

3333

HIOKI

3333-01

Instruction Manual

POWER HiTESTER



EN

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Introduction

Thank you for purchasing the Hioki "Model 3333, 3333-01 Power HiTester." To obtain maximum performance from the instrument, please read this manual carefully, and keep it handy for future reference.

In this document, the "instrument" means the Model 3333 or 3333-01 Power HiTester.

Confirming Package Contents

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

Confirm that these contents are provided.

This instrument: Model 3333 or 3333-01
Power HiTester
(3333-01: Model with GP-IB interface)

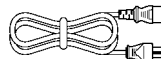


Accessories

Instruction Manual 1



Power Cord 1



Options

Printers

- 9442 Printer
- 9444 Connection Cable (for printer)
- 1196 Recording Paper (for printer)
- 9443-01 AC Adapter (for printer, for Japan)
- 9443-02 AC Adapter (for printer, for EU)
- A number 3 Phillips screwdriver

Interface Connection Cables

- 9637 RS-232C Cable (1.8 m, 9-pin to 9-pin)*
 - 9638 RS-232C Cable (1.8 m, 9-pin to 25-pin)*
- * 9637 and 9638 do not use cross cable or hardware handshake.

(3333-01 only)

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

Safety Information






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

This manual contains information and warnings essential for safe operation of the instrument 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 instrument.

The  symbol printed on the instrument indicates that the user should refer to a corresponding topic in the manual (marked with the  symbol) before using the relevant function.



Indicates AC (Alternating Current).



Indicates a grounding terminal.



Indicates the ON side of the power switch.



Indicates the OFF side of the power switch.

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



Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.



Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.



Indicates that incorrect operation presents a possibility of injury to the user or damage to the instrument.



Indicates advisory items related to performance or correct operation of the instrument.

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.



Bold alphanumeric characters in this manual indicate key labels.

Accuracy

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

- f.s. (maximum display value or scale length)
The maximum displayable value or scale length. This is usually the name of the currently selected range.
- rdg. (reading or displayed value)
The value currently being measured and indicated on the measuring instrument.
- dgt. (resolution)
The smallest displayable unit on a digital measuring instrument, i.e., the input value that causes the digital display to show a "1" as the least-significant digit.

Measurement categories

This instrument complies with CAT III safety requirements.

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

CAT II: Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.)

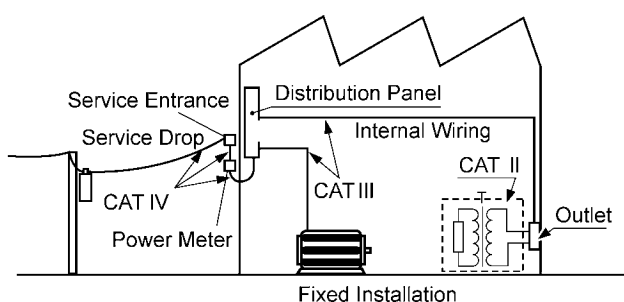
CAT II covers directly measuring electrical outlet receptacles.

CAT III: Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.

CAT IV: The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).

Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.

Use of a measurement instrument that is not CAT-rated in CAT II to CAT IV measurement applications could result in a severe accident, and must be carefully avoided.



Operating Precautions

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

Before Use

- Before using the instrument the first time, verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.
- Before using the instrument, make sure that the insulation on the connection cable is undamaged and that no bare conductors are exposed. A damaged product could cause an electric shock or short circuits and should be replaced with an undamaged product.

Instrument Installation

Operating temperature and humidity: 0 to 40°C at 80% RH or less (non-condensating)
Temperature and humidity range for guaranteed accuracy: 23±5°C, 80%RH or less

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



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



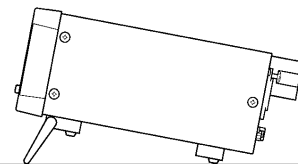
Exposed to high levels of particulate dust



Subject to vibration

Installation

- Do not install the instrument with any side except the bottom facing down.
- Do not install the product on an unstable or unlevel surface



Use the instrument with the stand extended.

See "How to use the stand" (⇒ p.13)

! DANGER

To prevent electric shocks and personal injury, do not directly touch the exposed metallic parts of the input terminals and other wiring materials when the measurement lines connected to the input terminals at the rear panel of the instrument are live lines. In addition, do not allow them to touch or come near metallic parts.

NOTE

To meet the measurement accuracy, ensure the surrounding temperature of the instrument does not exceed 23±5°C, by keeping it away from heat sources.

Handling the Instrument

WARNING

- Do not allow the instrument to get wet, and do not take measurements with wet hands. This may cause an electric shock.
- Never modify the instrument. Only Hioki service engineers should disassemble or repair the instrument. Failure to observe these precautions may result in fire, electric shock, or injury.
- To avoid electric shock, do not remove the instrument's case. The internal components of the instrument carry high voltages and may become very hot during operation.

CAUTION

To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.

NOTE

This instrument may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

Handling the cables

CAUTION

- Avoid stepping on or pinching cables, which could damage the cable insulation.
- To avoid breaking the cables, do not bend or pull them.
- To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.
- Keep the cables well away from heat sources, as bare conductors could be exposed if the insulation melts.

Before Connecting

WARNING

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

See Connection procedure:"2.3 Connecting the Power Cord"(⇒ p.24)

Input and Measurement Precautions** DANGER**

- The maximum input voltage and current is 300 V AC, 30 A. Attempting to measure voltage and current in excess of the maximum input could destroy the instrument and result in personal injury or death.
- The maximum rated voltage between input terminals and ground is 300 V AC. Attempting to measure voltages exceeding 300V with respect to ground could damage the instrument and result in personal injury.
- This product should only be connected to the secondary side of a breaker, so the breaker can prevent an accident if a short circuit occurs. Connections should never be made to the primary side of a breaker, because unrestricted current flow could cause a serious accident if a short circuit occurs.

 WARNING**When connecting wires,**

Observe the following to avoid electric shock and short circuits.

- Turn off the power to lines to be measured before making connections to terminals to be measured and turning on the instrument.
- Be sure to connect the voltage input and current input terminals correctly. An incorrect connection could damage or short circuit this instrument.
- Make sure no connecting wires are routed so they short circuit input voltage terminals.

When the instrument gives off smoke, a strange odor or makes a strange noise,

Stop measuring immediately. Then perform the following procedure. Continued use under these conditions could result in fire and electric shock.

1. Turn the instrument power switch off.
2. Disconnect the power cord from the wall outlet.
3. Turn off the line to be measured and remove any connections.
4. Contact your dealer (agent) or nearest sales office.

 CAUTION

- For safety reasons, disconnect the power cord when the instrument is not used and before connecting it to a device to be tested.
- To avoid damage to the instrument, do not short circuit or apply an input voltage to output terminals.

NOTE

- Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.
- This instrument is a wattmeter designed for use only with alternating current. It cannot make RMS measurements of signals containing DC components (for example, full-wave and half-wave rectifier waves).

To ensure measurements are accurate,

- Warm up the instrument 10 minutes or more before use.
 - Pay attention to heat dissipation to maintain accurate measurements.
Example: Keep the instrument away from heat sources, make sure there is enough free space around the instrument and install a fan when the unit is mounted in a rack.
 - The instrument should be calibrated once a year.
 - This instrument is warranted against failure for a period of one year.
-

Overview

Chapter 1

1.1 Product Overview and Features

The 3333 and 3333-01 Power HiTesters are AC only single-phase wattmeters suited to measurements of household electrical appliances.

One unit enables measurements of voltage, current, active power, apparent power and power factor. All measurement data is simultaneously displayed. The instrument complies with IEC61010-1 safety standard and guarantees a basic accuracy of $\pm 0.1\% \text{rdg.} \pm 0.1\% \text{f.s.}$ for a period of one year. It guarantees a basic accuracy of $\pm 0.1\% \text{rdg.} \pm 0.2\% \text{f.s.}$ for a period of three years.

Performing the following operations

- Checking the power consumption and current of an electrical appliance
- Printing measurement data
- Importing measurement data into the controller
- Connecting a DMM or recorder to monitor measurement data

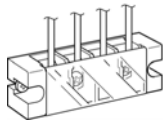
Voltage and current input terminals with protective cover attached

The instrument can handle inputs of up to 300 V, 30 A.

See: "2.2 Connecting a Connection Cable" (\Rightarrow p.18)

The protective cover prevents personnel from inadvertently touching the terminals.

The voltage input terminals are insulated from the current input terminals.



Level output of measurement values (D/A output)

This function converts voltage, current and active power to +2 V f.s.. DC voltage for output via the D/A terminal.

(Values for the three channels of voltage, current and active power are output. Connect a device to the terminals you wish measurements for.) Combined with DMMs, recorders, data loggers and other devices enable long-term recording of measurement changes.

See: "4.2 Converting to voltage for output (D/A output)" (\Rightarrow p.43)

Displaying voltage, current, active power, apparent power and power factor

The instrument can simultaneously display up to three measurements.

The user can switch to display the desired value during measurement. Input data is displayed within 0.4 s.

See: "3.2.1 Selecting an item to be displayed" (\Rightarrow p.28)

Setting an external VT (PT) CT ratio

When the voltage or current exceeds the maximum rated input for this instrument, use an external VT (PT) or CT device and set the VT or CT ratio to read measurement values directly.

See: "2.2 Connecting a Connection Cable" (\Rightarrow p.18), "3.2.4 Setting the VT or CT ratio" (\Rightarrow p.32)

Displaying averages for measurements that fluctuate substantially

Set the average times (AVG) of a measurement value to display an average value.

See: "3.2.3 Displaying average measurement values (AVG: average)" (\Rightarrow p.31)

Outputting measurement data to a printer (DATA OUT)

The optional 9442 Printer allows you to print measurement data. Hold down the **SHIFT** key and press the **DATA OUT** key to print measurement data

See: "4.1 Printing measurement values and setup status" (\Rightarrow p.39)



Connecting this instrument to a controller with standard RS-232C capability for data acquisition and remote control

This instrument can be connected to a controller with the RS-232C or GP-IB (3333-01 only) interface to enable control of the device and acquisition of measurement data.

See: "5.2 Connect a cable to the RS-232C connector or GP-IB connector" (\Rightarrow p.48)

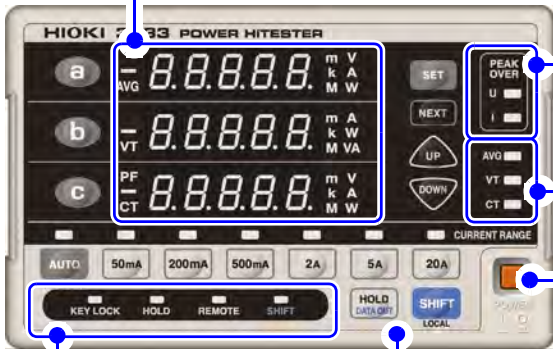


1.2 Names and Functions of Parts

Front Panel

Display (LED) (⇒ p.11)

Screen Display



Operating Keys (⇒ p.12)



Operating key LEDs

KEY LOCK Lights when operating keys are invalid (in key lock state).

To cancel lock:

Hold down the **SHIFT** key and press the **AUTO (KEY LOCK)*** key (⇒ p.35)

HOLD Lights when the **HOLD** key is pressed to lock a display value (in hold state).

To cancel hold:

Press the **HOLD** key again (⇒ p.34)

REMOTE Lights when this instrument is controlled via an interface (in remote control state).
The operating keys are disabled in this state.

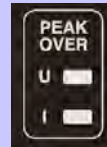
To cancel remote control:

Press the **SHIFT (LOCAL)*** key.

SHIFT Lights when the **SHIFT** key is depressed and the functions in blue under the keys are available.

To cancel the SHIFT function:

Press the **SHIFT** key again.



PEAK OVER LED

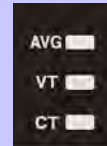
PEAK OVER U

Lights when the input voltage peak value exceeds 425 V.

PEAK OVER I

Lights when the input current peak value exceeds 42.5 A or 300% of the current range.

See "3.3 When o.r, PEAK OVER and units flash" (⇒ p.37)



Status LED

Lights when any of the following items is set to something other than 1 (default value).

AVG Sets average times (⇒ p.31)

VT Sets VT ratio (⇒ p.32)

CT Sets CT ratio (⇒ p.32)

POWER Switch

Turns the instrument on and off (⇒ p.25)

(**I** : Power On **O** : Power Off)

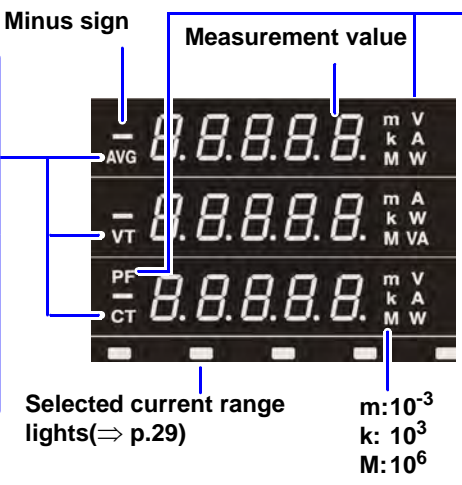
*AUTO (KEY LOCK), SHIFT (LOCAL)

As shown above, use of the functions indicated below the operating keys (key legends in blue or LOCAL) are given in parentheses.

Display

Setting items
 Lights setting item selected using **NEXT** or the **a, b** or **c** keys after opening the setting screen with the **SET** key.

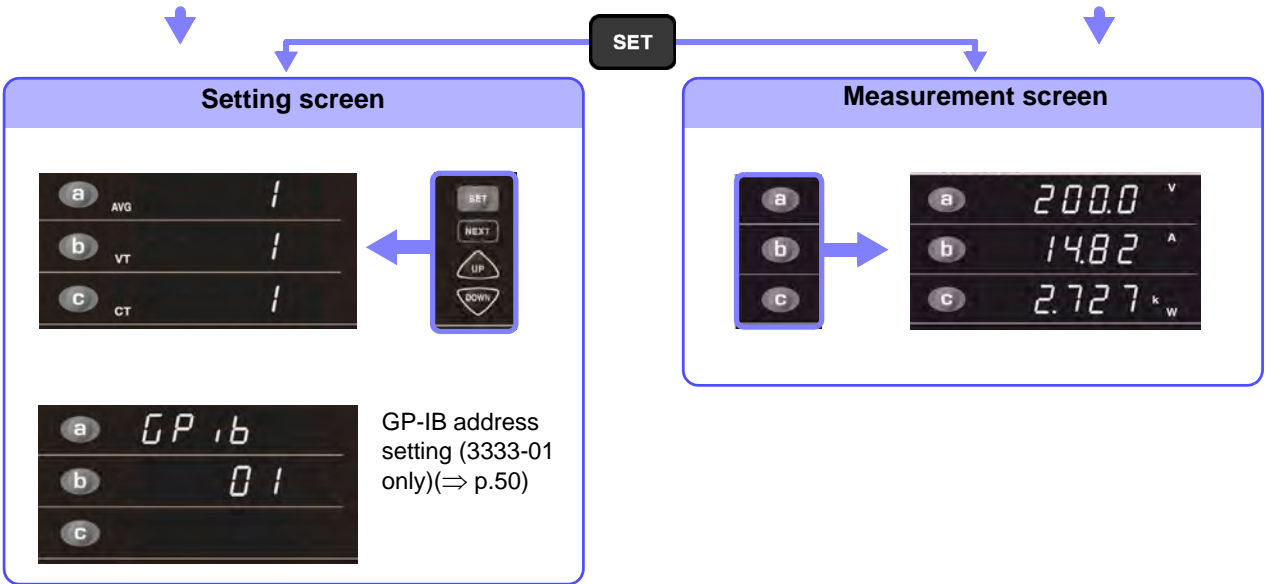
AVG Sets average times(⇒ p.31)
VT Sets VT ratio(⇒ p.32)
CT Sets CT ratio(⇒ p.32)



Display items(⇒ p.28)
 Display item selected using the **a, b** or **c** keys lights.

- V** Voltage (*U*)
- A** Current (*I*)
- W** Active power (*P*)
- VA** Apparent power (*S*)
- PF** Power ratio (λ)


The **a, b** and **c** keys select different items



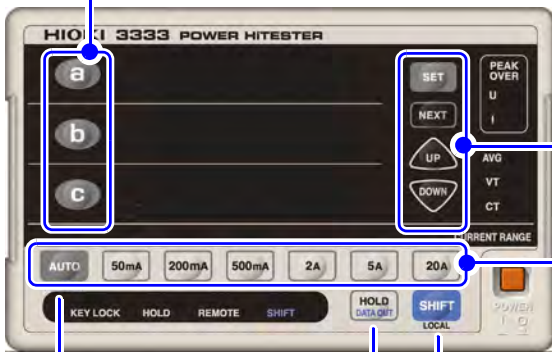
Other indications

Err. 1 Error indication
 See "7.2 Error Indication"(⇒ p.101)

o.r Over range
 See "3.3 When o.r, PEAK OVER and units flash"(⇒ p.37)

2000  **Flashing unit**
 Indicates that an averaged value (o.r.) is included
 See "3.3 When o.r, PEAK OVER and units flash"(⇒ p.37)

Operation Keys



SHIFT Makes available the function printed in blue below the keys.

Holding and outputting display values

HOLD Holds display values. (hold state)
To cancel the HOLD function:
Press the **HOLD** key again.

HOLD (DATA OUT) Outputs measurement data to printer when pressed.
Hold down the **SHIFT** key and press this key to use this function.

Enabling and disabling operating keys

AUTO (KEY LOCK) Disables operating keys. (KEY LOCK state)
Hold down the **SHIFT** key and press this key to use this function.
To cancel the KEY LOCK function:
Hold down the **SHIFT** key again and press this key to cancel this function.

SHIFT (LOCAL) Cancels a remote control state engaged via an interface.
Press the **SHIFT(LOCAL)** key once to set the instrument to local status.

Selecting display items or setting items

In the measurement screen (normal display)
Select display items (V, A, W, VA and PF) to be displayed in display areas a, b and c.
The items that can be displayed depend on the display area.

Display	Voltage V	Current A	Active power W	Apparent power VA	Power factor PF
a	●	●	●	—	—
b	—	●	●	●	—
c	●	●	●	—	●

In the setting screen
Press the **SET** key to open the setting screen and select setting items. (Or use the **NEXT** key to select setting items.)

Making settings in the setting screen

SET Opens the setting screen.
Press again to exit the screen.

NEXT Goes to the next setting item.

UP Changes set values and increments numeric values

DOWN Changes set values and decrements numeric values.

Changes current range

Illuminates selected current range.

AUTO Sets the current range to auto-range.

50mA to 20A Sets respective range.

Measurement range

Range	Effective measurement range
50mA	5 mA to 75 mA
200mA	20 mA to 300 mA
500mA	50 mA to 750 mA
2A	0.2 A to 3 A
5A	0.5 A to 7.5 A
20A	2 A to 30 A

See "6.2 Basic Specifications"(⇒ p.94)

NOTE

This instrument includes a key processing program used in production and for checking (for example, to invoke a mode for making adjustments). Should a key operation open a screen not described in this manual, immediately shut down the instrument and power it up again.

Rear Panel

Protective cover

The instrument should be used with a protective cover to prevent personnel from inadvertently touching the terminals. Make sure that no voltage is applied to a line to be measured before installing and removing the protective cover. (⇒ p.18)

Power Inlet

Connect the supplied power cord here. (⇒ p.24)

D/A OUTPUT terminal

Outputs voltage values from the connected terminal. (⇒ p.43)

GND Ground terminal

U Outputs the voltage via the D/A output.

I Outputs the current via the D/A output.

P Outputs the active power via the D/A output.

Example: 3333-01

The 3333-01 model comes with a GP-IB interface.

Except for the GP-IB connector, the 3333 and 3333-01 are identical

Current input terminal (I)

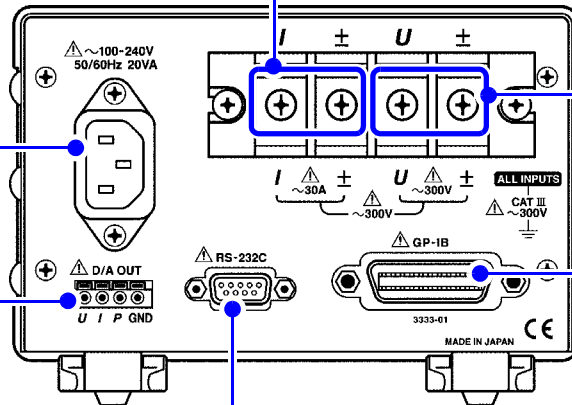
Connect a current output to this input. (⇒ p.18)

Voltage input terminal (U)

Connect a voltage output to this input. (⇒ p.18)

GP-IB connector

(3333-01 only)
Connect a GP-IB interface connection cable. (⇒ p.48)

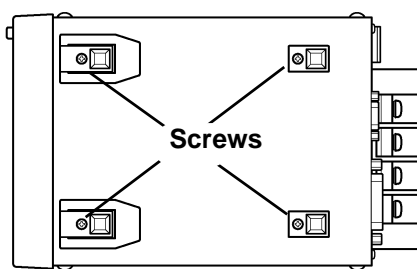


RS-232C connector

- Connect an RS-232C interface connection cable. (⇒ p.48)
- This connection enables printing out measurement data on an optional printer (⇒ p.39)

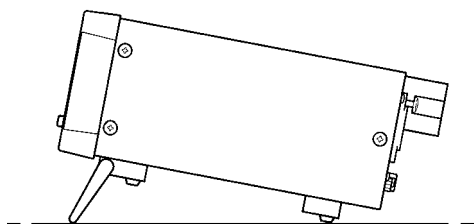
Bottom Panel

Stand



Foot

How to use the stand



This instrument can be rack mounted.

See "Chapter 8 Rack Mounting" (⇒ p.103)

Parts removed from this instrument should be stored in a safe place to enable future reuse

CAUTION

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

When using the stand

Extend the stand until it clicks into place.
Make sure to extend both legs of the stand.

Collapsing the stand

Fold in the stand until it clicks into place.

1.3 Measurement Work Flow

1 Installation, Connection and Turning the Power On

Installation

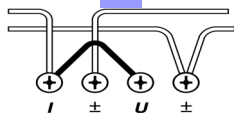
See (⇒ p.4)

Check!

