HIOKI

Instruction Manual

# 3504
# 3504-10
# C HiTESTER

HIOKI E. E. CORPORATION

December 2008 Revised edition 2 3504A981-02 08-12H

# Contents

# Introduction

Thank you for purchasing the HIOKI “Model 3504, 3504-10 C HiTester.” To obtain maximum performance from the unit, please read this manual first, and keep it handy for future reference.

# Verifying Package Contents

When you receive the unit, 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.

**This unit**

3504 C HiTester
3504-10 C HiTester

**Accessories**

- Instruction Manual..... 1
- Power cord..... 1
- Spare fuse for power supply (according to voltage specification)..... 1
  100 V, 120 V setting : 250 V F 1.0 AL 5 x 20 mm dia
  220 V, 240 V setting : 250 V F 0.5 AL 5 x 20 mm dia

NOTE

Probes, fixture are not supplied with the unit as standard equipment. You should order them separately, according to requirements.

## Shipping precautions

Use the original packing materials when transporting the unit, if possible.

## Options

❖ Chapter 10 "Options" (p. 199)

## About Special Specifications

These specifications are not included in standard products.

# Safety Information

**⚠WARNING**

**This unit 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 unit. 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 unit defects.**

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

## Safety Symbols

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

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

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

## Other Symbols

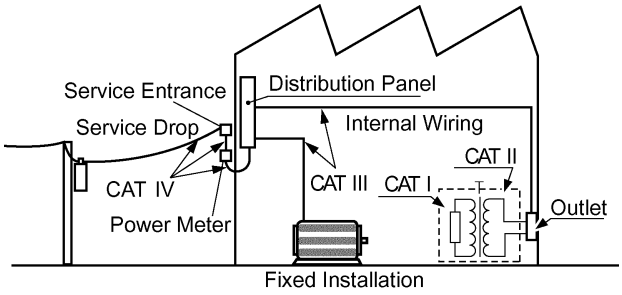
| | |
|---|---|
|  | Indicates a prohibited action. |
| ❖ | Indicates the location of reference information. |
|  | Indicates quick references for operation and remedies for troubleshooting. |
| * | Indicates that descriptive information is provided below. |

## Measurement Categories (Overvoltage categories)

To ensure safe operation of measurement units, IEC 60664 establishes safety standards for various electrical environments, categorized as CAT I to CAT IV, and called overvoltage 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 unit in an environment designated with a higher-numbered category than that for which the unit is rated could result in a severe accident, and must be carefully avoided.




## Accuracy

We define measurement tolerances in terms of rdg. (reading) and dgt. (digit) values, with the following meanings:

| | |
|---|---|
| **rdg. (reading or displayed value)** | The value currently being measured and indicated on the measuring unit. |
| **dgt. (resolution)** | The smallest displayable unit on a digital measuring unit/ device/ product, i.e., the input value that causes the digital display to show a "1" as the least-significant digit. |

# Operating Precautions

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

## Unit Installation

Operating Temperature and Humidity: 0 to 40°C), 80%RH or less, no condensation

Storage Temperature and Humidity: -10 to 55°C, 80%RH or less, no condensation

Accuracy-guaranteed temperature and humidity ranges: 23±5°C, 80%RH

**Avoid the following locations that could cause an accident or damage to the unit.**

Exposed to direct sunlight
Exposed to high temperature


In the presence of corrosive or explosive gases

Exposed to liquids
Exposed to high humidity or condensation

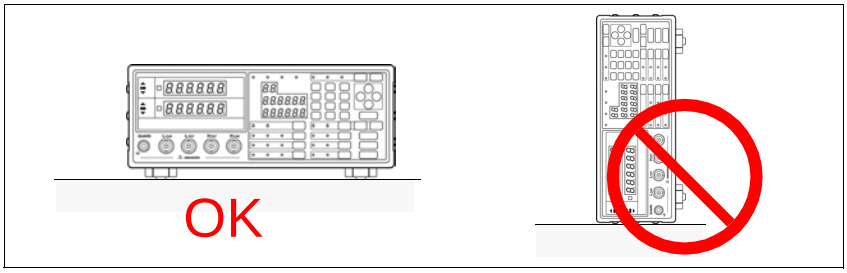
Exposed to strong electromagnetic fields
Near electromagnetic radiators

Exposed to high levels of particulate dust

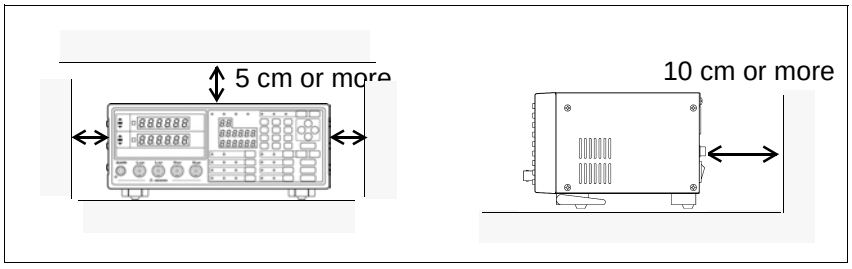
Subject to vibration

## Installing

- Do not install the unit with any side except the bottom facing down.




- Vents must not be obstructed.



**⚠CAUTION**

- To avoid damage to the unit, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.
- Do not apply heavy downward pressure with the stand extended. The stand could be damaged.

## Handling this device

**⚠WARNING**

**Never modify the unit. Only Hioki service engineers should disassemble or repair the unit. Failure to observe these precautions may result in fire, electric shock, or injury.**

**⚠CAUTION**

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.

## Before connection and powering on

**⚠WARNING**

- **Before turning the unit on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the unit and present an electrical hazard.**
- **The power supply voltage for this unit is switchable. To avoid electrical accidents, check that the voltage selector is set correctly for the supply voltage you are using.**

  ❖ Setting Procedure for the Power Voltage : 2.2 "Checking the Power Voltage" (p. 16)
- **To avoid electrical accidents and to maintain the safety specifications of this unit, connect the power cord only to a 3-contact (two-conductor + ground) outlet.**

  ❖ Connection Procedure : 2.3 "Connecting the Power Cord" (p. 17)
- **To avoid shock and short circuits, turn off all power before connecting probes.**

**⚠CAUTION**

Check the connections carefully in order to avoid any chance of setting up a short-circuit etc.

## 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.

## Preliminary Checks

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

⚠WARNING

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

# Overview Chapter 1

1

## 1.1 Product Overview

The HIOKI Model 3504 and 3504-10 C HiTesters are capacitance meters employing 120 Hz and 1 kHz frequencies to measure capacitors other than electrolysis capacitors (Capacitors other than the non-electrolytic capacitors) at high speed and high accuracy. Primary applications include pass-fail judgment and ranking of capacitors on tape machines and sorters.

## 1.2 Features

### Capacitance-specific units

These capacitance meters use 120 Hz and 1 kHz measurement frequencies.

### High-speed measurement

The 3504 and 3504-10 are capable of high-speed measurement: 2 ms at measurement frequency 1 kHz, and 10 ms at 120 Hz.

### Constant-voltage measurements

Provides constant-voltage measurement capability.

| | | |
|---|---|---|
| (With 1 kHz selected) | 1V: to 70 µF | 500 mV: to 170 µF |
| (With 120 Hz selected) | 1V: to 700 µF | 500 mV: to 1.45 mF |

### Bin sorting function (Model 3504 only)

Capacitors are easily ranked according to C (Capacitance*1) measurement values into as many as 14 classifications.

### Comparator function

Easily perform pass-fail judgment of components according to measurements of both C and D (Dissipation Factor*2).

### LED display

Provides superior visibility.

### Equipped with standard data transfer interfaces

The 3504 offers external I/O for sequencing, a standard RS-232C interface, and a standard GP-IB interface (Model 3504 only).

## Measurement value memory

Up to 200 measurement values can be stored in memory.

## Trigger-synchronous measurement capability

The measurement signal can be input to the sample in sync with a trigger.

## Synchronous measurement (Special feature of Model 3504)

Synchronize multiple meters to reduce interference-induced measurement instability.

*1. Capability to store electric charge.*2. An indicator of capacitor losses.

# 1.3 Entire Workflow

**Measurement Preparations**

❖ Chapter 2 "Measurement Preparations" (p. 15)

1.Check the power voltage.
2.Connect the power cord.
3.Connect the probes or fixture (option) to the measurement terminals.
4.Turn the power on.
5.Connect the sample.

**Pre-Operation Inspection**

❖ 3.1 "Pre-Operation Inspection" (p. 21)

Be sure to perform pre-operation inspection prior to measurement.

**Basic Measurement**

❖ 3.2 "Measurement Example" (p. 23)

1.Prepare the unit, fixture, and sample.
2.Connect the fixture to the measurement terminals.
3.Set the measurement conditions.
4.Connect the sample to the fixture.
5.Check the measurement results.

**Application Functions**

❖ Chapter 4 "Application Functions" (p. 41), Chapter 7 "Controlling the Unit from a PC" (p. 91)

| Function | Description | Reference Section |
|---|---|---|
| **Comparator measurement function** | Set the upper limit and lower limit values and judge whether samples pass or fail. | ❖ 4.1 (p. 41) |
| **BIN measurement function (only for 3504)** | Set variations of the upper limit and lower limit values and rank samples accordingly. | ❖ 4.2 (p. 50) |
| **Synchronous measurement function (special specification for 3504)** | Reduce the differences in measurement values caused by interference when using multiple 3504 units for measurement. | ❖ 4.3 (p. 60) |
| **Trigger synchronous output function** | Apply the measurement signal only during measurement to reduce the generation of heat in the sample and decrease electrode wear. | ❖ 4.4 (p. 62) |
| **Key lock function** | Disable key operations. | ❖ 4.5 (p. 64) |
| **Communication function** | Control the unit from a PC. | ❖ Chapter 7 (p. 91) |
| **Panel save function** | Save measurement conditions. | ❖ 4.6 (p. 65) |
| **Panel load function** | Load saved measurement conditions | ❖ 4.7 (p. 66) |
| **Printing function** | Print measurement values. | ❖ 4.8 (p. 69) |

**Application Measurement**

❖ Chapter 6 "Application Measurement" (p. 81)
Measurement using EXT I/O
Measurement of high impedance components
Measurement of components in circuit networks

**Other Settings**

❖ Chapter 5 "Other Settings" (p. 73)
Beep tone setting
Reset of system
Countermeasures against incorporation of external noise

# 1.4 Names and Functions of Parts



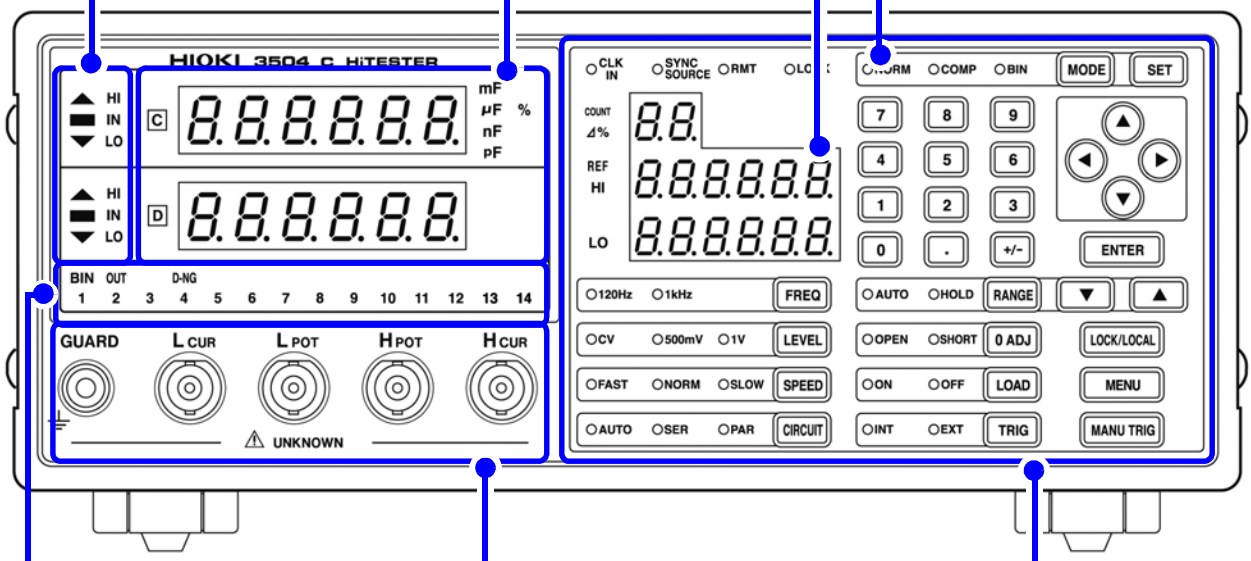
## Front

### SUB Display
Displays the limit values of BIN (only for 3504) and comparator.

### Comparator Evaluation Result Display
Displays evaluation results in Comparator Mode.
❖ 4.1 "Comparator Function" (p. 41)

### MAIN Display
Displays the measurement values of C and D.
Displays the MENU items.

### Setting Condition Display
Displays current measurement conditions, presettings, and other information.
*BIN (3504 only)




### BIN Judgment Result Display (only for 3504)
Displays judgment results in BIN mode.
❖ 4.2 "BIN Measurement Function (Only for 3504)" (p. 50)

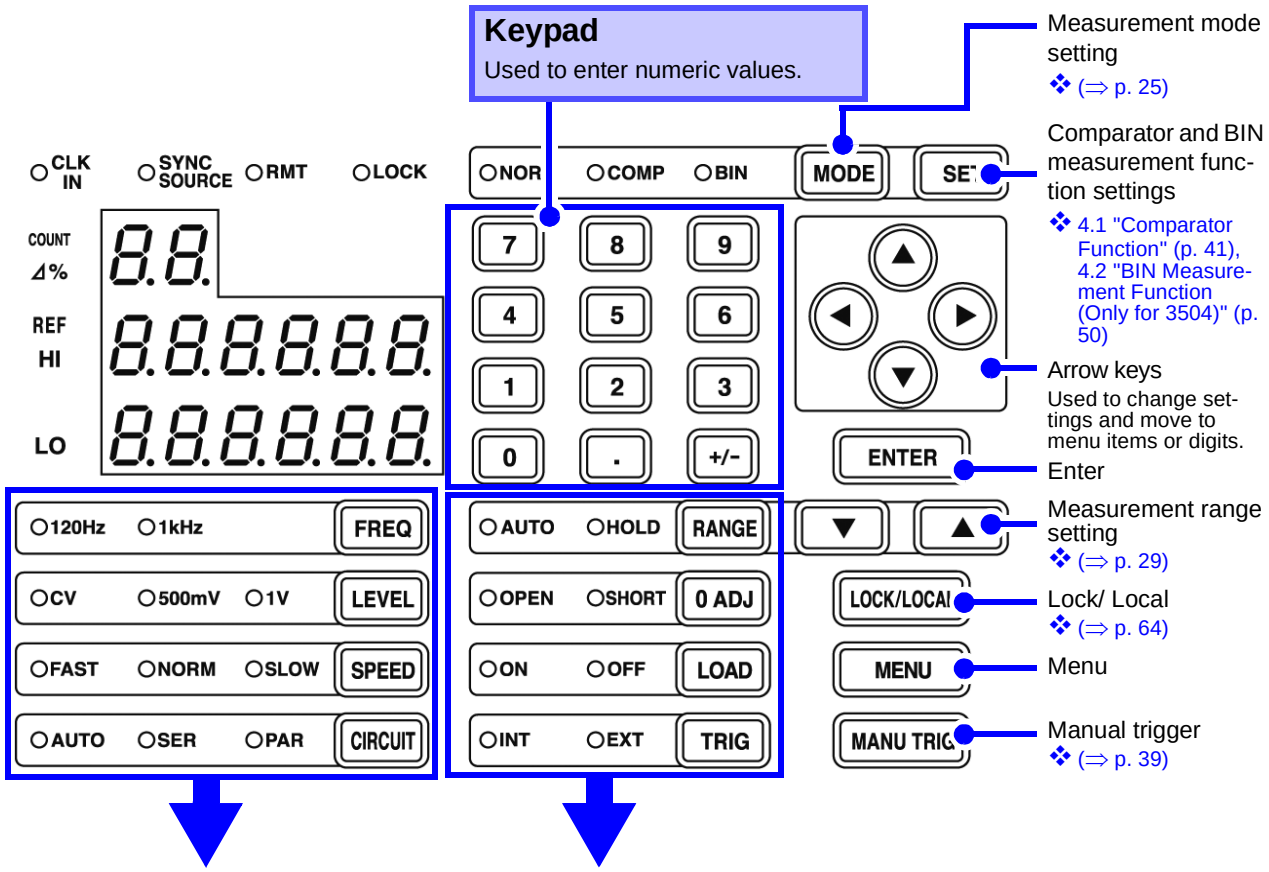
### Measurement Terminals
There are five measurement terminals:

| | |
|---|---|
| $H_{CUR}$ | Measurement-signal input terminal |
| $H_{POT}$ | Detected voltage high terminal |
| $L_{POT}$ | Detected voltage low terminal |
| $L_{CUR}$ | Measurement current detected terminal |
| GUARD | Guard terminal |

❖ 2.4 "Connecting the Probes and Fixtures" (p. 18)

### Operating Panel
Use to set measurement conditions and to make other settings
❖ (⇒ p. 12)

# Operating Panel




FREQ — Measurement frequency setting
❖ (⇒ p. 25)

LEVEL — Measurement signal level setting
❖ (⇒ p. 26)

SPEED — Measurement speed setting
❖ (⇒ p. 27)

CIRCUIT — Equivalent circuit mode
❖ (⇒ p. 27)

RANGE — Measurement range setting
❖ (⇒ p. 29)

0 ADJ — Open short circuit compensation
❖ (⇒ p. 31)

LOAD — Load compensation setting
❖ (⇒ p. 36)

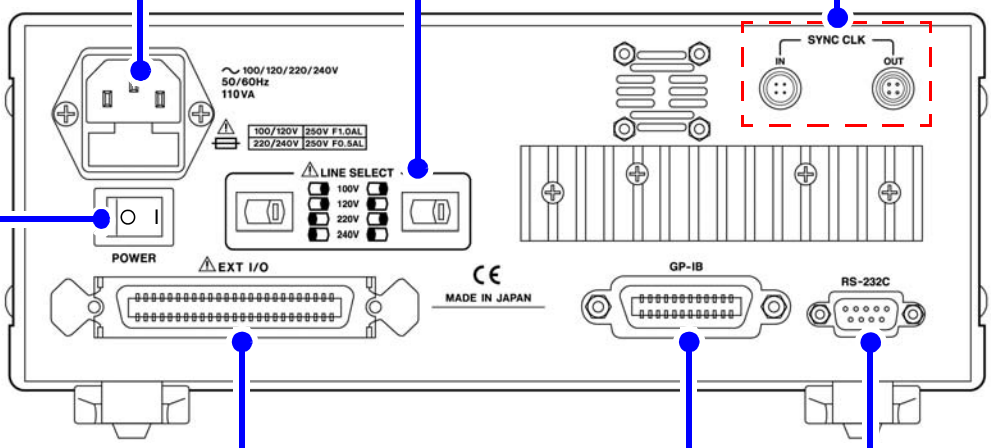
TRIG — Trigger mode setting
❖ (⇒ p. 39)

## Back

### Power Inlet
Connect the supplied power cord
❖ 2.3 "Connecting the Power Cord" (p. 17)

### Voltage Selectors
Changes the power voltage

### Phase Synchronization Connector (Special Specification)
Connect this to another 3504 (3504-10) unit when performing synchronous measurement.
❖ 4.3 "Synchronous Measurement Function (3504 special specification)" (p. 60)




### Power Switch
Turns the power on and off.
○ : Turns the power off.
| : Turns the power on.
❖ 2.5 "Turning the Power On and Off" (p. 19)

### EXT I/O Connector
Inputs external trigger signals and outputs comparator result signals and other signals. Supports connection to a sequencer.
❖ 6.1 "Measurement Using EXT I/O" (p. 81)

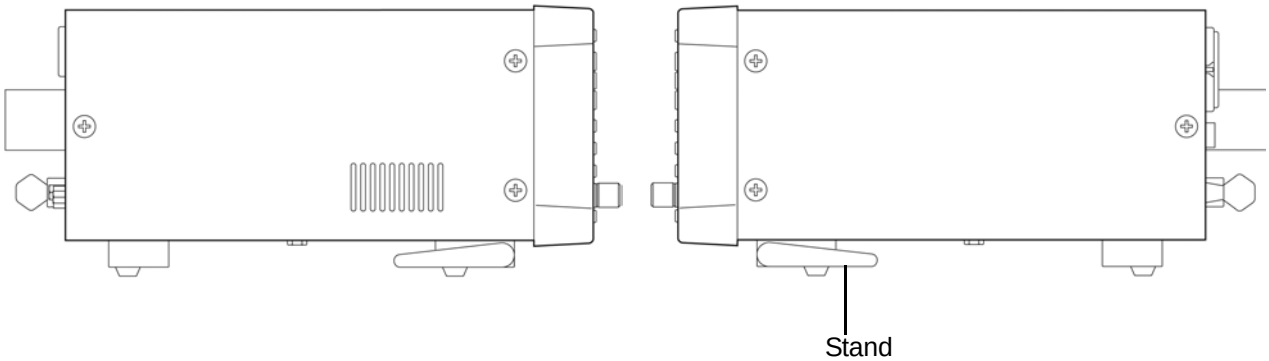
### GP-IB Connector (only for 3504)
Connect a GP-IB cable.
❖ Chapter 7 "Controlling the Unit from a PC" (p. 91)

### RS-232C Connector
Connect an RS-232C cable.
❖ Chapter 7 "Controlling the Unit from a PC" (p. 91)

## Side

### Left side

### Right side




**⚠CAUTION**

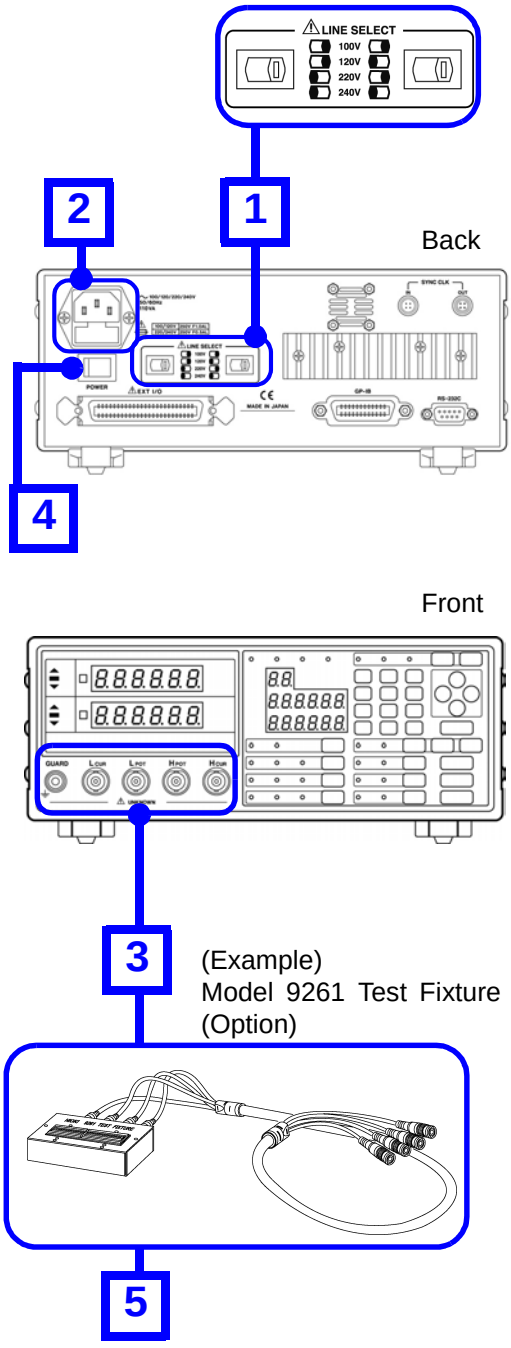
Do not apply heavy downward pressure with the stand extended. The stand could be damaged.

# Measurement Preparations Chapter 2

Be sure to read "Operating Precautions" (p. 4) prior to setting up the unit.

2

## 2.1 Preparation Flowchart




**1 Check the power voltage.**

❖ 2.2 "Checking the Power Voltage" (p. 16)

**2 Connect the power cord.**

❖ 2.3 "Connecting the Power Cord" (p. 17)

**3 Connect the probes or fixture (option) to the measurement terminals.**

❖ 2.4 "Connecting the Probes and Fixtures" (p. 18)

**4 Turn the power on.**

❖ 2.5 "Turning the Power On and Off" (p. 19)

**5 Connect the sample.**

### Unit Settings and Measurement

❖ Chapter 3 "Basic Measurement" (p. 21)
❖ Chapter 4 "Application Functions" (p. 41)
❖ Chapter 6 "Application Measurement" (p. 81)

# 2.2 Checking the Power Voltage

**WARNING**

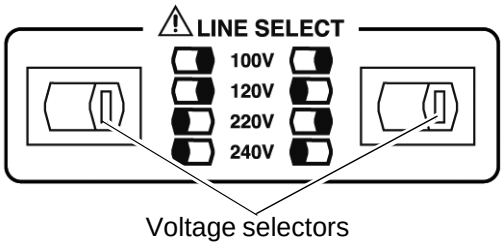
- **Before turning the unit on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the unit and present an electrical hazard.**
- **The power of the unit can be changed with the voltage selectors. To avoid an electric accident, use the unit with the voltage selectors set to a voltage value that matches the voltage to be used.**
- **Make sure the power is off when you change the voltage with the voltage selectors. Changing the power voltage when the power is on may result in damage to the unit or an electric accident.**
- **The maximum rated power is 110 VA.**

The power voltage specification of the unit is set as specified when the unit was ordered.
You can select from 100 V, 120 V, 220 V, and 240 V.

You can determine which voltage is set by checking the positions of the voltage selectors.
Refer to the diagram between the voltage selectors.

| Voltage | Position of Left Voltage Selector | Position of Right Voltage Selector |
|---|---|---|
| 100 V | Right side | Right side |
| 120 V | Right side | Left side |
| 220 V | Left side | Right side |
| 240 V | Left side | Left side |

Back




Voltage selectors

In the diagram, the voltage value is 100 V because both the left and right voltage selectors are set to the right side.

# 2.3 Connecting the Power Cord

**WARNING**

**To avoid electrical accidents and to maintain the safety specifications of this unit, connect the power cord only to a 3-contact (two-conductor + ground) outlet.**

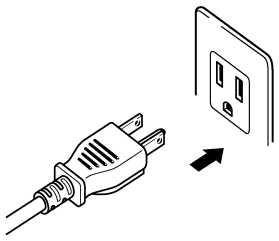


**CAUTION**

- To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.
- Turn off the power before disconnecting the power cord.

**Connection Procedure**

1. Make sure the power switch of the unit is off.
2. Make sure the power voltage matches and connect the power cord to the power inlet with voltage selectors on the rear of the unit.
3. Insert the plug into the power outlet.



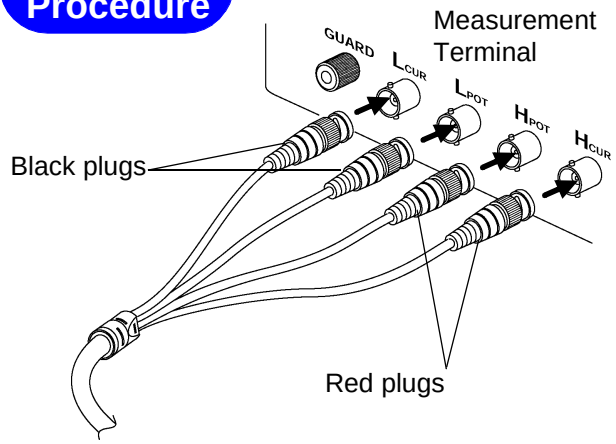
# 2.4 Connecting the Probes and Fixtures

**⚠CAUTION**

- Do not apply a voltage to the measurement terminals. Doing so may damage the unit.
- When disconnecting the BNC connector, be sure to release the lock before pulling off the connector. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.
- To avoid breaking the probes, do not bend or pull them.
- The ends of the probes are sharp. Be careful to avoid injury.
- Avoid stepping on or pinching cables, which could damage the cable insulation.
- A voltage of ±12 V is generated at the $L_{CUR}$ terminal when the $L_{POT}$ and $L_{CUR}$ terminals are in an open state.

## Connection Procedure

Example: Connecting a Model 9261 Test Fixture (Option)



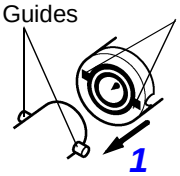

Connect the red plugs to the $H_{CUR}$ terminal and $H_{POT}$ terminal and the black plugs to the $L_{CUR}$ terminal and $L_{POT}$ terminal.

The unit has the following five measurement terminals.

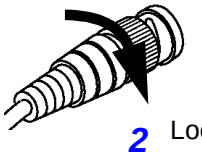
| | |
|---|---|
| $H_{CUR}$ terminal | Terminal for applying measurement signals |
| $H_{POT}$ terminal | Voltage detection HIGH terminal |
| $L_{POT}$ terminal | Voltage detection LOW terminal |
| $L_{CUR}$ terminal | Measurement current detection terminal |
| GUARD terminal | Connect this terminal to the case |

Measurement Terminal Connections

3504 (3504-10) Measurement Terminal Connector Guides




9261 Test Fixture BNC Connector Grooves




Align the grooves of the BNC connector with the connector guides of the connector of the unit and then insert the connector and rotate it clockwise until it locks into position.
To disconnect the connector, rotate it counterclockwise until it unlocks and then remove it.

For details such as the connection procedure for a fixture, refer to the corresponding instruction manual.

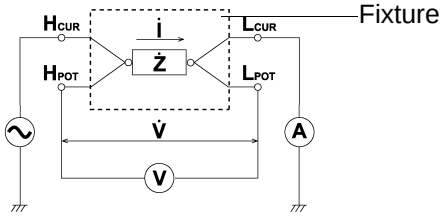
**NOTE**

- Use Hioki probes, fixtures (option), etc.

❖ Chapter 10 "Options" (p. 199)

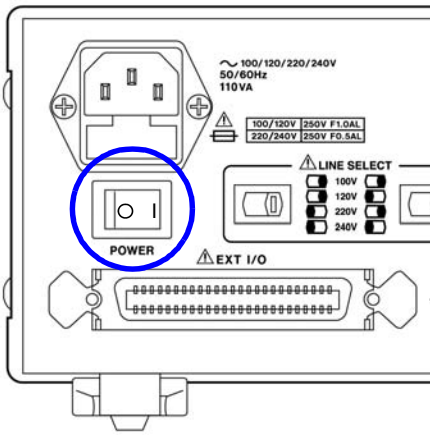
- If all four terminals are disconnected, a meaningless number may be displayed on the unit.

## Measurement Terminal Configuration



# 2.5 Turning the Power On and Off






| | |
|---|---|
| Power ON | | |
| Power OFF | ○ |

## Turning the power On

Set the power switch on the rear of the unit to ON (|).

All LEDs on the front panel light up.
The measurement conditions at startup are the same as the last time the power was turned off.

After turning the power on, wait 60 minutes for the unit to warm up before beginning measurement.

## Turning the power Off

Set the power switch on the rear of the unit to OFF (○).

The measurement conditions are saved when the power is turned off.

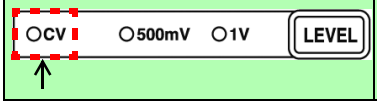
Even if there is a power failure or other problem with the power, the unit will be in the measurement mode prior to the power failure after it recovers.

# Basic Measurement Chapter 3

## 3.1 Pre-Operation Inspection

**To ensure safe use of the unit, be sure to check the following inspection items prior to performing measurements.**



| Items | Countermeasure | See: |
|---|---|---|
| Inspect the unit, probe, and fixture<br>(Are there any damaged parts?) | If there is damage:<br>Unit and fixture: Submit them for repairs.<br>Probe: Replace it with a new one. | _____ |
| Inspect the connection cord<br>(Is the covering cracked or is any metal exposed?) | Do not use a damaged cord because doing so may result in electric shock. (Replace the cord with a new one.) | _____ |
| Check the power supply voltage setting<br>(Does the setting of the voltage selector on the rear of the unit match the power supply voltage to be used?) | Use of the unit outside the specified power supply voltage range may result in the unit being damaged or an electrical fault. Set the voltage selector in accordance with the power supply voltage to be used. | Setting the Voltage Selector:<br>2.2 (page 16) |
| When the power is turned on, does the fan spin and do the “3504 (3504-10)” and version number indications appear on the MAIN display area? | If the fan does not spin or the “3504 (3504-10)” and version number indications are not displayed, the unit may be malfunctioning. Submit it for repairs. | _____ |
| Does the CV LED light up when measurement is performed with the measurement terminals open while the probe and fixture are connected to the unit?<br>(Range: AUTO)<br>  | If the CV LED does not light up, the unit, probe, or fixture may be malfunctioning.<br>Unit and fixture: Submit them for repairs.<br>Probe: Replace it with a new one. | Connecting the Probe and Fixture:<br>2.4 (page 18) |

| Items | Countermeasure | See: |
|---|---|---|
| Are the measurement values indicated on the unit normal when measuring known samples such as standard capacitors? | If the measurement values are abnormal, check/perform the following.<br>• Are the measurement conditions set appropriately?<br>• Perform open circuit and short circuit compensation again.<br>• Turn load compensation off.<br>If the measurement values are still abnormal after you have checked/performed the above, the unit, probe, or fixture may be malfunctioning.<br>Unit and fixture: Submit them for repairs.<br>Probe: Replace it with a new one. | • Measurement Conditions:<br>3.3.2 (page 25)<br>3.3.3 (page 26)<br>3.3.4 (page 27)<br>3.3.5 (page 27)<br>3.3.6 (page 29)<br>• Open Circuit Compensation and Short Circuit Compensation:<br>3.4.1 (page 31)<br>• Load Compensation:<br>3.4.2 (page 36) |

# 3.2 Measurement Example

The following example shows a measurement operation using the 3504 (3504-10).

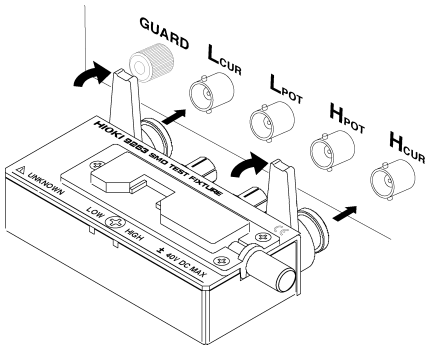
**Example** The 9263 SMD Test Fixture is used for the measurement of multilayer ceramic capacitors.:

**Necessary tools**
- 3504 (3504-10)
- 9263 SMD Test Fixture
- Sample to be measured: Multilayer ceramic capacitor

**Measurement Conditions** See 2.



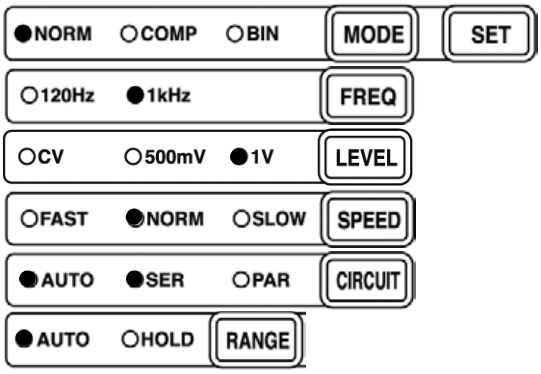
## 1 Connect the 9263 SMD Test Fixture (Option).




Connect the 9263 SMD Test Fixture to the measurement terminal.

For the connection method, refer to the instruction manual supplied with the fixture.

## 2 Set the measurement conditions.




Using the keys on the operating panel, set the measurement conditions as shown at left.

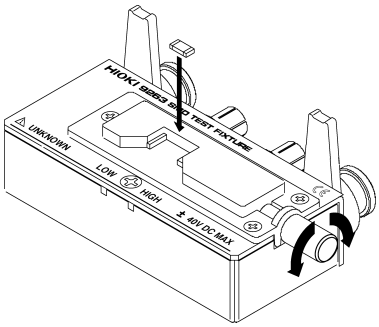
| | | |
|---|---|---|
| MODE | Measurement mode..... NORM | ❖ (⇒ p. 25) |
| FREQ | Frequency..... 1 kHz | ❖ (⇒ p. 25) |
| LEVEL | Measurement signal level..... 1 V | ❖ (⇒ p. 26) |
| SPEED | Measurement speed..... NORM | ❖ (⇒ p. 27) |
| CIRCUIT | Equivalent-circuit mode .. AUTO | ❖ (⇒ p. 27) |
| RANGE | Measurement range..... AUTO | ❖ (⇒ p. 29) |

Make other settings as necessary.

❖ 3.4.1 "Open Circuit Compensation • Short Circuit Compensation" (p. 31)
❖ 3.4.2 "Load Compensation" (p. 36)
❖ 3.4.3 "Trigger Signal" (p. 39)

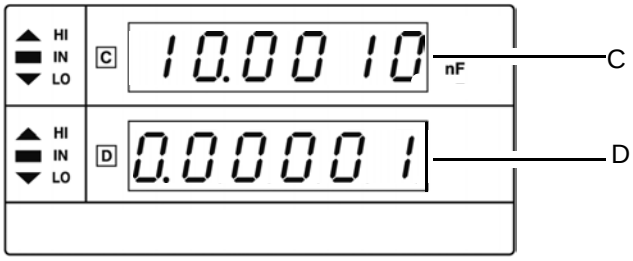
The open circuit compensation and short circuit compensation settings improve measurement accuracy.

## 3 Connect the sample to be measured to the 9263 SMD Test Fixture.



For the connection method, refer to the instruction manual supplied with the fixture.

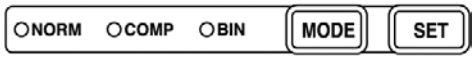
## 4 Check the measurement results.



# 3.3 Setting the Measurement Conditions (Required Settings)

## 3.3.1 Measurement Mode

Select a measurement mode.




Mode: **NORM**, **COMP**, **BIN**

**Press** MODE **to change the mode.**

The selected item is indicated by the lit LED lamp.

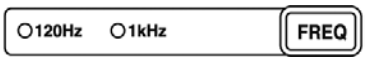
| | | |
|---|---|---|
| **NORM** | Select this when using normal measurement mode. | _____ |
| **COMP** | Select this when using comparator measurement mode. | ❖ 4.1 (page 41) |
| **BIN** (Model 3504 only) | Select this when using BIN measurement mode. | ❖ 4.2 (page 50) |

NOTE

The measurement conditions cannot be changed in comparator mode and BIN mode. Set them in normal measurement mode.

## 3.3.2 Measurement Frequency

Set the measurement frequency.
Set a frequency appropriate for the sample to be measured.




Measurement frequency: **120 Hz**, **1 kHz**

**Press** FREQ **to change the mode.**

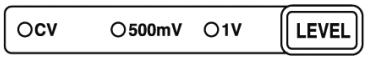
The selected item is indicated by the lit LED lamp.

# 3.3.3 Measurement Signal Level

**CAUTION**

A voltage of ±12 V is generated at the $L_{CUR}$ terminal when the $L_{POT}$ and $L_{CUR}$ terminals are in an open state.

Set the measurement signal level.
Set a signal level appropriate for the sample to be measured.




Measurement signal level: **500 mV, 1 V**

**Press LEVEL to change the mode.**

The selected item is indicated by the lit LED lamp.

| | |
|---|---|
| **500mV** | Constant-voltage measurement can be performed within the range of 0.94 pF up to 170 µF (1 kHz) or 9.4 pF up to 1.45 mF (120 Hz). |
| **1V** | Constant-voltage measurement can be performed within the range of 0.94 pF up to 70 µF (1 kHz) or 9.4 pF up to 700 µF (120 Hz). |

When the set voltage is applied to both sides of the sample, the CV indicator lights up. The CV indicator does not light up when the applied voltage is lower than the set voltage. In such a case, the EXT.I/O outputs a CV-ERR signal.

| Range No. | 120 Hz | 1 kHz | Measurement Voltage Mode |
|---|---|---|---|
| 1 | 200 pF | 20 pF | Constant voltage mode |
| 2 | 2 nF | 200 pF | |
| 3 | 20 nF | 2 nF | |
| 4 | 200 nF | 20 nF | |
| 5 | 2 µF | 200 nF | |
| 6 | 20 µF | 2 µF | |
| 7 | 200 µF | 20 µF | |
| 8 | 700 µF (when 1 V)<br>1.45 mF (when 500mV) | 70 µF (when 1 V)<br>170 µF (when 500mV) | |
| 9 | 2 mF | 200 µF | Open terminal voltage mode<br>Output resistance of 5 Ω |
| 10 | 20 mF | 2 mF | |

**NOTE**

- In some samples, the value may vary depending on the measurement-signal level.
- Constant voltage measurement may not be possible if the value of the contact resistance between the measurement terminals and the sample is high. When this is the case, "– – – – – –" appears on the MAIN display area, CV LED goes out, and a $\overline{\text{CV-ERR}}$ signal is output from EXT.I/O.

## 3.3.4 Measurement Speed

Set the measurement speed.


Measurement speed: **FAST**, **NORM**, **SLOW**

**Press** SPEED **to change the mode.**

The selected item is indicated by the lit LED lamp.

| | |
|---|---|
| **FAST** | Measures at high speed. |
| **NORM** | Measures at normal speed. |
| **SLOW** | Measures at low speed, but provides improved measurement accuracy. |

The lower the measurement speed, the higher the measurement accuracy becomes.

Measurement speed

| Measurement frequency | FAST | NORM | SLOW |
|---|---|---|---|
| 120 Hz | 10 ms | 37.5 ms | 146 ms |
| 1 kHz | 2.0 ms | 5.5 ms | 29.5 ms |

(Allowance: ±5%±0.5 ms)

NOTE The measurement time varies depending on such factors as the open/short circuit compensation ON/OFF and the comparator ON/ OFF.

## 3.3.5 Equivalent Circuit Mode

You may set an equivalent circuit mode (SER/ PAR).
Automatic selection is also possible.

❖ "Equivalent Circuit Mode" (page 28)


Equivalent circuit mode: **AUTO**, **SER**, **PAR**

**Press** CIRCUIT **to change the mode.**

The selected item is indicated by the lit LED lamp.

**AUTO** The series equivalent circuit mode or parallel equivalent circuit mode is automatically selected according to the measurement range.

| Range No. | Automatically selected mode |
|---|---|
| 6 to 10 | Series equivalent circuit |
| 1 to 5 | Parallel equivalent circuit |

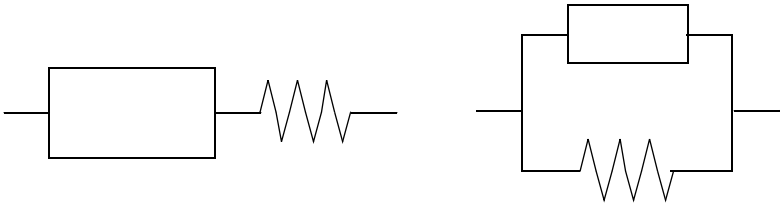
**SER** Series equivalent circuit mode

**PAR** Parallel equivalent circuit mode

## Equivalent Circuit Mode

The 3504 (3504-10) unit analyses the measurement sample in terms of 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 C and R components.

