

HIOKI

Instruction Manual

3390

POWER ANALYZER

HIOKI E. E. CORPORATION

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600276341

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Introduction

Thank you for purchasing the HIOKI "3390 POWER ANALYZER". To obtain maximum performance from the product, please read this manual first, and keep it handy for future reference.

In this document, the "instrument" means the Model 3390 Power Analyzer. To measure current, the power analyzer requires clamp-on current probes or AC/DC current probes (Options, (p. 2), afterwards referred to generically as "current sensors"). See your current sensor's instruction manual for details.

Registered trademarks

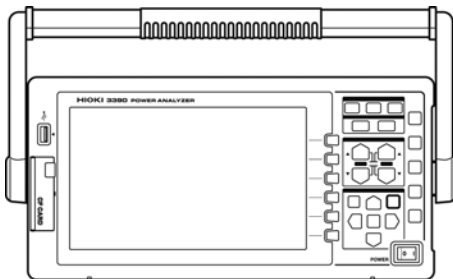
- CompactFlash is a registered trademark of Sandisk Corporation (USA). Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries.
- Sun, Sun Microsystems, Java, and any logos containing Sun or Java are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries.
- Adobe and Reader are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.

Confirming Package Contents

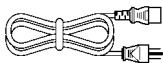
When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.

Confirm that these contents are provided.

- 3390 POWER ANALYZER 1



- Grounded power cord 1



- USB Cable 1



- D-Sub Connector 1
(for use only with Model 9792 or
9793 D/A output options)



Accessories

- Instruction Manual 1



- Measurement Guide 1



Please attach to the instrument before use.
(p. 24)

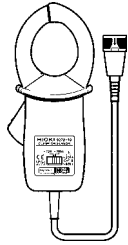
- Input Cable Labels 2
(to identify voltage cable leads and input channels)



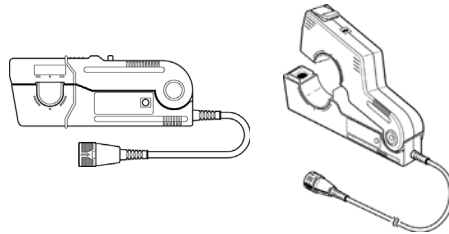
Option

Current Sensors

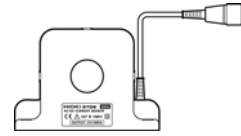
9272-10
Clamp On Sensor



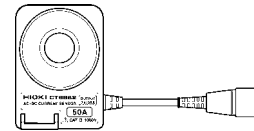
9277, 9278, 9279
Universal Clamp On CT



9709
AC/DC Current Sensor



CT6862, CT6863
AC/DC Current Sensor



For Voltage Measurement

- L9438-50 Voltage Cord (p. 24)
- 9243 Grabber Clip
- 9448 Concent Input Cord

For Printing

- 9670 Printer (includes one thermal paper roll, Sanei Electric Model BL-80RS II)
- 9671 AC Adapter (Sanei Electric Model BL-100W)
- 9237 RECORDING PAPER (thermal paper 80 mm x 25 m, 4 rolls)
- 9638 RS-232C Cable

For Computer Connection

- 9642 LAN Cable
- 9726 PC Card 128M (128MB CFCard + Adapter)
- 9727 PC Card 256M (256MB CFCard + Adapter)
- 9728 PC Card 512M (512MB CFCard + Adapter)
- 9729 PC Card 1GB (1GB CFCard + Adapter)
- 9830 PC Card 2GB (2GB CFCard + Adapter)

Others

- 9794 Carrying Case
 - L9217 Connection Cord (for Model 9791 and the 9793)
- See** "8.5 Using the Motor Testing Option (when specified before factory shipping, for motor analysis)" (p. 138)
- 9683 Connection Cable (for synchronization)
- See** "Connecting Multiple 3390 (Synchronized Measurements)" (p. 129)

Safety Notes



WARNING

This instrument is designed to comply with IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the instrument. However, 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 product and for maintaining it in safe operating condition. Before using the product, be sure to carefully read the following safety notes.

Safety Symbols



In the manual, the symbol indicates particularly important information that the user should read before using the product.

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



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 a significant 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 product.



Advisory items related to performance or correct operation of the product.

Symbols for Various Standards



WEEE marking:

This symbol indicates that the electrical and electronic appliance is put on the EU market after August 13, 2005, and producers of the Member States are required to display it on the appliance under Article 11.2 of Directive 2002/96/EC (WEEE).





This symbol indicates that the product conforms to safety regulations set out by the EC Directive.



This symbol indicates applicability to the Electrical Appliance and Material Safety law (Japan only).

Other Symbols

Symbols in this manual

| | |
|---|---|
|  | Indicates the prohibited action. |
| (p.) | Indicates the location of reference information. |
|  | Indicates quick references for operation and remedies for troubleshooting. |
| * | Indicates that descriptive information is provided below. |
| [] | Menus, commands, dialogs, buttons in a dialog, and other names on the screen and the keys are indicated in brackets. |
| CURSOR (Bold character) | Bold characters within the text indicate operating key labels. |
| Windows | Unless otherwise specified, "Windows" represents Windows 95, 98, Me, Windows NT4.0, Windows 2000, Windows XP, or Windows Vista. |
| Dialog | Dialog box represents a Windows dialog box. |

Mouse action terminology

| | |
|---------------|--|
| Click: | Press and quickly release the left button of the mouse. |
| Right-click: | Press and quickly release the right button of the mouse. |
| Double click: | Quickly click the left button of the mouse twice. |
| Drag: | While holding down the left button of the mouse, move the mouse and then release the left button to deposit the chosen item in the desired position. |
| Activate: | Click on a window on the screen to activate that window. |

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 (Overvoltage categories)

This instrument complies with CAT II (1000 V)/ III (600 V) safety requirements.

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

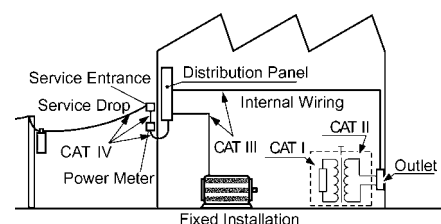
| | |
|------------------|--|
| CAT I : | Secondary electrical circuits connected to an AC electrical outlet through a transformer or similar device. |
| CAT II : | Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.)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

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

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

Never use a CAT I measuring instrument in CAT II, III, or IV environments.

The measurement categories comply with the Overvoltage Categories of the IEC60664 Standards.



Usage Notes

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 voltage cords is undamaged and that no bare conductors are improperly exposed. Using the instrument in such conditions could cause an electric shock, so contact your dealer or Hioki representative for replacements.

Instrument Installation

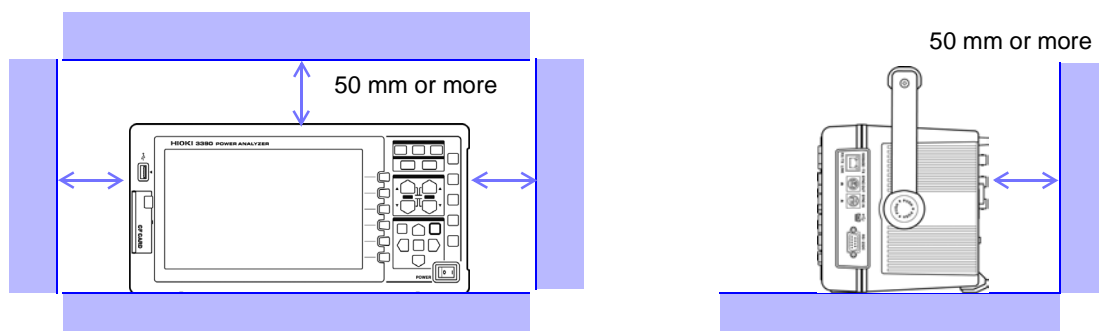
Operating temperature and humidity to RH or less, Indoors only (non-condensating) Storing temperature and humidity to RH or less, Indoors only (non-condensating) Temperature and humidity range for guaranteed accuracy, RH or less

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 |  | Near induction heating systems (e.g., high-frequency induction heating systems and IH cooking utensils) |
|  | Subject to vibration | | |

Installing

- The instrument should be operated only with the bottom or rear side downwards.
- Vents (on the right side of the instrument) must not be obstructed.