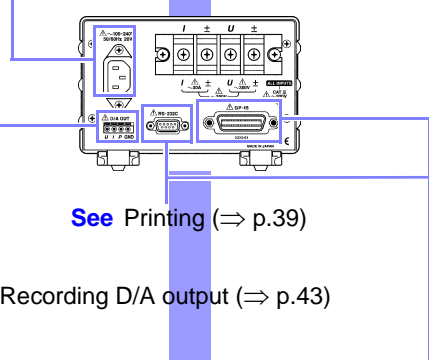
- Confirm whether the line to be measured is turned off.
- Confirm whether the instrument is turned off and the power cord is disconnected.

Connections

See Connection cable (⇒ p.18)



See Power cord (⇒ p.24)



See Printing (⇒ p.39)

See Recording D/A output (⇒ p.43)

See Connecting to a controller (⇒ p.45)

Connect a cable to the line to be measured and connect the power cord of the instrument

Check!

- Confirm whether the instrument is connected to the secondary side of the breaker.
- Confirm that the voltage in the wiring does not exceed 300 V AC.
⇒ If the voltage is exceeded use VT or CT.
- Confirm that the wiring connected to the voltage and current input terminals is made of an appropriate material
⇒ Use crimp contacts (terminal screw: M6) with insulating coating. Also make sure that the materials used have sufficient withstand voltage and current capacity.
- Confirm that the wiring is not short-circuited
- Confirm that the input terminals are not loose
- Confirm that no connection mistakes have been made

Turn the power on

See (⇒ p.25)

(Warm up the instrument for at least 10 minutes.)

Before powering up, make one more check to confirm that all connections are correct

When the initial screen appears, input values are displayed according to current settings.

2 Make Instrument Settings (settings can be changed during measuring)

Select an item to be displayed

See (⇒ p.28)

Default setting:

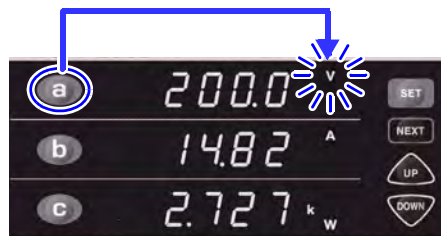
a: V

b: A

c: W

Select items to be displayed by **a**, **b** and **c**

Select up to three items of voltage (V), current (A), active power (W), apparent power (VA) or power factor (PF).



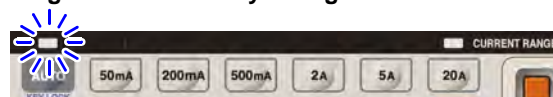
Select a current range

See (⇒ p.29)

Initial setting: 20 A

Select a range between 50 mA to 20 A

Press the **AUTO** key when the range is not known. The range is automatically changed



Make the following settings when required.

When the displayed value fluctuates, display an average value.

Set the display average times

See (⇒ p.31)

When the voltage exceeds 300 V, select VT (PT) to measure.

Set the VT ratio

See (⇒ p.32)

When the voltage exceeds 30 A, select CT to measure

Set the CT ratio

See (⇒ p.32)

Using the GP-IB interface (3333-01 only)

Enter a GP-IB address

See (⇒ p.50)

3 Starting measurements

Turning on the power to a line to be measured

Monitoring and outputting measurement values

The measured values appear

The current range and items to be displayed can be changed also during measurements



Printing measurement values and setting values(⇒ p.39)



Holding display values (⇒ p.34)



4 Ending measurements

Turn the power off

See (⇒ p.25)

Disconnect all cables from the device under test before turning the power off

Regarding measurement values

- Apparent power (S) and power factor (λ) displayed by this instrument are values calculated from measured voltage (U), current (I) and active power (P). For information on the calculation method used, refer to "6.2 Basic Specifications"(⇒ p.95). A measuring instrument using a different operating principle or a different calculation method may therefore produce different values.
- A voltage and current input that is less than 1% of the measurement range will forcibly be set to zero.
- Deviations may occur in the measurement of high-frequency common mode voltages
- This instrument is designed to handle frequencies between 45 Hz to 5 kHz and cannot measure frequencies outside this range.

Measurement Preparations

Chapter 2

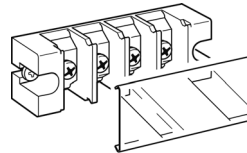
2.1 Installation & Connection Procedures

Be sure to read the "Operating Precautions" (⇒ p.4) before installing and connecting this instrument.

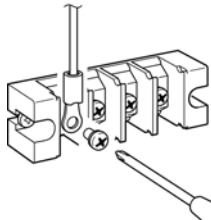
1 Install this instrument (⇒ p.4)



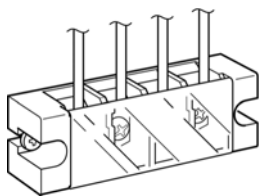
2 Remove the protective covers



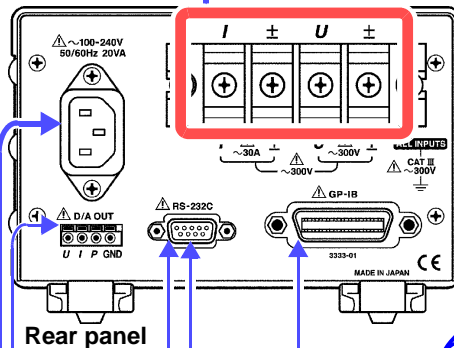
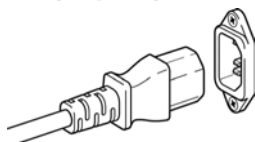
3 Connect connection cables to the voltage and current input terminals. (⇒ p.18)



4 Attach the protective covers



5 Connect the power cord (⇒ p.24)

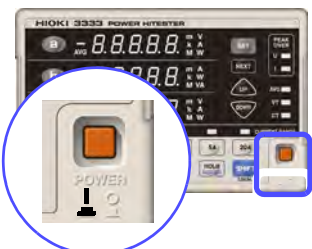


Using the printer
Connect a cable to the RS-232C connector (⇒ p.39)

Using an interface
Connect a connection cable to the RS-232C or GP-IB connector (3333-01) (⇒ p.48)

Using D/A output
Connect a cable to the D/A OUTPUT terminal (⇒ p.43)

6 Turn the power on (⇒ p.25)



7 Turn on the power to the line to be measured

When finished measuring, disconnect the cables from the measurement object(s), and turn the power off.

2.2 Connecting a Connection Cable



Please read the following before making connections

DANGER

- The maximum input voltage and current is 300 V AC, 30 A.
Attempting to measure voltage in excess of the maximum input could destroy the instrument and result in personal injury or death.
- The maximum rated voltage between input terminals and ground is 300V AC.
Attempting to measure voltages exceeding 300V with respect to ground could damage the instrument and result in personal injury.
- This instrument should only be connected to the secondary side of a breaker
So the breaker can prevent an accident if a short circuit occurs. Connections should never be made to the primary side of a breaker, because unrestricted current flow could cause a serious accident if a short circuit occurs.
- Confirm that no terminal is loose.
A connection that becomes disconnected could cause a short circuit or electrical shock. A loose connection will increase the insulation resistance resulting in heat generation, burn damages or fire.
(Use a torque of 3Nm to secure the input terminals.)

WARNING

- Observe the following to avoid electric shock and short circuits.
- Turn off the power to lines to be measured before making connections to terminals to be measured and before turning on the instrument
 - Be sure to connect the voltage input and current input terminals correctly. An incorrect connection could damage or short circuit this instrument
 - Make sure no connecting wires are routed so they short circuit input voltage terminals
 - Do not move cables around unnecessarily as terminals may become loose.

Before turning on the power to the line to be measured

CAUTION

Turn on this instrument before turning on the power to the line to be measured. Confirm that no errors are indicated and then turn on the power to the line to be measured.

Powering up the line to be measured before this instrument is turned on may damage the instrument or generate an error when it is powered up

[See](#) "2.4 Turning the Power On and Off" (⇒ p.25), "7.2 Error Indication" (⇒ p.101)

Using an external VT (PT) or CT device

Use an external VT (PT) or CT device to for measurements of a device under test whose voltage exceeds the measurement range of this device. By setting the VT or CT ratio, you can directly read primary side input values

See "3.2.4 Setting the VT or CT ratio" (⇒ p.32)



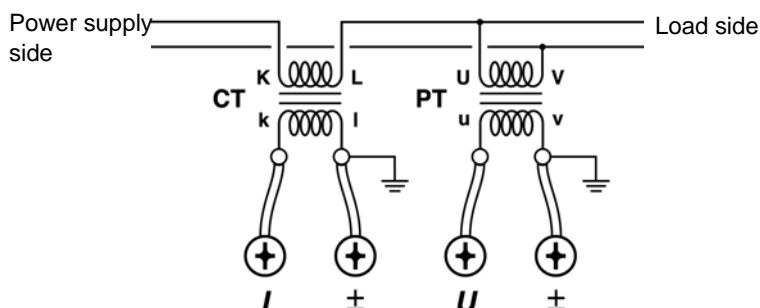
To prevent electrical shock and personnel injury, do not touch any input terminals on the VT (PT), CT or the instrument when they are in operation.



- Do not short circuit the secondary side when using an external VT (PT) device
Applying a voltage to the primary side when the secondary side is short-circuited will result in the generation of a high current on the secondary side that could lead to burn damages and fire.
- Do not open the secondary side when using an external CT device.
Applying current to the primary side when open will generate high current in the secondary side and could pose serious danger

NOTE

- Note that a phase difference in the external VT (PT) or CT device may cause substantial deviations in current measurements.
Use a VT (PT) or CT device with a minimal phase difference in the frequency bandwidth to ensure accurate measurement results.
- For reasons of safety, connect the secondary side of a VT (PT) and CT device to ground. (See figure below.)



For other safety precautions, refer to "Operating Precautions" (⇒ p.4)

For accurate measurements:**NOTE**

- Since polarity is an important factor in power measurements, make sure that voltage and current inputs are correctly connected. The instrument will not yield accurate measurement results when incorrectly connected.
- Make sure that power lines are routed away from the instrument as the external electromagnetic fields they produce could have a negative effect on operation.

Wiring material (for voltage and current input terminals)

WARNING

To avoid electric shock and short-circuit accidents, use only solderless terminals whose wires are properly insulated.
(Screws for voltage and current input connectors: M6)

CAUTION

To prevent electrical shock, make sure that the materials used have sufficient withstand voltage and current capacity.

Connecting procedure

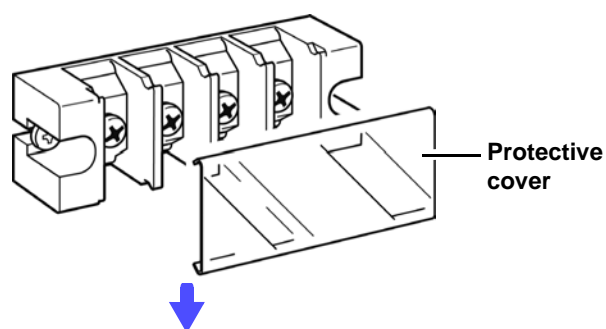
Please read the Section, "Please read the following before making connections" (⇒ p.18).

Make sure that the power to a line to be measured is turned off before making connections.

Tools required: a number 3 Phillips screwdriver (optional) or a Phillips screwdriver that has a no. 3 size bit

1. Connect cables to the voltage and current input terminals.

Remove the protective covers

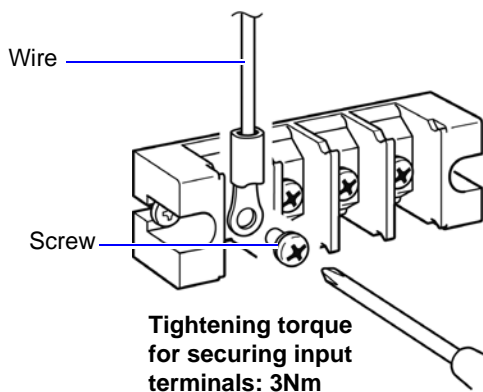


Connect the cables to the input terminals.

Use solderless terminals with a width of 13 mm or less.

Tighten the screws properly

Be sure to use the screws provided with the input terminals to connect the cables. Use of other screws may damage the connector threads, and it may cause of preventing attachment and disconnection of wires.



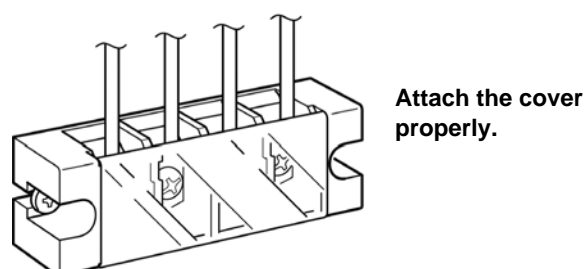
1 Use a Phillips screwdriver to remove the screw.

2 Secure the screw as shown in the wiring diagram.



To avoid electric shock and short-circuit accidents, use only insulated terminals.
(Screws for voltage and current input connectors: M6)

Attach the protective cover



2. Connect to the lines to be measured

Use one of the following two methods to make a connection.

When the voltage or current for the line being measured is within the maximum rated input for this instrument

Connect the device to the instrument for direct measurement.

1

When the voltage or current for the line being measured exceeds the maximum rated input for this instrument

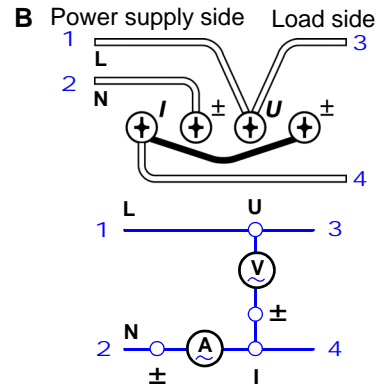
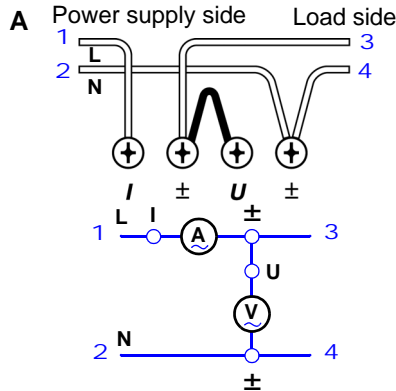
Connect a VT (PT) or CT device.

2

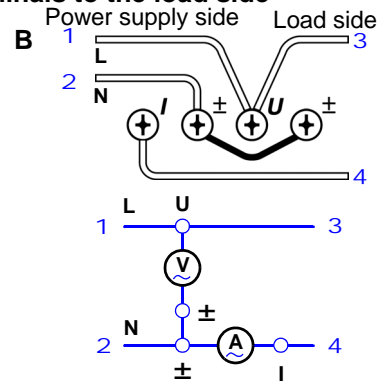
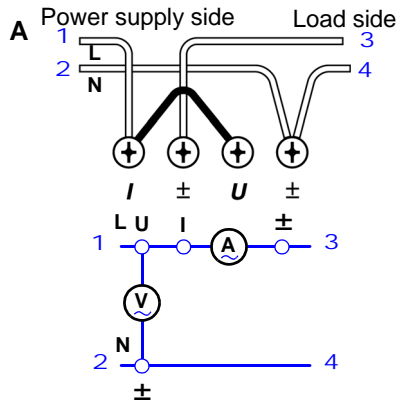
1 Connect to the lines to be measured

Refer to "Selecting connection method" (⇒ p.23) to select a connection method to minimize wattmeter loss.

Method 1: Connect the voltage input terminals to the load side



Method 2: Connect the current input terminals to the load side



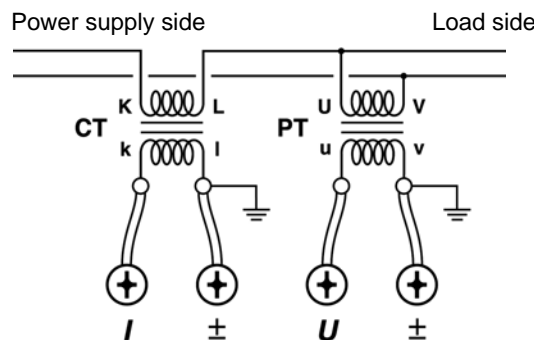
NOTE

If the instrument is affected by common mode voltage, connect an ammeter as shown at B to reduce the error.

NOTE

If the connection will be maintained after measurement, perform an inspection (⇒ p.27) before conducting the next measurement. Such an inspection will help prevent electric shock and measurement errors from disconnected cables, short circuits and instrument failure.

2 Connect a VT (PT) or CT device



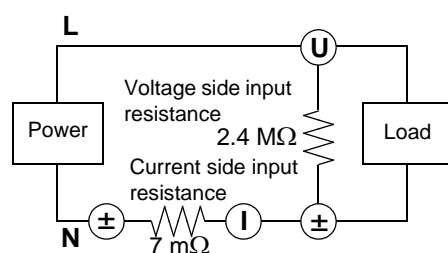
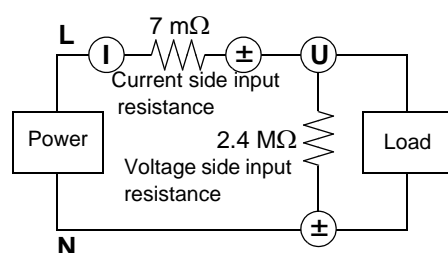
Selecting connection method

Instrument loss in the wattmeter may affect the measurement value depending on the input level.

Then use method 2 to minimize loss.

Method 1
Connect the **voltage** input terminal to the load side.

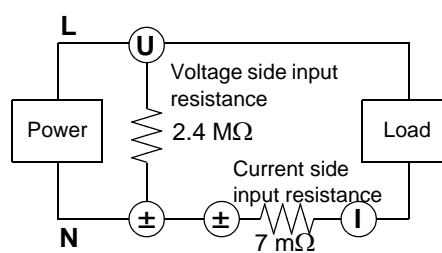
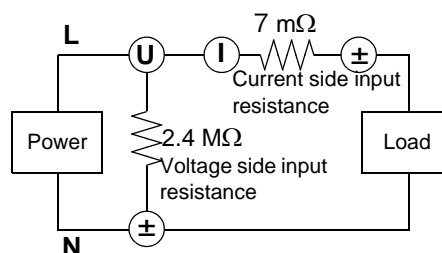
$$\text{Loss} = (\text{input voltage [V]})^2 / 2.4 \text{ [M}\Omega\text{]}$$



Make a power measurement that includes the loss resulting from the input resistance in the voltage input terminals.

Method 2
Connect the **current** input terminal to the load side.

$$\text{Loss} = (\text{input current [A]})^2 \times 7 \text{ [m}\Omega\text{]}$$



Make a power measurement that includes the loss resulting from the input resistance in the current input terminals.

Example:

When measuring 100 V, 20 A

$$\text{Method 1: loss} = (100 \text{ [V]})^2 / 2.4 \text{ [M}\Omega\text{]} = \underline{0.0042 \text{ [VA]}}$$

$$\text{Method 2: loss} = (20 \text{ [A]})^2 \times 7 \text{ [m}\Omega\text{]} = \underline{2.8 \text{ [VA]}}$$

Method 1 involves less loss and provides a more accurate measurement.

When measuring 100 V, 50 A

$$\text{Method 1: loss} = (100 \text{ [V]})^2 / 2.4 \text{ [M}\Omega\text{]} = \underline{0.0042 \text{ [VA]}}$$

$$\text{Method 2: loss} = (50 \text{ [mA]})^2 \times 7 \text{ [m}\Omega\text{]} = \underline{0.0000175 \text{ [VA]}}$$

Method 2 involves less loss and provides a more accurate measurement.

2.3 Connecting the Power Cord

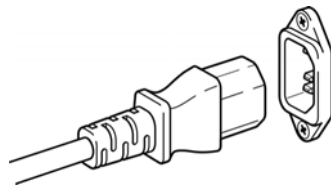


WARNING

- Before turning the instrument on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.
Rated power supply voltage (100V AC to 240 V AC), rated power supply frequency (50/60 Hz)
(Voltage fluctuations of $\pm 10\%$ from the rated supply voltage are taken into account.)
- To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord provided only to a 3-contact (two-conductor + ground) outlet.

Connection procedure

Rear panel



- 1.** Verify that the instrument's power switch is turned off.
- 2.** Confirm that the mains supply voltage matches the instrument, and connect the power cord to the power inlet on the instrument.
- 3.** Plug the power cord into the mains outlet.

Turn off the power before disconnecting the power cord.

2.4 Turning the Power On and Off

! WARNING

Check the following again before turning on the power.

- Confirm that the instrument and all peripheral equipment are correctly connected.
- Confirm that no wires are short-circuiting the voltage input terminals. A short circuit could lead to electric shock and short circuits.

! CAUTION

Turn on the instrument and make sure no errors are indicated before turning on the power to lines to be measured.

Powering up the line to be measured before this instrument is turned on may damage the instrument or generate an error when it is powered up.

Turning Power On



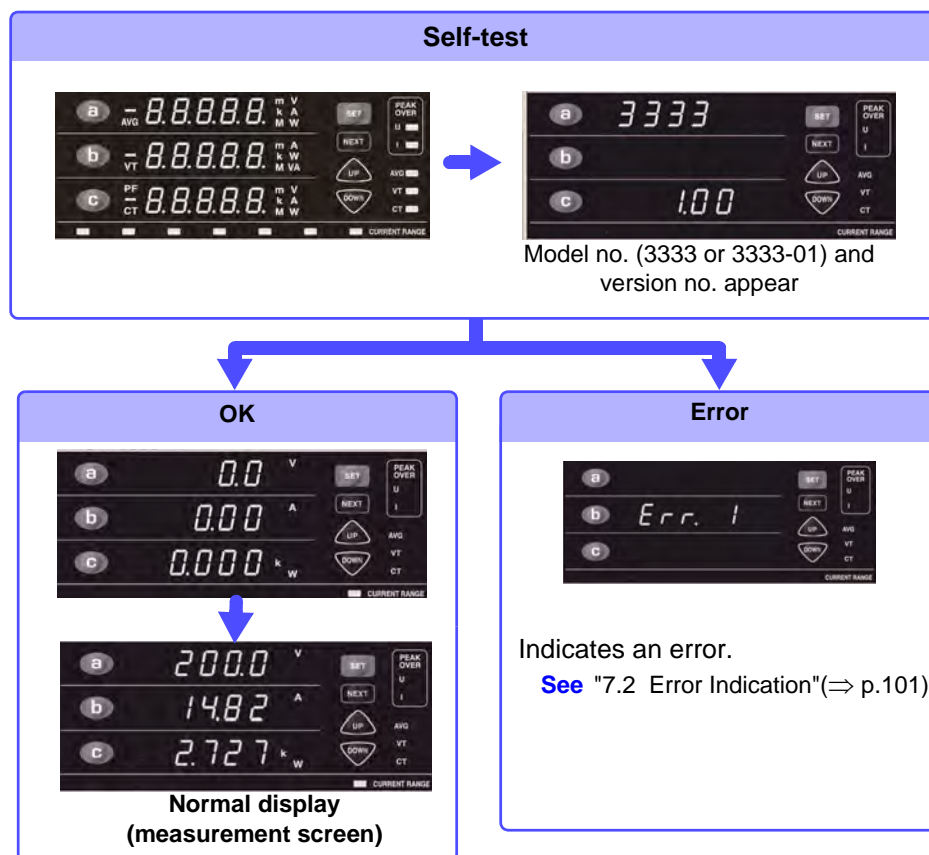
Power On |

Turn the **POWER** switch on (|).

