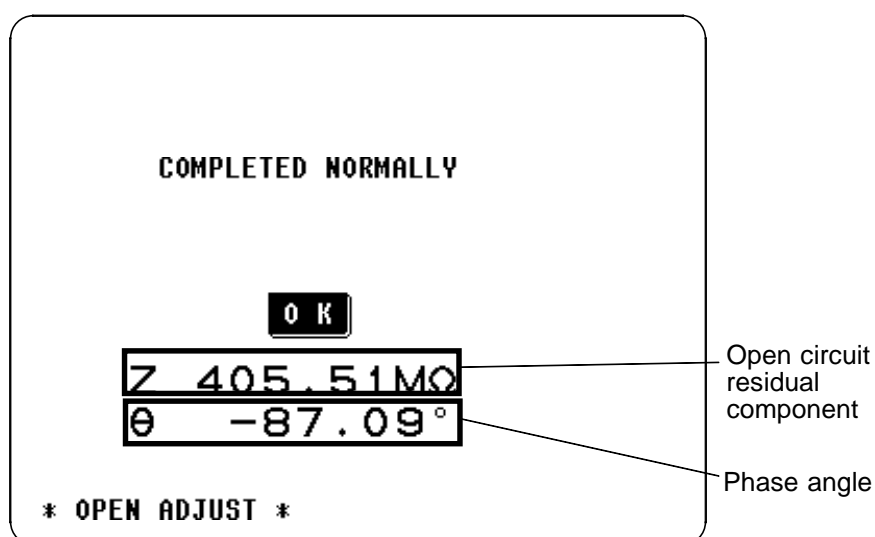
3. When the **RUN** key is pressed, the ALL open circuit compensation process starts. After about 2 minutes, the determination and adjustment of the open circuit compensation values is complete.



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.)



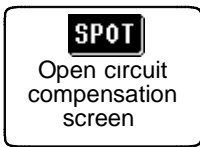
These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)

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

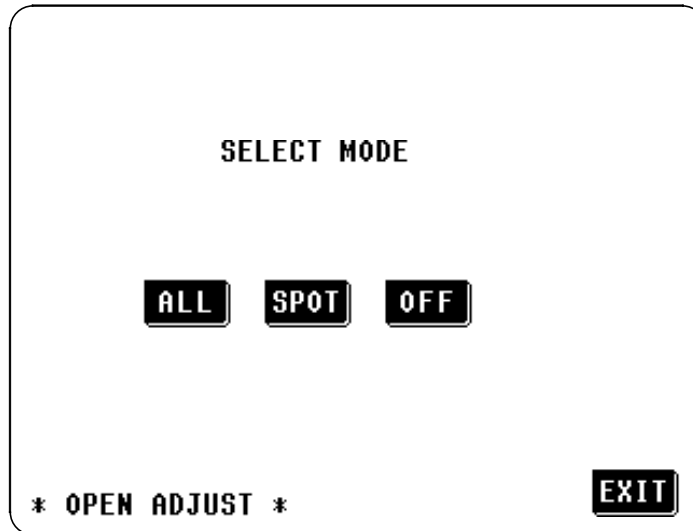
NOTE

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

4.7.4 Spot Compensation

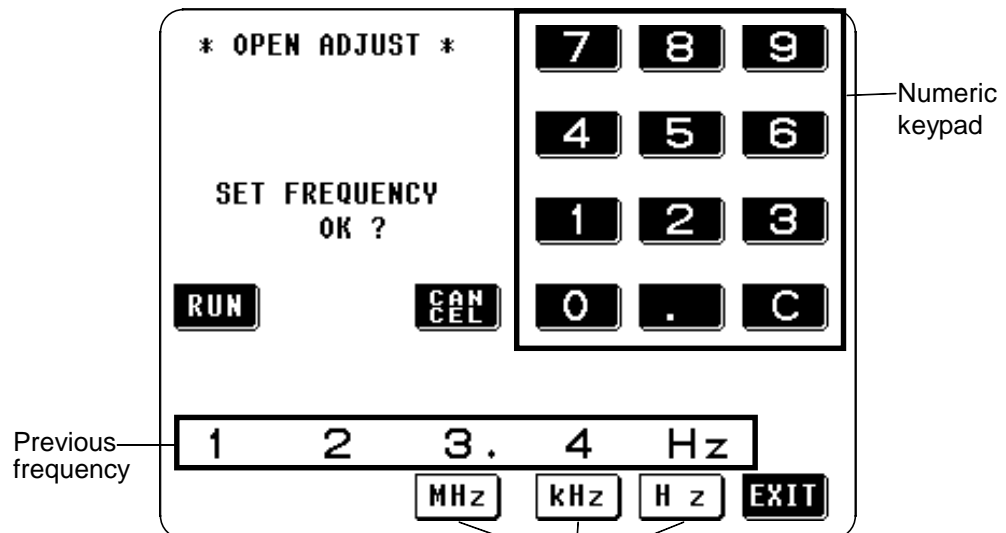


1. To select SPOT compensation, press this key with the Open circuit compensation screen displayed.



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.



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.

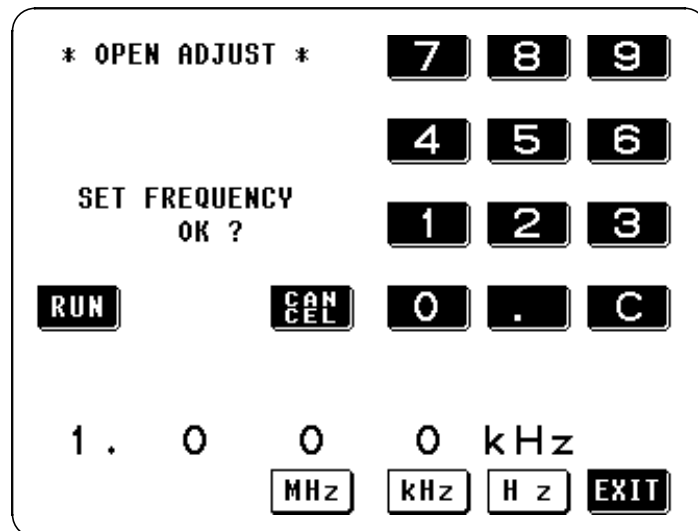
Frequency range which can be set : 42.0 Hz to 5.000 MHz

NOTE

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

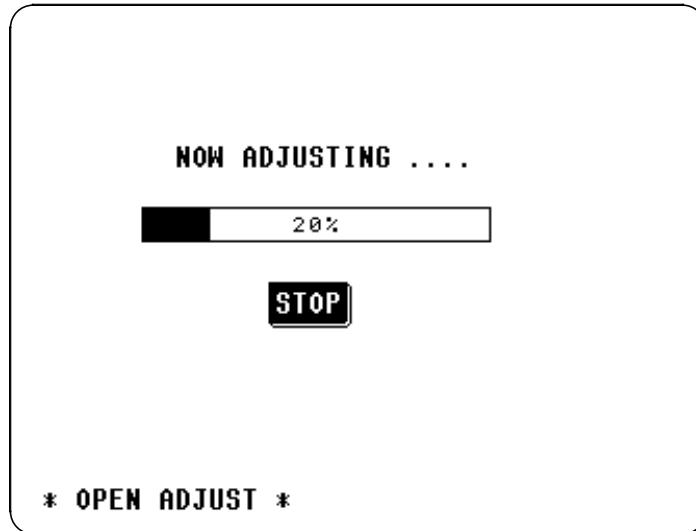
If you attempt to set a test frequency lower than 42 Hz, it will automatically be set to 42 Hz.

- 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 **Hz** 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.

**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.

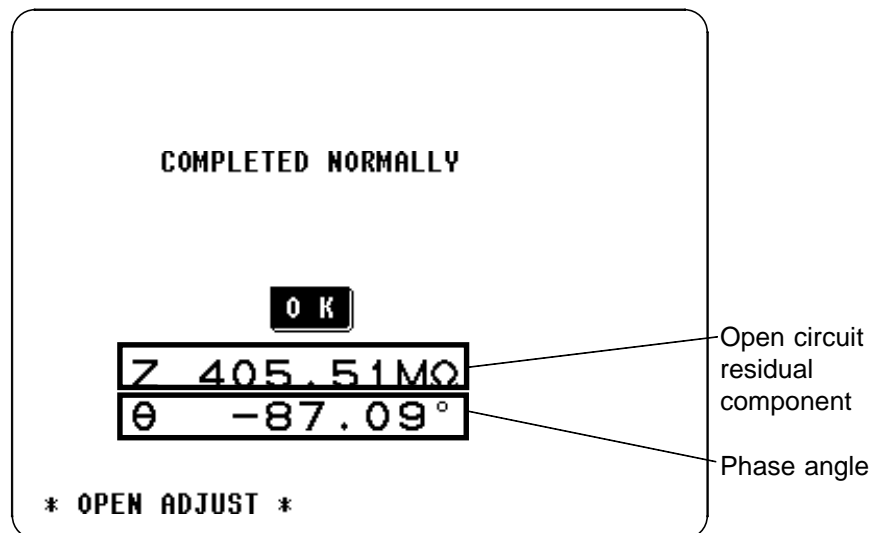


Interrupting the SPOT compensation process:

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.)



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".)

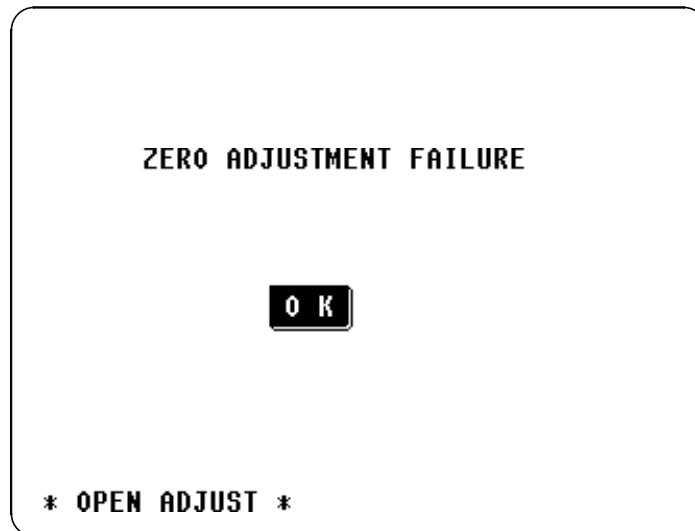
After checking the open circuit residual component and its phase angle, press the **OK** key, and the display will return to the Initial screen.

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.



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.

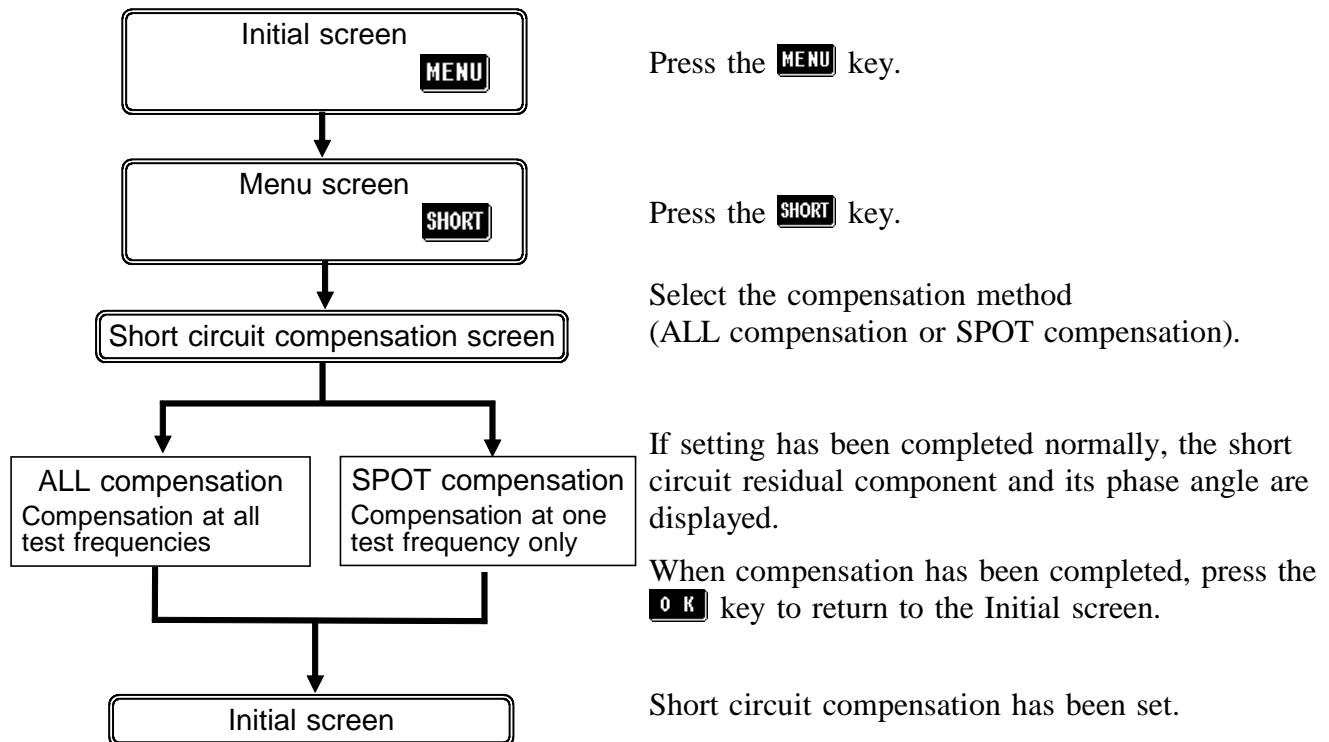
SPOT compensation

Compensation is performed for one specified test frequency only.

NOTE

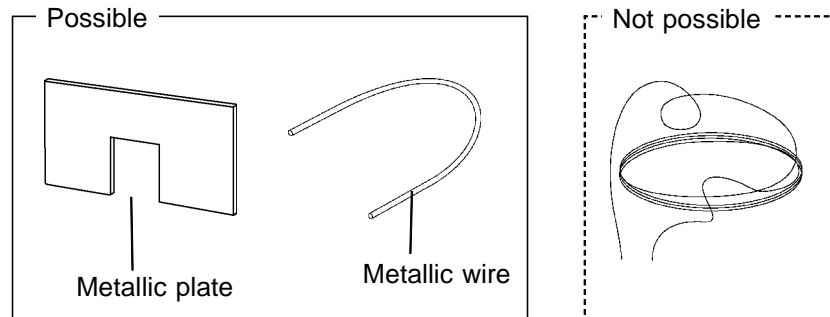
- Before short circuit compensation, always set the cable length. For details, refer to Section 4.14.
- The testing accuracy specified in the specification of the 3532-50 unit assumes that open circuit compensation and short circuit compensation is being performed, as appropriate.
- When you have changed 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.

4.8.1 Control Screen Sequence



4.8.2 Setting the Compensation Method

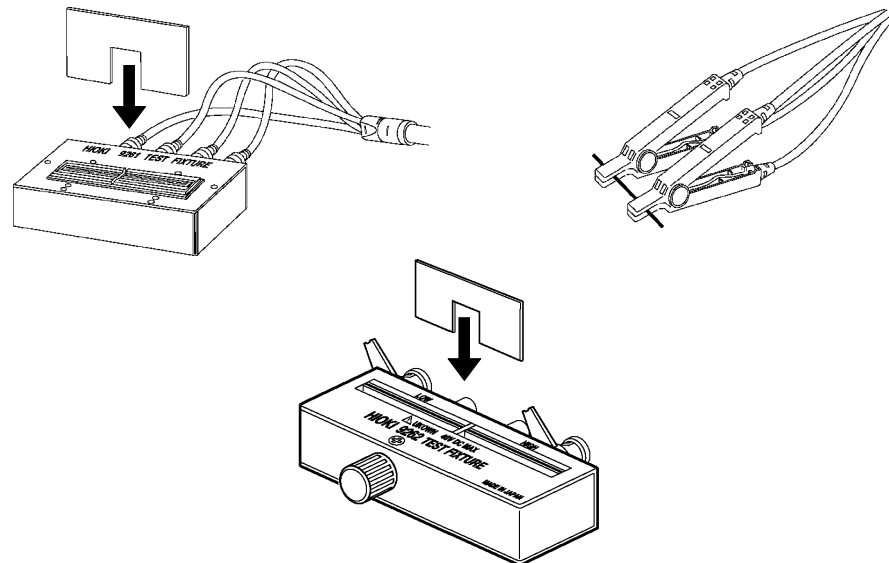
1. A shorting bar is used. This shorting bar is for short circuiting together the ends of the test leads. Use an object whose impedance is as low as possible.



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.

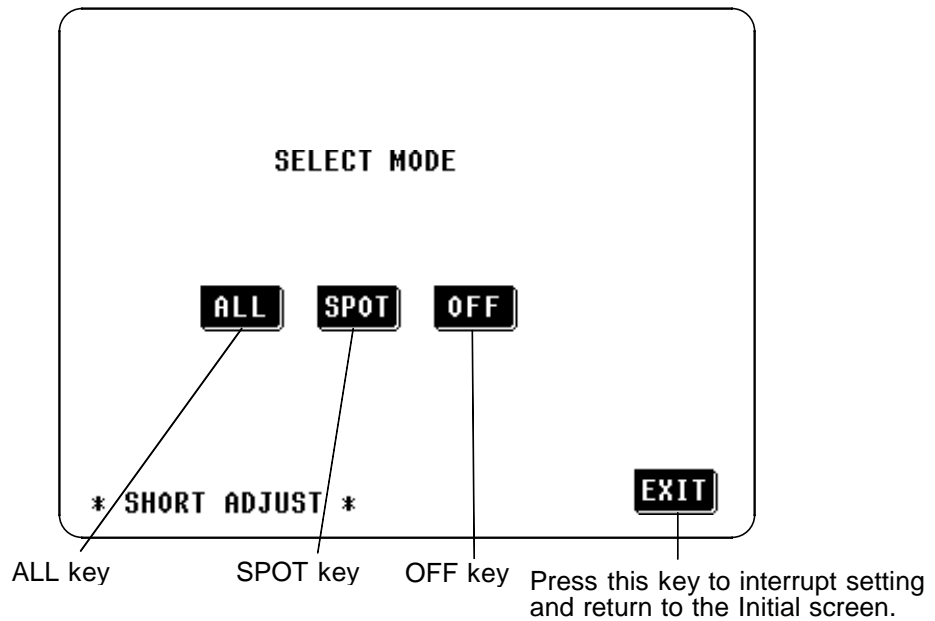
2. Arrange the test leads as closely as possible to their configuration in which measurement will be performed, and short circuit together the HIGH and LOW leads. In order to keep external influences as low as possible, be sure to thrust the shorting bar in all the way.



NOTE

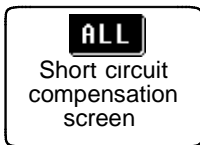
If you intend to short circuit between the clamps at the ends of the test leads, clip both clamps onto a short piece of metallic wire as shown. If you clip the two clamps together directly, they will not be properly short circuited together.

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.

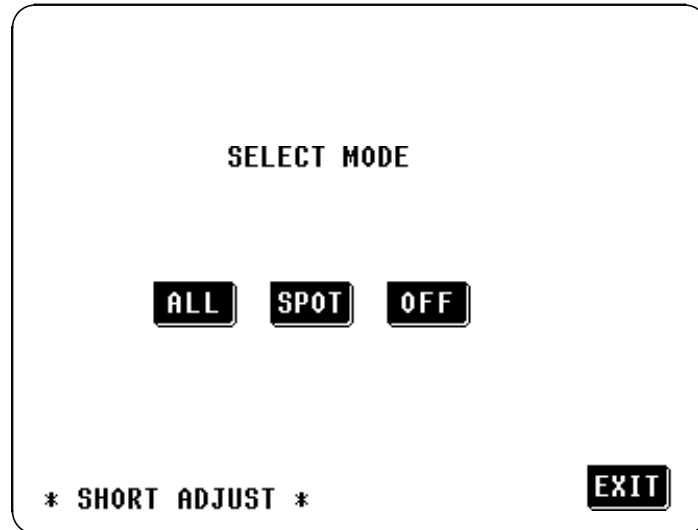


5. The SHORT circuit compensation method can be set to:
 - ALL** : Compensation values are obtained for all test frequencies .
 - SPOT** : Compensation values are obtained at the set test frequency only.
 - OFF** : The short circuit compensation data are cleared.

4.8.3 ALL Compensation



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



Short Circuit Compensation Screen

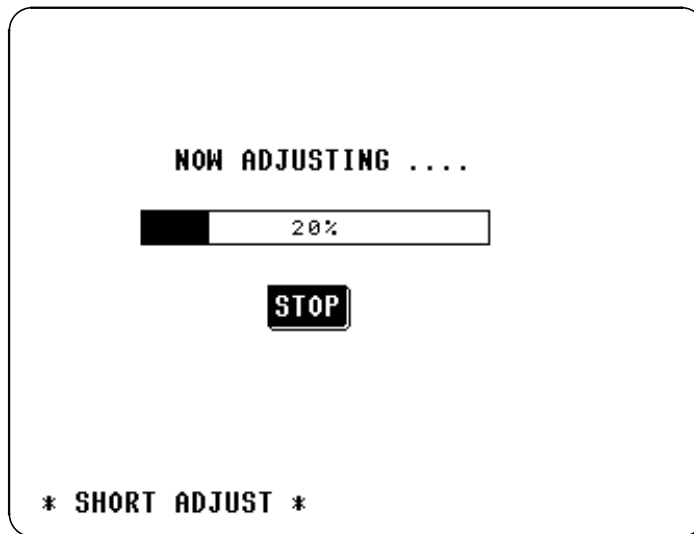
2. A Confirmation screen will appear for confirmation. To proceed, press the **RUN** key; if not, press the **CANCEL** key to return to the Short circuit compensation screen.



NOTE

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

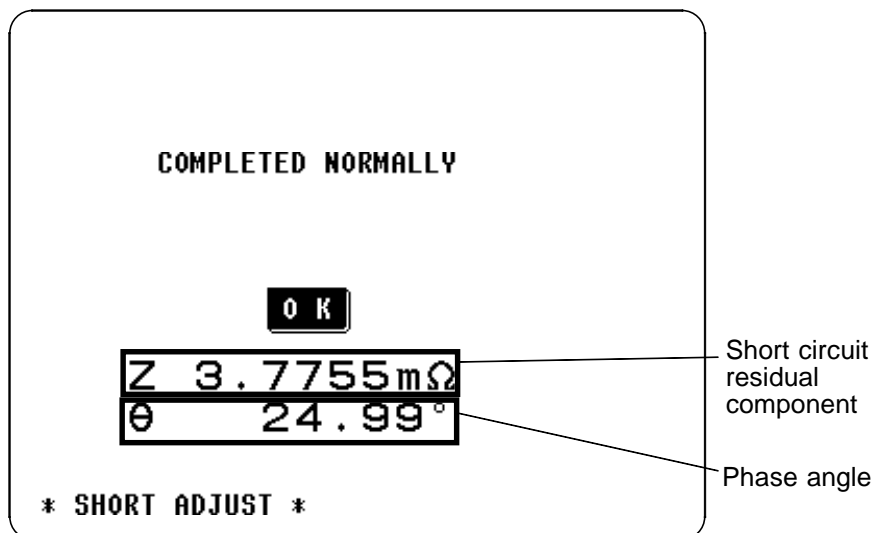
3. When you press the **RUN** key, the ALL short circuit compensation process starts. After about 2 minutes, the determination and adjustment of the short circuit compensation values is complete.



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.)



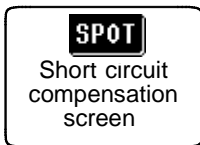
These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)

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

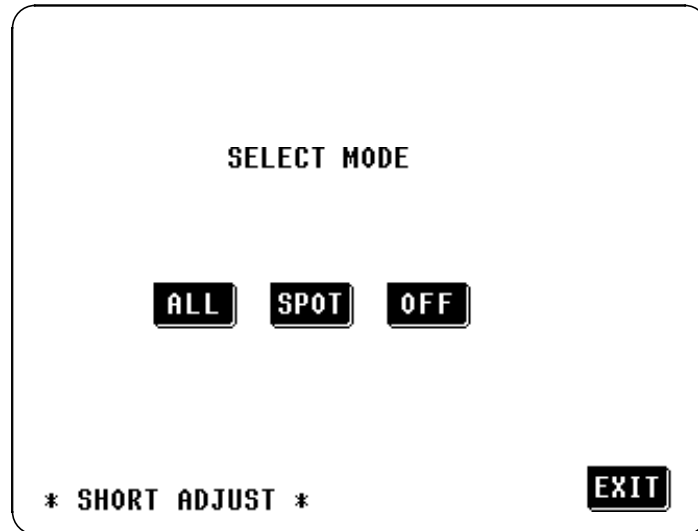
NOTE

Compensation can be performed for impedances less than 1 kΩ

4.8.4 Spot Compensation

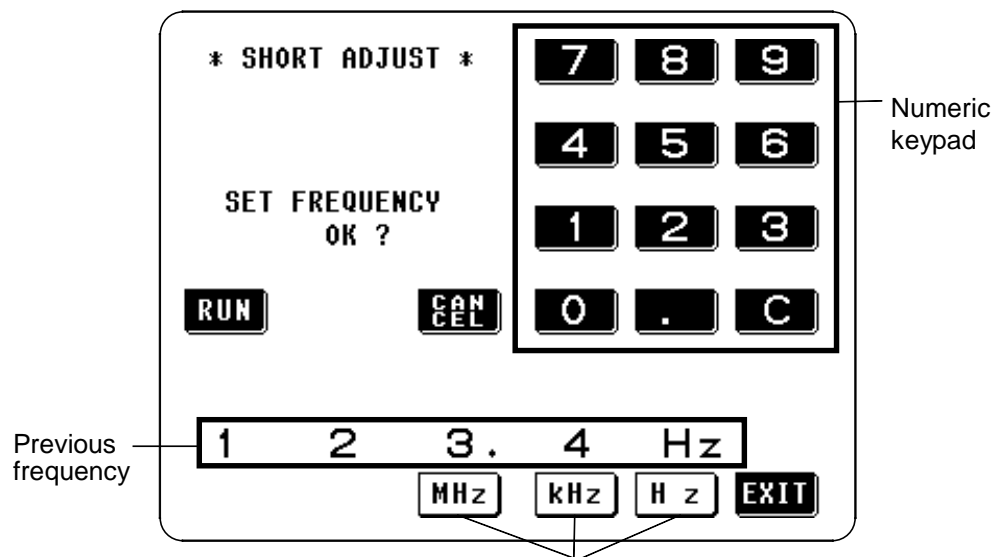


1. To select SPOT compensation, press this key with the Short circuit compensation screen displayed.



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.



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

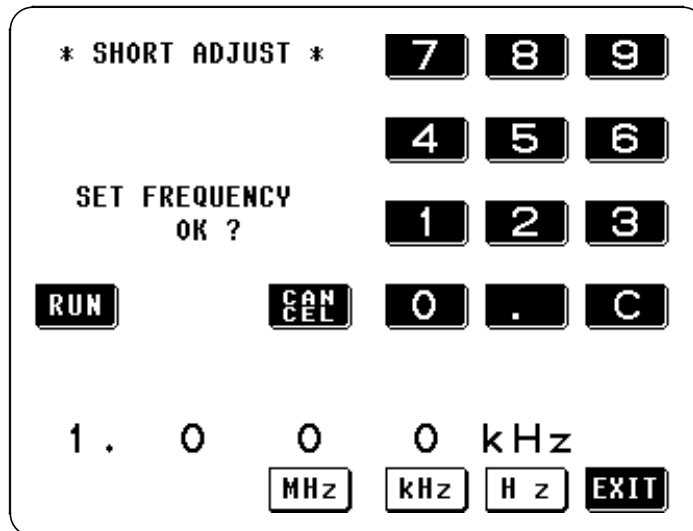
If you attempt to set a test frequency greater than 5 MHz, it will automatically be reduced to 5 MHz.