Shipping precautions

Hioki disclaims responsibility for any direct or indirect damages that may occur when this instrument has been combined with other devices by a systems integrator prior to sale, or when it is resold.

Handling the Instrument

DANGER

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

- If the instrument exhibits abnormal operation or display during use, review the information in Troubleshooting section "11.2 Trouble Shooting" (p. 175) and Error Indications section "11.3 Error Indication" (p. 177) before contacting your dealer or Hioki representative.
- To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.
- To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.
- To move the instrument, first disconnect all cables, remove any CF card and USB memory, and carry it by the handle.
- Do not apply heavy downward pressure with the stand extended. The stand could be damaged.

See "Using the Handle as a Stand" (p. 13)

Handling the cords and current sensors

DANGER

Connect the current sensors or voltage cords to the instrument first, and then to the active lines to be measured. Observe the following to avoid electric shock and short circuits.

- Do not allow the voltage cord clips to touch two wires at the same time. Never touch the edge of the metal clips.
- When the current sensor is opened, do not allow the metal part of the clamp to touch any exposed metal, or to short between two lines, and do not use over bare conductors.
- To avoid short circuits and potentially life-threatening hazards, never attach the current sensor to a circuit that operates at more than the maximum rated voltage to earth (See your current sensor's instruction manual for its maximum ratings.) Current sensor and voltage cables 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.
- Connect only those voltage cables necessary for measurement.

WARNING

In order to use the 9709 AC/DC Current Sensor, the line to be measured must be temporarily disconnected.

To avoid 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.

CAUTION

- To avoid electric shock and short-circuit accidents, use only the specified voltage cord to connect the instrument input terminals to the circuit to be tested.
- For safety reasons, when taking measurements, only use the optional voltage cord.
- Avoid stepping on or pinching cables, which could damage the cable insulation.
- To avoid breaking the cables, do not bend or pull them.
- To prevent an electric shock accident, confirm that the white or red portion (insulation layer) inside the cable is not exposed. If a color inside the cable is exposed, do not use the cable.
- 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.
- Be careful to avoid dropping the current sensors or otherwise subjecting them to mechanical shock, which could damage the mating surfaces of the core and adversely affect measurement.
- Be careful when handling the cords, since the conductor being measured may become very hot.
- When disconnecting the connector, be sure to release the lock before pulling off the connector. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.
- To prevent damage to the instrument and current sensors, never connect or disconnect a sensor while the power is on, or while the sensor is clamped around a conductor.

Before Connecting Measurement Cables

DANGER

- The maximum input voltage is 1500 VDC, 1500 Vrms. Attempting to measure voltage in excess of the maximum input could destroy the instrument and result in personal injury or death.
- Never exceed a current sensor's input current rating. Doing so could destroy the instrument and cause personal injury.
- The maximum rated voltage between input terminals and the ground is as follows; (CAT II) 1000 VDC, 1000 Vrms
(CAT III) 600 VDC, 600 Vrms
Attempting to measure voltages exceeding this level with respect to ground could damage the instrument and result in personal injury.

WARNING

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

CAUTION

The power supply voltage for this product is switchable. To avoid electrical accidents, check that the voltage selector is set correctly for the supply voltage you are using.

Before Connecting to the Lines to be Measured

DANGER

To avoid electrical hazards and damage to the instrument, do not apply voltage/ exceeding the rated maximum to the external input terminals.

WARNING

- To avoid electrical accidents, confirm that all connections are secure. The increased resistance of loose connections can lead to overheating and fire.
- Ensure that the input does not exceed the maximum input voltage or current to avoid instrument damage, short-circuiting and electric shock resulting from heat building.

CAUTION

- When the power is turned off, do not apply voltage or current to the voltage input terminals, current input terminals, or current sensors. Doing so may damage the instrument.
- Note that the instrument may be damaged if the applied voltage or current exceeds the measurement range.

While Measuring

WARNING

If an abnormality such as smoke, strange sound or offensive smell occurs, stop measuring immediately, disconnect from the measurement lines, turn off the instrument, unplug the power cord from the outlet, and undo any changes to the wiring. Contact your dealer or Hioki representative as soon as possible. Continuing to use the instrument may result in fire or electric shock.

Overview

Chapter 1

1

1.1 Product Overview

The HIOKI 3390 Power Analyzer is a high-precision, broad-range instrument for measuring electrical power from DC to inverter frequencies. Four input channels are provided to support single- and three-phase inverter motor system measurements.

For developing and evaluating high efficiency inverter motors

- High precision and stability ensure highly reproducible power measurements
- Electrical phase angle measurements necessary for motor analysis
- Measure motor efficiency by connecting with a high precision torque meter or encoder.

For developing and evaluating alternative energy sources such as solar, wind power, and fuel cells

- Simultaneously measure AC and DC power.
- Separately measure power input, sold, consumed, and regenerated using the DC mode and the current and integrated power (electrical energy) in RMS mode.
- Save long-term measurement data to high-capacity storage media.

For inverter motor maintenance

- Easily measure inverter secondary power on site.
- Simultaneously measure primary and secondary inverter power.
- Measure inverter noise.

1.2 Features

◆ Supports multiple power system configurations

- Four isolated voltage and current input channels are provided to support simultaneous multi-system measurements such as inverter primary and secondary power.
- Measure power system wiring configurations from single-phase to three-phase, four-wire.
- Broad frequency range (0.5 Hz to 5 kHz fundamental) supports DC to inverter frequencies.

◆ High accuracy over a broad range

- Basic accuracy is $\pm 0.05\%$ rdg. $\pm 0.05\%$ f.s. at DC and from 0.5 Hz to 150 kHz.
- Precise measurements over a broad range of inverter carrier frequencies: $\pm 0.2\%$ rdg. $\pm 0.1\%$ f.s. at 10 kHz, and $\pm 1.5\%$ rdg. $\pm 0.5\%$ f.s. at 100 kHz.

◆ Provides both fast data processing and high accuracy

- While maintaining high accuracy, power measurements and harmonic analysis updates every 50 ms.
- During low-frequency measurements, data is automatically updated in sync with frequency, so no refresh (data update rate) switching is needed when changing from low to high rotation rates.

◆ Extensive data analysis functions are included as standard features

- Simultaneously measure RMS, mean, AC and DC components, and fundamental waveforms.
- Perform harmonic analysis up to the 100th order and inverter noise (FFT) analysis up to 100 kHz.
- Display high-speed waveforms sampled at up to 500 kS/s.
- Perform multifaceted analysis with X-Y graph functions.

◆ Simultaneous analysis of all parameters

- Simultaneously analyzes harmonics and noise while performing integration and displaying waveforms.

◆ Supports measurements with both easy-to-use clamp probes and high-precision penetrating probes

- Select from various AC and AC/DC clamp-on current probes with ranges from 20 to 500 A.
- Measure high currents with high precision using clamp-on current sensor probes.
- Clamp-on current probes eliminate the need for problematic direct contact with wiring.
- In-phase effects on inverter measurements are greatly reduced by isolating current sensors from the measurement objects.

◆ Single-unit instrument ideal for portable as well as rack-mount applications

- Small and light weight (4.8 kg), with a convenient carrying handle (p. 13).
 - Rack mountable in 170 mm (EIA 4U) vertical space (p. 179).
-

- ◆ **Variety of interfaces are equipped in standard**
 - Includes 100 Mbps Ethernet and USB 2.0 High Speed communications interfaces.
 - Supports high-speed data communication systems.
 - Provides a dedicated front-panel USB port and CF card slot for removable storage devices.
 - Supports high-capacity media for high-speed data storage.

 - ◆ **PC application program provides remote control and data acquisition (p. 141)**
 - With the instrument connected to a computer by Ethernet or USB cable, use the PC application program to acquire data on the computer and control the instrument remotely. Download the PC application program from Hioki's website. (<http://www.hioki.com>)
 - Even without the PC application program, the same operations can be performed using a browser to access the HTTP server function.