After Power-On

A self-test (instrument diagnostic routine) is performed.

The self-test lights all LEDs and checks model name, version and saved data.



NOTE

Do not press an operating key during the self-test.

2.4 Turning the Power On and Off

When the power is turned on, the same setting as when the power was last turned off appears (backup function). When powered up for the first time, the default settings appear(⇒ p.36)

Before Starting Measurement

To obtain precise measurements, provide about 10 minutes warm-up after turning power on.

Turning Power Off

Power Off ○

Turn the POWER switch off (○).

When power is turned on again, the display appears with the settings that existed when power was last turned off.

Settings and Measurements

Chapter 3

For information on measurement work flow, refer to "1.3 Measurement Work Flow" (⇒ p.14)

3.1 Pre-Operation Inspection

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

1 Peripheral Device Inspection

When using connection cables

Is the insulation of the connection cable to be used damaged, or is bare metal exposed?
Is the input terminal screw loose?

Metal Exposed
Screw Is Loose

Do not use if damage or short-circuited, or the screw is loose as you could receive an electric shock. Replace the damaged items. Tighten the screw properly.

No Metal Exposed
Screw Is Properly Tightened.

2 Instrument Inspection

Is damage to the instrument evident?

Yes

If damage is evident, request repairs.

No

Turn on the power

Does the self-test screen appear (model no., version no.)?

No

The power cord may be damaged, or the instrument may be damaged internally. Request repairs.

Yes

Does the measurement screen appear after the self-test?

An error indication occurs (Err)

The instrument may be damaged internally. Request repairs.

See "7.2 Error Indication" (⇒ p.101)

Yes

End of inspection

Turn on the DUT.

No measurement value appears
Measurement values are incorrect

Connected cables may be short-circuited, incorrectly connected or an internal instrument failure may have occurred. Immediately turn the power off and re-inspect. If the wiring is correct, turn the instrument in for repair.

Allow the instrument to warm up for 10 minutes or more after powering up before use.

Please read the "Operating Precautions" (⇒ p.4) before use.

3.2 Setup Procedure

3.2.1 Selecting an item to be displayed

Use the **a**, **b** and **c** keys to select items for display areas a, b and c. The items change with each press of the key. This setting can also be made during measurements.

Press the key (**a**, **b** or **c**) to select item to be displayed.

Switching items to display

Default setting:
 Display area a: V
 Display area b: A
 Display area c: W

Display items

Display area	Voltage V	Current A	Active power W	Apparent power VA	Power factor PF	Display sequence
a	●	●	●	–	–	➤ V ➤ A ➤ W
b	–	●	●	●	–	➤ A ➤ W ➤ VA
c	●	●	●	–	●	➤ W ➤ PF ➤ V ➤ A

●: Available, –: Not Available

NOTE

Voltage and current are displayed up to 152% of the range.
 Active power is displayed up to 231.04% of the range.

For information on display range and effective measurement range:

See "3.2.2 Selecting a Current Range" (⇒ p.29)



When o.r. or the PEAK OVER lamp goes on

See "3.3 When o.r., PEAK OVER and units flash" (⇒ p.37)

3.2.2 Selecting a Current Range



When the input exceeds 300 V or 30 A, Maximum input voltage and maximum input current are 300 V and 30 A, respectively.

When the maximum input voltage or current is exceeded, terminate measurements as soon as possible, turn off the measurement line and disconnect all connections.

Continuing measurements while maximum input voltage and maximum input current are exceeded will damage the instrument and could lead to injuries.

Selecting a range

You can select any range.

Wait (one second or more) until the internal circuit has stabilized after changing a range before reading measurements.



Default setting: 20 A

Press a range key.

The LED for the selected range key lights and measurement values for the selected range appear.

See "Effective measurement range and display range" (⇒ p.30)



Note that the instrument may be damaged if the applied voltage or current exceeds the measurement range.

Selecting auto-range

Use auto-range when the range is not known.



Press **AUTO**.

The **AUTO** LED goes on when auto-range is engaged.

The LED for the range where measurements can be made light.

See "Auto-range" (⇒ p.30)

To cancel auto-range: Press any key or press **AUTO** again.

NOTE

When the measurement range is set to auto-range, D/A output changes the output rate according to changes in range. In measuring a line whose measurement value fluctuates wildly, take care not to mistake the range conversion. It is recommended that a fixed range be used for such measurements.

3.2.3 Displaying average measurement values (AVG: average)

When the display fluctuates wildly, set the average times for the measurement value to display an average value. This minimizes fluctuations in displayed values. Measurement values are displayed as simple averages.

Measurement range:

1 (OFF), 2, 5, 10, 25, 50, 100

Display area a in the setting screen shows the average times.

Example: set the average times to "2"

1 Press **SET** to open the setting screen.

2 Press **NEXT** to select AVG (display area a).
AVG and the average times flash in display area a. (Default setting: 1)

3 Press **UP** or **DOWN** to set the average times (2).
The AVG LED flashes when set to 2 or more.

4 Press **SET** to exit the setting screen.
The normal measurement screen appears.

This example shows the average value for two data items.

$$\text{Average value} = \frac{\sum_{k=1}^n X_k}{n}$$

X_k: measurement value every 200 ms
n: average times

Interval between display updates

Average times	1 (OFF)	2	5	10	25	50	100
Display update	200 ms	400 ms	1 s	2 s	5 s	10 s	20 s

Averaging starts over when the range is changed. The data displayed when averaging started remains on until the first average value appears.

The unit may flash during measurement.

See "3.3.3 When the unit flashes" (⇒ p.38)

Averaging is performed for voltage, current, active power and apparent power.

The power factor is calculated from the averaged effective and apparent power.

3.2.4 Setting the VT or CT ratio

Use an external VT (PT) or CT device to measure voltage or current values that exceed the maximum rated input for this instrument.

See "Connect a VT (PT) or CT device" (⇒ p.22)

By setting the VT or CT ratio in the setting screen, you can directly read primary side input values.

- Measuring voltages exceeding 300 V:
Connect an external VT (PT) and set the VT ratio.
- Measuring current exceeding 30 A:
Connect an external CT and set the CT ratio.

Measurement range:

VT ratio ..1 (OFF), 2, 4, 10, 20, 30, 60, 100

CT ratio...1 (OFF), 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 25, 30, 40, 50, 60, 75, 80, 100

Set the VT and CT ratios in display area b and c in the setting screen.

Setting VT ratio (example: measuring a 600 V line)

Use an external VT (PT) and enter 10:1 (60 V) voltage ratio on this instrument:
Enter a VT ratio of 10. A voltage of 60 V is input to the instrument, but it displays an input value of 600 V.

1 Press **SET** to open the setting screen.

2 Press **NEXT** to select VT (display area b).
VT and the VT ratio in display area b flashes.

3 Press **UP** or **DOWN** to set the VT ratio (10).
The VT LED flashes when set to 2 or more.

4 Press **SET** to exit the setting screen.
The normal measurement screen appears.

VT indicates the primary side voltage.

Setting a CT ratio (example: measuring a 100 A line)

Use CT device and set a 10:1 (10 A) current ratio on this instrument:

Set the current range to "20 A" and the CT ratio to "10".

A current of 10 A is input to the instrument, but it displays an input value of 100 A.

See Range selection: "3.2.2 Selecting a Current Range"(⇒ p.29)

1 Press **SET** to open the setting screen.

2 Press **NEXT** to select CT (display area c).
CT and the CT ratio in display area c flashes.

3 Press **UP** or **DOWN** to set the CT ratio (10).
The CT LED flashes when set to 2 or more.

4 Press **SET** to exit the setting screen.
The normal measurement screen appears.

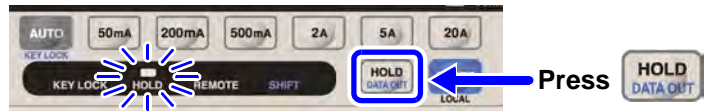
The normal measurement screen appears.

The VT and CT ratios are also used to multiply active power and apparent power.

3.2.5 Display hold (Hold)

Pressing the **HOLD** key makes it possible to hold all displayed measurement values (hold state).

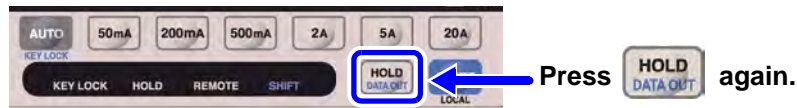
Invoking hold state



The **HOLD** LED lights.

Pressing the **HOLD** key holds displayed measurement values

Canceling hold state



The **HOLD** lamp goes out and the normal measurement screen reappears.

NOTE

The following operations are disabled in the hold state.

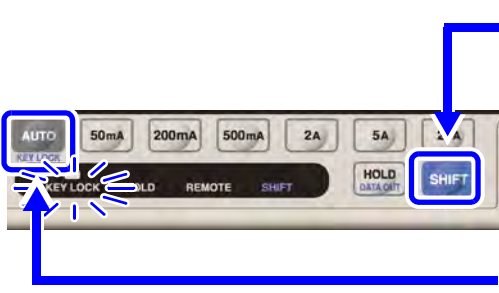
- Range switching
Err.5 appears when a range key is pressed.
 Range changing is also disabled in auto-range mode. The **HOLD** key locks the current range.
- Changing settings (average times, VT and CT ratio setting)
 In the setting screen, set items light and cannot be changed.

To change ranges and settings, press the **HOLD** key to cancel the hold state (**HOLD** LED goes off).

3.2.6 Disables key operations (key lock)

This function disables key operations (key lock state) to prevent inadvertent operation during measurement.

Invoking key lock state



1 Press **SHIFT** .
The **SHIFT** LED lights.

2 Press **AUTO** .
The **KEY LOCK** LED lights.
Keys do not function when pressed.

Canceling key lock state

Press **SHIFT** again (the **SHIFT** lamp lights) and press **AUTO** .
The **KEY LOCK** lamp goes off and operating key functions are again available.

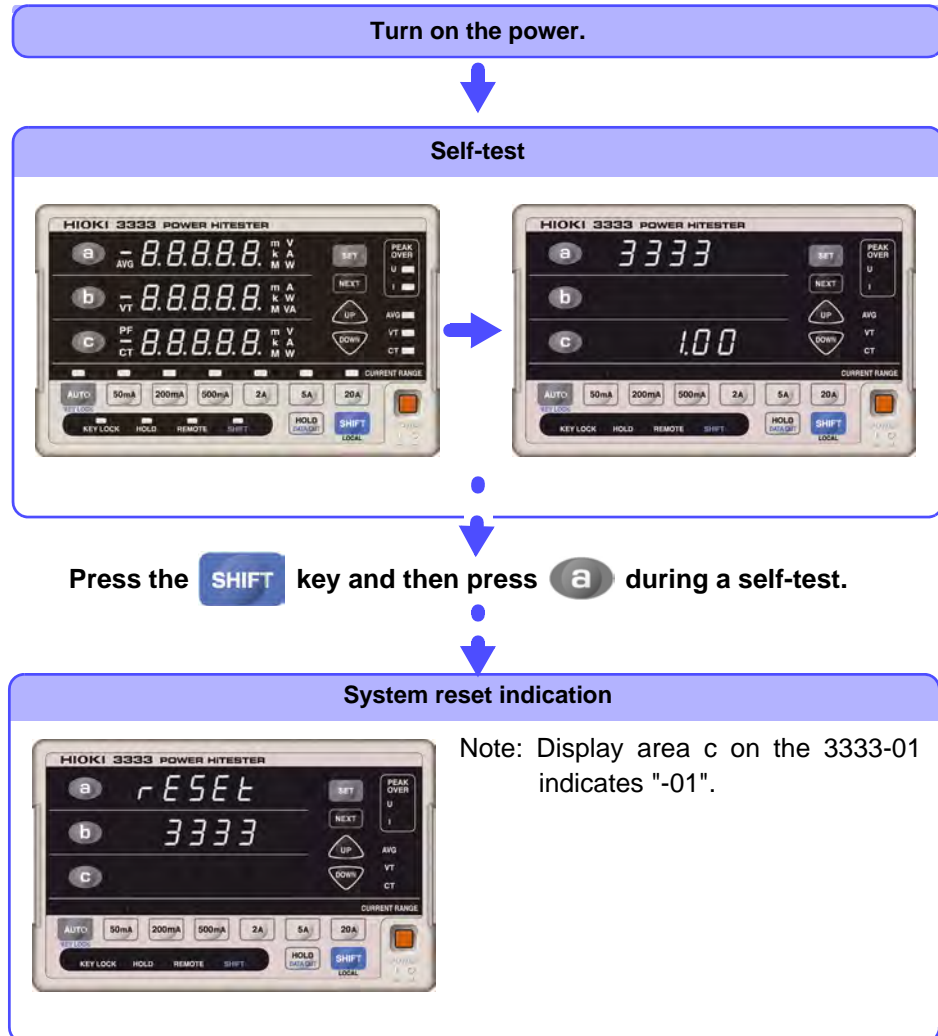
NOTE

Communications via an interface in **KEY LOCK** state turns off the **KEY LOCK** LED and engages the remote state (**REMOTE** LED lights).
The remote state also prevents use of the operating keys.
To enable the operating keys, press the **SHIFT (LOCAL)** key to cancel the remote control state.

See "To cancel the Remote state (enter the local state)" (⇒ p.51)

3.2.7 Initializing (system reset)

Instrument functions can be returned to their factory defaults (system reset). Perform a system reset during the self-test (the interval until the normal screen appears) after powering up.



All settings return to their factory defaults.

Factory default settings

Item	Settings
Display area a	Voltage (V)
Display area b	Current (A)
Display area c	Active power (W)
Current range	20 A range (Auto range OFF)
VT ratio (VT)	1 (OFF)
CT ratio (CT)	1 (OFF)
Average times (AVG)	1 (OFF)
Hold	OFF
GP-IB address (3333-01 only)	1

3.3 When o.r, PEAK OVER and units flash

3.3.1 When o.r (over range) appears



This icon appears when a range is exceeded by 152%.

(For information on ranges: refer to "Range configuration" (⇒ p.94))

A calculation based on data that has generated an "o.r" will also produce an "o.r" display.

- When the voltage or current is "o.r", the apparent power, active power and power factor all become "o.r".
- When the apparent voltage is 0, the power factor becomes "o.r".
- However, a power factor that is "o.r" when apparent power is 0 will produce a normal value if the voltage and current inputs are made.

Remedy:

- **When the voltage is "o.r",**
Stop measurements as soon as possible, turn off the power to the line to be measured and disconnect all connections.
- **When the current is "o.r",**
Switch to a range that is not over range.
[See](#) "3.2.2 Selecting a Current Range" (⇒ p.29)

3.3.2 When the PEAK OVER U and PEAK OVER I LEDs go on



The LEDs go on when the voltage input or the current input waveform peak value exceed the following value.

- The voltage input waveform peak value: 425 V peak
- The current input waveform peak value: when 300% of any current range and 42.5 A in a 20 A range

When the displayed data is not accurate.

Remedy:

- **When the PEAK OVER U LED lights**
Stop measurements as soon as possible, turn off the power to the line to be measured and disconnect all connections.
- **When the PEAK OVER I LED lights**
Stop measurements when 42.5 A is exceeded
When the LED lights at a lower value, the internal circuit is not operating correctly. Switch over to a range that does not light the [PEAK OVER](#) LED.
[See](#) "3.2.2 Selecting a Current Range" (⇒ p.29)

3.3.3 When the unit flashes



The unit may sometimes flash during an average operation.

This indicates that the displayed measurement value is an average value that contains "o.r".

In an "o.r" event, an average is calculated assuming that the voltage and current are 152% of the range while the active power and apparent power are assumed to be 231.04% of the range.

Remedy:

- The LED does not flash when "o.r" does not occur in the average period.
- When the voltage flashes:
Stop measurements as soon as possible, turn off the power to the line to be measured and disconnect all connections.
- When the current, active power or apparent power LED flashes:
Switch to a range that does not cause flashing
See "3.2.2 Selecting a Current Range" (⇒ p.29)
- When only the power factor flashes:
This happens when the apparent power is 0 and is thought to be caused by load fluctuations. Flashing stops when the apparent power changes to something other than 0.

Outputting and Analyzing Measurement Data

Chapter 4

4.1 Printing measurement values and setup status

Connect an optional 9442 Printer to the RS-232C connector on this instrument to print measurement values or setup status.



WARNING

Turn off all devices before disconnecting the 9444 Connection Cable from the printer and the instrument. Failure to do so may lead to electric shock.

For detailed information on printer setup procedures:
Refer to the instruction manual supplied with the 9442 Printer.

Connecting a printer to the instrument

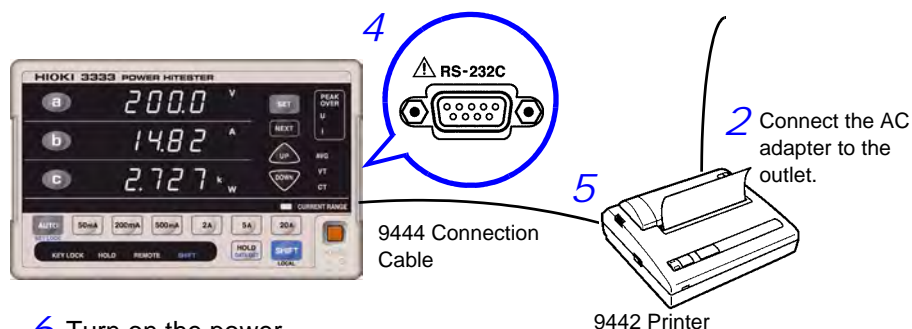
Printers and cables that permit connection to this instrument

- 9442 Printer
- 9443-01 AC Adapter (for Japan)
- 9443-02 AC Adapter (for EU)
- 9444 Connection Cable
- 1196 Recording Paper

Connection procedure

1 Turn the power supply off.

3 Connect the AC adapter to the instrument



6 Turn on the power.

1. Check that the instrument and the 9442 Printer are both turned off.
2. Connect the AC adapter output plug to the 9442 Printer.
3. Connect the AC adapter to the outlet.
4. Connect the plug of the 9444 Connection Cable to the RS-232C interface connector on this instrument.

4.1 Printing measurement values and setup status

5. Connect the other connector of the 9444 to the 9442 serial input connector.
6. Turn on the instrument and the 9442 Printer.

NOTE

When printing

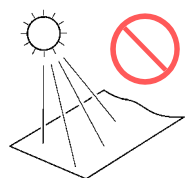
- Avoid slow printing as much as possible in hot or humid environments. Otherwise, printer life may be severely shortened.

Recording Paper Usage Precautions

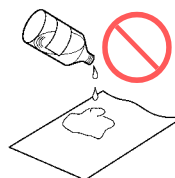
- If the recording paper is skewed on the roller, paper jams may result.
- Printing is not possible if the front and back of the recording paper are reversed.

Handling and Storing Recording Paper

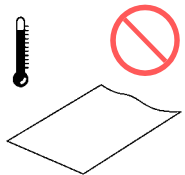
The recording paper is thermally and chemically sensitized. Observe the following precautions to avoid paper discoloration and fading.



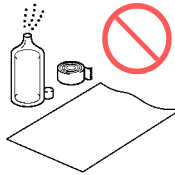
Avoid exposure to direct sunlight.



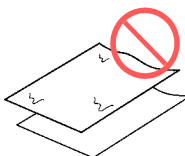
Avoid exposure to volatile organic solvents like alcohol, ethers and ketones.



Do not store thermal paper above 40°C or 90% RH.



Avoid contact with adhesive tapes like soft vinyl chloride and cellophane tape.



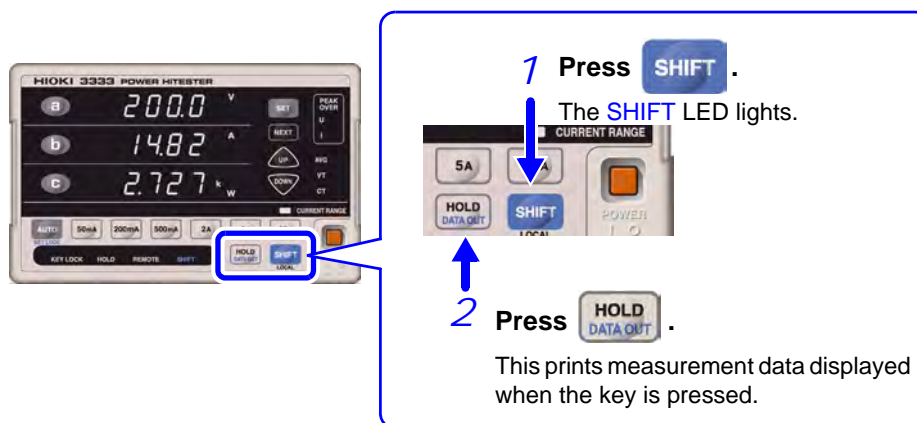
Avoid stacking with wet Diazo copy paper.

4.1 Printing measurement values and setup status

Outputting data to the printer

Printing measurement data

Use the following procedure to print measurement data when measurement data is displayed.



Print example

```
STATUS,000000,U,+0200.0E+0,I,+014.82E+0,
P,+02.727E+3,S,+02.964E+3,PF,+00.920E+0
```

Description of print items

STATUS: a 6-digit numeric indicates the instrument status.