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

NOTE

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

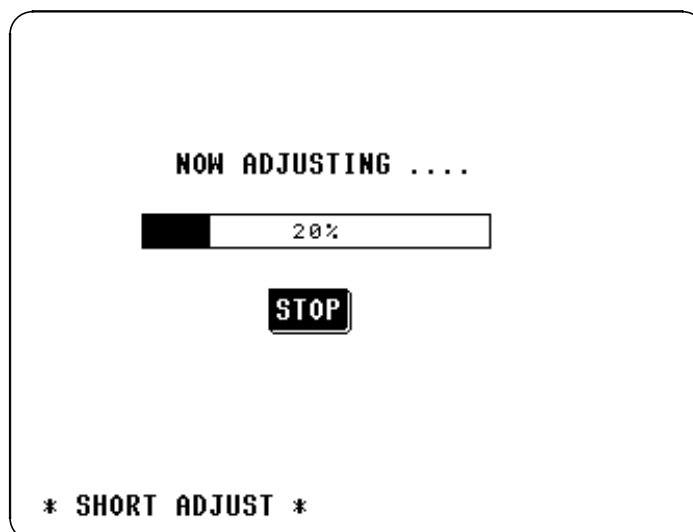
- When you have completed inputting the numerical value for the frequency, press the appropriate units key **MHz**, **kHz**, or **Hz** so as to confirm the displayed frequency for compensation.
 - Until the numerical value for the frequency has been input, the units keys cannot be used.
3. After the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



NOTE

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

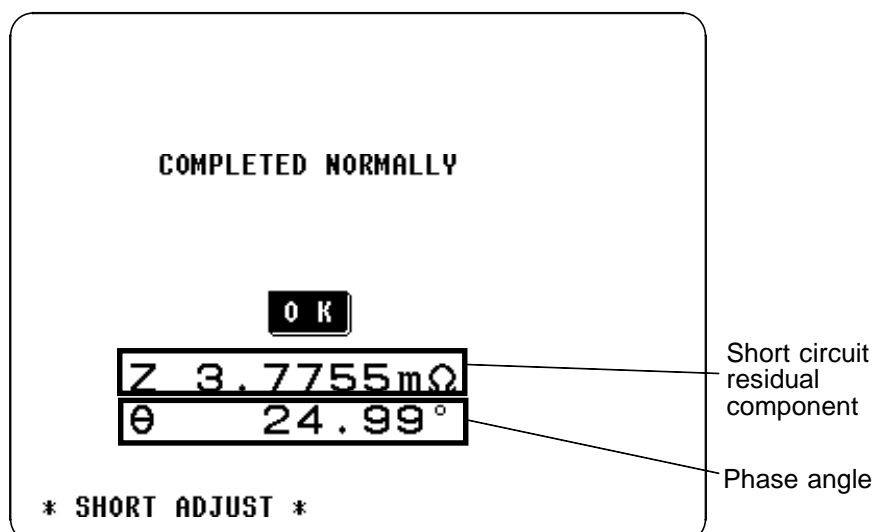
4. When you press the **RUN** key, the SPOT short circuit compensation process starts.



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.)

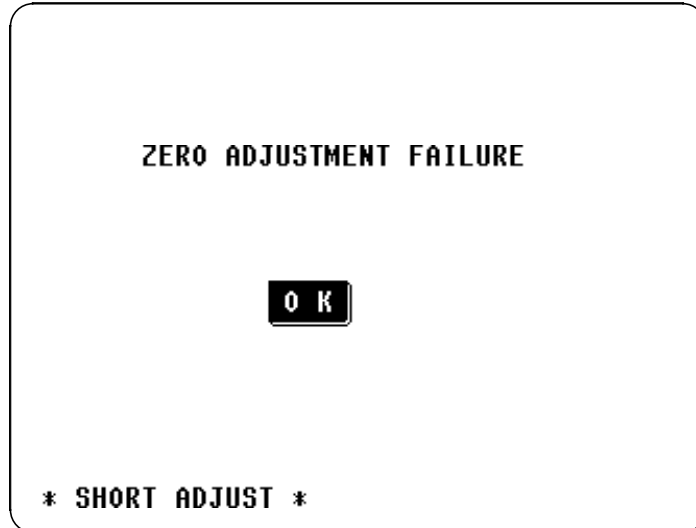


These values are required for use with the test range on HOLD. (For details, refer to Section 4.9, "Open Circuit Compensation and Short Circuit Compensation".)

After checking the short circuit residual component and its phase angle, press the **OK** 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.



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

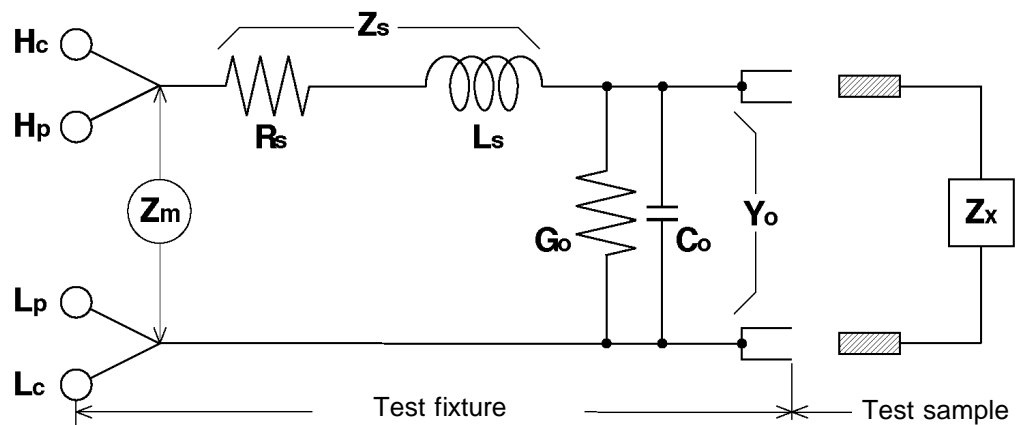
- Check that the test cables are properly connected.
- Check that the test cables are properly shorted together with the shorting bar. (Short circuit compensation cannot be performed while any test sample is connected to the test cables.)
- Check that the test leads are arranged as closely as possible 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 Z_m 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.



Z_x : true value	R_s : residual resistance
L_s : residual inductance	G_o : residual conductance
C_o : floating capacitance value	Z_s : short circuit residual component
Y_o : open circuit residual component	Z_m : measured value

In this case, for the measured value Z_m :

$$Z_m = Z_s + 1/(Y_o + 1/Z_x)$$

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 Z_s is now zero, therefore the open circuit residual component Y_o can be determined.

Short circuit compensation

The terminals of the test fixture are connected together (short circuited). Because the open circuit residual component Y_o is now zero, therefore the short circuit residual component Z_s 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 Z_m 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:

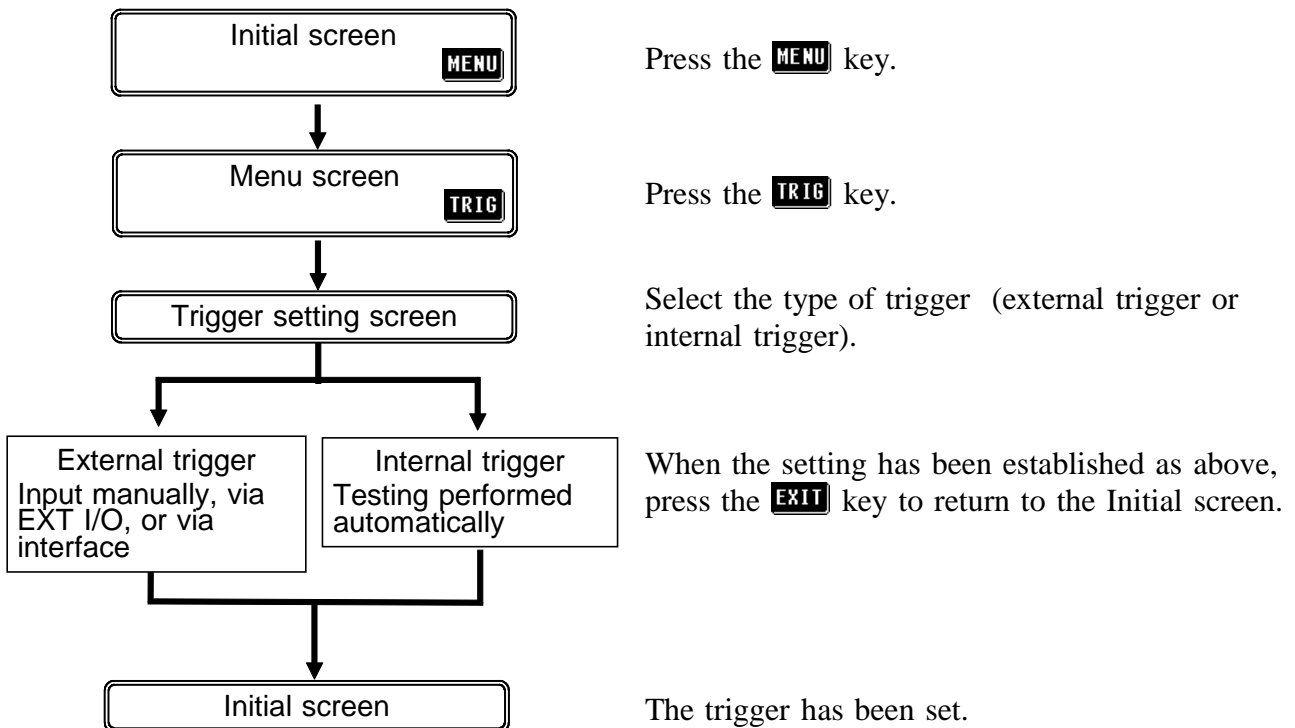
- If only short circuit compensation has been performed.
With short circuit compensation only having been performed, since no compensation can be performed in terms of the open circuit residual component Y_o (which is not available), thereby deviation in the resultant values will become large if the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

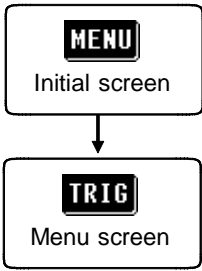
4.10 Setting the Trigger

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.

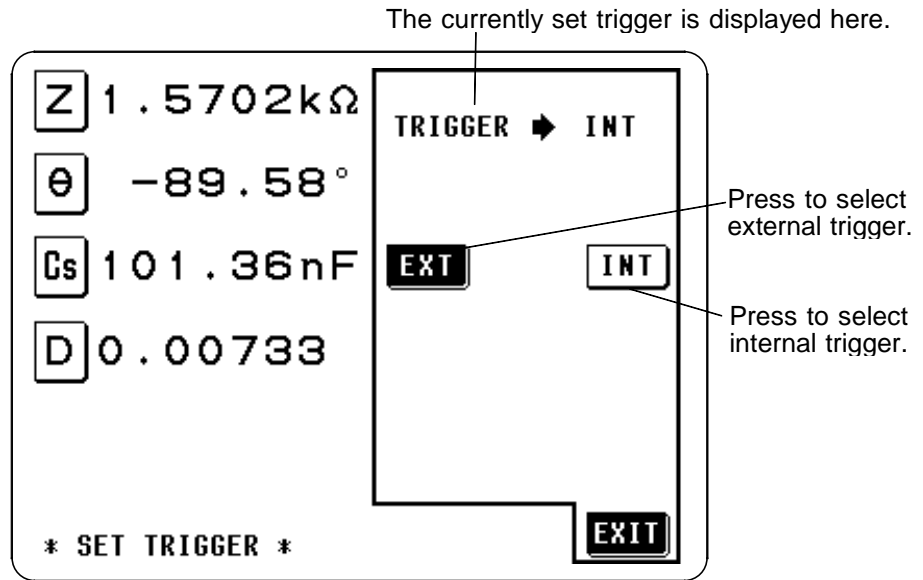
4.10.1 Control Screen Sequence



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.



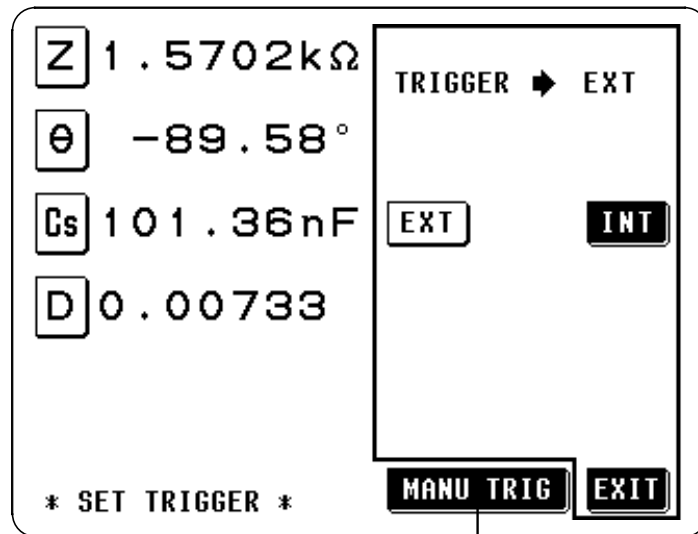
Trigger Setting Screen

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.



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:

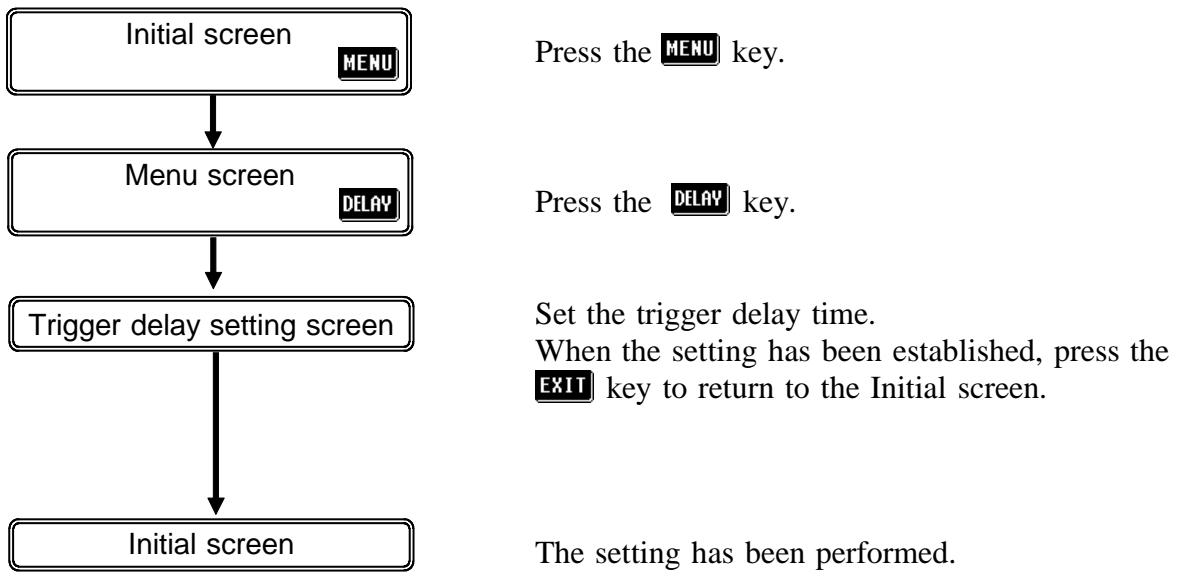
Testing is performed once, when the "*TRG" command is transferred from the interface. (For details, see the "Command Reference" of the Instruction Manuals for the interface.

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

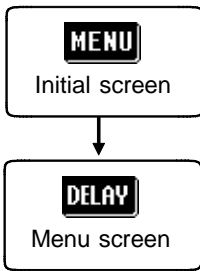
4.11 Setting the Trigger Delay

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.

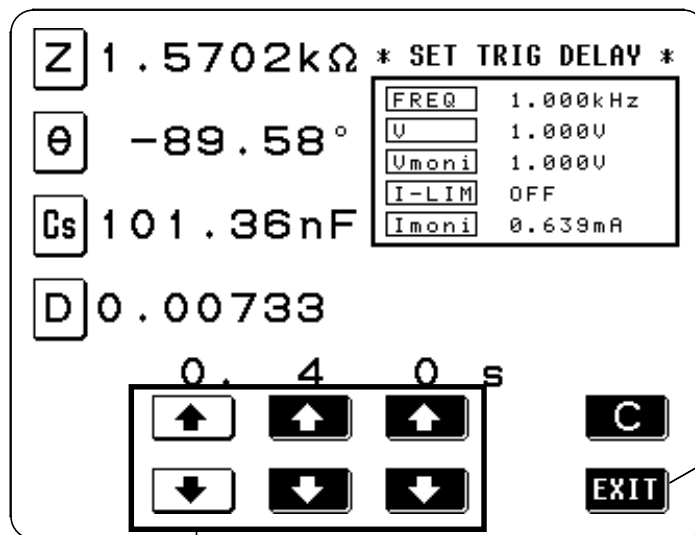
4.11.1 Control Screen Sequence



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.



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.

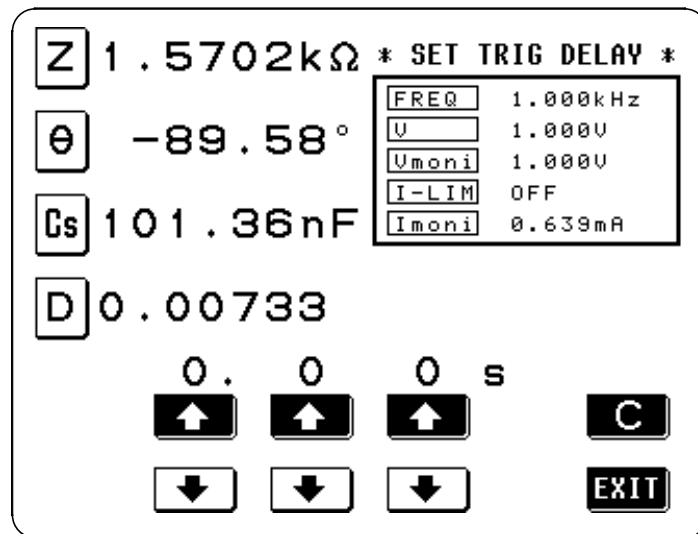
The range over which the delay time period can be set :
10 ms to 9.99 s, with a resolution of 10 ms

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.

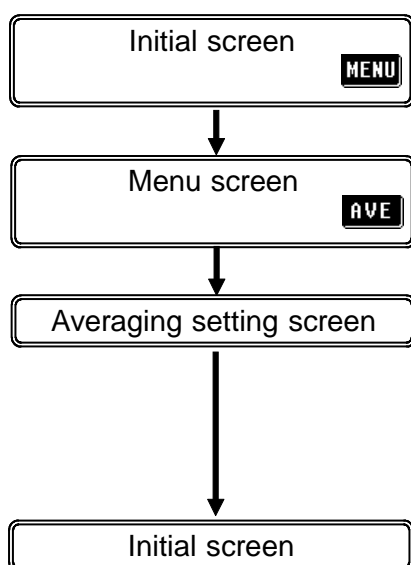


4.12 Setting Averaging

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.

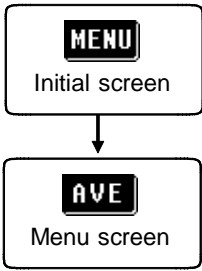
Press the **AVE** key.

Set the number of measurement times for averaging.

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

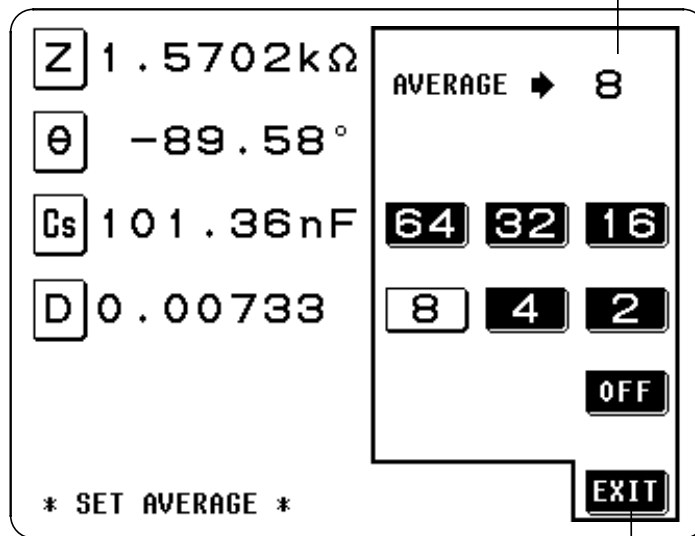
The setting has been made.

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.



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.

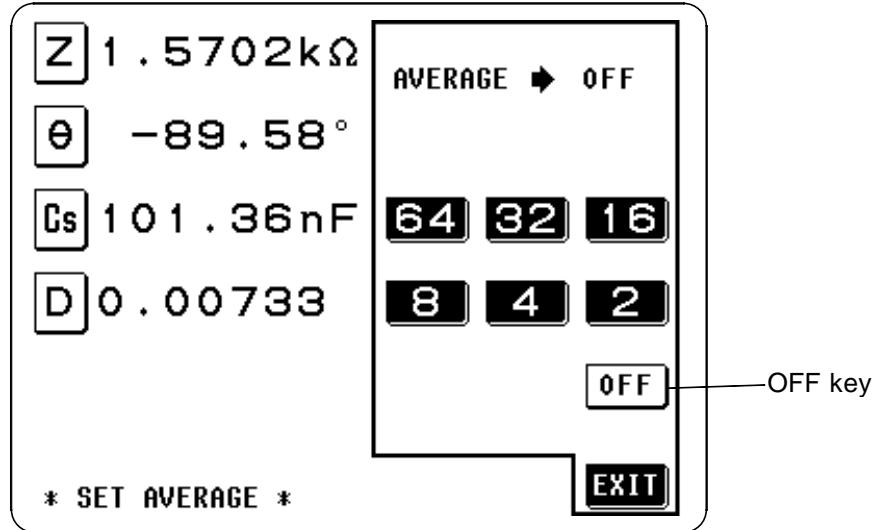
With external trigger:

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

- 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:

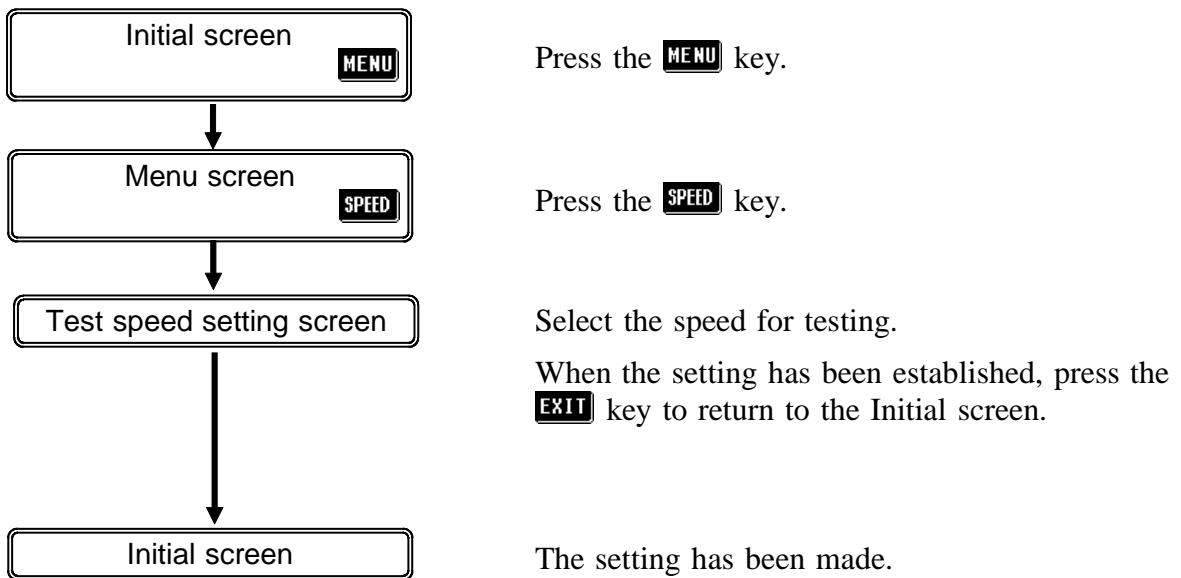
FAST low accuracy testing is performed at high speed

NORM the speed used for normal testing

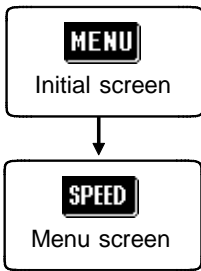
SLOW high accuracy testing is performed slowly

SLOW2 high accuracy testing is performed slowly

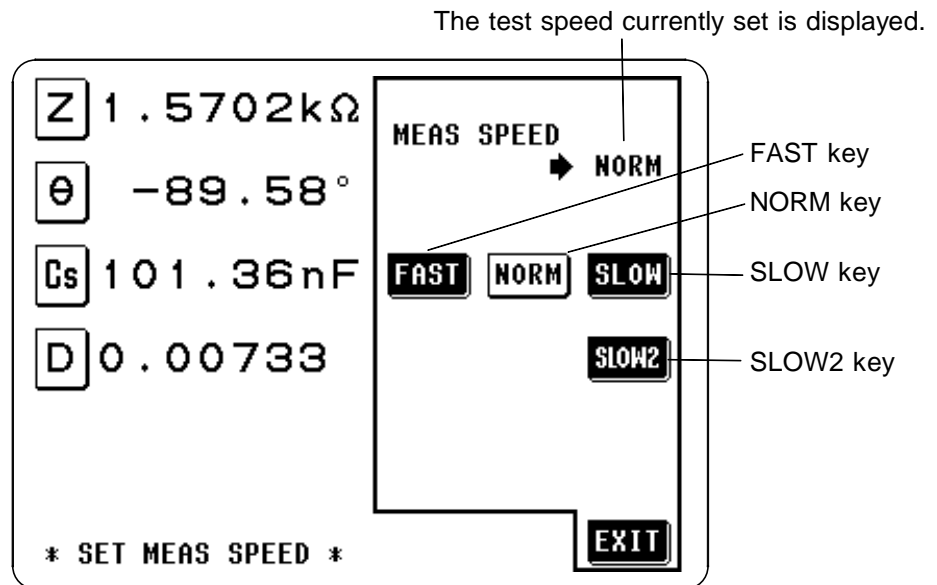
4.13.1 Control Screen Sequence



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.