 - ◆ **Wiring confirmation function avoids wiring mistakes (p. 36)**
 - The vector display avoids wiring mistakes by confirming even complicated three-phase wiring.

 - ◆ **Multi-instrument synchronization capability supports additional measurement channels (p. 129)**
 - Measure with up to four instruments simultaneously.
 - Slave instruments measure and record data in synchronization with the master instrument.
 - Using the PC application program, synchronously acquire and record data on up to four instruments.

 - ◆ **Prepared for motor evaluation options (p. 138)**
 - Motor power can be determined by measuring torque meter output and rotation rate.
 - Supports both analog DC and frequency-output-type torque measurement inputs.
 - Supports both analog DC and rotation pulse outputs for measurement inputs.
 - Supports encoder Z-phase signals for phase measurements with standard encoder pulses.

 - ◆ **D/A output option for waveform output (p. 132)**
 - Outputs up to 16 analog measurement parameters on 16 D/A output channels.
 - Voltage and current waveforms sampled at 500 kHz in the waveform output mode provide safely isolated voltage and current waveforms for other waveform measuring instruments.

 - ◆ **Easy-to-see color LCD (p. 13)**
 - Includes a 9-inch color TFT LCD.
 - Easily view waveforms and graphs on the wide-screen 800 × 480 dot display.

 - ◆ **Radiation thermometer connection support (p. 127)**
 - Connect to the RS-232C interface for simultaneous temperature recording.

 - ◆ **Printer connection support (p. 123)**
 - Connect an optional printer to print screen captures on site.
-

1.3 Operating Overview

Be sure to read "Usage Notes" (p. 5) before measuring.

Follow the procedures below to perform measurements. Data saving and analysis on the computer can be performed as necessary.

Initial Instrument Preparations

See 3.2 (p.24)

Pre-Operation Inspection

See 3.3 (p.26)

Always perform these checks before connecting, and when turning the power on.

Installing the Instrument

See "Instrument Installation" (p. 5)

Connecting Cables and Probes, and Turning Power On

See 3.4 (p.27) to 3.8 (p.29)

For high-precision measurements, allow at least 30 minutes warm-up after power-on before executing zero adjustment.

Connecting and Checking Connections to Measurement Objects

See 3.9 (p.30) to 3.11 (p.36)

Always execute zero adjustment before connecting to measurement objects.

Viewing Measurement Values

See Chapter 4 (p.37)

Press the **MEAS** key, and select display contents with the **MEAS**, **◀**, **▶** and **F** keys.
See "2.2 Basic Operations" (p. 16)

Saving

Manual saving

Press the **SAVE**.

See Chapter 7 (p.103)

Save in realtimecontrol

After pressing **START/STOP** saving starts at the specified start time.

Stops automatically at the specified stop time.
Press the **START/STOP** key to force stop.

Save timer control

Press **START/STOP** to save for a specified time span.

Stops automatically when the specified time has elapsed.
Press the **START/STOP** key to force stop.

Save interval control

Press **START/STOP** to start.
Save the specified time span.

Press **START/STOP** to stop.
When the timer and real-time control are set, stops at the specified time.

Analyzing Saved Data on a Computer

See Chapter 9 (p.141)

Connect the instrument to a computer with the supplied USB cable or an Ethernet cable and use the dedicated PC application program to transfer data to the computer for analysis. This also enables remote operation and control of the instrument.

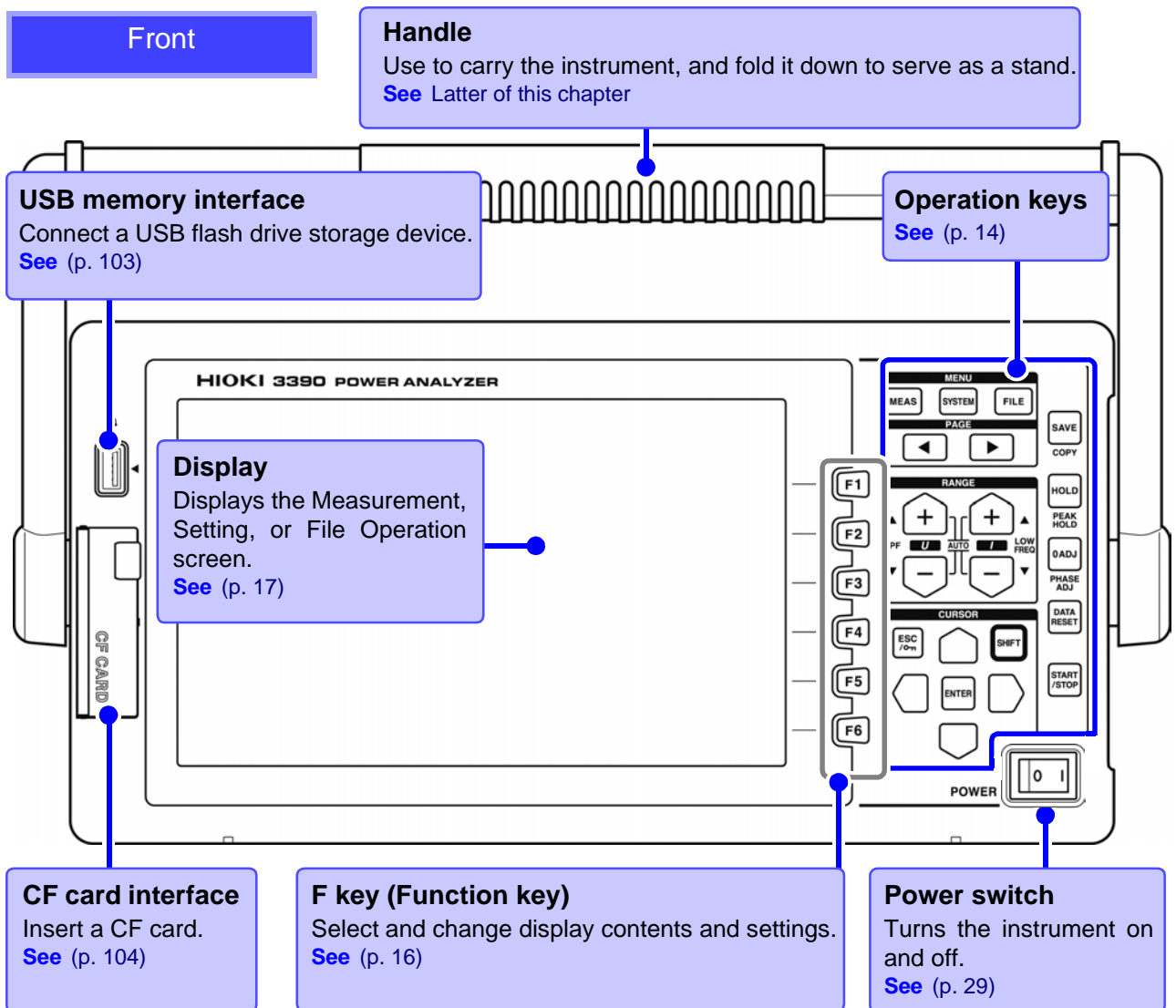
Turning Power Off

See 3.8 (p.29)

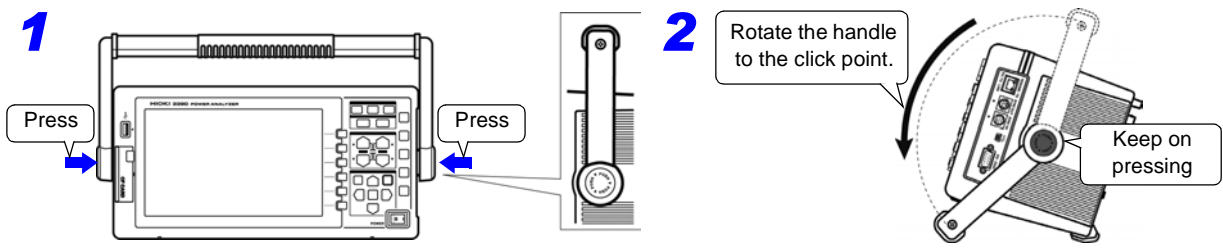
Names and Functions of Parts, Basic Operations & Screens