Normally, the parallel-equivalent circuit mode is used for a small capacitance (high-impedance components) because a small capacitance is a major cause of parallel resistance loss. While the series-equivalent circuit mode is used for a large capacitance (low-impedance components) because a large capacitance is a major cause of series resistance loss from the resistive parts of lead wires, etc.



Series-equivalent circuit　　Parallel-equivalent circuit

The measurement errors are likely to be large if the equivalent circuit setting is configured incorrectly. If the parallel-equivalent circuit is used to measure, for example, an electrolytic capacitor with a large D (low Q [quality factor][*1]), the measurement values will differ from those when a series-equivalent circuit is used for measurement. The table below shows an example of the measurement values obtained using a parallel-equivalent circuit and a series-equivalent circuit when D is altered for a capacitor for which the capacitance is the same.

| 3504 (3504-10) displayed value | | |
|---|---|---|
| D | Cs | Cp |
| 0 | C’ | C’ |
| 0.1 | 1.005C’ | 0.995C’ |
| 0.5 | 1.118C’ | 0.8944C’ |

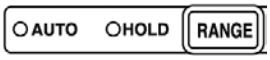
C' : Static capacitance (nominal value)
Cs : Static capacitance in series-equivalent circuit mode
Cp : Static capacitance in parallel-equivalent circuit mode
D : Dissipation factor

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

*1: Measure of reactance purity.

## 3.3.6 Measurement Range

Select a measurement range. Automatic selection is also possible.




Measurement Range: **AUTO**, **HOLD**

**Press** RANGE **to change the mode.**

The selected item is indicated by the lit LED lamp.

| | |
|---|---|
| **AUTO** (Auto range) | The optimal measurement range is selected automatically. This is useful for the measurement of unknown samples. However, measurement takes longer. |
| **HOLD** (Hold range) | The measurement range is fixed, and may only be altered manually. Take measurements in the same range regardless of the value of the sample. This is useful for high-speed measurement. Changing the range: ▼ ▲<br>When the range is changed, the decimal point and unit in the measurement value display area change. The range number is displayed in the SUB display area. |

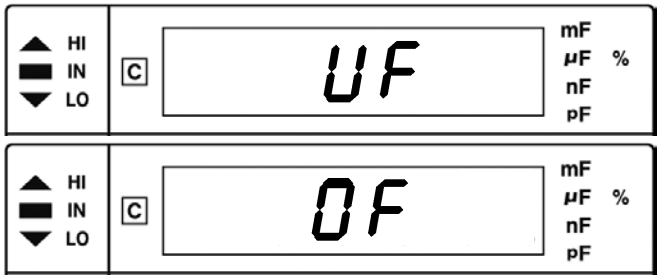
### Measurement ranges and display ranges

| Range No. | Guaranteed Accuracy Range of C (when D ≤ 0.1) | |
|---|---|---|
| | 120 Hz | 1 kHz |
| 1 | 009.400 pF to 200.000pF | 00.9400 pF to 20.0000 pF |
| 2 | 0.09400 nF to 2.00000nF | 009.400 pF to 200.000 pF |
| 3 | 00.9400 nF to 20.0000nF | 0.09400 nF to 2.00000 nF |
| 4 | 009.400 nF to 200.000nF | 00.9400 nF to 20.0000 nF |
| 5 | 0.09400 µF to 2.00000 µF | 009.400 nF to 200.000 nF |
| 6 | 00.9400 µF to 20.0000 µF | 0.09400 µF to 2.00000 µF |
| 7 | 009.400 µF to 200.000 µF | 00.9400 µF to 20.0000 µF |
| 8 | 0.09400 mF to 0.70000 mF (when 1 V)<br>1.45000 mF (when 500 mV) | 009.400 µF to 070.000 µF (when 1 V)<br>170.000 µF (when 500 mV) |
| 9 | 0.13500 mF to 2.00000 mF | 016.000 µF to 200.000 µF |
| 10 | 01.3500 mF to 20.0000 mF | 0.16000 mF to 2.00000 mF |

NOTE

- If the measurement values displayed on the unit are outside of the guaranteed accuracy range, the HOLD LED flashes.
- If the values are outside of the measurement value range, the following may be displayed.

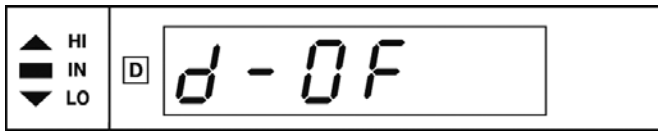
**MAIN Display Area**




Under flow:
C is smaller than the measurement range

Over flow:
C is larger than the measurement range

**SUB Display Area**




Over flow:
D is larger than the measurement range

- Do not connect a low-impedance component with, for example, a static capacitance larger than the Range 8 guaranteed accuracy range for a prolonged period of time while the unit is in a Range 8 HOLD state.
  If a low-impedance component is connected for at least ten minutes, the “i-ovEr Error” indication flashes in the MAIN display area and measurement stops. To clear the error, open the measurement terminals and then press ENTER.

# 3.4 Measurement Conditions (Optional Settings)

## 3.4.1 Open Circuit Compensation • Short Circuit Compensation



Open circuit compensation and short circuit compensation enable you to reduce the effect of impedance remaining in parts such as the probe or fixture and improve measurement accuracy.
There are two ways of performing open circuit compensation and short circuit compensation.

- All Compensation
  This performs compensation at all frequencies (120 Hz and 1 kHz). This can be performed from the front panel or via a PC.
- Spot Compensation
  This performs compensation at the frequency currently set. Perform this from a PC through the interface.

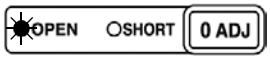
❖ "Setting and Query of Open Circuit Compensation Function" (page 145) and "Setting and Query of Short Circuit Compensation Function" (page 148) of “7.9, "Message Reference".

NOTE

- The measurement accuracy values defined in the specifications are for when open circuit compensation and short circuit compensation are performed.
- Be sure to perform compensation again after replacing the probe or fixture. You will be unable to obtain correct values if measurement is performed in the compensation state prior to replacement.
- The open circuit compensation range of impedance is 1 kΩ or more. However, if the values are not sufficiently high compared to the impedance of the sample, the measurement errors will be larger and measurement may become no longer possible.
- The short circuit compensation range of impedance is less than 1 kΩ. However, if the values are not sufficiently low compared to the impedance of the sample, the measurement errors will be larger and measurement may become no longer possible.

## Performing Open Circuit Compensation, Short Circuit Compensation

**1. In normal measurement mode, press [0 ADJ].**




The state becomes as follows.

- The OPEN LED flashes.
- The “oPEn SEt” indication is displayed and the “SEt” indication flashes in the MAIN display area.

NOTE

If you do not want to perform open circuit compensation, press [▶] to proceed to configuring the short circuit compensation settings. (The SHORT LED flashes and the “Short SEt” indication is displayed and the “SEt” indication flashes in the MAIN display area.) Proceed to Step 4. (page 33).

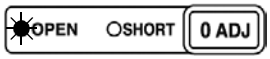
**2. Set an open state between the HIGH and LOW terminals of the probe or fixture connected to the measurement terminals.**

NOTE

- When performing compensation, the placement of things like the probe and the distances between terminals must be as similar as possible to the state when performing measurement.
- If compensation is being affected by external noise, use the shielding process.

❖ For details on the shielding process, refer to 6.2 "Measurement of High Impedance Components" (p. 87).

**3. Press [0 ADJ].**




Incorporate the open circuit compensation values. (ALL Compensation)

- The OPEN LED flashes.
- The “oPEn AdJuSt” indication is displayed and the “AdJuSt” indication flashes in the MAIN display area.

End of Compensation:


When compensation ends, the state becomes as follows.

- A beep tone sounds once and the “oPEn End” indication is displayed in the MAIN display area for one second.
- The OPEN LED flashes.
- The SHORT LED flashes.
- The “Short SEt” indication is displayed and the “SEt” indication flashes in the MAIN display area.

Compensation Error:

If there was a compensation error, the state becomes as follows.

- A warning beep tone sounds
- The “oPEn Error” indication is displayed in the MAIN display area.

Compensation stops.

## What if there is an error?

- If [0 ADJ] is pressed, the unit enters short circuit compensation incorporate mode. (Proceed to Step 4. (page 33).) (The settings for open circuit compensation remain the same as last time.)
- Are the measurement terminals open? Open the measurement terminals and then perform compensation again.
- If there is a compensation error even when the measurement terminals are open, external noise may be affecting compensation or the unit, probe, or fixture may be malfunctioning. Use the shielding process, submit the unit or fixture for repairs, or replace the probe with a new one. (The probe cannot be repaired.)

❖ 6.2 "Measurement of High Impedance Components" (p. 87)



### 4. Use a shorting bar to create a short circuit state between the HIGH terminal and LOW terminal of the probe or fixture connected to the measurement terminals.

Use a shorting bar with as low an impedance as possible.

NOTE

- When performing compensation, the placement of things like the probe and fixture and the distances between terminals must be as similar as possible to the state when performing measurement.
- If you do not want to perform short circuit compensation, press [▶] to return to normal measurement mode.

### 5. Press [0 ADJ].


Incorporate the short circuit compensation values. (ALL Compensation)

- The SHORT LED flashes.
- The “Short AdJuSt” indication is displayed and the “AdJuSt” indication flashes in the MAIN display area.


End of Compensation:
When compensation ends, the state becomes as follows.

- A beep tone sounds once
- The “Short End” indication is displayed in the MAIN display area for one second.
- The SHORT LED flashes.

The unit returns to normal measurement mode.

Compensation Error:
If there was a compensation error, the state becomes as follows.

- A warning beep tone sounds
- The “Short Error” indication is displayed in the MAIN display area.

Compensation stops.

## What if there is an error?

- If 0 ADJ is pressed, the unit returns to normal measurement mode. (The settings for short circuit compensation remain the same as last time.)
- Are the measurement terminals in a short circuit state? Short circuit the measurement terminals and then perform compensation again.
- If there is a compensation error even when the measurement terminals are short circuited, the unit, probe, or fixture may be malfunctioning. Use the shielding process, submit the unit or fixture for repairs, or replace the probe with a new one. (The probe cannot be repaired.)

## Canceling Open Circuit Compensation and Closed Circuit Compensation

**1. In normal mode, press 0 ADJ for at least two seconds while open circuit compensation and closed circuit compensation are in an ON state.**


The state becomes as follows.

- The OPEN LED flashes.
- The “oPEn oFF” indication is displayed and the “oFF” indication flashes in the MAIN display area.

* State when the OPEN or SHORT LED is flashing.

NOTE

- While open circuit compensation and closed circuit compensation are in an OFF state, the unit will not enter cancel mode even if you press and hold 0 ADJ for at least two seconds.
- If only short circuit compensation is in an ON state, the unit enters short circuit compensation cancel mode. (Proceed to Step 3. (page 34)).

**2. Press 0 ADJ.**

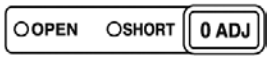

Open circuit compensation is set to OFF and the state becomes as follows.

- The OPEN LED goes out.
- The “oPEn CAnSEL” indication lights up in the MAIN display area for one second.
- The SHORT LED flashes.
- The “Short oFF” indication is displayed and the “oFF” indication flashes in the MAIN display area.

NOTE

- If you do not want to cancel open circuit compensation, press ▶ to enter short circuit compensation cancel mode. (Proceed to Step 3. (page 34).)
- If short compensation mode is OFF, the unit returns to normal measurement mode.

**3. Press 0 ADJ.**




Short circuit compensation is set to OFF and the state becomes as follows.

- The SHORT LED goes out.
- The “Short CAnSEL” indication lights up in the MAIN display area for one second.

The unit returns to normal measurement mode.

**NOTE**

If you do not want to cancel short circuit compensation, press ▶ to return to normal measurement mode

# 3.4.2 Load Compensation

Load compensation allows for the calculation of the compensation rate by measuring a standard sample with known measurement values and compensating the measurement values.

This function can be used for the following.

- When using multiple 3504 (3504-10) units, reduce the measurement errors of individual 3504 (3504-10) units and match the measurement values.
- Match the measurement values of the 3504 (3504-10) unit to those of the reference measure device.

The conditions that are currently set (frequency, level, range, equivalent circuit mode, open circuit compensation, and short circuit compensation) are used as the measurement conditions for load compensation. Changing the measurement conditions while load compensation in enabled results in load compensation being disabled. (When this happens, the OFF LED of LOAD flashes.)
If, however, the measurement conditions are returned to what they were during load compensation, then load compensation is resumed. (The ON LED of LOAD lights up.)

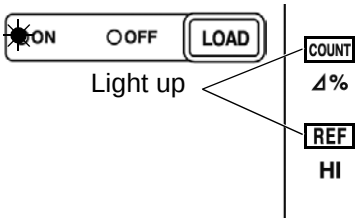
The compensation rate is determined by first calculating the impedance Z and phase angle θ from the reference values of the measurement conditions, C, and D and the actual measurement values and then using the following formula for the calculation.
Z compensation rate = (Z reference value)/(Z actual value)
θ compensation rate = (θ reference value) – (θ actual value)
For the actual values of Z and θ, compensation is performed using the above compensation rate and then C and D are calculated from Z and θ after compensation.

**NOTE**

When open circuit compensation and short circuit compensation are enabled, load compensation performs compensation for Z and θ after open circuit compensation and short circuit compensation are finished.
Perform open circuit compensation and short circuit compensation before you incorporate load compensation data.

## Performing Load Compensation

*1.* **In normal measurement mode, press LOAD.**




The state becomes as follows.

- The ON LED flashes.
- The “LoAd SEt” indication is displayed and the “SEt” indication flashes in the MAIN display area.
- The COUNT and REF LEDs light up in the SUB display area.
- The reference values for C and D are displayed in the SUB display area.
- The LED on the far left of the C reference value flashes.

**NOTE**

If you want to exit the reference value input screen and return to normal measurement mode, press LOAD for at least two seconds.

## 2. Use the numeric keypad or arrow keys to enter a reference value for C and then press [ENTER].

Use the numeric keypad to enter a number. (If you enter a number, each digit moves one place to the right.) Settable Range: 1 to 999999
You can use ◄ and ► to move to the digit you want to change.
You can also use ▲ and ▼ to change the number set for a digit.

**NOTE**

- If you do not want to change the reference value of C, press [ENTER] without changing the number. The reference value input screen for D is displayed.
- Set count values for the reference values. The reference values at the time of shipment are 100000 for C and 0 for D.



## 3. Use the numeric keypad or arrow keys to enter a reference value for D and then press [ENTER].

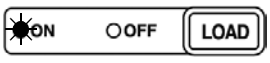
Use the numeric keypad to enter a number. (If you enter a number, each digit moves one place to the right.) Settable Range: 0 to 199000
You can use ◄ and ► to move to the digit you want to change.
You can also use ▲ and ▼ to change the number set for a digit.

The unit returns to the state of Step 1. (page 36).

**NOTE**

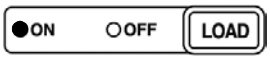
- If there is no need to change the reference value of D, proceed to Step 4. (page 37) without changing the number.
- If you want to exit the reference value input screen and return to normal measurement mode, press [LOAD] for at least two seconds.

## 4. Press [LOAD].




Incorporate the load compensation values.

- The ON LED flashes.
- The “LoAd AdJuSt” indication is displayed and the “AdJuSt” indication flashes in the MAIN display area.




End of Compensation:
When compensation ends normally, the state becomes as follows.

- A beep tone sounds once.
- The “LoAd End” indication lights up in the MAIN display for one second.
- The ON LED lights up.

The unit returns to normal measurement mode.

Compensation Error:
If there was a compensation error, the state becomes as follows.

- A warning beep tone sounds
- The “LoAd Error” indication lights up in the MAIN display area.

Compensation stops.

NOTE

The conditions that are currently set (frequency, level, range, equivalent circuit mode, open circuit compensation, and short circuit compensation) are used as the measurement conditions for load compensation. Changing the measurement conditions while load compensation in enabled results in load compensation being disabled. (When this happens, the OFF LED of LOAD flashes.)
If, however, the measurement conditions are returned to what they were during load compensation, then load compensation is resumed. (The ON LED of LOAD lights up.)

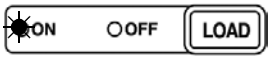
## What if there is an error?

- To return to normal measurement mode, press LOAD.
- If the value is outside the measurement range (under flow or over flow) or the constant voltage is not output (CV error), a compensation error is generated. Set an appropriate range and then perform compensation again.

## Canceling Load Compensation

1. **In normal mode, press LOAD for at least two seconds while load compensation is in an ON state.**

* State when the ON LED of LOAD is lit.




The state becomes as follows.

- The ON LED flashes.
- The “LoAd oFF” indication is displayed and the “oFF” indication flashes in the MAIN display area.

NOTE

While load compensation is in an OFF state, the unit will not enter cancel mode even if you press and hold LOAD for at least two seconds.

2. **Press LOAD.**


Load compensation is set to OFF and the state becomes as follows.

- The “LoAd CAnSEL” indication lights up in the MAIN display area for one second.
- The OFF LED lights up.

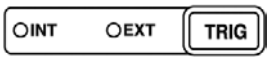
The unit returns to normal measurement mode.

NOTE

If you do not want to cancel load compensation, press ▶ to enter normal measurement mode.

## 3.4.3 Trigger Signal

The internal trigger or the external trigger can be set.




Trigger signal: **INT**, **EXT**

**Press** TRIG **to change the mode.**

| | |
|---|---|
| **INT** (Internal trigger mode) | • Continuous measurement is performed while automatically generating an internal trigger signal.<br>• The INT LED flashes. |
| **EXT** (External trigger mode) | • A trigger signal is input from the outside either manually or automatically.<br>• The EXT LED lights up.<br>• Manual setting:<br>Press MANU TRIG to perform measurement once.<br>• Measurement is performed with a trigger from the EXT I/O connector TRIG terminal. |

When inputting the trigger signal through the interface

Measurement starts when a "*TRG" command is received through the interface.

❖ For details on inputting the trigger signal through the interface, refer to "Sampling Request" (page 130) of 7.9, "Message Reference".

When inputting the trigger signal through the EXT I/O connector

When a negative-logic pulse signal is input to TRIG (pin 1) of the EXT I/O connector on the rear panel, one measurement operation is performed.

❖ 6.1 "Measurement Using EXT I/O" (p. 81)

# Application Functions Chapter 4

## 4.1 Comparator Function

This function enables you to set the upper limit and lower limit values for each of C and D, and then indicates the judgment result with HI, IN, or LO in the comparator judgment result display area.
The judgment result enables you to determine whether the sample has passed or failed.



The corresponding signal is also output from the EXT.I/O connector on the rear of the unit.
There are two judgment modes for comparator measurement: the count value setting and deviation percent (Δ%) setting.

- **Count Value Setting**
  Set count values for the upper limit and lower limit values of the measurement parameters. The values of measurement parameters are displayed unchanged as the measurement values.

- **Deviation Percent (Δ%) Setting**
  - Enter reference values and then set percentages corresponding to the reference values as the upper limit and lower limit values. The differences from reference values (C: Δ%, D: Δ) are displayed as the measurement values.
  - When Δ% is set, the displayed results are calculated with C as Δ%=(measurement value – reference value)/|reference value| × 100 and D as Δ=(measurement value – reference value).

If the power is turned off while the unit is in comparator measurement mode, the unit will be in comparator measurement mode when the unit is turned back on again.

NOTE

- Set the upper limit and lower limit values of any parameter that does not require a comparator judgment to be made to OFF so that judgment will not be performed.
- The measurement conditions for normal measurement mode are inherited as is for the measurement conditions when the comparator is executed. However, the AUTO range is automatically set to the HOLD range.

## Setting Judgment Mode

First, set the judgment mode. (Select the count value setting or the deviation percent [Δ%] setting.)

NOTE

The judgment modes are the same for both the comparator and BIN.

1. In normal measurement mode, press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE

- This setting cannot be changed in comparator mode and BIN mode.
- Use ◄ and ► to move through the menu items as follows.
  "LoAd_A(C/h)" ←→ "SAVE" ←→ "Ld_tYP" ←→ "JudGE" ←→ "bEEP_J" ←→ "bEEP_K" ←→ "CLK" (only for special specifications) ←→ "SYnC" ←→ "IF.GPib(rS/Prnt)" ←→ "LoAd_A(C/h)" ←→ …

2. Use ◄ or ► to select the "JudGE" menu item. (Judgment mode setting screen)

The setting items are as follows.

| |
|---|
| "Count": Count setting |
| "d-PAr": Deviation percent (Δ%) setting |

3. Use ▲ or ▼ to select a setting item.
Pressing ▲ or ▼ switches between "Count" ←→ "d-PAr."

4. Press ENTER.

The judgment mode is confirmed
After confirmation, "bEEP_J" is displayed at the top of the MAIN display area. (Beep setting screen for judgment result)

NOTE

The judgment mode is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to normal measurement mode.

## Setting the Upper Limit and Lower Limit Values for the Comparator Setting Workflow

**1 Normal measurement mode**

MODE — Switch to comparator measurement mode. The range is automatically set to HOLD.

**2 Comparator measurement mode**

SET — Switch to the setting mode for the upper limit and lower limit values.

**3 C setting**

ENTER — Confirm C. Move to the next setting.

**4 Reference value setting for C**
**(Only for the Δ% setting)**

- Numeric keypad
- Arrow keys — Set the reference value for C.

ENTER — Move to the next setting.

**5 Upper limit and lower limit value settings for C**

- Numeric keypad
- Arrow keys — Set the upper limit value for C.

ENTER — Confirm the upper limit value.

- Numeric keypad
- Arrow keys — Set the lower limit value for C.

ENTER — Confirm the lower limit value. Move to the next setting.

**6 D setting**

▲▼ — Select D.

ENTER — Confirm D. Move to the next setting.

**7 Reference value setting for D**
**(Only for the Δ% setting)**

- Numeric keypad
- Arrow keys — Set the reference value for D.

ENTER — Move to the next setting.

**8 Upper limit and lower limit value settings for D**

- Numeric keypad
- Arrow keys — Set the upper limit value for D.

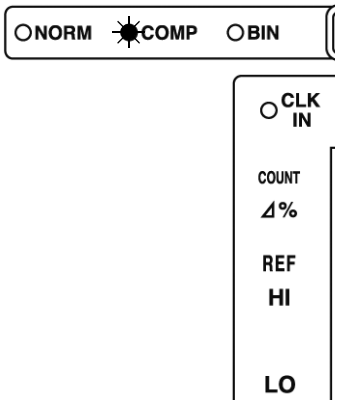
ENTER — Confirm the upper limit value.

- Numeric keypad
- Arrow keys — Set the lower limit value for D.

ENTER — Confirm the lower limit value.

## Setting Procedure

**1.** Use MODE to switch to the comparator measurement mode and press SET.




The state becomes as follows.

- The COMP LED flashes.
- The "C" indication at the top of the SUB display area flashes.
- For the Δ% setting: The Δ% and REF LEDs light up.
- For the count setting: The COUNT, HI, and LO LEDs light up.

**NOTE**

- When the "C" or "D" indication is flashing at the top of the SUB display area, you can configure the settings in any order if you use ▲ or ▼ to change the setting mode as follows and then press ENTER.
  C Reference Value (only for the Δ% setting) ←→ C Upper Limit and Lower Limit Values ←→ D Reference Value (only for the Δ% setting) ←→ D Upper Limit and Lower Limit Values ←→ C Reference Value …
- For the count setting, proceed to Step 5. (page 45).

**2.** Press ENTER to confirm C.

**(Only for the Δ% setting)**

The unit switches to the setting mode for the C reference value and the state becomes as follows.

- The "C" indication at the top of the SUB display area flashes.
- The LED on the far left of the C reference value flashes.
- The C reference value index number at the bottom of the SUB display area lights up.

**3.** Use the numeric keypad or arrow keys to enter a reference value for C.

**(Only for the Δ% setting)**

Use the numeric keypad to enter a number. (If you enter a number, each digit moves one place to the right.) Settable Range: 1 to 999999

You can use ◀ and ▶ to move to the digit you want to change.

You can also use ▲ and ▼ to change the number set for a digit.

**NOTE**

Set a count value for the reference value. At the time of shipment, the reference value for C is 100000.

**4.** Press ENTER to confirm the C reference value.

**(Only for the Δ% setting)**

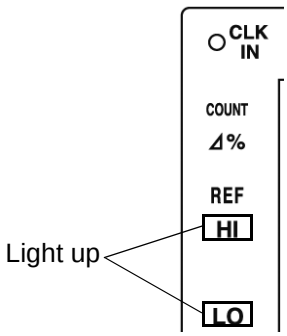
The state becomes as follows.

- The "C" indication at the top of the SUB display area flashes.
- The HI and LO LEDs light up.

**NOTE**

The reference value entered this time is not confirmed unless ENTER is pressed. The reference value used last time becomes valid.

**5.** Press ENTER to confirm C.




The unit switches to the setting mode for the C upper limit value and the state becomes as follows.

- The HI and LO LEDs light up.
- The “C” indication at the top of the SUB display area lights up.
- The LED on the far left of the C upper limit value of the SUB display area flashes.

**6.** Use the numeric keypad or arrow keys to enter an upper limit value for C and then press ENTER.

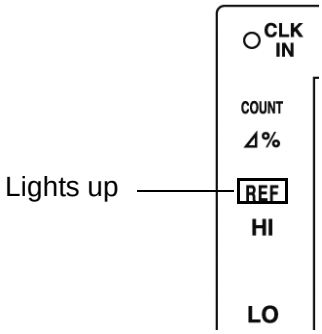
The C upper limit value is confirmed and the unit switches to the setting mode for the C lower limit value.The state becomes as follows.

The LED on the far left of the C lower limit value of the SUB display area flashes.

The settable ranges for the C upper limit and lower limit values are as follows.

- For the Δ% setting: OFF/–999.99 to 999.99
- For the count setting: OFF/0 to 999999

**7.** Use the numeric keypad or arrow keys to enter a lower limit value for C and then press ENTER.




(Only for the Δ% setting)
The C lower limit value is confirmed and the state becomes as follows.

- The “d” indication at the top of the SUB display area flashes.
- The REF LED lights up.

NOTE

For the count setting, proceed to Step 10. (page 46).

8. Press ENTER to confirm “d”.

**(Only for the Δ% setting)**

The unit switches to the setting mode for the D reference value and the state becomes as follows.

- The “d” indication at the top of the SUB display area lights up.
- The LED on the far left of the D reference value flashes.

9. Use the numeric keypad or arrow keys to enter a reference value for D and then press ENTER.

**(Only for the Δ% setting)**

The D reference value is confirmed and the state becomes as follows.

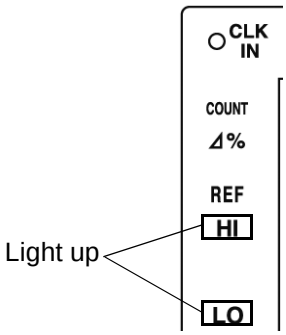
- The “d” indication at the top of the SUB display area flashes.
- The HI and LO LEDs light up.

Settable range: 0 to 199000

NOTE

Set a count value for the reference value. At the time of shipment, the reference value for D is 0.

10. Press ENTER to confirm “d”.




The unit switches to the setting mode for the D upper limit value and the state becomes as follows.

- The HI and LO LEDs light up.
- The “d” indication at the top of the SUB display area lights up.
- The LED on the far left of the D upper limit value of the SUB display area flashes.

11. Use the numeric keypad or arrow keys to enter an upper limit value for D and then press ENTER.

The D upper limit value is confirmed and the unit switches to the setting mode for the D lower limit value.
The state becomes as follows.

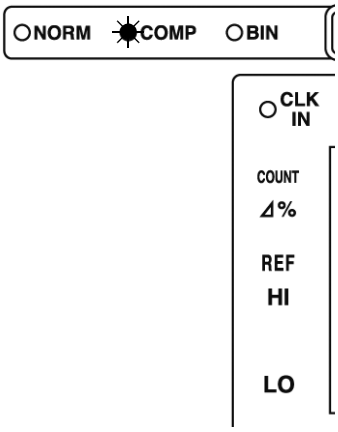
- The LED on the far left of the D lower limit value of the SUB display area flashes.

The settable ranges for the D upper limit and lower limit values are as follows.

- For the Δ% setting: OFF/–199000 to 199000
- For the count setting: OFF/0 to 199000

## 12.

Use the numeric keypad or arrow keys to enter a lower limit value for D and then press ENTER.




The D lower limit value is confirmed and the state becomes as follows.

- The COMP LED flashes.
- The “C” indication at the top of the SUB display area flashes.
- For the Δ% setting: The Δ% and REF LEDs light up.
- For the count setting: The COUNT, HI, and LO LEDs light up.

## 13.

Press SET.


The unit switches to the comparator measurement mode. (The COMP LED lights up.)

**NOTE**

- The upper limit and lower limit values for the count setting and the reference value for the Δ% setting become display count values that are independent of the measurement conditions. If the measurement conditions differ, the absolute values that signify the count values change.
- The measurement conditions for normal measurement mode are used for the comparator measurement mode. Set the measurement conditions to use for comparator measurement mode while the unit is in normal measurement mode.
- The comparator judgment is performed in the following order.
  1. When the measurement value is “– – – – – –”: HI is displayed
     When the measurement value is “OF”: HI is displayed
     When the measurement value is “UF”: LO is displayed
  2. The unit judges whether or not the measurement value is larger than the lower limit value and then displays LO if it is not.
  3. The unit judges whether or not the measurement value is smaller than the upper limit value and then displays HI if it is not.
  4. IN is displayed if the conditions of 2 and 3 are satisfied.
- The large/small judgment for the upper limit and lower limit values is not performed. An error is not generated if the upper limit and lower limit values are set in reverse, but the judgment cannot be performed properly.

## Setting the Upper Limit and Lower Limit Values to OFF

1. When entering the upper limit and lower limit values, use ◀ to move left until the far left digit flashes and then press and hold ◀ for at least two seconds or use ▶ to move right until the far right digit flashes and then press and hold ▶ for at least two seconds.

   The display changes to "– – – – – –" and OFF is set.

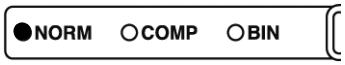
2. Press ENTER to confirm the OFF setting.

3. Press SET.


The unit switches to comparator measurement mode. (The COMP LED lights up)

## Canceling Comparator Measurement Mode

In comparator measurement mode, press MODE twice.

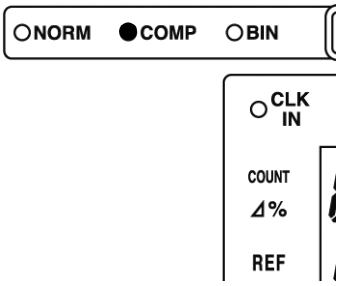



The measurement mode LEDs light in the order of COMP → BIN (only for 3504) → NORM, and then the unit switches to normal measurement mode.

## Performing Comparator Measurement

Follow the procedure below to perform comparator measurement.

In normal measurement mode, press MODE




The state becomes as follows (comparator measurement mode).

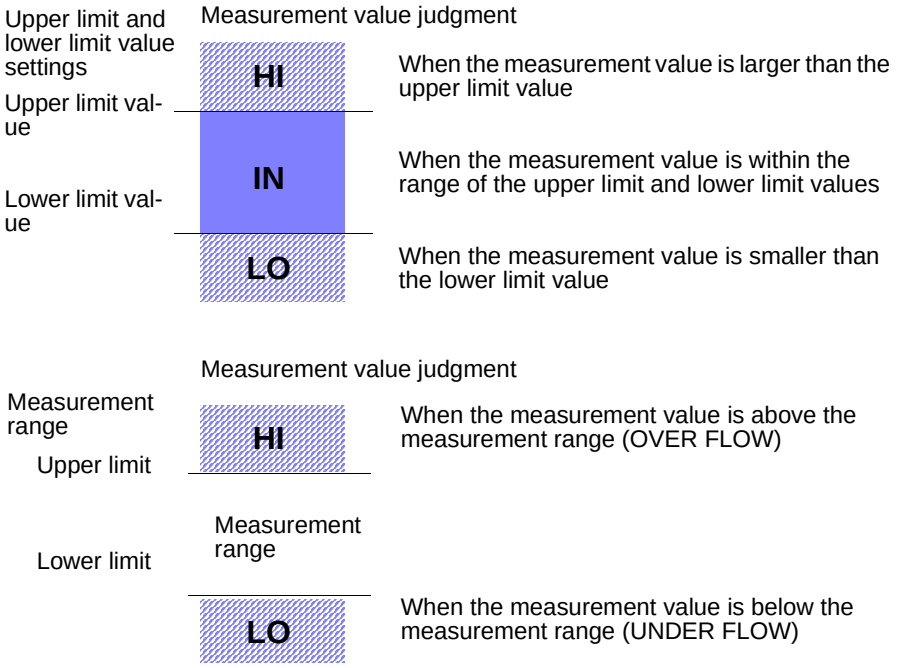
- The COMP LED lights up.
- For the deviation percent setting:
  The Δ% and REF or HI and LO LEDs light up.
  The comparator setting state is displayed in the SUB display area.
- For the count setting:
  COUNT, HI, and LO LEDs light up.
  The comparator setting state is displayed in the SUB display area.

NOTE

- You can use ▲ and ▼ to change the indications in the SUB display area.
- C Reference Value (only for the Δ% setting) ←→ C Upper Limit and Lower Limit Values ←→ D Reference Value (only for the Δ% setting) ←→ D Upper Limit and Lower Limit Values ←→ C Reference Value …
- The measurement range is automatically set to HOLD.

## Displaying Judgment Results


Each of the judgment results for C and D is displayed in the comparator judgment result display area.
The comparator judgment is not performed for parameters with the upper limit and lower limit values set to OFF.




## Outputting Judgment Results

- Output the judgment result for each of C and D (LO/IN/HI) and the AND results for both judgment results (only when both parameters are IN) from EXT.I/O.
  ❖6.1 "Measurement Using EXT I/O" (p. 81)
- The comparator judgment results (IN/NG) can be differentiated by beep tones.
  ❖5.1 "Setting Beep Tones" (p. 73)

Except for the trigger setting, the measurement conditions cannot be changed in comparator measurement mode.

Press MODE to switch to normal measurement mode and then change the measurement conditions.

## Keys Enabled for Comparator Mode

| Key | Function |
|---|---|
| MODE | Switches the measurement mode. |
| SET | Switches to the setting modes for the upper limit and lower limit values. |
| TRIG | Switches the trigger setting to INT/EXT. |
| MANU TRIG | This key is only enabled when the trigger setting is EXT. One measurement is performed each time the key is pressed. |
| MENU | Menu items other than “JudGE,” “bEEP_J,” “CLK” (only for special specifications), and “SynC” can be set.<br>For functions that cannot be set, the “– – – –” indication is displayed at the bottom of the MAIN display area.<br>(Set “JudGE,” “bEEP_J,” “CLK” (only for special specifications), and “SynC” in normal measurement mode.) |
| LOCK/LOCAL | Changes the keylock function and cancels the remote state. |

# 4.2 BIN Measurement Function (Only for 3504)

This function enables you to set up to 14 categories of upper limit and lower limit values for C and one category of upper limit and lower limit values for D, and indicates the judgment results in the BIN judgment result display area. The corresponding signal is also output from the EXT.I/O connector on the rear of the unit.
There are two judgment modes for BIN measurement: the count value setting and deviation percent (Δ%) setting

- **Count Value Setting**
  Set count values for the upper limit and lower limit values of the measurement parameter. The measurement parameter values are displayed unchanged as the measurement values.

- **Deviation Percent (Δ%) Setting**
  Enter reference values and then set percentages corresponding to the reference values for the upper limit and lower limit values. The differences from the reference values (C: Δ%, D: Δ) are displayed as the measurement values.

If the power is turned off while the unit is in BIN measurement mode, the unit will be in BIN measurement mode when the unit is turned back on again.

NOTE

- Set the upper limit and lower limit values of any BIN number that does not require a BIN judgment to be made to OFF so that judgment will not be performed.
- The measurement conditions for normal measurement mode are inherited as is for the measurement conditions when the BIN is executed. However, the AUTO range is automatically set to the HOLD range.

## Setting Judgment Mode

First, set the judgment mode. (Select the count value setting or the deviation percent [Δ%] setting.)

NOTE

The judgment modes are the same for both the comparator and BIN.

1. In normal measurement mode, press MENU.
The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE

- This setting cannot be changed in comparator mode and BIN mode.
- Use ◄ and ► to move through the menu items as follows.
"LoAd_A(C/h)" ←→ "SAVE" ←→ "Ld_tYP" ←→ "JudGE" ←→ "bEEP_J" ←→ "bEEP_K" ←→ "CLK" (only for special specifications) ←→ "SYnC" ←→ "IF.GPib(rS/Prnt)" ←→ "LoAd_A(C/h)" ←→ ...

2. Use ◄ or ► to select the "JudGE" menu item. (Judgment mode setting screen)

The setting items are as follows.

| |
|---|
| "Count": Count setting |
| "d-PAr": Deviation percent (Δ%) setting |

3. Use ▲ or ▼ to select a setting item.

**Pressing ▲ or ▼ switches between "Count" ←→ "d-PAr."**

4. Press ENTER.

The judgment mode is confirmed
After confirmation, "bEEP_J" is displayed at the top of the MAIN display area. (Beep setting screen for judgment result)

NOTE

The judgment mode is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to normal measurement mode.

# Setting the Upper Limit and Lower Limit Values for the BIN

## Setting Workflow

**1 Normal measurement mode**

MODE — Switch to comparator measurement mode.

MODE — Switch to BIN measurement mode.
The range is automatically set to HOLD.

**2 BIN measurement mode**

SET — Switch to the setting mode for the upper limit and lower limit values.

**3 Reference value setting for C**
**(Only for the Δ% setting)**

ENTER — Confirm C.
Set the reference value for C.

- Numeric keypad
- Arrow keys

ENTER — Confirm the setting value.
Move to the next setting.

**4 Upper limit and lower limit value settings for BIN1**

ENTER — Confirm BIN1.

- Numeric keypad
- Arrow keys

Set the upper limit value for BIN1.

ENTER — Confirm the upper limit value.

- Numeric keypad
- Arrow keys

Set the lower limit value for BIN1.

ENTER — Confirm the lower limit value.
Move to the next setting.

**5 Upper limit and lower limit value settings for BIN2 to BIN14**

ENTER — Confirm BIN2 to BIN14.

- Numeric keypad
- Arrow keys

Set the upper limit values.

ENTER — Confirm the upper limit values.

- Numeric keypad
- Arrow keys

Set the lower limit values.

ENTER — Confirm the lower limit values.
Move to the next setting.

**6 Reference value setting for D**
**(Only for the Δ% setting)**

ENTER — Confirm D.
Set the reference value for D.

- Numeric keypad
- Arrow keys

ENTER — Confirm the reference value.
Move to the next setting.

**7 Upper limit and lower limit value settings for D.**

ENTER — Confirm D.
Set the upper limit value for D.
- Numeric keypad
- Arrow keys

ENTER — Confirm the upper limit value.

Set the lower limit value for D.
- Numeric keypad
- Arrow keys

ENTER — Confirm the lower limit value.
Move to the next setting.

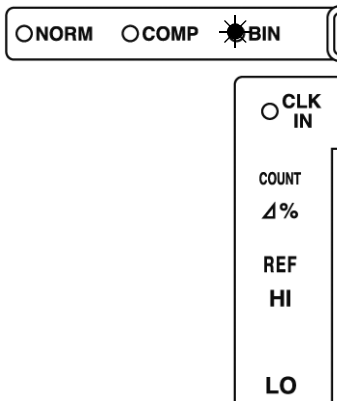
**8 BIN measurement mode**

SET — Switch to BIN measurement mode.

## Setting Procedure



*1.* Use MODE to switch to the BIN measurement mode and press SET.




The state becomes as follows.

- The BIN LED flashes.
- For the Δ% setting:
  The Δ% and REF LEDs light up.
  The “C” indication at the top of the SUB display area flashes.
- For the count setting:
  The COUNT, HI, and LO LEDs light up.
  The “1” indication at the top of the SUB display area flashes.

NOTE

- When the “1 to 14,” “C,” or “d” indication is flashing at the top of the SUB display area, you can configure the settings in any order if you use ▲ or ▼ to change the setting mode as follows and then press ENTER.
  C Reference Value (only for the Δ% setting) ←→ BIN 1 to 14 Upper Limit and Lower Limit Values ←→ D Reference Value (only for the Δ% setting) ←→ D Upper Limit and Lower Limit Values ←→ C Reference Value …
- For the count setting, proceed to Step 5. (page 54).

*2.* Press ENTER to confirm “C”.

**(Only for the Δ% setting)**

The unit switches to the setting mode for the C reference value and the state becomes as follows.

- The “C” indication at the top of the SUB display area flashes.
- The LED on the far left of the C reference value flashes.
- The index number for the C reference value at the bottom of the SUB display area lights up.

**3.** Use the numeric keypad or arrow keys to enter a reference value for C.

**(Only for the Δ% setting)** Use the numeric keypad to enter a number. (If you enter a number, each digit moves one place to the right.) Settable Range: 1 to 999999

You can use ◄ and ► to move to the digit you want to change.

You can also use ▲ and ▼ to change the number set for a digit.

NOTE

Set a count value for the reference value. At the time of shipment, the reference value for C is 100000.

**4.** Press ENTER to confirm the C reference value.

**(Only for the Δ% setting)** The state becomes as follows.

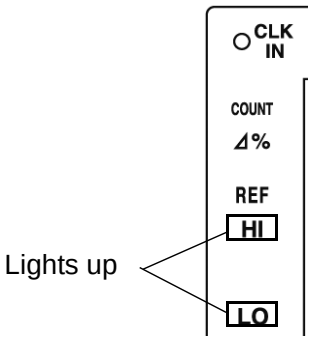
- The HI and LO LEDs light up.
- The "1" indication at the top of the SUB display area flashes.

NOTE

The reference value entered this time is not confirmed unless ENTER is pressed. The reference value used last time becomes valid.

**5.** Press ENTER to confirm "1".

The unit switches to the setting mode for the BIN1 upper limit value and the state becomes as follows.




- The HI and LO LEDs light up.
- The "1" indication at the top of the SUB display area lights up.
- The LED on the far left of the BIN1 upper limit value of the SUB display area flashes.

**6.** Use the numeric keypad or arrow keys to enter an upper limit value for BIN1 and then press ENTER.

The BIN1 upper limit value is confirmed and the unit switches to the setting mode for the BIN1 lower limit value.
The state becomes as follows.

The LED on the far left of the BIN1 lower limit value of the SUB display area flashes.

The settable ranges for the C upper limit and lower limit values are as follows.

- For the Δ% setting: OFF/–999.99 to 999.99
- For the count setting: OFF/0 to 999999

NOTE

- At the time of shipment, the upper limit and lower limit values are OFF("------"). If any key is pressed, the LEDs on the far left of the BIN upper and lower values flash.
- The BIN upper limit and lower limit values entered this time are not confirmed unless ENTER is pressed. The BIN upper limit and lower limit values used last time become valid.

**7.** Use the numeric keypad or arrow keys to enter a lower limit value for BIN1 and then press ENTER.

The BIN1 lower limit value is confirmed and the state becomes as follows.

- The "2" indication at the top of the SUB display area flashes.

**8.** Press ENTER to confirm "2".

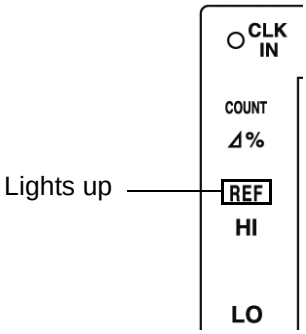
The unit switches to the setting mode for the BIN2 upper limit value and the state becomes as follows.