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

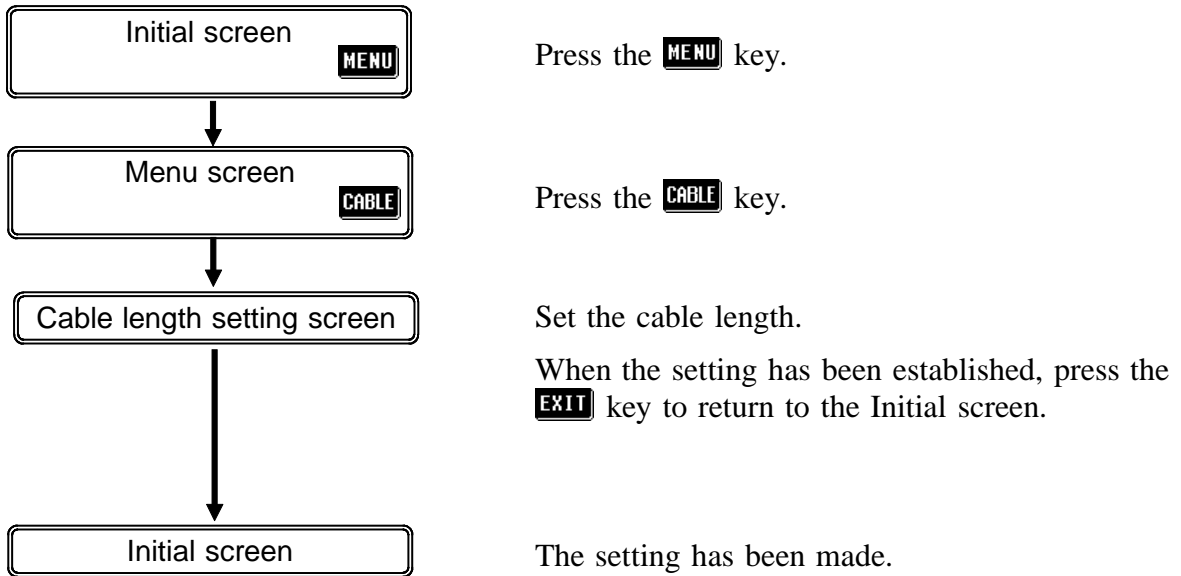
The testing speed varies according to the number of parameters being displayed, and according to their type. The speeds given in the table relate to the case of |Z| only being displayed. For details, refer to Section 7.3, "Time Taken for Testing."

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

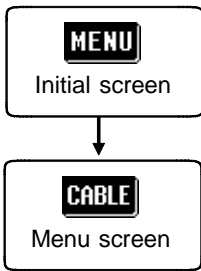
4.14 Setting the Measurement Cable Length

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.

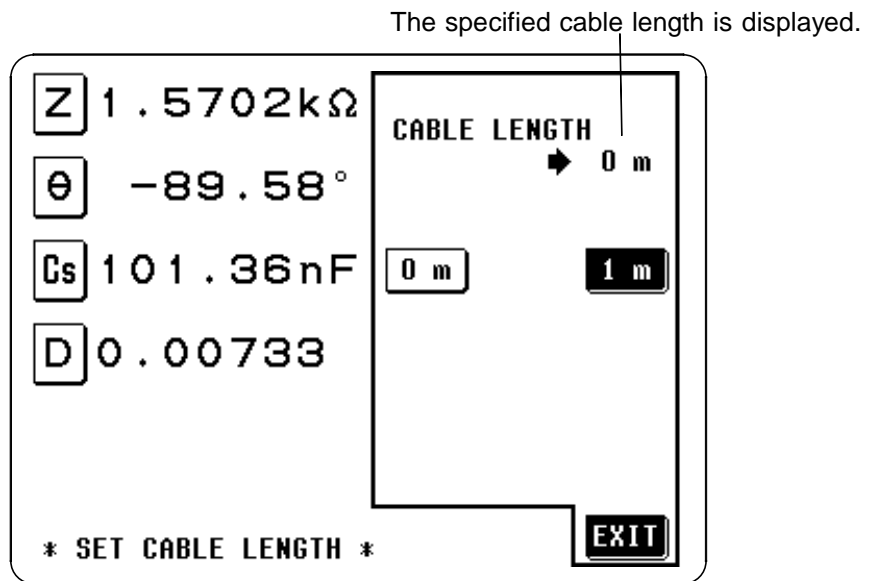
4.14.1 Control Screen Sequence



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.



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.

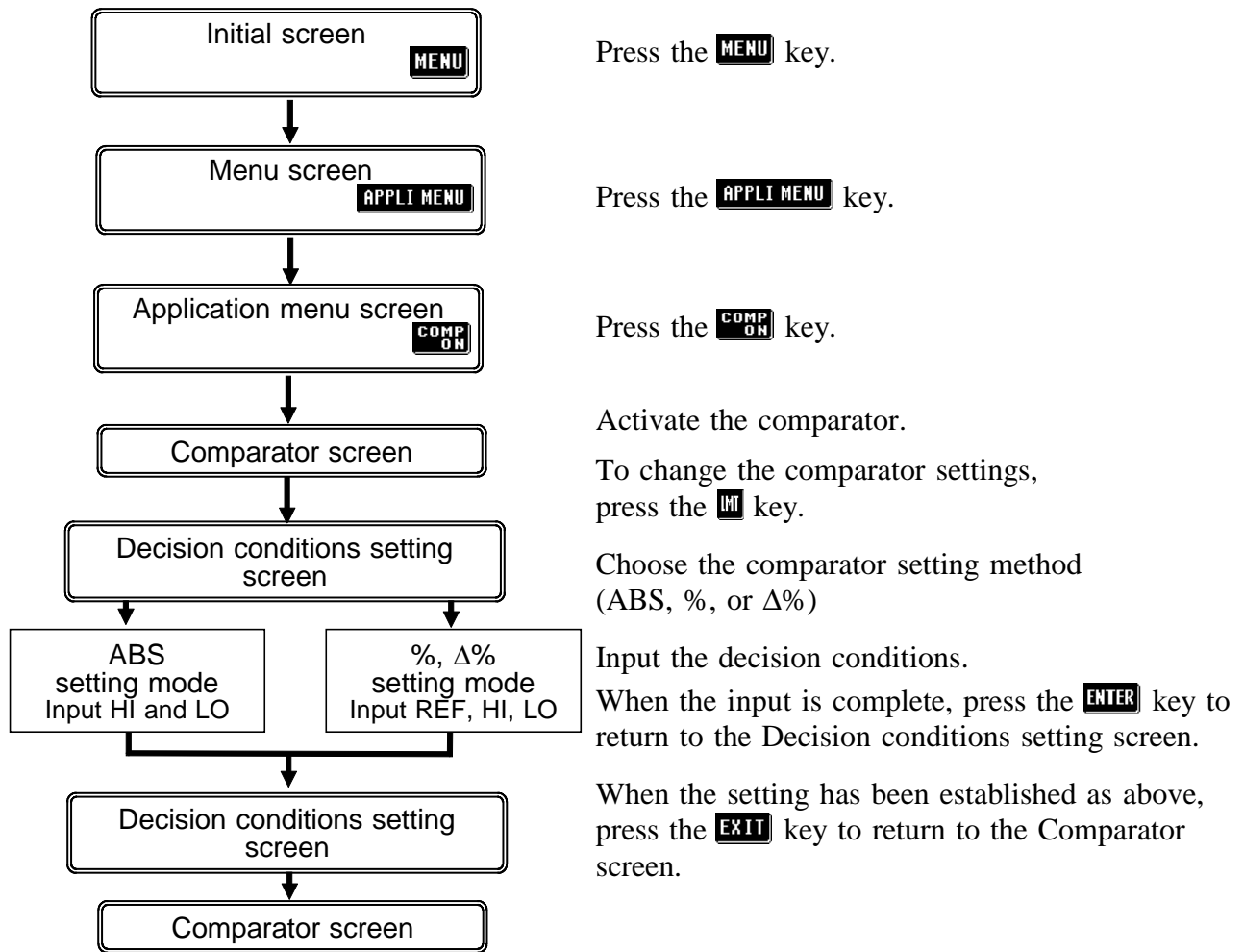
Setting of the deviation percentage ($\Delta\%$)

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 ($\Delta\%$) from the reference value.

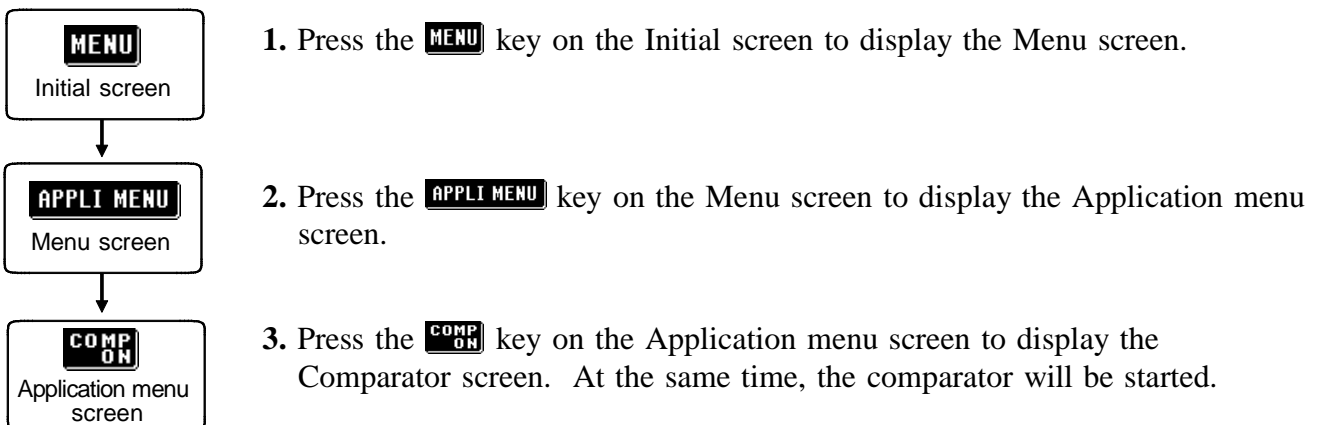
The comparator can deal with two test values at the most. "ABS", "%", and " $\Delta\%$ " can be selected for each of these values individually.

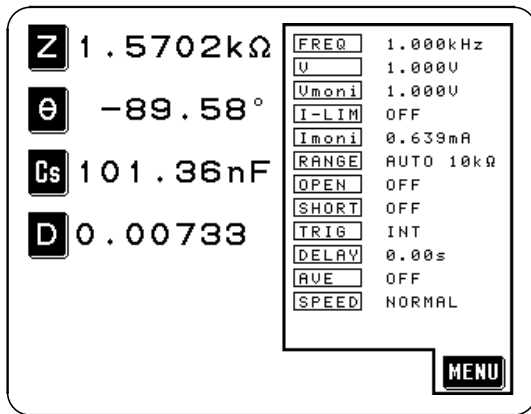
After powering off on the Comparator setting screen, the screen is displayed when the power is turned on again.

4.15.1 Control Screen Sequence

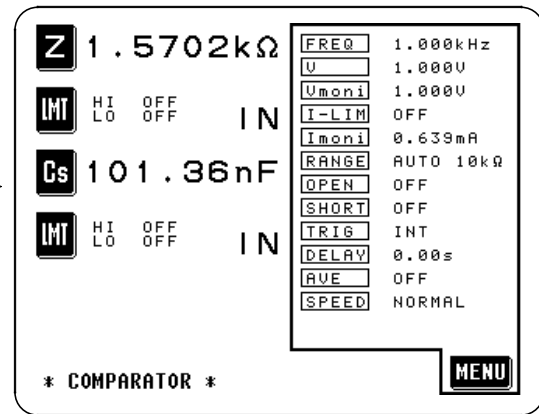


4.15.2 Setting the Comparator





Initial Screen

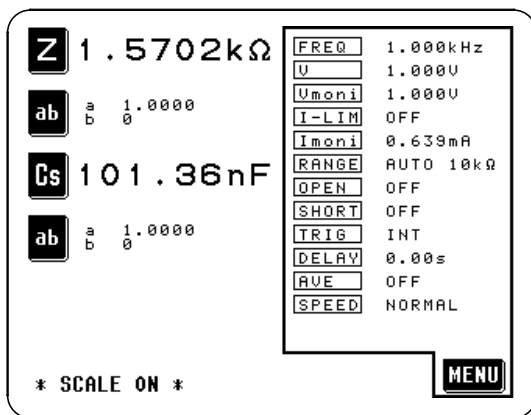


Comparator Screen

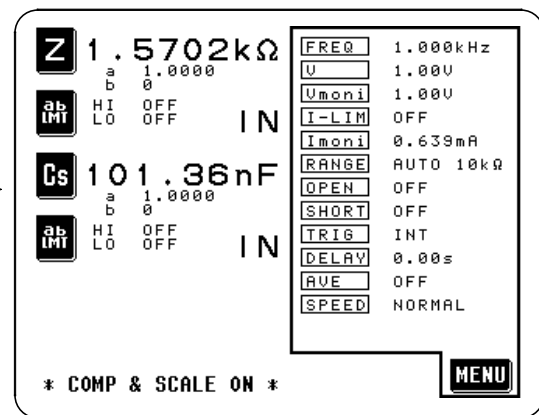
NOTE

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.

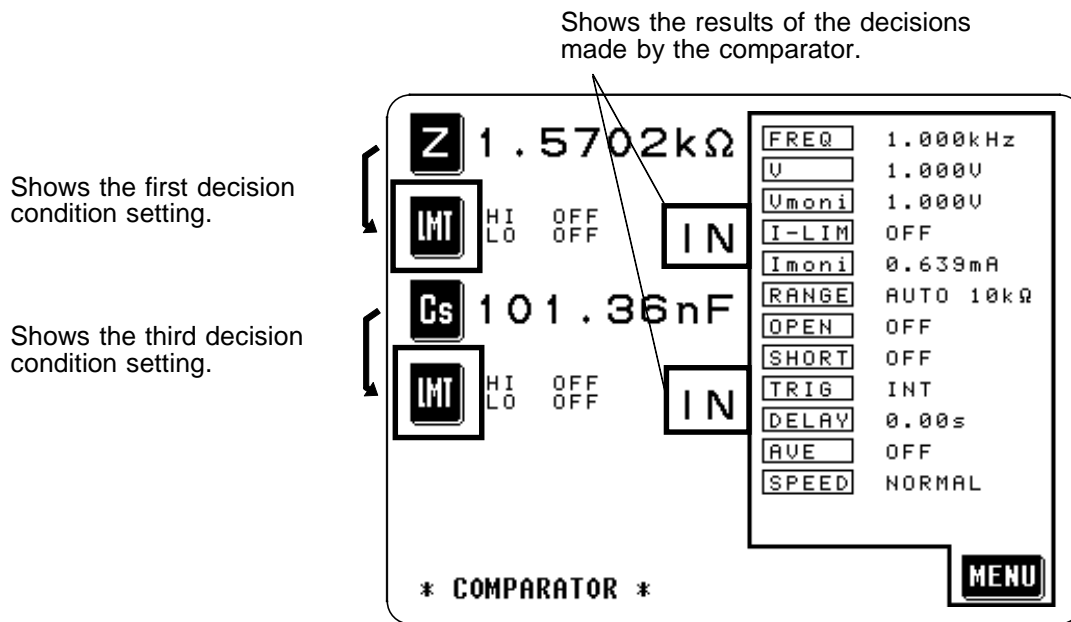


Scaling Screen



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.)



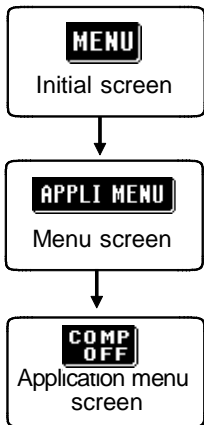
The Conditions setting screen is accessed by pressing the **IMT** key.

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

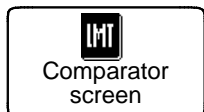


1. Press the **MENU** key on the Comparator screen or the Comparator scaling screen to display the Menu screen.
2. Press the **APPLI MENU** key on the Menu screen to display the Application menu screen.
3. Press the **COMP OFF** key on the Application menu screen to return the Initial screen or the Scaling 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**.

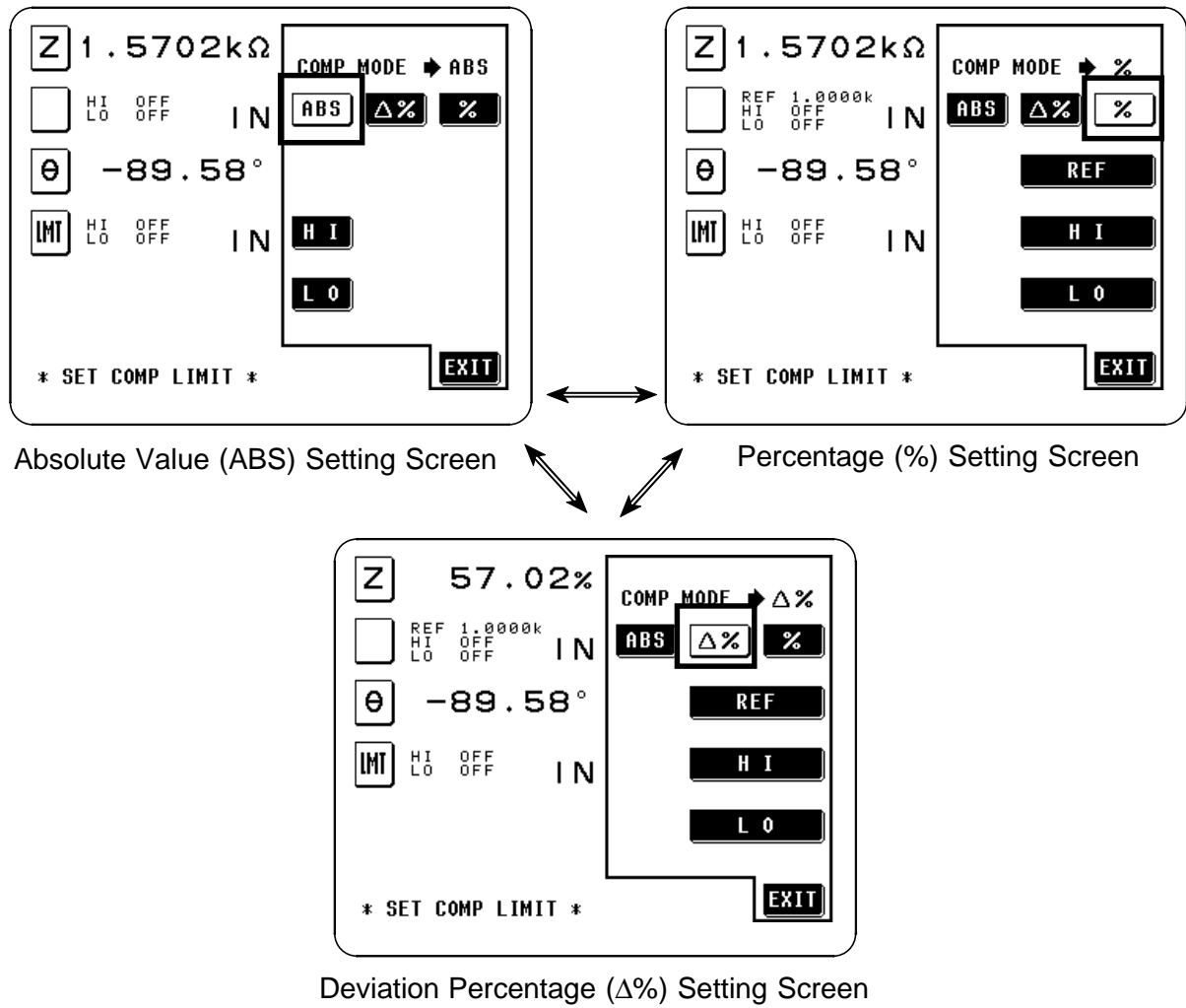
NOTE

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 ($\Delta\%$)
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 ($\Delta\%$) from the reference value.

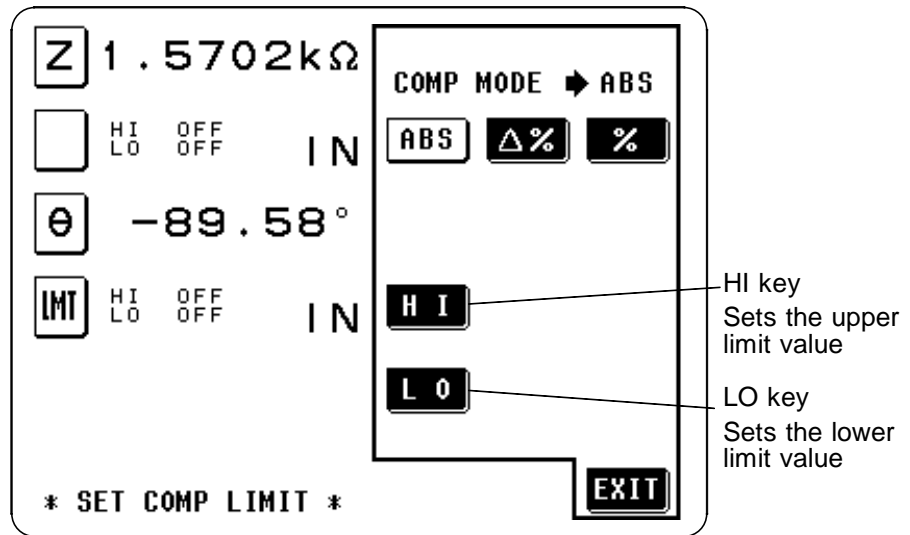


4.15.5 Setting the Upper or Lower Limit Value as an Absolute Value (ABS)



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

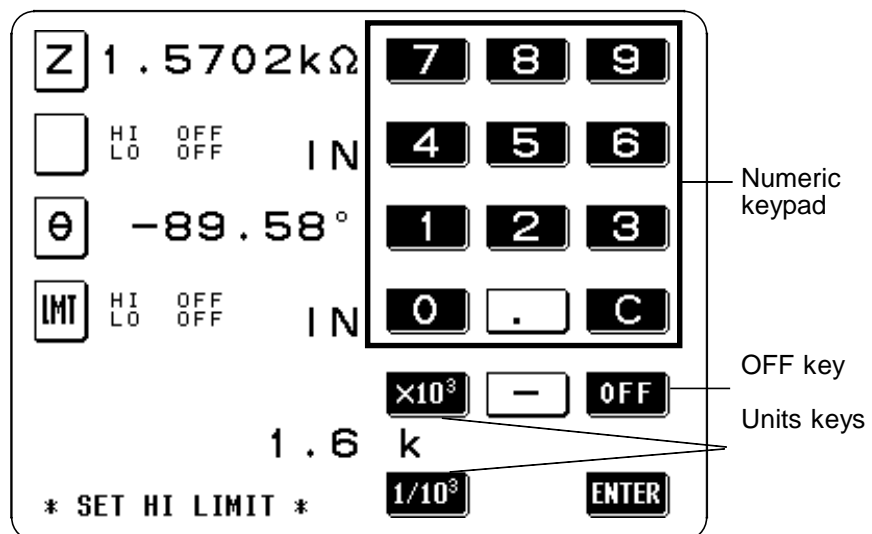
At this time the **ABS** key will go into non-reversed video, and simultaneously **HI** and **LO** keys will appear for setting the upper and lower limit values.



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.

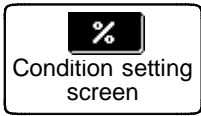
In order to set no upper limit value, press the **OFF** key.



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).

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

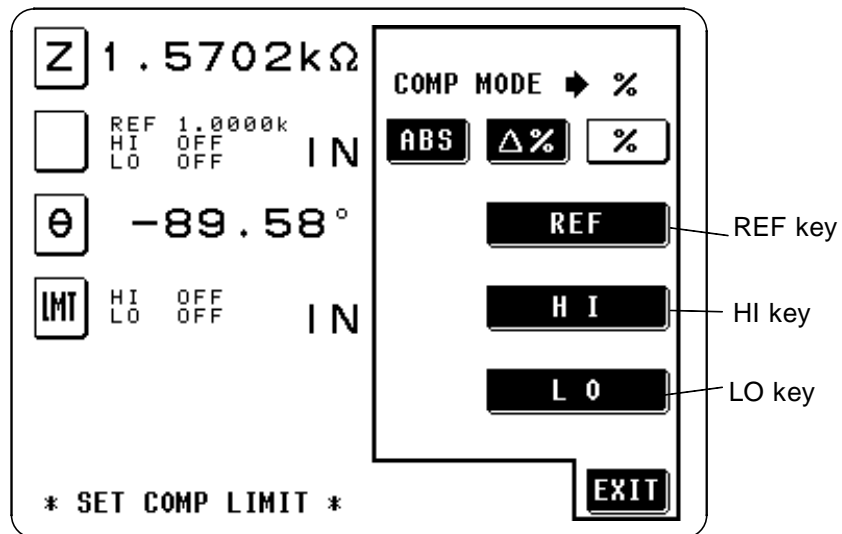


1. Press this key on the Conditions setting screen to select the percentage value setting mode.

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

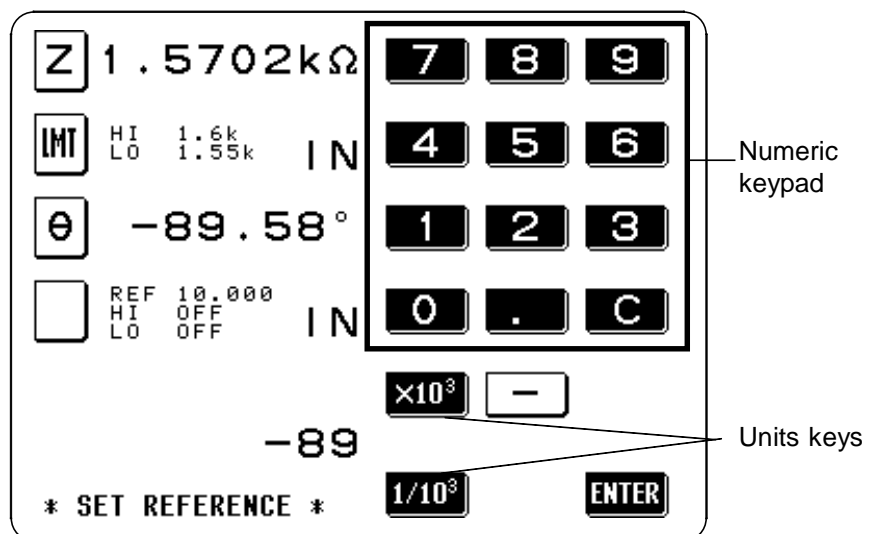
NOTE

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:

$\times 10^3$: step the units up

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

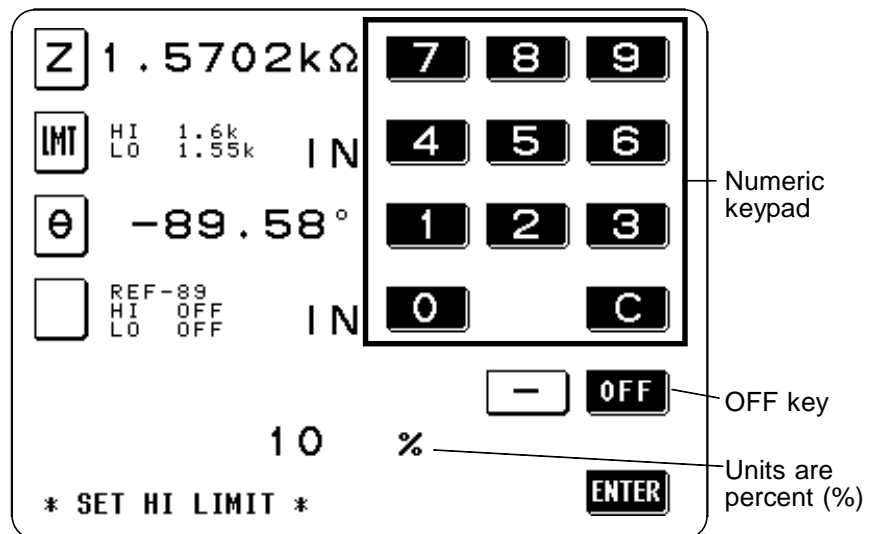
p -- n -- μ -- m -- (none) -- k -- M

<= 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. 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.