Chapter 2

2.1 Names and Functions of Parts



Using the Handle as a Stand



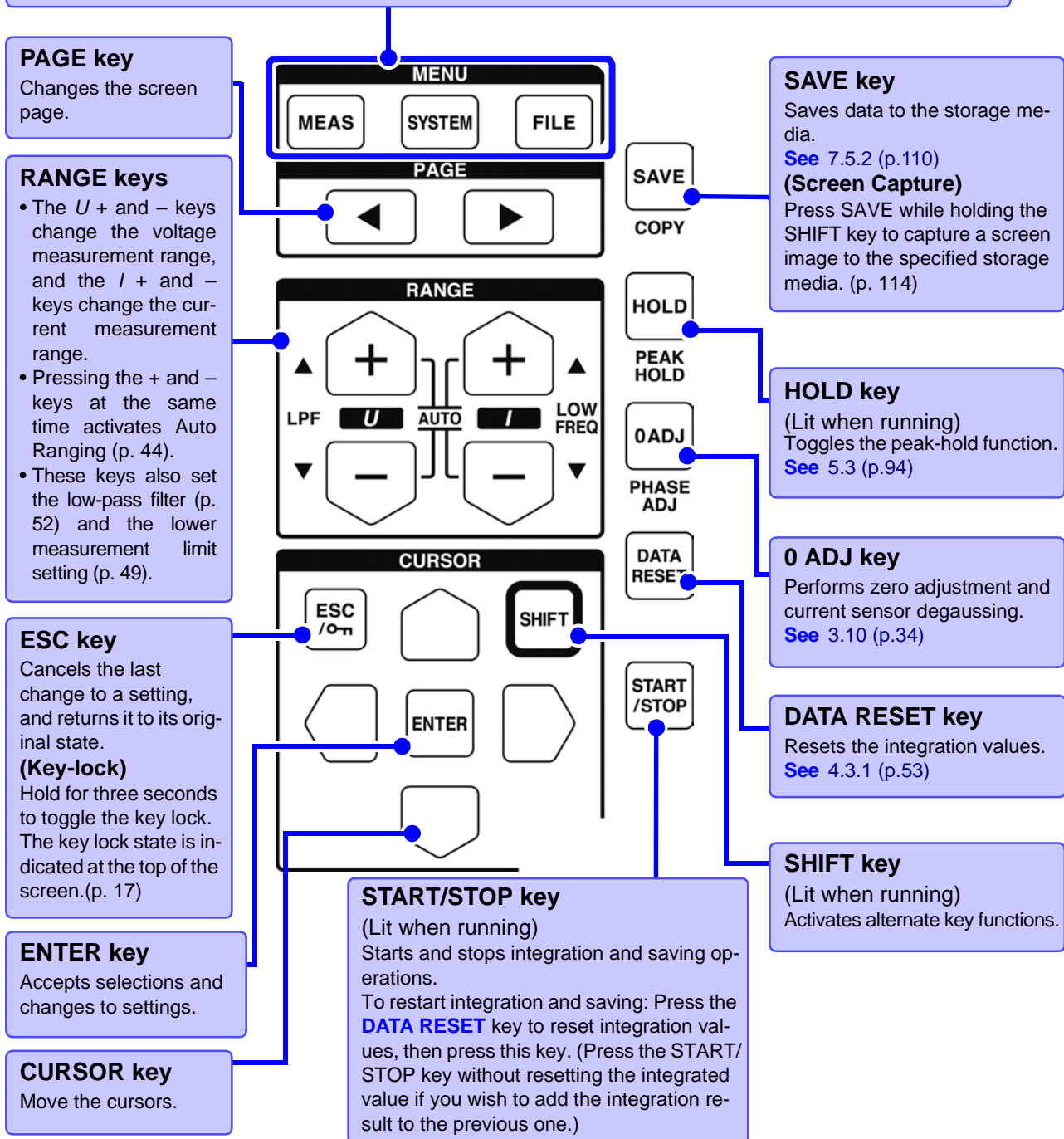
2.1 Names and Functions of Parts

Operation keys

MENU keys (Screen selection)

Press a key to select a screen (the lit key indicates the current selection).

| | |
|---------------|---|
| MEAS | Displays the Measurement screen for viewing measurement values. Voltage and current ranges can be selected, and low-pass filter settings can be changed.(p. 19) |
| SYSTEM | Displays the Setting screen for setting measurement criteria, wiring mode (phase systems), wiring check and system environment configuration.(p. 20) |
| FILE | Displays the File Operation screen for performing file operations on data saved to storage media, and selecting data file formats.(p. 21) |



NOTE

- When the key lock function is enabled, all other key operations are disabled.
- The key lock state is retained even when power is off.

Right side

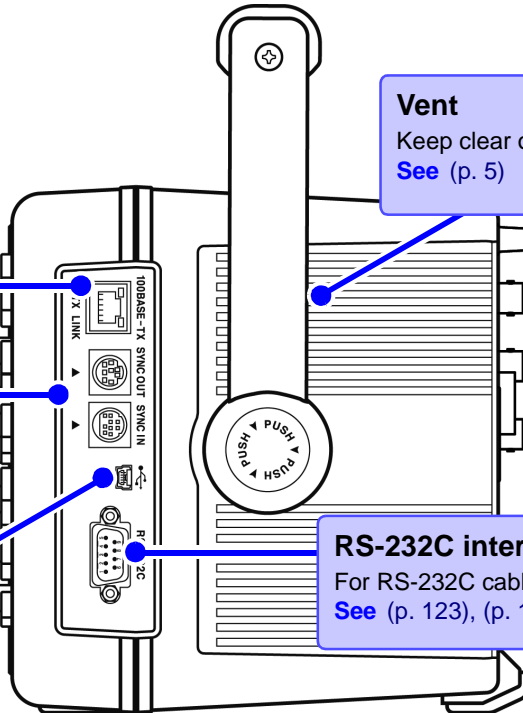
Ethernet interface jack
For LAN connection with an Ethernet cable.
See (p. 144)

Sync interface
For synchronizing cables, as needed.
See (p. 129)

USB port
For the supplied USB cable, as needed.
See (p. 148)

Vent
Keep clear of obstructions.
See (p. 5)

RS-232C interface
For RS-232C cable connection, as needed.
See (p. 123), (p. 127)

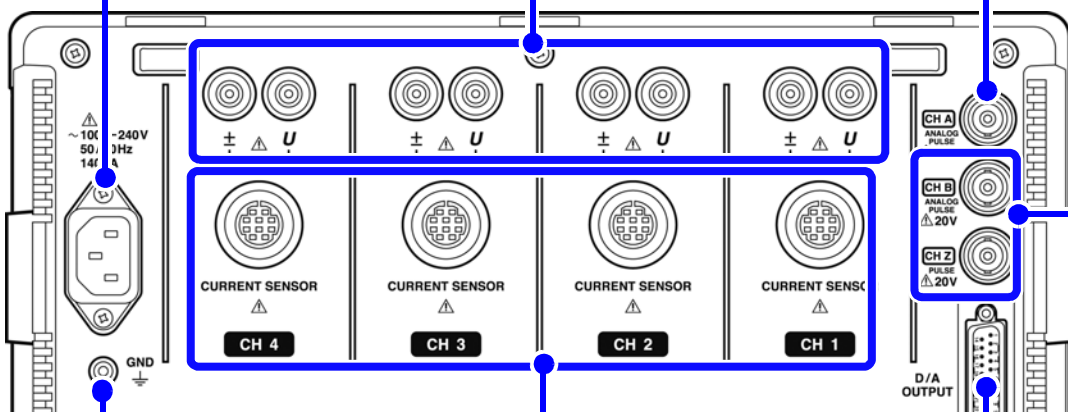


Rear

Power inlet
Connect the supplied power cord.
See (p. 27)

Voltage input terminals
Connect Hioki-specified voltage measurement cables.
See (p. 28)

CH A torque signal input BNC jack
Connect the Hioki L9217 BNC connection cable to this terminal (only when using the 9791 Motor Evaluation option or the 9793 Motor Evaluation and D/A Output option).
See (p. 138)



Output terminal
Connect the supplied D-sub plug (only when using the 9792 D/A Output option or the 9793 Motor Evaluation and D/A Output option).
See (p. 132)

Serial No.
This is the instrument's serial number.