- The "2" indication at the top of the SUB display area lights up.
- The LED on the far left of the BIN2 upper limit value of the SUB display area flashes.

Set all the BIN upper limit and lower limit values in the same manner.

(Only for the Δ% setting)
After all the BIN upper limit and lower limit values have been set, the state becomes as follows.

- The REF LED lights up.
- The "d" indication at the top of the SUB display area lights up.




**NOTE** For the count setting, proceed to Step 12. (page 56).

**9.** Press ENTER to confirm "d".

**(Only for the Δ% setting)**

The unit switches to the setting mode for the D reference value and the state becomes as follows.

- The "d" indication at the top of the SUB display area lights up.
- The LED on the far left of the D reference value flashes.

**10.** Use the numeric keypad or arrow keys to enter a reference value for D and then press ENTER.

**(Only for the Δ% setting)**

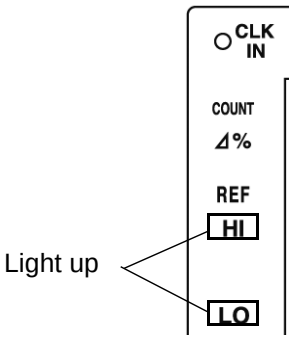
The D reference value is confirmed and the state becomes as follows.

- The "d" indication at the top of the SUB display area flashes.
- The HI and LO LEDs light up.

Settable range: 0 to 199000

**NOTE** Set a count value for the reference value. At the time of shipment, the reference value for D is 0.

**11.** Press ENTER to confirm “d”.




The unit switches to the setting mode for the D upper limit value and the state becomes as follows.

- The HI and LO LEDs light up.
- The “d” indication at the top of the SUB display area lights up.
- The LED on the far left of the D upper limit value of the SUB display area flashes.

**12.** Use the numeric keypad or arrow keys to enter an upper limit value for D and then press ENTER.

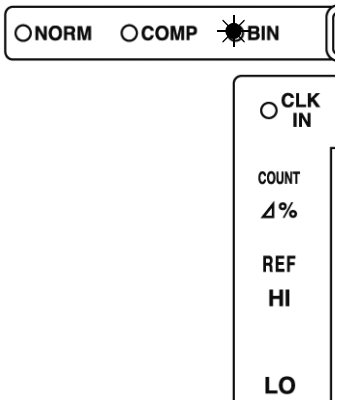
The D upper limit value is confirmed and the unit switches to the setting mode for the D lower limit value. The state becomes as follows.

The LED on the far left of the D lower limit value of the SUB display area flashes.

The settable ranges for the D upper limit and lower limit values are as follows

- For the Δ% setting: OFF/–199000 to 199000
- For the count setting: OFF/0 to 199000

**13.** Use the numeric keypad or arrow keys to enter a lower limit value for D and then press ENTER.




The D lower limit value is confirmed and the state becomes as follows.

- The BIN LED flashes.
- For the Δ% setting:
  The Δ% and REF LEDs light up.
  The “C” indication at the top of the SUB display area flashes.
- For the count setting:
  The COUNT, HI, and LO LEDs light up.
  The “1” indication at the top of the SUB display area flashes.

**14.** Press SET.


The unit switches to the BIN measurement mode. (The BIN LED lights up.)

NOTE

- The upper limit and lower limit values for the count setting and the reference value for the Δ% setting become display count values that are independent of the measurement conditions. If the measurement conditions differ, the absolute values that signify the count values change.
- The measurement conditions for normal measurement mode are used for the BIN measurement mode. Set the measurement conditions to use for BIN measurement mode while the unit is in normal measurement mode.
- Error judgment is not performed when the upper limit and lower limit values are confirmed.
- Check the following because judgment cannot be performed properly if the upper limit and lower limit values are set incorrectly.
  - •Are the setting values within the display range of the measurement range?
  - •Is the large/small relationship of the upper limit and lower limit values correct?



## Setting the Upper Limit and Lower Limit Values to OFF

1. When entering the upper limit and lower limit values, use ◄ to move left until the far left digit flashes and then press and hold ◄ for at least two seconds or use ► to move right until the far right digit flashes and then press and hold ► for at least two seconds.

   The display changes to "– – – – – –" and OFF is set.

2. Press ENTER to confirm the OFF setting.

## Canceling BIN Measurement Mode

In BIN measurement mode, press MODE.


The measurement mode LEDs light in the order of BIN → NORM, and then the unit switches to normal measurement mode.

## Performing BIN Measurement

Follow the procedure below to perform BIN measurement.

In normal measurement mode, press MODE twice.


The state becomes as follows (BIN measurement mode).

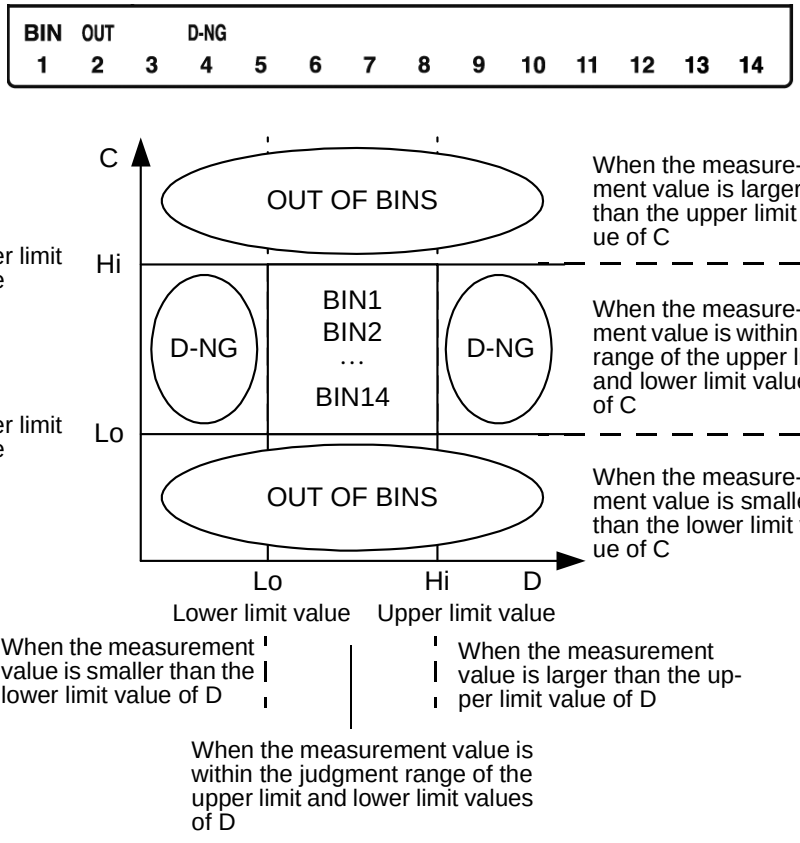
- The BIN LED lights up.
- For the deviation percent setting:
  The Δ% and REF or HI and LO LEDs light up.
  The BIN setting state is displayed in the SUB display area.
- For the count setting:
  COUNT, HI, and LO LEDs light up.
  The BIN setting state is displayed in the SUB display area.

NOTE

- You can use ▲ and ▼ to change the indications in the SUB display area.
- C Reference Value (only for the Δ% setting) ←→ BIN1 to 14 Upper Limit and Lower Limit Values ←→ D Reference Value (only for the Δ% setting) ←→ D Upper Limit and Lower Limit Values ←→ Display OFF ←→ C Reference Value …
- If both the upper limit and lower limit values have not be set for C and D, the BIN judgment automatically becomes OUT OF BINS.
- The measurement range is automatically set to HOLD.

### Displaying Judgment Results

Each of the judgment results is displayed in the BIN judgment result display area.



## Outputting Judgment Results

- Output the judgment result for BIN (BIN1 to 14, OUT OF BINS, and D-NG) from EXT.I/O.
  ❖6.1 "Measurement Using EXT I/O" (p. 81)
- The BIN judgment results (IN/NG) can be differentiated by beep tones.
  ❖5.1 "Setting Beep Tones" (p. 73)

NOTE

The unit checks whether or not a value falls within the range of the upper limit and lower limit values in order from the smallest BIN number, and displays the BIN number of the first range that the value falls within as the judgment result.

Except for the trigger setting, the measurement conditions cannot be changed in BIN measurement mode.

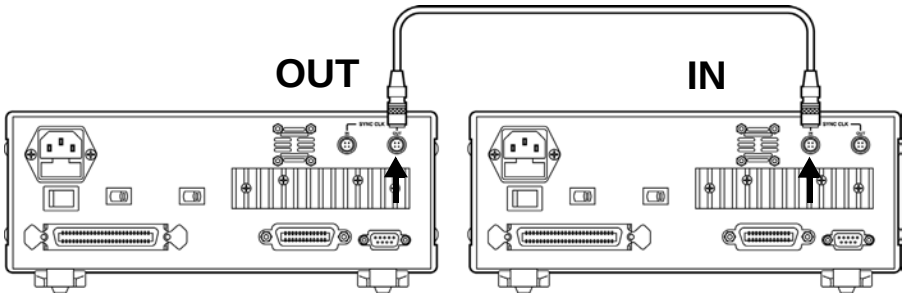
Press MODE to switch to normal measurement mode and then change the measurement conditions.

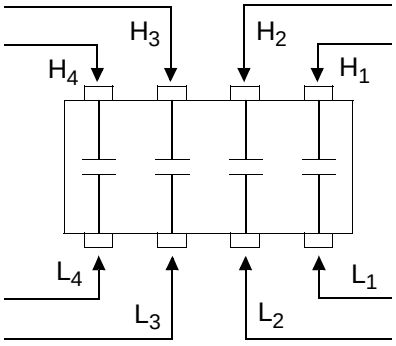
## Keys Enabled for Comparator Mode

| Key | Function |
|---|---|
| MODE | Switches the measurement mode. |
| SET | Switches to the setting modes for the upper limit and lower limit values. |
| TRIG | Switches the trigger setting to INT/EXT. |
| MANU TRIG | This key is only enabled when the trigger setting is EXT. One measurement is performed each time the key is pressed. |
| MENU | Menu items other than “JudGE,” “bEEP_J,” “CLK” (only for special specifications), and “SynC” can be set.<br>For functions that cannot be set, the “– – – –” indication is displayed at the bottom of the MAIN display area.<br>(Set “JudGE,” “bEEP_J,” “CLK” (only for special specifications), and “SynC” in normal measurement mode.) |
| LOCK/LOCAL | Changes the keylock function and cancels the remote state. |

# 4.3 Synchronous Measurement Function (3504 special specification)

This function reduces differences in measurement values caused by interference when using multiple 3504 units for measurement.
Use the 9679 Connection Cable to connect the phase synchronization connector of this unit to that of another 3504 unit and set the same conditions for the measurement signals and frequencies of each of the units.




## Configuration

**1.** In normal measurement mode, press MENU.

The menu items are displayed at the top of the MAIN display area and the settings for the menu items are displayed at the bottom of the MAIN display area.

NOTE

- This setting cannot be changed in comparator mode and BIN mode.
- Use ◀ and ▶ to move through the menu items as follows.
  “LoAd_A(C/h)” ←→ “SAVE” ←→ “Ld_tYP” ←→ “JudGE” ←→ “bEEP_J” ←→ “bEEP_K” ←→ “CLK” (only for special specifications) ←→ “SYnC” ←→ “IF.GPib(rS/Prnt)” ←→ “LoAd_A(C/h)” ←→ …

2. Use ◀ or ▶ to select the “CLK” menu item. (Synchronous measurement function setting screen)

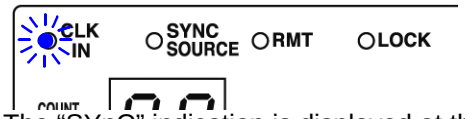
The setting items are as follows.

| |
|---|
| “out”: Master setting (state when using as a standalone unit) |
| “in”: Slave setting |

3. Use ▲ or ▼ to select a setting item.
Pressing ▲ or ▼ switches between “out” ←→ “in.”

4. Press ENTER.

The synchronous measurement function setting is confirmed.
When the slave setting is set, the CLK IN LED lights up.




The “SYnC” indication is displayed at the top of the MAIN display area. (Trigger synchronization output function setting screen)

NOTE The synchronous measurement function setting is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to normal measurement mode.

NOTE A 3504 unit set to slave cannot be used as a standalone unit for measurement.
The measurement value “– – – – – –” is displayed, and the comparator judgment becomes HI and the BIN judgment becomes OUT OF BINS.

## Using the Synchronous Measurement Function

1. Set the master and slave.
2. Turn off all the 3504 units.
3. Use a 9679 Connection Cable (option) to connect the SYNC CLK OUT connector on the rear panel of a 3504 unit set to master and the SYNC CLK IN connector on the rear panel of a 3504 unit set to slave.
4. Turn on the 3504 unit set to slave.
5. Turn on the 3504 unit set to master.

NOTE
- If the 3504 units are turned on in the wrong order, the 3504 unit set to slave will not work properly.
- When changing the frequency, first change the frequency on the 3504 that was set as the slave unit.

# 4.4 Trigger Synchronous Output Function

This function enables the measurement signal to be output after measurement is triggered and ensures that the signal is applied to the sample only during measurement. Thus reducing the generation of heat in the sample and decreasing electrode wear.

## Setting the Trigger Synchronous Output Function

1. In normal measurement mode, press [MENU].

   The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE

- This setting cannot be changed in comparator mode and BIN mode.
- Use ◄ and ► to move through the menu items as follows.
  “LoAd_A(C/h)” ←→ “SAVE” ←→ “Ld_tYP” ←→ “JudGE” ←→ “bEEP_J” ←→ “bEEP_K” ←→ “CLK” (only for special specifications) ←→ “SYnC” ←→ “IF.GPib(rS/Prnt)” ←→ “LoAd_A(C/h)” ←→ …

2. Use ◄ or ► to select the “SYnC” menu item. (Trigger synchronous output function setting screen)

   The setting items are as follows.

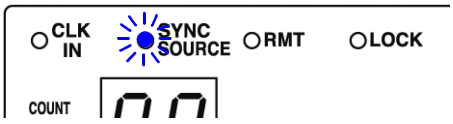
| |
|---|
| “on”: Sets the trigger synchronous output function to ON |
| “oFF”: Sets the trigger synchronous output function to OFF |

3. Use ▲ or ▼ to select a setting item.

   Pressing ▲ or ▼ switches between “on” ←→ “oFF.”

4. Press [ENTER].

   The trigger synchronous output function setting is confirmed.
   When the trigger synchronous output function is set, the SYNC SOURCE LED lights up.




   After confirmation, “IF.GPib(rS/Prnt)” is displayed at the top of the MAIN display area. (Interface setting screen)

NOTE

The trigger synchronous output function setting is not confirmed unless [ENTER] is pressed.

5. Press MENU.

The unit returns to normal measurement mode.

NOTE

- Only use this function within the constant voltage measurement range. If it used outside the constant voltage measurement range, accurate values will not be displayed.
  ❖3.3.3 "Measurement Signal Level" (p. 26)
- When the trigger synchronous output function is set to ON, there is a measurement time delay because the unit enters a wait time which spans from when the measurement signal is output to when measurement starts.
- The wait time can be set from a PC. (At the time of shipment, the wait time is 2 ms when 1 kHz and 10 ms when 120 Hz.)
  Set the optimal wait time for the DUT (device under test).
  A wait time that is too short may increase measurement errors and display differences.
  ❖6.1.3 "About Input and Output Signals" (p. 84)

# 4.5 Keylock Function

If the keylock function is set, the keys on the front panel are disabled. This function enables you to protect your setup.

## Setting the Keylock

Press and hold [LOCK/LOCAL] for at least two seconds.

The LOCK LED of the SUB display area lights up.

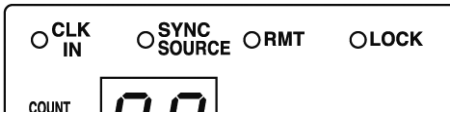

NOTE

- All the keys except [MANU TRIG] are locked.
- The following tasks can still be performed when the keylock is set.
  In the case of external triggers: Manual triggering is possible.
  In the case of internal triggers: When the interface is a printer, the measurement values can be output to the printer.
- The keylock can be set in normal measurement mode, comparator measurement mode, and BIN measurement mode (only for 3504).

## Canceling the Keylock

Press and hold [LOCK/LOCAL] for at least two seconds.

The LOCK LED goes out and the keylock function is canceled.




NOTE

Turning off the power does not cancel the keylock function.

# 4.6 Panel Save Function

- The current measurement conditions can be saved to internal memory. Up to 99 panels (99 sets) of measurement conditions can be saved.
- When the panel save function is used, the measurement mode and all of the measurement conditions are saved. The saved values include comparator and BIN (only for 3504) upper limit and lower limit values and the open circuit, short circuit, and load compensation values.
- Use the panel load function to load saved measurement conditions.

❖ 4.7 "Panel Load Function" (p. 66)

## Saving Panels

**1.** Press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

**NOTE**

Use ◄ and ► to move through the menu items as follows.
"LoAd_A(C/h)" ←→ "SAVE" ←→ "Ld_tYP" ←→ "JudGE" ←→ "bEEP_J" ←→ "bEEP_K" ←→ "CLK" (only for special specifications) ←→ "SYnC" ←→ "IF.GPib(rS/Prnt)" ←→ "LoAd_A(C/h)" ←→ …

**2.** Use ◄ or ► to select the "SAVE" menu item. (Panel save function setting screen).

The state becomes as follows.

A panel number that has not been saved lights up at the bottom of the MAIN display area. (At the time of shipment: "01")
(If all panels have not been saved, the "01" indication is displayed.)

**3.** Use the numeric keypad or ▲ and ▼ to select the panel number to save.

The numbers 01 to 99 can be set.
Panel numbers already in use flash. To overwrite a panel number, select the panel number to overwrite.

**4.** Press ENTER to save the measurement conditions.

The unit returns to the measurement mode it was in prior to the menu items being displayed.

**NOTE**

- The panel is not saved unless ENTER is pressed.
- The lifespan of the backup battery for internal memory is approximately six years under normal use.
- Measurement conditions can no longer be saved after the life of the battery runs out. When this happens, submit a request for the battery to be replaced by our repair service personnel. (A fee will be charged.)

# 4.7 Panel Load Function

The saved measurement values and compensation values can be loaded from internal memory.

First, set the load condition.
There are the following three load conditions.

- All
  Loads the measurement conditions (frequency, level, range, upper limit and lower limit values, etc.) and the open circuit, short circuit, and load compensation values.
- Compensation values
  Loads the open circuit, short circuit, and load compensation values.
- Measurement conditions
  Loads the measurement conditions (frequency, level, range, upper limit and lower limit values, etc.).

## Setting the Load Condition

1. Press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE

Use ◄ and ► to move through the menu items as follows.
“LoAd_A(C/h)” ←→ “SAVE” ←→ “Ld_tYP” ←→ “JudGE” ←→ “bEEP_J” ←→ “bEEP_K” ←→ “CLK” (only for special specifications) ←→ “SYnC” ←→ “IF.GPib(rS/Prnt)” ←→ “LoAd_A(C/h)” ←→ …

2. Use ◄ or ► to select the “Ld_tYP” menu item. (Load condition setting screen).

The setting items are as follows.

- “ALL”: Loads the measurement conditions (frequency, level, range, upper limit and lower limit values, etc.) and the open circuit, short circuit, and load compensation values.
- “Corr”: Loads the open circuit, short circuit, and load compensation values.
- “hArd”: Loads the measurement conditions (frequency, level, range, upper limit and lower limit values, etc.).

3. Use ▲ and ▼ to select a setting item.

Pressing ▲ or ▼ switches between “ALL” ←→ “Corr” ←→ “hArd” ←→ “ALL” …

4. Press ENTER.

The load condition setting is confirmed. The “JudGE” indication is displayed in the MAIN display area. (Judgment mode selection screen)

NOTE The load condition setting is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to the measurement mode it was in prior to the menu items being displayed.

## Loading Panels



1. Press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE Use ◄ and ► to move through the menu items as follows.
“LoAd_A(C/h)” ←→ “SAVE” ←→ “Ld_tYP” ←→ “JudGE” ←→ “bEEP_J” ←→ “bEEP_K” ←→ “CLK” (only for special specifications) ←→ “SYnC” ←→ “IF.GPib(rS/Prnt)” ←→ “LoAd_A(C/h)” ←→ …

2. Use ◄ or ► to select the “LoAd_A(C/h)” menu item. (Panel load screen)

There are three types of panel load screens.

- “LoAd_A” Loads the measurement conditions and the open circuit, short circuit, and load compensation values.
- “LoAd_C” Loads the open circuit, short circuit, and load compensation values.
- “LoAd_h” Loads the measurement conditions.

NOTE The panel load screen that is displayed differs depending on the load condition set in 4.6 "Panel Save Function" (p. 65). (Refer to the following table.)

❖ For details on changing the load condition setting, refer to "Setting the Load Condition" (page 66).

| Load Condition Setting | Panel Screen Displayed |
|---|---|
| **ALL** | "LoAd_A” |
| **Corr** | “LoAd_C” |
| **hArd** | “LoAd_h” |

**3.** Use the numeric keypad or ▲ and ▼ to select the panel number to load.

The number is entered at the bottom of the MAIN display area.

**NOTE**

- Only saved numbers can be set. If a number that was not saved with the numeric keypad is set, the set number flashes and then changes to the nearest saved number after one second elapses.
- At the time of shipment, when the unit has been reset, or at any other time when there are no measurement conditions saved, "– –" is displayed at the bottom of the MAIN display area.
- Each time a panel number is changed, the LED (in the operation area) for the measurement conditions of that panel number flashes.

**4.** Press ENTER to load the measurement conditions.

When the load condition is set to ALL (measurement conditions and compensation values) or hArd (measurement conditions), the unit switches to the saved measurement mode.
When the load condition is set to Corr (compensation values), the unit returns to the measurement mode it was in prior to the menu items being displayed.

**NOTE**

- The panel is not loaded unless ENTER is pressed.
- When loading a panel from EXT I/O, the wait time (the time from the trigger being input to the start of measurement) varies depending on the load condition.
  - •ALL: Approximately 300 ms
  - •Compensation values: Approximately 0.5 ms
  - •Measurement conditions: Approximately 300 ms

# 4.8 Printing Function

The optional 9442 Printer and 9444 Connection Cable can be used to print measurement values.

**WARNING**

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

## 4.8.1 Preparation Prior to Connecting the Printer



### Things to Prepare

- 9442 Printer (DPU-414 Seiko Instruments Inc.)
- 9443-01 AC Adapter (for Japan) (PW-4007-J1-E or PW-4007-JU1-E (power cord CB-JP01-18B-E), Seiko Instruments Inc.)
- 9443-02 AC Adapter (for EU) (PW-4007-E1-E, Seiko Instruments Inc.)
- 9443-03 AC Adapter (for USA) (PW-4007-U1-E, Seiko Instruments Inc.)
- 1196 Recording Paper
- 9444 Connection Cable (for connecting this unit and the printer)

### 9442 Printer Setup

The settings of the software DIP SW need to be changed to use the 9442 Printer with this unit.

**NOTE**

- At the time of shipment, the 9442 Printer is configured to be connected and used with the Hioki 3166 Clamp On Power HiTester. Be sure to change the settings of the software DIP SW.
- For details on handling the printer, be sure to careful read the instruction manual supplied with the printer.
- Use 1196 Recording Paper (thermal paper; 10 rolls per set) or the equivalent as the printer paper.

#### Procedure

1. Turn off power of the 9442 Printer.
2. Turn the power back on while holding down the ON LINE switch, and then let go of the switch when printing starts.

The current settings are printed.
The following is printed at the end of the printout.

```
Continue? :Push 'On-line SW'
Write?    :Push 'Paper feed SW'
```

3. Press the ON LINE switch to change the settings.
"Dip SW-1" is printed and the printer enters the configuration state for the software DIP SW1.

4. Set the switches numbered 1 to 8 of DIP SW1 to either ON or OFF in accordance with the table below.

Press the **ON LINE** switch once to set a switch to ON and the **FEED** switch once to set a switch to OFF.

You can confirm the input result that is printed each time a switch is pressed. If a setting is configured incorrectly, repeat the procedure from Step 1. (page 69).

is the setting to use with this unit.

**Software DIP SW1 Settings**

| Switch No. | Function | ON (Press ON LINE) | OFF (Press FEED) |
|---|---|---|---|
| 1 | Input method setting | Parallel | Serial |
| 2 | Print speed | Fast | Slow |
| 3 | Auto loading | Enable | Disable |
| 4 | CR function | Carriage return | Return |
| 5 | Setting command | Enable | Disable |
| 6 | Print density (set to 100%) | | OFF |
| 7 | | ON | |
| 8 | | ON | |

After you finish configuring the switch numbered 8, the following is printed again.

```
Continue? :Push 'On-line SW'
Write?    :Push 'Paper feed SW'
```

5. Press the ON LINE switch again so that the printer enters the configuration state and configure each of the settings for DIP SW2 and DIP SW3 as shown in the table below.

**Software DIP SW2 Settings**

| Switch No. | Function | ON (Press ON LINE) | OFF (Press FEED) |
|---|---|---|---|
| 1 | Print mode | Normal print (40 digits) | Reduced print (80 digits) |
| 2 | User-defined character backup | Enable | Disable |
| 3 | Character type | Normal characters | Special characters |
| 4 | Zero font | 0 | Ø |
| 5 | International characters | ON | |
| 6 | | ON | |
| 7 | | ON | |
| 8 | | ON | |

**Software DIP SW3 Settings**

| Switch No. | Function | ON (Press ON LINE) | OFF (Press FEED) |
|---|---|---|---|
| 1 | Data bit length | 8 bits | 7 bits |
| 2 | Use parity | No | Yes |
| 3 | Parity setting | Odd | Even |
| 4 | Control flow | H/W BUSY | XON/XOFF |
| 5 | Baud rate (Set to 19200 bps) | | OFF |
| 6 | | ON | |
| 7 | | ON | |
| 8 | | | OFF |

6. After you finish configuring the switch numbered 8 of DIP SW3, press either the ON LINE switch or the FEED switch to complete the setup.

The following is printed.

```
Dip SW setting complete!!
```



## 4.8.2 Connection Procedure

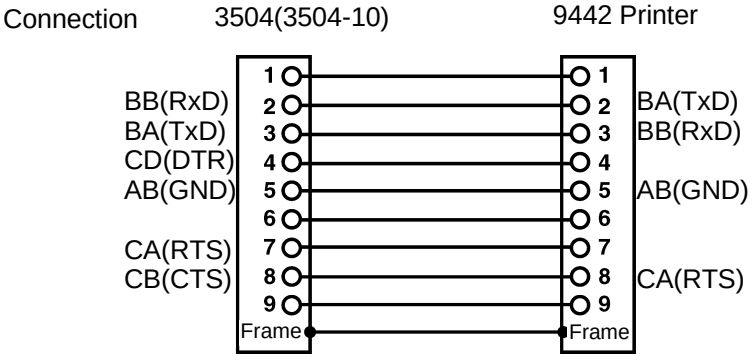
**WARNING**

**To avoid electric shock, be sure to turn off the power of the printer and unit before you connect or disconnect a cable.**

Connect the 9442 Printer to the RS-232C connector of the unit.
Configure the printer and unit beforehand.
❖ 7.3.2 "Setting the Interface Communication Conditions" (p. 96)

**Procedure**

1. Turn off the power of the 3504 (3504-10) unit and the 9442 Printer.
2. Connect the 9444 Connection Cable to the unit and the printer.



3. Turn on the power of the 3504 (3504-10) unit.

4. Turn on the power of the 9442 Printer.

NOTE

Turn on the power of the 3504 (3504-10) unit before you turn on the power of the 9442 Printer. If the 9442 Printer is on when you turn on the 3504 (3504-10) unit, undefined values may be sent from the 3504 (3504-10) unit because of BA(TxD) being unstable.

## 4.8.3 Printing

If MANU TRIG is pressed when an external trigger is set, the measurement values are output to the printer after measurement finishes.

If MANU TRIG is pressed when an internal trigger is set, the measurement values up until the time when the key is pressed are output to the printer.

**1. Example when performing normal measurement**

```
CP 100.034n F   |D  0.00041
CP 100.029n F   |D  0.00038
```

**2. Example when performing comparator measurement**

```
CP 100.052n F   HI|D  0.00050     HI
CP 100.047n F   IN|D  0.00045     IN
```

**3. Example when performing BIN measurement (only for 3504)**

```
CP 100.016n F   |D  0.00042      BIN1
CP 100.023n F   |D  0.00036      OUTB
```

Connecting a PC instead of the 9442 Printer enables you to receive the measurement values on the PC.
Set the RS-232C communication conditions on the PC as shown below.

- Bits per second: 19200
- Data bits: 8
- Parity: None
- Stop bits: 1

NOTE

Flow control is automatically set to Hardware (RTS/CTS control) if the interface used with the 3504 (3504-10) unit is a printer.

# Other Settings Chapter 5

## 5.1 Setting Beep Tones

### Setting the Beep Tone for Judgment Results of Comparator and BIN (only for 3504)

Any of following three settings is possible for the beep tone.

- A beep tone is not played.
- A beep tone plays when there is an IN judgment (AND) for both C and D during comparator measurement and a judgment corresponding to a BIN number during BIN measurement.
- A beep tone plays when there is a HI or LO judgment during comparator measurement and an OUT OF BINS or D-NG judgment during BIN measurement.

### Setting the Beep Tone for Key Operations



### 5.1.1 Setting the Beep Tone for Judgment Results of Comparator and BIN

1. In normal measurement mode, press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE

- This setting cannot be changed in comparator mode and BIN mode.
- Use ◀ and ▶ to move through the menu items as follows.
  “LoAd_A(C/h)” ↔ ”SAVE” ↔ ”Ld_tYP” ↔ ”JudGE” ↔ “bEEP_J” ↔ “bEEP_K” ↔ ”CLK” (only for special specifications) ↔ ”SYnC” ↔ ”IF.GPib(rS/Prnt)” ↔ “LoAd_A(C/h)” ↔ ...

2. Use ◀ or ▶ to select the "bEEP_J" menu item. (Beep tone setting screen for judgment results)

The setting items are as follows.

| | |
|---|---|
| "oFF" | : A beep tone is not played regardless of the judgment results. |
| "in" | : A beep tone plays when there is an IN judgment (AND) for both C and D during comparator measurement and a judgment corresponding to a BIN number during BIN measurement. |
| "nG" | : A beep tone plays when there is a HI or LO judgment during comparator measurement and an OUT OF BINS or D-NG judgment during BIN measurement. |

3. Use ▲ or ▼ to select a setting item.

Pressing ▲ or ▼ switches between “oFF”↔“in”↔“nG”↔“oFF”...

4. Press ENTER.

The beep tone setting for judgment results is confirmed. The "bEEP_K" indication is displayed in the MAIN display area. (Beep tone setting screen for key operations)

NOTE The beep tone setting for judgment results is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to normal measurement mode.

## 5.1.2 Setting the Beep Tone for Key Operations

1. Press MENU.

The menu items are displayed at the top of the MAIN display area and the setting items are displayed at the bottom of the MAIN display area.

NOTE Use ◀ and ▶ to move through the menu items as follows.
“LoAd_A(C/h)” ↔ ”SAVE” ↔ ”Ld_tYP” ↔ ”JudGE” ↔ “bEEP_J” ↔ “bEEP_K” ↔ ”CLK” (only for special specifications) ↔ ”SYnC” ↔ ”IF.GPib(rS/Prnt)” ↔ “LoAd_A(C/h)” ↔ ...

2. Use ◀ or ▶ to select the "bEEP_K" menu item. (Beep tone setting screen for judgment results)

The setting items are as follows.

| | |
|---|---|
| “on” | : A beep tone plays when a key operation is performed. |
| “oFF” | : A beep tone is not played when a key operation is performed |

3. Use ▲ or ▼ to select a setting item.

Pressing ▲ or ▼ switches between “on”↔“oFF”.

4. Press ENTER.

The beep tone setting for key operations is confirmed.

After confirmation, "CLK" is displayed at the top of the MAIN display area if there is a synchronous measurement function and "SYnC" (trigger synchronization output function setting screen) is displayed if there is no synchronous measurement function.

**NOTE**

The beep tone setting for key operations is not confirmed unless ENTER is pressed.

5. Press MENU.

The unit returns to the measurement mode it was in prior to the menu items being displayed.

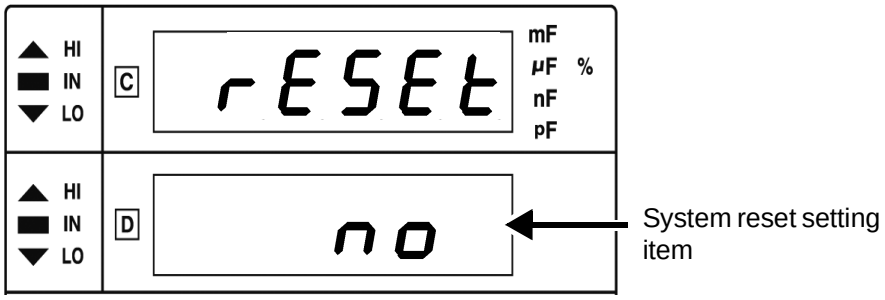
# 5.2 Performing a System Reset

Performing a system reset returns all the measurement conditions to their initial states at the time of shipment. These measurement conditions also include measurement conditions saved for panels.

## Reset Procedure

1. Turn the power of the unit off.
2. Turn the power back on while holding down [ENTER], and then let go of [ENTER] when the version information is displayed.

The version information is displayed for approximately 15 seconds after all LEDs light up. Then, the system reset setting is displayed.




3. Use  to set system reset while the indication is displayed.

| | |
|---|---|
| no | A system reset is not performed. |
| YES | A system reset is performed. |

4. Press [ENTER] to confirm the setting.

If a system reset is performed, all the measurement conditions are returned to their initial states at the time of shipment and the unit returns to normal measurement mode.

The initial settings at the time of shipment are as follows.

| | |
|---|---|
| Measurement Mode | Normal Measurement Mode |
| Measurement Frequency | 1 kHz |
| Measurement Signal Level | 1 V |
| Measurement Speed | NORMAL |
| Equivalent Circuit Mode | AUTO |
| Measurement Range | AUTO |
| Open Circuit Compensation | OFF |
| Open Circuit Compensation Value Output Parameter | ZPH |
| Short Circuit Compensation | OFF |
| Short Circuit Compensation Value Output Parameter | ZPH |
| Load Compensation | OFF<br>Reference Values (C,D)=(100000, 0) |
| Load Compensation Value Output Format | COEFficient |
| Trigger Mode | INT (Internal Trigger) |
| Header | ON |
| Trigger Synchronous Output Function | OFF |
| Lock Function | OFF |
| Beep Tone Setting | The key operation beep tone is ON and the comparator and BIN judgment results beep tone is OFF. |
| Panel Save | All conditions are cleared |
| Comparator | (1st/2nd Parameter)<br>Count Setting Value The upper limit and lower limit values are OFF.<br>Deviation Percent Setting Value<br>C reference value: 100000<br>D reference value: 0<br>The upper limit and lower limit values are OFF. |
| BIN (only for 3504) | (1st/2nd Parameter)<br>Count Setting Value The upper limit and lower limit values are OFF.<br>Deviation Percent Setting Value<br>C reference value: 100000<br>D reference value: 0<br>The upper limit and lower limit values are OFF. |
| Interface Setting | 3504 Interface :GP-IB<br>Address :1<br>Terminator :LF with EOI<br>3504-10 Interface :RS-232C<br>Baud Rate :9600 bps<br>Terminator :CR+LF |
| Reset EXT I/O Judgment Results | ON |

NOTE The settings of the RS-232C interface in the 3504 unit are initialized to 9600 bps for the baud rate and CR+LF for the terminator.

# 5.3 Countermeasures Against Incorporation of External Noise

The unit is designed not to malfunction as a result of noise incorporated from the probes, fixture, and power line. However, extremely large levels of noise may still cause measurement errors and malfunctions.

Refer to the following examples of countermeasures against noise when the unit malfunctions, etc

## 5.3.1 Countermeasures Against Incorporation of Noise from the Power Line

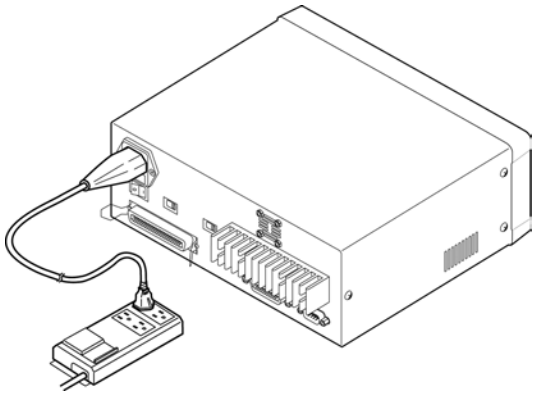
You can use the following countermeasures to reduce the effect of noise being incorporated from the power line.

### Grounding Using a Protective Ground Wire

The unit is structured so that the ground wire of the power cable can be used as protective grounding for the unit. Protective grounding plays an important role in not only the prevention of electrical accidents but also the use of an internal filter to eliminate the incorporation of noise from the power line.
Use the supplied power cord.

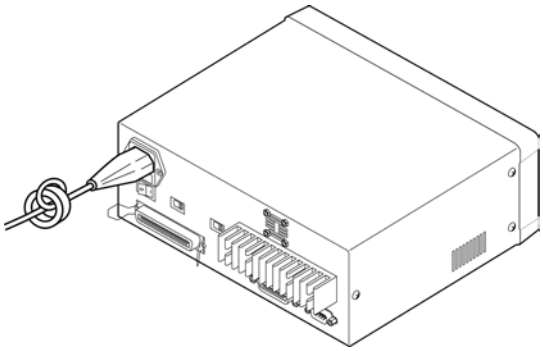
### Attaching a Noise Filter to the Power Line

Connect a commercial plug-in noise filter to the power outlet and then connect the unit to the output of the noise filter in order to suppress the incorporation of noise from the power line.
Plug-in noise filters are commercially available from various specialist manufacturers.



### Attaching an EMI Suppression Ferrite Core to the Power Cord

Pass the power cord through a commercially available EMI suppression ferrite core and secure the core as close as possible to the AC power inlet of the unit in order to suppress the incorporation of noise from the power line.
Suppression is even more effective if you also attach an EMI suppression ferrite core close to the power plug of the power source.
If a toroidal ferrite core or split ferrite core with a large enough internal diameter is used, the amount of noise suppression can be increased by passing the power cord through the core several times.
EMI ferrite cores and ferrite beads are commercially available from various specialist manufacturers.



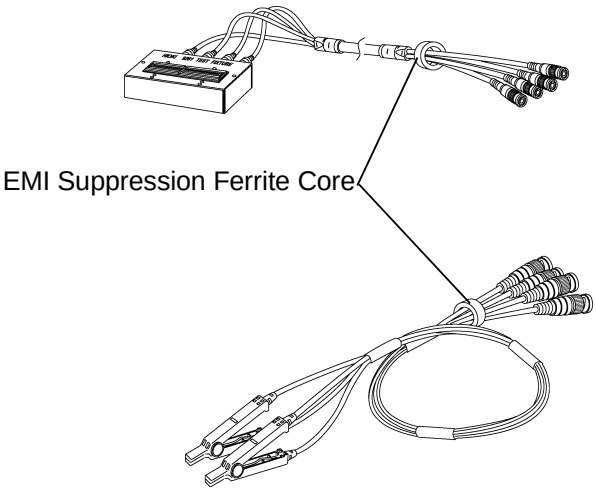


## 5.3.2 Countermeasures Against Incorporation of Noise from the Input Line (Types of Probe)

You can use the following countermeasures to reduce the effect of noise being incorporated from, for example, a probe or fixture.

### Attaching an EMI Suppression Ferrite Core to Commercial Cables

Noise from things like probes can be suppressed if you pass them through commercially available EMI suppression ferrite cores and secure the cores as close as possible to the measurement terminals. Furthermore, if large enough ferrite cores are used, the amount of noise suppression can be increased by passing things like probes through the cores several times in the same manner as with the power cord.



# Application Measurement Chapter 6

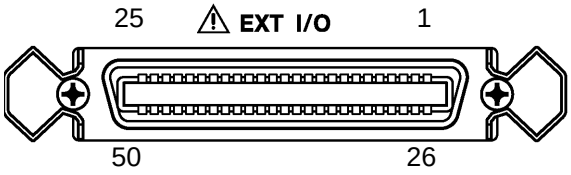
## 6.1 Measurement Using EXT I/O

### 6.1.1 About the EXT I/O Connector

The EXT I/O connector includes the following functions.

- Output signal for comparator result
- Output signal for BIN result (only for 3504)
- Output end of measurement signal (/EOM)
- Output analog end of measurement signal (/INDEX)
- Input external trigger signal
- Select the panel number to load

Connector Used DDK 57RE-40500-730B (D29)
Applicable Connector DDK 57-30500




#### EXT I/O Connector Terminal

| PIN No. | I/O | Signal Line Name | PIN No. | I/O | Signal Line Name |
|---|---|---|---|---|---|
| 1 | IN | /TRIG | 26 | IN | /LD0 |
| 2 | IN | /LD1 | 27 | IN | /LD2 |
| 3 | IN | /LD3 | 28 | IN | /LD4 |
| 4 | IN | /LD5 | 29 | IN | /LD6 |
| 5 | IN | /LD-VALID | 30 | OUT | /BIN1, /C-HI |
| 6 | OUT | /BIN2, /C-IN | 31 | OUT | /BIN3, /C-LO |
| 7 | OUT | /BIN4, /D-HI | 32 | OUT | /BIN5, /D-IN |
| 8 | OUT | /BIN6, /D-LO | 33 | OUT | /BIN7, /AND |
| 9 | OUT | /BIN8 | 34 | OUT | /BIN9 |
| 10 | OUT | /BIN10 | 35 | OUT | /BIN11 |
| 11 | OUT | /BIN12 | 36 | OUT | /BIN13 |
| 12 | OUT | /BIN14 | 37 | OUT | /OUT OF BINS |
| 13 | OUT | /INDEX | 38 | OUT | /EOM |
| 14 | OUT | /CV-ERR | 39 | OUT | /D-NG |
| 15 | - | Unused | 40 | - | Unused |
| 16 to 20 | IN | EXT DCV | 41 to 45 | OUT | INT DCV |
| 21 to 25 | IN | EXT COM | 46 to 50 | OUT | INT COM |

*The output of BIN results is only for 3504.

## EXT I/O Connector Signal Lines

NOTE All input and output signals other than the power signal are negative logic.

**$\overline{\text{TRIG}}$** If a negative logic signal is input in external trigger mode, a single measurement begins at the corresponding LOW level (100 µs or more).

NOTE This is not valid during analog measurement (during output of INDEX signal), even if a TRIG signal is input.

**$\overline{\text{LD0}}$Å`$\overline{\text{LD6}}$** Selects the number of the panel to load.
If a trigger signal is input in external trigger mode, the selected panel is loaded and used for measurement.

| Panel Number | /LD6 | /LD5 | /LD4 | /LD3 | /LD2 | /LD1 | /LD0 |
|---|---|---|---|---|---|---|---|
| Panel 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Panel 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Panel 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Panel 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Panel 16 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Panel 32 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Panel 64 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panel 99 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

**$\overline{\text{LD-VALID}}$** Inputs a negative logic signal from an external device so that the selected panel number is recognized as valid.