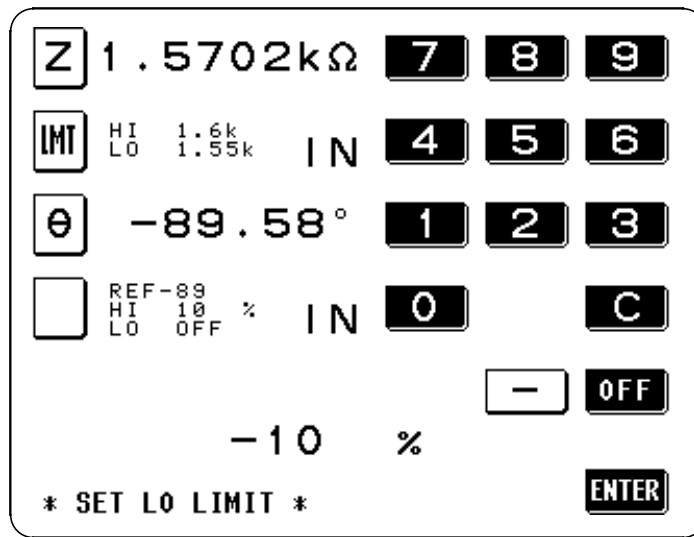
NOTE

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.



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.

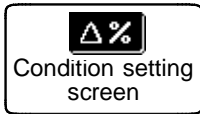
NOTE

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.

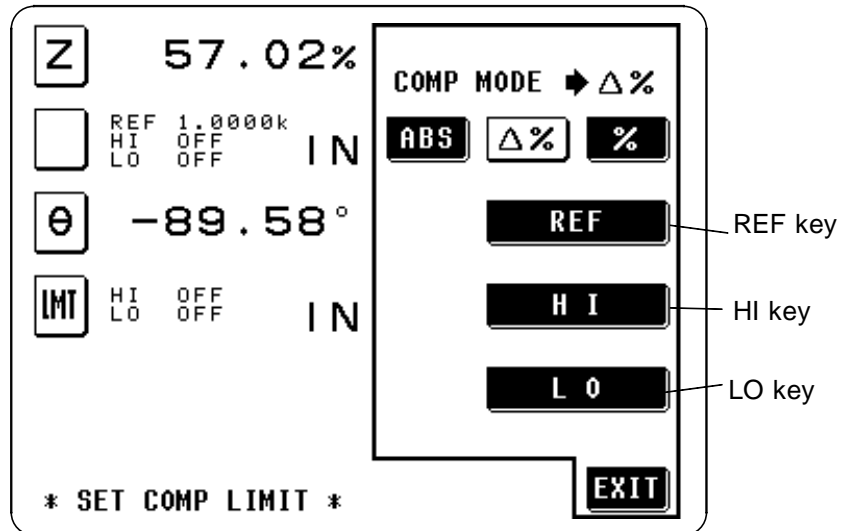
No test is performed in order to ensure that the upper limit value is greater than the lower limit value. Therefore no error message will be displayed even if you mistakenly interchange the settings for the desired upper limit value and the desired lower limit value. However, be careful that the decision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

4.15.7 Displaying Measurement Values as Deviations from the Reference Value ($\Delta\%$)



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

At this time the $\Delta\%$ key will go into non-reversed video, and simultaneously a REF key will appear for inputting the reference value, and HI and LO 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 ($\Delta\%$) 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 $\Delta\%$ value is calculated using the following equation:

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

| |: 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.

$$Y = a \times X + b$$

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

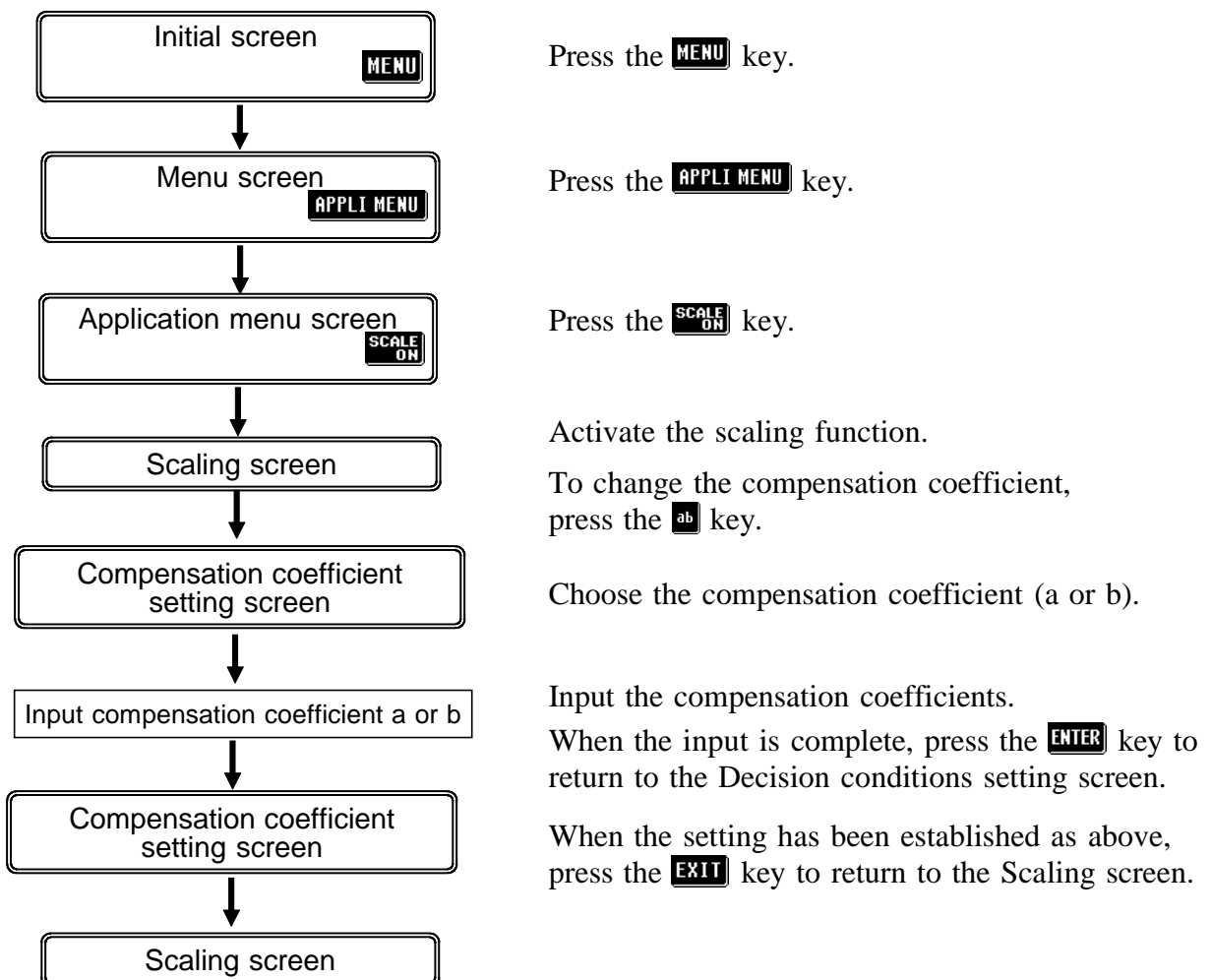
Here, when the parameter corresponding to X is either D or Q, the scaling is applied to θ as follows:

$$\theta' = a \times \theta + b$$

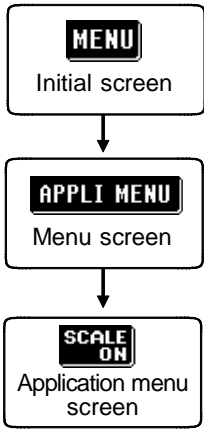
This gives a new value θ' , from which D or Q is obtained.

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

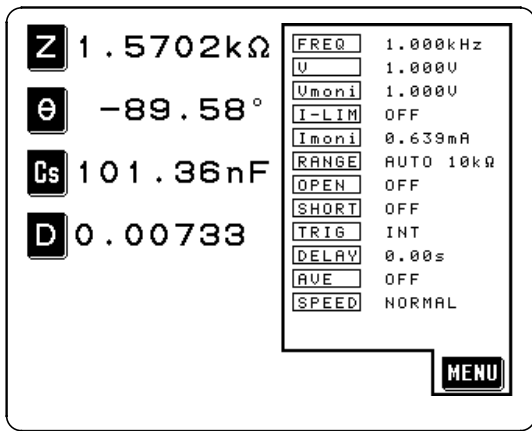
4.16.1 Control Screen Sequence



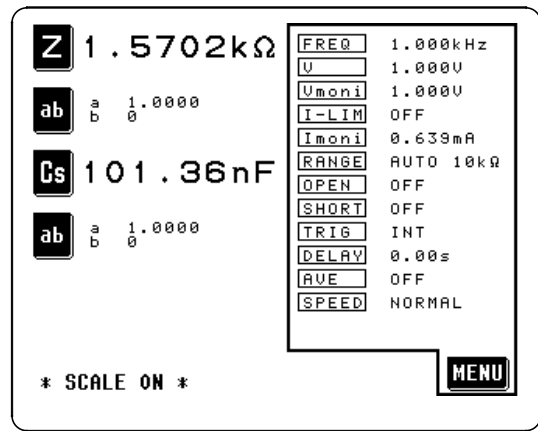
4.16.2 Setting Scaling



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.



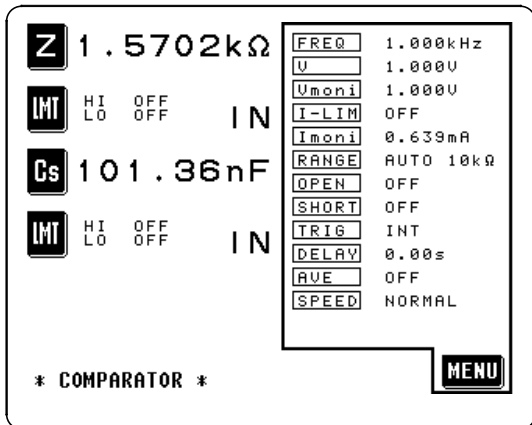
Initial Screen



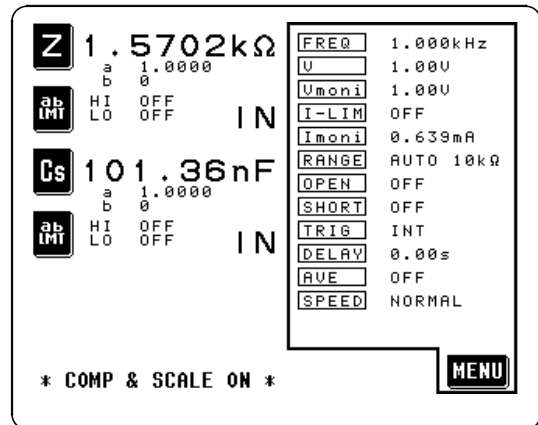
Scaling Screen

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.

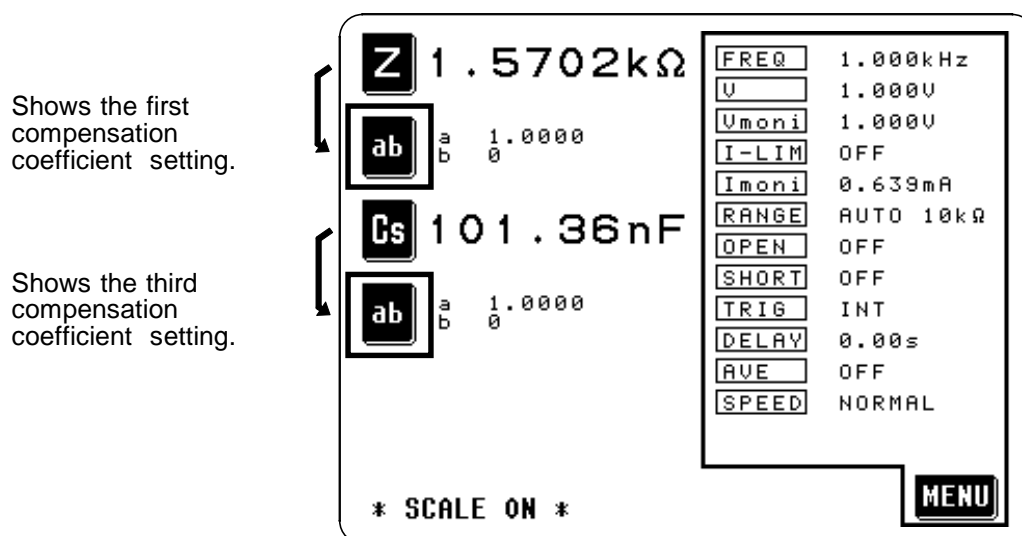


Comparator Screen



Comparator Scaling Screen

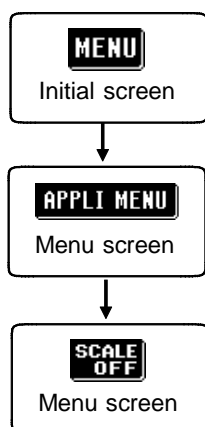
- Set the first and third parameters to be the two parameters which you wish to measure. (Refer to the section on display parameter setting for details upon how to make the setting.)



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

- 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

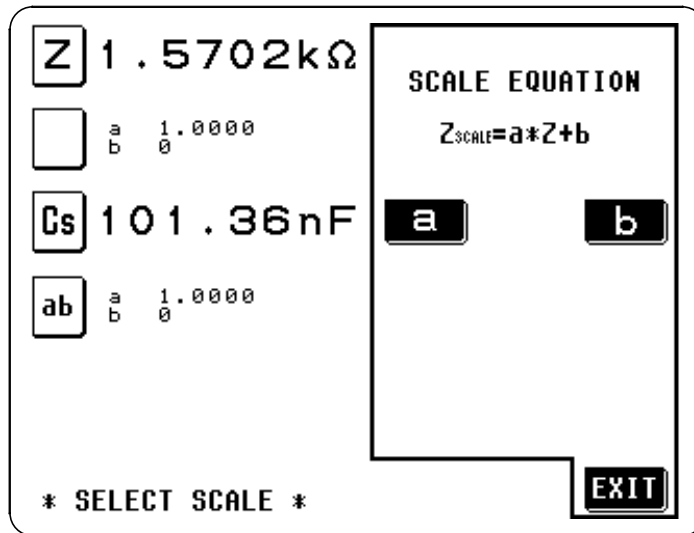


- Press the **MENU** key on the Scaling screen or the Comparator scaling screen to display the Menu screen.
- Press the **APPLI MENU** key on the Menu screen to display the Application menu screen.
- Press the **SCALE OFF** key on the Application menu screen to return the Initial screen or the Scaling screen.

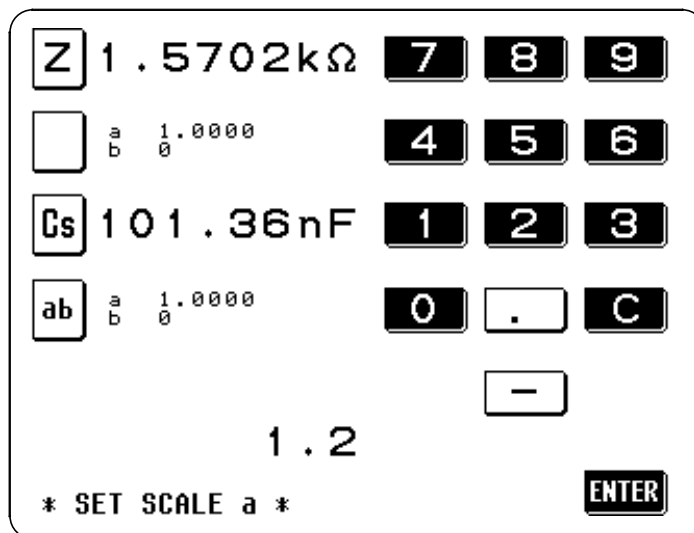
On the Initial screen, the second and fourth display parameter positions **ab** will revert to displaying the parameters which they were displaying before the comparator mode was started. On the Comparator screen, they will revert to displaying **WT**.

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.



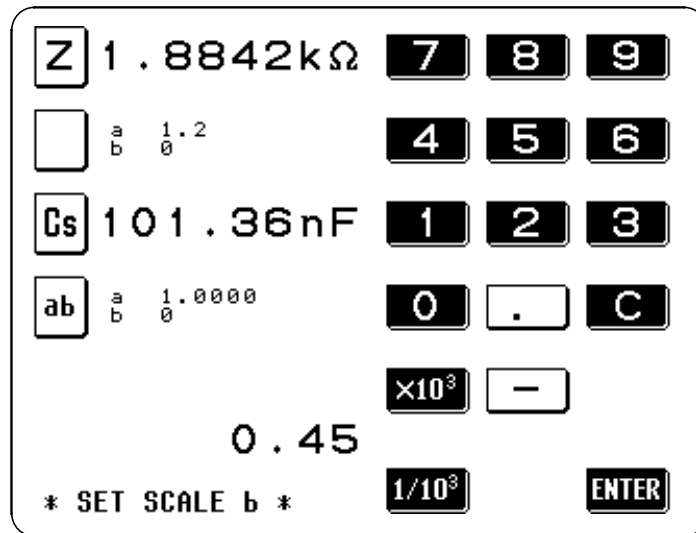
3. Press the **a** key, and a screen will appear for setting the compensation coefficient a. Use the numeric keypad to input the desired value.



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.



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

×10³ : step the units up

1/10³ : 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.

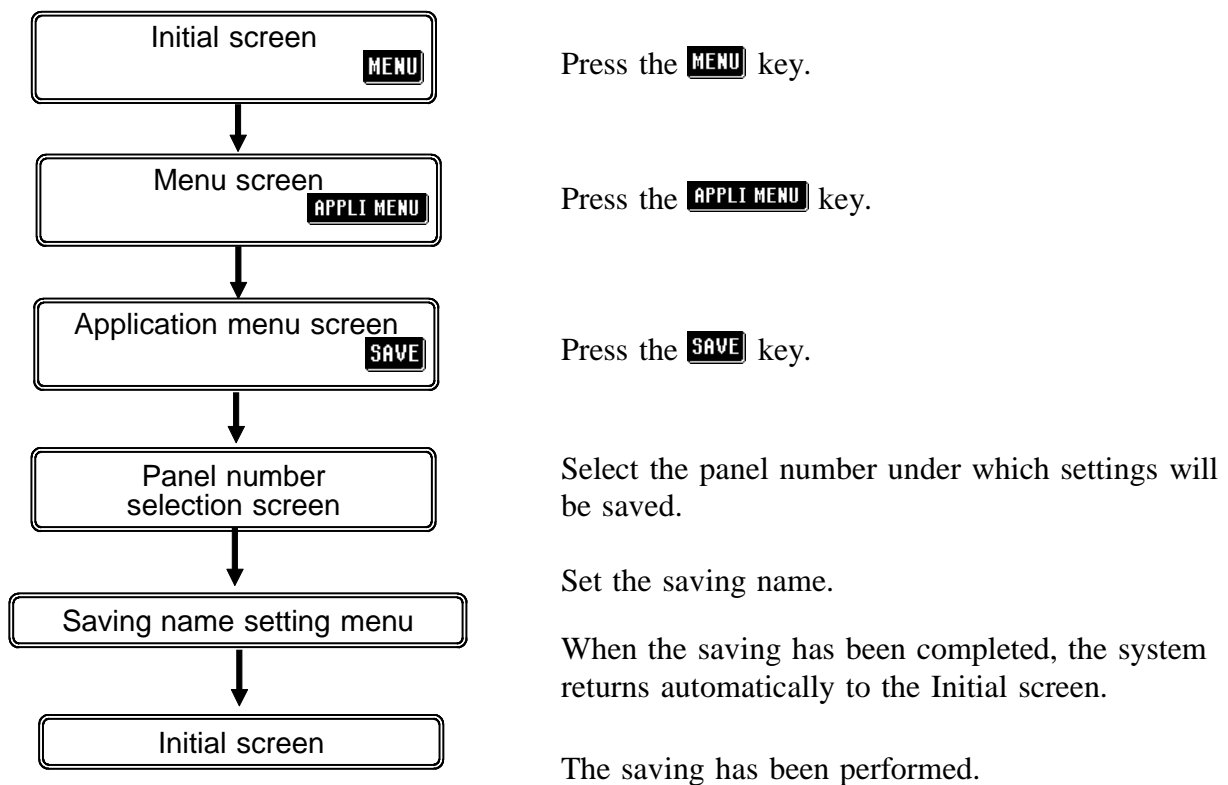
4.17 Panel Save Function

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).

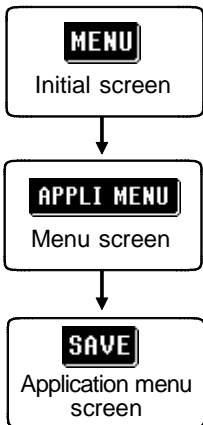
The test conditions which are saved are:

- 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

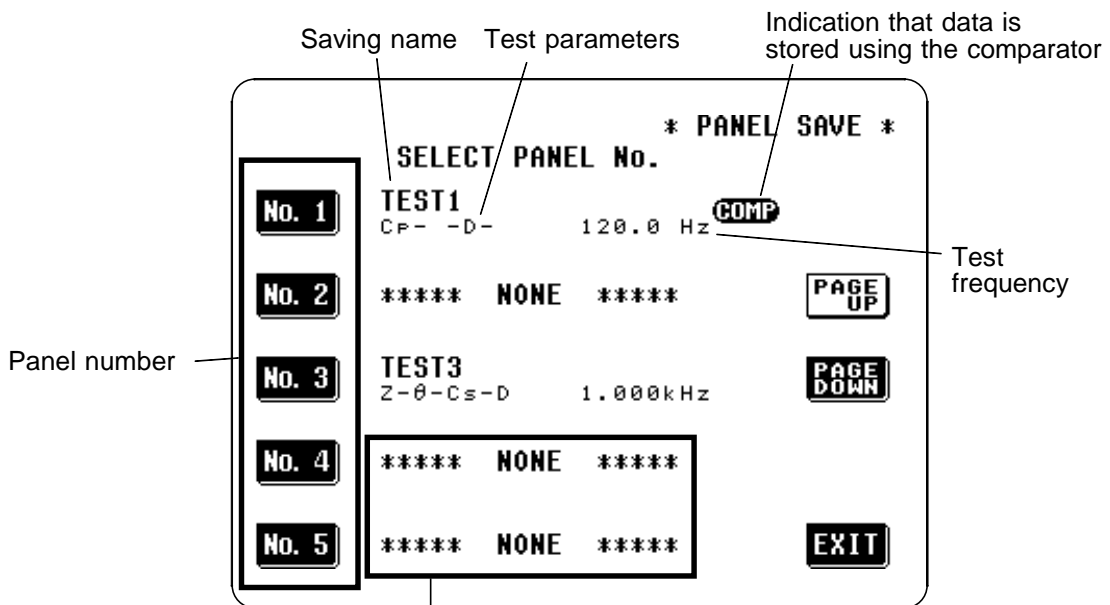
4.17.1 Control Screen Sequence



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.

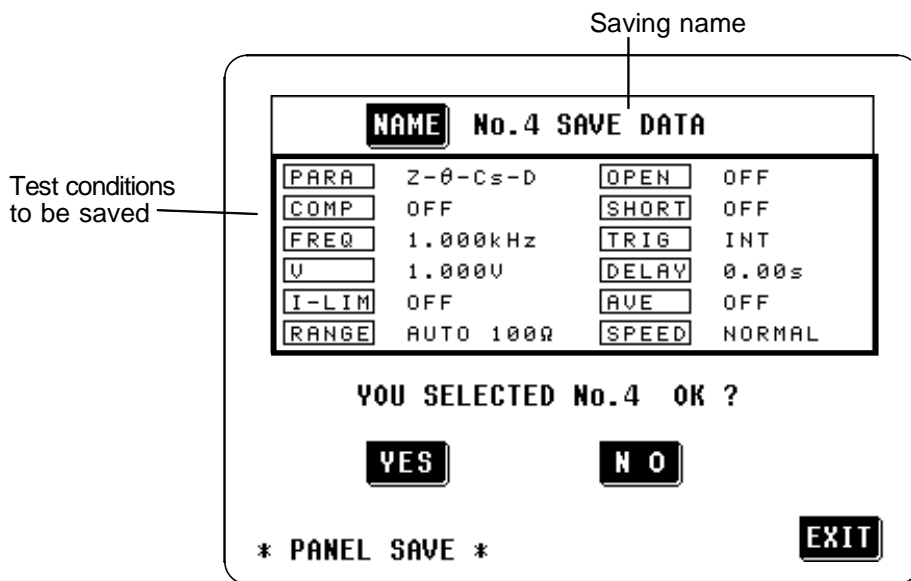


NONE means that nothing is saved.

Panel Number Selection Screen

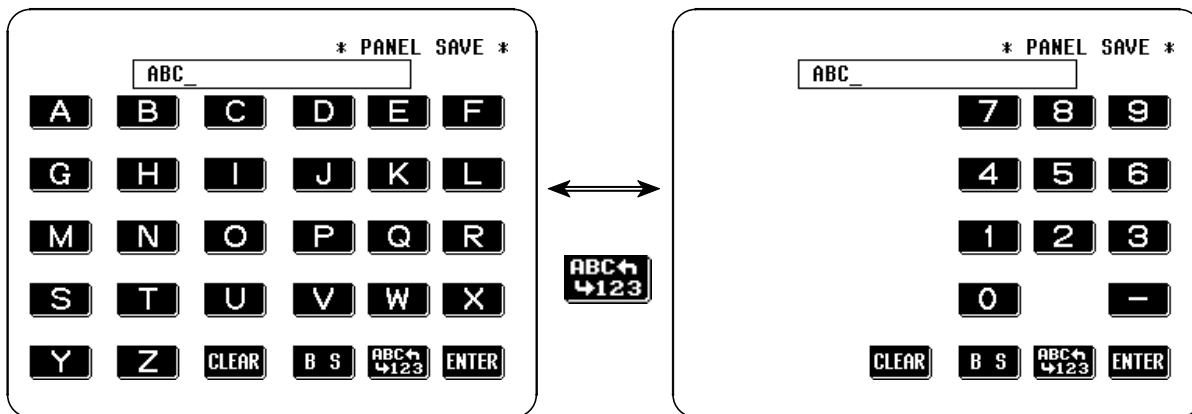
- EXIT** : cancel the saving, and the display reverts to the Initial screen.
PAGE UP, **PAGE DOWN** : change the position of the panel number

- 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.



- YES** : save the current test conditions with the saving name, and the display automatically reverts to the Initial screen.
- NO** : change the panel number, and the previous screen will be displayed again.

- 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.