- This numeric indicates, in order from left to right, voltage unit flashing, current unit flashing, voltage peak over, current peak over, HOLD ON status, averaging in progress.
- The meaning of the numbers is given below.

0:	normal, HOLD OFF, no averaging
1:	Unit flashing, peak over, HOLD ON, averaging operation

U : Voltage measurement value
 I : Current measurement value
 P : Active power measurement value
 S : Apparent power measurement value
 PF: Power factor measurement value

- Units (m, k, M, etc.) are indicated in exponential notation on the display.

m : E-3
 None: E+0
 k : E+3
 M : E+6

NOTE

An "o.r" indication appears as 999.99E+9.

4.1 Printing measurement values and setup status

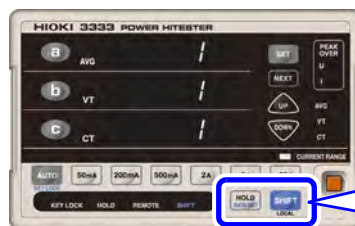
Printing setup status

Use the following procedure to display setup status on the display and print it.



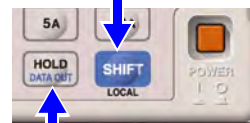
1 Press **SET**.

The current settings appear on the display.



2 Press **SHIFT**.

The **SHIFT** LED lights.



3 Press **HOLD DATA OUT**.

This prints values set when the key is pressed.

Print example

```
RANGE: 20A(AUTO:OFF),AVERAGE:OFF,
VT:OFF,CT:OFF,GP-IB: 1
```

Description of print items

RANGE : Current range and auto-range On/Off status

AVERAGE : Average times

VT : VT ratio

CT : CT ratio

GP-IB : GP-IB address

NOTE

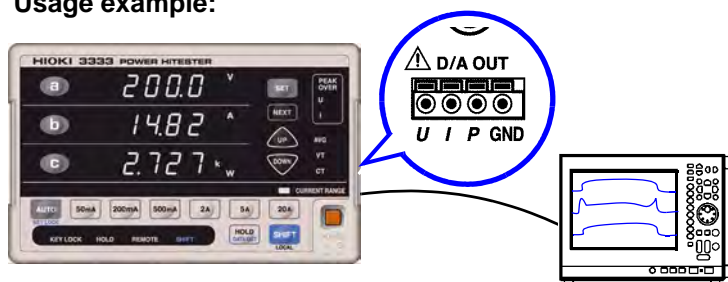
"OFF" is printed when AVERAGE, VT or CT are set to "1".

4.2 Converting to voltage for output (D/A output)



The D/A OUTPUT terminal can output measurement values (voltage, current, active power) as a level converted voltage.
A data logger or recorder can use this data.

Usage example:



D/A specifications

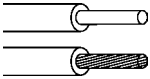
Output voltage	DC + 2 V f.s. for a 100% voltage and current range; DC + 2 V f.s. (absolute value output) for 100% of active range
Output resistance	100 Ω \pm 5 Ω (\pm 5%)
Response time	0.5 s or less
Output update rate	200 ms

NOTE

- When a VT or CT ratio is used, the range is multiplied by the VT ratio and CT ratio producing DC + 2 V.
- When the measurement range is set to auto-range, the D/A output changes the output rate according to changes in range. In measuring a line whose measurement value fluctuates wildly, take care not to mistake the range conversion.
It is recommended that a fixed range be used for such measurements.
- The response time for the D/A output of this instrument is 0.5 s.
- Note that a line that fluctuates faster than the output response time of the instrument will produce a deviation in the output voltage.
- The D/A output outputs measured instantaneous values every 200 ms. Thus the D/A output changes also in the display hold and during an averaging process.

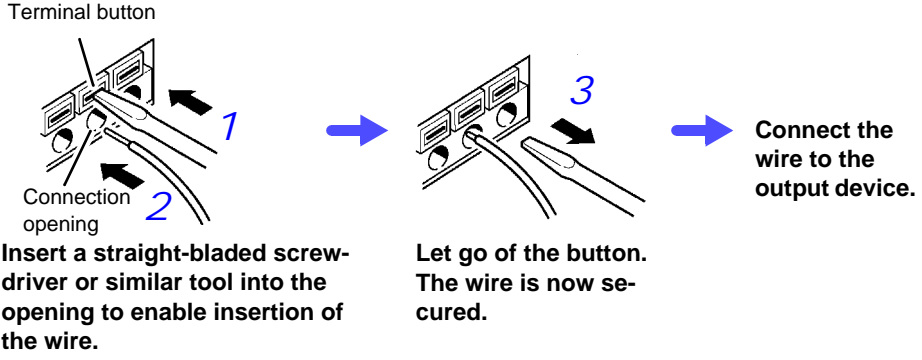
4.2 Converting to voltage for output (D/A output)

Wire materials that can be used for connection

	Rated wire	Single wire 1.2 mm in diameter (AWG 16) Stranded wire 1.25 mm ² (AWG 16), wire diameter 0.18 mm or more
	Range of usable wire	Single wire 0.4 mm in diameter (AWG 26) to 1.2 mm (AWG 16) Stranded wire 0.3 mm ² (AWG 22) to 1.25 mm ² (AWG 16), wire diameter 0.18 mm or more
	Standard length of removed wire section	11 mm
	Recommended tools	Phillips screwdriver (3 mm shaft diameter, 2.6 mm blade width)

Connecting to the D/A Output Terminal

Connect a wire to the D/A terminal of this instrument, then connect the wire to the output device. Connect the GND terminal of this instrument to the GND terminal of a data logger or recorder to which the data is to be output.



When the power to the line to be measured is turned on after connection, the voltage is also output to the output device.



To avoid damage to the instrument, do not short circuit or apply an input voltage to output terminals.

RS-232C/ GP-IB Interface

Chapter 5

The symbol shown below indicates that the following instructions are specific to the RS-232C or the GP-IB interface. Instructions without this symbol are for both the RS-232C and the GP-IB interface.

RS-232C : RS-232C only, or devices prepared for RS-232C

GP-IB : GP-IB only (3333-01), or devices prepared for GP-IB

5.1 Overview

This instrument can be controlled via the RS-232C and GP-IB.

RS-232C

Using the RS-232C, the measurement values can be printed out by connecting the instrument to the optional 9442 Printer.

See "4.1 Printing measurement values and setup status"(⇒ p.39)

GP-IB

- Complies with the following standard:Applicable standard IEEE 488.1-1987 *1
- This instrument is designed with reference to the following standard:
Reference standard IEEE 488.2-1987*2
- If the output queue becomes full, a query error is generated and the output queue is cleared. Therefore, clearing the output queue and query error output from the deadlocked condition*3 as defined in IEEE 488.2 is not supported.

NOTE

To users of the 3186 Digital Power HiTester

The 3333 tester differs from the 3186 in range configuration, measurement items, number of indications that can be displayed , output format and other functions.

Be sure to note the difference in commands that are provided by the two models before replacing the 3186.

Running commands that are not available on the 3333 has the following effect.

3186 commands	3333 commands
:VOLTage:RANGe <data> :VOLTage:AUTO <data> :BEEPPer <data> :DISPlay <data1>, <data2>	A command error is not output. No processing is performed
:VOLTage?	"VOLTAGE: RANGE 200; AUTO OFF" is output.
:VOLTage:RANGe?	"VOLTAGE:RANGE 200" is output.
:VOLTage:AUTO?	"VOLTAGE:AUTO OFF" is output.
:BEEPPer?	":BEEPER OFF" is output.

*1. ANSI/IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation

*2. ANSI/IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols, and Common Commands

*3. The situation in which the input buffer and the output queue become full, so that processing cannot continue.

Before Use

- 1. Connect to this connector.**
 Always make use of the connector screws to affix the GP-IB or RS-232C connectors.
 See "5.2 Connect a cable to the RS-232C connector or GP-IB connector"(⇒ p.48)

- 2. GP-IB Enter a GP-IB address.**
 Enter a GP-IB address in the setting screen.
 See "5.3 Enter a GP-IB address (3333-01 only)"(⇒ p.50)

- RS-232C Refer to the table below to set up the communication protocol of the controller so that these settings are identical to those of the instrument.**
 See "Setting up the communication protocol of the controller" (⇒ p.49)

The RS-232C interface

Specifications

Transfer method	Full duplex
Communications	Start-stop synchronization
Synchronization	
Baud rate	9600 bps
Data length	8 bits
Parity	none
Stop bit	1 bit
Message terminator (delimiter)	Receiving: LF Transmitting: CR + LF (switchable to LF)
Flow control	none
Electrical specification	Input voltage levels 5 to 15 V : ON -15 to -5 V : OFF Output voltage levels +5 V or more : ON -5 V or less : OFF
Connector	RS-232C Interface Connector Pinout (Male 9-pin D-sub, with #4-40 attachment screws) The I/O connector is a DTE (Data Terminal Equipment) configuration <ul style="list-style-type: none"> • Recommended cables 9637 RS-232C Cable(for PC/AT-compatibles) • 9638 RS-232C Cable(for PC98-series) See "5.2 Connect a cable to the RS-232C connector or GP-IB connector"(⇒ p.48)

Operating Code: ASCII codes

The GP-IB interface

Interface Functions

SH1	All Source Handshake functions	Yes
AH1	All Acceptor Handshake functions	Yes
T6	Basic talker functions	Yes
	Serial poll function	Yes
	Talk-only mode	No
	The talker cancel function with MLA (My Listen Address)	Yes
L4	Basic listener functions	Yes
	Listen-only mode	No
	The listener cancel function with MTA (My Talk Address)	Yes
SR1	All Service Request functions	Yes
RL1	All Remote/Local functions	Yes
PP0	Parallel Poll function	No
DC1	All Device Clear functions	Yes
DT1	All Device Trigger functions	Yes
C0	Controller functions	No

Operating Code: ASCII codes

NOTE

Precautions

Use an RS-232C or an GP-IB interface.

Simultaneous use of both interfaces may prevent communications and RS-232C control may block GP-IB SRQ (service request).

5.2 Connect a cable to the RS-232C connector or GP-IB connector

WARNING

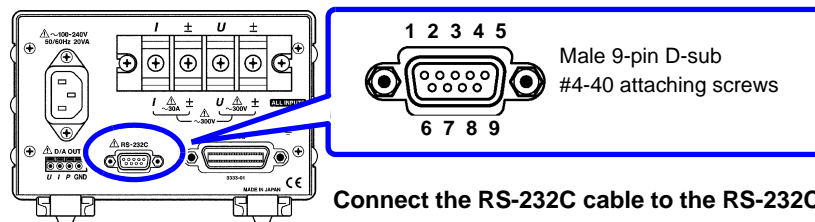
- Always turn both devices OFF when connecting and disconnecting an interface connector. Otherwise, an electric shock accident may occur.
- To avoid damage to the product, do not short-circuit the terminal and do not input voltage to the terminal.
- Connect this instrument to the RS-232C or GP-IB connector on the device to be connected.
A connection to a connector with different electrical specifications may result in an electric shock or equipment damage hazard.

CAUTION

After connecting, always tighten the connector screws. If the connector is not secured, operation may fail to meet specifications, and damage could result.

Connect to the RS-232C connector

RS-232C connector



Connect the RS-232C cable to the RS-232C connector.

To connect the instrument to a controller (DTE), use a cross-over cable compatible with the connectors on both the instrument and the controller.

The I/O connector is a DTE (Data Terminal Equipment) configuration. This instrument uses only pins 2, 3, 5, 7 and 8. The other pins are unconnected.

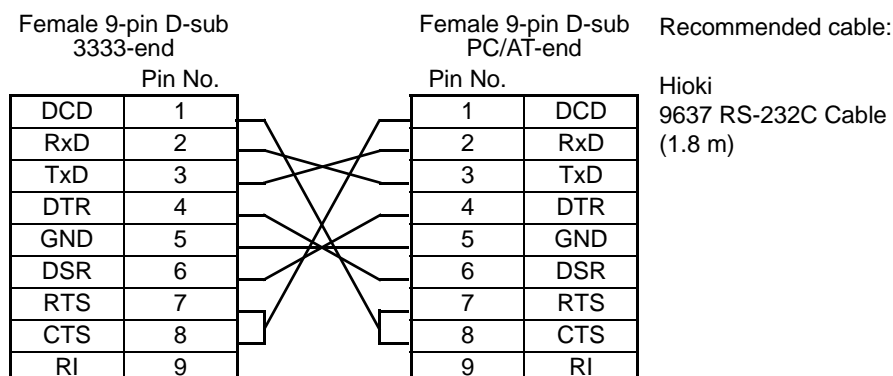
Pin No.	Mutual connection circuit name		CCITT	EIA	JIS	Signal Name
			Circuit No.	Code Addr.	Code Addr.	
1	Carrier Detect	Carrier Detect	109	CF	CD	DCD
2	Receive Data	Receive Data	104	BB	RD	RxD
3	Transmit Data	Send Data	103	BA	SD	TxD
4	Data Terminal Ready	Data Terminal Ready	108/2	CD	ER	DTR
5	Signal Ground	Signal Ground	102	AB	SG	GND
6	Data Set Ready	DATA Set Ready	107	CC	DR	DSR
7	Request to Send	Request to Send	105	CA	RS	RTS
8	Clear to Send	Clear to Send	106	CB	CS	CTS
9	Ring Indicator	Ring Indicator	125	CE	CI	RI

5.2 Connect a cable to the RS-232C connector or GP-IB connector

Connecting a controller with a 9-pin D-sub male port

Use a crossover cable with female 9-pin D-sub connectors.

Crossover Wiring

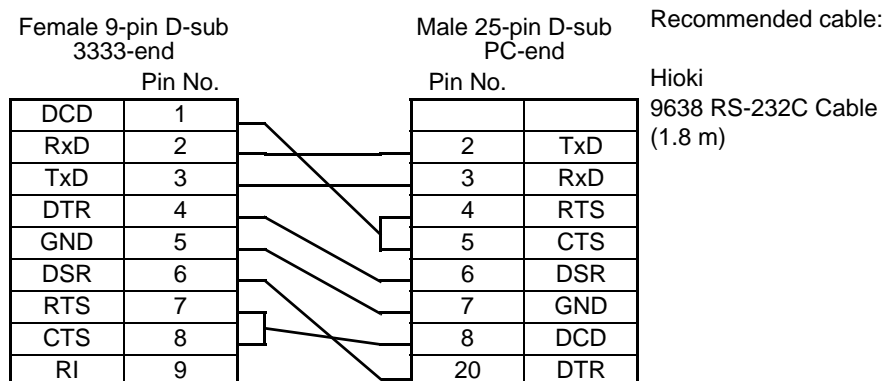


Connecting a controller with a 25-pin D-sub female port

Use a crossover cable with a female 9-pin D-sub and a male 25-pin D-sub connector.

As the figure shows, RTS and CTS pins are shorted together and crossed to DCD in the other connector.

Crossover Wiring



Note that the combination of a dual male 25-pin D-sub cable and a 9- to 25-pin adapter cannot be used.

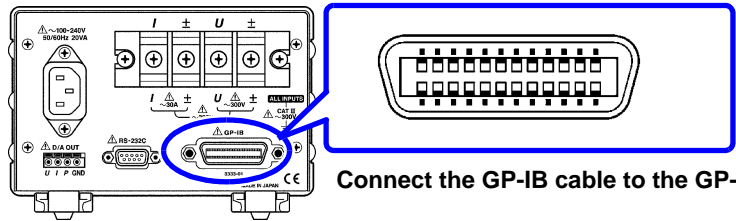
Setting up the communication protocol of the controller

Be sure to make set up the controller as shown below.

- Asynchronous communication
- Transfer rate 9600 bps
- Stop bit: 1
- Data length 8
- Parity check: None

5.3 Enter a GP-IB address (3333-01 only)

Connect to the GP-IB connector



Connect the GP-IB cable to the GP-IB connector.

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

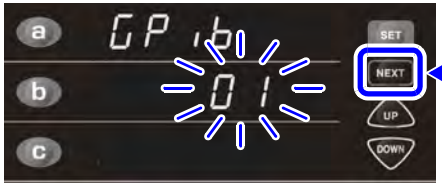
5.3 Enter a GP-IB address (3333-01 only)

Enter the GP-IB address in the setting screen before use of the GP-IB interface.

Settable range: 00 to 30

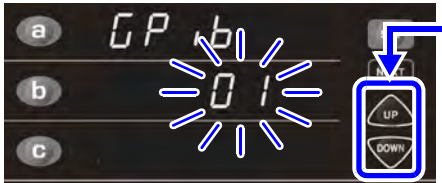


1 Press **SET** to display the setting screen.



2 Press **NEXT** to select the left display.

Press **NEXT** until GPib appears in display area a and the address flashes in display area b.



3 Use **UP** or **DOWN** to enter the GP-IB address.



4 Press **SET** to exit the setting screen.

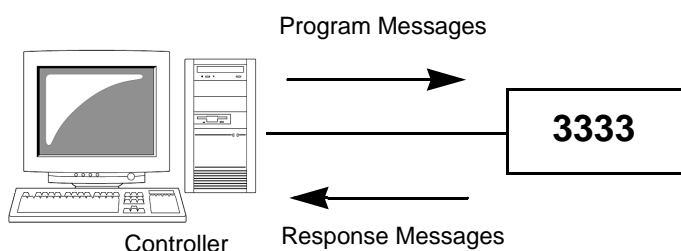
The normal measurement screen appears.

5.4 Communication Methods

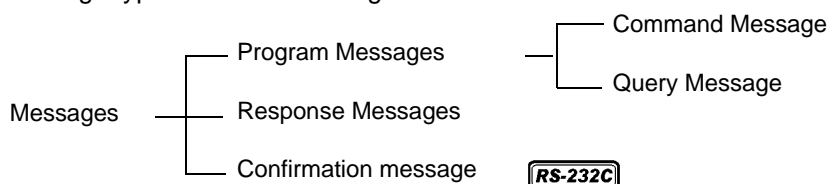
Various messages are supported for controlling the instrument through the interfaces.

Messages can be either program messages, sent from the controller such as PC to the instrument, or response messages, sent from the instrument to the controller.

RS-232C also provides messages that confirm operations to ensure that controller and instrument processing are synchronized.



Message types are further categorized as follows:



When issuing commands that contain data, make certain that the data is provided in the specified format.

NOTE

During communications, REMOTE is lit to indicate the remote control state. SHIFT (LOCAL)

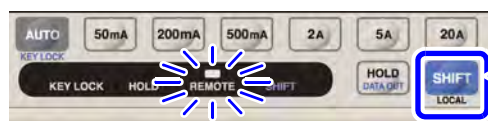
Pressing the key except the **SHIFT (LOCAL)** key has no effect.

When the remote control state is invoked and the instrument is in the setting screen, the measurement screen is displayed automatically

This key is disabled if the GP-IB controller has put the instrument into the local lock out state (LLO: Local Lock Out (\Rightarrow p.62)). In this case, run the GTL command of the interface function, or reboot the instrument. Then it returns to the local state.

To cancel the Remote state (enter the local state))

Remote state



Press the **SHIFT(LOCAL)** key.
The **REMOTE** LED goes out.

5.4.1 Message Format

Program Messages

Program messages can be either Command Messages or Query Messages.

- **Command Messages**

Instructions to control the instrument, such as to change settings or reset

Example: instruction to set the measurement range

:CURRENT:RANGE 0.5

- **Query Messages**

Requests for responses relating to results of operation or measurement, or the state of instrument settings.

Example: Command for inquiring current measurement range

:CURRENT:RANGE?

For details:

See "Headers" (⇒ p.53), "Separators" (⇒ p.54), "Data Formats" (⇒ p.54)

Response Messages

When a query message is received, its syntax is checked and a response message is generated.

The "**:HEADer**" command determines whether headers are prefixed to response messages.

Header ON **:CURRENT:RANGE 0.5**
 Header OFF **0.5**
 (the current range is 500 mA)

At power-on, Header ON is selected.

If an error occurs when a query message is received, no response message is generated for that query.

There are also messages such as *TST? that do not have a header.

Confirmation Messages

RS-232C

A confirmation message is created from three-digit numeric data (ASCII code) after analyzing and running 1 line of data (data up to the terminator) from the controller.

This numeric data is returned to the controller. This data makes it possible to synchronize controller and instrument operations. (⇒ p.81)

Example: Confirmation messages

000: Indicates the transferred command ended normally.

001: The command at the beginning (first) of the program message was not correctly processed.

010: The 10th command in the program message was not correctly processed.

NOTE

- When a confirmation message is specified, import it after sending the program message as the tester will not otherwise properly synchronize with the controller. This message also works with GP-IB and must be received. Any query commands should be added at the end of a response message.
- A command that generates command errors, execution errors or device dependent errors is regarded as abnormal.

Command Syntax

Command names are chosen to mnemonically represent their function, and can be abbreviated. The full command name is called the "long form", and the abbreviated name is called the "short form".

The command references in this manual indicate the short form in upper-case letters, extended to the long form in lower case letters, although the commands are not case-sensitive in actual usage.

DISPLAY	OK (long form)
DISP	OK (short form)
DISPL	Error
DIS	Error

Response messages generated by the instrument are in long form and in upper case letters.

Headers

Headers must always be prefixed to program messages.

(1) Command Program Headers

There are three types of commands: Simple, Compound and Standard.

- **Headers for Simple Commands**

This header type is a sequence of letters and digits

:ESE0 1

- **Headers for Compound Commands**

These headers consist of multiple simple command type headers separated by colons ":"

:CURRENT :RANGE

- **Headers for Standard Commands**

This header type begins with an asterisk "*", indicating that it is a standard command defined by IEEE 488.2.

***RST**

(2) Query Program Header

These commands are used to interrogate the instrument about the results of operations, measured values and the current states of instrument settings.

As shown by the following examples, a query is formed by appending a question mark "?" after a program header.

***TST?**

Message Terminators

This instrument recognizes the following message terminators:

GP-IB

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

RS-232C

- LF
- CR+LF

From the instrument's interface settings, the following can be selected as the terminator for response messages.

GP-IB

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

RS-232C

- LF
- CR+LF (initial setting)

See "Set and query the response message terminator" (⇒ p.86)

Separators

(1) Message Unit Separator

Multiple message can be written in one line by separating them with semicolons ";".

```
:CURRent:RANGe 0.5;:AVERaging 10
```

When messages are combined in this way and if one command contains an error, all subsequent messages up to the next terminator will be ignored.