Functional ground terminal
Connect this terminal to a clean common ground to suppress electrical noise when measuring in an electrically noisy environment.
See (p. 27)

Current input terminals
Connect an Hioki-specified current sensor.
See (p. 28)

CH B and CH Z rotation signal input BNC jacks
Connect the Hioki L9217 BNC connection cable to these terminals (only when using the 9791 Motor Evaluation option or the 9793 Motor Evaluation and D/A output option).
See (p. 138)

2.2 Basic Operations

To select a display screen
 Press **MEAS**, **SYSTEM**, or **FILE** to display the corresponding screen.
 See (p. 19) to (p. 21)

To select the displayed screen page
 Press the **◀ ▶** keys to change.
 See (p. 19), (p. 21)

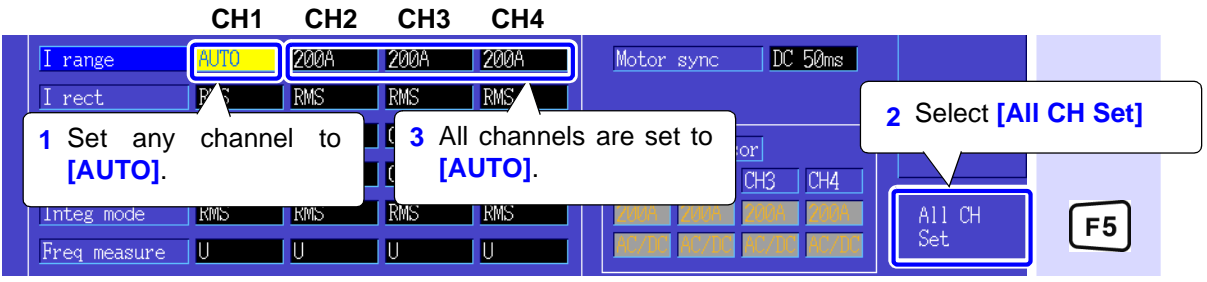


Help comment
 Describes the object at the current cursor position (only on Setting and File Operations screens).

To select and change display contents and settings
 Press one of the **F** keys to select and change display contents and settings. The displayed function labels depend on the currently displayed screen.
 Special Setting Items

| | |
|------------|---|
| Next | This appears when more than six setting items are available. Press F6 to display the function labels of the additional items. |
| All CH Set | Select to apply the same setting to all channels. |

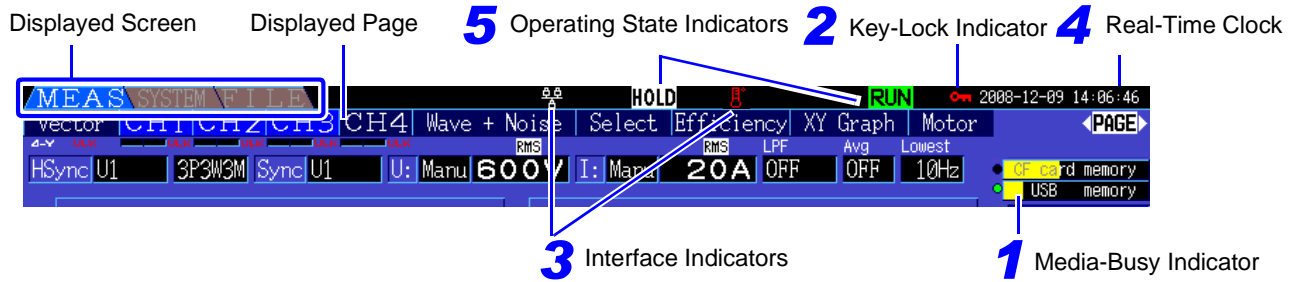
Using [All CH Set]
 (For example, to enable auto-ranging on all channels.)



2.3 Display Items and Screen Types

2.3.1 Common Display Items


These items are displayed on every screen.







1 Storage Media Indicators

Level indicators for the CF card and USB memory stick. The used storage space is indicated in yellow, and it turns to red when the media is 95% full.

2 Key-Lock Indicator

Lights to indicate Key Lock is active (keys are locked), after holding the  for three seconds.






3 Interface Indicators

| | |
|---|--|
|  | Lights when the instrument is connected to a computer by USB cable (and the computer is on). |
|  | Lights when the instrument is connected to a LAN. |
|  | Indicates a printer is connected to the RS-232 interface. |
|  | Indicates a thermometer is connected to the RS-232 interface. Red: Temperature data has not been acquired. Blue: Temperature data has been acquired. |

4 Real-time clock

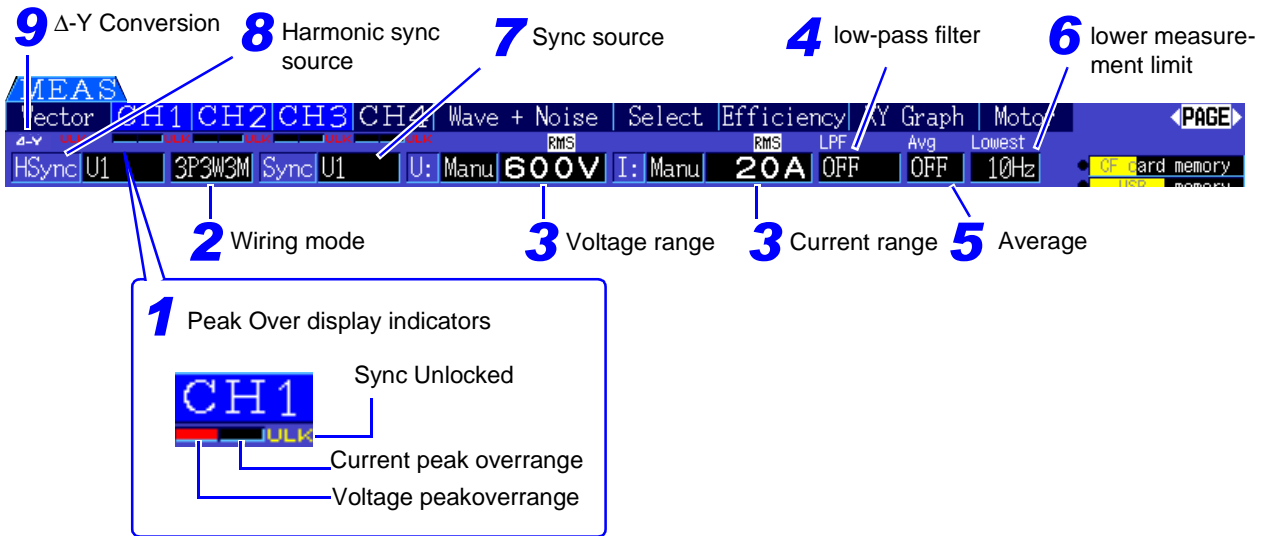
Displays the current date and time.
To set the Clock: (p. 101)

5 Operating State Indicators

| | |
|---|--|
|  | Lights during integration and recording. |
|  | Indicates integration is in progress. |
|  | Indicates integration is stopped. |
|  | Indicates Data Hold is active. |
|  | Indicates Peak Hold is active. |

2.3.2 Measurement Screen

These display items appear only on the Measurement screen.



1 Peak Over display indicators

These indicators appear in red at the bottom of each channel page tab (CH1 to CH4). These indicate (from the left) when voltage and current peak ranges are exceeded (p. 40), and when synchronization is unlocked (p. 48).

2 Wiring mode

Indicates the selected wiring mode (p. 30). The wiring mode (phase system selection) must be set to match actual measurement connections.

3 Voltage range/Current range

- Indicate the voltage and current range settings.
- The settings are made by the RANGE keys (p. 44).
- When the range has been set manually, **[MANU]** appears.
- When the auto-ranging is enabled, **[AUTO]** appears (p. 43).

4 Low-pass filter

Indicates the low-pass filter setting (p. 52).