- After input, press the **ENTER** key to return the Saving confirmation screen.
- 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	
				Stored using the comparator mode
No. 2	TEST2			
	Z-θ-Cs-D	1.000kHz		

- 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).

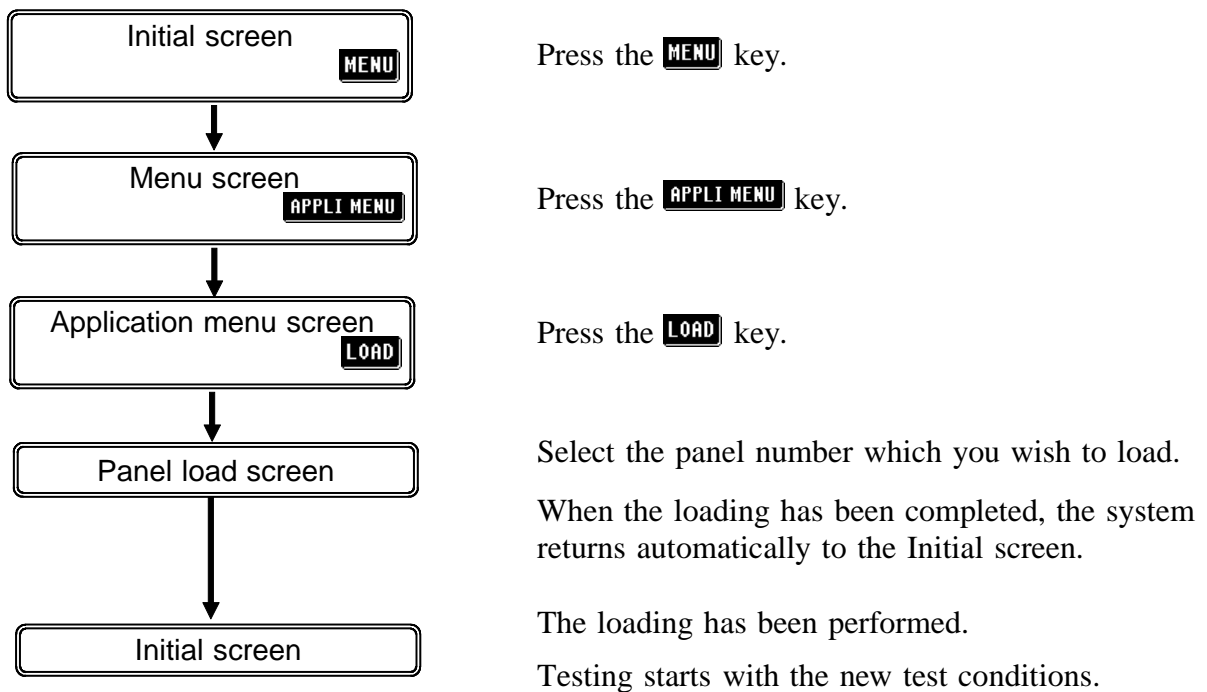
4.18 Panel Load Function

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

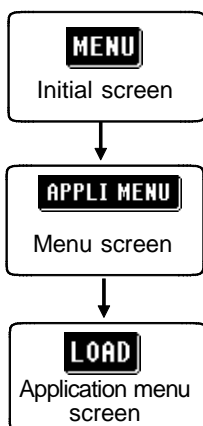
The test conditions which are saved:

- 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

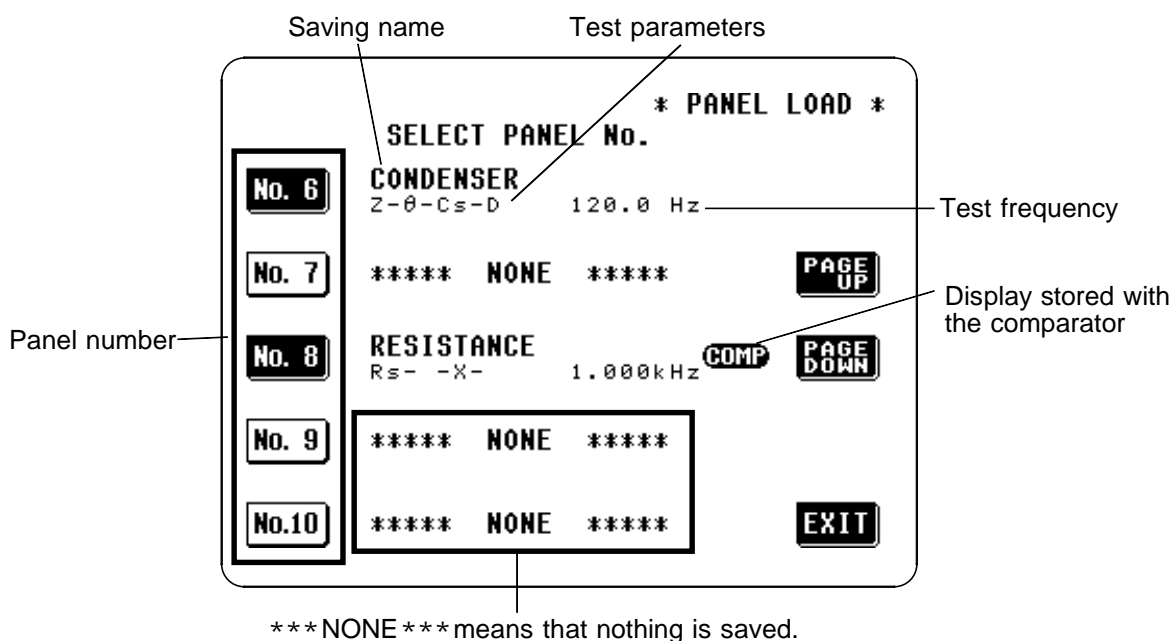
4.18.1 Control Screen Sequence



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 Screen

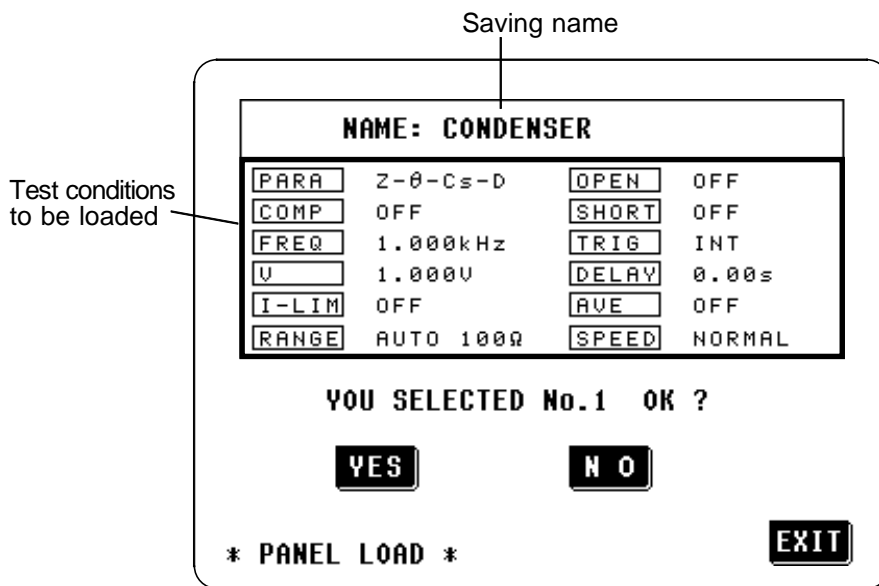
4. For each panel number, some of the values currently saved are shown on the Panel load screen. Check these stored values and then select the panel number for which the stored test conditions will be loaded.

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.

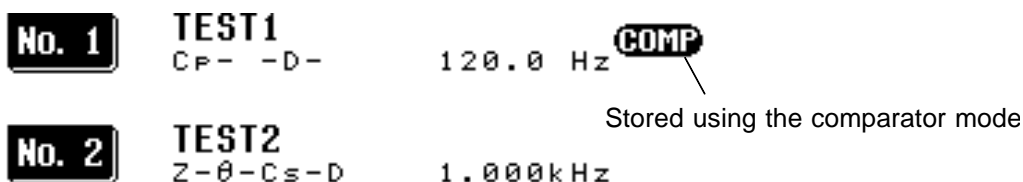
- A message requesting confirmation will be displayed. To continue, press the **YES** key. The test conditions saved under the panel number which was selected will be loaded in place of the present test conditions.



To change the panel number for the load, press the **NO** 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:

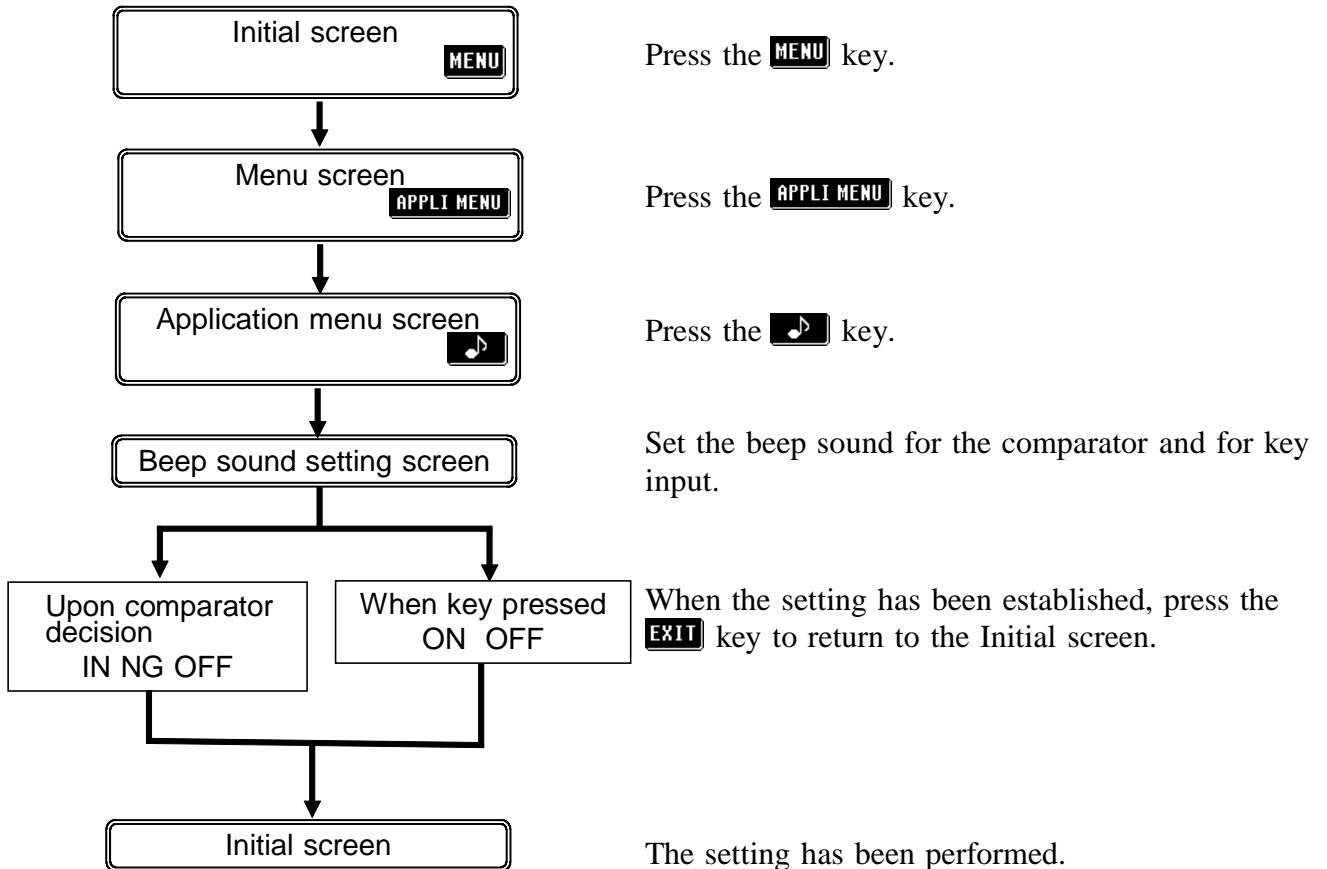


- Under normal conditions of use, the average life of the backup battery is about 10 years.
- If the internal battery becomes exhausted, it is no longer possible to save the test conditions. You should have the battery changed by an approved HIOKI service facility (which is chargeable).

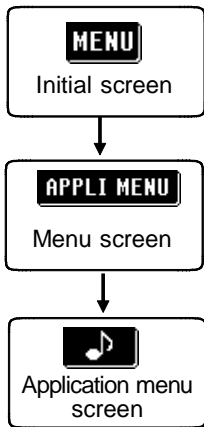
4.19 Setting the Beep Sound

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.

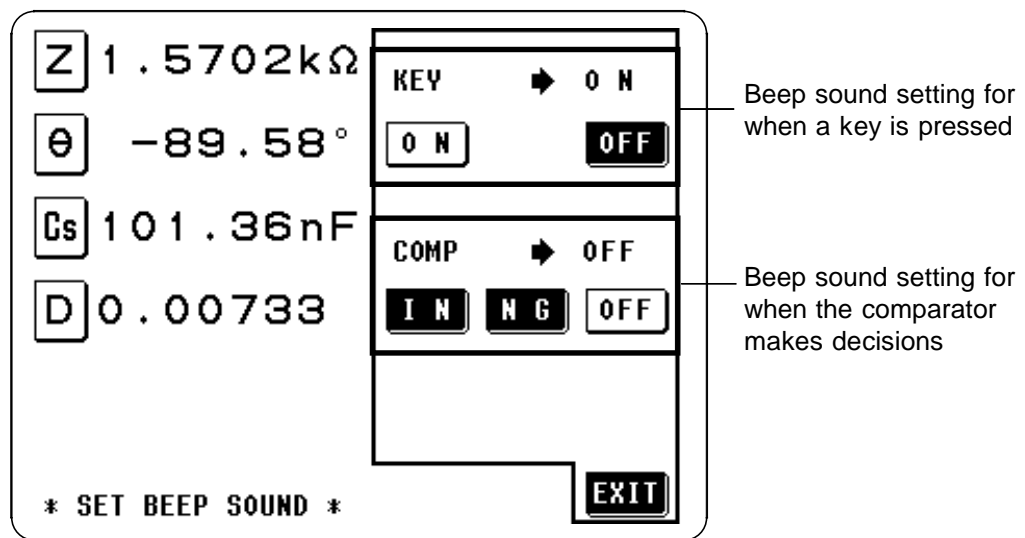
4.19.1 Control Screen Sequence



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 **Musical Note** key on the Application menu screen to display the Beep sound setting screen.



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.

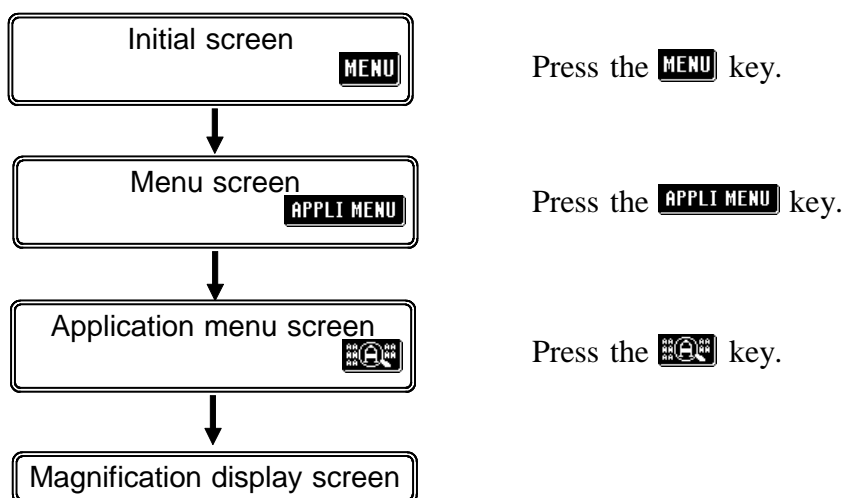
3. When the setting has been established as above, press the **EXIT** key to return to the Initial screen.

4.20 Enlarged Display of Measurement Values

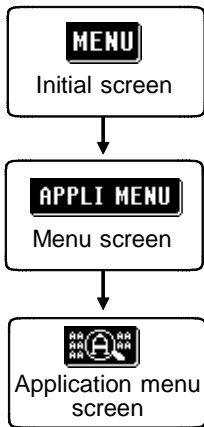
The measurement values and comparator decision results can be displayed in enlarged form. This function is convenient when the unit is used under constant measurement conditions.

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

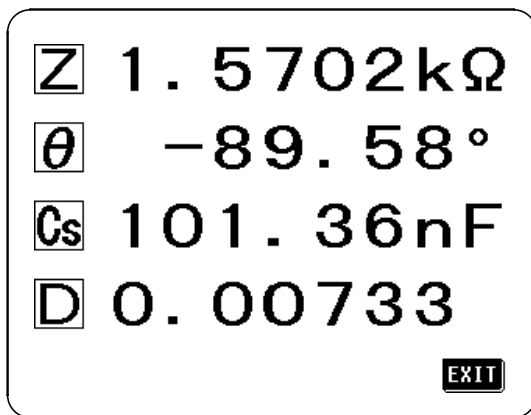
4.20.1 Control Screen Sequence



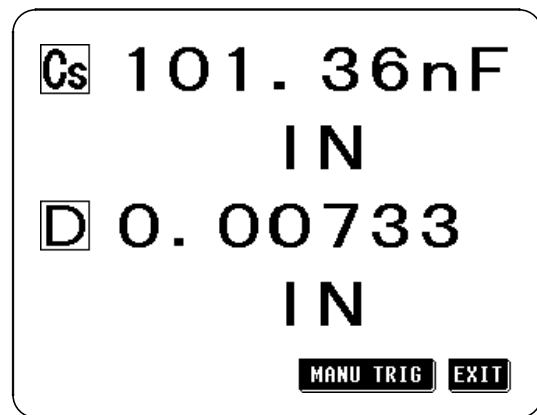
4.20.2 Details of the Setting Process



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 **MAGN** key on the Application menu screen to display the Magnification display screen.



Normal Screen



Comparator Screen

EXIT : return the Initial screen

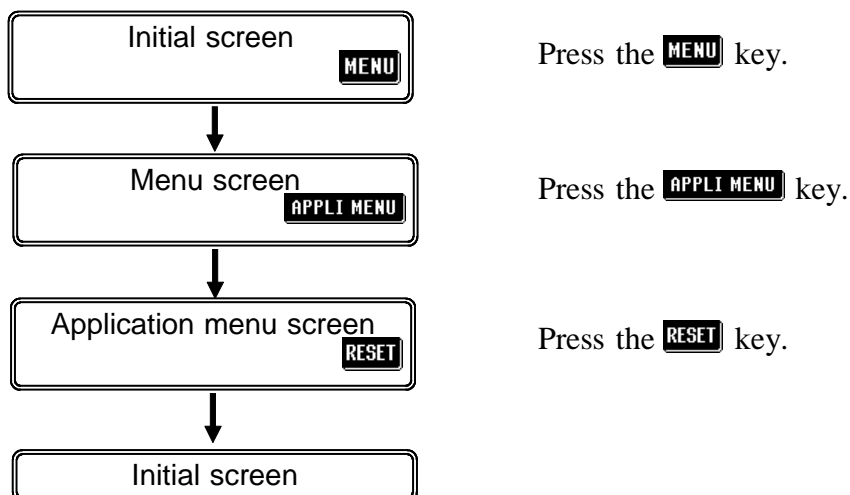
MANU TRIG (during the external trigger setting): measure once

On the Magnification display screen, only **EXIT** and **MANU TRIG** keys are displayed.

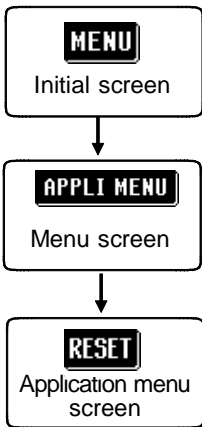
4.21 System Reset

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

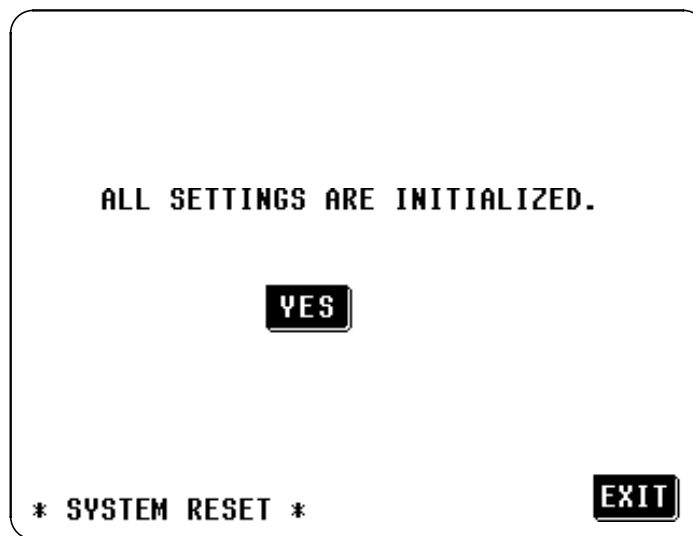
4.21.1 Control Screen Sequence



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.



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	$ Z , \theta$
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

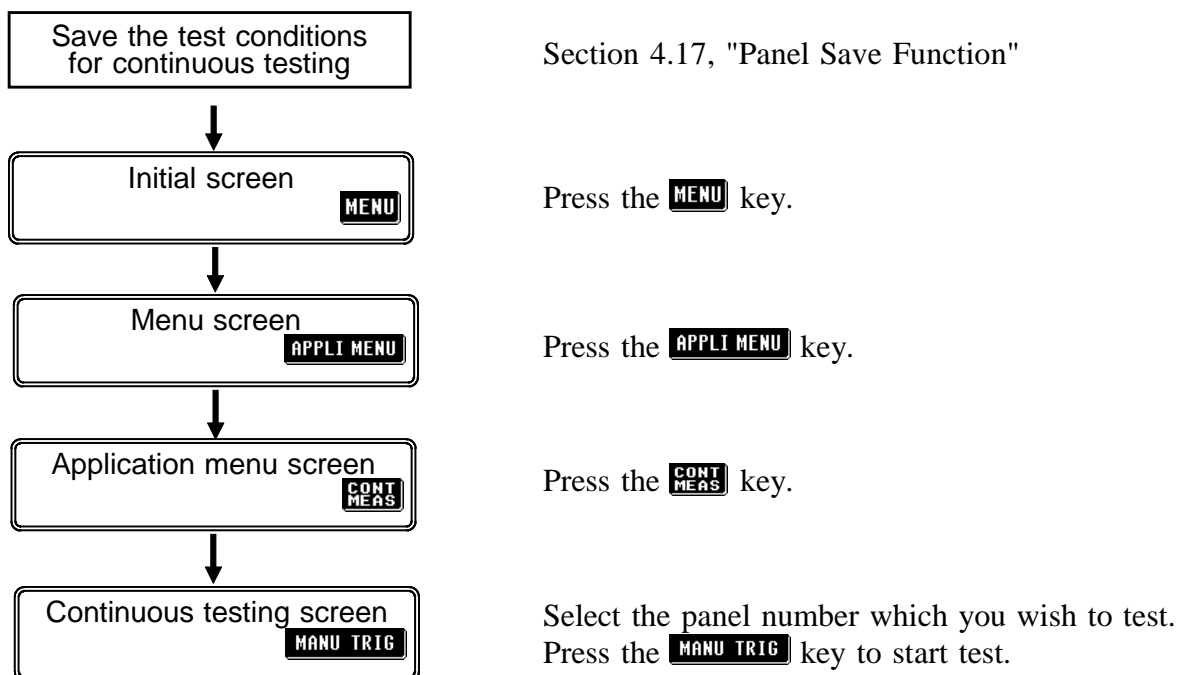
It is possible to read in order test conditions which have been saved using the panel save function, and to perform continuous testing.

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



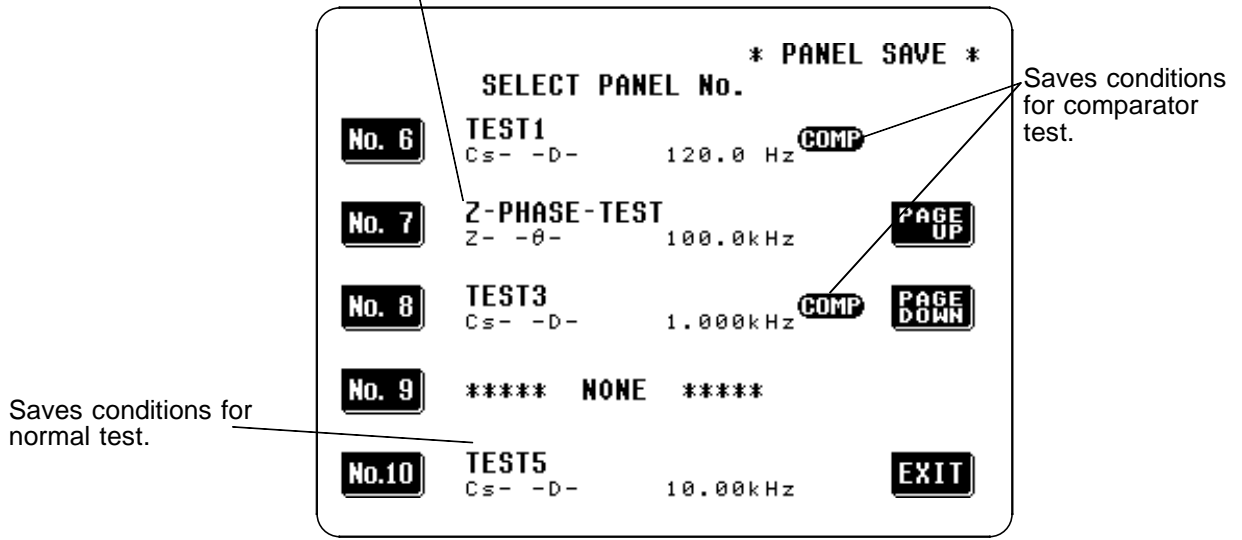
4.22.2 Details of the Setting Process

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

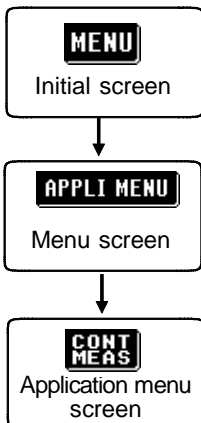
1. Save the continuous testing conditions on panel numbers 6, 8, and 10 using the panel save function. The continuous testing is performed for the first and third parameters which have been saved.

For details on panel save function, see Section 4.17.

Test conditions for some other test sample are already saved here

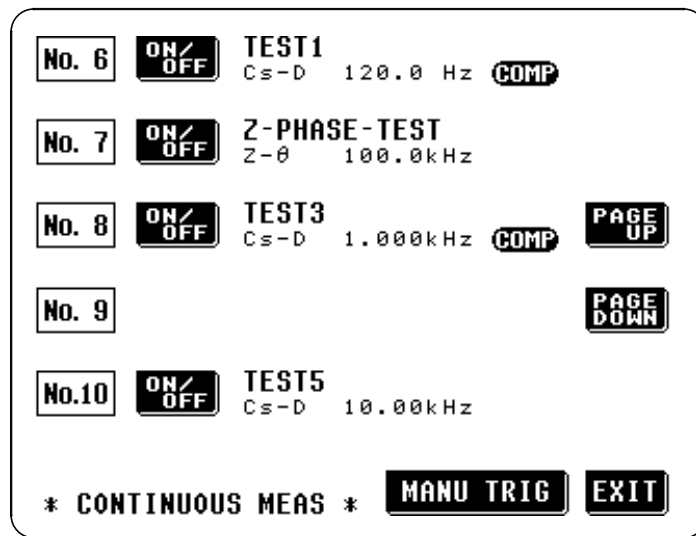


Panel Save Screen



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.