(2) Header Separator

In a message containing multiple data items, commas are required to separate the data items from one another.

```
:CURRent:RANGe 0.5
```

(3) Data Separator

In a message containing multiple data items, commas are required to separate the data items from one another.

```
:MEASure? U,I
```

Data Formats

The instrument uses character data and decimal numeric data, depending on the command.

(1) Character Data

Character data always begins with an alphabetic character, and subsequent characters may be either alphabetic or numeric. Character data is not case-sensitive, although response messages from the instrument are only upper case.

```
:HOLD ON
```

(2) Decimal Numeric Data

Three formats are used for numeric data, identified as NR1, NR2 and NR3. Numeric values may be signed or unsigned. Unsigned numeric values are handled as positive values.

Values exceeding the precision handled by the instrument are rounded to the nearest valid digit.

- NR1 Integer data(e.g.: +12, -23, 34)
- NR2 Fixed-point data(e.g.:+1.23, -23.45, 3.456)
- NR3 Floating-point exponential representation data(e.g.:+1.0E-2, -2.3E+4)

The term "NRf format" includes all three of the above numeric decimal formats. The instrument accepts NRf format data.

The format of response data is specified for each command, and the data is sent in that format.

:AVERAGING 10



The instrument does not fully support IEEE 488.2. As much as possible, please use the data formats shown in the Reference section.

Also, be careful to avoid constructing single commands that could overflow the input buffer or output queue.

Compound Command Header Omission

When several commands having a common header are combined to form a compound command (e.g., **:CURRENT:RANGE** and **:CURRENT:AUTO**), if they are written together in sequence, the common portion (here, **:CURRENT:**) can be omitted after its initial occurrence.

This common portion is called the "current path" (analogous to the path concept in controller file storage), and until it is cleared, the interpretation of subsequent commands presumes that they share the same common portion. This usage of the current path is shown in the following example:

Full expression

:CURRENT:RANGE 0.5;:CURRENT:AUTO ON

Compacted expression

:CURRENT:RANGE 0.5;AUTO ON



This portion becomes the current path, and can be omitted from the messages immediately following.

The current path is cleared when the power is turned on, when reset by key input, by a colon ":" at the start of a command, and when a message terminator is detected.

Standard command messages can be executed regardless of the current path. They have no effect upon the current path.

A colon ":" is not required at the start of the header of a Simple or Compound command. However, to avoid confusion with abbreviated forms and operating mistakes, we recommend always placing a colon at the start of a header.



In this instrument, the current path is as follows

:CURRENT:, :RS232c:, :SCALE:, :TRANSMIT:

5.4.2 Output Queue and Input Buffer

Output Queue

Response messages are stored in the output queue until read by the controller. The output queue is also cleared in the following circumstances:

- Power on
- Device clear 
- Query Error 

The output queue capacity of the instrument is 500 bytes. If response messages overflow the buffer, a query error is generated and the output queue is cleared. Also, with GP-IB, if a new message is received while data remains in the output queue, the output queue is cleared and a query error is generated.

Input Buffer

The output queue capacity of the instrument is 500 bytes. When the input buffer receives data that exceeds 500 bytes and becomes full, the GP-IB interface buss waits until buffer space becomes available.

RS-232C does not receive data that exceeds 500 bytes. For example, if it receives 520 bytes from the controller, the 20 bytes from the 501st byte are not received.

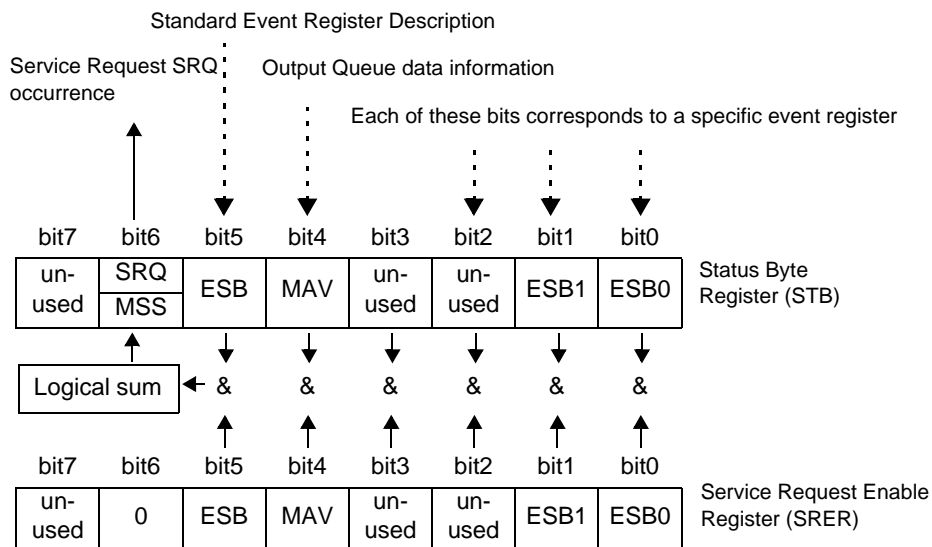
NOTE

Ensure that the no command ever exceeds 500 bytes.

5.4.3 Status Byte Register

GP-IB

This instrument implements the status model defined by IEEE 488.2 with regard to the serial poll function using the service request line. The term "event" refers to any occurrence that generates a service request.



Overview of Service Request Occurrence

The Status Byte Register contains information about the event registers and the output queue. Required items are selected from this information by masking with the Service Request Enable Register. When any bit selected by the mask is set, bit 6 (MSS; the Master Summary Status) of the Status Byte Register is also set, which generates an SRQ (Service Request) message and dispatches a service request.

NOTE

SRQ (Service Request) is a GP-IB only function. However, STB (Status Byte Register) data uses the ***STB?** command, RS-232C can also access this information.

RS-232C

RS-232C does not provide a function for issuing service requests. Still, SRER setup and STB reading are available.

Status Byte Register (STB)

During serial polling, the contents of the 8-bit Status Byte Register are sent from the instrument to the controller.

When any Status Byte Register bit enabled by the Service Request Enable Register has switched from 0 to 1, the MSS bit becomes 1. Consequently, the SRQ bit is set to 1, and a service request is dispatched.

The SRQ bit is always synchronous with service requests, and is read and simultaneously cleared during serial polling. Although the MSS bit is only read by an ***STB?** query, it is not cleared until a clear event is initiated by the ***CLS** command.

Bit 7		unused
Bit 6	SRQ	Set to 1 when a service request is dispatched.
	MSS	This is the logical sum of the other bits of the Status Byte Register.
Bit 5	ESB	Standard Event Status (logical sum) bit This is logical sum of the Standard Event Status Register.
Bit 4	MAV	Message available Indicates that a message is present in the output queue.
Bit 3		unused
Bit 2		unused
Bit 1	ESB1	Event Status (logical sum) bit 1 This is the logical sum of Event Status Register 1.
Bit 0	ESB0	Event Status (logical sum) bit 0 This is the logical sum of Event Status Register 0.

Service Request Enable Register (SRER)

This register masks the Status Byte Register. Setting a bit of this register to 1 enables the corresponding bit of the Status Byte Register to be used.

5.4.4 Event Registers

Standard Event Status Register (SESR)

The Standard Event Status Register is an 8-bit register.

If any bit in the Standard Event Status Register is set to 1 (after masking by the Standard Event Status Enable Register), bit 5 (ESB) of the Status Byte Register is set to 1.

See "Standard Event Status Register (SESR) and Standard Event Status Enable Register (SESER)" (⇒ p.60)

The Standard Event Status Register is cleared in the following situations:

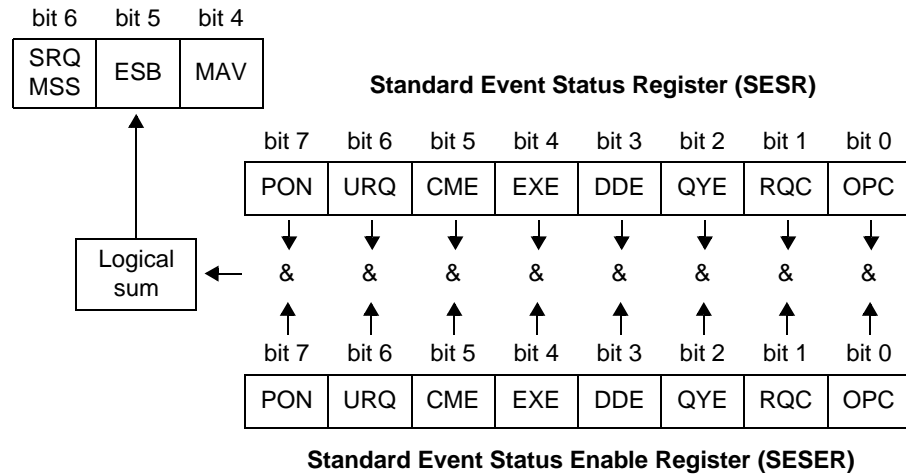
- When a ***CLS** command is executed
- When an event register query (***ESR?**) is executed
- When the instrument is powered on

Bit 7	PON	Power-On Flag Set to 1 when the power is turned on, or upon recovery from an outage.
Bit 6	URQ	User Request unused
Bit 5	CME	Command error. (The command to the message terminator is ignored.) This bit is set to 1 when a received command contains a syntactic or semantic error: <ul style="list-style-type: none"> • Program header error • Incorrect number of data parameters • Invalid parameter format • Received a command not supported by the instrument
Bit 4	EXE	Execution Error This bit is set to 1 when a received command cannot be executed for some reason. <ul style="list-style-type: none"> • The specified data value is outside of the set range • The specified setting data cannot be set • Execution is prevented by some other operation being performed
Bit 3	DDE	Device-Dependent Error This bit is set to 1 when a command cannot be executed due to some reason other than a command error, a query error or an execution error. <ul style="list-style-type: none"> • Execution is impossible due to an internal instrument fault (Error indication) • The command is executed in the hold state • A value outside the range is read in using the "MEASure?" command when "o.r" is on.
Bit 2	QYE	Query Error (the output queue is cleared) This bit is set to "1" when an abnormality occurs in processing an output queue <ul style="list-style-type: none"> • When an attempt has been made to read an empty output queue (GP-IB only) • When the data overflows the output queue • When the next command is received while there is data in the output queue (GP-IB only) • When a *IDN? query is followed by a query in the same line
Bit 1	RQC	Controller privilege request unused
Bit 0	OPC	Operation Complete (GP-IB only) This bit is set to 1 in response to an *OPC command. <ul style="list-style-type: none"> • It indicates the completion of operations of all messages up to the *OPC command

Standard Event Status Enable Register (SESER)

Setting any bit of the Standard Event Status Enable Register to 1 enables access to the corresponding bit of the Standard Event Status Register.

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



Device-Specific Event Status Registers (ESR0 and ESR1)

This instrument provides two event status registers for controlling events. Each event register is an 8-bit register.

When any bit in one of these event status registers enabled by its corresponding event status enable register is set to 1, the following happens:

- For Event Status Register 0, bit 0 (ESB0) of the Status Byte Register (STB) is set to 1.
- For Event Status Register 1, bit 1 (ESB1) of the Status Byte Register (STB) is set to 1.

Event Status Registers 0 or 1 are cleared in the following situations:

- When a ***CLS** command is executed
- When an Event Status Register query (:ESR0? or :ESR1?) is executed
- When the instrument is powered on

Event Status Register 0 (ESR0)

Bit 7	DS	Display update
Bit 6	BE	The setting could not be written to EEPROM
Bit 5	–	Held at 0
Bit 4	–	Held at 0
Bit 3	–	Held at 0
Bit 2	–	Held at 0
Bit 1	–	Held at 0
Bit 0	AVG	When an average data update is reached (can be set at start)

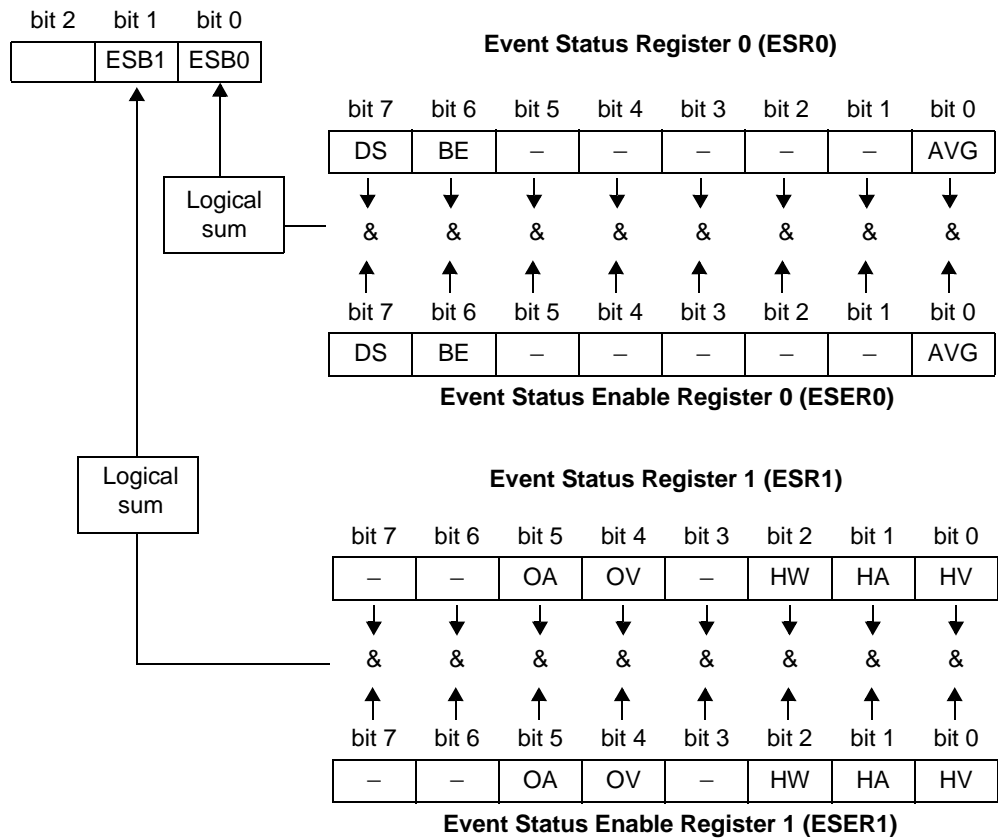
Event Status Register 1(ESR1)

Bit 7	–	Held at 0
Bit 6	–	Held at 0
Bit 5	OA	OVER-A current peak over
Bit 4	OV	OVER-V voltage peak over
Bit 3	–	Held at 0
Bit 2	HW	HIGH-W Power range over
Bit 1	HA	HIGH-A Current range over
Bit 0	HV	HIGH-V Voltage range over

5.4 Communication Methods

Event Status Registers 0 (ESR0) and 1 (ESR1), and Event Status Enable Registers 0 (ESER0) and 1 (ESER1)

Status Byte Register (STB)



Register Reading and Writing

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

GP-IB Commands

The following commands can be used for performing interface functions.

Command	Description
GTL	Go To Local Cancels the Remote state and enters the Local state.
LLO	Local Lock Out Disables all keys, including the LOCAL key.
DCL	Device Clear Clears the input buffer and the output queue.
SDC	Selected Device Clear Clears the input buffer and the output queue.
GET	Group Execute Trigger When the display values are held, processes one sample.

5.4.5 Initialization Items

●: initialized/ -: not initialized

Item	Initialization method	Power on	Key reset (⇒ p.36)	*RST command	Device clear (GP-IBonly)	*CLS command	Initial setting
GP-IB address		-	●	-	-	-	1
RS-232C setting (fixed)		-	-	-	-	-	-
Device specific functions (ranges etc.)		-	●	●	-	-	(⇒ p.36)
Output queue		●	●	-	●	-	-
Input buffer		●	●	-	●	-	-
Status byte register		●	●	-	- *1	● *2	-
Event register		● *3	●	-	-	●	-
Enable register		●	●	-	-	-	0
Current path		●	●	-	●	-	-
Headers on/off		●	●	●	-	-	ON
Response message terminator		●	●	-	-	-	CR+LF
Response message separator		●	●	●	-	-	;

*1. Only the MAV bit (bit 4) is cleared.

*2. All bits except the MAV bit are cleared.

*3. Except the PON bit (bit 7).

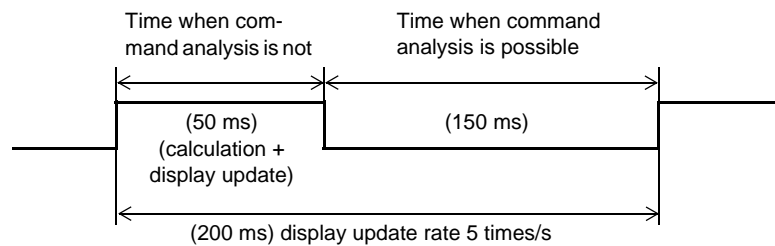
5.4.6 Command Execution Time

Command execution time indicates the time for analyzing and processing long form commands.

However, the command execution time for commands with data is the time described according to the data format specified in the <data portion>, and for query commands it is the time when the header is ON.

NOTE

- Due to internal processing, there may be a maximum time lag of 50 ms between command reception and analysis in this instrument.
- When an analysis cannot be completed in the time allotted for internal processing, data display is delayed.
- All commands are sequential commands.
- In communications with the controller, time must be added for data transmission.
- GP-IB transfer time depends on the controller.
The time for RS-232C transfers involving a total of 10 bits (the start bit is 1, data length is 8, no parity, stop bit is 1) is shown below.
9600 bps: approximately 960 characters/s
- Wait until measurements stabilize after a change before using a setting command.



Command	Execution time
*RST	200 ms or less
*TRG (including GET) *WAI :MEASure?	When measurement values appear: 200 ms or less No indication: wait for a measurement value to appear
:CURRent:RANGe :SCALE:CT :SCALE:VT	50 ms or less
*TST?	6 s
Commands other than those above	20 ms or less

5.5 Message List

Commands specific to RS-232C or GP-IB are identified by  or , respectively.

5.5.1 Standard Commands

Command	Data Formats (Response data if a Query)	Description	Error	Ref page
*CLS		Clears the event registers and the Status Byte Register.	*1	70
*ESE	0 to 255 (NR1)	Sets the contents of the Standard Event Status Enable Register.	*3, *5	71
*ESE?	0 to 189 (NR1)	Queries the Standard Event Status Enable Register.	*2, *5	71
*ESR?	0 to 189 (NR1)	Queries the Standard Event Status Register.	*2	71
*IDN?	<Manufacturer's name>,<Model name>,<Serial number>,<Software version>	Queries the Device ID.	*2	69
*OPC	_____		*1, *5	70
*OPC?	1	Queries execution completion.	*2, *5	70
*RST	_____	Initializes the device.	*1	69
*SRE	0 to 255 (NR1)	Sets the Service Request Enable Register.	*3, *5	72
*SRE?	0 to 51 (NR1)	Queries the contents of the Service Request Enable Register.	*2, *5	72
*STB?	0 to 115 (NR1)	Queries the Status Byte Register.	*2	72
*TRG	_____	Executes one sampling.	*1, *4, *5	72
*TST?	0 to 4 (NR1)	Initiates a self-test and queries the result.	*2	69
*WAI	_____	Wait for operations to finish.	*1, *5	70

Error description (an error occurs when executing messages in the following cases):

- *1 Command Error.....When data is present after the command
- *2 Query ErrorWhen the response message exceeds 500 bytes, or when a query follows *IDN?.
- *3 Execution ErrorWhen invalid character or numeric data is present
- *4 Device dependent ErrorWhen this command is executed at times other than in the hold state
- *5 Device dependent ErrorWhen the self-test generates an error

NOTE:

- A misspelled message and the presence of data after a query always produce a command error.
- < > = contents of the data portion.
Numeric data values are indicated by format as (NR1), (NR2) and (NR3), representing integer, fixed-point and floating point decimal data values respectively, or as (NRf), representing any of these formats.
- In GP-IB, *ESE or *SRE can be set to enable SRQ interrupts to the controller.

5.5.2 Device-Specific Commands

Command	Data Contents () = response data	Description	Error	Ref page
Event registers				
:ESE0	0 to 255	Sets Event Status Enable Register 0.	*3, *5	73
:ESE0?	(0 to 193)	Queries Event Status Enable Register 0.	*2, *5	73
:ESR0?	(0 to 193)	Queries Event Status Register 0.	*2, *5	74
:ESE1	0 to 255	Sets Event Status Enable Register 1.	*3, *5	73
:ESE1?	(0 to 55)	Queries Event Status Enable Register 1.	*2, *5	73
:ESR1?	(0 to 55)	Queries Event Status Register 1.	*2, *5	74
Average times (average)				
:AVERaging	1/ 2/ 5/ 10/ 25/ 50/ 100 (NR1)	Sets average times	*3, *4, *5	74
:AVERaging?	(1/ 2/ 5/ 10/ 25/ 50/ 100)	Queries average times	*2, *5	74
Current range				
:CURRent?		Queries current setting	*2, *5	75
:CURRent:AUTO	ON/ OFF	Sets current auto-range	*3, *4, *5	75
:CURRent:AUTO?	(ON/ OFF)	Queries current auto-range	*2, *5	75
:CURRent:RANGe	(NR2)	Sets current range	*3, *4, *5	76
:CURRent:RANGe?	(NR2)	Queries current range	*2, *5	76
Display items				
:DISPlay	<Display area a>, <Display area b>, <Display area c> <Display area a>= U, I, P <Display area b>= I, P, S <Display area a>= U, I, P, PF	Sets display item	*3, *5	77
:DISPlay?		Queries display item	*2, *5	77
Header				
:HEADer	ON/OFF	Sets header	*3, *5	77
:HEADer?		Queries the header	*2, *5	77
Display hold (hold)				
:HOLD	ON/OFF	Sets hold status	*3, *5	78
:HOLD?		Queries hold status	*2, *5	78


Error description (an error occurs when executing messages in the following cases):

- *1 Command Error.....When data is present after the command
- *2 Query Error.....When the response message exceeds 500 bytes, or when a query follows *IDN?
- *3 Execution Error.....When invalid character or numeric data is present
- *4 Device dependent Error.....When this command is executed in the hold state
- *5 Device dependent Error.....When the self-test generates an error

For information on other errors, refer to the notes attached to each command.