**$\overline{\text{C-HI}}$, $\overline{\text{C-IN}}$, $\overline{\text{C-LO}}$** Outputs the comparator judgment result for the measurement value of the first parameter (MAIN PARAMETER).

**$\overline{\text{D-HI}}$, $\overline{\text{D-IN}}$, $\overline{\text{D-LO}}$** Outputs the comparator judgment result for the measurement value of the second parameter (SUB PARAMETER).

**$\overline{\text{AND}}$** Outputs a result if the judgment result AND is obtained for the measurement value of the first parameter and the measurement value of the second parameter.
Outputs a result if both judgments results are IN or if one of either the first or second parameters was not judged but the judgment result of the judged parameter is IN.

**$\overline{\text{BIN1}}$ to $\overline{\text{BIN14}}$**
**$\overline{\text{OUT}}$ OF BINS**
**D-NG** Outputs judgment results for BIN measurement (only for 3504).

**/INDEX** This is the analog end of measurement signal. After this signal is set to ON (from the trailing edge), the sample can be changed.

**/EOM** This is the end of measurement signal.

**EXT DCV, EXT COM** This terminal supplies power from an external device. It enables an isolated connection to be established between the unit and an external device. The range of power voltages that can be connected is 5 to 24 V DC.

**INT DCV, INT COM** Outputs internal +5 V DC and internal COM of the unit.

**$\overline{\text{CV-ERR}}$** This outputs a signal when the voltages of both ends of the sample fall outside the ±10% range of the set voltage.

## 6.1.2 Circuit Configuration and Connections of the EXT I/O Connector

**⚠CAUTION**

- The range of power voltages that can be connected to the external DC power supply EXT DCV and EXT COM terminals is 5 to 24 V DC. Do not apply a voltage that exceeds +24 V DC. Doing so may damage the device. Connect a device with an output capacitance of at least 200 mA in order to drive the circuit.
- Signal lines are insulated to stop interference between signals. Be sure to use protective grounding for the connected device. Otherwise the insulation may be damaged.

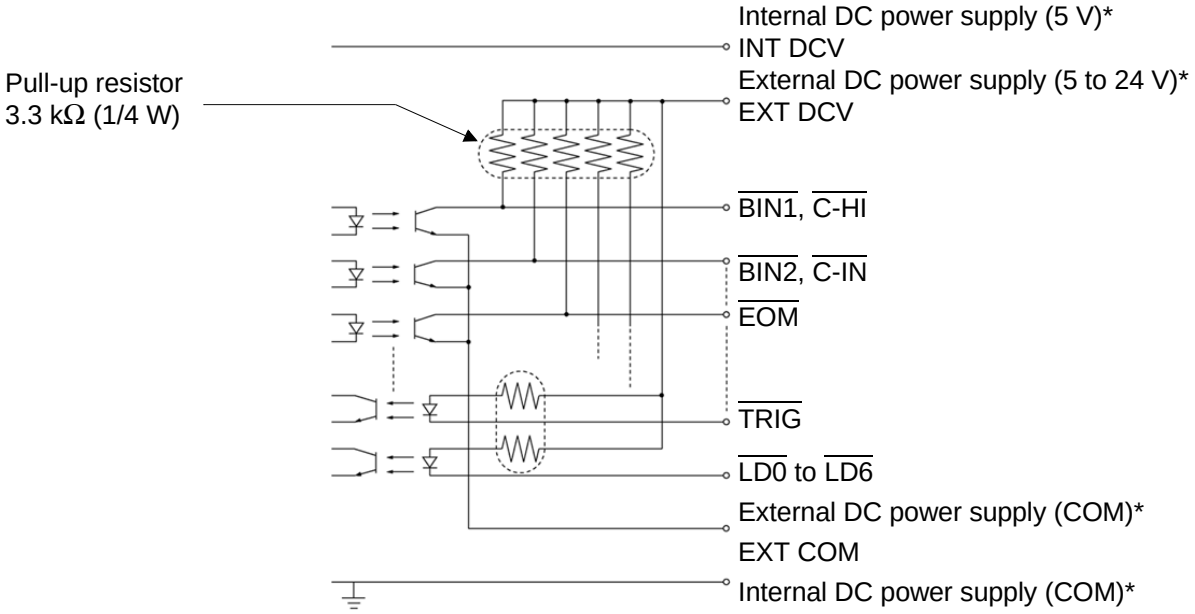
**NOTE**

- +5 V DC is output between the internal DC power supply INT DVC and INT COM. The maximum current capacity is 100 mA. Do not connect a circuit that consumes 100 mA or more to an external device.
- INT COM is connected to the case.
- The maximum low level output current of the output signal is 30 mA. When a current of more than 30 mA is required, connect, for example, a transistor circuit, which is capable of current amplification and run on an external power source, to the external device.

6

### Circuit Configuration

All input and output signal lines other than the power signal line are isolated by a photocoupler.




* A connection is possible when using an internal DC power supply voltage of 5 V.

# 6.1.3 About Input and Output Signals

## Electrical Characteristics of Output Signals

The output signals are photocoupler open collector output. Inside the unit, a 3.3 kΩ pull-up resistor is used to connect to the external DC power source (EXT DCV).

**Relation Between External DC Power Source Voltage and Output Signal Voltage/Current**

| External DC Power Source | Output Signal (Internal Pull-up Resistor of 3.3 kΩ) | | |
|---|---|---|---|
| | High Level | Low Level (Output Current) | |
| | | (10 mA) | (30 mA) |
| 5 | 5 | 0.9 V | 1.1 V |
| 12 | 12 | | |
| 24 | 24 | | |

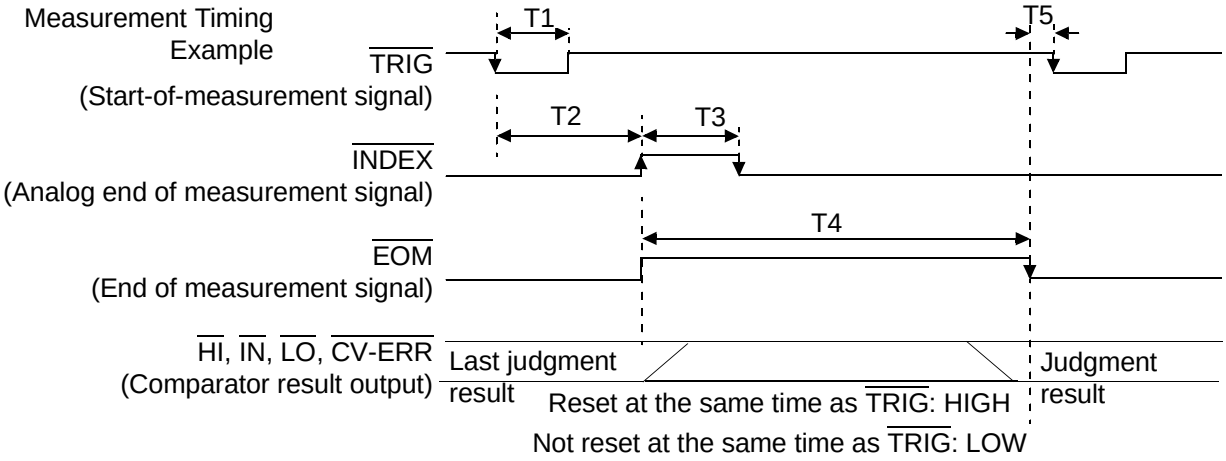
It is not possible to directly connect a circuit that has a maximum input voltage $V_{IL}$ of 0.8 V or more. Add a transistor and buffer circuit capable of driving so that the $V_{IL}$ becomes less than 0.8 V.

## Timing of Input Signals

Set the judgment conditions with the comparator and input a trigger signal from EXT I/O in that state. (The trigger setting is set to external trigger.)

If you press MANU TRIG, the judgment result is output from the EXT I/O comparator result output signal line.

Measurement Timing Example




NOTE

You can use a communication command to select whether the judgment results for comparator measurement and BIN measurement are reset when the start-of-measurement signal is input or updated when measurement ends.

| Symbol | Description | | Approximate Time |
|---|---|---|---|
| T1 | TRIG width (LOW) | : Trigger signal minimum time | 100 µs |
| T2 | From TRIG (LOW) to /INDEX (HIGH) | : Time from trigger to circuit response | 200 µs *1 |
| T3 | /INDEX width (HIGH) | : Minimum chuck time, switching chuck with /INDEX (LOW) is possible | 1 ms *2 |
| T4 | /EOM width (HIGH) | : Measurement time | 2.0 ms *2 |
| T5 | From /EOM width (LOW) to TRIG (LOW) to next trigger | : Minimum time from end of measurement | 0 s |

*1: When the range is 8 and there is no trigger input for at least 10 minutes at the external trigger, the response times may become 2 ms (1 kHz) and 8 ms (120 Hz).
When the panel number is being loaded by the panel load function, the response times become approximately 0.5 ms (loading compensation values) and approximately 300 ms (ALL, loading measurement conditions).
When the trigger synchronous output function is enabled, wait times are included. (The wait times at the time of shipment are approximately 2 ms [1 kHz] and 10 ms [120 Hz] and can be changed from a PC.)

*2: These reference values are when the measurement frequency is 1 kHz, the measurement speed is FAST, and the range is HOLD.

# 6.1.4 About Measurement Times

Measurement times differ depending on the measurement conditions. Refer to the following values.

NOTE

- All of the values are reference values. Note that they may differ depending on the conditions of use.
- A wait of 300 ms is included when the frequency, level, and range change.

## Analog Measurement Signal

### INDEX

The output time (**T3**) for an analog measurement signal (INDEX) depends on the measurement frequency and measurement speed as shown below. (When the range is HOLD.)

| Measurement Speed / Measurement Frequency | FAST | NORM | SLOW |
|---|---|---|---|
| | T3 (ms) | T3 (ms) | T3 (ms) |
| 120 Hz | 8.3 | 33.3 | 133.3 |
| 1 kHz | 1 | 4 | 24 |

(Allowable tolerance: ±5%±0.3 ms)

## End of Measurement Signal

### EOM

The output time (**T4**) for an end of measurement signal (EOM) can be obtained by the following equation.

**T4 = A + B + C + D**

**A** These measurement times are for when the unit is in normal measurement mode and not performing open circuit and short circuit compensation, and when the range is HOLD.

| Measurement Frequency | Measurement Speed | | |
|---|---|---|---|
| | FAST (ms) | NORM (ms) | SLOW (ms) |
| 120 Hz | 10.0 | 37.5 | 146.0 |
| 1 kHz | 2.0 | 5.5 | 29.5 |

(Allowable tolerance: ±5%±0.5 ms)

**B** The calculation time differs depending on whether or not there is open circuit, short circuit, or load compensation

| Open Circuit and Short Circuit Compensation | (ms) |
|---|---|
| No | 0.0 |
| Yes | Max. 0.4 Each |

**C** The calculation time differs if comparator is executed.

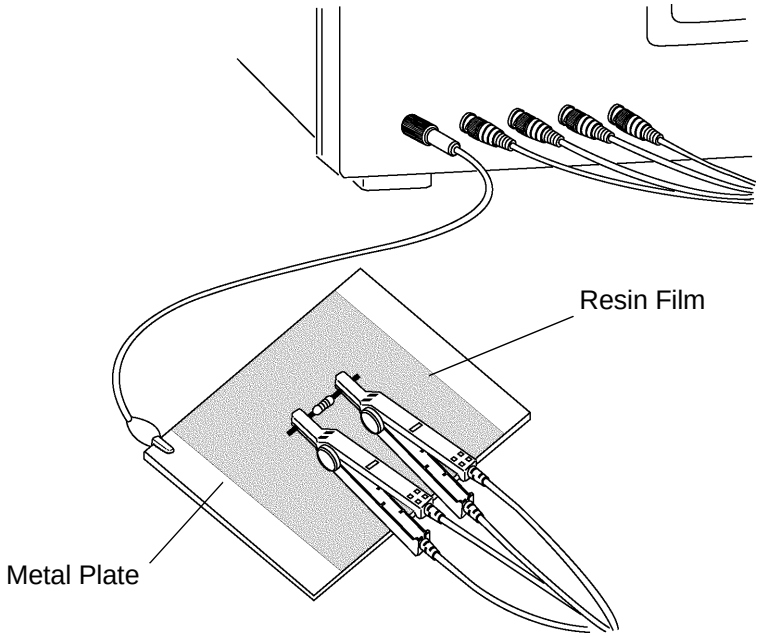
| Measurement Mode | (ms) |
|---|---|
| Normal Measurement Mode | 0.0 |
| Comparator Measurement Mode | MAX 0.4 |

**D** The calculation time differs if BIN is executed. (Only for 3504.)

| Measurement Mode | (ms) |
|---|---|
| Normal Measurement Mode | 0.0 |
| BIN Measurement Mode | MAX 0.4 |

# 6.2 Measurement of High Impedance Components

Since high impedance components (for example, capacitors of 1 μF or less) are susceptible to things like external induction noise, measurement values may become unstable. When this happens, stable measurement can be performed by measuring components on a metal plate connected to the GUARD terminal (shielding process).



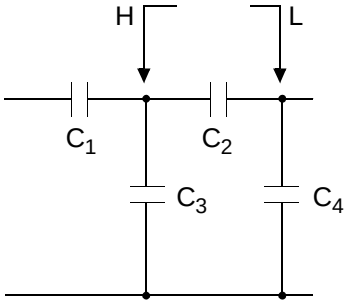

When measuring components on a metal plate, use, for example, resin film as insulation to ensure terminals and the like are not short-circuited.
Open circuit compensation is high impedance measurement, so be sure to use the shielding process. If it is not used, the compensation values may become unstable and affect the measurement values.

# 6.3 Measurement of In-circuit Components

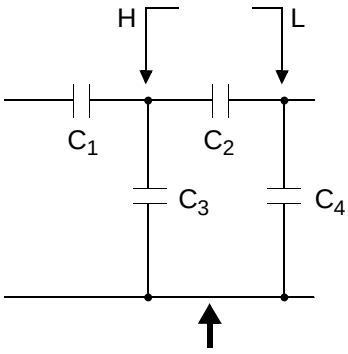
## 6.3.1 Measurement Using Guarding Technique

Measure an in-circuit component after providing guarding.

$$C = C_2 + \frac{C_3 \times C_4}{C_3 + C_4}$$




When measuring the capacitance of capacitor $C_2$ as shown in the diagram, measure the parallel capacitance by adding up the value of the current that flows through capacitor $C_2$ and the values of the current that flows through capacitors $C_3$ and $C_4$, after the probes are connected to both sides of capacitor C2.

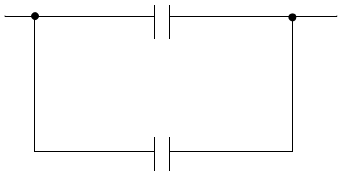



To guard terminal

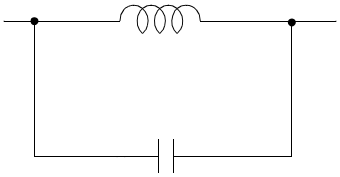
If you use a guard terminal as shown in the diagram, however, the current does not flow through capacitor $C_4$ and the current that flows through capacitor $C_3$ is absorbed by the guard terminal so that you can measure the capacitance of capacitor $C_2$.

NOTE

- However, if, for example, the capacitance of $C_2$ is less than that of $C_3$ ($C_2 << C_3$), this technique does not improve measurement precision.
- When two capacitors or a capacitor and a coil are connected in parallel as shown in the diagram, you cannot measure each component separately.



Two capacitors connected in parallel

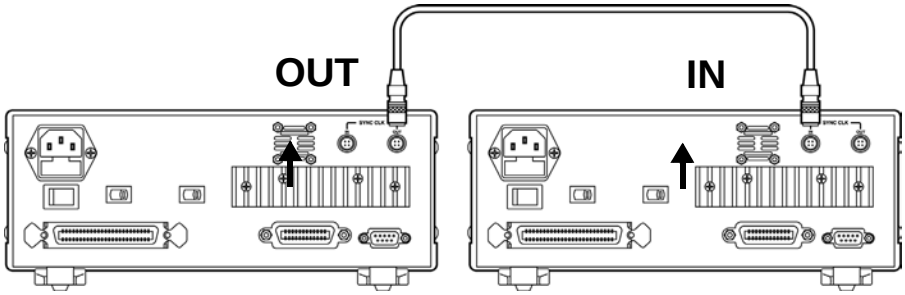


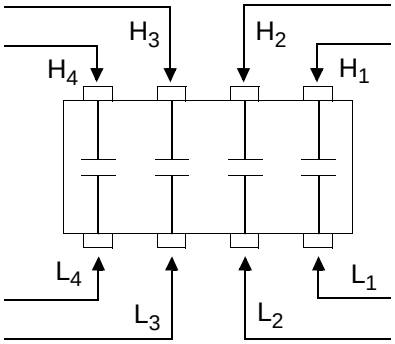
A coil and a capacitor connected in parallel

## 6.3.2 Synchronous Measurement

You can measure an in-circuit component using multiple 3504 (3504-10) units.
Configure the units for the state of synchronous measurement and set the measurement signal and frequency for each unit to the same conditions.

❖ Setting Procedure : 4.3 "Synchronous Measurement Function (3504 special specification)" (p. 60)



# Controlling the Unit from a PC Chapter 7

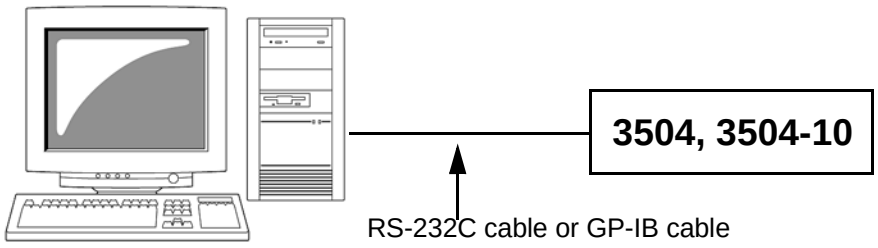
## About Marks

The following marks are used in this section to indicate whether a description applies to each of GP-IB and RS-232C. If no specific mark is shown, the description applies to both.

| | |
|---|---|
| GP-IB : | Only for GP-IB (only for 3504) |
| RS-232C : | Only for RS-232C |

## 7.1 Outline and Features

You can connect a PC to the unit via the GP-IB interface or RS-232C interface and control the unit from the PC.




- All functions other than the power switch can be controlled.
- The buzzer tone can be switched on and off.
- The system can be reset.

RS-232C

Measurement results can be printed if you connect an optional 9442 Printer to the unit.

❖ 4.8 "Printing Function" (p. 69)

GP-IB

- Use of the common commands of IEEE-488-2 1987 (required) is possible.
- This function is compliant with the following standard. : IEEE-488.1 1987
- This function was designed in reference to the following standard: IEEE-488.2 1987

# 7.2 Specifications

## 7.2.1 RS-232C Specifications

| | |
|---|---|
| Transmission Method | Communication method: Full duplex<br>Synchronous method: Start-stop synchronization |
| Transmission Speed | 9600 bps, 19200 bps |
| Data Bits | 8 bits |
| Parity | None |
| Stop Bits | 1 bit |
| Message Terminator (Delimiter) | CR+LF, CR |
| Flow Control | Hardware (RTS/CTS control), software (XON/XOFF control)<br>❖ "Handshake (About Buffer Flow Control)" (p. 92) |
| Electrical Specifications | Input voltage level<br>5 to 15 V ON<br>-15 to -5 V OFF<br><br>Output voltage level<br>5 to 9 V ON<br>-9 to -5 V OFF |

NOTE

If a PC is used to read data from the 3504 (3504-10) unit immediately after the power of the 3504 (3504-10) unit is turned on, undefined values may be read because of BA(TxD) being unstable. After turning the power on, wait at least six seconds before starting to read data.

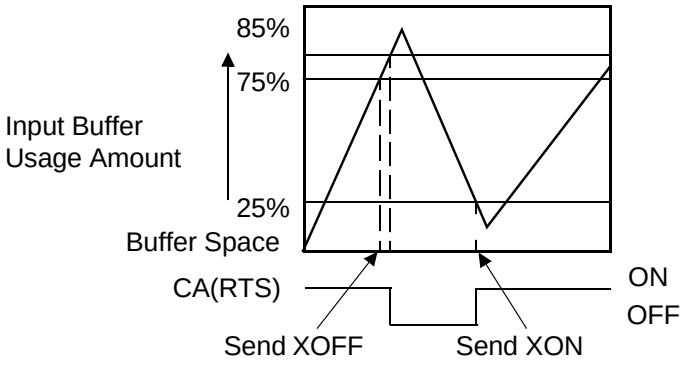
### Handshake (About Buffer Flow Control)

RS-232C

**Control during Receiving**

**When using hardware (RTS/CTS control):**
When the data in the receive buffer exceeds 85% of the buffer, CA(RTS) is set to OFF and the controller is notified that there is not much space remaining in the buffer.
Processing of the data in the buffer continues, and then CA(RTS) is set to ON and the controller is notified that there is sufficient remaining space in the buffer when the amount of data becomes less than 25%.

**When using software (XON/XOFF control):**
When the data in the receive buffer exceeds 75% of the buffer, XOFF(13H) is sent and the controller is notified that there is not much space remaining in the buffer.
Processing of the data in the buffer continues, and then XON(11H) is sent and the controller is notified that there is sufficient remaining space in the buffer when the amount of data becomes less than 25%.




**Control during Sending**

**When using hardware (RTS/CTS control):**
When CB(CTS) is confirmed to be OFF, the sending of data is halted. When it is confirmed to be ON, the sending of data is resumed.

**When using software (XON/XOFF control):**
When XOFF is received, the sending of data is halted. When XON is received, the sending of data is resumed.

## 7.2.2 GP-IB Specifications (Only for 3504)

### Interface Functions

| | |
|---|---|
| SH1 | Supports all source handshake functions. |
| AH1 | Supports all acceptor handshake functions. |
| T6 | Supports standard talker functions.<br>Supports serial poll functions.<br>Talk only mode is not supported.<br>Supports the talker cancel function by MLA (My Listen Address). |
| L4 | Supports standard listener functions.<br>Listener only mode is not supported.<br>Supports the listener cancel function by MTA (My Talk Address). |
| SR1 | Supports all service request functions. |
| RL1 | Supports all remote/local functions |
| PP0 | Parallel poll functions are not supported. |
| DC1 | Supports all device clear functions. |
| DT1 | Supports all device trigger functions. |
| C0 | Controller functions are not supported. |

Code used: ASCII code

# 7.3 Connection and Setting Procedures

## 7.3.1 Connecting the RS-232C Cable / GP-IB Cable

**⚠WARNING**

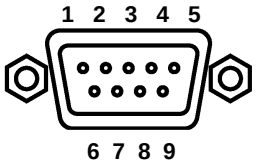
- **Always turn both devices OFF when connecting and disconnecting an interface connector. Otherwise, an electric shock accident may occur.**
- **To avoid damage to the unit, do not short-circuit the terminal and do not input voltage to the terminal.**

**⚠CAUTION**

After connecting the cable, be sure to secure the connector in place by tightening the screws.

### RS-232C Connector Pin Configuration

RS-232C




D-sub 9-pin male
M2.6 fixing screws

Connect the RS-232C cable.

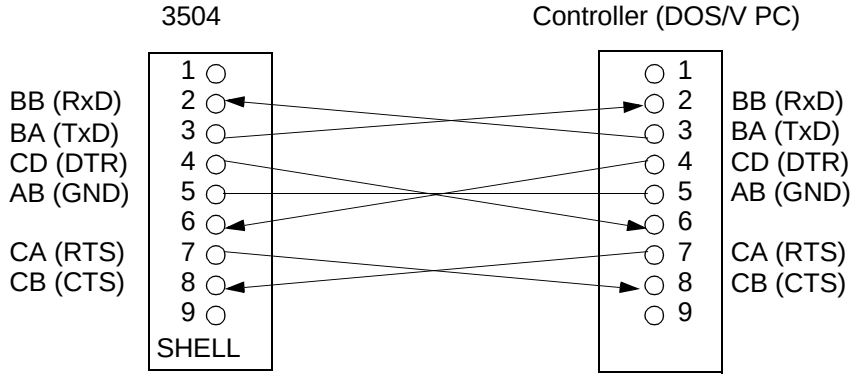
When connecting the controller (DTE), prepare a cross cable that meets the specifications of the connector of the unit and the connector of the controller

The input/output connector complies with the terminal (DTE) specifications.

| Connector (D-sub) Pin No. | Interchange Circuit Name | CCITT Circuit No. | EIA Abbreviation | JIS Abbreviation | Common Abbreviation |
|---|---|---|---|---|---|
| 1 | Unused | | | | |
| 2 | Received Data | 104 | BB | RD | RxD |
| 3 | Transmitted Data | 103 | BA | SD | TxD |
| 4 | Data Terminal Ready | 108/2 | CD | ER | DTR |
| 5 | Signal Ground | 102 | AB | SG | GND |
| 6 | Unused | | | | |
| 7 | Request to Send | 105 | CA | RS | RTS |
| 8 | Clear to Send | 106 | CB | CS | CTS |
| 9 | Unused | | | | |

## Example: Connecting to a DOS/V PC

Specification: D-sub 9-pin female and female connector, reverse connection

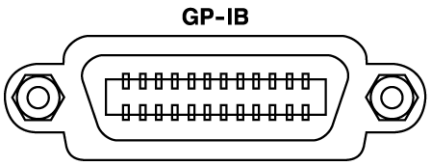



NOTE

Hardware control will not work properly if you use a cable that has CA(RTS) and CB(CTS) short-circuited.

## GP-IB Connector Pin Configuration (Only for 3504)

GP-IB




Connect the GP-IB cable.

Recommended Cables
9151-02 GP-IB Connector Cable (2 m)
9151-04 GP-IB Connector Cable (4 m)

7

# 7.3.2 Setting the Interface Communication Conditions

This section describes how to set the communication conditions for the interface used by the 3504 (3504-10) unit.
A GP-IB interface (only for 3504), RS-232C interface, and 9442 Printer can be set.

## Setting Procedure for Communication Conditions

**1. Press MENU.**

The menu items are displayed at the top of the MAIN display area and the settings for the menu items are displayed at the bottom of the MAIN display area.

NOTE

Use ◀ and ▶ to move through the menu items as follows.
"LoAd_A(C/h)" ↔ "SAVE" ↔ "Ld_tYP" ↔ "JudGE" ↔ "bEEP_J" ↔ "bEEP_K" ↔ "CLK" (only for special specifications) ↔ "SYnC" ↔ "IF.GPib(rS/Prnt)" ↔ "LoAd_A(C/h)" ↔ ...

**2. Use ◀ or ▶ to select the "IF.GPib(rS/Prnt)" menu item. (Communication condition setting screen)**

There are the following three types of communication condition setting screens.

- "IF.GPib" : For using the GP-IB interface (only for 3504)
- "IF. rS" : For using the RS-232C interface
- "IF.Prnt" : For using the 9442 Printer

**3. Use ▲ or ▼ to select one of the above items.**

Pressing ▲ or ▼ switches the display.

**4. Press ENTER.**

The interface type is confirmed.

NOTE

Selecting "IF.Print" completes the setup because there are no advanced setting items for this interface. After you complete the setup, "LoAd_A(C/h)" is displayed at the top of the MAIN display area. (Panel load screen)

## 5. Use ▲ or ▼ to select a setting item.

The setting items are configured as follows.

- If "IF.GPib" was selected (for using the GP-IB interface) (only for 3504):

1. Use the numeric keypad or ▲ and ▼ÇÝto set an address (0 to 30) and then press ENTER to confirm the address.
2. Use ▲ or ▼ to set the terminator.
   "LF" :LF with EOI
   "CrLF" :LF with CR+EOI
   (Pressing ▲ or ▼ switches between "LF"↔"CrLF".)

- If "IF. rS" was selected (for using the RS-232C interface):

1. Use ▲ or ▼ to set a baud rate (9600, 19200) and then press ENTER to confirm the baud rate.
2. Use ▲ or ▼ to set the terminator.
   "Cr" :CR
   "CrLF" :CR+LF
   (Pressing ▲ or ▼ switches between "Cr"↔"CrLF".)

## 6. Press ENTER.

The terminator is confirmed.
After confirmation, "LoAd_A(C/h)" is displayed at the top of the MAIN display area. (Panel load screen)

**NOTE** The interface communication conditions are not confirmed unless ENTER is pressed.

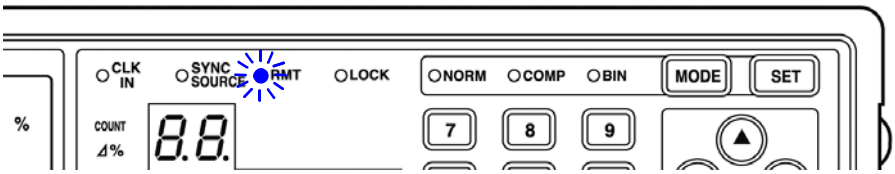
## 7. Press MENU.

The unit returns to the measurement mode it was in prior to the menu items being displayed.

# 7.4 Remote Function

When a connection is established to the interface and communication begins, the 3504 (3504-10) unit enters remote mode (remote control state) and the RMT LED lights up.

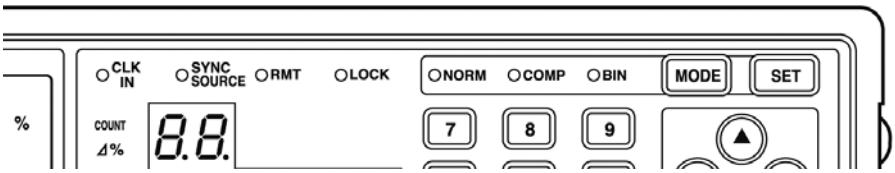
❖ Connecting to the interface: 7.3 "Connection and Setting Procedures" (p. 94)
❖ Starting communication: 7.5 "Communication Procedure" (p. 98)




The keys at the top of the front panel are disabled.

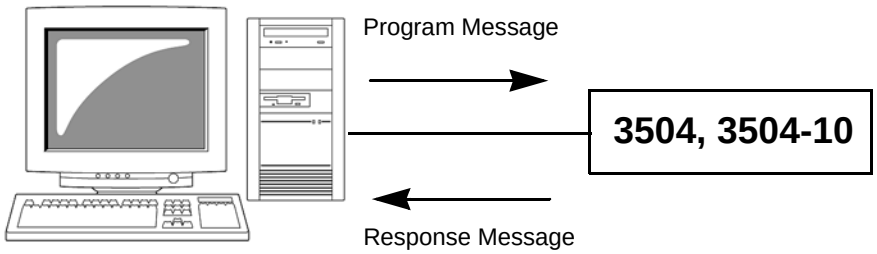
## Canceling Remote Mode

Press LOCK/LOCAL when you want to return to the normal state (local state).
The RMT LED goes out.

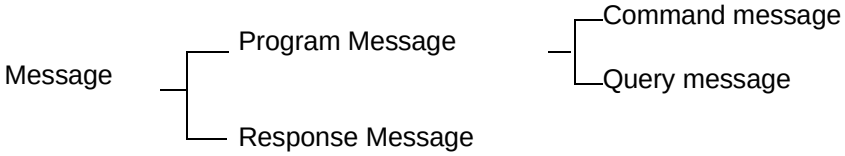



# 7.5 Communication Procedure

You can control the unit by sending messages from a PC to the unit via the interface
Program messages (⇒ p. 99) are sent from the PC to the unit and response messages(⇒ p. 99) are sent from the unit to the PC.




Messages are classified as follows.




NOTE

The term "command" appearing in the following explanations has the same meaning as "program message."

# 7.6 Things to Know before Beginning Communication

## 7.6.1 About Message Formats

### Program Messages

Program messages can be divided into command messages and query messages.

- Command Message
  A command for controlling the unit such as an instruction to configure a setting or reset the settings of the device.

  Example `:FREQUENCY 1000` (instruction for setting the frequency)

  Header Separator Data Section

- Query Message
  A command for finding out the results of operations, results of measurements, or the current configuration state of the device.

  Example `:FREQUENCY?` (instruction for finding out the set frequency)

  Header Question Mark

❖ For details:Header(page 100), Separator(page 101),Data Section(page 102)

### Response Message

A response message is created after the syntax of a received query message has been checked. The "HEADer" command can be used to select whether there is a header.

Header ON `:FREQUENCY 1000`
Header OFF `1000`
(The current frequency is 1 kHz.)

The header is set to ON when the power is turned on.
If some sort of error was generated when a query message was received, a response message is not created for the query message.
❖ About errors: See page 113.

## Command Syntax

Command names are selected for functions to be executed in a language that is as easy as possible to understand, and command names can also be shortened.
The unshortened form of a command name is known as the "long form" and the shortened form of a command name is know as the "short form." In this manual, uppercase characters are used for the short form part and lowercase characters are used for the remaining part. However, either uppercase or lowercase characters are acceptable.

| | |
|---|---|
| **FREQuency** | OK (long form) |
| **FREQ** | OK ((short form) |
| **FREQu** | Error |
| **FRE** | Error |

For response messages returned from the unit, uppercase characters and the long form are used.

## Header

The header indicates what is to be controlled. Program messages must have a header.

### (1) Command Program Headers

There are three types of headers: simple command, compound command, and common command.

- Simple Command Header
  Simple command headers contain a single word beginning with an alphabetic character.
  **:HEADer**

- Compound Command Header
  Compound command headers contain multiple simple command headers separated by colons (**:**).
  **:BEEPer:KEY**

- Common Command Header
  Common command headers begin with an asterisk (*****) to indicate the commands are common commands.
- (As specified in IEEE488.2)
  ***RST**

### (2) Query Program Header

This is used for finding out the results of operations performed in response to device commands, the results of measurements, or the current configuration state of the device. A program header is identified as a query if a question mark (**?**) is added at the end as shown in the example below.

**:FREQuency?**

## Message Terminator

A message terminator indicates the end of a command.
The unit accepts the following as message terminators.

GP-IB

- LF
- CR+LF
- EOI
- LF with EOI

RS-232C

- CR
- CR+LF

NOTE The 3504 (3504-10) unit analyzes a message after it has confirmed the message terminator.

Depending on the interface setting, the following can be selected as terminators of response messages.

GP-IB

- LF with EOI (initial state)
- LF with CR and EOI

RS-232C

- CR
- CR and LF (initial state)

## Separator

### (1) Message Unit Separator (Semicolon)

Semicolons are used as separators when executing compound messages. Linking multiple messages by semicolons (`;`) enables a single line to be used to describe a compound command.

```
:RANGe:AUTO ON;:BEEPer:KEY ON;*IDN?
```

If a command error occurs when messages are described in succession, the messages from the error to the terminator are not executed.

Example) If `:RAN:AUTO ON;:BEEPer:KEY ON;*IDN?` is executed and `:RAN:AUTO` is a command error, `:BEEPer:KEY ON;*IDN?` following the error will also not be executed

Command processing is continued for an execution error or a query error

❖ For details on errors: 7.6.4 "About Event Registers" (p. 107), and the error explanations in 7.7"Message List"; (Pages 112 to 120)

### (2) Message Unit Separator (Space)

A space is used as a separator to differentiate the header and data section. Add a space ( ) between the header and data section.

```
:LEVel 0.5
```

### (3) Message Unit Separator (Comma)

When a message has multiple data sections, a comma is used as a separator to differentiate data sections. Add a comma (`,`) between data sections.

```
:COMParator:FLIMit:COUNt 112345,123456
```

## Data Section

A data section indicates the content of a command. In the unit, character data and decimal numeric data are used for data sections, and use differs depending on the command.

### (1) Character Data

Character data begins with an alphanumeric character and consists of alphabetic characters and numbers. Both uppercase and lowercase characters are acceptable, but uppercase characters are always used for response messages from the unit.

```
:TRIGger INTernal
```

### (2) Decimal Numeric Data

There are three numeric data formats: NR1, NR2, and NR3. Both signed numeric and unsigned numeric values are acceptable for each of these formats. Unsigned numeric values are treated as positive numeric values.
Furthermore, if the accuracy of numeric values exceeds that capable of being handled by the unit, the numeric values are rounded off.

- NR1Integer data (Example: +12, -23, 34)
- NR2Fixed-point data (Example:+1.23, -23.45, 3.456)
- NR3Floating-point representation exponent data
  (Example:+1.0E-2, -2.3E+4)

The format that includes all three of the above types is referred to as the NRf format. The NRf format is accepted by the unit

For response data, the format is specified separately for each command and the data is sent in that format.

```
:RANGe 6
:LEVel 0.5
```

NOTE For commands with data, make every effort to enter the data in the specified format.

## Omitting Compound Command Headers

When compound commands contain common initial parts (example: **:BEEPer:KEY**, **:BEEPer:JUDGment**), the common initial part (example: **:BEEPer:**) can be omitted just for subsequent commands.
The common initial part is known as the "current path," and until cleared, the current paths of subsequent commands are determined to have been omitted when analysis is performed.
The following shows an example of the procedure for using current paths.

Normal expression

**:BEEPer:KEY ON;:BEEPer:JUDGment NG**

Expression with current path omitted

**:BEEPer:KEY ON;JUDGment NG**

This becomes the current path and can be omitted from subsequent commands.

The current path is cleared when the power is turned on, the interface type is changed, the device is cleared* (only for GP-IB), or upon detection of a colon (:) at the beginning of a command or a message terminator.
Common command messages can be executed regardless of the current path. Furthermore, the current path is not affected.
A colon does not need to be added to the beginning of simple and compound command headers. However, Hioki recommends adding a colon to the beginning of these headers to prevent them from being mixed up with headers that have omissions and to prevent an incorrect operation from being performed.

* Device Initialization

The current paths become as follows in the unit.

| |
|---|
| **:BEEPer:** |
| **:BIN:** (3504 only) |
| **:BIN:FLIMit:** (3504 only) |
| **:BIN:SLIMit:** (3504 only) |
| **:CIRCuit:** |
| **:COMParator:** |
| **:COMParator:FLIMit:** |
| **:COMParator:SLIMit:** |
| **:CORRection:** |
| **:CORRection:LOAD:** |
| **:JUDGment:** |
| **:LOAD:** |
| **:MEMory:** |
| **:RANGe:** |
| **:SSource:** |
| **:TRANsmit:** |
| **:USER:** |

# 7.6.2 About the Output Queue and Input Buffer

## Output Queue

The output queue is the area in the unit where response messages are stored. Stored response messages are cleared once they are read by the controller of the PC. The output queue is also cleared at the following times.

GP-IB

- The power is turned on
- The device is cleared*
- There is a query error

* The device is initialized

RS-232C

- The power is turned on

The output queue of the unit is 10 kB. If a response message exceeds this size, a query error is generated and the output buffer is cleared.
For GP-IB, the output queue is cleared and a query error is generated if a new message is received when there is data in the output queue.

## Input Buffer

The input buffer is the area in the unit where received data is stored. The input buffer is 10 kB. If data exceeding 10 kB was sent and the input buffer becomes full, the GP-IB interface bus enters a wait state until free space becomes available. RS-232C cannot receive data that exceeds 10 kB.

NOTE Keep the length of one command under 10 kB.

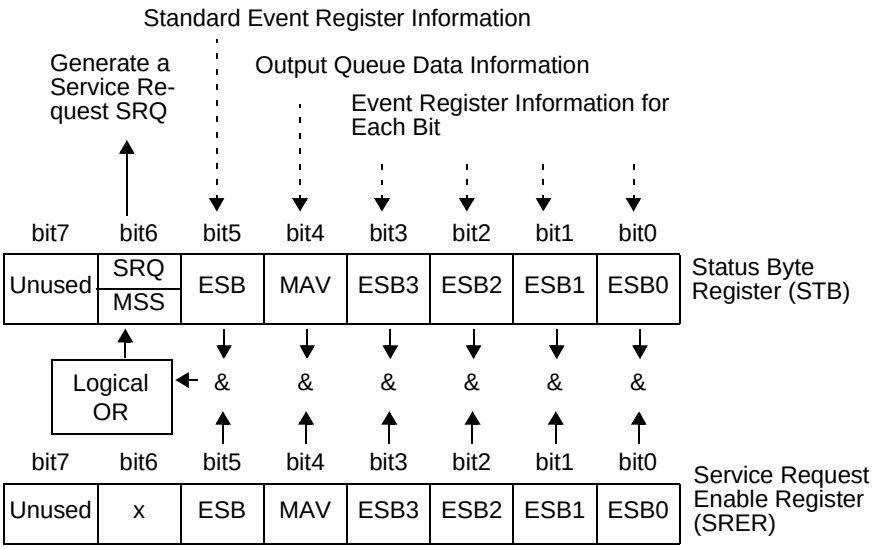
## 7.6.3 About the Status Byte Register

RS-232C

RS-232 reads the status bytes to find out the status of the unit.

GP-IB

The unit adopts the IEEE488.2 defined status model for parts related to the serial polling performed by the service request function. A trigger for generating a service request is called an event.




Conceptual Diagram of Generation of Service Request

The event register and output queue information is set in the status byte register. The service request enable register can be used to further select required items from this information. If the selected information is set, bit 6 (MMS master summary status bit) of the status byte register is set and an SRQ (service request) message is generated and used to generate a service request.

NOTE

For RS-232C, bit 4 (MAV message available) of the status byte register is not set.

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## Status Byte Register (STB)

A status byte register is an 8-bit register output from the unit to the controller during serial polling. If even one of the status byte register bits enabled by the service request enable register changes from "0" to "1," the MSS bit becomes 1. At the same time, the SRQ bit also becomes "1" and a service request is generated.

The SRQ bit is always synchronized with the service request and only read and simultaneously cleared upon being serial polled. The MSS bit is only read by an **"*STB?"** query and is not cleared until the event is cleared by a command such as a "***CLS**" command.

| | |
|---|---|
| Bit 7 | Unused |
| Bit 6<br>SRQ<br><br>MSS | This becomes 1 when a service request is sent.<br><br>This indicates logical OR of other bits of the status byte register. |
| Bit 5<br>ESB | Standard event summary (logical OR) bit<br>This indicates the logical OR of a standard event status register. |
| Bit 4<br>MAV | Message available<br>This indicates there is a message in the output queue. |
| Bit 3<br>ESB3 | Event summary (logical OR) bit 3<br>This indicates the logical OR of event status register 3. |
| Bit 2<br>ESB2 | Event summary (logical OR) bit 2<br>This indicates the logical OR of event status register 2. |
| Bit 1<br>ESB1 | Event summary (logical OR) bit 1<br>This indicates the logical OR of event status register 1. |
| Bit 0<br>ESB0 | Event summary (logical OR) bit 01<br>This indicates the logical OR of event status register 0. |

## Service Request Enable Register (SRER)

When the service request enable register is used to set each of the bits to "1," the corresponding bits are enabled in the status byte register.

# 7.6.4 About Event Registers

## Standard Event Status Register (SESR)

A standard event status register is an 8-bit register.

If even one of the standard status byte register bits enabled by the standard event status enable register becomes “1,” bit 5 (ESB) of the status byte register becomes 1.

❖ Standard Event Status Enable Register (SESER)(page 108)

The content of the standard event register is cleared at the following times.