To change, hold the **[SHIFT]** key while pressing an LPF key (one of the left-most **[+]** or **[-]** RANGE keys).

5 Average

Indicates the averaging setting state (p. 93). The setting is made on the Setting screen.

6 Lower measurement limit

Displays the lower measurement limit setting (p. 49).

To change the setting, hold the **[SHIFT]** key while pressing a LOW FREQ key (one of the right-most **[+]** or **[-]** RANGE keys).

7 Sync source

Indicates the synchronization source signal that determines the period (between zero crossings) used as the basis for all calculations.(p. 47) The setting is made on the Input Settings page of the Settings screen.

8 Harmonic sync source

Indicates the synchronization signal source used for harmonic measurements.(p. 67) The setting is made on the Input Settings page of the Settings screen.

9 Δ-Y Conversion

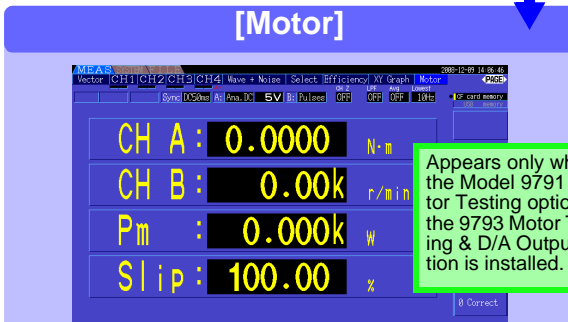
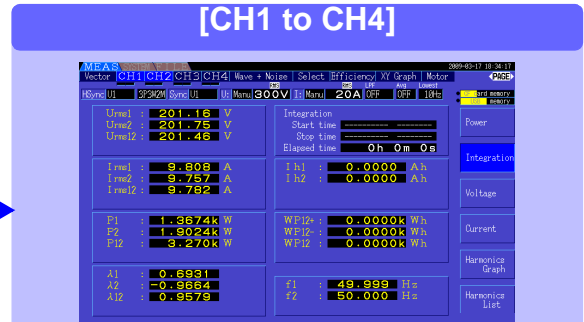
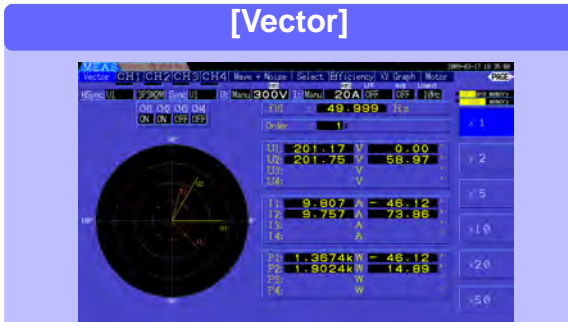
Indicates whether D-Y conversion is enabled or disabled (ON/OFF).(p. 98) The setting is made on the Input Settings page of the Settings screen.

2.3.3 Screen Types

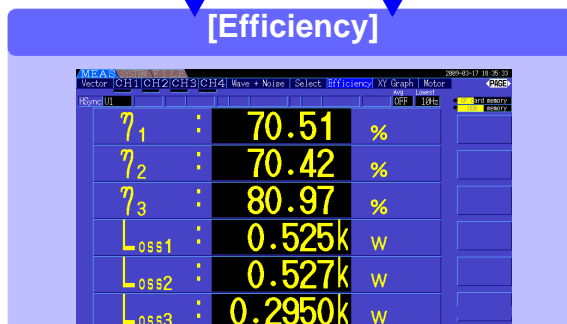
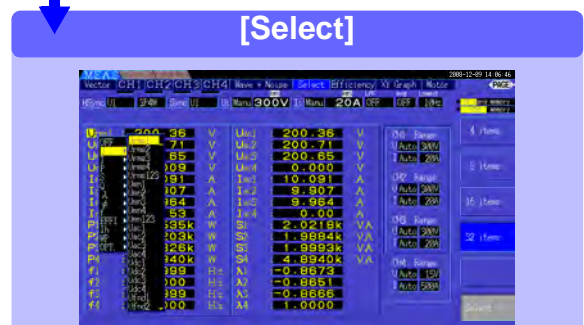
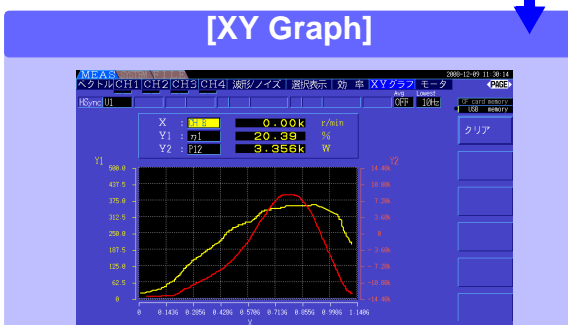
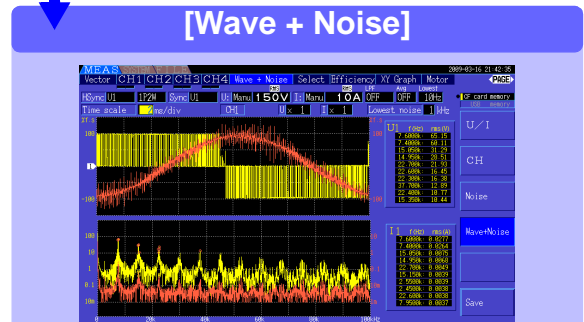
Measurement Screen (Press the **MEAS** key to display)

This screen displays measurement values.

Press the **◀** **▶** keys to change the screen page as follows.



Appears only when the Model 9791 Motor Testing option or the 9793 Motor Testing & D/A Output option is installed.



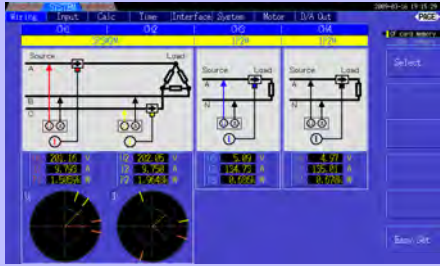
2.3 Display Items and Screen Types

Setting Screen (Press the **SYSTEM** key to display)

Use this screen to view and change settings for measurement criteria, wiring mode, wiring check and system environment configuration.

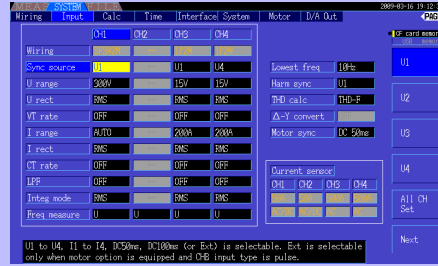
Press the **◀ ▶** keys to change the screen page as follows.

[Wiring]



Select the appropriate wiring mode (phase system configurations) and execute quick setup on this page. Wiring diagrams for each mode depict the appropriate measurement cable connections.

[Input]



Make detailed measurement criteria settings on this page.

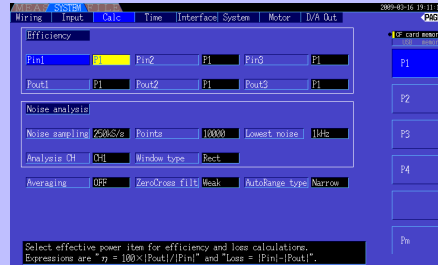
[D/A Out]



9792 D/A Output option or the 9793 Motor Testing & D/A Output option is installed.

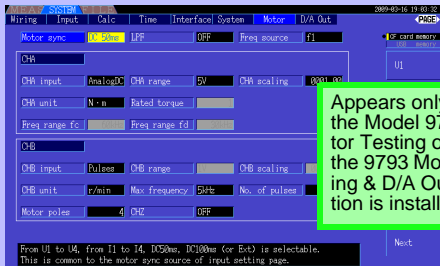
Make D/A output-related settings on this page.

[Calc]



Make calculation-related settings on this page.

[Motor]



Appears only when the Model 9791 Motor Testing option or the 9793 Motor Testing & D/A Output option is installed.

Make motor measurement-related settings on this page.

[Time]



Set measurement timers and the number of parameters to save on this page.

[System]



Configure system environment settings and perform system reset on this page.