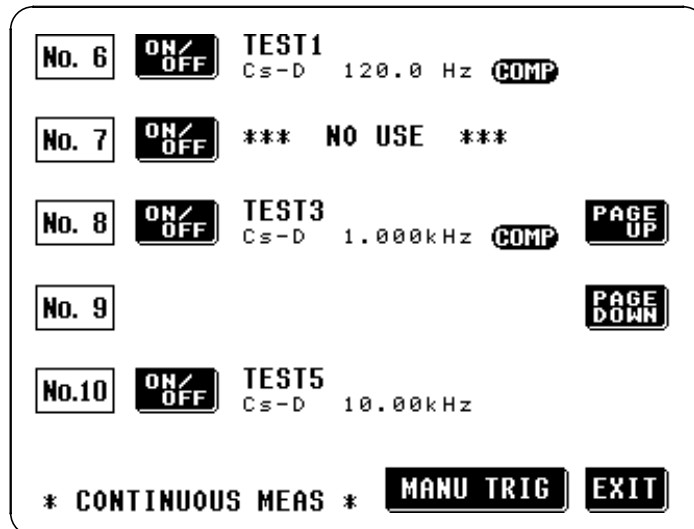
Continuous Test Screen

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.



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.

The screenshot shows a test result display screen with the following content:

- No. 6** **ON/OFF** Cs 979.14nF IN **OK**
- D** 0.00069 IN
- No. 7** **ON/OFF** *** NO USE ***
- No. 8** **ON/OFF** Cs 984.21nF HI **NG** **PAGE UP**
- D** 0.00034 LO
- No. 9** **PAGE DOWN**
- No.10** **ON/OFF** Cs 985.48nF
- D** 0.00401
- * **CONTINUOUS MEAS** * **MANU TRIG** **EXIT**

Annotations:

- "The first parameter test result" points to the "Cs 979.14nF" value for No. 6.
- "The third parameter test result" points to the "D 0.00034" value for No. 8.
- "When the comparator test, individual decision result and AND result are displayed." points to the "OK" and "NG" results.

NOTE

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

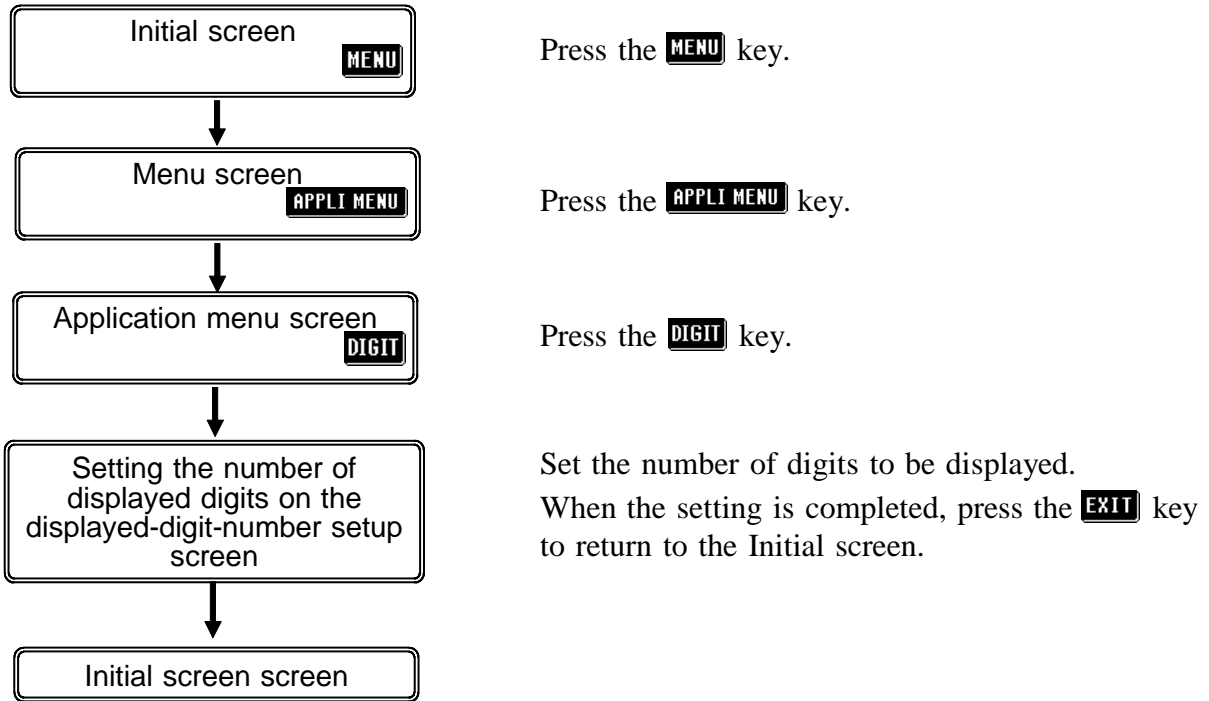
8. To exit from the continuous test, press the **EXIT** key to return the Initial screen.

The continuous test can be executed from the EXT I/O connector. For details, see Section 5.6, "Testing Using EXT I/O."

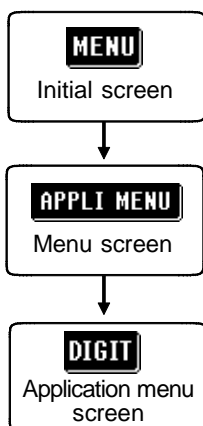
4.23 Setting the Number of Displayed Digits

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

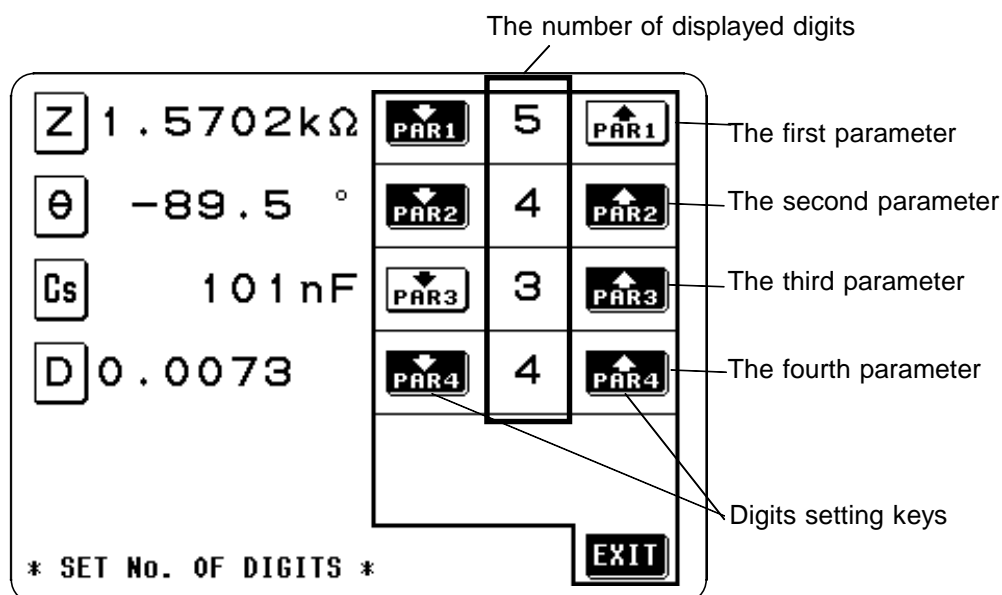
4.23.1 Control Screen Sequence



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 $\Delta\%$ 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

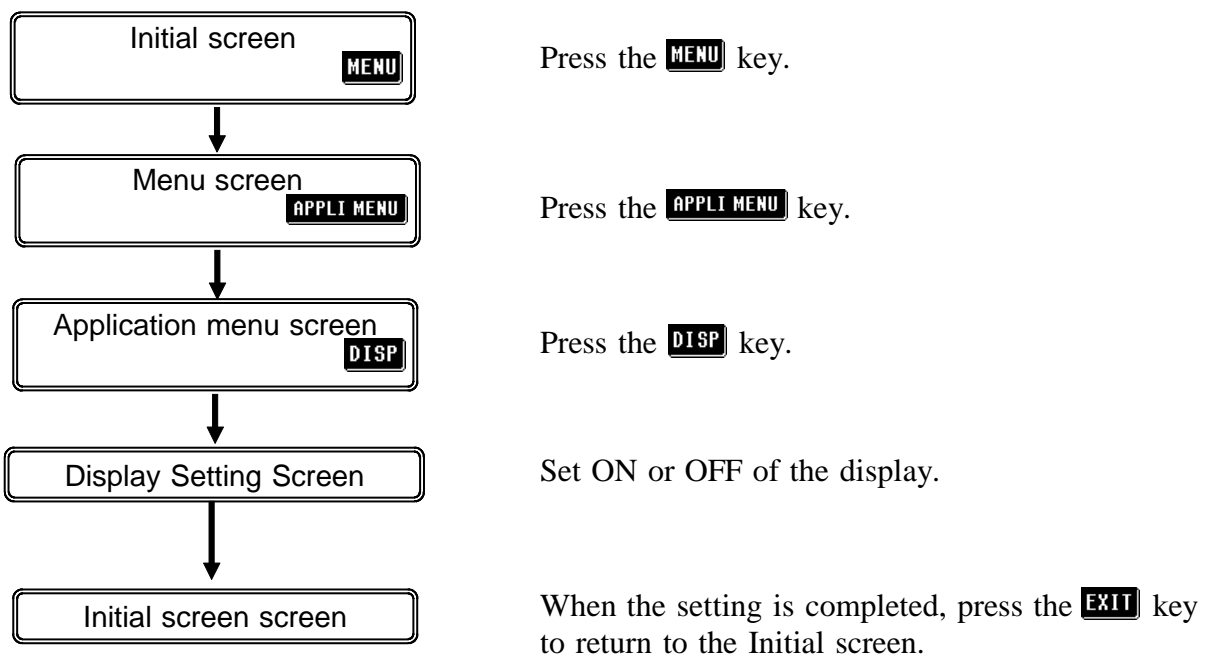
4. To exit from this mode, press the **EXIT** key to return the Initial screen.

4.24 Setting for Display

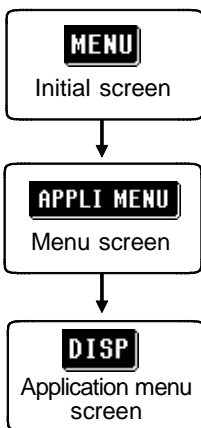
In some applications, such as on a production line or where EXT I/O or interfaces are used, it may not be necessary to display measurement values. This unit allows ON/OFF settings of the display and voltage/current monitors (Vmoni, Imoni) to be made.

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.

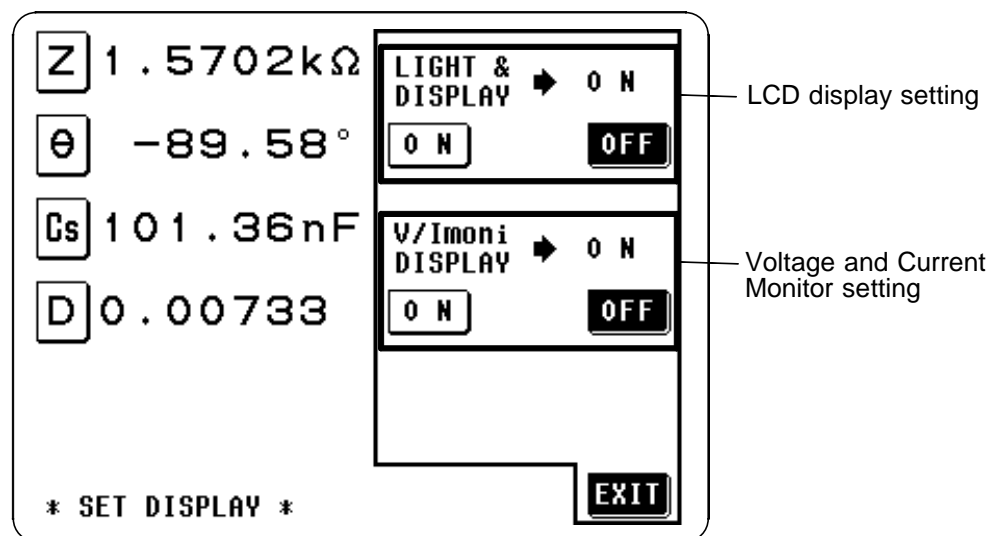
4.24.1 Control Screen Sequence



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

- ON** :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)

- ON** :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."

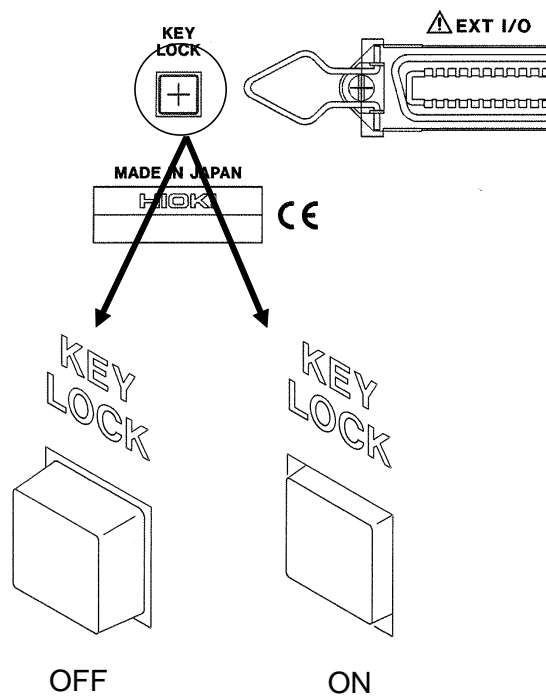
4. To exit from this mode, press the **EXIT** key to return the Initial screen.

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 C_p 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

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

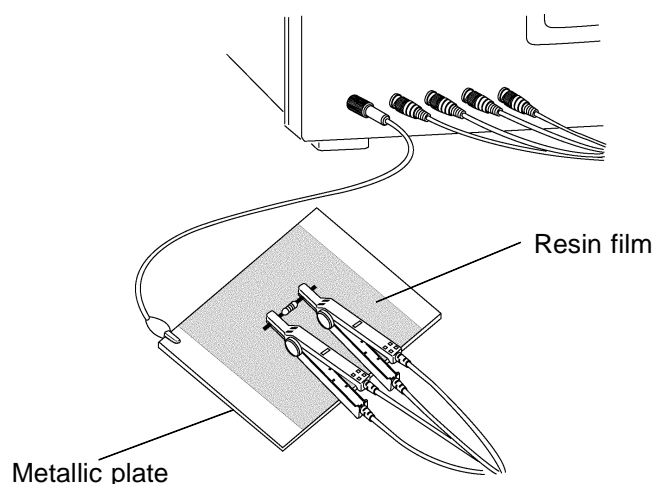
		Comparator decisions	
		Parameter 1 result	Parameter 3 result
	Band 1	HI	HI
First parameter upper limit value	10% (3.3 kΩ)		
	Band 2	IN	HI
First parameter lower limit value	5% (3.15 kΩ)		
	Band 3	LO	HI
Third parameter upper limit value	-5% (2.85 kΩ)		
	Band 4	LO	IN
Third parameter lower limit value	-10%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

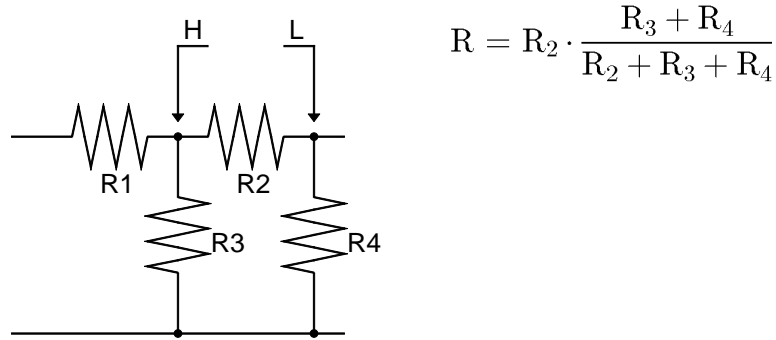
NOTE

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.

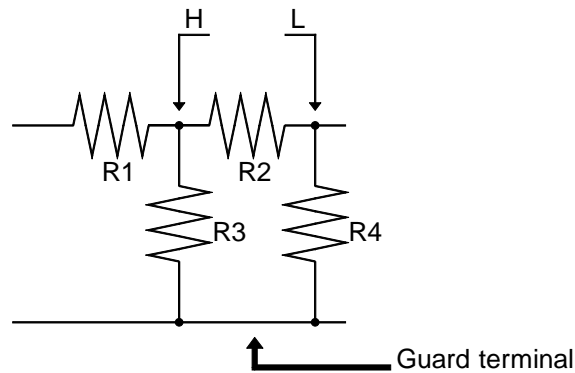
5.3 Testing an Element in a Circuit

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:



- 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.

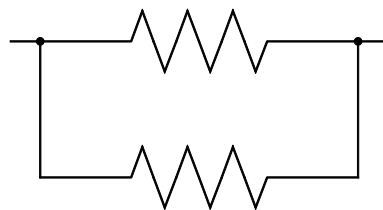


NOTE

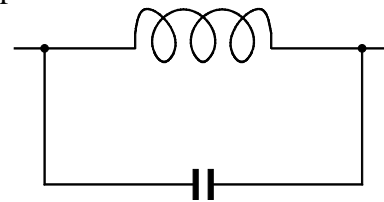
The accuracy of measurement will not be improved in cases where for example

$R_2 \gg R_3$ 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

5

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.

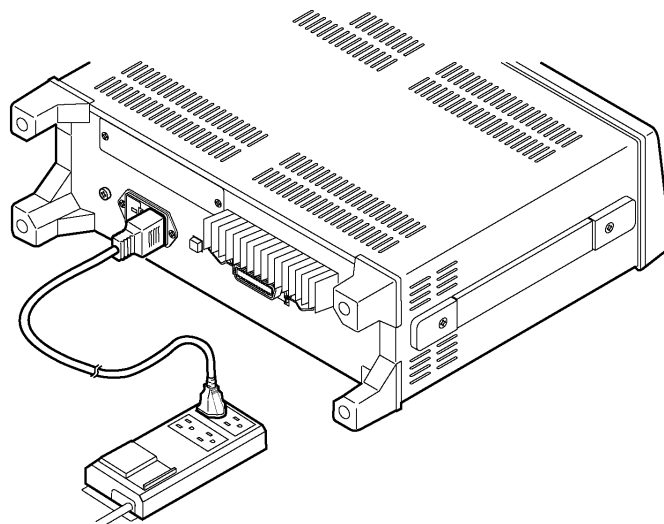
This protective grounding serves the important function, not only of avoiding the possibility of electric shock to the operator, but also of eliminating noise from the power supply line by the provision of an internal filter.

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.

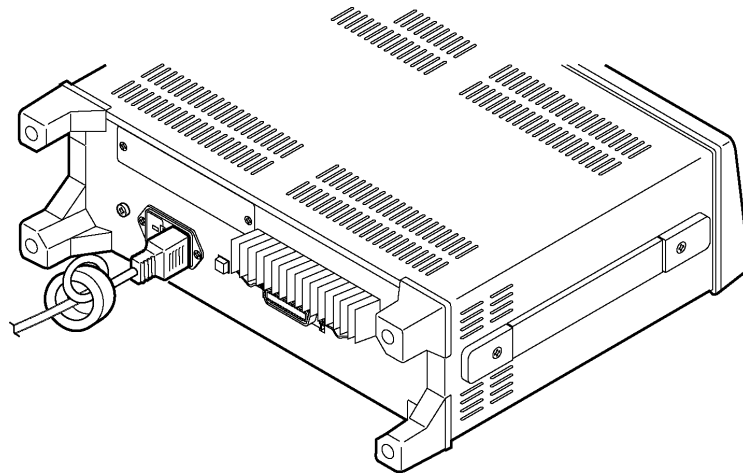
Various types of such socket type noise filters are readily available from specialist manufacturers.



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.



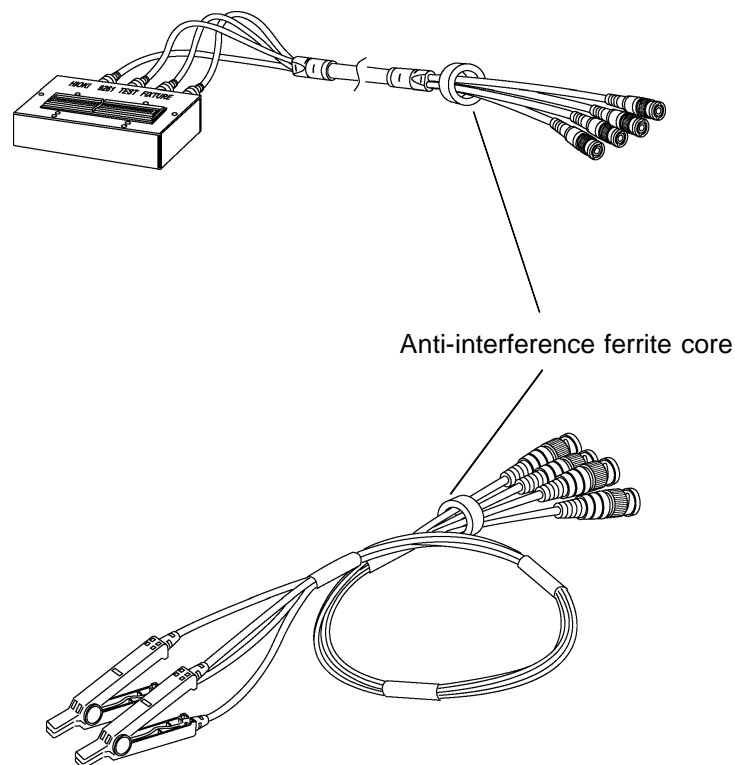
5.4.2 Countermeasures Against Noise from the Test Cables

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.

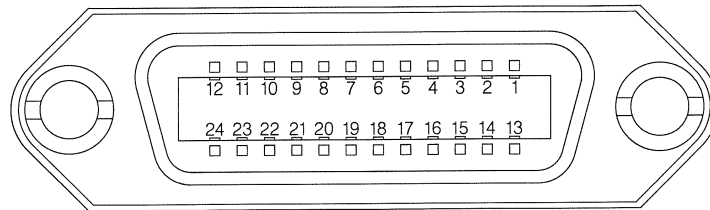




5.5 The EXT I/O Connector

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	TRIG	Input	16	M-HI	Output
5	LOCK	Input	17	M-IN	Output
6	LD1	Input	18	M-LO	Output
7	LD2	Input	19	S-HI	Output
8	LD3	Input	20	S-IN	Output
9	LD4	Input	21	S-LO	Output
10	LD5	Input	22	AND	Output
11	Unused	—	23	INDEX	Output
12	Unused	—	24	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) $\overline{M-HI}$, $\overline{M-IN}$, $\overline{M-LO}$ (Output signal of comparator result)

These lines output the comparator result for the first parameter.

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

These lines output the comparator result for the third parameter.

- (3) \overline{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{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{INDEX} (Signal during analog measurement)

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

NOTE

\overline{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{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.

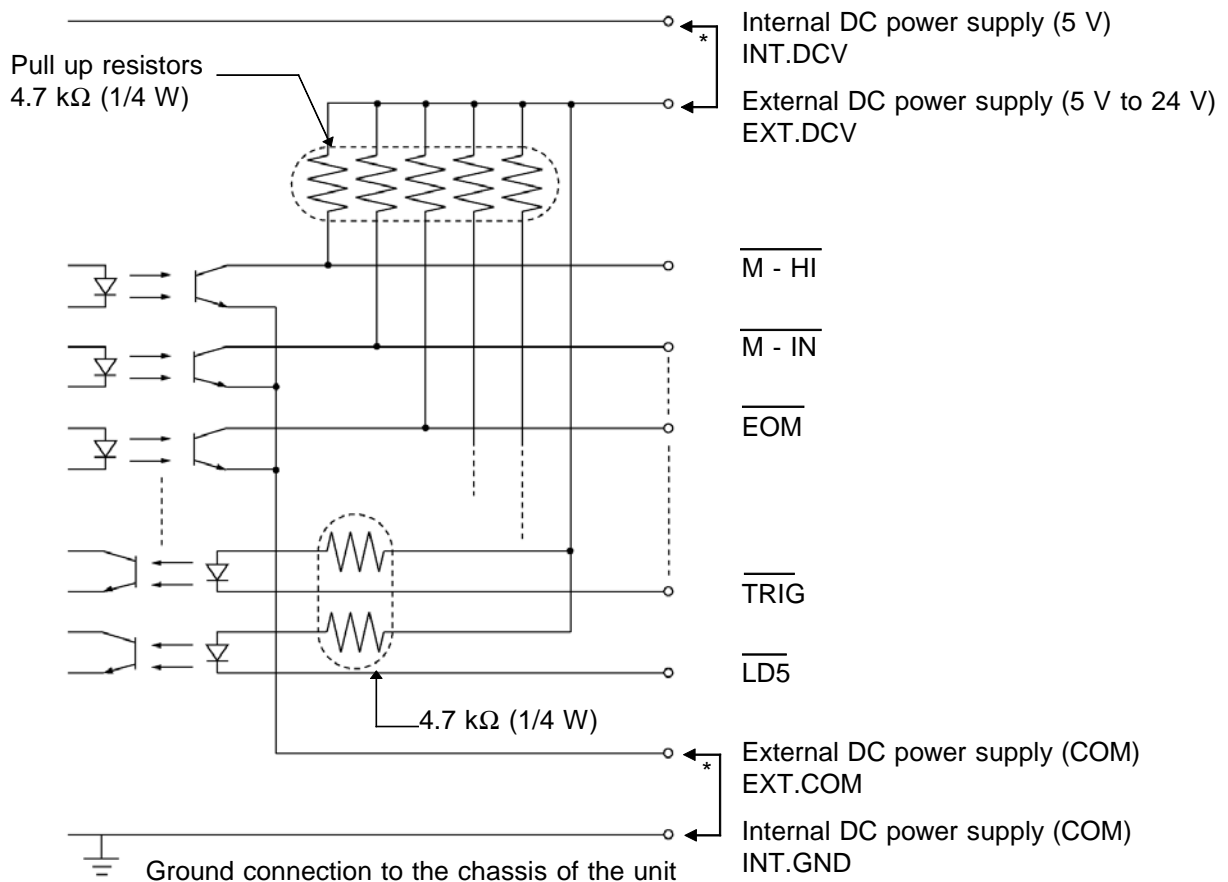
5.5.3 Circuit Construction and Connections for the EXT I/O Connector

⚠ 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 60 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 k Ω 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 k Ω)			
	High level	Low level (Output current)		
		10 mA	40 mA	60 mA (max.)
5 V	5V	0.9 V	1.1 V	1.2 V
12 V	12 V	0.9 V	1.1 V	1.2 V
24 V	24 V	0.9 V	1.1 V	1.2 V

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.