NOTE:

- A misspelled message and the presence of data after a query always produce a command error. (except :MEASure?)
- < > = contents of the data portion.
[Numeric data values are indicated by format as (NR1), (NR2) and (NR3), representing integer, fixed-point and floating point decimal data values respectively, or as (NRf), representing any of these formats]
- In GP-IB, *ESE or *SRE can be set to enable SRQ interrupts to the controller.

Command	Data Contents () = response data	Description	Error	Ref page
Measurement data				
:MEASure?	<Item 1>, <Item 2>, <Item 3>, <Item 4>, <Item 5> U/ I/ P/ S/ PF (A total of five items can, but need not, be set.)	Queries set measurement data	*3, *5	79
RS-232C				
				
:RS232c?		Queries RS-232C settings	*2	80
:RS232c:ANSWer	ON/ OFF	Sets confirmation message	*3	81
:RS232c:ANSWer?		Queries confirmation message	*2	81
:RS232c:ERRor?		Queries RS-232C communication error	*2	82
:RS232c:HANDshake	HARD/ OFF	Sets RS-232C communication handshake	*3	82
:RS232c:HANDshake?		Queries RS-232C communication handshake	*2	82
VT (PT)/CT ratio				
:SCALE?	(<VT ratio>;<CT ratio>)	Queries VT (PT) and CT ratio settings	*2, *5	83
:SCALE:CT	1/ 2/ 3/ 4/ 5/ 6/ 8/ 10/ 12/ 15/ 16/ 20/ 24/ 25/ 30/ 40/ 50/ 60/ 75/ 80/ 100 (NR1)	Sets CT ratio	*3, *5	83
:SCALE:CT?	(<CT ratio>(NR1))	Queries CT ratio	*2, *5	83
:SCALE:VT (:SCALE:PT)	1/ 2/ 4/ 10/ 20/ 30/ 60/ 100 (NR1)	Sets VT (PT) ratio	*3, *5	84
:SCALE:VT? (:SCALE:PT?)	(<VT(PT) ratio>(NR1))	Queries VT (PT) ratio	*2, *5	84
Separator, terminator				
:TRANsmit:SEParator	0/ 1 (NR1)	Sets message unit and separator	*3, *5	85
:TRANsmit:SEParator?	(0/ 1)	Queries message unit and separator	*2, *5	85
:TRANsmit:TERMinator	0/ 1 (NR1)	Set message and terminator	*3	86
:TRANsmit:TERMinator?	(0/ 1)	Queries message and terminator	*2	86

Error description (an error occurs when executing messages in the following cases):

- *1 Command Error.....When data is present after the command
- *2 Query ErrorWhen the response message exceeds 500 bytes, or when a query follows *IDN?
- *3 Execution ErrorWhen invalid character or numeric data is present
- *4 Device dependent ErrorWhen this command is executed in the hold state
- *5 Device dependent ErrorWhen the self-test generates an error

For information on other errors, refer to the notes attached to each command.

NOTE:

- A misspelled message and the presence of data after a query always produce a command error. (except :MEASure?)
- < > = contents of the data portion.
[Numeric data values are indicated by format as (NR1), (NR2) and (NR3), representing integer, fixed-point and floating point decimal data values respectively, or as (NRf), representing any of these formats]
- In GP-IB, *ESE or *SRE can be set to enable SRQ interrupts to the controller.

5.6 Message Reference

< >: Indicates the contents (character or numeric parameters) of the data portion of a message. Character parameters are returned as all capital letters.

Numeric Parameters:

- NRf Number format may be any of NR1, NR2 and NR3
- NR1 Integer data(e.g.: +12, -23, 34)
- NR2 Fixed-point data(e.g.: +1.23, -23.45, 3.456)
- NR3 Floating-point exponential representation data (e.g.: +1.0E-2, -2.3E+4)

Shows the command description.

Shows the message syntax.
Explains the command data or response message.

Describes the message.

Shows an example of an actual command application.
(Normally described with HEADER ON, (except the HEADER command itself).)

Read/Write the Standard Event Status Enable Register (SESER)

Syntax Command ***ESE <0 to 255 (NR1)>**
Query ***ESE?**
Response **<0 to 255 (NR1)>**

Description Command The SESER mask is set to the numerical value 0 to 255.
The initial value (at power-on) is 0.
Query The contents of the SESER, as set by the *ESE command, are returned as an NR1 value (0 to 255).

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

Example Command ***ESE 36**
(Sets bits 5 and 2 of SESER)

5.6.1 Standard Commands

Messages specific to the RS-232C or GP-IB interface are identified by their corresponding symbols.

(1) System Data Command

Queries device ID.

Syntax	Query	*IDN?
	Response	<Manufacturer's name>,<Model name>,<Model code>,<Software version>

Example	Response	HIOKI , 3333 , 0 , V1 . 00
		The Device ID is HIOKI, 3333, Model code 0 (standard model), software version 1.00.

- Note**
- The response message has no header.
 - In the model code, 0 denotes the standard model (3333) while 1 the model with GP-IB support (3333-01).
 - "*IDN?" is the last query message of the program messages. Thus a subsequent query on the same line will generate a query error and no response message is output.

(2) Internal Operation Command

Initialize Device

Syntax	Command	*RST
Description	Command	Resets instrument settings to factory defaults. Default setting: "5.4.5 Initialization Items"(⇒ p.63)

- Note**
- The GP-IB address is not initialized.
 - Communication handshake, confirmation message and message unit terminator settings are not initialized.

Execute Self-Test and Query the Result

Syntax	Query	*TST?
	Response	<0 to 4 (NR1)> 0: No Errors 1: ROM Error 2: RAM Error 3: Control circuit error 4: setup data error

Description Perform instrument self-test and return the result as numerical value 0 to 4.

Example	Query	*TST?
	Response	1 A ROM error occurred.

(3) Synchronization Commands**Set the OPC bit of SESR When Finished All Pending Operations**

Syntax	Command	*OPC
Description	Sets OPC bit 0 of the Standard Event Status Register (SESR) when all prior commands have finished processing.	
Example	:MEAS? ; *OPC The OPC bit of the SESR is set after commands MEAS? have finished processing.	

Set ASCII 1 in the output queue after completing all running operations

Syntax	Query	*OPC?
	Response	1
Description	.When the command (of transferred commands) prior to the *OPC command has finished processing, ASCII 1 is stored in the output queue.	
Example	:MEAS? ; *OPC? "1" is stored in the output queue after MEAS? data has been created.	

Wait for Pending Commands to Finish

Syntax	Command	*WAI
Description	No commands after *WAI are run until the next display update completes.	
Example	:MEAS? ; *WAI ; :MEAS? Data is imported at each display update.	

(4) Status and Event Control Commands**Clear the Event Resistors**

Syntax	Command	*CLS
Description	Clears the event registers. Also clears the bit of the Status Byte Register corresponding to event resistors.(SESR, ESR0, ESR1)	
Note	The output queue, the various enable registers and MAV bit 4 of the Status Byte Register are unaffected.	

Read/Write the Standard Event Status Enable Register (SESER)

Syntax	Command	*ESE <0 to 255 (NR1)>
	Query	*ESE?
	Response	<0 to 189 (NR1)>
Description	Command	The SESER mask is set to the numerical value 0 to 255. The initial value (at power-on) is 0. (⇒ p.59) Since the 3333 does not use URQ (bit6) and RQC (bit 1), setting 1 is reset to 0. *ESE? outputs bit 6 and 2 outputs 0 data.
	Query	The contents of the SESER, as set by the *ESE command, are returned as an NR1 value (0 to 189).

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 bits 5 and 2 of SESER.
	Query	*ESE?
	Response	*ESE 36 (Headers: ON) 36 (Headers: OFF)

Read and Clear the Standard Event Status Register (SESR)

Syntax	Query	*ESR?
	Response	<0 to 189 (NR1)>
Description		Returns the contents of the SESR as an NR1 value from 0 to 189, then clears register contents. The response message has no header.(⇒ p.59)

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	32 Bit 5 of the SESR was set to 1.
----------------	--

Write and Read the Service Request Enable Register (SRER)

Syntax	Command	*SRE <0 to 255 (NR1)>
	Query	*SRE?
	Response	<0 to 51 (NR1)>
Description	Command	The SRER mask is set to the numerical value 0 to 255. Although NRf numerical values are accepted, values to the right of the decimal are rounded to the nearest integer. Bit 6 and unused bits 2, 3 and 7 are ignored. The data is initialized to zero at power-on. (⇒ p.58)
	Query	The contents of the SRER, as set by the *SRE command, are returned as an NR1 value (0 to 51). Bit 6 and unused bits 2, 3 and 7 always return as zero.

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	0	ESB	MAV	unused	unused	ESE1	ESE0

Example	Command	*SRE 33 Set SRER bits 0 and 5 to 1.
	Query	*SRE?
	Response	*SRE 33 (Headers: ON) 33 (Headers: OFF) SRER bits 0 and 5 have been set to 1.

Read the Status Byte and MSS Bit

Syntax	Query	*STB?
	Response	<0 to 115 (NR1)>
Description	The contents of the STB are returned as an NR1 value (0 to 115). The response message has no header. (⇒ p.58)	

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	MSS	ESB	MAV	unused	unused	ESE1	ESE0

Example	Query	*STB?
	Response	16 STB bit 4 has been set to 1.

Request a Sample

Syntax	Command	*TRG
Description	Performs one measurement when the display values are held.	
Example	:HOLD ON; *TRG; :MEAS?	

5.6.2 Device-Specific Commands

(1) Event Status Register

Read and Write Device-Specific Event Status Enable Registers ESERO and ESER 1

ESERO

Syntax Command **:ESE0** <0 to 255 (NR1)>

Query **:ESE0?**

Response <0 to 193 (NR1)>

Description Command Sets the mask pattern in Event Status Enable Register 0 (ESERO) for the Event Status Register.(⇒ p.60)

128 bit 7	64 bit 6	32 bit 5	16 bit 4	8 bit 3	4 bit 2	2 bit 1	1 bit 0
DS	BE	–	–	–	–	–	AVG

Note Data initializes to zero at power-on.

ESER1

Syntax Command **:ESE1** <0 to 255 (NR1)>

Query **:ESE1?**

Response <0 to 55 (NR1)>

Description Command Sets the mask pattern in Event Status Enable Register 1 (ESER1) for the Event Status Register.(⇒ p.60)

128 bit 7	64 bit 6	32 bit 5	16 bit 4	8 bit 3	4 bit 2	2 bit 1	1 bit 0
–	–	OA	OV	–	HW	HA	HV

Example Command **:ESE0 255**
All ESERO data are made available

Query **:ESE0?**

Response **:ESE0 193** (Headers: ON)
193 (Headers: OFF)

Note Data initializes to zero at power-on.
Unused bits (bits indicated by "-") are set to 0.

Read Device-Specific Event Status Registers ESR0 and ESR1

Syntax	Query	:ESR0?
	Response	:ESR1? <0 to 193 (NR1)>
Description	Query	Returns event status register content as a numerical value in the NR1 format. A header is not added to the response message.
Note	Executing ESR0? clears the contents of ESR0. Executing ESR1? clears the contents of ESR1.	

(2) Average times (average)

Sets and queries average times

Syntax	Command	:AVERaging <Average times (NR1)>
	Query	:AVERaging?
	Response	<Average times (NR1)> <Average times (NR1)> = 1/ 2/ 5/ 10/ 25/ 50/ 100
Description	Command	Set the display average times The numerical value can be in NRf format, but any digits after the decimal point will be rounded.
	Query	Returns display average times as a numerical value in NR1 format.
Example	Command	:AVER 10 The count for averaging is set to 10.
	Query	:AVER?
	Response	:AVERAGING 10 (Headers: ON) 10 (Headers: OFF)
Note	<ul style="list-style-type: none"> Averaging starts over when the range is changed. See Acquiring the averaged data (⇒ p.88) The AVG LED lights when something other than 1 is the result and goes out when it is 1. 	

(3) Current range**Query the Current Range and Auto-Range Setting**

Syntax	Query	:CURRent?
	Response	<Current range(NR2)>;<Auto-range ON/OFF>
Description	Query	Returns the current range as a numerical value in NR2 format and the auto-range as ON or OFF.
Example	Query	:CURR?
	Response	:CURRENT:RANGE 0.5;AUTO ON (Headers: ON) 0.5;ON (Headers: OFF) Current measurement is in auto-range mode in 500 mA range.
Note	<ul style="list-style-type: none"> • When this query ends in some kind of error, no response message is created for this query. • The :TRANsmit:SEParator command makes it possible to change the message unit separator from a semicolon (;) to a comma (,). 	

Set and Query the Current Auto-Range Setting

Syntax	Command	:CURRent:AUTO <ON/ OFF>
	Query	:CURRent:AUTO?
	Response	<ON/ OFF> ON: measures current in the auto-range. OFF: ends current auto-range operation.
Description	Command	Enables and disables the current auto-range.
	Query	Returns the ON/OFF setting of the current auto-range setting as ON or OFF.
Example	Command	:CURR:AUTO ON The current auto-range is set to ON.
	Query	:CURR:AUTO?
	Response	:CURRENT:AUTO ON (Headers: ON) ON (Headers: OFF)

Set and Query the Current Range Setting

Syntax	Command	:CURRENT:RANGe <Current range(NR2)>
	Query	:CURRENT:RANGe?
	Response	Current range (NR2)> <Current range(NR2)> = 0.05, 0.2, 0.5, 2.0, 5.0, 20.0
Description	Command	Sets the current range. (The unit is ampere (A)) The numerical value can be in NRf format, but rounding is performed for figures beyond the last valid decimal place. (Valid digits: 4 digits) The instrument uses <current range> to select the optimum range for measurement. However, it goes to the next higher range when measurements are 120% f.s. of the range.
	Query	Queries the current range setting. Returns the current range as a numerical value in NR3 format.
Example	Command	:CURR:RANG 0.5 The 0.5 A range is set.
	Query	:CURR:RANG?
	Response	:CURRENT:RANGE 0.5 (Headers: ON)(Headers: ON) 0.5 (Headers: OFF)(Headers: OFF)
Note	<ul style="list-style-type: none"> • Do not add a unit to the measurement range. • Wait (five seconds or more) until the internal circuit has stabilized after changing a range before reading measurements. • Setting a range disables auto-range • The 20 A range accepts measurements up to 150% f.s.. Values that exceed this limit cause an execution error. • A set negative value is processed as an absolute value. • A change in the range when average times is set to something other than 1, restarts averaging. <p>See Acquiring the averaged data (⇒ p.88)</p>	

(4) Display items

Set and Query the Display Items

Syntax	Command	:DISPlay <Display a>,<Display b>,<Display c>
	Query	:DISPlay?
	Response	<Display a>,<Display b>,<Display c> <Display a> = U, I, P <Display b> = I, P, S <Display c> = U, I, P, PF U: voltage (also V), I: current (also A), P: active power (also W), S: apparent power (also VA), PF: power factor
Description	Command	Sets items in display areas a, b and c.
	Query	Returns the displayed parameters as character data. Returns the displayed parameters as character data.
Example	Command	:DISP U,I,P The voltage appears in display area a, current in display area b and active power in display area c.
	Query	:DISP?
	Response	:DISPLAY U,I,P (Headers: ON) U,I,P (Headers: OFF)

(5) Header

Enables/disables and queries headers for the response message

Syntax	Command	:HEADer <ON/ OFF>
	Query	:HEADer?
	Response	<ON/ OFF> ON: Headers are prefixed to response messages. OFF: No header is affixed to the response message.
Description	Command	Sets whether or not the instrument will prefix headers to its response messages. When the power is turned on, the data is initially set to ON.
	Query	Returns the setting of headers for the response messages as ON or OFF.
Example	Command	:HEAD ON Headers are prefixed to response messages.
	Query	:HEAD?
	Response	:HEADER ON (Headers: ON) OFF (Headers: OFF)

(6) Display hold

Set and query display hold

Syntax	Command	:HOLD <ON/ OFF>
	Query	:HOLD?
	Response	<ON/ OFF> ON: holds displayed value (hold state) OFF: cancels held display value.
Description	Command	Sets display hold (ON) and cancels (OFF) display hold.
	Query	Returns the setting of display hold as ON or OFF.
Example	Command	:HOLD ON Holds displayed values
	Query	:HOLD?
	Response	:HOLD ON (Headers: ON) ON (Headers: OFF) Displayed data is held.

(7) Measurement data

Queries measured data.

Syntax	Query Response	<p>:MEASure? <Measurement item 1>, ... ,<Measurement item 5> (Up to 5 items)</p> <p><Measurement item 1> <Measurement value>;<Measurement item 2> <Measurement value>;<Measurement item 3> <Measurement value>; <Measurement item 4> <Measurement value>;<Measurement item 5> <Measurement value></p> <p><Measurement item> = U, I, P, S, PF U: voltage (also V), I: current (also A), P: active power (also W), S: apparent power (also VA), PF: power factor</p> <p><Measurement value>= 10 fixed characters 4-digit display data: ±0ddddE±e (dddd: 5 character data or numerical value items including decimal point, e: index 0, 3, 6) 5-digit display data: ±00000E±e (00000: 6 character data or numerical value items including decimal point, e: index 0, 3, 6)</p>
Description	Query	<p>Queries measurement values of measure items and returns them as character data or a numerical value.</p> <p>Set character strings are used as a header. However, U, I, P and S are replaced with V, A, W and VA. The data is output in the order specified by the <measurement item>. When no <measurement item> is available, all data is output in U, I, P, S and PF order.</p>
Example	Query Response	<p>:MEAS? U,I,P</p> <p>V +0100.00E+0;A +020.00E+0;W +02.000E+3 (Headers: ON) +0100.00E+0;+020.00E+0;+02.000E+3 (Headers: OFF)</p>
Note		<ul style="list-style-type: none"> • The :TRANsmit:SEParator command makes it possible to change the message unit separator from a semicolon (;) to a comma (,). • An "o.r", or "-o.r." indication appears as "+999.99E+9" or "-999.99E+9". • When the display is blank such as when ranges are switched, a response message cannot be created until measurement data appears. Therefore it is recommended that a fixed range be used. <p>See "No response to the MEASure? command." (⇒ p.88)</p>

(8) RS-232C

Set and query RS-232C

RS-232C

Syntax	Query	:RS232c?
	Response	:RS232C:HANDSHAKE <HARD/OFF>;ANSWER <ON/ OFF> <HARAD/OFF> ;<ON/ OFF> <HARAD/OFF> HARD: hardware handshake OFF: no hardware handshake <ON/ OFF> ON: outputs a confirmation message. OFF: does not output a confirmation message.
Description	Query	Returns current RS-232C communication handshake setting and confirmation message setting as character data.
Example	Query	:RS232?
	Response	:RS232C:HANDSHAKE OFF;ANSWER OFF (Headers: ON) OFF;OFF (Headers: OFF)
Note		<ul style="list-style-type: none"> • The :TRANsmit:SEParator command makes it possible to change the message unit separator from a semicolon (;) to a comma (,). • Queries are available also in GP-IB.

Sets and queries a confirmation message

RS-232C

Syntax	Command	:RS232c:ANSWer <ON/ OFF>	
	Query	:RS232c:ANSWer?	
	Response	<ON/ OFF> ON: outputs a confirmation message(⇒ p.52) OFF: does not output a confirmation message.	
Description	Command	Determines whether or not a confirmation message is to be output.	
	Query	Returns ON or OFF to a confirmation message setting.	
Example	Command	PRINT #1,":RS232:ANSW ON"	[Result] (comment)
		INPUT #1,A\$	
		PRINT A\$	000(OK)
		PRINT #1,"CUR:RANG 5.0"	
		INPUT #1,A\$	
		PRINT A\$	001("CUR:RANG" is an error)
		PRINT #1,"CURR:RANG?"	
		INPUT #1,A\$	
		PRINT A\$: CURRENT : RANGE
			20.0;000
		↑(Query data is OK) Confirmation messages	
Note	<ul style="list-style-type: none"> • When set to ON, operation may become unstable if the message is not received. • This command is used for synchronizing with the controller in RS-232C, but can be used also in GP-IB. However, be sure to import this message. 		

Queries RS-232C communication error data



Syntax	Query	:RS232c:ERRor?
	Response	<Communication error data (NR1)> <Communication error data (NR1)> = 0 to 7
Description	Query	Returns RS-232C communication error data as NR1 numerical data and clears the contents. The *CLS command sets the communication error data to 0. A header is not added to the response message. Bit 2: overrun error (data loss) Bit 1: framing error (incorrect data read)

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	unused	Overrun	Framing	unused

Example	Query	:RS232:ERR?
	Response	4 An overrun error has occurred.

- Note**
- When this query ends in some kind of error, no response message is created for this query.
 - Queries are available also in GP-IB.

Set and query RS-232C communication handshake



Syntax	Command	:RS232c:HANDshake <HARD/ OFF>
	Query	:RS232c:HANDshake?
	Response	<HARD/ OFF> HARD: hardware handshake (using RTS/CTS) OFF: no hardware handshake
Description	Command	Sets a communication handshake This command runs also in the event of a system error. When HARD is set, the screen stops when the content of the input buffer exceeds 375 bytes. The screen is restored when input buffer content goes below 125 bytes. In the 3333, processing of commands reduces buffer space. However, communications are not restored until buffer content goes below 125 bytes. The Local key allows the user to reset the handshake to resolve situations like this. To prevent communications from stopping, command length should be 125 bytes or less and never exceed 375 bytes.
	Query	Returns the contents of a communication handshake as character data.
Example	Command	:RS232:HAND HARD Sets a hardware handshake (HARD).
	Query	:RS232:HAND?
	Response	:RS232C:HANDSHAKE HARD (Headers: ON) HARD (Headers: OFF)

- Note** Setup and queries are available also in GP-IB.

(9) VT and CT ratio

Queries VT (PT) and CT ratio

Syntax	Query	:SCALE?
	Response	<VT ratio (NR1)>;<CT ratio (NR1)> <VT ratio (NR1)> = 1, 2, 4, 10, 20, 30, 60, 100 <CT ratio (NR1)> = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 25, 30, 40, 50, 60, 75, 80, 100
Description	Query	Returns current VT and CT ratios as NR1 numerical data.
Example	Query	:SCALE?
	Response	:SCALE:VT 2;CT 3 2 is set as the VT (PT) ratio and 3 is set as the CT ratio.
Note		<ul style="list-style-type: none"> The :TRANsmit:SEParator command makes it possible to change the message unit separator from a semicolon (;) to a comma (,). When this query ends in some kind of error, no response message is created for this query.