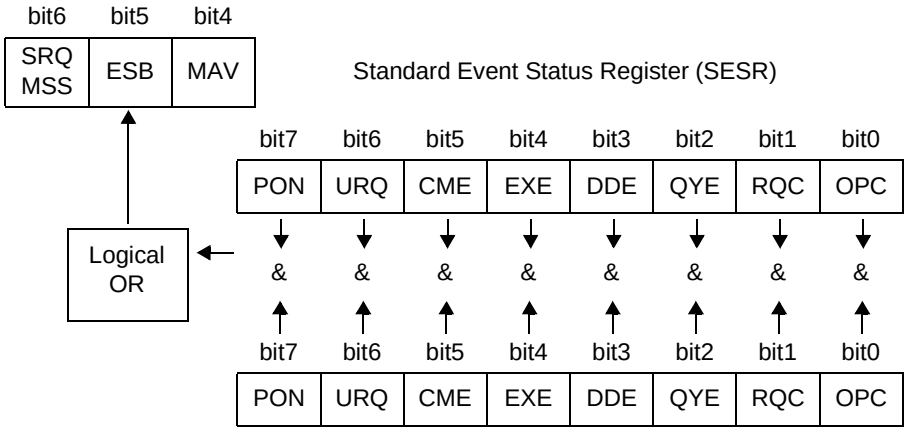
- The "***CLS"** command is executed.
- An event register query is executed (***ESR?**)
- The power is turned on again.

| Standard Event Status Register (SESR) | | |
|---|---|---|
| Bit 7 | PON | Power on flag<br>This becomes “1” when the power is turned on or the unit recovers from a power failure. |
| Bit 6 | URQ | User request<br>Unused |
| Bit 5 | CME | Command error (Commands up until the message terminator are ignored.)<br>This becomes "1" when there is an error with the syntax or meaning of a received command.<br>• When there is an error in the program header<br>• When the number of data items differs from that specified<br>• When the data format differs from that specified<br>• When a command not in the unit is received |
| Bit 4 | EXE | Execution error<br>This becomes "1" when a received command cannot be executed for some reason.<br>• When the specified data is outside the setting range<br>• When the specified data cannot be set<br>• When the command cannot be executed because another function is being used |
| Bit 3 | DDE | Device dependent error<br>This becomes "1" when a command cannot be cannot be executed for a reason other than a command error, query error, or execution error.<br>• When the command cannot be executed because there is an internal anomaly<br>• When data valid for open circuit, short circuit, or load compensation cannot be incorporated<br>• When the "i-ovEr Error" indication flashes in the MAIN display area |
| Bit 2 | QYE | Query error (Clears the output queue.)<br>This becomes "1" when a query error is detected by the controller of the output queue.<br>• When an attempt was made to read the output queue while it was empty (only for GP-IB)<br>• When there is an output queue overflow<br>• When data in the output queue is lost |
| Bit 1 | RQC | Request control<br>Unused |
| Bit 0 | OPC | End of operations<br>This becomes "1" when the operation complete "*OPC" command is executed.<br>• When operations for all messages up until the "*OPC" command have ended |

## Standard Event Status Enable Register (SESER)

When the standard event status enable register is used to set each of the bits to "1," the corresponding bits are enabled in the standard event status register.

Standard Event Status Register (SESR) and Standard Event Status Enable Register (SESER)




Standard Event Status Enable Register (SESER)

## Unique Event Status Registers (ESR0, ESR1, ESR2, ESR3)

Four event status registers have been provided for managing events in the unit. An event status register is an 8-bit register.

If even one of the event status register bits enabled by the event status enable register becomes "1," the corresponding bit becomes as follows.

- When event status register 0: Bit 0 (ESB0) of the status byte register becomes "1"
- When event status register 1: bit 1 (ESB1) becomes "1"
- When event status register 2: bit 2 (ESB2) becomes "1"
- When event status register 3: bit 3 (ESB3) becomes "1"

The content of event status register 0, 1, 2, and 3 is cleared at the following times.

- The "**`*CLS`**" command is executed.
- An event status register query is executed (**`:ESR0?,:ESR1?,:ESR2?,:ESR3?`**)
- The power is turned on again.

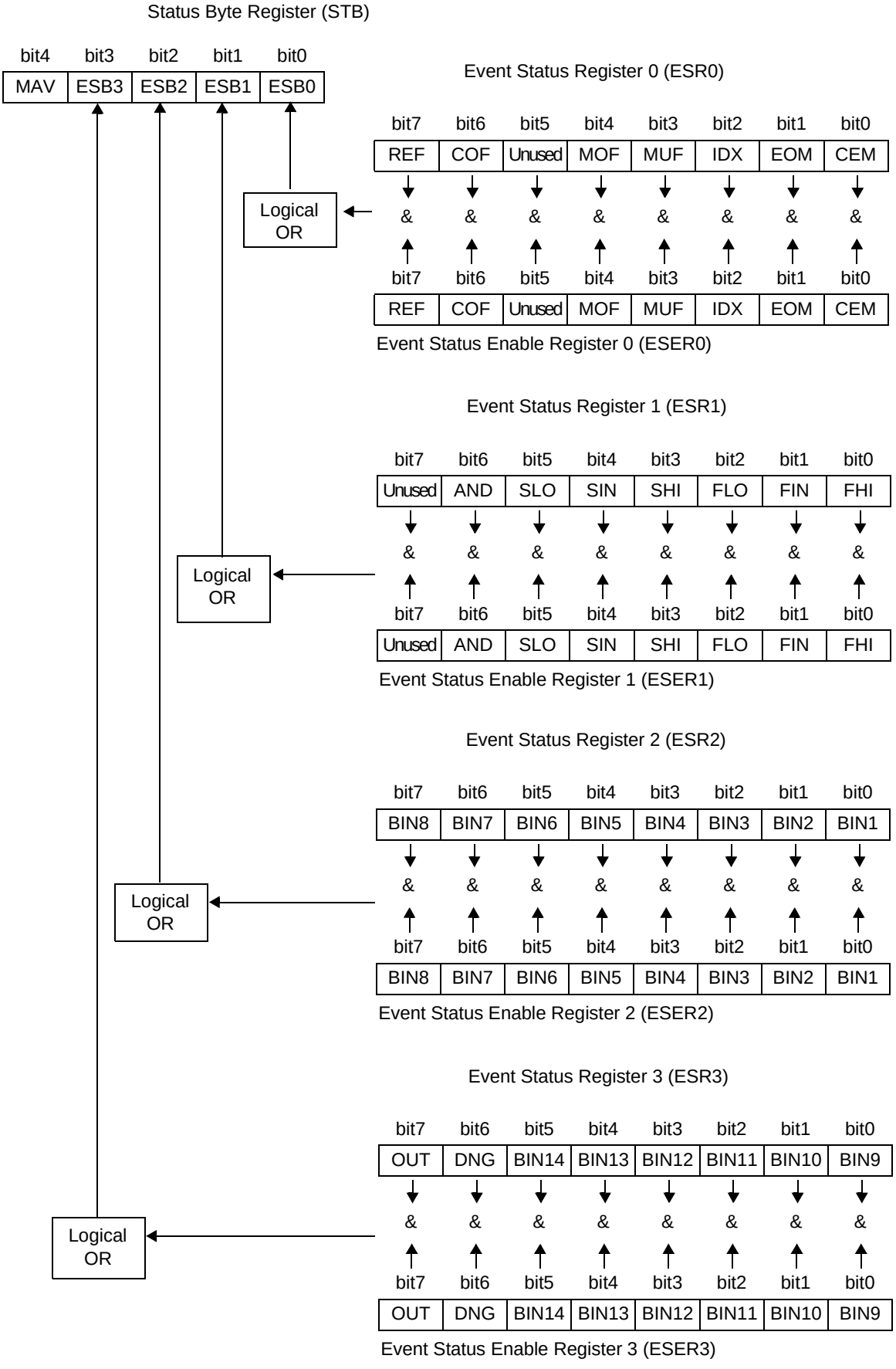
| Event Status Register 0 (ESR0) | | |
|---|---|---|
| Bit 7 | REF | Non-guaranteed accuracy bit |
| Bit 6 | COF | CV operation error bit |
| Bit 5 | | Unused |
| Bit 4 | MOF | First parameter over range bit |
| Bit 3 | MUF | First parameter under range bit |
| Bit 2 | IDX | Data incorporation end bit |
| Bit 1 | EOM | End of measurement bit |
| Bit 0 | CEM | End of compensation data measurement bit |

| Event Status Register 1 (ESR1) | | |
|---|---|---|
| Bit 7 | | Unused |
| Bit 6 | AND | Comparison result logical AND (AND of bit 1 and bit 4) |
| Bit 5 | SLO | Below lower limit value of second parameter |
| Bit 4 | SIN | Within range of second parameter |
| Bit 3 | SHI | Above upper limit of second parameter |
| Bit 2 | FLO | Below lower limit value of first parameter |
| Bit 1 | FIN | Within range of first parameter |
| Bit 0 | FHI | Above upper limit of first parameter |

| Event Status Register 2 (ESR2) | | |
|---|---|---|
| Bit 7 | BIN8 | Within range of BIN 8 |
| Bit 6 | BIN7 | Within range of BIN 7 |
| Bit 5 | BIN6 | Within range of BIN 6 |
| Bit 4 | BIN5 | Within range of BIN 5 |
| Bit 3 | BIN4 | Within range of BIN 4 |
| Bit 2 | BIN3 | Within range of BIN 3 |
| Bit 1 | BIN2 | Within range of BIN 2 |
| Bit 0 | BIN1 | Within range of BIN 1 |

| Event Status Register 3 (ESR3) | | |
|---|---|---|
| Bit 7 | DNG | Outside range of second parameter |
| Bit 6 | OUT | Outside range of BIN |
| Bit 5 | BIN14 | Within range of BIN 14 |
| Bit 4 | BIN13 | Within range of BIN 13 |
| Bit 3 | BIN12 | Within range of BIN 12 |
| Bit 2 | BIN11 | Within range of BIN 11 |
| Bit 1 | BIN10 | Within range of BIN 10 |
| Bit 0 | BIN9 | Within range of BIN 9 |

Event Status Register 0 (ESR0), 1 (ESR1), 2 (ESR2), and 3 (ESR3) and Event Status Enable Register 0 (ESER0), 1 (ESER1), 2 (ESER2), and 3 (ESER3)



## Reading and Writing of Each Register

| Register | Read | Write |
|---|---|---|
| Status Byte Register | ∗STB? | – |
| Service Request Enable Register | ∗SRE? | ∗SRE |
| Standard Event Status Register | ∗ESR? | – |
| Standard Event Status Enable Register | ∗ESE? | ∗ESE |
| Event Status Register 0 | :ESR0? | – |
| Event Status Enable Register 0 | :ESE0? | :ESE0 |
| Event Status Register 1 | :ESR1? | – |
| Event Status Enable Register 1 | :ESE1? | :ESE1 |
| Event Status Register 2 | :ESR2? | – |
| Event Status Enable Register 2 | :ESE2? | :ESE2 |
| Event Status Register 3 | :ESR3? | – |
| Event Status Enable Register 3 | :ESE3? | :ESE3 |

## GP-IB Command (Only for 3504)

The following commands can be used by interface functions.

| Command | Description | |
|---|---|---|
| GTL | Go To Local | Cancels the remote state and switches to the local state. |
| LLO | Local Lock Out | Disables all keys including LOCK/LOCAL. |
| DCL | Device CLear | Clears the input buffer and output queue. |
| SDC | Selected Device Clear | |
| GET | Group Execute Trigger | When there is an external trigger, performs the sampling process once. |

# 7.7 Message List

## Common Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| *CLS | | Clearing of the event register | *1, 3 | 127 |
| *ESE | Numeric values 0 to 255 (NR1) | Setting of the standard event status enable register | *3, 5 | 128 |
| *ESE? | | Query of standard event status enable register | *1, 2, 3 | 128 |
| *ESR? | | Query of standard event status register | *1, 2 | 128 |
| *IDN? | | Query of device ID | *1, 2, 3 | 125 |
| *OPC | | SRQ request when operation ends | *1 | 126 |
| *OPC? | | Query of operation end | *1, 2 | 126 |
| *RST | ———————— | Initialization of device | *1, 3 | 125 |
| *SRE | Numeric values 0 to 255 (NR1) | Setting of service request enable register | *3, 5 | 129 |
| *SRE? | | Query of service request enable register | *1, 2, 3 | 129 |
| *STB? | | Query of status byte register | *1, 2, 3 | 129 |
| *TRG | ———————— | Performing of sampling once | *1, 3, 4 | 130 |
| *TST? | | Query of self test and results | *1, 2, 3 | 126 |
| *WAI | ———————— | Wait | *1 | 127 |

Error Explanations (An error is generated when a message is executed in the following cases)
*1 Command Error ___ When there is data after a command or query
*2 Query Error _____ When a response message exceeds 10 kB
*3 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*4 Execution Error ____ When this command is executed while there is an internal trigger.
*5 Execution Error ____When set to other than the specified character data or numeric data.
Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| **Beep Tone** | | | | |
| :BEEPer:JUDGment | IN/ NG/ OFF | Setting of comparator and BIN measurement beep tone | *2,3,5 | 131 |
| :BEEPer:JUDGment? | | Query of comparator and BIN measurement beep tone | *1, 2 | 131 |
| :BEEPer:KEY | ON/ OFF | Setting of key input beep tone | *2, 3 | 131 |
| :BEEPer:KEY? | | Query of key input beep tone | *1, 2 | 131 |
| **BIN Function (Only for 3504)** | | | | |
| :BIN | ON/OFF | ON/OFF setting of BIN measurement | *2, 3 | 132 |
| :BIN? | | ON/OFF query of BIN measurement | *1, 2 | 132 |
| :BIN:DISPlay | Numeric value from 1 to 14 (NR1)/ D/ CREFerence/ DRFFer-ence/ OFF | Setting of the SUB display area indication during BIN measurement | *2,3,8 | 132 |
| :BIN:DISPlay? | | Query of the SUB display area indication during BIN measurement | *1, 2 | 132 |
| :BIN:FLIMit:COUNt | <BIN Number>, <Lower Limit Value>, <Upper Limit Value><br><BIN Number> = Numeric Value from 1 to 14 (NR1)<br><Lower Limit Value>, <Upper Limit Value><br>= OFF/ Numeric Value from 0 to 999999 (NR1) | Setting of upper limit and lower limit values of first parameter for BIN function in count value mode | *2, 3 | 133 |
| :BIN:FLIMit:COUNt? | <BIN Number> = Numeric Value from 1 to 14 (NR1) | Query of upper limit and lower limit values of first parameter for BIN function in count value mode | *1,2,3 | 133 |
| :BIN:FLIMit:DEViation | <BIN Number>, <Lower Limit Value>, <Upper Limit Value><br><BIN Number> = Numeric Value from 1 to 14 (NR1)<br><Lower Limit Value>, <Upper Limit Value><br>=OFF/ Numeric Value from -999.99 to 999.99 (NR2) | Setting of upper limit and lower limit values of first parameter for BIN function in deviation percent mode | *2, 3 | 134 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____ When a number that has not been saved is specified.
*5 Execution Error ____ When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____ When not even one measurement value is saved to memory.
*7 Execution Error ____ When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____ When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| :BIN:FLIMit:DEViation? | <BIN Number> = Numeric Value from 1 to 14 (NR1) | Query of upper limit and lower limit values of first parameter for BIN function in deviation percent mode | *1,2,3 | 134 |
| :BIN:FLIMit:REFerence | <Reference Value> = Numeric Value from 1 to 999999 (NR1) | Setting of reference values of first parameter for BIN function in deviation percent mode | *2, 3 | 135 |
| :BIN:FLIMit:REFerence? | | Query of reference values of first parameter for BIN function in deviation percent mode | *1, 2 | 135 |
| :BIN:SLIMit:COUNt | <Lower Limit Value>, <Upper Limit Value> <Lower Limit Value>, <Upper Limit Value> = OFF/ Numeric Value from 0 to 199000 (NR1) | Setting of upper limit and lower limit values of second parameter for BIN function in count value mode | *2, 3 | 135 |
| :BIN:SLIMit:COUNt? | | Query of upper limit and lower limit values of second parameter for BIN function in count value mode | *1, 2 | 135 |
| :BIN:SLIMit:DEViation | <Lower Limit Value>, <Upper Limit Value> <Lower Limit Value>, <Upper Limit Value> = OFF/ Numeric Value from -199000 to 199000 (NR1) | Setting of upper limit and lower limit values of second parameter for BIN function in deviation percent mode | *2, 3 | 136 |
| :BIN:SLIMit:DEViation? | | Query of upper limit and lower limit values of second parameter for BIN function in deviation percent mode | *1, 2 | 136 |
| :BIN:SLIMit:REFerence | <Reference Value> = Numeric Value from 0 to 199000 (NR1) | Setting of reference values of second parameter for BIN function in deviation percent mode | *2, 3 | 137 |
| :BIN:SLIMit:REFerence? | | Query of reference values of second parameter for BIN function in deviation percent mode | *1, 2 | 137 |
| **Equivalent Circuit** | | | | |
| :CIRCuit | SERial/ PARallel | Setting of equivalent circuit mode | *2,3,5 | 137 |
| :CIRCuit? | | Query of equivalent circuit mode | *1, 2 | 137 |
| :CIRCuit:AUTO | ON/ OFF | Automatic setting of equivalent circuit mode | *2,3,5 | 138 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____When a number that has not been saved is specified.
*5 Execution Error ____When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____When not even one measurement value is saved to memory.
*7 Execution Error ____When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| :CIRCuit:AUTO? | | Query of automatic setting of equivalent circuit mode | *1, 2 | 138 |
| **Comparator Function** | | | | |
| :COMParator | ON/ OFF | ON/OFF setting of comparator function | *2, 3 | 138 |
| :COMParator? | | ON/OFF query of comparator function | *1, 2 | 138 |
| :COMParator:DISPlay | C/ D/ CREFerence/ DREFerence/ OFF | Setting of the SUB display area indication during comparator measurement | *2,3,8 | 139 |
| :COMParator:DISPlay? | | Query of the SUB display area indication during comparator measurement | *1, 2 | 139 |
| :COMParator:FLIMit:COUNt | <Lower Limit Value>, <Upper Limit Value> OFF/Numeric Value from 0 to 999999 (NR1) | Setting of upper limit and lower limit values of first parameter for comparator function in count value mode | *2, 3 | 140 |
| :COMParator:FLIMit:COUNt? | | Query of upper limit and lower limit values of first parameter | *1, 2 | 140 |
| :COMParator:FLIMit:DEViation | <Reference Value>,<Lower Limit Value>, <Upper Limit Value> <Reference Value> = Numeric Value from 1 to 999999 (NR1) <Lower Limit Value>, <Upper Limit Value> = OFF/Numeric Value from -999.99 to 999.99 (NR2) | Setting of reference value and upper limit and lower limit values of first parameter for comparator function in deviation percent mode | *2, 3 | 141 |
| :COMParator:FLIMit:DEViation? | | Query of reference value and upper limit and lower limit values of first parameter for comparator function in deviation percent mode | *1, 2 | 141 |
| :COMParator:SLIMit:COUNt | <Lower Limit Value>, <Upper Limit Value> OFF/Numeric Value from 0 to 199000 (NR1) | Setting of upper limit and lower limit values of second parameter for comparator function in count value mode | *2, 3 | 142 |
| :COMParator:SLIMit:COUNt? | | Query of upper limit and lower limit values of second parameter for comparator function in count value mode | *1, 2 | 142 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____ When a number that has not been saved is specified.
*5 Execution Error ____ When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____ When not even one measurement value is saved to memory.
*7 Execution Error ____ When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____ When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| :COMParator:SLIMit:DEViation | <Reference Value>, <Lower Limit Value>, <Upper Limit Value><br><Reference Value> = Numeric Value from 0 to 199000 (NR1)<br><Lower Limit Value>, <Upper Limit Value><br>= OFF/Numeric Value from -199000 to 199000 (NR1) | Setting of reference value and upper limit and lower limit values of second parameter for comparator function in deviation percent mode | *2, 3 | 143 |
| :COMParator:SLIMit:DEViation? | | Query of reference value and upper limit and lower limit values of second parameter for comparator function in deviation percent mode | *1, 2 | 143 |
| **Open Circuit and Short Circuit Compensation** | | | | |
| :CORRection:DATA? | | Query of compensation values for open circuit and short circuit compensation | *1, 2 | 144 |
| :CORRection:OPEN | ALL/ ON/ OFF/RETurn | Setting of open circuit compensation function | *2,3,5 | 145 |
| :CORRection:OPEN? | | Query of open circuit compensation function | *1, 2 | 145 |
| :CORRection:OPEN:DATA :FORMat | ZPH/GB/CPG | Setting of output parameter for open circuit compensation values | *2, 3 | 147 |
| :CORRection:OPEN:DATA :FORMat? | | Query of output parameter for open circuit compensation values | *1, 2 | 147 |
| :CORRection:SHORt | ALL/ ON/ OFF/RETurn | Setting of short circuit compensation function | *2,3,5 | 148 |
| :CORRection:SHORt? | | Query of short circuit compensation function | *1, 2 | 148 |
| :CORRection:SHORt:DATA :FORMat | ZPH/RSX/LSRS | Setting of output parameter for short circuit compensation values | *2, 3 | 149 |
| :CORRection:SHORt:DATA :FORMat? | | Query of output parameter for short circuit compensation values | *1, 2 | 149 |
| **Load Compensation** | | | | |
| :CORRection:LOAD | ON/OFF/RETurn | Setting of load compensation function | *2,3,5 | 150 |
| :CORRection:LOAD? | | Query of load compensation function | *1, 2 | 150 |
| :CORRection:LOAD:DATA? | | Query of load compensation values | *1, 2 | 151 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____When a number that has not been saved is specified.
*5 Execution Error ____When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____When not even one measurement value is saved to memory.
*7 Execution Error ____When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| :CORRection:LOAD:DATA :FORMat | COEFficient/ZPH/CD | Setting of output format for load compensation values | *2, 3 | 151 |
| :CORRection:LOAD:DATA :FORMat? | | Query of output format for load compensation values | *1, 2 | 151 |
| :CORRection:LOAD:REFerence | <Reference Value 1>, <Reference Value 2> <Reference Value 1> = Numeric Value from 1 to 999999 (NR1) <Reference Value 2> = Numeric Value from 0 to 199000 (NR1) | Setting of load compensation condition reference value | *2,3,5 | 152 |
| :CORRection:LOAD:REFerence? | | Query of load compensation condition reference value | *1, 2 | 152 |
| **Confirmation of Communication Error** | | | | |
| :ERRor? RS-232C | | Query of RS-232C error | *1,2,7 | 152 |
| **Event Registers** | | | | |
| :ESE0 | Numeric Value from 0 to 255 (NR1) | Setting of event status enable register 0 | *2, 3 | 153 |
| :ESE0? | | Query of event status enable register 0 | *1, 2 | 153 |
| :ESE1 | Numeric Value from 0 to 255 (NR1) | Setting of event status enable register 1 | *2, 3 | 153 |
| :ESE1? | | Query of event status enable register 1 | *1, 2 | 153 |
| :ESE2 | Numeric Value from 0 to 255 (NR1) | Setting of event status enable register 2 | *2, 3 | 154 |
| :ESE2? | | Query of event status enable register 2 | *1, 2 | 154 |
| :ESE3 | Numeric Value from 0 to 255 (NR1) | Setting of event status enable register 3 | *2, 3 | 155 |
| :ESE3? | | Query of event status enable register 3 | *1, 2 | 155 |
| :ESR0? | | Query of event status register 0 | *1 | 155 |
| :ESR1? | | Query of event status register 1 | *1 | 156 |
| :ESR2? | | Query of event status register 2 | *1 | 156 |
| :ESR3? | | Query of event status register 3 | *1 | 156 |
| **Measurement Frequency** | | | | |
| :FREQuency | 120/ 1000 (NR1) | Setting of measurement frequency | *2,3,5 | 157 |
| :FREQuency? | | Query of measurement frequency | *1, 2 | 157 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB

*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation

*3 Execution Error ____ When set to other than the specified character data or numeric data.

*4 Execution Error ____ When a number that has not been saved is specified.

*5 Execution Error ____ When a command is executed during comparator measurement or BIN measurement.

*6 Execution Error ____ When not even one measurement value is saved to memory.

*7 Execution Error ____ When there is an RS-232C specific command or query while the interface type is set to GP-IB.

*8 Execution Error ____ When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| **Communication Handshake** | | | | |
| :HANDshake RS-232C | OFF/X/HARDware/ BOTH | Setting of RS-232C communication handshake | *2,3,7 | 157 |
| :HANDshake? RS-232C | | Query of RS-232C communication handshake | *1,2,7 | 157 |
| **Header** | | | | |
| :HEADer | ON/ OFF | Setting of header for response messages | *2, 3 | 158 |
| :HEADer? | | Query of header for response messages | *1, 2 | 158 |
| **EXT I/O Output** | | | | |
| :IO:RESult:RESet | ON/ OFF | Setting of output of judgment result signal line in EXT I/O | *2,3,5 | 158 |
| :IO:RESult:RESet? | | Query of output of judgment result signal line in EXT I/O | *1, 2 | 158 |
| **Judgment Mode** | | | | |
| :JUDGment:MODE | COUNt/ DEViation | Setting of judgment mode of comparator and BIN functions | *2,3,5 | 159 |
| :JUDGment:MODE? | | Query of judgment mode of comparator and BIN functions | *1, 2 | 159 |
| **Key Lock** | | | | |
| :KEYLock | ON/ OFF | Setting of key lock function | *2, 3 | 159 |
| :KEYLock? | | Query of key lock function | *1, 2 | 159 |
| **Measurement Signal Level** | | | | |
| :LEVel | 1/ 0.5 (NR2) | Setting of measurement signal level | *2,3,5 | 160 |
| :LEVel? | | Query of measurement signal level | *1, 2 | 160 |
| **Panel Load** | | | | |
| :LOAD | 1 to 99 (NR1) | Loading of specified panel number | *2,3,4 | 160 |
| :LOAD:TYPE | ALL/ CORRection/ HARDware | Setting of load method | *2, 3 | 160 |
| :LOAD:TYPE? | | Query of load method | *1, 2 | 160 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____When a number that has not been saved is specified.
*5 Execution Error ____When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____When not even one measurement value is saved to memory.
*7 Execution Error ____When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| **Normal Measurement** | | | | |
| :MEASure? | | Query of measurement data | *1, 2 | 162 |
| **Measurement Value Memory Function** | | | | |
| :MEMory? | No Data/ALL | Query of measurement values saved to memory by the measurement value memory function | *1,2,6 | 164 |
| :MEMory:CLEar | | Deleting data from memory of measurement value memory function | *2 | 165 |
| :MEMory:COUNt? | | Query of number of measurement values saved to memory by the measurement value memory function | *1, 2 | 165 |
| **Measurement Range** | | | | |
| :RANGe | 1 to 10 (NR1) | Setting of measurement range | *2,3,5 | 166 |
| :RANGe? | | Query of measurement range | *1, 2 | 166 |
| :RANGe:AUTO | ON/ OFF | Automatic setting of measurement range | *2,3,5 | 167 |
| :RANGe:AUTO? | | Query of automatic setting of measurement range | *1, 2 | 167 |
| **Panel Save** | | | | |
| :SAVE | 1 to 99 (NR1) | Saving of specified panel number | *2, 3 | 167 |
| :SAVE? | 1 to 99 (NR1) | Query of saving of specified panel number | *1,2,3 | 167 |
| **Measurement Speed** | | | | |
| :SPEEd | FAST/ NORMal/ SLOW | Setting of measurement speed | *2,3,5 | 168 |
| :SPEEd? | | Query of measurement speed | *1, 2 | 168 |
| **Synchronous Measurement Function (Special Specification)** | | | | |
| :SPHase | IN/ OUT | Setting of synchronous measurement function | *2,3,5 | 168 |
| :SPHase? | | Query of synchronous measurement function | *1, 2 | 168 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____ When a number that has not been saved is specified.
*5 Execution Error ____ When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____ When not even one measurement value is saved to memory.
*7 Execution Error ____ When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____ When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

## Unique Commands

| Command | Data Section | Explanation | Error | Reference Page |
|---|---|---|---|---|
| **Trigger Synchronous Output Function** | | | | |
| :SSOurce | ON/ OFF | Setting of trigger synchronous output function | *2,3,5 | 169 |
| :SSOurce? | | Query of trigger synchronous output function | *1, 2 | 169 |
| :SSOurce:WAIT | <Wait Time 1>, <Wait Time 2><br><Wait Time 1 and 2> Numeric Value from 0 to 9.999 (NR2) | Setting of wait time for trigger synchronous output function | *2,3,5 | 169 |
| :SSOurce:WAIT? | | Query of wait time for trigger synchronous output function | *1, 2 | 169 |
| **Message Terminator** | | | | |
| :TRANsmit:TERMinator | Numeric Value from 0 to 255 (NR1) | Setting of the terminator of a response message | *2, 3 | 170 |
| :TRANsmit:TERMinator? | | Query of the terminator of a response message | *1, 2 | 170 |
| **Trigger** | | | | |
| :TRIGger | INTernal/ EXTernal | Setting of trigger | *2, 3 | 171 |
| :TRIGger? | | Query of trigger | *1, 2 | 171 |
| **User ID** | | | | |
| :USER:IDENtity | <ID> = User ID Code | Setting of user ID | *2, 3 | 171 |
| :USER:IDENtity? | | Query of user ID | *1, 2 | 171 |

Error Explanations (An error is generated when a message is executed in the following cases)

*1 Query Error _____ When a response message exceeds 10 kB
*2 Execution Error ____ When a command is executed while open circuit, short circuit, or load compensation
*3 Execution Error ____ When set to other than the specified character data or numeric data.
*4 Execution Error ____When a number that has not been saved is specified.
*5 Execution Error ____When a command is executed during comparator measurement or BIN measurement.
*6 Execution Error ____When not even one measurement value is saved to memory.
*7 Execution Error ____When there is an RS-232C specific command or query while the interface type is set to GP-IB.
*8 Execution Error ____When a command to display a reference value in the SUB display area is executed while the count setting is configured.

Note: Command errors are generated for all messages with a misspelling.

# 7.8 Ability to Use Commands by State

The ability to use commands depends on the state of the unit; for example, whether the unit is in a measurement mode or performing compensation. Refer to the following table. (**Yes**: Available **No**: Unavailable)

## Common Commands

| Command Name | Normal Measurement Mode | Comparator Measurement Mode | BIN Measurement Mode (Only for 3504) | Performing Compensation | Reference Page |
|---|---|---|---|---|---|
| *CLS | Yes | Yes | Yes | No | 127 |
| *ESE | Yes | Yes | Yes | No | 128 |
| *ESE? | Yes | Yes | Yes | No | 128 |
| *ESR? | Yes | Yes | Yes | Yes | 128 |
| *IDN? | Yes | Yes | Yes | No | 125 |
| *OPC | Yes | Yes | Yes | Yes | 126 |
| *OPC? | Yes | Yes | Yes | Yes | 126 |
| *RST | Yes | Yes | Yes | No | 125 |
| *SRE | Yes | Yes | Yes | No | 129 |
| *SRE? | Yes | Yes | Yes | No | 129 |
| *STB? | Yes | Yes | Yes | No | 129 |
| *TRG | Yes | Yes | Yes | No | 130 |
| *TST? | Yes | Yes | Yes | No | 126 |
| *WAI | Yes | Yes | Yes | Yes | 127 |

## Unique Commands

| Command Name | Normal Measurement Mode | Comparator Measurement Mode | BIN Measurement Mode (Only for 3504) | Performing Compensation | Reference Page |
|---|---|---|---|---|---|
| :BEEPer:JUDGment | Yes | No | No | No | 131 |
| :BEEPer:JUDGment? | Yes | Yes | Yes | No | 131 |
| :BEEPer:KEY | Yes | Yes | Yes | No | 131 |
| :BEEPer:KEY? | Yes | Yes | Yes | No | 131 |
| :BIN * | Yes | Yes | Yes | No | 132 |
| :BIN? * | Yes | Yes | Yes | No | 132 |
| :BIN:DISPlay * | Yes | Yes | Yes | No | 132 |
| :BIN:DISPlay? * | Yes | Yes | Yes | No | 132 |
| :BIN:FLIMit:COUNt * | Yes | Yes | Yes | No | 133 |
| :BIN:FLIMit:COUNt? * | Yes | Yes | Yes | No | 133 |
| :BIN:FLIMit:DEViation * | Yes | Yes | Yes | No | 134 |
| :BIN:FLIMit:DEViation? * | Yes | Yes | Yes | No | 134 |
| :BIN:FLIMit:REFerence * | Yes | Yes | Yes | No | 135 |
| :BIN:FLIMit:REFerence? * | Yes | Yes | Yes | No | 135 |
| :BIN:SLIMit:COUNt * | Yes | Yes | Yes | No | 135 |
| :BIN:SLIMit:COUNt? * | Yes | Yes | Yes | No | 135 |
| :BIN:SLIMit:DEViation * | Yes | Yes | Yes | No | 136 |
| :BIN:SLIMit:DEViation? * | Yes | Yes | Yes | No | 136 |
| :BIN:SLIMit:REFerence * | Yes | Yes | Yes | No | 137 |
| :BIN:SLIMit:REFerence?* | Yes | Yes | Yes | No | 137 |

*Only for 3504

## Unique Commands

| Command Name | Normal Measurement Mode | Comparator Measurement Mode | BIN Measurement Mode (Only for 3504) | Performing Compensation | Reference Page |
|---|---|---|---|---|---|
| :CIRCuit | Yes | No | No | No | 137 |
| :CIRCuit? | Yes | Yes | Yes | No | 137 |
| :CIRCuit:AUTO | Yes | No | No | No | 138 |
| :CIRCuit:AUTO? | Yes | Yes | Yes | No | 138 |
| :COMParator | Yes | Yes | Yes | No | 138 |
| :COMParator? | Yes | Yes | Yes | No | 138 |
| :COMParator:DISPlay | Yes | Yes | Yes | No | 139 |
| :COMParator:DISPlay? | Yes | Yes | Yes | No | 139 |
| :COMParator:FLIMit:COUNt | Yes | Yes | Yes | No | 140 |
| :COMParator:FLIMit:COUNt? | Yes | Yes | Yes | No | 140 |
| :COMParator:FLIMit:DEViation | Yes | Yes | Yes | No | 141 |
| :COMParator:FLIMit:DEViation? | Yes | Yes | Yes | No | 141 |
| :COMParator:SLIMit:COUNt | Yes | Yes | Yes | No | 142 |
| :COMParator:SLIMit:COUNt? | Yes | Yes | Yes | No | 142 |
| :COMParator:SLIMit:DEViation | Yes | Yes | Yes | No | 143 |
| :COMParator:SLIMit:DEViation? | Yes | Yes | Yes | No | 143 |
| :CORRection:DATA? | Yes | Yes | Yes | No | 144 |
| :CORRection:OPEN | Yes | No | No | No | 145 |
| :CORRection:OPEN? | Yes | Yes | Yes | No | 145 |
| :CORRection:OPEN:DATA:FORMat | Yes | Yes | Yes | No | 147 |
| :CORRection:OPEN:DATA:FORMat? | Yes | Yes | Yes | No | 147 |
| :CORRection:SHORt | Yes | No | No | No | 148 |
| :CORRection:SHORt? | Yes | Yes | Yes | No | 148 |
| :CORRection:SHORt:DATA:FORMat | Yes | Yes | Yes | No | 149 |
| :CORRection:SHORt:DATA:FORMat? | Yes | Yes | Yes | No | 149 |
| :CORRection:LOAD | Yes | No | No | No | 150 |
| :CORRection:LOAD? | Yes | Yes | Yes | No | 150 |
| :CORRection:LOAD:DATA? | Yes | Yes | Yes | No | 151 |
| :CORRection:LOAD:DATA:FORMat | Yes | Yes | Yes | No | 151 |
| :CORRection:LOAD:DATA:FORMat? | Yes | Yes | Yes | No | 151 |
| :CORRection:LOAD:REFerence | Yes | No | No | No | 152 |
| :CORRection:LOAD:REFerence? | Yes | Yes | Yes | No | 152 |
| :ERRor? | Yes | Yes | Yes | No | 152 |
| :ESE0 | Yes | Yes | Yes | No | 153 |
| :ESE0? | Yes | Yes | Yes | No | 153 |
| :ESE1 | Yes | Yes | Yes | No | 153 |
| :ESE1? | Yes | Yes | Yes | No | 153 |
| :ESE2 | Yes | Yes | Yes | No | 154 |
| :ESE2? | Yes | Yes | Yes | No | 154 |
| :ESE3 | Yes | Yes | Yes | No | 155 |
| :ESE3? | Yes | Yes | Yes | No | 155 |
| :ESR0? | Yes | Yes | Yes | Yes | 155 |
| :ESR1? | Yes | Yes | Yes | Yes | 156 |
| :ESR2? | Yes | Yes | Yes | Yes | 156 |

## Unique Commands

| Command Name | Normal Measurement Mode | Comparator Measurement Mode | BIN Measurement Mode (Only for 3504) | Performing Compensation | Reference Page |
|---|---|---|---|---|---|
| :ESR3? | Yes | Yes | Yes | Yes | 156 |
| :FREQuency | Yes | No | No | No | 157 |
| :FREQuency? | Yes | Yes | Yes | No | 157 |
| :HANDshake | Yes | Yes | Yes | No | 157 |
| :HANDshake? | Yes | Yes | Yes | No | 157 |
| :HEADer | Yes | Yes | Yes | No | 158 |
| :HEADer? | Yes | Yes | Yes | No | 158 |
| :IO:RESult:RESet | Yes | No | No | No | 158 |
| :IO:RESult:RESet? | Yes | Yes | Yes | No | 158 |
| :JUDGment:MODE | Yes | No | No | No | 159 |
| :JUDGment:MODE? | Yes | Yes | Yes | No | 159 |
| :KEYLock | Yes | Yes | Yes | No | 159 |
| :KEYLock? | Yes | Yes | Yes | No | 159 |
| :LEVel | Yes | No | No | No | 160 |
| :LEVel? | Yes | Yes | Yes | No | 160 |
| :LOAD | Yes | Yes | Yes | No | 160 |
| :LOAD:TYPE | Yes | Yes | Yes | No | 160 |
| :LOAD:TYPE? | Yes | Yes | Yes | No | 160 |
| :MEASure? | Yes | Yes | Yes | No | 162 |
| :MEMory? | Yes | Yes | Yes | No | 164 |
| :MEMory:CLEar | Yes | Yes | Yes | No | 165 |
| :MEMory:COUNt? | Yes | Yes | Yes | No | 165 |
| :RANGe | Yes | No | No | No | 166 |
| :RANGe? | Yes | Yes | Yes | No | 166 |
| :RANGe:AUTO | Yes | No | No | No | 167 |
| :RANGe:AUTO? | Yes | Yes | Yes | No | 167 |
| :SAVE | Yes | Yes | Yes | No | 167 |
| :SAVE? | Yes | Yes | Yes | No | 167 |
| :SPEEd | Yes | No | No | No | 168 |
| :SPEEd? | Yes | Yes | Yes | No | 168 |
| :SPHase | Yes | No | No | No | 168 |
| :SPHase? | Yes | Yes | Yes | No | 168 |
| :SSOurce | Yes | No | No | No | 169 |
| :SSOurce? | Yes | Yes | Yes | No | 169 |
| :SSOurce:WAIT | Yes | No | No | No | 169 |
| :SSOurce:WAIT? | Yes | Yes | Yes | No | 169 |
| :TRANsmit:TERMinator | Yes | Yes | Yes | No | 170 |
| :TRANsmit:TERMinator? | Yes | Yes | Yes | No | 170 |
| :TRIGger | Yes | Yes | Yes | No | 171 |
| :TRIGger? | Yes | Yes | Yes | No | 171 |
| :USER:IDENtity | Yes | Yes | Yes | No | 171 |
| :USER:IDENtity? | Yes | Yes | Yes | No | 171 |

# 7.9 Message Reference

Refer to the following on how to read this section.

This indicates whether the command message format has a numeric value or character parameter.
<Numeric Value>**Numeric Value Parameter**
(NR1) Integer
(NR2) Fixed Point
(NR3) Floating point
(NRf) Format including all of NR1, NR2, and NR3
<Character> Character parameter
<Content to input>

Indicates the content of the command.

Describes the syntax of the message.

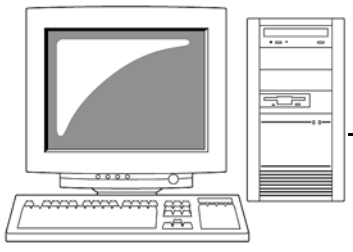
Provides an explanation of the command data section or response data.

Provides an explanation of the message

Shows an actual example of using the command.
This explanation is normally for when HEADER ON. (Except for HEADER command.)

**Setting and Query of Measurement Signal Level**

| | | |
|---|---|---|
| Syntax | Command | :LEVel <Numeric Value> |
| | Query | :LEVel ? |
| | Response | <Numeric Value> |
| | | <Numeric Value>=1/ 0.5 (NR2)<br>1: 1 V, 0.5: 500 mV |
| Explanation | Command | Sets the measurement signal level.<br>A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric |
| | Query | Returns the setting of the measurement signal level as an NR2 numeric value. |
| Example | Command | `:LEVel 0.5`<br>Sets the measurement signal level to 500 mV |
| | Query | `:LEVEL?`<br>`:LEVEL 0.5` (when HEADER ON)<br>`0.5` (when HEADER OFF)<br>The measurement signal level is set to 500 mV. |



Command/query (message)

**3504 , 3504-10**

Response (message)

# 7.9.1 Common Commands

(1) System Data Commands

## Query of Device ID (Identification Code)

**Syntax** Query ∗**IDN?**
Response <Maker Name>,< Model Name>,0 or 10,<Software Version>

**Example** `HIOKI,3504,0,V1.01` (3504)
`HIOKI,3504,10,V1.00` (3504-10)

(2) Internal Operation Commands

## Initialization of Device

**Syntax** Command ∗**RST**

**Explanation** Initializes the unit. (This is the same as performing a system reset. However, the interface setting and user ID setting are excluded.)

| | |
|---|---|
| Measurement frequency | 1 kHz |
| Measurement signal level | 1 V |
| Measurement range | AUTO range |
| Equivalent circuit mode | AUTO |
| Open circuit compensation | OFF |
| Output parameter for open circuit compensation values | ZPH |
| Short circuit compensation | OFF |
| Output parameter for short circuit compensation values | ZPH |
| Load compensation | OFF, Reference value (C,D)=(100000,0) |
| Trigger | Internal trigger |
| Output format for load compensation values | COEFficient |
| Header | ON |
| Lock function | OFF |
| Trigger synchronous output function | OFF |

| | |
|---|---|
| Measurement speed | NORMAL |
| Beep tones | Key ON, comparator and BIN judgment results OFF |
| Comparator | Count setting value, Deviation percent setting value<br>For both the first and second parameters<br>C reference value: 100000<br>D reference value: 0<br>Upper and lower values: OFF |
| BIN measurement (only for 3504) | Count setting value, deviation percent setting value<br>For both the first and second parameters<br>C reference value: 100000<br>D Reference value: 0<br>Upper and lower values: OFF |
| Panel save | Clear all content |
| Reset the Judgment result of EXT IO | ON |

## Query of Self Test Execution and Results

**Syntax**

Query ∗**TST?**

Response <Numeric Value>

<Numeric Value> = 0 to 15 (NR1)

**Explanation**

Returns the results of the self check of the unit as an NR1 numeric value.
No header is added to the response message.

| 128 bit 7 | 64 bit 6 | 32 bit 5 | 16 bit 4 | 8 bit 3 | 4 bit 2 | 2 bit 1 | 1 bit 0 |
|---|---|---|---|---|---|---|---|
| Unused | Unused | Unused | Unused | Interrupt error | I/O error | RAM error | ROM error |

**Example**

Query **`*TST?`**

Response **`2`**

There is a RAM error (bit 1).