[Interface]



Make settings related to synchronization, data saving and interfaces on this page.

2.3 Display Items and Screen Types

File Operations Screen (Press the **FILE** key to display) Use this screen to configure saving of data files to removable storage media, and to save and reload settings files.

Press the **◀** **▶** keys to change the screen page as follows.

[CF card]

This page displays data files on a CF card.

[USB drive]

This page displays data files on a USB flash drive.

Measurement Preparations

Chapter 3

3.1 Operations in general

Initial Instrument Preparations

See 3.2 (p.24)

Apply the appropriate adhesive labels near the input jacks and around the voltage and current sensor measurement cables. Then bundle the voltage cables together with the spiral tubes.

Pre-Operation Inspection

See 3.3 (p.26)

Always perform these checks before connecting, and when turning the power on.

Installing the Instrument

See "Instrument Installation" (p. 5)

Connecting the Power Cord

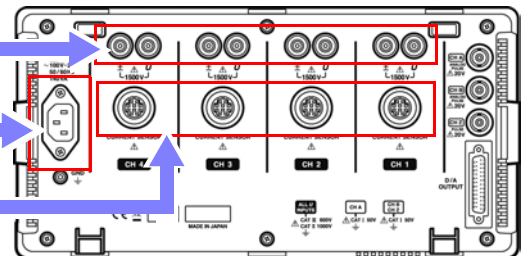
See 3.4 (p.27)

Connecting the Voltage Measurement Cables

See 3.6 (p.28)

Connecting the Current Sensors

See 3.7 (p.28)



Back side

Turning Power On

See 3.8 (p.29)

For best precision, allow at least 30 minutes warm-up before executing zero adjustment and measuring.

Setting the wiring mode

See 3.9 (p.30)

Connecting to the Lines to be Measured

See 3.10 (p.34)

Always execute zero adjustment before connecting to measurement objects.

Verifying Correct Wiring

See 3.11 (p.36)

3.2 Initial Instrument Preparations

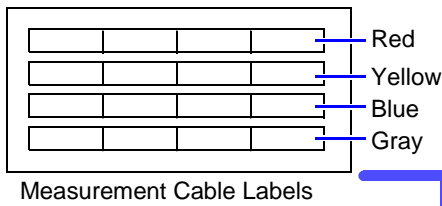
3.2 Initial Instrument Preparations

Perform the following before starting measurement the first time.

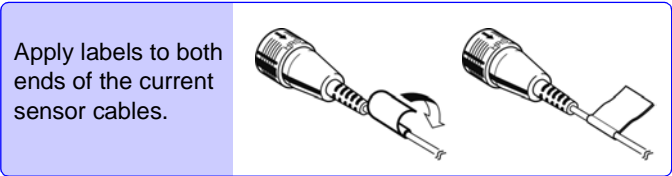
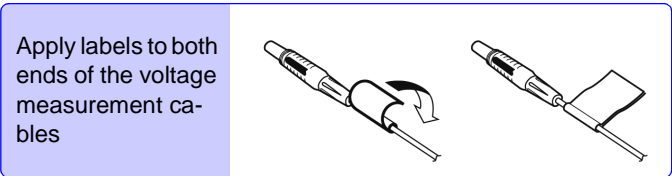
Put the provided input cord labels for each voltage cord and current sensor

The labels are provided to clearly indicate which cable connects to each input jack.

Before applying the labels
Wipe any dust from the surface of the voltage measurement cables and current sensors, and ensure that it is dry.



For each input jack, apply labels with the same color near the jack and to its corresponding voltage measurement cable lead or clamp sensor cable.

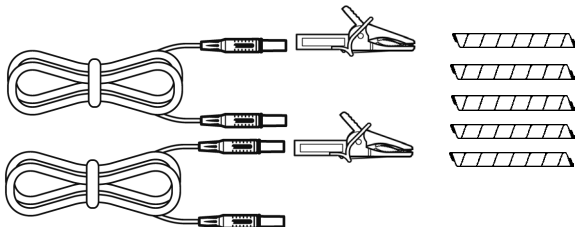


Bundle the voltage measurement cable leads with the spiral tubes

Five spiral tubes are supplied with the Model L9438-50 voltage measurement cables. Use the spiral tubes as needed to wrap red and black leads together.

Preparation items

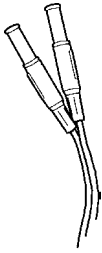
L9438-50 Voltage Cord



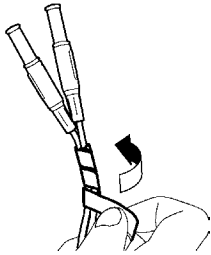
- Alligator Clips (two, one each red and black)
- Banana Plug Leads (two, one each red and black)
- Spiral Tubes (five, for cable bundling)

3.2 Initial Instrument Preparations

Procedure

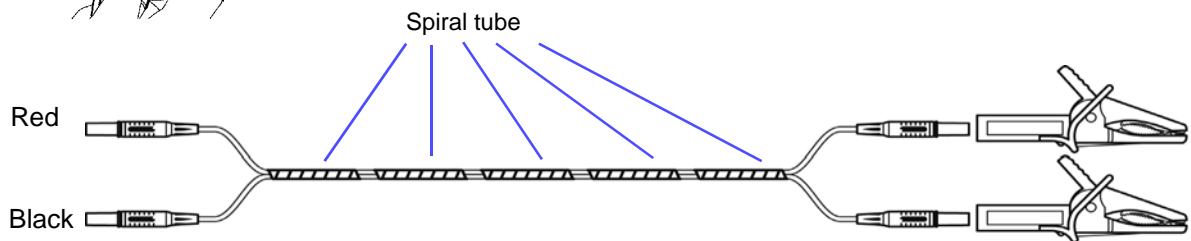


1. Hold two cable leads (one each red and black) side-by-side. Start bundling from one end of the leads.



2. Wind the spiral tube around the leads.

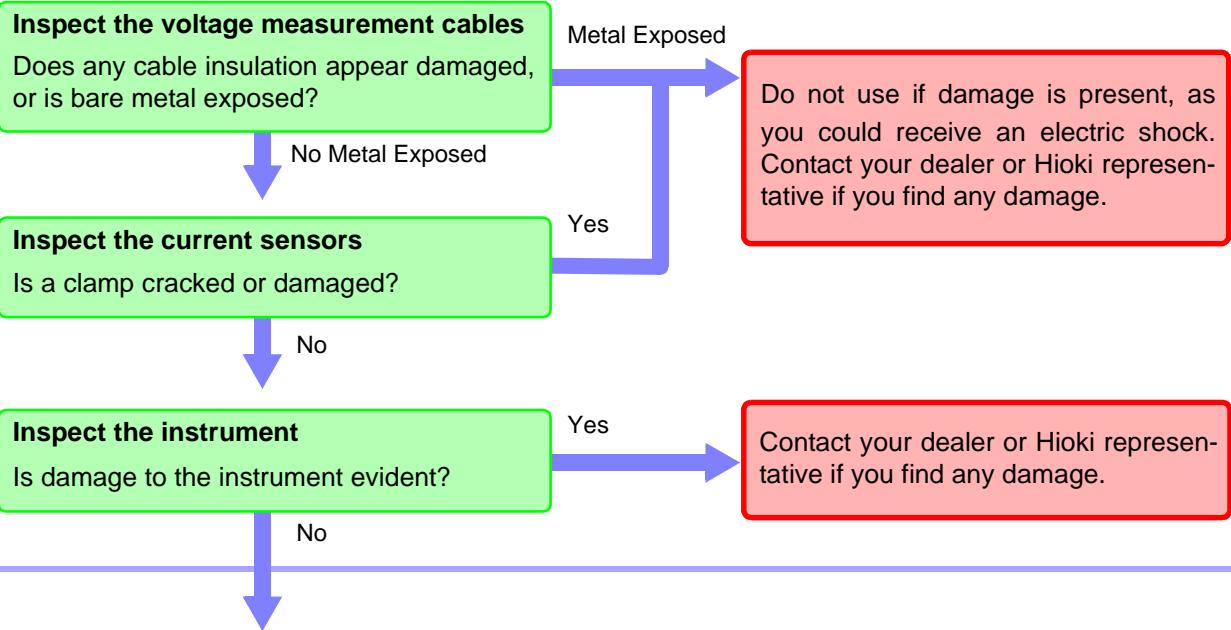
Wrap the two leads together with the spiral tube. The five supplied spiral tubes should be applied with suitable spacing.