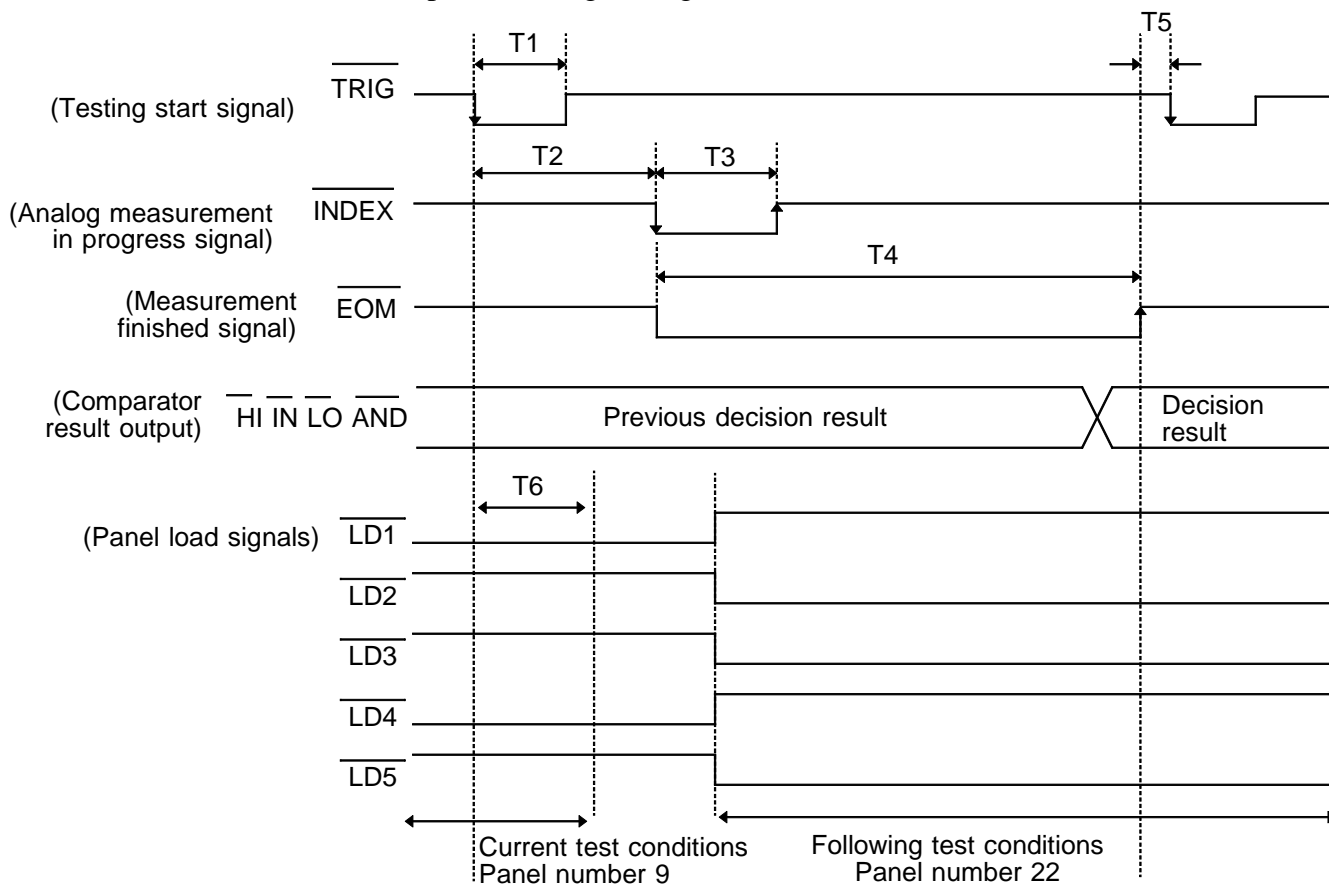
In such a case, keep V_{IL} below 0.8 V by incorporating a transistor or a drive capable buffer circuit or the like.

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:



	Meaning	Timing (approximate)
T1	Minimum time period for trigger signal recognition	100 μ s
T2	Time period from trigger to circuit response	300 μ s + 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 μ s

Note1: The chuck can be switched using the 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."

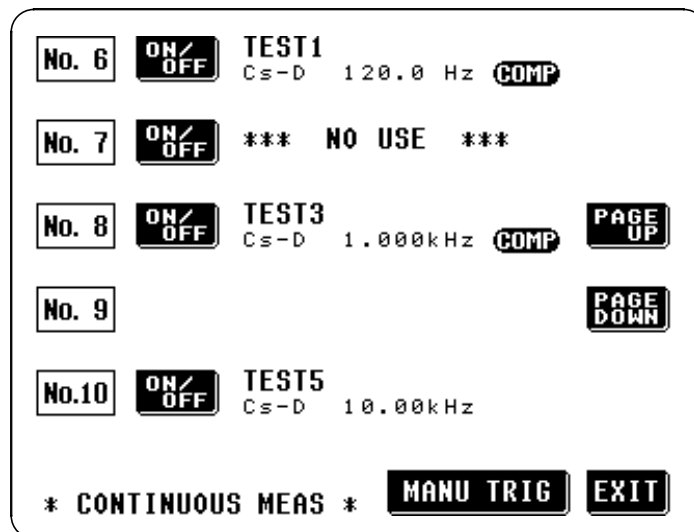
NOTE

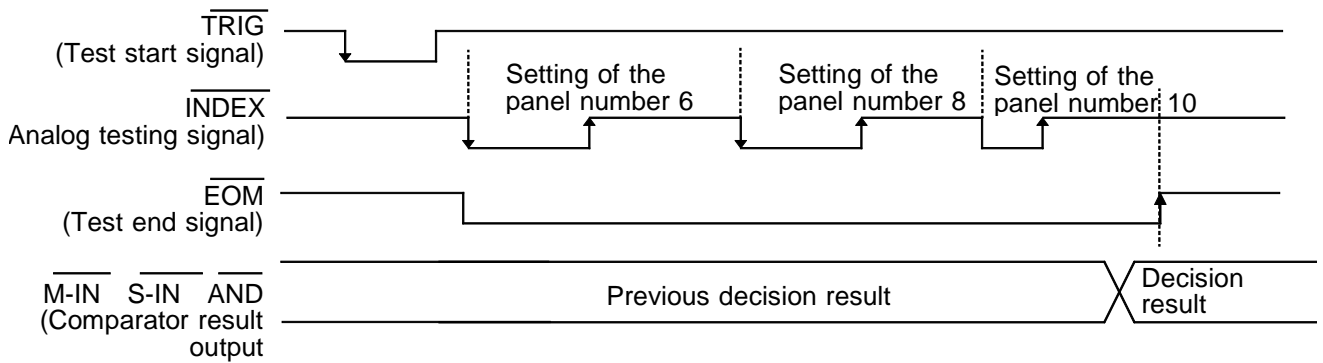
- When the selected panel number is not stored, the 3532-50 begins measurement without loading the measurement conditions.
- When the measurement conditions are loaded, the external trigger is always set.

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.





$\overline{\text{AND}}$ 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

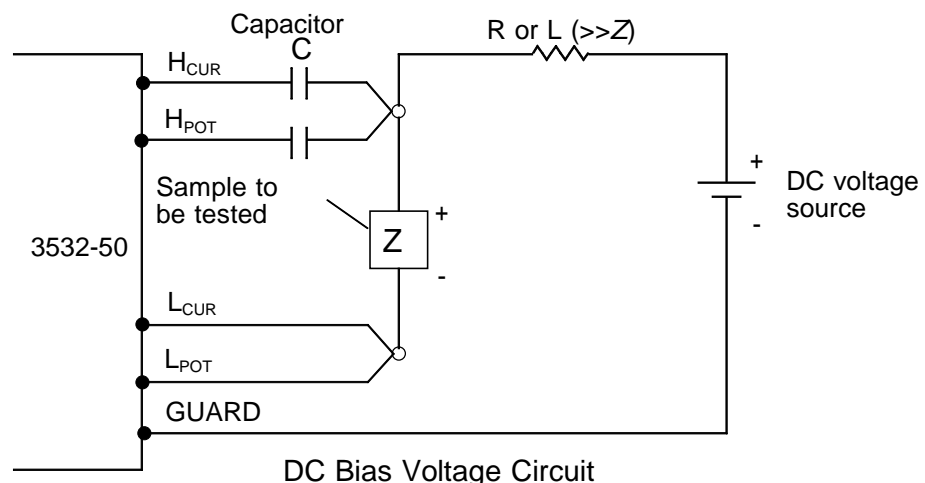
⚠ CAUTION

- 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.

To supply a DC bias voltage to a capacitor or the like, proceed as follows. Use the optional 9268 DC BIAS VOLTAGE UNIT.

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.



- Use a resistance (R) or inductance (L) which has a large enough impedance with reference to the sample under test (Z).
- Use a capacitor (C) which has a small enough impedance (i.e., a large enough capacitance) with reference to the sample under test (Z).
- 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

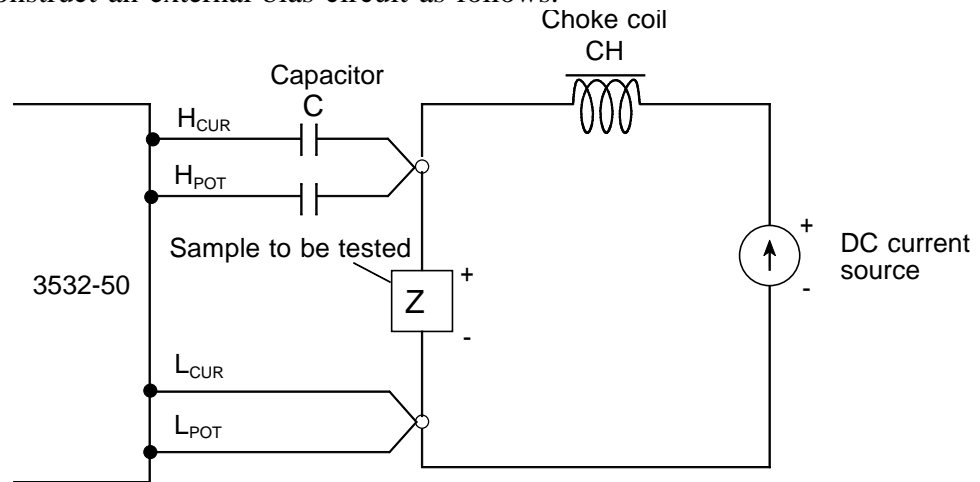
CAUTION

- 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.

To supply a DC bias, use the optional 9269 DC BIAS CURRENT UNIT. 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).
- Use a capacitor (C) which has a small enough impedance (i.e., a large enough capacitance) with reference to the sample under test (Z).
- 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	DPU-414	Seiko Instruments Inc.
9443-01	PW-4007-J1	Seiko Instruments Inc. (for Japan)
9443-02	PW-4007-E1	Seiko Instruments Inc. (for EU)
9443-03	PW-4007-U1	Seiko Instruments Inc. (for America)

(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	①
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

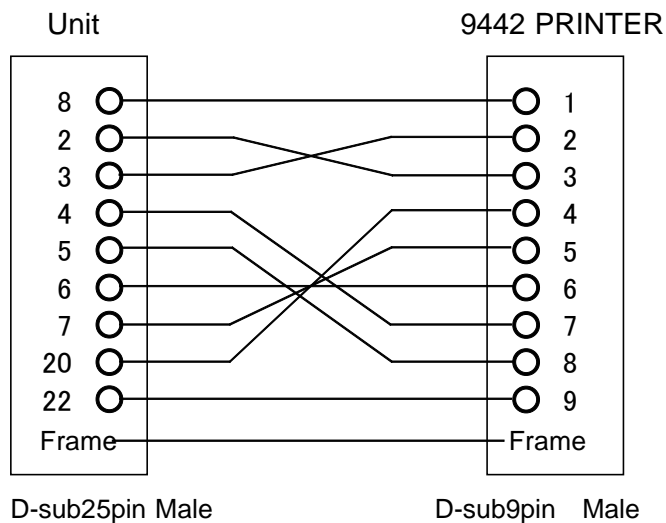


WARNING

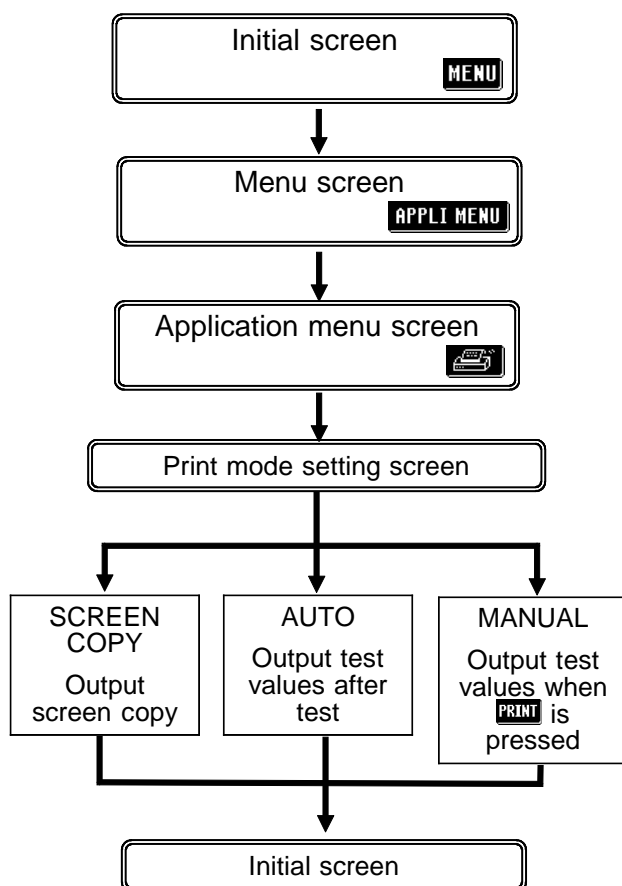
To avoid electrocution, turn off the power to all devices before plugging or unplugging any cables or peripherals.

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.

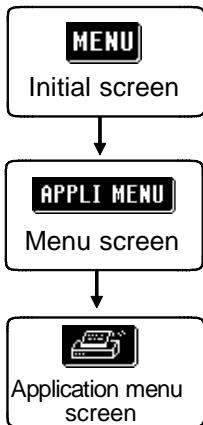
Press the **APPLI MENU** key.


Press the  key.

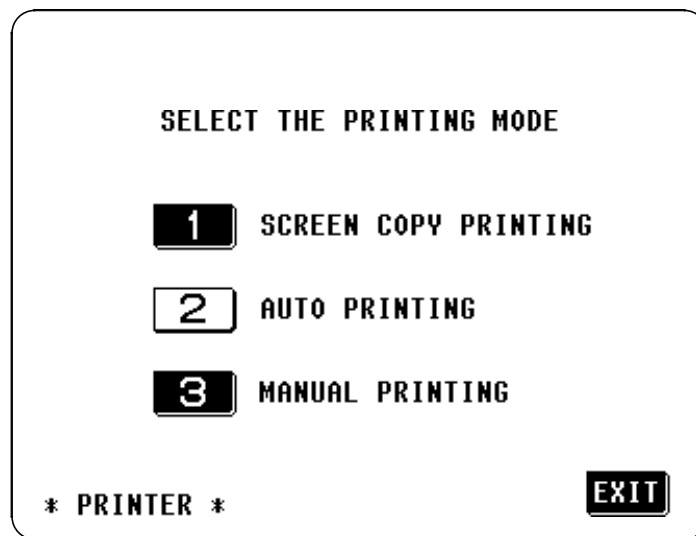
Select the print type.

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.

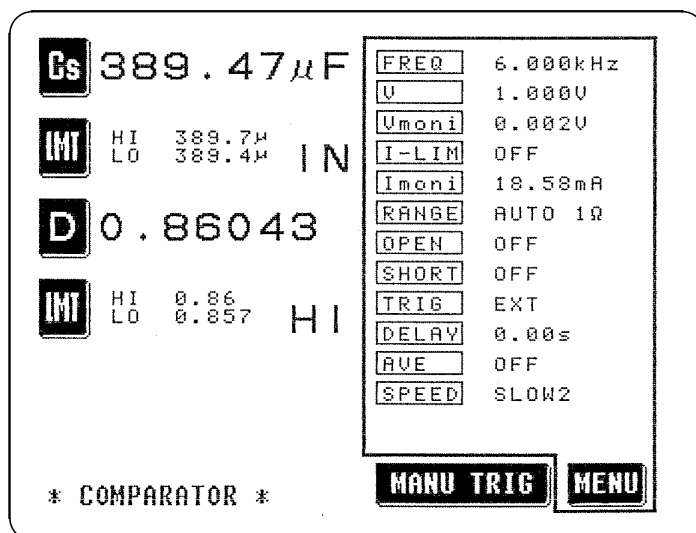
1: Screen copy printing	Prints out the Initial screen copy.
2: Auto printing	Prints out the test values after test.
3: Manual printing	Prints out the test values only when the PRINT key on the Initial screen is pressed.
5. When the setting is completed, press the **EXIT** key to return the Initial screen.

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



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

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.



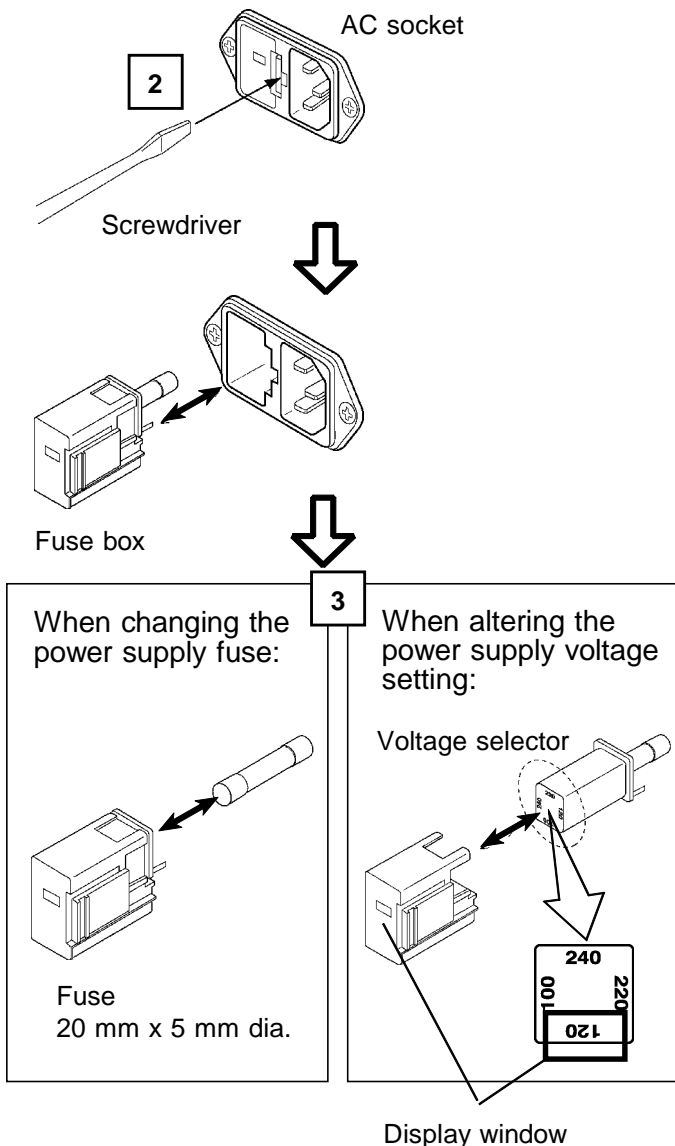
6.2 How to Change the Power Supply Fuse and Change the Power Supply Voltage

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 F1.0 AL 20 mm × 5 mm dia.
220 V, 240 V settings: 250 V F0.5 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:



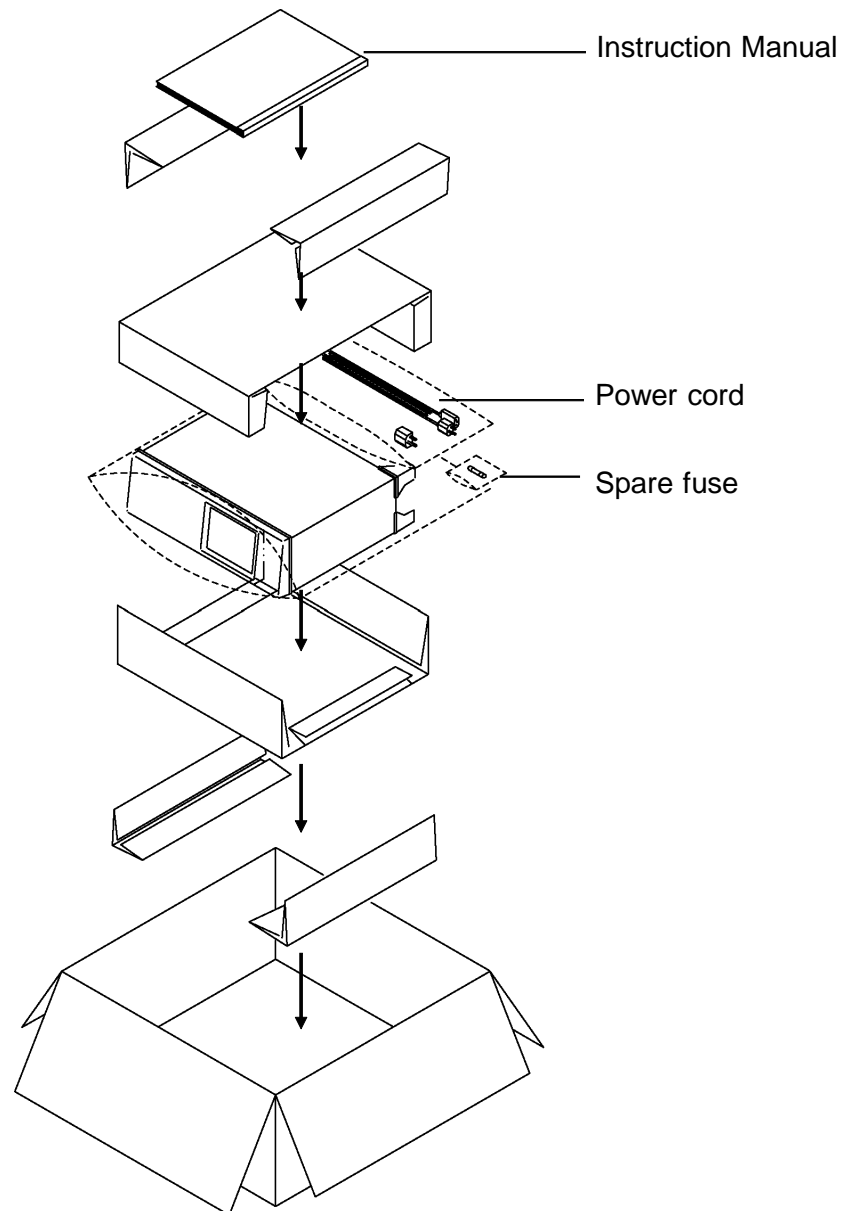
1. Turn the power switch off, and then remove the power cord.
2. Using a slot head screwdriver or the like, bias sideways the catch which holds the fuse box into the power input socket as shown in the figure, and then remove the fuse box.
3. When changing the power supply fuse:
Change the power supply 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.

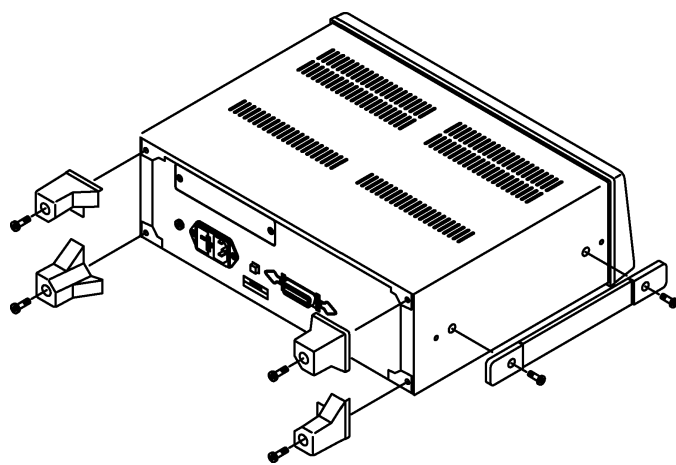
⚠ CAUTION

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.

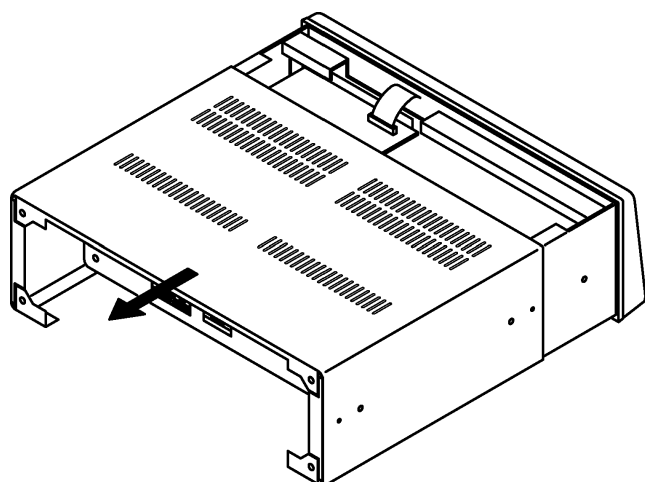
Tools required for dismantling

- Phillips screwdriver 1
- Pair of tweezers 1

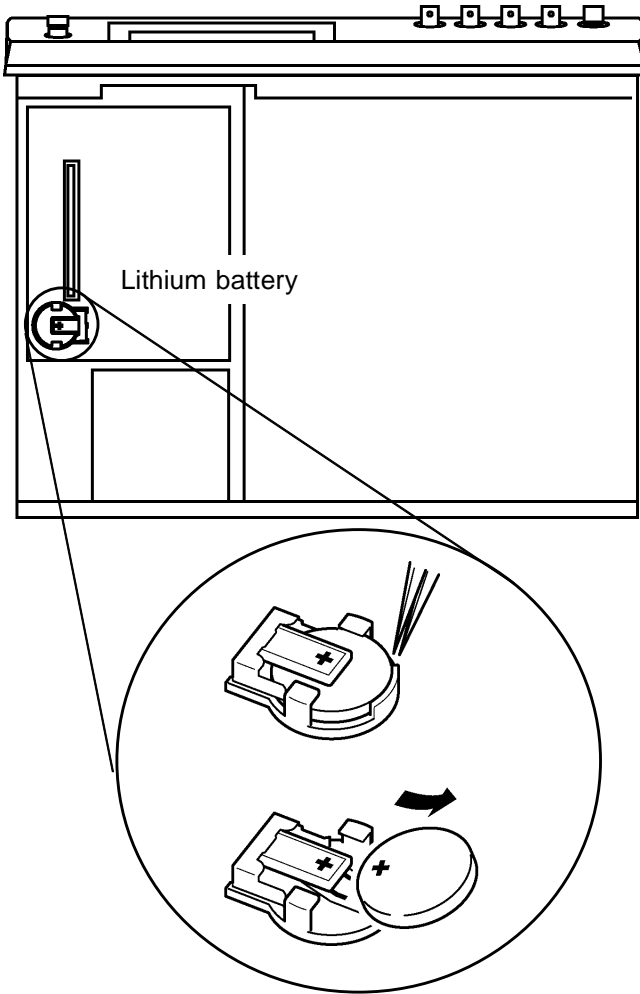
How to dismantle the unit



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.