(3) Synchronization Commands

## Setting of OPC of SESR after All Executed Operations End

**Syntax**

Command ∗**OPC**

**Explanation**

Sets the OPC (bit 0) of SESR (standard event status register) when processing ends for sent commands prior to the *OPC command.

**Example**

**`A;B;*OPC;C`**

Sets OPC of SESR after processing ends for commands A and B.

## Response of 1 of ASCII after All Executed Operations End

**Syntax**

Query ∗**OPC?**

Response 1

**Explanation**

Responds with 1 of ASCII when processing ends for sent commands prior to the *OPC command.

### Continuing Execution of Commands after Command Processing Ends

**Syntax** Command ∗**WAI**

**Example**

```
A;B;*WAI;C
```

Executes ***WAI** and then the C command after processing ends for commands A and B.

Current Frequency:1 kHz when in internal trigger state

- When the *WAI command was not used
  (Send)
  ```
  :FREQuency 120;:MEASure?
  ```
  In this case, it is not certain which frequency measurement value will be sent in response to the :MEASure? query.
- When the *WAI command was used
  (Send)
  ```
  :FREQuency 120;*WAI;:MEASure?
  ```
  In this case, the 120 Hz frequency measurement value is sent in response to the :MEASure? query.

**Note** Unique commands other than the ":MEASure?" query use sequential commands. Therefore, the *WAI command is only effective for the ":MEASure?" query.

## (4) Status and Event Control Commands

### Clearing of Status Byte Register and Related Queues (Except Output Queue)

**Syntax** Command ∗**CLS**

**Explanation** Clears the content of the event registers (SESR, ESR0, ESR1, ESR2, ESR3).

**Note**

RS-232C The output queue is not affected

GP-IB The output queue and the MAV (bit 4) of each type of enable register status byte are not affected.

## Reading and Writing of Standard Event Status Enable Register (SESER)

**Syntax**

Command ∗**ESE** <Numeric Value>
Query ∗**ESE?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command Sets the mask pattern of the SESER to a numeric value from 0 to 255.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric
The initial value (when the power is turned on) is 0.

Query Returns the SESER content set by the ESE command as an NR1 numeric value from 0 to 255.

| 128 bit 7 | 64 bit 6 | 32 bit 5 | 16 bit 4 | 8 bit 3 | 4 bit 2 | 2 bit 1 | 1 bit 0 |
|---|---|---|---|---|---|---|---|
| PON | URQ | CME | EXE | DDE | QYE | RQC | OPC |

**Example**

Command **`*ESE 36`**
Sets bit 5 and bit 2 of SESER
Query **`*ESE?`**
Response **`*ESE 36`** (when HEADER ON)
**`36`** (when HEADER OFF)
Bit 5 and bit 2 of SESER are 1.

## Reading and Clearing of Standard Event Status Register (SESR)

**Syntax**

Query ∗**ESR?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Returns the SESR content as an NR1 numeric value from 0 to 255, and then clears that content.
No header is added to the response message.

| 128 bit 7 | 64 bit 6 | 32 bit 5 | 16 bit 4 | 8 bit 3 | 4 bit 2 | 2 bit 1 | 1 bit 0 |
|---|---|---|---|---|---|---|---|
| PON | URQ | CME | EXE | DDE | QYE | RQC | OPC |

**Example**

Query **`*ESR?`**
Response **`32`**
Bit 5 of SESR is 1.

**Note**

Bit 6 and bit 1 are not used in the unit.

## Reading and Writing of Service Request Enable Register (SRER)

**Syntax**

Command ***SRE** <Numeric Value>
Query ***SRE?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command Sets the mask pattern of the SRER to a numeric value from 0 to 255. A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

The values of bit 6 and the unused bit (bit 7) are ignored.
The value is initialized to 0 when the power is turned on.

Query Returns the SRER content set by the *SRE command as an NR1 numeric value from 0 to 255.

The values of bit 6 and the unused bit (bit 7) are always 0.

| 128<br>bit 7 | 64<br>bit 6 | 32<br>bit 5 | 16<br>bit 4 | 8<br>bit 3 | 4<br>bit 2 | 2<br>bit 1 | 1<br>bit 0 |
|---|---|---|---|---|---|---|---|
| Unused | X | ESB | MAV | ESB3 | ESB2 | ESB1 | ESB0 |

**Example**

Command **`*SRE 34`**
Sets bit 5 and bit 1 of SRER to 1.

Query **`*SRE?`**
Response **`*SRE 34`** (when HEADER ON)
**`34`** (when HEADER OFF)
Bit 5 and bit 1 of SRER are 1.

## Reading of Status Byte Register

**Syntax**

Query ***STB?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Returns the STB setting content as a NR1 numeric value from 0 to 127.
No header is added to the response message.

| 128<br>bit 7 | 64<br>bit 6 | 32<br>bit 5 | 16<br>bit 4 | 8<br>bit 3 | 4<br>bit 2 | 2<br>bit 1 | 1<br>bit 0 |
|---|---|---|---|---|---|---|---|
| Unused | MSS | ESB | MAV | ESB3 | ESB2 | ESB1 | ESB0 |

**Example**

Query **`*STB?`**
Response **`8`**
Bit 3 of STB is 1.

## Sampling Request

**Syntax** Command ＊**TRG**

**Explanation** Performs sampling once when there is an external trigger.

**Example**

```
:TRIGger EXTernal;*TRG;:MEASure?
```

# 7.9.2 Unique Commands

## Setting and Query of Comparator and BIN Judgment Beep Tone Setting

**Syntax**

Command **:BEEPer:JUDGment** <Character>

Query **:BEEPer:JUDGment?**

Response <Character>

<Character> = IN/ NG/ OFF
IN : Set so that the beep tone plays when the value is within the range
NG : Set so that the beep tone plays when the value is outside the range
OFF : Mute

**Explanation**

Command Sets the comparator and BIN judgment beep tone.

Query Returns the setting of the comparator and BIN judgment beep tone as characters.

**Example**

Command **:BEEPer:JUDGment NG**
Sets the beep tone so that it plays when the value is outside the range

Query **:BEEPer:JUDGment?**

Response **:BEEPER:JUDGMENT NG** (when HEADER ON)
**NG** (when HEADER OFF)
The beep tone is set so that it plays when the value is outside the range.

## Setting and Query of Key Input Beep Tone

**Syntax**

Command **:BEEPer:KEY** <ON/ OFF>

Query **:BEEPer:KEY?**

Response <ON/ OFF>

ON : Set so that the beep tone plays
OFF : Set so that the beep tone does not play

**Explanation**

Command Sets the beep tone for key input of the unit.

Query Returns the beep tone setting of key input of the unit as ON or OFF

**Example**

Command **:BEEPer:KEY ON**
Sets the beep tone so that it plays

Query **:BEEPer:KEY?**

Response **:BEEPER:KEY ON** (when HEADER ON)
**ON** (when HEADER OFF)
The beep tone is set so that it plays.

## Setting and Query of ON/OFF Setting of BIN Measurement (Only for 3504)

**Syntax**

Command **:BIN** <ON/ OFF>
Query **:BIN ?**
Response <ON/ OFF>

ON : Starts BIN measurement
OFF : Ends BIN measurement

**Explanation**

Command: Sets the BIN measurement function to ON/OFF.
If the ":BIN ON" command is sent during comparator measurement, comparator measurement ends automatically and BIN measurement starts.

Query: Returns ON or OFF for the setting of the BIN measurement function.

**Example**

Command **:BIN ON**
Sets the BIN measurement function to ON.

Query **:BIN?**
Response **:BIN ON** (when HEADER ON)
**ON** (when HEADER OFF)
The BIN measurement function is set to ON.

## Setting and Query of SUB Display Indication during BIN Measurement (Only for 3504)

**Syntax**

Command **:BIN:DISPlay** <BIN Number/Characters>
Query **:BIN:DISPlay?**
Response <BIN Number/Characters>=1 to 14(NR1)/ D/ CREFerence/ DREFerence/ OFF

BIN Number : Sets the upper limit and lower limit values of the BIN number to be displayed in the SUB display area.
D : Sets the upper limit and lower limit values of D to be displayed in the SUB display area.
CREFerence: Sets the reference value of C to be displayed in the SUB display area.
DREFerence: Sets the reference value of D to be displayed in the SUB display area
OFF : Sets nothing to be displayed in the SUB display area.

**Explanation**

Command: Sets the set upper limit and lower limit values or the reference value to be displayed in the SUB display area during BIN measurement.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the indication setting of the SUB display area during BIN measurement as characters.

## Setting and Query of SUB Display Indication during BIN Measurement (Only for 3504)

**Example**

Command
```
:BIN:DISPlay 1
```
Sets the upper limit and lower limit values of BIN1 to be displayed during BIN measurement.

Query
```
:BIN:DISPlay?
```
Response
```
:BIN:DISPLAY 1
```
(when HEADER ON)
```
1
```
(when HEADER OFF)
The upper limit and lower limit values of BIN1 are set to be displayed during BIN measurement.

**Note**

If an attempt is made to set the indication setting to CREFerence or DEFerence when the judgment mode is count value mode, an execution error is generated.

## Setting and Query of Upper Limit and Lower Limit Values of First Parameter for BIN Function in Count Value Mode (Only for 3504)

**Syntax**

Command **:BIN:FLIMit:COUNt** <BIN Number>,<Lower Limit Value>, <Upper Limit Value>

Query **:BIN:FLIMit:COUNt?** <BIN Number>

Response <BIN Number>,<Lower Limit Value>, <Upper Limit Value>

<BIN Number>=1 to 14(NR1)

<Lower Limit Value>=OFF/ Numeric Value from 0 to 999999 (NR1)

<Upper Limit Value>=OFF/ Numeric Value from 0 to 999999 (NR1)

**Explanation**

Command CommandSets the upper limit and lower limit values of the first parameter in count value mode of the specified BIN number.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric value can be handled.

Query Returns the upper limit and lower limit value settings for the first parameter in count value mode of the specified BIN number in order of BIN number, lower limit value, and upper limit value.

**Example**

Command
```
:BIN:FLIMit:COUNt 1,100000,150000
```
Sets 100000 for the lower limit value and 150000 for the upper limit value of the first parameter in count value mode of BIN1.

Query
```
:BIN:FLIMit:COUNt? 1
```
Response
```
:BIN:FLIMit:COUNT 1,100000,150000
```
(when HEADER ON)
```
1,100000,150000
```
(when HEADER OFF)
100000 is set for the lower limit value and 150000 is set for the upper limit value of the first parameter in count value mode of BIN1.

## Setting and Query of Upper Limit and Lower Limit Values of First Parameter for BIN Function in Deviation Percent Mode (Only for 3504)

**Syntax**

Command / Query: **:BIN:FLIMit:DEViation** <BIN Number>,<Lower Limit Value>, <Upper Limit Value>

Response: **:BIN:FLIMit:DEViation?** <BIN Number>

<BIN Number>,<Lower Limit Value>, <Upper Limit Value>

<BIN Number>=1 to 14(NR1)

<Lower Limit Value>=OFF/ Numeric Value from -999.99 to 999.99 (NR2)

<Upper Limit Value>=OFF/ Numeric Value from -999.99 to 999.99 (NR2)

**Explanation**

Command: Sets the upper limit and lower limit values of the first parameter in deviation percent mode of the specified BIN number.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric value can be handled.

Query: Returns the upper limit and lower limit value settings for the first parameter in deviation percent mode of the specified BIN number in order of BIN number, lower limit value, and upper limit value.

**Example**

Command: `:BIN:FLIMit:DEViation 1,-10.0,10.0`
Sets -10 for the lower limit value and 10 for the upper limit value of the first parameter in deviation percent mode of BIN1.

Query: `:BIN:FLIMit:DEViation? 1`

Response: `:BIN:FLIMit:DEVIATION 1,-10.000,10.000` (when HEADER ON)
`1,-10.000,10.000` (when HEADER OFF)
-10% is set for the lower limit value and 10% is set for the upper limit value of the first parameter in deviation percent mode of BIN1.

## Setting and Query of Reference Value of First Parameter for BIN Function in Deviation Percent Mode (Only for 3504)

**Syntax**

Command **:BIN:FLIMit:REFerence** <Reference Value>
Query **:BIN:FLIMit:REFerence?**
Response <Reference Value>= Numeric Value from 1 to 999999 (NR1)

**Explanation**

Command: Sets the reference value of the first parameter in deviation percent mode. A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric value can be handled.

Query: Returns the reference value set for the first parameter in deviation percent mode

**Example**

Command `:BIN:FLIMit:REFerence 150000`
Sets 150000 for the reference value of the first parameter in deviation percent mode.

Query `:BIN:FLIMit:REFerence?`
Response `:BIN:FLIMit:REFERENCE 150000` (when HEADER ON)
`150000` (when HEADER OFF)
150000 is set for the reference value of the first parameter in deviation percent mode.

**Note**

The upper limit and lower limit values for count value mode and the upper limit and lower limit values for deviation percent mode of the unit are stored separately.

## Setting and Query of Upper Limit and Lower Limit Values of Second Parameter for BIN Function in Count Value Mode (Only for 3504)

**Syntax**

Command **:BIN:SLIMit:COUNt** <Lower Limit Value>, <Upper Limit Value>
Query **:BIN:SLIMit:COUNt?**
Response <Lower Limit Value>, <Upper Limit Value>
<Lower Limit Value>=OFF/Numeric Value from 0 to 199000 (NR1)
<Upper Limit Value>=OFF/Numeric Value from 0 to 199000 (NR1)

**Explanation**

Command: Sets the upper limit and lower limit values of the second parameter in count value mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric value can be handled.

Query: Returns the upper limit and lower limit value settings for the second parameter in count value mode in order of lower limit value and upper limit value.

**Example**

Command `:BIN:SLIMit:COUNt 100000,150000`
Sets 100000 for the lower limit value and 150000 for the upper limit value of the second parameter in count value mode.

Query `:BIN:SLIMit:COUNt?`
Response `:BIN:SLIMit:COUNT 100000,150000` (when HEADER ON)
`100000,150000` (when HEADER OFF)
100000 is set for the lower limit value and 150000 is set for the upper limit value of the second parameter in count value mode.

## Setting and Query of Upper Limit and Lower Limit Values of Second Parameter for BIN Function in Deviation Percent Mode (Only for 3504)

**Syntax**

Command **:BIN:SLIMit:DEViation** <Lower Limit Value>, <Upper Limit Value>

Query **:BIN:SLIMit:DEViation?**

Response <Lower Limit Value>, <Upper Limit Value>

<Lower Limit Value>=OFF/Numeric Value from -199000 to 199000 (NR1)

<Upper Limit Value>=OFF/Numeric Value from -199000 to 199000 (NR1)

**Explanation**

Command Sets the upper limit and lower limit values of the second parameter in deviation percent mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query Returns the upper limit and lower limit value settings for the second parameter in deviation percent mode in order of lower limit value and upper limit value.

**Example**

Command `:BIN:SLIMit:DEViation -10,10`
Sets -10 for the lower limit value and 10 for the upper limit value of the second parameter in deviation percent mode.

Query `:BIN:SLIMit:DEViation?`

Response `:BIN:SLIMit:DEVIATION -10,10` (when HEADER ON)
`-10,10` (when HEADER OFF)
-10 is set for the lower limit value and 10 is set for the upper limit value of the second parameter in deviation percent mode.

**Note**

The measurement value for the second parameter in deviation percent mode is the result of the calculation (measurement value - reference value).

## Setting and Query of Reference Value of Second Parameter for BIN Function in Deviation Percent Mode (Only for 3504)

**Syntax**

Command **:BIN:SLIMit:REFerence** <Reference Value>
Query **:BIN:SLIMit:REFerence?**
Response <Reference Value>=Numeric Value from 0 to 199000 (NR1)

**Explanation**

Command: Sets the reference value of the second parameter in deviation percent mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the reference value set for the second parameter in deviation percent mode.

**Example**

Command
```
:BIN:SLIMit:REFerence 150000
```
Sets 150000 for the reference value of the second parameter in deviation percent mode.

Query
```
:BIN:SLIMit:REFerence?
```
Response
```
:BIN:SLIMit:REFERENCE 150000
```
(when HEADER ON)
```
150000
```
(when HEADER OFF)
150000 is set for the reference value of the second parameter in deviation percent mode.

**Note**

The upper limit and lower limit values for count value mode and the upper limit and lower limit values for deviation percent mode of the unit are stored separately.

## Setting and Query of Equivalent Circuit

**Syntax**

Command **:CIRCuit** <Character>
Query **:CIRCuit?**
Response <Character>

<Character>=SERial, PARallel
SERial : Sets the equivalent circuit mode to series-equivalent circuit.
PARallel : Sets equivalent circuit mode to parallel-equivalent circuit.

**Explanation**

Command: Sets the equivalent circuit mode.

Query: Returns the setting of the current equivalent circuit mode as characters.

**Example**

Command
```
:CIRCuit SERIAL
```
Sets the equivalent circuit mode to series-equivalent circuit.

Query
```
:CIRCuit?
```
Response
```
:CIRCUIT SERIAL
```
(when HEADER ON)
```
SERIAL
```
(when HEADER OFF)
The equivalent circuit mode is set to series-equivalent circuit.

## Automatic Setting and Query of Equivalent Circuit

**Syntax**

Command **:CIRCuit:AUTO** <ON/ OFF>
Query **:CIRCuit:AUTO?**
Response <ON/ OFF>

ON : Switching is performed automatically.
OFF : Switching is not performed automatically.

**Explanation**

Command: Sets equivalent circuit mode to be switched automatically.

Query: Returns ON or OFF for the automatic setting of equivalent circuit mode.

**Example**

Command **:CIRCuit:AUTO ON**
Sets equivalent circuit mode to be switched automatically.

Query **:CIRCuit:AUTO?**
Response **:CIRCUIT:AUTO ON** (when HEADER ON)
**ON** (when HEADER OFF)
Equivalent circuit mode is set to be switched automatically.

## Setting and Query of ON/OFF Setting of Comparator Function

**Syntax**

Command **:COMParator** <ON/ OFF>
Query **:COMParator ?**
Response <ON/ OFF>

**Explanation**

Command: Sets the ON/OFF setting of the comparator function.

Query: Returns ON or OFF for the setting of the comparator function.

**Example**

Command **:COMParator ON**
Sets the comparator function to ON.

Query **:COMParator?**
Response **:COMPARATOR ON** (when HEADER ON)
**ON** (when HEADER OFF)
The comparator function is set to ON.

## Setting and Query of SUB Display Indication during Comparator Measurement

**Syntax**

Command **:COMParator:DISPlay** <Character>

Query **:COMParator:DISPlay?**

Response <Character>=C/ D/ CREFerence/ DREFerence/ OFF

C : Sets the upper limit and lower limit values of C to be displayed in the SUB display area.

D : Sets the upper limit and lower limit values of D to be displayed in the SUB display area.

CREFerence : Sets the reference value of C to be displayed in the SUB display area.

DREFerence : Sets the reference value of D to be displayed in the SUB display area.

OFF : Sets nothing to be displayed in the SUB display area.

**Explanation**

Command CommandSets the set upper limit and lower limit values or the reference value to be displayed in the SUB display area during comparator measurement.

Query Returns the indication setting of the SUB display area during comparator measurement as characters.

**Example**

Command
```
:COMParator:DISPlay C
```
Sets the upper limit and lower limit values of C to be displayed during comparator measurement.

Query
```
:COMParator:DISPlay
```
Response
```
:COMPARATOR:DISPLAY C
```
(when HEADER ON)
```
C
```
(when HEADER OFF)
The upper limit and lower limit values of C are set to be displayed during comparator measurement.

**Note**

If an attempt is made to set the indication setting to CREFerence or DEFerence when the judgment mode is count value mode, an execution error is generated.

## Setting and Query of Upper Limit and Lower Limit Values of First Parameter for Comparator Function in Count Value Mode

**Syntax**

Command **:COMParator:FLIMit:COUNt** <Lower Limit Value>,<Upper Limit Value>

Query

Response **:COMParator:FLIMit:COUNt?**
<Lower Limit Value>,<Upper Limit Value>

<Lower Limit Value> = OFF/Numeric Value from 0 to 999999 (NR1)
<Upper Limit Value> = OFF/Numeric Value from 0 to 999999 (NR1)

**Explanation**

Command: Sets the upper limit and lower limit values of the first parameter for the comparator function in count value mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns data for the upper limit and lower limit value settings of the first parameter for the comparator function in order of lower limit value and upper limit value.

**Example**

Command
```
:COMParator:FLIMit:COUNt 112345,123456
```
Sets 112345 for the lower limit value and 123456 for the upper limit value of the first parameter in count value mode.

Query
```
:COMParator:FLIMit:COUNt?
```
Response
```
:COMPARATOR:FLIMIT:COUNT 112345, 123456
```
(when HEADER ON)
```
112345,123456
```
(when HEADER OFF)
112345 is set for the lower limit value and 123456 is set for the upper limit value of the first parameter in count value mode.

## Setting and Query of Reference Value and Upper Limit and Lower Limit Values of First Parameter for Comparator Function in Deviation Percent Mode

**Syntax**

Command: **:COMParator:FLIMit:DEViation** <Reference Value>,<Lower Limit Value>,<Upper Limit Value>

Query Response: **:COMParator:FLIMit:DEViation?** <Reference Value>,<Lower Limit Value>,<Upper Limit Value>

<Reference Value> = 1 to 999999(NR1)

<Lower Limit Value> = OFF/Numerical Value from -999.99 to 999.99 (NR2)

<Upper Limit Value> = OFF/Numerical Value from -999.99 to 999.99 (NR2)

**Explanation**

Command: Sets the reference value and upper limit and lower limit values of the first parameter in deviation percent mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the reference value and upper limit and lower limit value settings for the first parameter in deviation percent mode in order of reference value, lower limit value, and upper limit value.

**Example**

Command:
```
:COMParator:FLIMit:DEViation 250000,
-5.0,5.0
```
Sets 250000 for the reference value, -5% for the lower limit value, and 5% for the upper limit value of the first parameter in deviation percent mode.

Query:
```
:COMParator:FLIMit:DEViation?
```
Response:
```
:COMPARATOR:FLIMit:DEVIATION 250000,
-5.0000,5.0000
```
(when HEADER ON)
```
250000,-5.0000,5.0000
```
(when HEADER OFF)
250000 is set for the reference value, -5% is set for the lower limit value, and 5% is set for the upper limit value of the first parameter in deviation percent mode.

## Setting and Query of Upper Limit and Lower Limit Values of Second Parameter for Comparator Function in Count Value Mode

**Syntax**

Command **:COMParator:SLIMit:COUNt** <Lower Limit Value>,<Upper Limit Value>

Query

Response **:COMParator:SLIMit:COUNt?**
<Lower Limit Value>,<Upper Limit Value>

<Lower Limit Value> = OFF/Numeric Value from 0 to 199000 (NR1)
<Upper Limit Value> = OFF/Numeric Value from 0 to 199000 (NR1)

**Explanation**

Command: Sets the upper limit and lower limit values of the second parameter for the comparator function in count value mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns data for the upper limit and lower limit value settings of the second parameter for the comparator function in order of lower limit value and upper limit value.

**Example**

Command `:COMParator:SLIMit:COUNt 112345,123456`
Sets 112345 for the lower limit value and 123456 for the upper limit value of the second parameter in count value mode.

Query `:COMParator:SLIMit:COUNt?`

Response `:COMPARATOR:SLIMIT:COUNT 112345,123456` (when HEADER ON)
`112345,123456` (when HEADER OFF)
112345 is set for the lower limit value and 123456 is set for the upper limit value of the second parameter in count value mode.

## Setting and Query of Reference Value and Upper Limit and Lower Limit Values of Second Parameter for Comparator Function in Deviation Percent Mode

**Syntax**

Command: **:COMParator:SLIMit:DEViation** <Reference Value>,<Lower Limit Value>,<Upper Limit Value>

Query Response: **:COMParator:SLIMit:DEViation?** <Reference Value>,<Lower Limit Value>,<Upper Limit Value>

<Reference Value> = 0 to 199000(NR1)
<Lower Limit Value> = OFF/Numeric Value from -199000 to 199000 (NR1)

<Upper Limit Value> = OFF/Numeric Value from -199000 to 199000 (NR1)

**Explanation**

Command: Sets the reference value and upper limit and lower limit values of the second parameter in deviation percent mode.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the reference value and upper limit and lower limit value settings for the second parameter in deviation percent mode in order of reference value, lower limit value, and upper limit value.

**Example**

Command:
```
:COMParator:SLIMit:DEViation 2000,
-5,5
```
Sets 2000 for the reference value, -5 for the lower limit value, and 5 for the upper limit value of the second parameter in deviation percent mode.

Query:
```
:COMParator:SLIMit:DEViation?
```
Response:
```
:COMPARATOR:SLIMit:DEVIATION 2000,
-5,5
```
(when HEADER ON)
```
2000,-5,5
```
(when HEADER OFF)
2000 is set for the reference value, -5 is set for the lower limit value, and 5 is set for the upper limit value of the second parameter in deviation percent mode.

**Note**

The measurement value for the second parameter in deviation percent mode is the result of the calculation (measurement value - reference value).

## Query of Compensation Values for Open Circuit and Short Circuit Compensation

**Syntax**

Query: **:CORRection:DATA?**

Response:

Output parameter for short circuit compensation values
Output parameter ZPH:

<Residual Impedance>=OFF/Numeric Value (NR3),
<Phase Angle>=OFF/Numeric Value (NR2)
Output parameter RSX:

<Rs>=OFF/Numeric Value (NR3),<X>=OFF/Numeric Value (NR3)
Output parameter LSRS:

<Ls>=OFF/Numeric Value (NR3),<Rs>=OFF/Numeric Value (NR3)

Output parameter for open circuit compensation values
Output parameter ZPH:

<Residual Impedance>=OFF/Numeric Value (NR3),
<Phase Angle>=OFF/Numeric Value (NR2)
Output parameter GB:

<G>=OFF/Numeric Value (NR3),<B>=OFF/Numeric Value (NR3)
Output parameter CPG:

<Cp>=OFF/Numeric Value (NR3),<G>=OFF/Numeric Value (NR3)

**Explanation**

Query

Returns the compensation values for open circuit and short circuit compensation in the current measurement conditions (frequency, level) as characters or a numeric value.
If compensation is set to OFF or the spot compensation frequency and measurement frequency differ, OFF is returned.

**Example**

Query: `:CORRection:DATA?`

Response: `RS OFF,X OFF,Z 247.456E+06,PH -21.583` (when HEADER ON)
`OFF,OFF,247,456E+06,-21.583` (when HEADER OFF)

The compensation values in the current conditions are OFF for short circuit compensation and 247.456 MΩ and -21.583° for the open circuit compensation values.

## Setting and Query of Open Circuit Compensation Function

**Syntax**

Command **:CORRection:OPEN** <Character>
<Character>ALL/ON/OFF/RETurn

Query **:CORRection:OPEN?**

<Character>=ALL/ON/SPOT/OFF

**Explanation**

Command Sets the open circuit compensation function.
If ALL or ON is set, open circuit compensation data begins to be incorporated and then open circuit compensation is enabled after incorporation ends.

ALL : Enables the compensation function for all measurement conditions (frequency, level).

ON : Enables the compensation function for the current measurement conditions (frequency, level).

OFF : Disables the compensation function.

RETurn: Recovers all disabled open circuit compensation values.
❖ Refer to the "Note" (p. 146).

Query Returns the setting of the open circuit compensation function as characters.

ALL : The compensation function is enabled for all measurement conditions (frequency, level).

ON : The compensation function is enabled for the current measurement conditions (frequency, level).

SPOT: The compensation function is enabled for other than the current measurement conditions (frequency, level).

OFF : The compensation function is disabled.

**Example**

Command `:CORRection:OPEN ALL`
Enables the compensation function for all measurement conditions (frequency, level).

Query `:CORRection:OPEN?`

Response `:CORRECTION:OPEN ALL` (when HEADER ON)
`ALL` (when HEADER OFF)
The compensation function is enabled for all measurement conditions (frequency, level).

## Setting and Query of Open Circuit Compensation Function

**Note**

About Recovering Compensation Values

If **:CORRection:OPEN RETurn** is executed, open circuit compensation values that were disabled once can be recovered. However, if open circuit compensation is executed again while compensation values are in a disabled state, the open circuit compensation values prior to the disabling of the values cannot be recovered.
Refer to the following example.

### Example of when compensation values can be recovered

A. State when open circuit compensation was executed at the points in the table below

| Frequency / Measurement Signal Level | **120 Hz** | **1 kHz** |
|---|---|---|
| **0.5 V** | Yes | No |
| **1 V** | No | Yes |

Yes: Compensation values enabled, No: No compensation values

B. If compensation is canceled (**:CORRection:OPEN OFF** is executed or 0 ADJ is pressed for at least two seconds), the state becomes as shown in the table below.

| Frequency / Measurement Signal Level | **120 Hz** | **1 kHz** |
|---|---|---|
| **0.5 V** | △ | No |
| **1 V** | No | △ |

△: Compensation values disabled, No: No compensation values

C. If **:CORRection:OPEN RETurn** is executed, the state returns to that prior to canceling compensation.

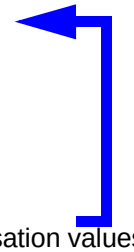
## Setting and Query of Open Circuit Compensation Function

**Note**

### Example of when compensation values cannot be recovered

a. State when open circuit compensation was executed at any of the points from the state of B (the table below shows an example of when **:CORRection:OPEN ON** was executed at a frequency of 1 kHz and level of 0.5 V).

| Frequency / Measurement Signal Level | 120 Hz | 1 kHz |
|---|---|---|
| **0.5 V** | No | Yes |
| **1 V** | No | No |



Yes: Compensation values enabled, No: No compensation values

b. The state of a remains even if **:CORRection:OPEN RETurn** is executed in the state of a. (This is because a new compensation value was obtained.)

## Setting and Query of Output Parameter for Open Circuit Compensation Values

**Syntax**

Command **:CORRection:OPEN:DATA:FORMat** <Character>
Query **:CORRection:OPEN:DATA:FORMat?**
Response <Character>=ZPH/GB/CPG

**Explanation**

Command :Sets the output parameter format of open circuit compensation values for when :CORRection:DATA? is executed.

Query :Returns the setting of the output parameter format for open circuit compensation values for when :CORRection:DATA? is executed.

**Example**

Command **:CORRection:OPEN:DATA:FORMat GB**
Sets the open circuit compensation values to be output with parameters G and B when :CORRection:DATA? is executed.

Query **:CORRection:OPEN:DATA:FORMat?**
Response **:CORRECTION:OPEN:DATA:FORMAT GB** (when HEADER ON)
**GB** (when HEADER OFF)
The open circuit compensation values are set to be output with parameters G and B when :CORRection:DATA? is executed.

## Setting and Query of Short Circuit Compensation Function

**Syntax**

Command **:CORRection:SHORt** <Character>

<Character>=ALL/ON/OFF/RETurn

Query **:CORRection:SHORt?**

<Character>=ALL/ON/SPOT/OFF

**Explanation**

Command

Sets the short circuit compensation function.
If ALL or ON is set, short circuit compensation data begins to be incorporated and then short circuit compensation is enabled after incorporation ends.

ALL : Enables the compensation function for all measurement conditions (frequency, level).

ON : Enables the compensation function for the current measurement conditions (frequency, level).

OFF : Disables the compensation function.

RETurn: Recovers all disabled short circuit compensation values.

Query

Returns the setting of the short circuit compensation function as characters.

ALL : The compensation function is enabled for all measurement conditions (frequency, level).

ON : The compensation function is enabled for the current measurement conditions (frequency, level).

SPOT: The compensation function is enabled for other than the current measurement conditions (frequency, level).

OFF : The compensation function is disabled.

**Example**

Command **`:CORRection:SHORt ON`**

Enables the compensation function for the current measurement conditions (frequency, level).

Query **`:CORRection:SHORt?`**

Response **`:CORRECTION:SHORT ON`** (when HEADER ON)

**`ON`** (when HEADER OFF)

The compensation function is enabled for the current measurement conditions (frequency, level).

## Setting and Query of Output Parameter for Short Circuit Compensation Values

**Syntax**

Command **:CORRection:SHORt:DATA:FORMat** <Character>
Query **:CORRection:SHORt:DATA:FORMat?**
Response <Character>=ZPH/RSX/LSRS

**Explanation**

Command :Sets the output parameter format of short circuit compensation values for when :CORRection:DATA? is executed.

Query Returns the setting of the output parameter format for short circuit compensation values for when :CORRection:DATA? is executed.

**Example**

Command **:CORRection:SHORt:DATA:FORMat RSX**
Sets the short circuit compensation values to be output with parameters Rs and X when :CORRection:DATA? is executed.

Query **:CORRection:SHORt:DATA:FORMat?**
Response **:CORRECTION:SHORT:DATA:FORMAT RSX** (when HEADER ON)
**RSX** (when HEADER OFF)
The short circuit compensation values are set to be output with parameters Rs and X when :CORRection:DATA? is executed.

## Setting and Query of Load Compensation Function

**Syntax**

Command **:CORRection:LOAD** <Character>
<Character>=ON/OFF/RETurn

Query **:CORRection:LOAD?**
<Character>=ON/SPOT/OFF

**Explanation**

Command Sets the load compensation function.
If ON is set, load compensation data begins to be incorporated based on the current measurement conditions (frequency, level, range, equivalent circuit mode, open circuit compensation, short circuit compensation) and reference values for load compensation conditions. After incorporating of the data ends properly, load compensation is enabled. If it does not end properly, the load compensation data remains the same as last time.

ON : Enables the load compensation function for the current measurement conditions.

OFF : Disables the load compensation function.

RETurn: Recovers all disabled load compensation values.

Query Returns the setting of the load compensation function as characters.

ON : The load compensation function is enabled for the current measurement conditions.

SPOT: The load compensation function is enabled for other than the current measurement conditions.

OFF : The load compensation function is disabled.

**Example**

Command **`:CORRection:LOAD ON`**
Enables the load compensation function for the current measurement conditions.

Query **`:CORRection:LOAD?`**

Response **`:CORRECTION:LOAD ON`** (when HEADER ON)
**`ON`** (when HEADER OFF)
The load compensation function is enabled for the current measurement conditions.

## Query of Load Compensation Values

**Syntax**

Query: **:CORRection:LOAD:DATA?**

Response: Output format COEFficient:

<Impedance Compensation Coefficient>=OFF/Numeric Value (NR2),
<Phase Compensation Coefficient>=OFF/Numeric Value (NR2)
Output format ZPH:

<Impedance>=OFF/Numeric Value (NR3),
<Phase Angle>=OFF/Numeric Value (NR2)
Output format CD:

<C>=OFF/Numeric Value (NR3),
<D>=OFF/Numeric Value (NR2)

**Explanation**

Query: Returns the load compensation values under the current measurement conditions (frequency, level, range).

**Example**

Query: `:CORRection:LOAD:DATA?`

Response: `ZCOEF 1.02453,PHCOEF 0.163` (when HEADER ON)
`1.02453, 0.163` (when HEADER OFF)
The load compensation values under the current measurement conditions are impedance compensation coefficient = 1.02453 and phase compensation coefficient = 0.163°.

## Setting and Query of Output Format for Load Compensation Values

**Syntax**

Command: **:CORRection:LOAD:DATA:FORMat** <Character>
Query: **:CORRection:LOAD:DATA:FORMat?**
Response: <Character>=COEFficient/ZPH/CD

COEFficient : Outputs the impedance compensation coefficient and phase compensation coefficient.
ZPH : Outputs the actual measurement values for the impedance and phase.
CD : Outputs the actual measurement values for C and D.

**Explanation**

Command: Sets the output format for load compensation values for when :CORRection:LOAD:DATA? is executed.

Query: Returns the setting of the output format for load compensation values for when :CORRection:LOAD:DATA? is executed.

**Example**

Command: `:CORRection:LOAD:DATA:FORMat COEFficient`
Sets the impedance compensation coefficient and phase compensation coefficient to be output when :CORRection:LOAD:DATA? is executed.

Query: `:CORRection:LOAD:DATA:FORMat?`

Response: `:CORRECTION:LOAD:DATA:FORMAT COEFFICIENT` (when HEADER ON)
`COEFFICIENT` (when HEADER OFF)
The impedance compensation coefficient and phase compensation coefficient are set to be output when :CORRection:LOAD:DATA? is executed.

## Setting and Query of Reference Values for Load Compensation Conditions

**Syntax**

Command **:CORRection:LOAD:REFerence** <Reference Value 1>, <Reference Value 2>
Query
Response **:CORRection:LOAD:REFerence?**

<Reference Value 1> =Numeric Value from 1 to 999999 (NR1)
<Reference Value 2> =Numeric Value from 0 to 199000 (NR1)

**Explanation**

Command: Sets the reference values for the load compensation conditions <Reference Value 1> indicates the reference value for C (capacitance) and <Reference Value 2> indicates the reference value for D (dissipation factor).
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the reference value setting in the order of <Reference Value 1> and <Reference Value 2>.

**Example**

Command `:CORRection:LOAD:REFerence 250000,1000`
Sets the reference values for the load compensation conditions to C=250000 and D=1000.

Query `:CORRection:LOAD:REFerence?`
Response `:CORRECTION:LOAD:REFERENCE 250000,1000` (when HEADER ON)
`250000,1000` (when HEADER OFF)
The reference values for the load compensation conditions are set to C=250000 and D=1000.

**Note**

If the settings are changed, load compensation is forcefully disabled.

## Query of RS-232C Communication Error

**Syntax**

Query **:ERRor?**
Response <Numeric Value>

<Numeric Value> = 0 to 7 (NR1)
1 Parity error (error in data)
2 Framing error (data read incorrectly)
4 Overrun error (loss of data)

**Explanation**

Query: Returns the RS-232C communication error register content as NR1 numeric data from 0 to 7 and then clears that content.
No header is added to the response message.

| | | | | | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| Unused | Unused | Unused | Unused | Unused | Overrun error | Framing error | Parity error |

**Example**

Query `:ERRor?`
Response `4`
An overrun error was generated.

## Setting and Query of Event Status Enable Register 0 (ESER0)

**Syntax**

Command **:ESE0** <Numeric Value>
Query **:ESE0?**
Response <Numeric Value>
<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command Sets the mask pattern of the ESER0 to a numeric value from 0 to 255.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric
The initial value (when the power is turned on) is 0.

Query Returns the ESER0 content as an NR1 numeric value.

| 128 bit 7 | 64 bit 6 | 32 bit 5 | 16 bit 4 | 8 bit 3 | 4 bit 2 | 2 bit 1 | 1 bit 0 |
|---|---|---|---|---|---|---|---|
| REF | COF | Unused | MOF | MUF | IDX | EOM | CEM |

**Example**

Command **:ESE0 20**
Sets bit 4 and bit 2 of ESER0.
Query **:ESE0?**
Response **:ESE0 20** (when HEADER ON)
**20** (when HEADER OFF)
Bit 4 and bit 2 of ESER0 are set to 1.

## Setting and Query of Event Status Enable Register 1 (ESER1)

**Syntax**

Command **:ESE1** <Numeric Value>
Query **:ESE1?**
Response <Numeric Value>
<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command CommandSets the mask pattern of the ESER1 to a numeric value from 0 to 255.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric
The initial value (when the power is turned on) is 0.

Query Returns the ESER1 content as an NR1 numeric value.

| 128 bit 7 | 64 bit 6 | 32 bit 5 | 16 bit 4 | 8 bit 3 | 4 bit 2 | 2 bit 1 | 1 bit 0 |
|---|---|---|---|---|---|---|---|
| Unused | AND | SLO | SIN | SHI | FLO | FIN | FHI |

**Example**

Command **:ESE1 64**
Sets bit 6 of ESER1.
Query **:ESE1?**
Response **:ESE1 64** (when HEADER ON)
**64** (when HEADER OFF)
Bit 6 of ESER1 is set to 1.

## Setting and Query of Event Status Enable Register 2 (ESER2)

**Syntax**

Command **:ESE2** <Numeric Value>
Query **:ESE2?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command Sets the mask pattern of the ESER2 to a numeric value from 0 to 255.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric
The initial value (when the power is turned on) is 0.

Query Returns the ESER2 content as an NR1 numeric value.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| BIN8 | BIN7 | BIN6 | BIN5 | BIN4 | BIN3 | BIN2 | BIN1 |

**Example**

Command **:ESE2 1**
Sets bit 0 of ESER2.
Query **:ESE2?**
Response **:ESE2 1** (when HEADER ON)
**1** (when HEADER OFF)
Bit 0 of ESER2 is set to 1.

**Note**

There is no BIN function for the 3504-10.

## Setting and Query of Event Status Enable Register 3 (ESER3)

**Syntax**

Command **:ESE3** <Numeric Value>
Query **:ESE3?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Command: Sets the mask pattern of the ESER3 to a numeric value from 0 to 255.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric
The initial value (when the power is turned on) is 0.

Query: Returns the ESER3 content as an NR1 numeric value.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| DNG | OUT | BIN14 | BIN13 | BIN12 | BIN11 | BIN10 | BIN9 |

**Example**

Command **:ESE3 64**
Sets bit 6 of ESER3.
Query **:ESE3?**
Response **:ESE3 64** (when HEADER ON)
**64** (when HEADER OFF)
Bit 6 of ESER3 is set to 1.

**Note**

There is no BIN function for the 3504-10.

## Query of Event Status Register 0

**Syntax**

Query **:ESR0?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Query: Returns the event status register 0 (ESR0) setting content as NR1 numeric data from 0 to 255 and then clears that content.
No header is added to the response message.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| REF | COF | Unused | MOF | MUF | IDX | EOM | CEM |

**Example**

Query **:ESR0?**
Response **4**
Bit 2 of ESR0 is 1.

## Query of Event Status Register 1

**Syntax**

Query **:ESR1?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Query

Returns the event status register 1 (ESR1) setting content as NR1 numeric data from 0 to 255 and then clears that content.
No header is added to the response message.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| Unused | AND | SLO | SIN | SHI | FLO | FIN | FHI |

**Example**

Query **:ESR1?**
Response **82**
Bit 6, bit 4, and bit 1 of ESR1 are 1.

## Query of Event Status Register 2

**Syntax**

Query **:ESR2?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Query

Returns the event status register 2 (ESR2) setting content as NR1 numeric data from 0 to 255 and then clears that content.
No header is added to the response message.
For the 3504-10, 0 is always returned.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| BIN8 | BIN7 | BIN6 | BIN5 | BIN4 | BIN3 | BIN2 | BIN1 |

**Example**

Query **:ESR2?**
Response **1**
Bit 0 of ESR2 is 1.

## Query of Event Status Register 3

**Syntax**

Query **:ESR3?**
Response <Numeric Value>

<Numeric Value> = 0 to 255 (NR1)

**Explanation**

Query

Returns the event status register 3 (ESR3) setting content as NR1 numeric data from 0 to 255 and then clears that content.
No header is added to the response message.
For the 3504-10, 0 is always returned.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| OUT | DNG | BIN14 | BIN13 | BIN12 | BIN11 | BIN10 | BIN9 |

**Example**

Query **:ESR3?**
Response **64**
Bit 6 of ESR3 is 1.

## Setting and Query of Measurement Frequency

**Syntax**

Command **:FREQuency** <Numeric Value>
Query **:FREQuency?**
Response <Numeric Value>

<Numeric Value>=120/ 1000 (NR1)

**Explanation**

Command: Sets the measurement frequency.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query: Returns the setting of the current measurement frequency as an NR1 numeric value.

**Example**

Command
```
:FREQuency 1000
```
Sets the measurement frequency to 1 kHz.