Set and query CT ratio

Syntax	Command	:SCALE:CT <CT ratio (NR1)>
	Query Response	:SCALE:CT ? <CT ratio (NR1)> <CT ratio (NR1)> = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 25, 30, 40, 50, 60, 75, 80, 100
Description	Command	Sets a CT ratio. The numerical value can be in NRf format, but any digits after the decimal point will be rounded.
	Query	Returns the CT ratio setting as an NR1 value.
Example	Command	:SCAL:CT 2 Sets a CT ratio of 2.
	Query Response	:SCAL:CT? :SCALE:CT 2 (Headers: ON) 2 (Headers: OFF)
Note		A change in CT ratio when average times is set to something other than 1, restarts averaging. See Acquiring the averaged data (⇒ p.88)

Set and query VT (PT) ratio

Syntax	Command	:SCALE:VT <VT ratio (NR1)> (also :SCALE:PT?)
	Query	:SCALE:VT ? (also :SCALE:PT?)
	Response	<VT ratio (NR1)> <VT ratio (NR1)> = 1, 2, 4, 10, 20, 30, 60, 100
Description	Command	Sets a VT (PT) ratio The numerical value can be in NRf format, but any digits after the decimal point will be rounded.
	Query	Returns the VT (PT) ratio setting as an NR1 value.
Example	Command	:SCAL:VT 10 Sets a VT (PT) ratio of 10.
	Query	:SCAL:VT?
	Response	:SCALE:VT 10 (Headers: ON) 10 (Headers: OFF)
Note	A change in VT ratio when average times is set to something other than 1, restarts averaging. See Acquiring the averaged data (⇒ p.88)	

(10)Message

Set and query a message unit separator

Syntax	Command :TRANsmit:SEParator <0/ 1> Query :TRANsmit:SEParator? Response <0/ 1> When header is set to OFF, the following message unit separator is set. 0: semicolon ";" 1: comma ","
Description	Command Sets the message unit separator for the response message. The numerical value can be in NRf format, but any digits after the decimal point will be rounded. Query Returns the message unit separator for the response message as 0 or 1. When this query ends in some kind of error, no response message is created for this query.
Example	Command :TRAN:SEP 0;:HEAD OFF;:MEAS? U,I (specify ;) Response +0101.2E+0;+02.120E+0 (; is produced) Command :TRAN:SEP 1;:HEAD OFF;:MEAS? V,A (specify ,) Response +0101.2E+0,+02.120E+0 (, is produced) Command :TRAN:SEP 0;:HEAD ON;:MEAS? V,A (specify ;) Response V +0101.2E+0;A +02.120E+0 (; is produced) Command :TRAN:SEP 1;:HEAD ON;:MEAS? V,A (specify ,) Response V +0101.2E+0,+A +02.120E+0 (, is not produced) When header is set to ON, a comma "," message unit separator setting is converted to a semicolon ";". Query :TRAN:SEP? Response :TRANSMIT:SEPARATOR 1 (Headers: ON) 1 (Headers: OFF)
Note	Be sure to turn the header off when changing a message unit separator. (:HEAD OFF)

Set and query the response message terminator

Syntax	Command	:TRANsmit:TERMinator <0/ 1>									
	Query	:TRANsmit:TERMinator?									
	Response	<0/ 1>									
		A terminator has the following format									
		<table> <thead> <tr> <th></th> <th>RS-232C</th> <th>GP-IB</th> </tr> </thead> <tbody> <tr> <td>0:</td> <td>LF</td> <td>EOI with LF</td> </tr> <tr> <td>1:</td> <td>CR+LF</td> <td>CR+EOI with LF</td> </tr> </tbody> </table>		RS-232C	GP-IB	0:	LF	EOI with LF	1:	CR+LF	CR+EOI with LF
	RS-232C	GP-IB									
0:	LF	EOI with LF									
1:	CR+LF	CR+EOI with LF									
Description	Command	Sets a response message terminator. The numerical value can be in NRf format, but any digits after the decimal point will be rounded.									
	Query	Returns the response message terminator setting as 0 or 1. When this query ends in some kind of error, no response message is created for this query.									
Example	Command	:TRAN:TERM 0 Sets the terminator to EOI with LF.									
	Query	:TRAN:TERM?									
	Response	:TRANSMIT:TERMINATOR 1 (Headers: ON) 1 (Headers: OFF)									

5.7 Troubleshooting (Communications)

When the 3333 is malfunctioning, attempt checking and troubleshooting according to the instructions shown below.

The causes/treatments without marks (**GP-IB** / **RS-232C**) are common to both the RS-232C and GP-IB.

Symptom	Cause / Treatment
The RS-232C/ GP-IB has stopped working completely.	<ul style="list-style-type: none"> • Are the cables properly connected? • Are all the devices powered on? • Are correct cables used? • Has the communication condition been correctly set? RS-232C • Is the device address for the instrument set correctly? GP-IB • Does some other device have the same device address? GP-IB
Communication failure with RS-232C/GP-IB.	<ul style="list-style-type: none"> • Do the instrument and controller have the same settings (baud rate, data length, parity, and stop bit)? RS-232C • Ensure the message terminators (delimiters) for the controller are same as the instrument. GP-IB <p>See "Message Terminators" (⇒ p.54)</p>
After transmission on the RS-232C/ GP-IB bus, the keys on the instrument freeze up and have no effect.	<ul style="list-style-type: none"> • Press the LOCAL key on the front panel of the instrument to release the remote state. • Has a LLO (Local Lock-Out) command been transmitted? Transmit a GTL command to put the instrument into the local state. GP-IB
When attempting to read data using a BASIC INPUT statement, the RS-232C bus hangs. RS-232C	<ul style="list-style-type: none"> • Be sure to transmit one query before each INPUT statement. • Have any of these transmitted queries resulted in an error?
When attempting to read data using a HP-Basic ENTER statement, the GP-IB bus hangs. GP-IB	<ul style="list-style-type: none"> • Be sure to transmit one query before each ENTER statement. • Have any of these transmitted queries resulted in an error?
Although a command has been transmitted, nothing has happened.	<ul style="list-style-type: none"> • Using the *ESR? query, inspect the standard event status register, and check what type of error has occurred.⇒Check error content. • Using the RS232c:ERROR? query, and check whether transmission error occurred on the RS-232C. RS-232C • Set the RS232c:ANSWER to ON and check execution. RS-232C
Sending several queries, produces only one response.	<ul style="list-style-type: none"> • Has an error occurred? • Send the queries one at a time, and read the responses individually. When you want to read them in all at once, try doing so by putting them all on one line separated by the message separator character. • Have you used the *IDN? query? The query command is not executed after *IDN?.
The response message to a query differs from the display on the front panel.	<ul style="list-style-type: none"> • Due to the response message being produced at the instant that the instrument receives the query, there is a possibility that it may not agree with the display at the instant that the controller reads it in.
Sometimes service requests are not generated. GP-IB	<ul style="list-style-type: none"> • Have the service request enable register and the various event status enable registers been correctly set? • Clear all the event registers at the end of SRQ processing subroutines by using the *CLS command. If an event bit is not cleared, no service request will be generated for that event.

5.7 Troubleshooting (Communications)

Symptom	Cause / Treatment
Averaged data cannot be acquired.	<p>A change in current range, average times, VT ratio and CT ratio restarts averaging process and indicates the instantaneous value measured when starting. To obtain an average value, wait for the first average process to end(See "Interval between display updates" (⇒ p.31)or monitor the ESR0? AVG flag described below.</p> <ol style="list-style-type: none"> 1. Clear the event flag and wait for the first indication to appear after a change in range : CURR:RANG 0.5, *WAI; *CLS (example: when changing to the 500 mA range) To change to VT ratio range, change the :CURR:RANG command to the SCAL:VT command; to change to CT ratio, change to the SCAL:CT command; to change to average times, change to the AVER command. 2. Check that the AVG flag becomes 1 Use :ESR0? to read 0 into the event status register Repeat until the AVG flag (bit 0) becomes 1 3. Import data when the AVG flag becomes 1 :MEAS?
No response to the MEASure? command.	<p>The MEASure? command does not generate a response message until display data is created when a flag is displayed to notify a change in range. In the 3333, a flag is displayed during a 0.6 s interval after a change in range and no response message is returned in this interval. In auto range operation, when ranges change irregularly and changes often involve multiple ranges, no response message may be returned during these changes. To prevent this, use a fixed range or monitor the ESR0? DS flag (bit 7) and obtain the data when the DS flag becomes 1.</p> <p>Example:</p> <ol style="list-style-type: none"> 1. Clear the *CLS event register 2. Use :ESR0? to read 0 into the event status register Repeat until the DS flag (bit 7) becomes 1 3. Import data when the DS flag becomes 1 :MEAS?

5.8 Device Compliance Statement



Information on compliance to standards" based on the IEEE 488.2 standard

(1) IEEE 488.1 interface functions

See "The GP-IB interface" (⇒ p.47)

(2) Operation with a device address other than 0 through 30

A setting outside the 0 to 30 range cannot be made.

(3) Timing of changed device address recognition

A change of address is recognized immediately after changing.

(4) Device settings at power on

The status information is cleared, and all other items are preserved. However, the header on/off setting, and response message separator and terminator are all reinitialized.

(5) List of message exchange options

- Input buffer capacity and operation
See "Input Buffer" (⇒ p.56)
- Queries to which multiple response message units are returned

:CURRent?	2
:MEASure?	1 to 5
:SCALe?	2
:RS232c?	2
- Queries producing responses as syntax checking is performed:
All queries produce responses when syntax checking is performed.
- Whether any queries produce responses when read:
There are no queries which produce response messages at the instant they are read in by the controller.
- Whether any commands are coupled:
There are no relevant commands.

(6) Summary of functional elements for use when constructing device specific commands, and whether compound commands or program headers can be used:

The followings can be 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 program data
- Compound commands and program headers

(7) Buffer capacity limitations for block data

Block data is not used.

(8) Summary of program data elements used in expressions, and deepest nesting level allowable in sub-expressions, including syntax restrictions imposed by the device.

Sub-expressions are not used. Character data and decimal data are the only program data elements used.

(excluding ***IDN?**)

(9) Response syntax for queries

See "5.6 Message Reference"(⇒ p.68)

(10) Transmission congestion relating to device-to-device messages which do not conform to the general principles for basic response messages

There are no device to device messages.

(11) Response capacity for block data

Block data does not appear in responses.

(12) Summary of standard commands and queries used

See "5.5 Message List"(⇒ p.65)

(13) Device state after a calibration query has been completed without any problem

The "***CAL?**" query is not used.

(14) Existence/nonexistence of "*DDT**" command**

The "***DDT**" command is not used.

(15) Existence/nonexistence of macro command

Macros are not used.

(16) For queries related to identification, explanation of the response to the "*IDN?" query

See "5.6.1 Standard Commands"(⇒ p.69)

(17) Capacity of the user data storage area reserved for when the "*PUD" command and the "*PUD?" query are being executed

The "*PUD" command and the "*PUD?" query are not used.
Further, there is no user data storage area.

(18) Resources when the "*RDT" command and the "*RDT?" query are being used

The "*RDT" command and the "*RDT?" query are not used.
Further, there is no user data storage area.

(19) Conditions which are influenced when "*RST", "*LRN?", "*RCL?", and "*SAV" are used

"*LRN?", "*RCL?", and "*SAV" are not used. The "*RST" command returns the unit to its initial state.

See "5.6.1 Standard Commands"(⇒ p.69)
"5.4.5 Initialization Items"(⇒ p.63)

(20) Scope of the self-testing executed as a result of the "*TST?" query

See "5.6.1 Standard Commands"(⇒ p.69)

(21) Additional organization of the status data used in a device status report

See "5.4.4 Event Registers"(⇒ p.59)

(22) Whether commands are overlap or sequential type

All the commands are sequential commands.

(23) Criterion relating to the functions required at the instant that the termination message is produced, as a response to each command

Termination occurs when the command has been parsed.

The **:MEASure?** query will run only when there is no valid data available and run until valid data is created. The ***TRG** command ends processing when the measurement data is ready.

Specifications

Chapter 6

6.1 General Specifications

Operating environment	Indoors, up to 2000 m (6562-ft.) ASL, Pollution degree 2
Operating temperature and humidity	0 to 40°C (32 to 104°F) 80% RH or less (non-condensating)
Storage temperature and humidity	-10 to 50°C (14 to 122°F) 80% RH or less (non-condensating)
Dielectric strength (50/60 Hz, for 15 seconds)	<ul style="list-style-type: none"> • 4.290 kVrms (Current sensitivity: 5 mA) Between voltage and current input terminals and the case, interface and output terminals Between voltage and current input terminals and the power supply • 2.570 kVrms (Current sensitivity: 1 mA) Between voltage input terminal and current input terminal • 1.690 kVrms (Current sensitivity: 10 mA) Between power supply and the case, interface and output terminals
Rated supply voltage	100 to 240 V AC (Voltage fluctuations of $\pm 10\%$ from the rated supply voltage are taken into account.)
Rated supply frequency	50/60 Hz
Maximum rated power	20 VA
Dimensions	Approx. 160W x 100H x 227D mm (6.30"W x 3.94"H x 8.94"D) (not including protrusions)
Mass	Approx. 1.9 kg (67.00 oz.)
Applicable Standards	Safety EN61010 EMC EN61326 Class A EN61000-3-2 EN61000-3-3
Accessories	<ul style="list-style-type: none"> • Instruction Manual 1 • Power Cord 1
Options	Printers <ul style="list-style-type: none"> • 9442 Printer • 9444 Connection Cable (for printer) • 1196 Recording Paper (for printer) • 9443-01 AC Adapter (for printer, for Japan) • 9443-02 AC Adapter (for printer, for EU) Interface <ul style="list-style-type: none"> • 9637 RS-232C Cable (1.8 m, 9-pin to 9-pin)* • 9638 RS-232C Cable (1.8 m, 9-pin to 25-pin)* <small>*9637 and 9638 are cross cables. Hardware handshake is not available.</small> <ul style="list-style-type: none"> • 9151-02 GP-IB Connector Cable (2 m) • 9151-04 GP-IB Connector Cable (4 m) Others <ul style="list-style-type: none"> • A number 3 Phillips screwdriver
Product warranty period	3 years

6.2 Basic Specifications

Measurement line type	Single-phase 2-wire																						
Input methods	Voltage	Input isolated by (resistance potential division) and (isolation device)																					
	Current	Input isolated by current (shunt method) and (isolation device)																					
Measurement method	Simultaneous digital sampling of voltage and current True RMS indication																						
Sampling frequency	Approx. 48 kHz																						
A/D converter resolution	16 bits																						
Input resistance (50/60 Hz)	Voltage	2.4 MΩ ±120 kΩ (±5%)																					
	Current	7 mΩ or less																					
Maximum input voltage	300 V _{rms} , 425 V _{peak}																						
Maximum input current	30 A _{rms} , 42.5 A _{peak}																						
Maximum rated voltage to earth	300 V (50/60 Hz) Measurement category III (anticipated transient overvoltage 4000 V)																						
Measurement items	Voltage, current, active power, apparent power, power factor																						
Screen update rate	200 ms±50 ms (approx. 5 times/s) to 20s (varies with average times setting)																						
Number of items displayed	3 items																						
Voltage effective measurement range	20 to 300 V (200V-range)																						
Current effective measurement range	5 to 75 mA (50mA-range) 20 to 300 mA (200mA-range) 50 to 750 mA (500mA-range) 0.2 to 3 A (2A-range) 0.5 to 7.5 A (5A-range) 2 to 30 A (20A-range) Current range: 50 mA/ 200 mA/ 500 mA/ 2 A/ 5 A/ 20 A/Auto-range																						
Active power effective measurement range	1 to 15 W (10 W-range) 4 to 60 W (40 W-range) 10 to 150 W (100 W-range) 40 to 600 W (400 W-range) 0.1 to 1.5 kW (1 kW-range) 0.4 to 6 kW (4 kW-range) Power range: automatically determined from voltage and current range (see information on range configuration)																						
Range configuration	<table border="1"> <tr> <td style="text-align: center;">Current range</td> <td>50.00 mA</td> <td>200.0 mA</td> <td>500.0 mA</td> <td>2.000 A</td> <td>5.000 A</td> <td>20.00 A</td> </tr> <tr> <td style="text-align: center;">Voltage range</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">200.0V</td> <td>10.000 W</td> <td>40.00 W</td> <td>100.00 W</td> <td>400.0 W</td> <td>1.0000 kW</td> <td>4.000 kW</td> </tr> </table> <p>Note: Substitute VA for the W units in the table above for information on apparent power. Auto-range: Automatically changes to the next higher range when inputs exceed 150% of range or a peak over occurs Goes to a lower range when input is 25% or less of current range A change to a lower range is not made when a peak over occurs in the lower range.</p>		Current range	50.00 mA	200.0 mA	500.0 mA	2.000 A	5.000 A	20.00 A	Voltage range							200.0V	10.000 W	40.00 W	100.00 W	400.0 W	1.0000 kW	4.000 kW
Current range	50.00 mA	200.0 mA	500.0 mA	2.000 A	5.000 A	20.00 A																	
Voltage range																							
200.0V	10.000 W	40.00 W	100.00 W	400.0 W	1.0000 kW	4.000 kW																	
Effective measurement range	10 to 150% of voltage, current and active power range Other measurement items conform to the effective measurement range of voltage, current and active power																						
Conditions of Guaranteed Accuracy	<ul style="list-style-type: none"> • Temperature and humidity for guaranteed accuracy: 23±5°C, 80%RH or less • Warm-up time: 10 minutes • Input : Sine-wave input, Power factor = 1, Common mode voltage = 0 V • Display area for guaranteed accuracy: Effective measurement area 																						

Period of guaranteed accuracy	3 years (However, accuracy figures after 1 year and 3 years differ)			
Measurement accuracy	At 100% of input range or less			
	1 year	Frequency(f)	Voltage, Current, Active power (at 20 A or below)	Current, Active power (at 20 A or above)
		45 Hz ≤ f ≤ 66 Hz	±0.1%rdg.±0.1%f.s.	±0.1%rdg.±0.1%f.s.
		66 Hz < f ≤ 1 kHz	±0.1%rdg.±0.2%f.s.	—
		1 kHz < f ≤ 5 kHz	±3.0%f.s.	—
	When input exceeds 100%			
		Frequency(f)	Voltage, Current, Active power (at 20 A or below)	Current, Active power (at 20 A or above)
		45 Hz ≤ f ≤ 66 Hz	±0.2%rdg.	±0.2%rdg.
		66 Hz < f ≤ 1 kHz	±0.3%rdg.	—
		1 kHz < f ≤ 5 kHz	±3.0%rdg.	—
3 years	At 100% of input range or less			
		Frequency(f)	Voltage, Current, Active power (at 20 A or below)	Current, Active power (at 20 A or above)
		45 Hz ≤ f ≤ 66 Hz	±0.1%rdg.±0.2%f.s.	±0.1%rdg.±0.2%f.s.
		66 Hz < f ≤ 1 kHz	±0.1%rdg.±0.35%f.s.	—
		1 kHz < f ≤ 5 kHz	±4.5%f.s.	—
	When input exceeds 100%			
		Frequency(f)	Voltage, Current, Active power (at 20 A or below)	Current, Active power (at 20 A or above)
		45 Hz ≤ f ≤ 66 Hz	±0.3%rdg.	±0.3%rdg.
		66 Hz < f ≤ 1 kHz	±0.45%rdg.	—
		1 kHz < f ≤ 5 kHz	±4.5%rdg.	—
Temperature characteristic	±0.03%f.s./°C or less			
Effect of external magnetic field	1.5 mArms or less (400 A/m, in a 50/60 Hz magnetic field)			
Power factor influence	±0.4%rdg.or less (45 to 66 Hz, power factor = at 0.5)			
Maximum effective peak voltage	425 V _{peak}			
Maximum effective peak current	300% of each current range, but the 20 A range has a peak of 42.5 A			
Effect of common mode voltage	0.25 mA or less (300 V _{rms} , 50/60 Hz, when applied between an input terminal and the case)			
Effect of radiated radio-frequency electromagnetic field	0.5 A current at 10 V/m or less, active power 5 W or less			
Effect of conducted radio-frequency electromagnetic field	0.5 A current at 3 V or less			
Calculation method	Measurement item	Calculation method		
	Apparent power (S)	$S = U \times I$		
	Power factor (λ)	$\lambda = P/S $		
	Note 1: U, I and P indicate the measured values for voltage RMS, current RMS and active power, respectively. None of the values have been rounded (deviation ±1 dgt.)			
	Note 2: The accuracy of values calculated from measurement values is ±1 dgt.			
	Note 3: When $ P > S$, S values replace $ P $.			

6.3 Functions

Voltage measurement (Displays: V)

Total display area	1 to 152% of selected range (1% or less is processed as 0) VT ratio enables indication of up to 30.40 kV
Over range indication	"o.r" (over range) is indicated for inputs that exceed 152% of the input range
Over range warning	The PEAK OVER U LED lights when the input voltage peak value exceeds 425 V
Threshold voltage for lamp lighting	425 V to 433.5 V

Current measurement (Displays: A)

Total display area	1 to 152% of selected range (1% or less is processed as 0) CT ratio enables indication of up to 3.040 kA
Over range indication	"o.r" (over range) is indicated for inputs that exceed 152% of the input range
Over range warning	The PEAK OVER I LED lights when the input current peak value exceeds 42.5 A or exceeds 300% of the input range.
Threshold current for lamp lighting	20 A range: 42.5 A to 42.35 A Other ranges: 300% to 302% of range

Active power measurement (Displays: W)

Total display area	0 to 231.04% (152% x 152%) of selected range The VT and CT ratios permit indication of up to ±92.42 MW
Over range indication	"o.r" is indicated when the voltage or current input exceeds the range.