Chapter 7

Specification and Options

7.1 General Specification

7

1. Test parameters	$ Z $	Impedance
	$ Y $	Admittance
	θ	Phase angle
	Cs	Series-equivalent static capacitance
	Cp	Parallel-equivalent static capacitance
	D	Loss coefficient = $\tan \delta$ ($\delta = \text{delta}$)
	Ls	Series-equivalent impedance
	Lp	Parallel-equivalent impedance
	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 $\pm 0.005\%$ or less

3. Output impedance

50 $\Omega \pm 10 \Omega$

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 Accuracy	1 mV steps $\pm 10\% \pm 10$ mV (1.000 MHz or less) $\pm 20\% \pm 10$ mV (1.001 MHz or more)
Constant current (CC) mode	Range	10 μ A to 100 mA, 5 V max. (1.000 MHz or less) 10 μ A to 20 mA, 1 V max. (1.001 MHz or more)
	Resolution Accuracy	10 μ A steps $\pm 10\% \pm 10$ μ A (1.000 MHz or less) $\pm 20\% \pm 10$ μ A (1.001 MHz or more)
Monitor function Voltage monitor (Vmoni)	Range Accuracy	0.000 V to 5.000 V $\pm 10\% \pm 10$ mV (1.000 MHz or less) $\pm 20\% \pm 10$ mV (1.001 MHz or more)
Current monitor (Imoni)	Range Accuracy	0.000 mA to 100.0 mA $\pm 10\% \pm 10$ μ A (1.000 MHz or less) $\pm 20\% \pm 10$ μ A (1.001 MHz or more)
Limit function Current limit (I-LIM) (V, CV mode)	Range Accuracy	0.01 mA to 99.99 mA $\pm 10\% \pm 10$ μ A (1.000 MHz or less) $\pm 20\% \pm 10$ μ A (1.001 MHz or more)
Voltage limit (V-LIM) (CC mode)	Range Accuracy	0.010 V to 5.000 V $\pm 10\% \pm 10$ mV (1.000 MHz or less) $\pm 20\% \pm 10$ 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 m Ω , 1 Ω , 10 Ω , 100 Ω , 1 k Ω , 10 k Ω , 100 k Ω , 1 M Ω , 10 M Ω , and 100 M Ω (10 ranges, can be set either automatically or manually)	
$ Z $ display range	10.00 m Ω to 200.00 M Ω (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 m Ω) to 5.0000 nS (200 M Ω)	5 digits
R, X	10.00 m Ω to 200.00 M Ω	5 digits
L	38.000 μ H(100m Ω) to 750.00 kH(200M Ω) (at 42 Hz, $\theta = 90^\circ$)	5 digits
	32.000 nH(10 Ω) to 3.2000 mH(100k Ω) (at 5 MHz, $\theta = 90^\circ$)	5 digits
C	19.000 pF(200M Ω) to 370.00 mF(100m Ω) (at 42 Hz, $\theta = 90^\circ$)	5 digits
	0.3200 pF(100k Ω) to 32.000 nF(10 Ω) (at 5 MHz, $\theta = 90^\circ$)	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 \pm 2 ms
NORMAL 21 ms \pm 2 ms
SLOW 72 ms \pm 2 ms
SLOW2 140 ms \pm 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 k Ω .

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 k Ω .

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

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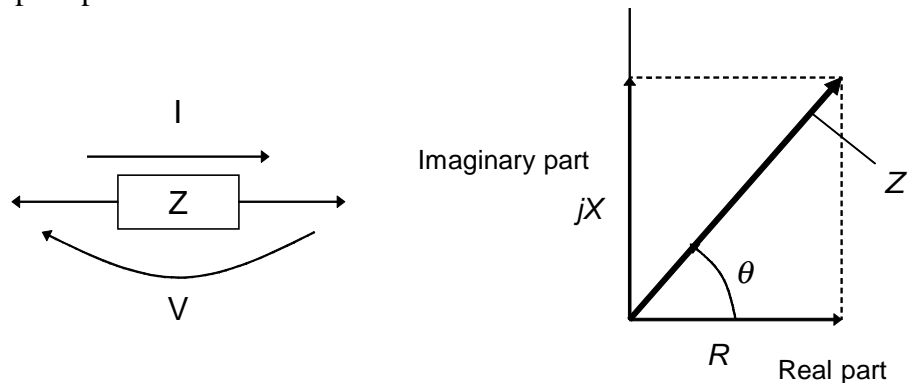
14. Comparator function (COMP)

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 $\Delta\%$ (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 ($\Delta\%$).																
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. $[\text{test value after compensation}] = a \times [\text{test value}] + b$ 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.																
	<table border="1"> <thead> <tr> <th>Parameter Setting value</th> <th>θ, Q Comparator $\Delta\%$ setting</th> <th>D</th> <th>Others</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>Up to the second decimal place</td> <td>Up to the fifth decimal place</td> <td>Up to 5 digits</td> </tr> <tr> <td>4</td> <td>Up to the first decimal place</td> <td>Up to the fourth decimal place</td> <td>Up to 4 digits</td> </tr> <tr> <td>3</td> <td>No decimal place</td> <td>Up to the third decimal place</td> <td>Up to 3 digits</td> </tr> </tbody> </table>	Parameter Setting value	θ, Q Comparator $\Delta\%$ 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
Parameter Setting value	θ, Q Comparator $\Delta\%$ 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°C (32 to 104°F), up to 80% relative humidity, no condensation.																
26. Temperature range for storage	-10 to 55°C (14 to 131°F), up to 80%RH, no condensation.																

27. Operating environment	Indoors, altitude up to 2000 m (6562 feet)	
28. Power supply	Rated supply voltage 100/120/220/240 V AC (switchable)(Voltage fluctuations of $\pm 10\%$ from the rated supply voltage are taken into account.) Rated supply frequency 50/60 Hz Maximum rated power 50 VA (with options installed)	
29. 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.)	
30. Accessories supplied	Instruction Manual	1
	Power cord (selected according to shipping destination)	1
	Spare fuse for power supply 1 (selected according to shipping destination) (100/120 V: 250 V F1.0 AL, 200/240 V: 250 V F1.0 AL)	
31. Component replacement	Power supply fuse (refer to above)	
32. 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)(PW-4007-J1 Seiko Instruments Inc.) 9443-02 AC ADAPTER (for printer, for EU)(PW-4007-E1 Seiko Instruments Inc.) 9443-03 AC ADAPTER (for printer, for America)(PW-4007-U1 Seiko Instruments Inc.) 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.	
33. Applicable Standards	EMC	EN61326:1997+A1:1998+A2:2001+A3:2003 EN61000-3-2:2000 EN61000-3-3:1995+A1:2001
	Safety	EN61010-1:2001 Pollution Degree 2 Measurement Category I (anticipated transient overvoltage 330 V)
34. Withstand voltage	1.39 kV AC for 15s, 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.



$$Z = R + jX$$

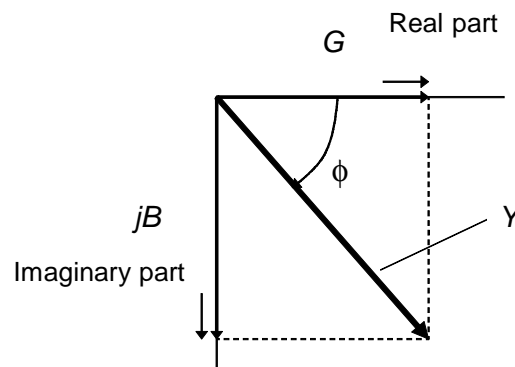
$$\theta = \tan^{-1} (X/R)$$

$$|Z| = \sqrt{R^2 + X^2}$$

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:



$$Y = G + jB$$

$$\phi = \tan^{-1} (B/G)$$

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	$ Z = \frac{V}{I} \left(= \sqrt{R^2 + X^2} \right)$	
Y	$ Y = \frac{1}{ Z } \left(= \sqrt{G^2 + B^2} \right)$	
R	$R_s = \text{ESR} = \ Z\ \cos\theta$	$R_p = \left \frac{1}{ Y \cos\phi} \right \left(= \frac{1}{G} \right)^*$
X	$X = \ Z\ \sin\theta$	_____
G	_____	$G = \ Y \cos\phi ^*$
B	_____	$B = \ Y \sin\phi ^*$
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 \frac{1}{\tan\theta} \right $	
Q	$Q = \tan\theta \left(= \frac{1}{D} \right)$	

* ϕ : phase angle of admittance Y ($\phi = -\theta$)

L_s, R_s, C_s : The measured values of $L, C,$ and R in series equivalent circuit mode.

L_p, R_p, C_p : 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:

$$Tf(s) = 1 / \text{test frequency}$$

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

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)

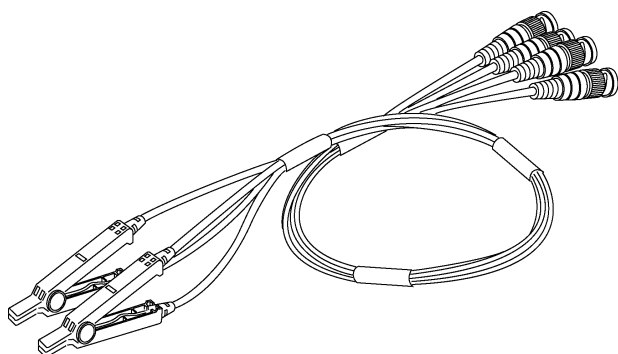
For explanation of how to fit the 9518-01 GP-IB INTERFACE BOARD and for a detailed description of its commands etc., reference should be made to the user manual supplied with the 9518-01.

■ 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

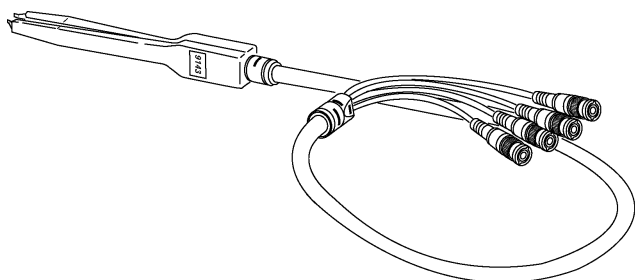


This is a crocodile clip type of test probe.

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

■ 9143 PINCHER PROBE



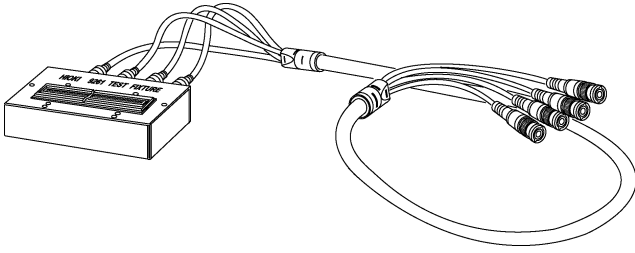
This tweezer type probe is very convenient for testing samples such as chips. The impedance range which can be measured by the 3532-50 using this probe varies according to the frequencies.

The range of test frequency which can be used is from DC to 5 MHz.

NOTE

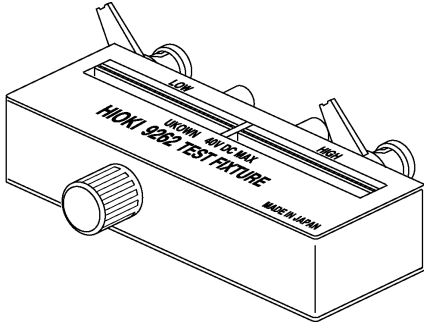
When using a probe, it may happen that the values obtained vary because the contact resistance is altering due to alterations in the pinch pressure exerted. Therefore it is necessary to keep the pinch pressure as constant as possible.

■ 9261 TEST FIXTURE

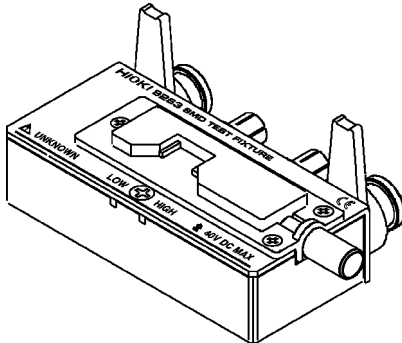


Samples to be tested can be comparatively easily loaded into and removed from this type of fixture. The range of test frequency which can be used is from DC to 5 MHz.

■ 9262 TEST FIXTURE

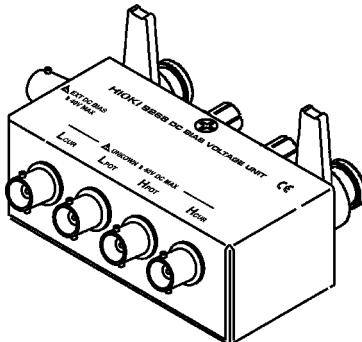


■ 9263 SMD TEST FIXTURE

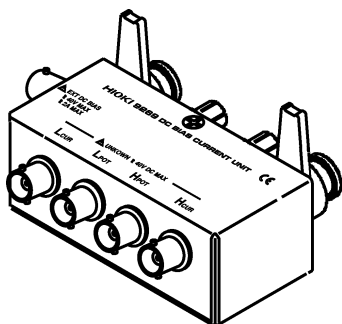


This is very convenient for testing samples such as chips. The range of test frequency which can be used is from DC to 5 MHz.

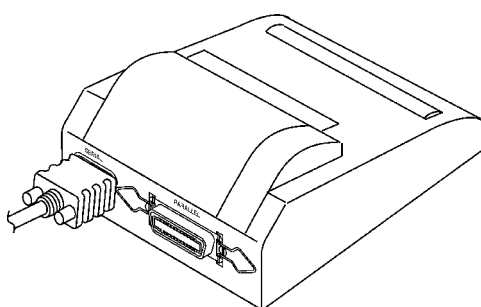
■ 9268 DC BIAS VOLTAGE UNIT



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 ($^{\circ}$), and the following coefficients.

$$\text{Test accuracy} = \text{Basic accuracy} \times C \times D + E$$

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, $(f [\text{MHz}] + 3)/4$ must be multiplied to the basic accuracy.

(*2): In CV or CC mode, the accuracy varies according to the test signal level.

(1 k Ω range or more)

$$\text{Basic accuracy } Z(\%) \text{ or } \theta(^{\circ}) = \pm \left(A + \frac{B \times |10 \times Z_x[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]} \right)$$

(100 Ω range or less)

$$\text{Basic accuracy } Z(\%) \text{ or } \theta(^{\circ}) = \pm \left(A + \frac{B \times |\text{Range}[\Omega] - Z_x[\Omega]| \times 10}{\text{Range}[\Omega]} \right)$$

Z_x : sample of $|Z|$

The impedance of the measurement sample (Z_x) 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 $|Z|$ ").

$$\begin{aligned} |Z_x| (\Omega) &\stackrel{\cdot}{=} \omega L (\text{H}) (\theta \stackrel{\cdot}{=} 90^{\circ}) \\ &\stackrel{\cdot}{=} 1/\omega C (\text{F}) (\theta \stackrel{\cdot}{=} -90^{\circ}) \\ &\stackrel{\cdot}{=} R (\Omega) (\theta \stackrel{\cdot}{=} 0^{\circ}) \end{aligned}$$

Basic accuracy conditions:

- Using the 9262 TEST FIXTURE
- Test speed: SLOW2
- Cable length coefficient: 0 m
- Temperature and humidity: $23 \pm 5^{\circ}\text{C}$, 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 ($Z=500 \Omega$) basic accuracy

Measurement conditions: test frequency = 10 kHz, signal level = 1 V, speed = SLOW2, range = 1 k Ω

Basic Accuracy Coefficient Table
(0.501V to 1.000V)

RANGE	100Hz - 1kHz	1.001kHz - 10kHz
10k Ω	A=0.08 B=0.01 A=0.05 B=0.005	
1k Ω		

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:

$$Z \text{ accuracy} = \pm \left(0.08 + \frac{0.01 \times |10 \times 500 - 1 \times 10^3|}{1 \times 10^3} \right) = \pm 0.12\%$$

Similarly for θ basic accuracy coefficients A = 0.05, B=0.005, and thus:

$$\theta \text{ accuracy} = \pm \left(0.05 + \frac{0.005 \times |10 \times 500 - 1 \times 10^3|}{1 \times 10^3} \right) = \pm 0.07^\circ$$

2. Capacitance ($C_s=160 \text{ nF}$) basic accuracy

Measurement conditions: test frequency = 1 kHz, signal level = 1 V, speed = SLOW2

Basic Accuracy Coefficient Table
(0.501V to 1.000V)

RANGE	100Hz - 1kHz
10k Ω	A=0.08 B=0.01 A=0.05 B=0.005

Test Z and θ .

Measurement range: AUTO

When $Z = 1.0144 \text{ k}\Omega$, $\theta = -78.69^\circ$, test range is 10 k Ω

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:

$$Z \text{ accuracy} = \pm \left(0.08 + \frac{0.01 \times |10 \times 1.0144 \times 10^3 - 10 \times 10^3|}{10 \times 10^3} \right) = \pm 0.08\%$$

Similarly for θ basic accuracy coefficients A = 0.05, B=0.005, and thus:

$$\theta \text{ accuracy} = \pm \left(0.05 + \frac{0.005 \times |10 \times 1.0144 \times 10^3 - 10 \times 10^3|}{10 \times 10^3} \right) = \pm 0.05^\circ$$

From the basic accuracy, find ranges that each of Z and θ can take.

$$\begin{aligned} Z_{\min} &= 1.0144 \text{ k}\Omega \times (1 - 0.08/100) \approx 1.0136 \text{ k}\Omega \\ Z_{\max} &= 1.0144 \text{ k}\Omega \times (1 + 0.08/100) \approx 1.0152 \text{ k}\Omega \\ \theta_{\min} &= 78.69 - 0.05 = 78.64^\circ \quad (\theta: |\theta| \text{ absolute value}) \\ \theta_{\max} &= 78.69 + 0.05 = 78.74^\circ \end{aligned}$$

From the ranges of Z and θ , determine ranges of Cs can take.

$$\begin{aligned} C_{\min} &= 1/(Z_{\max} \times \omega \times \sin\theta_{\max}) \approx 159.85 \text{ nF} \quad \dots\dots -0.09\% \\ C_{\max} &= 1/(Z_{\min} \times \omega \times \sin\theta_{\min}) \approx 160.15 \text{ nF} \quad \dots\dots +0.09\% \\ \omega &= 2 \times \pi \times f \\ f: &\text{ frequency [Hz]} \end{aligned}$$

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)

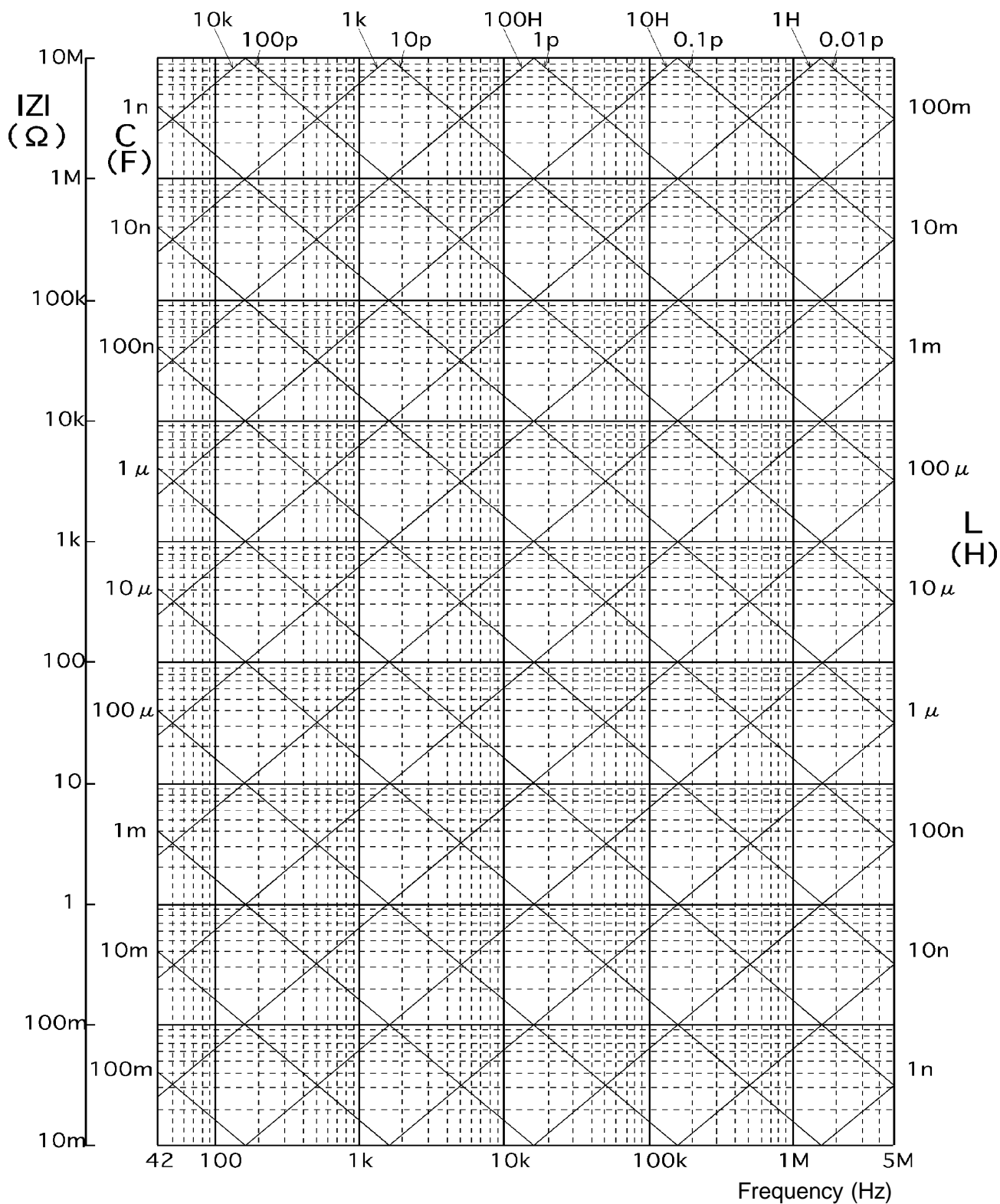
Cable length	0 m	1 m
D	1	(100 kHz max) $1.5 + 0.015 \times f$ [kHz]
		(100.1 kHz min) $1.5 + 0.3 \times f$ [MHz]

f: measurement frequency

4. Temperature coefficient (E)

Temperature	Operating temperature = T °C
E	$0.1 \times \text{basic accuracy} \times (T-23)$

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

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |10 \times Z[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]} \right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |\text{Range}[\Omega] - Z[\Omega]| \times 10}{\text{Range}[\Omega]} \right)$$

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

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |10 \times Z_x[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]} \right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |\text{Range}[\Omega] - Z_x[\Omega]| \times 10}{\text{Range}[\Omega]} \right)$$

Z_x: 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

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |10 \times Z_x[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]} \right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |\text{Range}[\Omega] - Z_x[\Omega]| \times 10}{\text{Range}[\Omega]} \right)$$

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

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |10 \times Z_x[\Omega] - \text{Range}[\Omega]|}{\text{Range}[\Omega]} \right)$$

100 Ω range or less

$$\text{Basic accuracy} = \pm \left(A + \frac{B \times |\text{Range}[\Omega] - Z_x[\Omega]| \times 10}{\text{Range}[\Omega]} \right)$$

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		

Index

- A -

Absolute value setting (ABS)	84,88
Admittance	33,164
Averaging	77
Averaging setting screen	78

- B -

Beep sound	109
Beep sound setting screen	110

- C -

Cable length	82
Comparator screen	86
Condition setting screen	81
Conductance	33,164
Constant current (CC)	39,44
Constant voltage (CV)	39,43
Continuous test	116,138
Contrast adjustment knob	3
Current limit	45

- D -

DC Bias	140
Delay time	74
Deviation percentage ($\Delta\%$)	84,95
Display parameters	32

- E -

EXT I/O connector	4,132
Equations (for calculation)	164
External trigger	72

- F -

Factory settings	114
Frequency setting screen	35

- G -

GP-IB interface	169
Guard terminal	3,127
Guarding	127

- H -

Handle	6
--------------	---

- I -

Impedance	33,164
Impedance phase angle	33,164
Inductance	33
Interference	129-131
Internal trigger	72

- K -

Key lock	4,124
Key lock switch	4

- L -

LCD screen	11
Limit setting screen	46
Loss coefficient	33

- M -

Measurement ranges	48
Menu keys	12
Menu screen	12,31
Monitor display	12,30

- N -

Noise	129-131
-------------	---------

- O -

Open circuit compensation	52,69
Open circuit compensation screen	53
Open circuit residual components	69
Open circuit voltage (V)	39,42

- P -

Panel load function	106
Panel load screen	107
Panel numbers	102,106,116
Panel save function	102
Panel save screen	103
Parallel equivalent circuit mode	34
Parameter keys	16,30
Parameter setting screen	32
Percentage setting	84,92
Power supply fuse	153,154
Power switch	3,10

- Q -

Q factor	33
----------------	----

- R -

RS-232C interface	169
Range setting screen	49
Reactance	33,164
Residual charge protection	143
Residual conductance	69
Residual inductance	69
Residual resistance	69

- S -

Saved test conditions	102
Series equivalent circuit mode	34
Short circuit compensation	60
Short circuit compensation screen	62
Short circuit residual component	69
Shorting bar	61
Specification	159
Stand	5
Static capacitance	33,159
Susceptance	33,164
System reset	113

- T -

Test cables	8,82,131
Test fixture	69
Test frequency	35
Test level setting screen	40
Test parameters	32
Test ranges	48,161
Test signal levels	39
Test speed	80
Test speed setting screen	81
Test terminals	3,8
Trigger delay function	74
Trigger delay setting screen	75
Trigger setting screen	72

- V -

Voltage limit	45
Voltage selector (power inlet)	4,154

HIOKI

DECLARATION OF CONFORMITY

Manufacturer's Name: HIOKI E.E. CORPORATION
Manufacturer's Address: 81 Koizumi, Ueda, Nagano 386-1192, Japan
Product Name: LCR HiTESTER
Model Number: 3532-50
Options:
9518-01 GP-IB INTERFACE
9593-01 RS-232C INTERFACE
9261 TEST FIXTURE
9262 TEST FIXTURE
9263 SMD TEST FIXTURE
9268 DC BIAS VOLTAGE UNIT
9269 DC BIAS CURRENT UNIT
9140 4-TERMINAL PROBE
9143 PINCHER PROBE
9165 CONNECTION CORD
9166 CONNECTION CORD
9151-02 GP-IB CONNECTOR CABLE
9151-04 GP-IB CONNECTOR CABLE

The above mentioned products conform to the following product specifications:

Safety: EN61010-1:2001
EMC: EN61326:1997+A1:1998+A2:2001+A3:2003
ClassB equipment
Minimum immunity test requirement
EN61000-3-2:2000
EN61000-3-3:1995+A1:2001

Supplementary Information:

The products herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

15 September 2006

HIOKI E.E. CORPORATION



Tatsuyoshi Yoshiike
President

3532C999-03

HIOKI 3532-50 LCR HiTESTER

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