Query
```
:FREQuency?
```
Response
```
:FREQUENCY 1000
```
(when HEADER ON)
```
1000
```
(when HEADER OFF)
The measurement frequency is set to 1 kHz.

## Setting and Query of RS-232C Communication Handshake

**Syntax**

Command **:HANDshake** <Character>
Query **:HANDshake?**
Response <Character> = X/HARDware/BOTH/OFF

| | |
|---|---|
| X | : Software handshake |
| HARDware | : Hardware handshake |
| BOTH | : Software handshake + hardware handshake |
| OFF | : No handshake |

**Explanation**

Command: Sets the communication handshake.

Query: Returns the setting of the communication handshake as characters.

**Example**

Command
```
:HANDshake X
```
Sets the communication handshake to software handshake.

Query
```
:HANDshake?
```
Response
```
:HANDshake X
```
(when HEADER ON)
```
X
```
(when HEADER OFF)
The communication handshake is set to software handshake.

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## Setting and Query of Header for Response Messages

**Syntax**

Command **:HEADer** <ON/ OFF>
Query **:HEADer?**
Response <ON/ OFF>

**Explanation**

Command: Sets whether there is a header for response messages.
This is initialized to ON when the power is turned on.

Query: Returns ON or OFF for the header setting of response messages.

**Example**

Command **:HEADer ON**
Sets a header to be added to response messages.

Query **:HEADer?**
Response **:HEADER ON** (when HEADER ON)
**OFF** (when HEADER OFF)
A header is set to be added to response messages.

## Setting and Query of Output of Judgment Result Signal Line in EXT I/O

**Syntax**

Command **:IO:RESult:RESet** <Character>
Query **:IO:RESult:RESet?**
Response <Character>=ON/OFF

ON : Resets the judgment results when the start-of-measurement signal (trigger signal) is input.
OFF : Updates the measurement results when measurement ends.

**Explanation**

Command: Sets whether to reset the judgment result signal line in EXT I/O.

Query: Returns the setting of whether to reset the judgment result signal line in EXT I/O.

**Note**

The judgment result signal line indicates judgment results for C or D-HI, C or D-IN, and C or D-LO for comparator measurement and judgment results OUT-OF-BINS, D-NG, and BIN1 to BIN14 for BIN measurement.
❖ **6.1 "Measurement Using EXT I/O" (p. 81)**

**Example**

Command **:IO:RESult:RESet OFF**
Sets the judgment results to be updated when measurement ends.

Query **:IO:RESult:RESet?**
Response **:IO:RESULT:RESET OFF** (when HEADER ON)
**OFF** (when HEADER OFF)
The judgment results are set to be updated when judgment ends.

## Setting and Query of Judgment Mode for Comparator and BIN Functions

**Syntax**

Command **:JUDGment:MODE** <Character>

Query **:JUDGment:MODE?**

Response <Character>=COUNt/DEViation

COUNt : Count value mode

DEViation: Deviation percent (⊿%) mode

**Explanation**

Command Selects the judgment mode.

Query Returns the judgment mode as characters.

**Example**

Command **:JUDGment:MODE COUNt**

Selects count value mode.

Query **:JUDGment:MODE?**

Response **:JUDGMENT:MODE COUNT** (when HEADER ON)

**COUNT** (when HEADER OFF)

The judgment mode is set to count value mode.

## Setting and Query of Key Lock Function

**Syntax**

Command **:KEYLock** <ON/ OFF>

Query **:KEYLock?**

Response <ON/ OFF>

**Explanation**

Command Sets the key lock function to ON/OFF.

Query Returns ON or OFF for the setting of the key lock function.

**Example**

Command **:KEYLock ON**

Sets the key lock function to ON.

Query **:KEYLock?**

Response **:KEYLOCK ON** (when HEADER ON)

**ON** (when HEADER OFF)

The key lock function is set to ON.

## Setting and Query of Measurement Signal Level

**Syntax**

Command **:LEVel** <Numeric Value>

Query **:LEVel?**

Response <Numeric Value>

<Numeric Value>= 1/ 0.5 (NR2)
1: 1 V, 0.5: 500 mV

**Explanation**

Command Sets the measurement signal level.
A numeric value in NRf format is accepted but non significant digits are rounded off so the numeric

Query Returns the setting of the measurement signal level as an NR2 numeric value.

**Example**

Command `:LEVel 0.5`
Sets the measurement signal level to 500 mV.

Query `:LEVel?`

Response `:LEVEL 0.5` (when HEADER ON)
`0.5` (when HEADER OFF)
The measurement signal level is set to 500 mV.

## Loading of Specified Panel Number

**Syntax**

Command **:LOAD** <Numeric Value>

<Numeric Value> = 1 to 99 (NR1)

**Explanation**

Command Loads the specified panel number.
A numeric value in NRf format is accepted but decimals are rounded off so the numeric value can be handled.

**Example**

Command `:LOAD 2`
Loads panel number 2.

## Setting and Query of Load Method

**Syntax**

Command **:LOAD:TYPE** <Character>

Query **:LOAD:TYPE?**

<Character> = ALL/ CORRection/ HARDware

ALL : Sets the device settings and compensation values to be loaded.

CORRection: Sets the compensation values to be loaded.

HARDware : Sets the device settings to be loaded.

**Explanation**

Command Sets the load method.

Query Returns the setting of the load method as characters.

**Example**

Command `:LOAD:TYPE CORRection`
Sets only the data of the compensation values to be loaded at load time.

## Setting and Query of Load Method

Query `:LOAD:TYPE?`

Response `:LOAD:TYPE CORRECTION` (when HEADER ON)
`CORRECTION` (when HEADER OFF)
Only the data of the compensation values are set to be loaded at load time.

## Query of Measurement Data

**Syntax**

Query **:MEASure?**

Response

- During normal measurement
  C <Measurement Value (NR3)>, D <Measurement Value (NR2)>
- During comparator measurement
  <Comparison Result Logical AND>,<Measurement Value of C (NR3)>,<Comparison Result of C>, <Measurement Value of D (NR2)>, <Comparison Result of D>

  <Comparison Result Logical AND>= 0/ 1
  0 When one of C and D is LO or HI or both parameters were not judged
  1 When the judgment results for both C and D are IN (within the range) or if one of the parameters was not judged but the judgment result of the judged one is IN.

  <Comparison Result>= 0/ 1/ -1/ 2
  0 : IN
  1 : HI
  -1 : LO
  2 : Not judged (when the upper limit and lower limit values are OFF)
- During BIN measurement (only for the 3504)
  <BIN Result>, <Measurement Value of C (NR3)>, <Measurement Value of D (NR2)>
  <BIN Result>=-1, -2, 1 to 14
  1 to 14 BIN No.
  -1 OUT OF BINS
  -2 DNG
  However, if not even one measurement has been performed since the settings of the unit were changed, the measurement values obtained when the previous settings were configured are returned.

**Explanation**

Query

- Normal measurement
  Returns the measurement data as NR2 and NR3 numeric values.
- Comparator measurement
  Returns the measurement values and comparison result of the comparator.
  However, if not even one measurement has been performed since the measurement mode was changed, 2 is returned for the comparison results of both C and D.
- BIN measurement (only for the 3504)
  Returns the measurement values and BIN measurement result.
  However, if not even one measurement has been performed since the measurement mode was changed, OUT OF BINS is returned for the BIN measurement result.

## Query of Measurement Data

### Example

- During normal measurement

Query
```
:MEASure?
```
Response
```
CP 1.23456E-06,D 0.12345
```
(when HEADER ON)
```
1.23456E-06,0.12345
```
(when HEADER OFF)

- During comparator measurement

Query
```
:COMParator ON
:MEASure?
```
Response
```
0,CP 1.23456E-06,0,D 0.12345,-1
```
(when HEADER ON)
```
0,1.23456E-06,0,0.12345,-1
```
(when HEADER OFF)
Indicates that the judgment result for C is IN and the judgment result for D is LO.

Query
- During BIN measurement (only for the 3504)

```
:BIN ON
:MEASure?
```
Response
```
1,CP 1.23456E-06, D 0.12345
```
(when HEADER ON)
```
1,1.23456E-06, 0.12345
```
(when HEADER OFF)
Indicates that the measurement value is within the set BIN1 range.

### Note

- The following values are returned if not even one measurement has been performed since the power was turned on.
  <Measurement Value of C>=888888E+88
  <Measurement Value of D>=888888
  Comparison Result of C and D: 2
  BIN Measurement Result: -1
- The header of C returns CS when the equivalent circuit is a series-equivalent circuit and CP when the equivalent circuit is a parallel-equivalent circuit.
- The following values are returned when over range and under range.
  Over range : <Measurement Value of C>=999999E+99
  <Measurement Value of D>=999999
  Comparison Results of C and D: 1
  BIN Measurement Result: -1
  Under Range: <Measurement Value of C>=-999999E+99
  <Measurement Value of D>=-999999
  Comparison Results of C and D: -1
  BIN Measurement Result: -1
- The following values are returned when there is a CV operation error.
  <Measurement Value of C> 777777E+77
  <Measurement Value of D> 777777
  Comparison Results of C and D: 1
  BIN Measurement Result: -1

## Query of Measurement Values Saved to Memory by the Measurement Value Memory Function

**Syntax**

Query: **:MEMory?** <Character>

Response: <Character>=No Data/ALL

- When there is no data section
  <First Item in Memory><Message Terminator><Second Item in Memory><Message Terminator>...<nth Item in Memory> <Message Terminator>
  n indicates a number up to 200.
- When the characters of the data section are ALL
  <First Item in Memory><Comma( ,)><Second Item in Memory><Comma(,)>...<nth Item in Memory><Message Terminator>

**Explanation**

Query

- Returns all of the most recent measurement values saved to memory by the measurement value memory function.
- The measurement results for a maximum of 200 most recent measurements are saved to memory.
- To delete the data from memory, use the :MEMory:CLEar command.
- The format of items in memory is the same as that of the response data of the :MEASure? query. For details on the format, refer to the explanation of the :MEASure? query (⇒ p. 162).
- A memory terminator is inserted between each memory item when :MEMory? and a comma (,) is inserted between each memory item when :MEMory? ALL.
- The number of data items currently saved to memory can be confirmed with the :MEMory:COUNt? query.
- If the trigger setting is set to internal trigger, the number of data items obtained with the :MEMory:COUNt? query and the n value may differ. Set the trigger setting to external trigger before using the :MEMory:COUNt? query.

**Example**

Query: When the measurement values for one measurement were saved to memory during normal measurement:

Response:

```
:MEMory?
CP 1.23456E-06, D 0.12345   (when HEADER ON)
1.23456E-06, 0.12345        (when HEADER OFF)
```

NOTE

GP-IB When :MEMory? is executed, only the first item in memory is returned with the first receive operation (specified talker). To obtain all measurement values saved to memory, perform the receive operation a number of times equal to the number of data items saved to memory or send :MEMory? ALL and then perform the receive operation once.

RS-232C The only difference between :MEMory? and :MEMory? ALL is whether data is separated by a message terminator or comma (,).
When :MEMory? is executed, there is no need to perform the receive operation a number of times equal to the number of data items saved to memory in order to obtain all measurement values.

## Deleting Data from Memory of Measurement Value Memory Function

**Syntax** Command **:MEMory:CLEar**

**Explanation** Command Deletes all measurement values saved to memory by the measurement value memory function.
If this command is sent, subsequent measurement values are saved from the beginning of memory.

**Example** Command `:MEMory:CLEar`
Deletes all measurement values saved to memory.

## Query of Number of Measurement Values Saved to Memory by the Measurement Value Memory Function

**Syntax** Query **:MEMory:COUNt?**
Response <Numeric Value>

<Numeric Value> = 0 to 200 (NR1)

**Explanation** Query Returns the number of data items saved to memory by the measurement value memory function as an NR1 numeric value.
No header is added to the response message.

**Example** Query `:MEMory:COUNt?`
Response `1`
Indicates that one measurement value is saved to memory.

## Setting and Query of Measurement Range

**Syntax**

Command **:RANGe** <Numeric Value>
Query **:RANGe?**
Response <Numeric Value>

<Numeric Value> = 1 to 10 (NR1)

**Explanation**

Command
Sets the measurement range.
A numeric value in NRf format is accepted but decimals are rounded off so the numeric value can be handled.
If this command is executed, the setting of the :RANGe:AUTO command is automatically changed to OFF.
If this command is executed when the setting of the equivalent circuit is set to AUTO, the setting (SER/PAR) of the equivalent circuit is automatically changed to the optimal setting.

Query
Returns the setting of the measurement range as an NR1 value from 1 to 10.

**Example**

Command **`:RANGe 5`**
Sets the measurement range to 5 (200 nF) (when 1 kHz).

Query **`:RANGe?`**
Response **`:RANGE 5`** (when HEADER ON)
**`5`** (when HEADER OFF)
The measurement range is set to 5 (200 nF) (when 1 kHz).

**Note**

| Numerical Value (Range Number) | Measurement Frequency | |
|---|---|---|
| | 120Hz | 1kHz |
| 1 | 200 pF | 20 pF |
| 2 | 2 nF | 200 pF |
| 3 | 20 nF | 2 nF |
| 4 | 200 nF | 20 nF |
| 5 | 2 µF | 200 nF |
| 6 | 20 µF | 2 µF |
| 7 | 200 µF | 20 µF |
| 8 | 700 µF (when 1 V),<br>1.45 mF (when 500 mV) | 70 µF (when 1 V),<br>170 µF (when 500 mV) |
| 9 | 2 mF | 200 µF |
| 10 | 20 mF | 2 mF |

## Automatic Setting and Query of Measurement Range

**Syntax**

Command **:RANGe:AUTO** <ON/ OFF>
Query **:RANGe:AUTO?**
Response <ON/ OFF>

ON Changes the measurement range automatically.
OFF Does not change the measurement range automatically.

**Explanation**

Command Sets the measurement range to be changed automatically.

Query Returns ON or OFF for the automatic setting of the measurement range.

**Example**

Command **:RANGe:AUTO ON**
Sets the measurement range to be changed automatically.

Query **:RANGe:AUTO?**
Response **:RANGE:AUTO ON** (when HEADER ON)
**ON** (when HEADER OFF)
The measurement range is set to be changed automatically.

## Query and Saving of Specified Panel Number

**Syntax**

Command **:SAVE** <No.>
Query **:SAVE?** <No.>
Response 0/ 1

<No.>1 to 99 (NR1)

**Explanation**

Command Specifies the panel number and saves the measurement conditions.
A numeric value in NRf format is accepted but decimals are rounded off so the numeric value can be handled.

Query Returns 1 if measurement conditions are saved for the specified number, and 0 if no measurement conditions are saved.
A numeric value in NRf format is accepted but decimals are rounded off so the numeric value can be handled.
No header is added to the response message.

**Example**

Command **:SAVE 3**
Saves the measurement conditions to Panel No. 3.

Query **:SAVE? 3**
Response **1**
Measurement conditions are saved to Panel No. 3.

## Setting and Query of Measurement Speed

**Syntax**

Command **:SPEEd** <Character>

Query **:SPEEd?**

Response <Character>

<Character> = FAST/ NORMal/ SLOW

**Explanation**

Command Sets the measurement speed.

Query Returns the setting of the measurement speed as characters.

**Example**

Command **:SPEEd NORMal**

Sets the measurement speed to normal speed.

Query **:SPEEd?**

Response **:SPEED NORMAL** (when HEADER ON)

**NORMAL** (when HEADER OFF)

The measurement speed is set to normal speed.

## Setting and Query of Synchronous Measurement Function (Special Specification for 3504)

**Syntax**

Command **:SPHase** <Character>

Query **:SPHase?**

Response <Character> = IN/OUT

IN : Operates in slave mode.

OUT : Operates in master mode.

**Explanation**

Command Sets the synchronous measurement function.

Query Returns the setting of the synchronous measurement function as characters.

**Example**

Command **:SPHase OUT**

Sets the synchronous measurement function to master mode.

Query **:SPHase?**

Response **:SPHase OUT** (when HEADER ON)

**OUT** (when HEADER OFF)

The synchronous measurement function is set to master mode.

## Setting and Query of Trigger Synchronous Output Function

**Syntax**

Command **:SSOurce** <ON/ OFF>
Query **:SSOurce?**
Response <ON/ OFF>

ON : Enables the trigger synchronous output function.
OFF : Disables the trigger synchronous output function.

**Explanation**

Command: Enables/disables the trigger synchronous output function.

Query: Returns ON or OFF for the current setting of the trigger synchronous output function.

**Example**

Command
```
:SSOurce ON
```
Enables the trigger synchronous output function.

Query
```
:SSOurce?
```
Response
```
:SSOURCE ON
```
(when HEADER ON)
```
ON
```
(when HEADER OFF)
The trigger synchronous output function is enabled.

## Setting and Query of Wait Time for Trigger Synchronous Output Function

**Syntax**

Command **:SSOurce:WAIT** <Wait Time 1>, <Wait Time 2>
Query **:SSOurce:WAIT?**
Response <Wait Time 1, 2>=0 to 9.999 (NR2)

<Wait Time 1> : Sets the wait time for a measurement frequency of 120 Hz.
<Wait Time 2> : Sets the wait time for a measurement frequency of 1 kHz.

**Explanation**

Command: Sets the wait time from after the triggered output of the measurement signal to the start of measurement.

Query: Returns the setting of the wait time for the trigger synchronous output function as a numeric value.

**Example**

Command
```
:SSOurce:WAIT 0.500,0.250
```
Sets the wait time from after the trigger to the start of measurement to 500 ms for 120 Hz and 250 ms for 1 kHz.

Query
```
:SSOurce:WAIT?
```
Response
```
:SSOURCE:WAIT 0.500,0.250
```
(when HEADER ON)
```
0.500, 0.250
```
(when HEADER OFF)
The wait time from after the trigger to the start of measurement is set to 500 ms for 120 Hz and 250 ms for 1 kHz.

**Note**

At the time of shipment, the wait time is 2 ms when 1 kHz and 10 ms when 120 Hz.
Set the optimal wait time for the DUT (device under test).
A wait time that is too short may increase measurement errors and display differences.

## Setting and Query of Terminator of Response Message

**Syntax**

Command **:TRANsmit:TERMinator** <Numeric Value>
<Numeric Value>=0 to 255(NR1)

Query **:TRANsmit:TERMinator?**

Response <Numeric Value>=0/1(NR1)

**Explanation**

Command

Sets the terminator of the response message.
A numeric value in NRf format is accepted but decimals are rounded off so the numeric value can be handled.

- When RS-232C
  CR+LF : when 0
  CR : when 1 to 255
- When GP-IB (only for the 3504)
  LF+EOI : when 0
  CR+LF+EOI : when 1 to 255

Query

Returns the setting of the terminator of the response message as NR1 numeric data of 0 and 1.

- When RS- 232C
  CR+LF : when 0
  CR : when 1
- When GP-IB (only for the 3504)
  LF+EOI : when 0
  CR+LF+EOI : when 1

**Example**

Command **:TRANsmit:TERMinator 0**

- RS- 232C
  Sets the terminator to CR+LF.
- GP-IB(3504ÇÃÇ›)
  Sets the terminator to LF+EOI.

Query **:TRANsmit:TERMinator?**

Response **:TRANSMIT:TERMINATOR 0** (when HEADER ON)
**0** (when HEADER OFF)

RS-232C : The terminator is set to CR+LF.

GP-IB : The terminator is set to LF+EOI. (Only for the 3504)

## Setting and Query of Trigger Mode

**Syntax**

Command **:TRIGger** <Character>
Query **:TRIGger?**
Response <Character>

<Character> = INTernal/ EXTernal
INTernal : Internal trigger
EXTernal : External trigger

**Explanation**

Command: Sets the trigger mode.

Query: Returns the setting of the trigger mode as characters.

**Example**

Command **:TRIGger INTernal**
Sets the trigger mode to internal trigger.

Query **:TRIGger?**
Response **:TRIGGER INTERNAL** (when HEADER ON)
**INTERNAL** (when HEADER OFF)
The trigger mode is set to internal trigger.

## Setting and Query of User ID

**Syntax**

Command **:USER:IDENtity** <ID>
Query **:USER:IDENtity?**
Response <ID>

<ID> = User ID Code (Example: AB-1234)
A to Z, a to z, 0 to 9, and - (hyphen)

**Explanation**

Command: Allows you to set an ID code for the user.
The ID code is backed up in the same manner as the settings of the unit.
If more than 12 characters are entered, only the first 12 characters are valid.
The user ID code is cleared when the system is reset.

Query: Returns the setting of the ID as characters or numeric values.

**Example**

Command **:USER:IDEN AB-1234**
Stores AB-1234 as the user ID.

Query **:USER:IDENtity?**
Response **:USER:IDENTITY AB-1234** (when HEADER ON)
**AB-1234** (when HEADER OFF)
The user ID is set to AB-1234.

# 7.9.3 Response Format of Queries for Returning Values

## Measurement Values

### C(Capacitance)<NR3>

□.□□□□□ E±□□
1 2

1: Mantissa part: 6 digit numeric value + decimal point
2: Exponent part: 2 digit numeric value

When over and under range
Over range: 999999E+99
Under range: -999999E+99

When CV operation error
777777E+77

When not even one measurement has been performed since the power was turned on
888888E+88

### D (Dissipation Factor) <NR2>

□.□□□□ Numeric value with 5 digits after the decimal point

When over and under range
Over range: 999999
Under range: -999999

When CV operation error
777777

When not even one measurement has been performed since the power was turned on
888888

## Compensation Values

### Compensation Values for Open Circuit and Short Circuit Compensation

- Residual Impedance (Z, G, B, Cp, Rs, X, Ls) <NR3>

□.□□□□□ E±□□
1 2

1: Mantissa part: 6 digit numeric value + decimal point
2: Exponent part: 2 digit numeric value

- Phase Angle <NR2>

(-) □□□.□□□
(-) □□.□□□
(-) □.□□□

1:Sign part : The only sign added is the minus sign (-) when the value is negative
2: Numeric value part: Numeric value with 3 digits after the decimal point

### Compensation Values for Load Compensation <NR2>

- **Impedance Compensation Coefficient**

□.□□□□□
□□.□□□□
□□□.□□□
□□□□.□□
□□□□□□

6 digit numeric value

- Phase Compensation Values and Phase Angle <**NR2**>

(-) □□□.□□□
(-) □□.□□□
(-) □.□□□

1:Sign part : The only sign added is the minus sign (-) when the value is negative
2: Numeric value part: Numeric value with 3 digits after the decimal point

- Residual Impedance (Z, C) <NR3>

□.□□□□□ E±□□
1 2

1: Mantissa part: 6 digit numeric value
2: Exponent part: 2 digit numeric value

- D (Dissipation Factor) <NR2>

□.□□□□□

Numeric value with 5 digits after the decimal point

## Upper Limit and Lower Limit Values for BIN and COMP

### COUNT Mode <NR1>

□□□□□

6 digit numeric value

### Δ% Mode

(-) □□□.□□
(First parameter: C<NR2>)

1:Sign part : The only sign added is the minus sign (-) when the value is negative
2: Numeric value part: Numeric value with 2 digits after the decimal point

(-) □□□□□□
(Second parameter: D<NR1>)

1:Sign part : The only sign added is the minus sign (-) when the value is negative
2: Numeric value part: 6 digit numeric value

### Wait Time for Trigger Synchronous Output Function <NR2>

□.□□□

Numeric value with 3 digits after the decimal point

# 7.10 Initialized Items

Some items are initialized when, for example, the power is turned on. Refer to the table below.

RS-232C

●: Initialized/ x: Not Initialized

| Item \ Initialization Method | Upon Power On | *RST Command | *CLS Command |
|---|---|---|---|
| Device-specific functions (range, etc.) | × | ● | × |
| Output queue | ● | × | × |
| Input buffer | ● | × | × |
| Status byte register | ● | × | ● *2 |
| Event register | ● *3 | × | ● |
| Enable register | ● | × | × |
| Current path | ● | × | × |
| Header ON/OFF | ● | ● | × |

GP-IB

(Only for the 3504)

●: Initialized/ x: Not Initialized

| Item \ Initialization Method | Upon Power On | *RST Command | Clearing of Device* | *CLS Command |
|---|---|---|---|---|
| GP-IB address | × | × | × | × |
| Device-specific functions (range, etc.) | × | ● | × | × |
| Output queue | ● | × | ● | × |
| Input buffer | ● | × | ● | × |
| Status byte register | ● | × | × *1 | ● *2 |
| Event register | ● *3 | × | × | ● |
| Enable register | ● | × | × | × |
| Current path | ● | × | ● | × |
| Header ON/OFF | ● | ● | × | × |

*1 Only the MAV bit (bit 4) is cleared.
*2 Other than the MAV bit is cleared.
*3 Excluding the PON bit (bit 7).

* This means to initialize the unit.

# 7.11 Creating Programs

This section describes an example of how to use the Windows development language Visual Basic 6.0 to operate the 3504 (3504-10) unit from a PC via RS-232C, incorporate measurement values, and save measurement values to a file.

- Windows and Visual Basic 6.0 are registered trademarks of Microsoft Corporation.

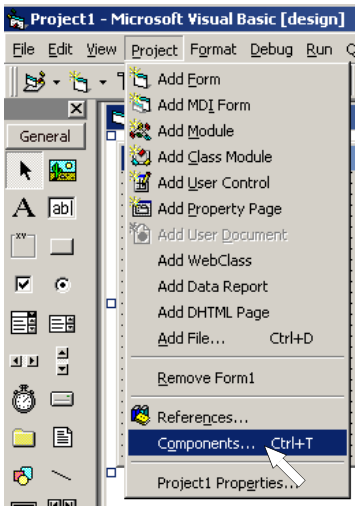
## 7.11.1 Creation Procedure

This section describes the procedure for using Visual Basic 6.0 to create programs. Visual Basic 6.0 is referred to as VB hereafter.

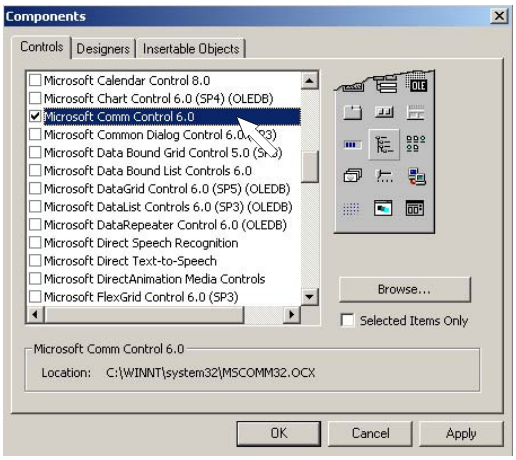
NOTE

Depending on the environment of the PC and VB, the procedure may differ slightly from the one described here. For a detailed explanation on how to use VB, refer to the instruction manual or Help of VB.

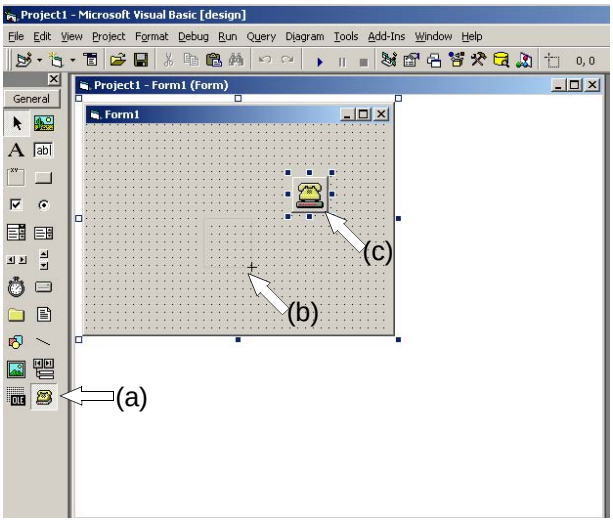

**1. Start VB, select [Standard EXE] from the New tab, and then click the [Open] button.**




**2. Select [Components] from the [Project] menu.**



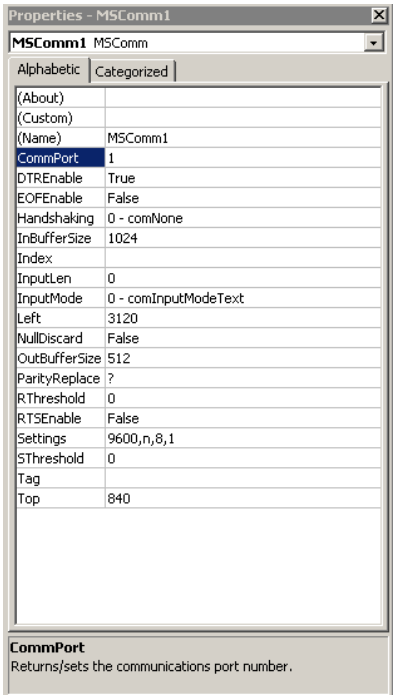

**3.** **Add a check mark to [Microsoft Comm Control 6.0] in the Controls tab of the Components dialog box and then click the [OK] button.**




**4.** **Click the (phone) icon in the tool box. (a)**

**On the form, draw a square while holding down the left mouse button, and then release the button. (b)**

The (phone) icon is placed on the form. (c)

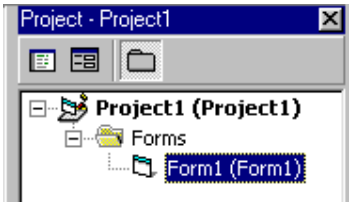



The window on the left is an object for enabling the phone icon created in Step 4 to employ VB to use the RS-232C port. This object is named "MSComm1" when it is created. Use the name "MSComm1" when you subsequently access RS-232C from VB.

**5.** **While the (phone) icon is selected, change the settings in the Properties window in accordance with the communication conditions of the 3504 (3504-10) unit and the operating conditions of the PC.**

Be especially sure to configure the following settings.

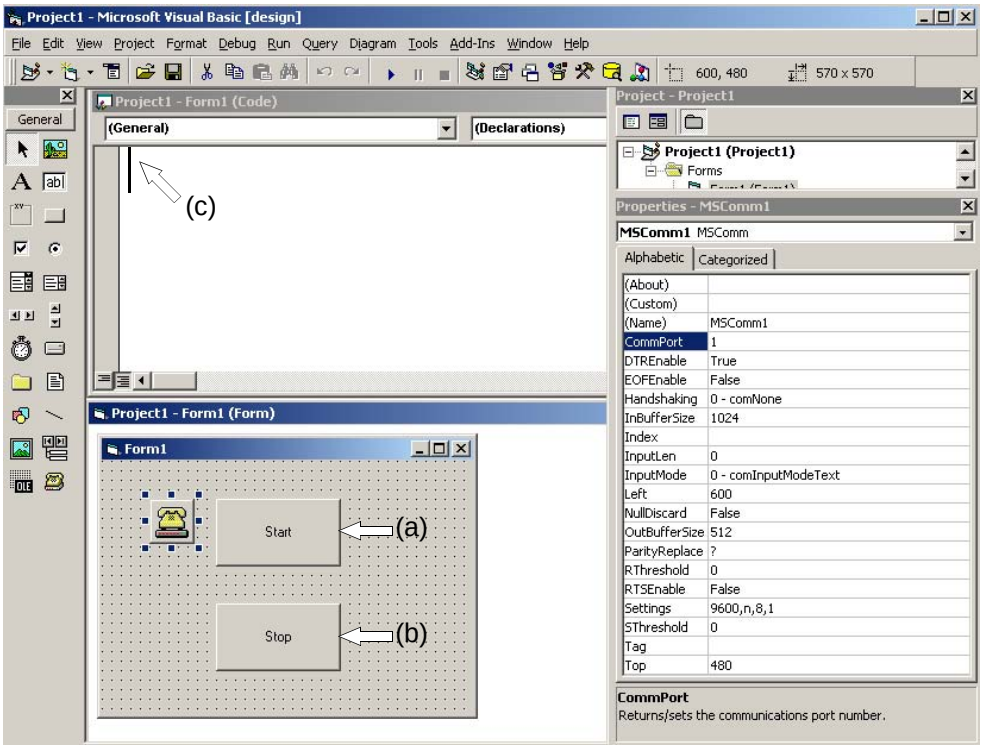
CommPort :Set the port number used by the PC.
(Example: 1 when using COM1)
Handshaking : 0-comNone
Settings : 9600,n,8,1




**6.** **Select [Form1] in the Project window and then click to display the code of Form1 in the Code window.**

Follow the procedure below so that the VB window becomes as shown in the diagram below.

- The layout and display items may differ depending on the operating environment, etc.
  Next, place buttons on Form1 as indicated by (a) and (b) and then write the program code in the window indicated by (c). Then, execute the program you created by, for example, using the execution command of VB.



# 7.11.2 Sample Programs

The following shows sample programs for using VB to communicate with the 3504 (3504-10) unit via RS-232C, incorporate measurement values, and save measurement values to a file.
The descriptions in the sample programs are as follows.

Descriptions in 7.11.1 (page 175).....Descriptions in sample programs
RS-232C Object: .....“MSComm1”
The command button created for
starting measurement (Start button):..... “Command1”
The command button created for
ending the application (Stop button):..... “Command2”

Furthermore, all of the following programs are described as Form1 code.

## 1. Program for Operating RS-232C

### Program Code

```
Private Sub COMOpen()
  MSComm1.PortOpen = True- - - - - - - - - - - - - - - - - - - '(a)
End Sub

Private Sub COMClose()
  MSComm1.PortOpen = False - - - - - - - - - - - - - - - - - - '(b)
End Sub

Private Sub COMCommand(CommandData As String)  - - - - - - - - '(c)
  MSComm1.Output = CommandData & Chr(&HD) & Chr(&HA) - - - - '(d)
End Sub

Private Function COMQuery(QueryData As String) As String- - - - - '(e)
  Dim strbuf As String
  Dim a As String
  Dim i As Integer, j As Integer, k As Integer
  COMCommand (QueryData)- - - - - - - - - - - - - - - - - - - - '(f)
  strbuf = ""
  Do While MSComm1.InBufferCount = 0 - - - - - - - - - - - - - - '(g)
  Loop
  For i = 0 To 10000
    If MSComm1.InBufferCount > 0 Then
      strbuf = strbuf & MSComm1.Input - - - - - - - - - - - - - - - '(h)
      If Asc(Right(strbuf, 1)) = &HA Then
        COMQuery = ""
        For j = 1 To Len(strbuf)- - - - - - - - - - - - - - - - - - - - -'(i)
          a = Mid(strbuf, j, 1)
          If Asc(a) > 32 Then COMQuery = COMQuery & a
        Next j
        Exit Function
      End If
    End If
  Next i
  COMQuery = "COMERROR"
End Function
```

## Program Explanation

(a) Enables use of the RS-232C port
(b) Disables use of the RS-232C port
(c) Function for sending the CommandData character string to the 3504 (3504-10) unit.
(d) Adds CR,LF to the CommandData character string and then sends the character string to the 3504 (3504-10) unit.
(e) Function for sending the CommandData character string of a command (query) with response data and then storing to COMCuery the resulting response character string returned to the PC from the 3504 (3504-10) unit.
(f) Sends the CommandData character string to the 3504 (3504-10) unit.
(g) Waits for the response character string to be returned from the 3504 (3504-10) unit.
(h) Incorporates the response character string in the strbuf variable
(i) If LF (line feed code) is at the end of the incorporated character string, other than the message terminator (CR+LF) of the character string is retrieved and stored to COMCuery.

## 2. Settings of the 3504 (3504-10) Unit

## Program Code

```
Private Sub SendSetting()
  COMCommand (":HEAD OFF")
  COMCommand (":LEV 0.5")
  COMCommand (":FREQ 1000")
  COMCommand (":TRIG EXT")
  End Sub
```

## Program Explanation

Sets the following measurement conditions of the 3504 (3504-10) unit.

Header: OFF
Signal Level : 500 mV
Measurement Frequency : 1 kHz
Trigger : External Trigger

## 3. Incorporation and Saving to File of Measurement Values of the 3504 (3504-10) Unit

### Program Code

```
Private Sub Command1_Click() - - - - - - - - - - - - - - - - - - '(a)
  Dim strbuf As String
  Dim i As Integer
  Command1.Enabled = False - - - - - - - - - - - - - - - - - - -'(b)
  Command2.Enabled = False
  COMOpen
  SendSetting
  Open "data.csv" For Output As #1 - - - - - - - - - - - - - - -'(c)
  For i = 1 To 10
    strbuf = COMQuery("*TRG;:MEAS?") - - - - - - - - - - - - - -'(d)
    Print #1, Str(i) & "," & strbuf - - - - - - - - - - - - - - -'(e)
  Next i
  Close #1
  COMClose
  Command1.Enabled = True
  Command2.Enabled = True
End Sub

Private Sub Command2_Click()
  Unload Me
End Sub
```

### Program Explanation

(a) If the Command1 command button that was created for starting measurement is clicked, the measurement conditions of the 3504 (3504-10) unit are set and the results of ten measurements are saved to the comma-separated value text file "data.csv."

(b) Disables the Start and Stop buttons during communication.

(c) Opens a "data.csv" file. However, if a file of the same name already exists, the previous "data.csv" file is deleted and a new file is created.

(d) Sends to the 3504 (3504-10) unit the command for performing one measurement and returning the measurement result to the PC, and then incorporates the measurement result in the strbuf variable.

(e) Separates the data number and measurement result with a comma and then saves them to the file opened in (b).

# 7.12 Troubleshooting the Interface

If the interface is not working properly, check the following causes and solve the problem accordingly. In particular, if you are using a PC from the NEC PC-9801 series as the controller, refer to the following because there are some precautionary notes specific to that series.
* Causes and solutions without a mark are common to both RS-232C and GP-IB.

| Symptom | Cause/Solution |
|---|---|
| RS-232C/GP-IB does not work at all. | • Is the cable connected properly?<br>• Is the power of all connected devices turned on?<br>• Is the correct cable being used?<br>• Are the settings of the communication conditions correct? RS-232C<br>• Is the address setting of the unit correct? GP-IB<br>• Is the address identical to that of another device? GP-IB |
| Cannot perform RS-232C/GP-IB communication properly. | • Are the RS-232C settings (baud rate, data bit length, parity, and stop bits) of the 3504 (3504-10) unit and PC the same? RS-232C<br>• Configure the message terminator (delimiter) of the controller properly. GP-IB<br>❖ "Message Terminator" (p. 101) |
| The keys do not work after using RS-232C/GP-IB for communication. | • Press the **LOCAL** key on the panel of the unit to cancel the remote state.<br>• Was the LLO (local lockout) command sent?<br>• Send the GTL command to switch to the local state. GP-IB |
| The program stops when attempting to read data in INPUT. RS-232C | • Be sure to send a query each time before INPUT.<br>• Did the sent query generate an error? |
| The GP-IB path is stopped when attempting to read data in INPUT @ (ENTER). GP-IB | • Be sure to send a query each time before INPUT @ (ENTER).<br>• Did the sent query generate an error? |
| An operation is not performed even though the command was sent. | • Use ***ESR?** to view the content of the standard event status register and confirm the type of error.<br>• Use ***ERR?** to check whether an RS-232C communication error was generated. RS-232C |
| The number of read data sections was insufficient (PC-9801). | • Try using LINE INPUT for data including a comma (,). |
| Only one response was returned despite sending multiple queries. | • Was an error generated?<br>• Perform one read for each query sent. When you want them to be read in one go, use message separators and place the description on a single line. |
| The query response message differs from the indications on the panel. | • The indications when the controller performs the read may sometimes not match because the response message is created when the unit receives the query. |

| Symptom | Cause/Solution |
|---|---|
| Service requests are sometimes not generated. GP-IB | • Are the service request enable register and each event status enable register configured properly?<br>• At the end of the SRQ process subroutine, use an ***CLS** command to clear all event registers. If the bits of an event are not cleared once, a service request will not be generated for the same event. |
| Service requests do not function properly (PC-9801). GP-IB | • When using N88BASIC, add the following four lines (command to set the SRQ flag of a PC-9801 to OFF) to the SRQ process subroutine<br>DEF SEG=SEGPTR(7)<br>A%=PEEK(&H9F3)<br>A%=A% AND &HBF<br>POKE &H9F3,A% |
| A beep tone is played if a TRG command is sent. | • Is the trigger setting configured to internal trigger?<br>• The ***TRG** command is only valid for the external trigger setting. The internal trigger setting generates an execution error. |
| The hardware handshake is not functioning properly. RS-232C | • Is a cable that has CA (RTS) and CB (CTS) shorted being used? Use a cross cable that does not have CA (RTS) and CB (CTS) shorted. |

# 7.13 Device Document Requirements (Only for the 3504)

GP-IB

Standard implementation method related information based on the IEEE 488.2 standard

(1) Functionality of IEEE 488.1 interface function

This is included in 7.2.2 "GP-IB Specifications (Only for 3504)" (p. 93).

(2) Explanation of operation when the address is set to other than a value from 0 to 30.

Such a setting is not possible.

(3) Recognition of change to the address initially set by the user

The change to the address is recognized when the address is changed.

(4) Explanation of the device settings at power on

The status information is cleared. Other information is backed up. However, the header and response message terminator are initialized.

(5) Description of message exchange options

- Capacity and operation of input buffer
  This is included in7.6.2 "About the Output Queue and Input Buffer" (p. 104).
- Queries that return multiple response message units

:BIN:FLIMit:COUNt? .....3
:BIN:FLIMit:DEViation? .....3
:BIN:SLIMit:COUNt? .....3
:BIN:SLIMit:DEViation? .....3
:COMParator:FLIMit:COUNt? .....2
:COMParator:FLIMit:DEViation? .....3
:COMParator:SLIMit:COUNt? .....2
:COMParator:SLIMit:DEViation? .....3
:CORRection:DATA? .....4
:CORRection:LOAD:DATA? .....2
:CORRection:LOAD:REFerence? .....2
:MEASure? ..... 2, 3, 5
:MEMory? .....1 to 200

- Queries that result in the creation of a response once the syntax is checked
  All queries result in the creation of responses once the syntax is checked.
- Use/non use of queries that result in a response being created upon being read
  Queries that result in a response being created when they are read by the controller are not used.
- Use/non use of a coupling command
  There is no such command.

(6) List of the functional elements used for device-specific commands and explanation of whether to use compound command program headers

The following are used
- Program message
- Program message terminator
- Program message unit
- Program message unit separator
- Command message unit
- Query message unit
- Command program header
- Query program header
- Program data
- Character program data
- Decimal numeric program data
- Compound command program header

(7) Explanation of buffer capacity limits related to block data

Block data is not used

(8) List of program data elements used in <expression> and maximum nesting level for sub-expressions (including syntax rules assigned for <expression> by device)

Sub-expressions are not used. The program data elements used are character program data and decimal numeric program data.

(9) Explanation of response syntax for each query

The response syntax is included in 7.9 "Message Reference" (p. 124).

(10) Explanation of delay in sending messages between devices not following response message element rules

Messages are not sent between devices

(11) Explanation of block data response capacity

There is no block data response.

(12) List of the common commands and queries used

This is included in 7.7 "Message List" (p. 112).

(13) Explanation of the device state after the calibration command ends without a problem

The *CAL? command is not used

(14) Use/non use of the "*DDT" command

In the case of a *DDT command being executed, the maximum block length used to define the trigger macro.
The *DDT command is not used.

(15) Use/non use of the macro command

In the case of the macro command being executed, the maximum macro label length, the maximum block length used to define the macro, and how to process reflection when extending the macro.
The macro command is not used.

(16) Explanation of queries related to the identification and response for the *IDN? query

These are defined in 7.9.1 "Common Commands" (p. 125).