Apparent power measurement (Display: VA)

Total display area	0 to 231.04% (152% x 152%) of selected range The VT and CT ratios permit indication of up to 92.42 MVA
Over range indication	"o.r" is indicated when the voltage or current input exceeds the range.
Measurement accuracy	±1 dgt. for values calculated from measurement values

Power factor measurement (Display: PF)

Total display area	0.000 to 1.000 (No polarity)
Over range indication	"o.r" is indicated when the voltage or current input exceeds the range. "o.r" is indicated for 0 apparent power
Measurement accuracy	±1 dgt. for values calculated from measurement values

Average (the AVG lamp goes on when average times is something other than 1)

System	Simple average							
Average times and display update rate interval	Average times	1(OFF)	2	5	10	25	50	100
	Interval between display updates	200 ms	400 ms	1 s	2 s	5 s	10 s	20 s
Error alarm	The unit flashes when data used for calculating averages contain "o.r" data							

VT/CT Ratio (the VT LED or CT LED lights when respective ratio is something other than 1)

VT ratio	1(OFF), 2, 4, 10, 20, 30, 60, 100
CT ratio	1(OFF), 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 25, 30, 40, 50, 60, 75, 80, 100

D/A Output

Configuration	12bit D/A converter (No polarity), 3channels
Output items	Voltage, Current, Active power
Output accuracy	(Measurement accuracy for each output) + ($\pm 0.5\%$ f.s.) ($23\pm 5^{\circ}\text{C}$)
Temperature characteristic	$\pm 0.03\%$ f.s./ $^{\circ}\text{C}$ or less
Output voltage	DC +2 Vf.s at 100% of voltage and current range Active power DC +2 Vf.s (absolute value output) at 100% of range (outputs maximum output voltage when "o.r" is on)
Maximum output voltage	DC +3.04 V (152% of the measurement range)
Output update rate	200 ms \pm 50 ms (approx. 5 times/s)
Response time	0.5 s or less (the time it takes for indication to stabilize within an accurate range for fluctuations of 0 \rightarrow 90% and 100 \rightarrow 10% of input range)
Output resistance	100 Ω \pm 5 Ω ($\pm 5\%$)

External Interface

RS-232C Interface	Standard equipment <ul style="list-style-type: none"> Asynchronous communication: Full duplex Baud rate: 9600 bps (fixed) Stop bit: 1 (fixed) Data length: 8 (fixed) Parity:none Remote control from controller (REMOTE LED lights) Data output to printer (when pressing SHIFT \rightarrow DATA OUT key) Settings output to printer (when pressing SHIFT \rightarrow DATA OUT key and settings are displayed) Use LOCAL key to cancel remote state (REMOTE LED goes out)
GP-IB Interface	Specify when placing order (Model 3333-01) <ul style="list-style-type: none"> Complies with IEEE 488.1 1987, refer to IEEE 488.2 1987 Interface functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0 Remote control from controller (REMOTE LED lights) Use LOCAL key to cancel remote state (REMOTE LED goes out)

Other functions

Display hold	Disables display updates for all measurement values (HOLD LED lights)
Key-lock	Disables all keys other than SHIFT and KEY LOCK (KEY LOCK LED lights) at measurement state.
Backup function	Backup items: Current range (including auto-range), average times (AVG), VT ratio, CT ratio, GP-IB address, key-lock Backup frequency: approx. 1.8 million times for backup items and updates thereof
System reset	Returns all settings to factory defaults

Maintenance and Service

Chapter 7

7.1 Troubleshooting

Inspection and Repair

Refer to "7.2 Error Indication"(⇒ p.101) for error messages.

CAUTION

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

NOTE

- If damage is suspected, check the "Before returning for repair" (⇒ p.100) section before contacting your dealer or Hioki representative.

Transporting

Use the original packing materials when transporting the instrument, if possible. Pack the instrument 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.

Replaceable Parts

Certain parts require replacement periodically and at the end of their useful life: (Useful life depends on the operating environment and frequency of use. Operation cannot be guaranteed beyond the following periods)

Part	RemarksLife	Remarks
EEPROM	approx. 1.8 million times for backup items and updates thereof	An EEPROM backs up instrument settings. It is time to replace the EEPROM when backing up range and settings trigger a backup error (Err.4).
Electrolytic Capacitors	Approx. 10 years	The instrument contains many electrolytic capacitors. The useful life of electrolytic capacitors varies greatly according to the operating environment. In severe operating environments (40°C ambient temperature), degradation occurs in about ten years, so they should be replaced periodically.

The fuse is housed in the power unit of the instrument. If the power does not turn on, the fuse may be blown. If this occurs, a replacement or repair cannot be performed by customers. Please contact your dealer or Hioki representative.

Before returning for repair

Symptom	Check Item, or Cause	Remedy and Reference
The display does not appear when you turn the power on.	Is the power cord disconnected? Are connections made correctly?	Verify that the power cord is connected properly. See "2.3 Connecting the Power Cord"(⇒ p.24)
Keys do not work.	<ul style="list-style-type: none"> Check whether the instrument is in the key lock state. 	Cancel key lock status See "3.2.6 Disables key operations (key lock)"(⇒ p.35)
	<ul style="list-style-type: none"> Check whether the REMOTE LED is on. 	The instrument is controlled by a controller. End control and cancel remote control. See "Before Use" (⇒ p.4), "1.2 Names and Functions of Parts"(⇒ p.10)
Cannot print.	<ul style="list-style-type: none"> Check whether the recording paper has been properly installed. Check whether the printer has been properly set up. (For example, transmission speed and interface) Check whether the appropriate cable connects the instrument to the printer 	Refer to the printer instruction manual for information on printer setup.

When no apparent cause can be established

Perform a system reset.

This will return all settings to their factory defaults.







See "3.2.7 Initializing (system reset)"(⇒ p.36)

7.2 Error Indication

Display area b, or display area c indicate any errors when abnormalities occur in the self-test at startup, during display hold (\Rightarrow p.34) or when a disabled key is pressed in the setting screen.

Err.5 appears (A system reset can clear the error, but operation is not guaranteed.) "Initializing (system reset)" (\Rightarrow p.36))

Error indication list

Error indication	Description	Remedy
	ROM error	Requires repair. (instrument circuit failure)
	RAM error	
	Signal circuit failure	
	Setup data error	Requires repair. (instrument circuit failure) Replace EEPROM. (\Rightarrow p.99) (This error occurs when attempts to import data from and write data to the EEPROM fails)
	Pressing disabled keys in a hold state (Invalid keys: range key, and )	Cancel the hold state to enable operating keys. See "Canceling hold state" (\Rightarrow p.34)

Contact your dealer (agent) or local sales office if a repair should become necessary.

NOTE

Powering up the line to be measured before this instrument is turned on may damage the instrument or generate an error when it is powered up.

Be sure to turn on the instrument and check that no errors are indicated before turning on the power to lines to be measured.

7.3 Cleaning

NOTE

To clean the instrument and input modules, 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.

Rack Mounting

Chapter 8

8.1 Installation Procedure

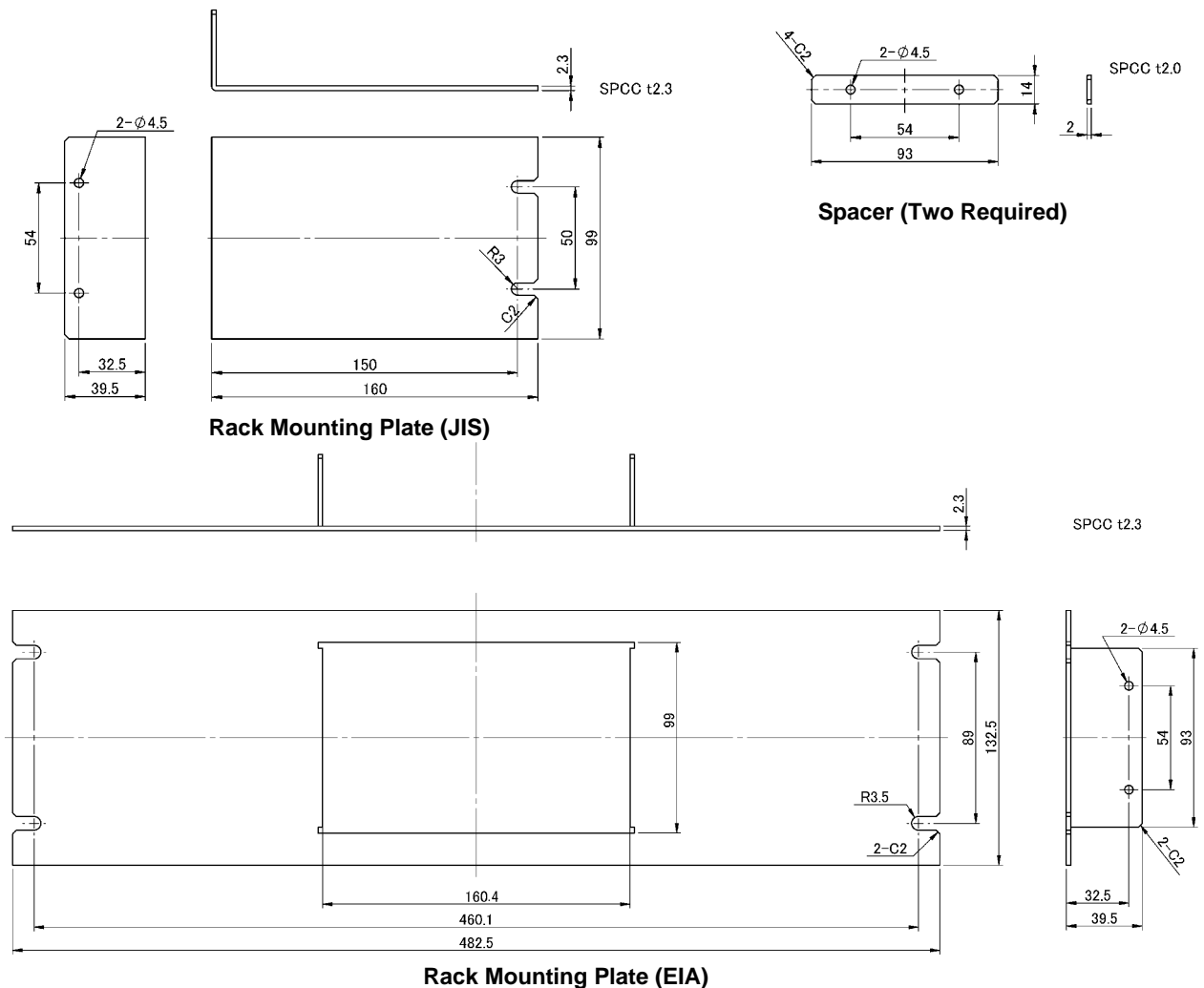
By removing the screws on the sides, this instrument can be installed in a rack mounting plate.



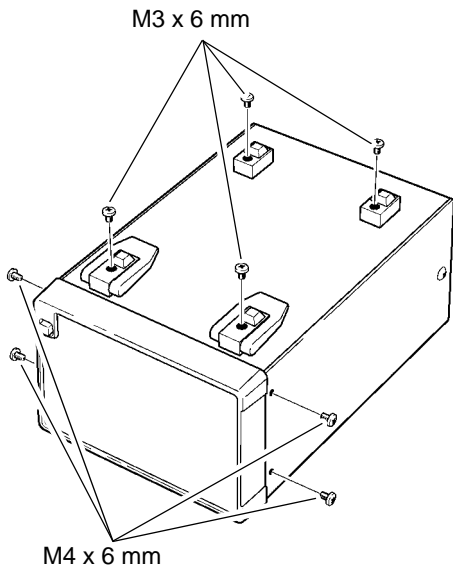
Observe the following precautions regarding the mounting screws to avoid instrument damage and electric shock accidents.

- When installing the Rack Mounting Plate, the screws must not intrude more than 6 mm into either side of the instrument.
- When removing the Rack Mounting Plate to return the instrument to stand-alone use, replace the same screws that were installed originally.
(Feet: M3 x 6 mm, Sides: M4 x 6 mm)

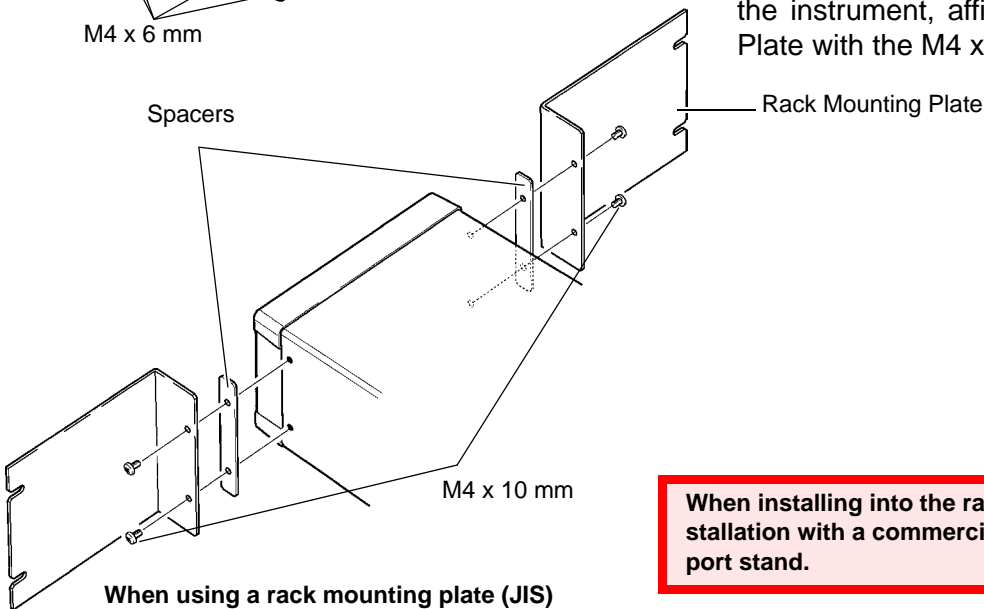
Rack Mounting Plate Template Diagram



Installation Procedure

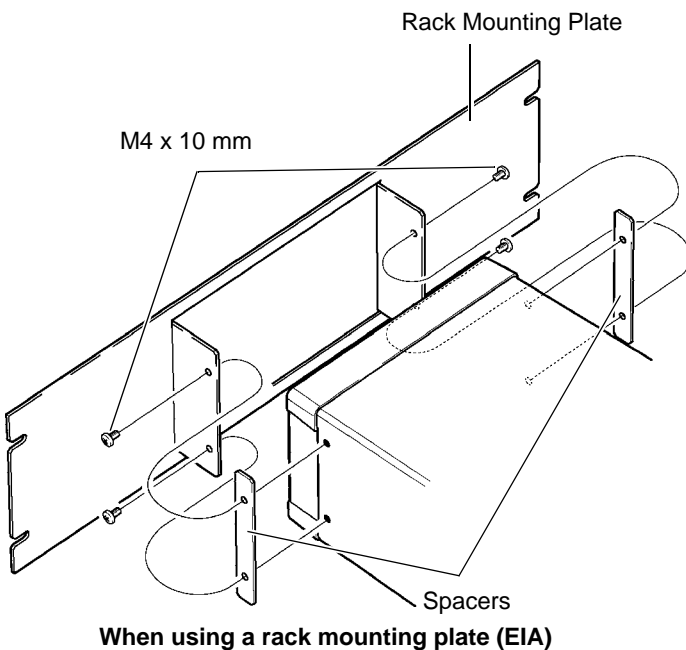


1. Remove the feet from the bottom of the instrument, and the screws from the sides (four near the front).

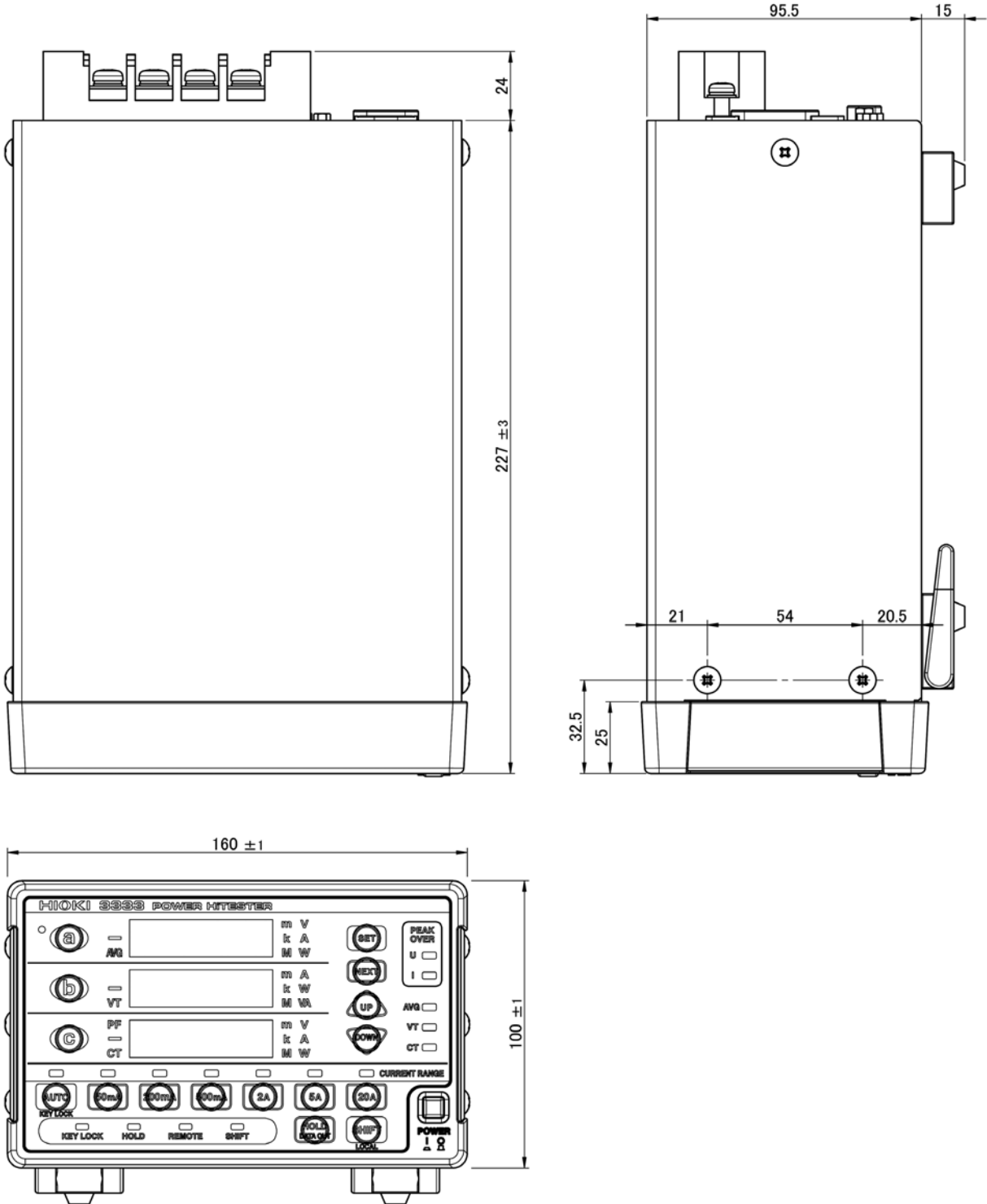


2. Installing the spacers on both sides of the instrument, affix the Rack Mounting Plate with the M4 x 10 mm screws.

When installing into the rack, reinforce the installation with a commercially available support stand.



8.2 Dimensional Diagram



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Warranty Certificate

HIOKI

Model	Serial number	Warranty period Three (3) years from date of purchase (___ / ___)
-------	---------------	--

Customer name: _____
Customer address: _____

Important

- Please retain this warranty certificate. Duplicates cannot be reissued.
- Complete the certificate with the model number, serial number, and date of purchase, along with your name and address. The personal information you provide on this form will only be used to provide repair service and information about Hioki products and services.

This document certifies that the product has been inspected and verified to conform to Hioki's standards. Please contact the place of purchase in the event of a malfunction and provide this document, in which case Hioki will repair or replace the product subject to the warranty terms described below.

Warranty terms

1. The product is guaranteed to operate properly during the warranty period (three [3] years from the date of purchase). If the date of purchase is unknown, the warranty period is defined as three (3) years from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYMM format).
2. If the product came with an AC adapter, the adapter is warranted for one (1) year from the date of purchase.
3. The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
4. In the event that the product or AC adapter malfunctions during its respective warranty period due to a defect of workmanship or materials, Hioki will repair or replace the product or AC adapter free of charge.
5. The following malfunctions and issues are not covered by the warranty and as such are not subject to free repair or replacement:
 - 1. Malfunctions or damage of consumables, parts with a defined service life, etc.
 - 2. Malfunctions or damage of connectors, cables, etc.
 - 3. Malfunctions or damage caused by shipment, dropping, relocation, etc., after purchase of the product
 - 4. Malfunctions or damage caused by inappropriate handling that violates information found in the instruction manual or on precautionary labeling on the product itself
 - 5. Malfunctions or damage caused by a failure to perform maintenance or inspections as required by law or recommended in the instruction manual
 - 6. Malfunctions or damage caused by fire, storms or flooding, earthquakes, lightning, power anomalies (involving voltage, frequency, etc.), war or unrest, contamination with radiation, or other acts of God
 - 7. Damage that is limited to the product's appearance (cosmetic blemishes, deformation of enclosure shape, fading of color, etc.)
 - 8. Other malfunctions or damage for which Hioki is not responsible
6. The warranty will be considered invalidated in the following circumstances, in which case Hioki will be unable to perform service such as repair or calibration:
 - 1. If the product has been repaired or modified by a company, entity, or individual other than Hioki
 - 2. If the product has been embedded in another piece of equipment for use in a special application (aerospace, nuclear power, medical use, vehicle control, etc.) without Hioki's having received prior notice
7. If you experience a loss caused by use of the product and Hioki determines that it is responsible for the underlying issue, Hioki will provide compensation in an amount not to exceed the purchase price, with the following exceptions:
 - 1. Secondary damage arising from damage to a measured device or component that was caused by use of the product
 - 2. Damage arising from measurement results provided by the product
 - 3. Damage to a device other than the product that was sustained when connecting the device to the product (including via network connections)
8. Hioki reserves the right to decline to perform repair, calibration, or other service for products for which a certain amount of time has passed since their manufacture, products whose parts have been discontinued, and products that cannot be repaired due to unforeseen circumstances.

HIOKI E.E. CORPORATION

<http://www.hioki.com>

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HIOKI

<http://www.hioki.com>



**Our regional
contact
information**

HEADQUARTERS

81 Koizumi
Ueda, Nagano 386-1192 Japan

HIOKI EUROPE GmbH

Rudolf-Diesel-Strasse 5
65760 Eschborn, Germany
hioki@hioki.eu

1808EN

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