(17) Capacity of the user data storage area protected by executing the *PUD command and *PUD? query

The *PUD command and *PUD? query are not used. Furthermore, there is no user data storage area.

(18) Explanation of resources when the *RDT command and *RDT? query are used

The *RDT command and *RDT? query are not used. Furthermore, there is no user data storage area.

(19) Explanation of effect of *RST, *LRN?, *RCL?, and *SAV

*LAN?, *RCL?, and *SAV are not used. The *RST command returns the unit to the initial state.
(Refer to 7.9.1 "Common Commands" (p. 125), 7.10 "Initialized Items" (p. 174).)

(20) Explanation of the range of the self test executed by the *TST? query

This is included in the section on *TST?(page 126) in 7.9.1 "Common Commands".

(21) Explanation of additional structure for the status data used in the status report of the Device

This is included in 7.6.4 "About Event Registers" (p. 107).

(22) Explanation of whether each command is an overlap or sequential command

All commands except :MEASure?, :MEMory?, :CORRection:OPEN, :CORRection:SHORt, and :CORRection:LOAD are sequence commands.

(23) Explanation of criteria related to the function requested when an operation end message is generated as a response for a command

The operation end message is generated when the command is analyzed.

# Specifications Chapter 8

## 8.1 Basic Specifications

### Product Specifications

| | |
|---|---|
| Measurement items | C (capacitance), D (dissipation factor tanδ) |
| Measurement Frequency | 120 Hz, 1 kHz<br>Frequency accuracy: ±0.01% or less |
| Measurement Signal Level | (1) Constant voltage mode: 500 mV, 1 V<br>Measurement range<br>CV1V: to 70 µF range (measurement frequency: 1 kHz)<br>CV1V: to 700 µF range (measurement frequency: 120 Hz)<br>CV500 mV: to 170 µF range (measurement frequency: 1 kHz)<br>CV500 mV: to 1.45 mF range (measurement frequency: 120 Hz)<br>Signal level accuracy of ±10% ± 5 mV<br>(2) Open terminal voltage mode: 500 mV, 1 V<br>Measurement range: other than above<br>Output resistance: 5Ω±1Ω<br>Signal level accuracy: ±10% ± 5 mV |
| Guaranteed Accuracy Range | C : 0.9400 pF to 20.0000 mF<br>D : 0.00001 to 1.99000 |
| Measurement Range | C : 009.400 pF to 20.0000 mF (120 Hz, 10 range)<br>00.9400 pF to 2.00000 mF (1 kHz, 10 range)<br>Auto, manual (up, down) |
| Equivalent Circuit Mode | Series and parallel equivalent circuit modes<br>Auto, manual |
| Measurement Time | Representative value: 2.0 ms (measurement frequency: 1 kHz, measurement speed: FAST)<br>* The measurement speed differs depending on the measurement frequency and measurement speed. |
| Measurement Speed | FAST, NORMAL, SLOW |
| Trigger Function | Setting of internal trigger or external trigger is possible |
| Zero Compensation | Open circuit and short circuit compensation is possible |
| Load Compensation | Measuring the sample to be used as the standard sample and then compensating the measurement values is possible |
| Trigger Synchronous Output Function | Applying a measurement signal only during measurement is possible |
| Key Lock Function | The setting and canceling of this function by pressing a key on the front panel is possible |
| BIN Measurement (Only for the 3504) | The setting of 14 categories for C and upper limit and lower limit values for D is possible (absolute value setting, ⊿% setting) |
| Comparator | The setting of the upper limit and lower limit values of each of C and D is possible (absolute value setting, ⊿% setting) |

## Product Specifications

| | |
|---|---|
| Panel Save and Load | The saving of 99 sets of measurement conditions is possible<br>The reading of any measurement condition (readable settings: ALL, compensation values only, and measurement conditions only) by pressing a key or sending a EXT.I/O control signal is possible |
| Buzzer Tone | Setting the buzzer for comparator judgment results (IN or NG) to ON or OFF is possible |
| Synchronous Measurement Function<br>(The 3504 special specification) | Performing phase synchronous measurement is possible if an external connector is connected |
| Printer Function | Printing measurement values is possible<br>* The 9442 and 9444 options are required |

## Basic Specifications

| | |
|---|---|
| Display Device | LED |
| Operating Temperature and Humidity Ranges | 0 to 40°C (32°F to 104°F), 80% RH or less, no condensation |
| Storage Temperature and Humidity Ranges | -10 to 55°C (14°F to 131°F), 80% RH or less, no condensation |
| Location of Use | Indoors, Altitude of 2000 m (6562-ft.) or less |
| Rated Power Voltage | 100, 120, 220, and 240 V AC are settable<br>(Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) |
| Rated Power Frequency | 50/ 60 Hz |
| Maximum Rated Apparent Power | 110 VA |
| Dimensions and Mass | Approx. 260 W x 100 H x 220 D mm(10.24”W x 3.94”H x 8.66”D) (excluding protrusions), Approx. 3.8 kg (134 oz.) |
| Guaranteed accuracy period | 6 months |
| Specification Compliance | EMC EN61326 Class A<br>EN61000-3-2<br>EN61000-3-3<br>Safety EN61010<br>Pollution degree 2 |
| Radiated Immunity Level | C: 6% rdg, D: 0.06 at 10 V/m |
| Conducted Immunity Level | C: 0.2% rdg, D: 0.005 at 3 V |
| Withstand Voltage | Between the power wire and ground wire: 1.69 kV AC for 15 seconds |
| Backup Battery (Lithium Battery) Lifespan | Approx. 6 years |
| Interfaces | EXT I/O (standard)<br>RS-232C Interface (standard)<br>GP-IB Interface (only for the 3504) |
| Standard Accessories | • 2 pin power cord with ground<br>• Instruction manual<br>• Spare fuse for power supply<br>(Select from 100 to 120 V and 220 to 240 V in accordance with destination)<br>For 100 to 120V: 250VF1.0AL ϕ5 x 20 mm<br>For 220 to 240V: 250VF0.5AL ϕ5 x 20 mm |

# Basic Specifications

| | |
|---|---|
| Options | Probes and Fixtures<br>• 9140 4-Terminal Probe<br>• 9143 Pincher Probe<br>• 9261 Test Fixture<br>• 9262 Test Fixture<br>• 9263 SMD Test Fixture<br>• 9677 SMD Test Fixture<br>• 9699 SMD Test Fixture<br><br>Printer Related<br>• 9442 Printer (DPU-414 Seiko Instruments Inc.)<br>• 9443-01 AC Adapter (for Japan) (PW-4007-J1-E or PW-4007-JU1-E (power cord CB-JP01-18B-E), Seiko Instruments Inc.)<br>• 9443-02 AC Adapter (for EU) (PW-4007-E1-E, Seiko Instruments Inc.)<br>• 9443-03 AC Adapter (for USA) (PW-4007-U1-E, Seiko Instruments Inc.)<br>• 9444 Connection Cable (for the printer)<br>• 1196 Recording Paper<br><br>Cables<br>• 9151-02 GP-IB Connector Cable<br>• 9151-04 GP-IB Connector Cable<br>• 9679 Connection Cable (phase synchronization cable) |

# 8.2 Accuracy

## Basic Accuracy

Guaranteed accuracy for temperature and humidity ranges: 23±5°C, 80% RH or less (no condensation)
Warm-up time: 1 hour

Measurement Accuracy = Basic Accuracy × Measurement Signal Level Coefficient × Measurement Speed Coefficient × Cable Length Coefficient × Temperature Coefficient

| | | | |
|---|---|---|---|
| Measurement signal level | 500 mV | 1 V | |
| Coefficient | 1 | 1 | |
| Measurement speed | FAST | NORMAL | SLOW |
| Coefficient | 1.5 | 1.2 | 1 |
| Cable length | 0 m | 1 m | |
| Coefficient | 1 | 1.5 | |
| Temperature*1 | t = Operating temperature ( °C) | | |
| Coefficient | 1 + 0.1 x \| t-23 \| | | |

*1:The coefficient is 1 when the operating temperature (t) is 23±5°C.

**Measurement Conditions**

Measurement signal level: 1 V
Measurement speed: SLOW
Executing open circuit and short circuit compensation
Cable length: 0 m

### C-D (CL: electrostatic capacitance [pF] of sample, , CH: electrostatic capacitance [mF] of sample) when D ≤ 0.1

| Range No. | Frequency Parameter | Guaranteed Accuracy of 6 Months | | Guaranteed Accuracy of 1 Year | |
|---|---|---|---|---|---|
| | | 120 Hz | 1 kHz | 120 Hz | 1 kHz |
| 1 | C | ±0.20%rdg.±300dgt. | ±0.20%rdg.±300dgt. | ±0.30%rdg.±450dgt. | ±0.30%rdg.±450dgt. |
| | D | ±0.0120±2/CL | ±0.0120±0.25/CL | ±0.0180±3/CL | ±0.0180±0.375/CL |
| 2 | C | ±0.20%rdg.±60dgt. | ±0.20%rdg.±60dgt. | ±0.30%rdg.±90dgt. | ±0.30%rdg.±90dgt. |
| | D | ±0.0020±2.2/CL | ±0.0020±0.265/CL | ±0.0030±3.3/CL | ±0.0030±0.3975/CL |
| 3 | C | ±0.16%rdg.±20dgt. | ±0.14%rdg.±20dgt. | ±0.24%rdg.±30dgt. | ±0.21%rdg.±30dgt. |
| | D | ±0.0036 | ±0.0036 | ±0.0054 | ±0.0054 |
| 4 | C | ±0.15%rdg.±15dgt. | ±0.13%rdg.±15dgt. | ±0.23%rdg.±23dgt. | ±0.20%rdg.±23dgt. |
| | D | ±0.0020 | ±0.0020 | ±0.0030 | ±0.0030 |
| 5 | C | ±0.15%rdg.±15dgt. | ±0.13%rdg.±15dgt. | ±0.23%rdg.±23dgt. | ±0.20%rdg.±23dgt. |
| | D | ±0.0016 | ±0.0016 | ±0.0024 | ±0.0024 |
| 6 | C | ±0.15%rdg.±15dgt. | ±0.09%rdg.±10dgt. | ±0.23%rdg.±23dgt. | ±0.14%rdg.±15dgt. |
| | D | ±0.0020 | ±0.0016 | ±0.0030 | ±0.0024 |
| 7 | C | ±0.25%rdg.±20dgt. | ±0.13%rdg.±15dgt. | ±0.38%rdg.±30dgt. | ±0.20%rdg.±23dgt. |
| | D | ±0.0035 | ±0.0030 | ±0.00525 | ±0.0045 |
| 8 | C | ±1.2%rdg.±50dgt. | ±0.7%rdg.±40dgt. | ±1.8%rdg.±75dgt. | ±1.05%rdg.±60dgt. |
| | D | ±0.0060 | ±0.0050 | ±0.0090 | ±0.0075 |
| 9 | C | ±1.2%rdg.±50dgt. | ±0.7%rdg.±40dgt. | ±1.8%rdg.±75dgt. | ±1.05%rdg.±60dgt. |
| | D | ±0.0060 | ±0.0050 | ±0.0090 | ±0.0075 |
| 10 | C | ±2.5%rdg.±50dgt. | ±2.0%rdg.±40dgt. | ±3.75%rdg.±75dgt. | ±3.0%rdg.±60dgt. |
| | D | ±0.0200±0.008x$C_H$ | ±0.0180±0.08x$C_H$ | ±0.0300±0.012x$C_H$ | ±0.0270±0.12x$C_H$ |

## Support for Range Numbers and Range Names

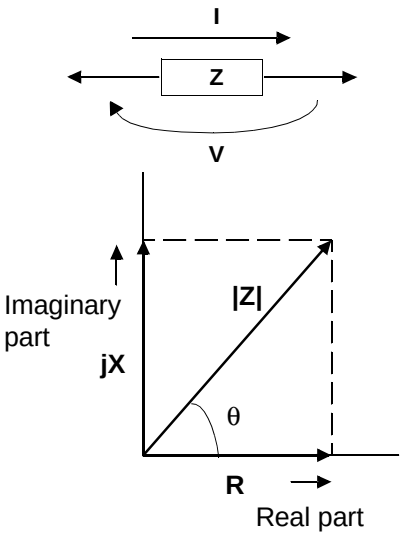
| Parameter | C | | CV Operation |
|---|---|---|---|
| Frequency Range No. | 120 Hz | 1 kHz | |
| 1 | 200 pF | 20 pF | Yes |
| 2 | 2 nF | 200 pF | Yes |
| 3 | 20 nF | 2 nF | Yes |
| 4 | 200 nF | 20 nF | Yes |
| 5 | 2 µF | 200 nF | Yes |
| 6 | 20 µF | 2 µF | Yes |
| 7 | 200 µF | 20 µF | Yes |
| 8 | 700 µF (when 1 V)<br>1.45 mF (when 500 mV) | 70 µF (when 1 V)<br>170 µF (when 500 mV) | Yes |
| 9 | 2 mF | 200 µF | No |
| 10 | 20 mF | 2 mF | No |

**NOTE**

- When D>0.1, the measurement values are the reference values.
- Using the 3504 or 3504-10 to measure a high-volume capacitor that uses a transformer may cause the transformer to enter into the feedback loop of the constant voltage (CV), causing the loop to become unstable, which can lead to problems such as measurement inaccuracies and CV error display.
  Not using a capacitor that removes the direct current (DC) in order for the 3504 or 3504-10 to conduct measurements at high speeds will cause the Hc terminal's mV degree DC will overlap, resulting in continued DC flow that will affect measurement accuracy.

# 8.3 Measurement Parameters and Arithmetic Expressions

In general, impedance Z is used to evaluate the characteristics of, for example, circuit components.
Measure voltage and current vectors for circuit components relative to AC measurement frequency signals. The unit uses these values to obtain the impedance Z and phase difference θ. The following values can be obtained from impedance Z by rotating the impedance Z around the complex plane.



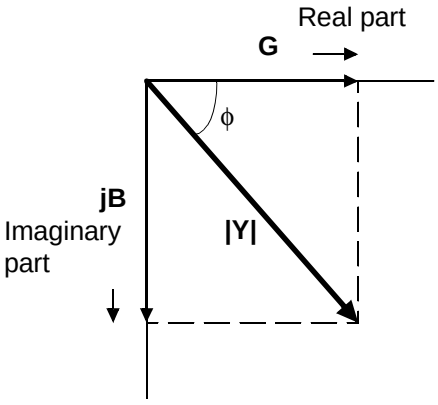

$$Z = R + jX = |Z| \angle \theta$$

$$\theta = \tan^{-1} \frac{X}{R}$$

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

$Z$ : Impedance (Ω)
$\theta$ : Phase angle (deg)
$R$ : Resistance (Ω)
$X$ : Reactance (Ω)
$|Z|$ : Absolute value of impedance (Ω)

Furthermore, admittance Y that is the reciprocal of impedance Z can also be used depending on the characteristics of circuit components. As in the case of impedance Z, the following values can also be obtained from admittance Y by rotating the admittance Y around the complex plane




$$Y = G + jB = |Y| \angle \phi$$

$$\phi = \tan^{-1} \frac{B}{G}$$

$$|Y| = \sqrt{G^2 + B^2}$$

Y : Admittance (S)
$\phi$ : Phase angel (deg) = $-\theta$
G : Conductance (S)
B : Susceptance (S)
|Y| : Absolute value of admittance (S)

The unit calculates each of the elements using the following arithmetic expressions, based on a voltage V applied between terminals of the measurement sample, a current I that flows through the sample at that time, a phase angle θ between voltage V and current I, and an angle speed ω of the measurement frequency.

| Item | Series Equivalent Circuit Mode | Parallel Equivalent Circuit Mode |
|---|---|---|
| **Z** | $\|Z\| = \frac{V}{I} (= \sqrt{R^2 + X^2})$ | |
| **C** | $Cs = -\frac{1}{\omega \|Z\| \sin \theta}$ | $Cp = \frac{\sin \theta}{\omega \|Z\|}$ |
| **D** | $D = \left\|\frac{1}{\tan \theta}\right\|$ | |

Cs indicates the measurement item of C in the series equivalent circuit mode
Cp indicates the measurement item of C in the parallel equivalent circuit mode.

# Maintenance and Service Chapter 9

## 9.1 Inspection, Repair, and Cleaning

### To ensure safe use, periodically inspect the unit

**⚠WARNING**

**Never modify the unit. Only Hioki service engineers should disassemble or repair the unit. Failure to observe these precautions may result in fire, electric shock, or injury.**

**⚠CAUTION**

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

n any of the following cases, stop using the unit, disconnect the power cord, and contact your dealer or Hioki representative.

- The unit is clearly damaged.
- Measurement is not possible.
- The unit was stored for a prolonged period of time in a very hot and humid location or other unfavorable conditions.
- Rough transportation resulted in stress being applied.
- The unit has become wet with water or dirty with oil or dust.
- If the unit becomes wet with water or oil and dust enters inside, the risk of an electrical accident or fire will be greatly increased as a result of deterioration of the insulation.

In the following case, submit the unit to be repaired by our repair service personnel.

- Measurement conditions can no longer be saved.
  The unit contains a built-in backup lithium battery, which offers a service life of about six years. Measurement conditions can no longer be saved after the life of the battery runs out.

9

### Transportation

**NOTE**

- Pack the unit so that it will not sustain damage during shipping, and include a description of existing damage. We cannot accept responsibility for damage incurred during shipping.
- Use the original packing materials when transporting the unit, if possible.

## Before Submitting the Unit for Repairs

| Symptom | Check Item | Solution |
|---|---|---|
| No indications appear on the display when the power switch is turned on. | Is the power cord disconnected? | Connect the power cord. |
| | Is the fuse blown? | Replace the fuse. |
| Key input is not possible. | Is the key lock set? | Cancel the key lock. |
| | Is the unit being remotely operated from an external device using GP-IB? | Switch GP-IB to local |
| | Is the unit being remotely operated from an external device using RS-232C? | Switch RS-232C to local. |
| Measurement values are not displayed. | Is the slave setting set? | Set the setting to master<br>❖ 4.3 "Synchronous Measurement Function (3504 special specification)" (p. 60) |
| | Is the unit in a trigger synchronous output state? | Cancel the trigger synchronous output state<br>❖ 4.4 "Trigger Synchronous Output Function" (p. 62) |
| "i-ovEr Error" appears in the MAIN display area. | Were large capacitance components and other low-impedance components measured at range 8 for a prolonged period? | Open the measurement terminal and press ENTER. |
| "- - - - - -" appears in the MAIN display area. | Are all the measurement terminals open? | Connect the probe or fixture to the unit. |
| | Is there a high contact resistance between the measurement terminal and sample? | Gently wipe the measurement terminals with a cloth. |
| | Is the cable of the probe or fixture disconnected? | Submit the fixture for repair. Replace the probe with a new one. (The probe cannot be repaired.) |
| Do not know what the cause is. | | Try resetting the system.<br>❖ 5.2 "Performing a System Reset" (p. 76) |

## Cleaning

⚠CAUTION

To clean the unit, 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.

# 9.2 Replacing the Power Fuse

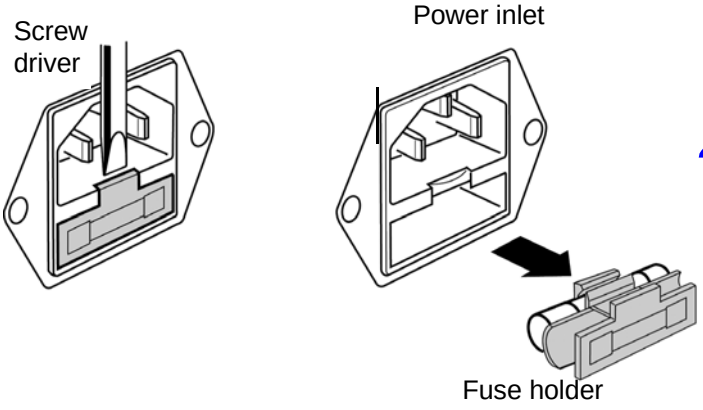
**WARNING**

- **To avoid an electric accident, be sure to turn the power switch off and disconnect the power cord before replacing the fuse or switching the power voltage.**
  **Afterwards, be sure to check that the power voltage set for the power switch with power selectors on the rear of the unit and the voltage to be used match before reconnecting the power cord.**
- **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 setting: 250 V F1.0AL ϕ5 mm x 20 mm**
  **220 V 240 V setting: 250 V F0.5AL ϕ5 mm x 20 mm**
- **Prior to shipment, the power voltage is set and the fuse designated for that power voltage is included (same applies for the spare fuse). If you want to set another power voltage, be sure to replace the fuse with one of the designated rating.**
- **If you want to use a power voltage other than one indicated, set the corresponding power voltage setting shown below.**
  **Set the power voltage to 110 V →120 V/ 200V→220 V/230 V→240 V**

❖ 2.2 "Checking the Power Voltage" (p. 16)

## Removing the Fuse Holder

Rear panel of the unit

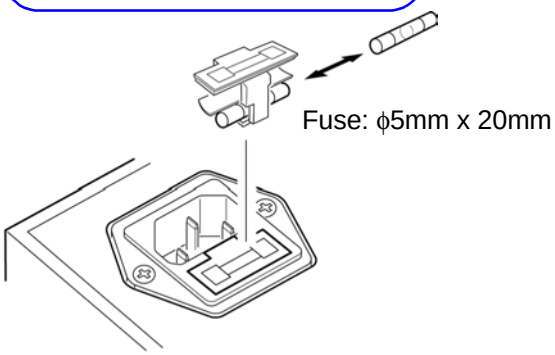



Tools to Prepare: Flat blade screwdriver

1. Turn off the power switch and disconnect the power cord.

2. Align the flat blade screwdriver with the fuse holder securing part of the power inlet and then remove the fuse holder by pushing the handle of the screwdriver toward the opposite side of the unit.

## Replacing the Power Fuse




3. Replace the power fuse with a fuse of the designated rating.

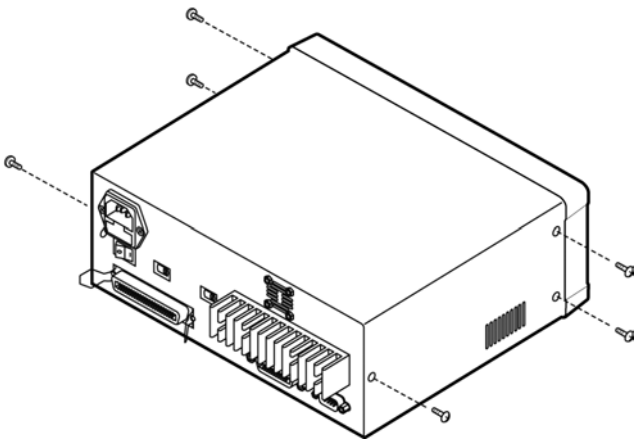
4. Reinsert the fuse holder in the power inlet.

# 9.3 Discarding the Unit

The unit uses a lithium battery as power for storing measurement conditions.

**⚠WARNING**

- **To avoidelectric shock, turn off the power switch and disconnect the power cord, probes, and fixtures before removing the lithium battery.**
- **When disposing of this unit, remove thelithium battery and dispose of battery and unit in accordance with local regulations.**
- **If the protective functions of the unit are damaged, either remove it from service or mark it clearly so that others do not use it inadvertently.**

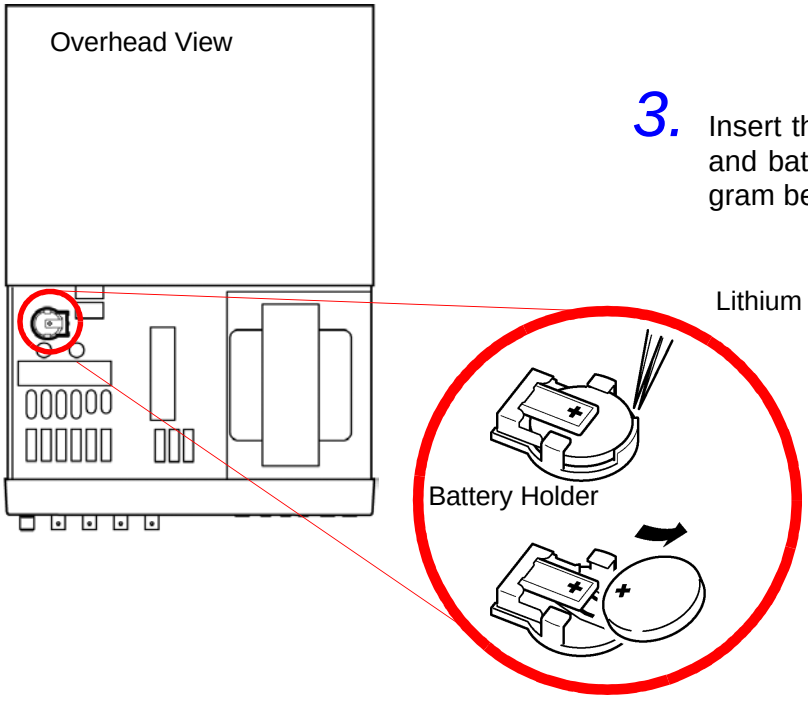


Tools to Prepare:

- One Phillips screwdriver
- Pair of tweezers

1. Remove the six screws from the sides of the unit.

2. Remove the case.




3. Insert the tweezers between the battery and battery holder as shown in the diagram below and lift up the battery.

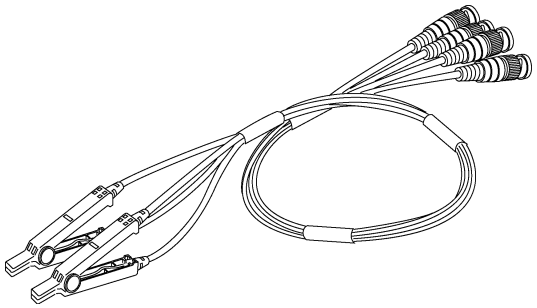
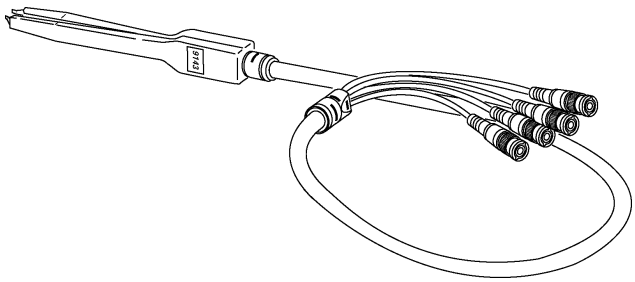
**NOTE**

Take care not to short the + and -. Doing so may cause sparks.

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

# Options Chapter 10

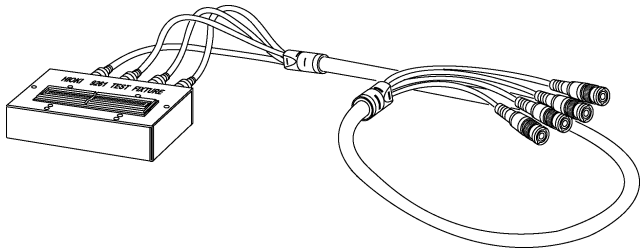
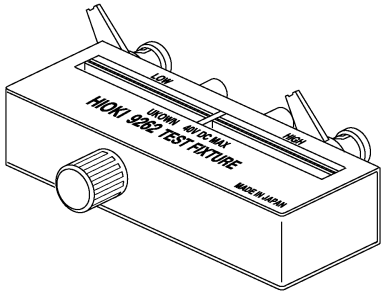
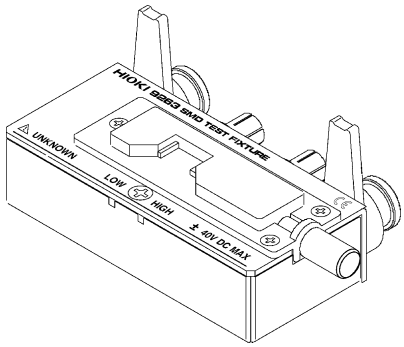
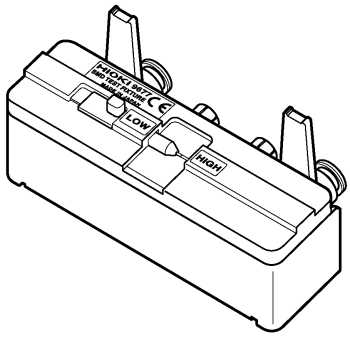
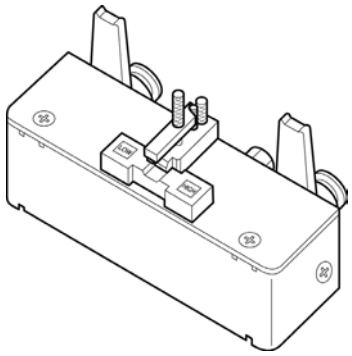
## Probes

| | |
|---|---|
| 9140 4-Terminal Probe<br><br>This is an alligator clip measurement probe. It is a versatile probe that can be clipped on wires ranging from relatively thin to thick. |  |
| 9143 Pincher Probe<br><br>This pincher probe is convenient for measuring components such as chips.<br>The impedance range that can be measured differs depending on the frequency. |  |

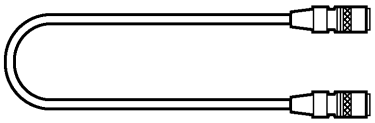
NOTE

Try your best to ensure even force is applied when using a probe. Since the contact resistance varies depending on the contact pressure, uneven force may cause variations in values.

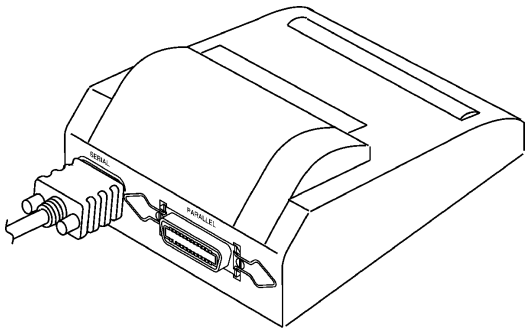
## Fixtures

| | |
|---|---|
| 9261 Test Fixture<br><br>It is relatively easy to attach and remove samples when you use this type of fixture. |  |
| 9262 Test Fixture |  |
| 9263 SMD Test Fixture<br><br>This fixture is suitable for measuring components such as chips. |  |
| 9677 SMD Test Fixture |  |
| 9699 SMD Test Fixture |  |

## Connection Cables

| | |
|---|---|
| 9679 Connection Cable<br><br>Use this cable when using the synchronous measurement function |  |

## Printer

| | |
|---|---|
| 9442 Printer<br><br>Use this cable when using the synchronous measurement function<br>• 9443-01 AC Adapter (when using the printer in Japan)<br>• 9443-02 AC Adapter (when using the printer in the EU)<br>• 9443-03 AC Adapter (when using the printer in the U.S)<br>• 9444 Connection Cable<br>• 1196 Recording Paper |  |

# Appendix

## Appendix 1 Mounting the Unit in a Rack

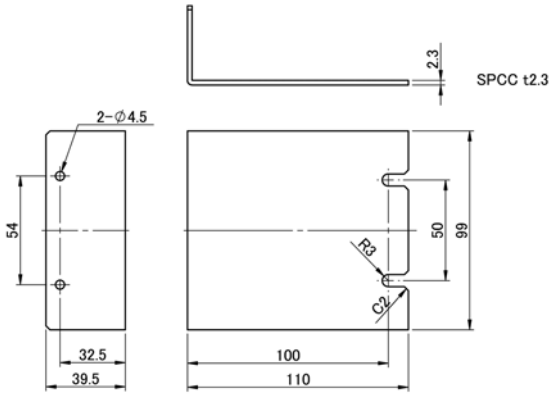
You can remove the screws on the sides of the unit and attach rack mounting brackets.

**WARNING**

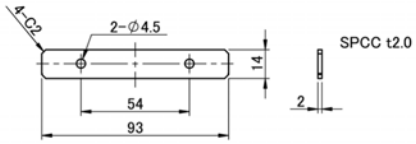
**To avoid damage to the unit or an electrical accident, be sure to observe the following precautions on using screws.**

- **Ensure that the screws used to attach the rack mounting brackets to the sides of the unit are not screwed into the unit more than 6 mm.**
- **If the rack mounting brackets are removed, be sure to use screws identical to the ones used originally.**
  **(Support legs: M3 x 6 mm, side covers: M4 x 6 mm)**

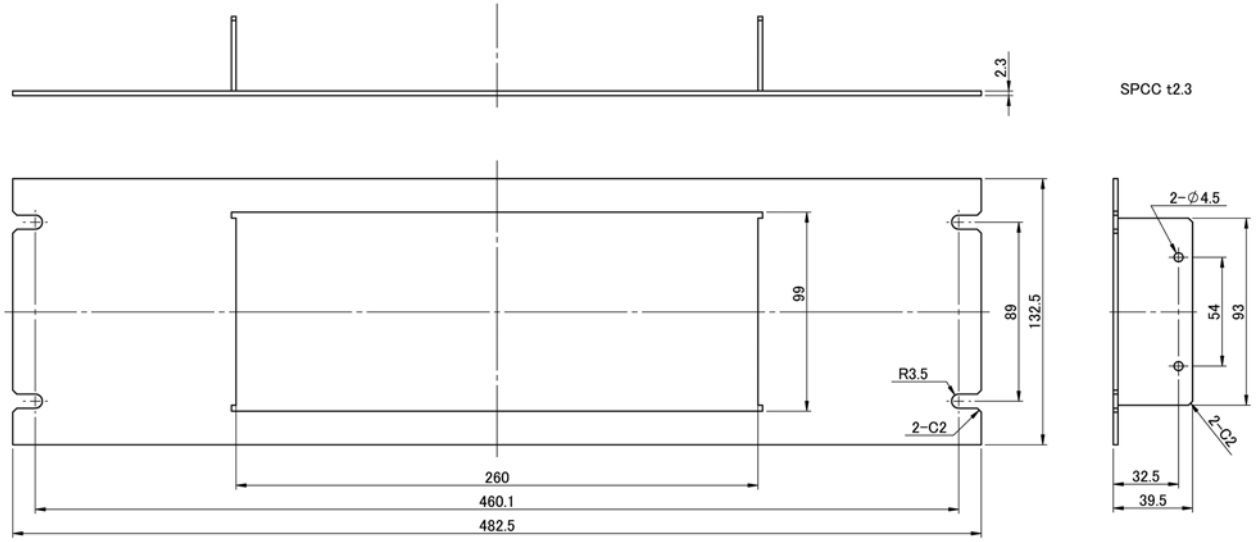
### Reference Diagrams and Attachment Procedure for Rack Mounting Brackets




Rack Mounting Bracket (JIS)

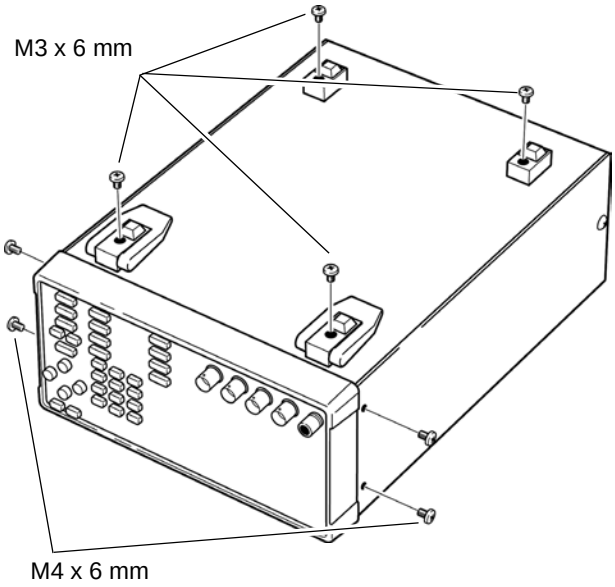



Spacers (Use 2)



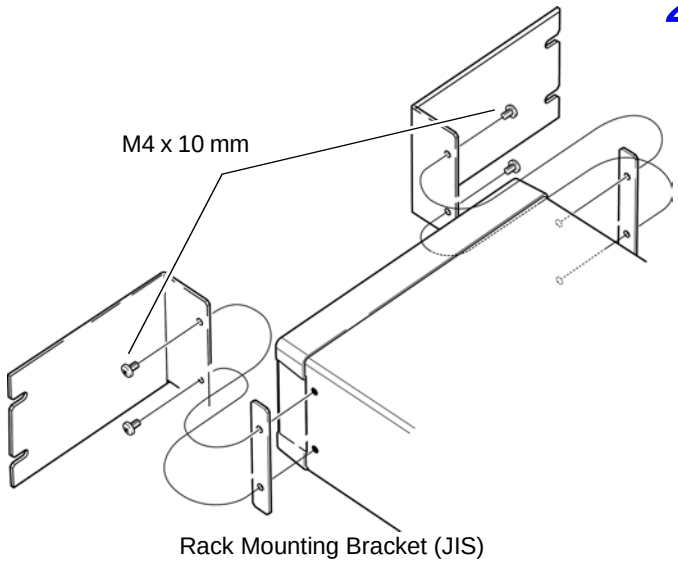

Rack Mounting Bracket (EIA)

App

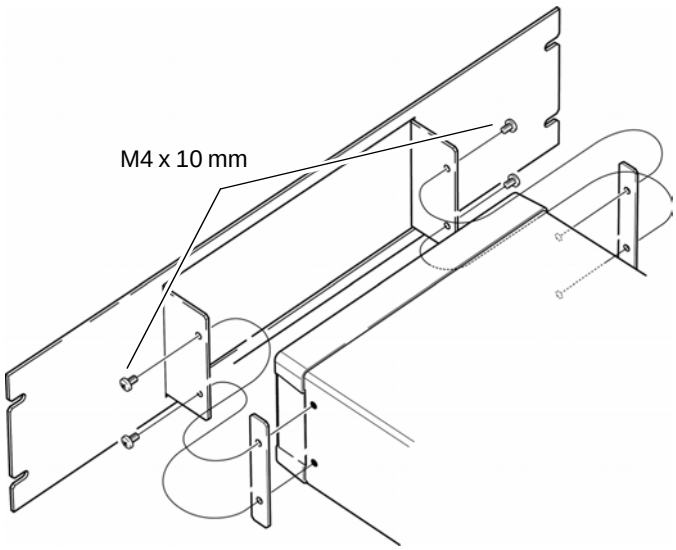



1. Remove the support legs from the bottom of the unit and screws from the side covers (4 screws at the front).

2. Insert spacers on both sides of the unit and attach the mounting brackets with M4 x 10 mm screws.



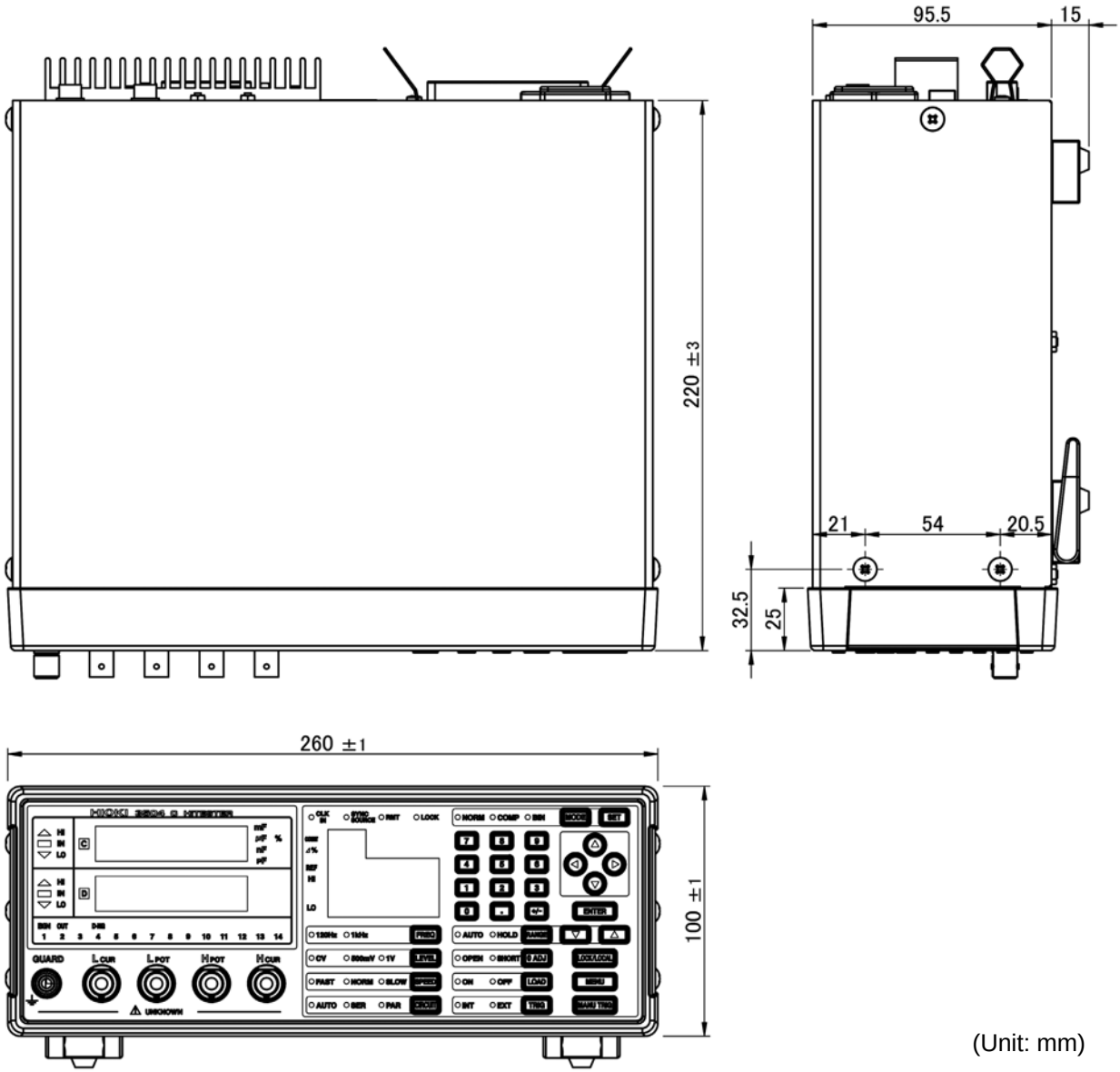

Rack Mounting Bracket (JIS)




Rack Mounting Bracket (EIA)

When mounting the unit in a rack, use, for example, a commercially available base for reinforcement

# Appendix 2 External View




(Unit: mm)

App

# *Appendix 2 External View*

# Index

## T



## U

HIOKI

# DECLARATION OF CONFORMITY

| | |
|---|---|
| Manufacturer's Name: | HIOKI E.E. CORPORATION |
| Manufacturer's Address: | 81 Koizumi, Ueda, Nagano 386-1192, Japan |
| Product Name: | C HiTESTER |
| Model Number: | 3504, 3504-10 |
| Options: | 9140 4-TERMINAL PROBE<br>9143 PINCHER PROBE<br>9261 TEST FIXTURE<br>9262 TEST FIXTURE<br>9263 SMD TEST FIXTURE<br>9677 SMD TEST FIXTURE<br>9699 SMD TEST FIXTURE |

The above mentioned product conforms to the following product specifications:

| | |
|---|---|
| Safety: | EN61010-1:2001 |
| EMC: | EN61326-1:2006<br>Class A equipment<br>Equipment intended for use in industrial location<br>EN61000-3-2:2006<br>EN61000-3-3:1995+A1:2001+A2:2005 |

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC.

HIOKI E.E. CORPORATION

12 December 2008

Atsushi Mizuno

Atsushi Mizuno

Director of Quality Assurance

3504A999-02

HIOKI

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