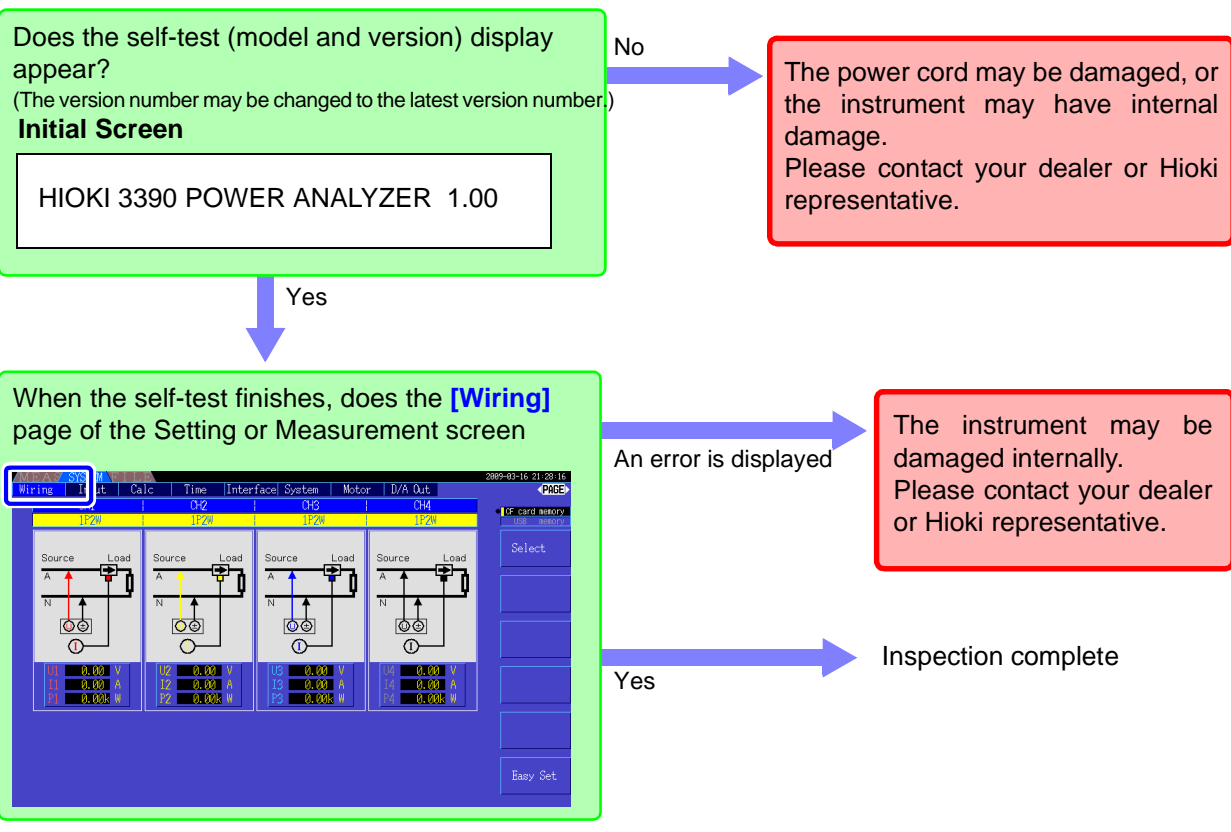
3.3 Pre-Operation Inspection

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 Pre-connection inspection



2 Power-on confirmation

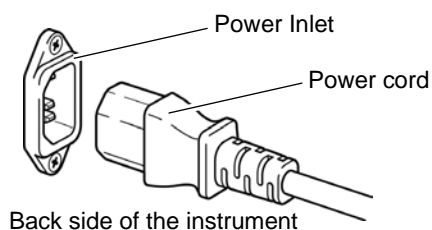


3.4 Connecting the Power Cord



Be sure to read the "Usage Notes" (p. 5) before connecting power.
Connect the power cord to the power inlet on the instrument, and plug it into an outlet.

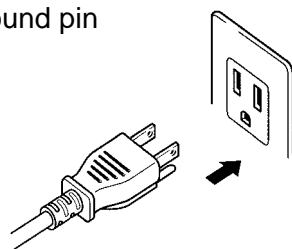
Connection Procedure



Turn off the power before disconnecting the power cord.

1. Check that the instrument's power switch is turned off.
2. Confirm that the line voltage matches instrument requirements, and plug the power cord into the power inlet on the instrument.
3. Plug the other end of the power cord into an outlet.

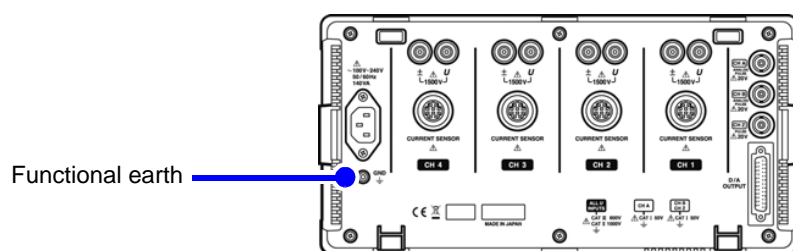
About the outlet with ground pin



Plug the power cord into the mains outlet.

3.5 Grounding the Instrument's Functional Earth (when measuring in noisy environments)

Ground the instrument's functional earth.
Connect the functional ground terminal to a clean common ground to suppress noise effects when measuring in an electrically noisy environment. When measuring AC power lines using a VT (PT), connect the PT ground to the same grounding point.



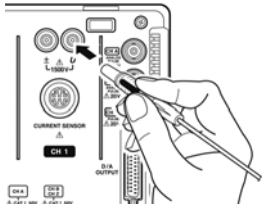
3.6 Connecting the Voltage Measurement Cables

3.6 Connecting the Voltage Measurement Cables



Be sure to read the "Usage Notes" (p. 7) before connecting measurement cables. Plug the voltage measurement cable leads into the voltage measurement jacks on the instrument (the number of connections depends on the lines to be measured and selected wiring mode).

Connection Procedure



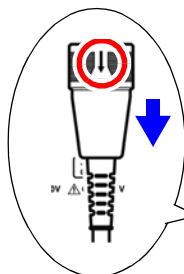
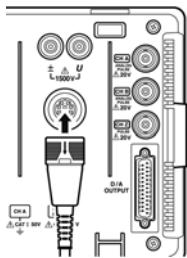
Plug the voltage cables into the appropriate channels' voltage measurement jacks. Insert the plugs into the terminals as far as they will go.

3.7 Connecting the Current Sensors



Be sure to read the "Usage Notes" (p. 5) before connecting measurement cables. Plug the current sensor cables into the current measurement jacks on the instrument (the number of connections depends on the lines to be measured and selected wiring mode). See the instruction manual supplied with the current sensor for specification details and usage procedures.

Connection Procedure



With the arrow on top of the plug, plug each current sensor cable into the appropriate channel's current measurement jack. Insert each plug until you hear it lock.

To disconnect:
Holding the plug around its arrow, slide it forward to unlock, then pull out.

To measure voltage and current beyond the range of the instrument or current sensor

Use an external VT (PT) or CT. By specifying the VT or CT winding ratio on the instrument, the input level at the primary side can be read directly.

See "4.2.6 Setting Scaling (when using VT(PT) or CT)" (p. 51)



During wiring, avoid touching the VT(PT), CT or input terminals. Exposed live contacts can cause electric shock or other accident resulting in personal injury or death.



- When using an external VT (PT), avoid short-circuiting the secondary winding. If voltage is applied to the primary when the secondary is shorted, high current flow in the secondary could burn it out and cause a fire.
- When using an external CT, avoid open-circuiting the secondary winding. If current flows through the primary when the secondary is open, high voltage across the secondary could present a dangerous hazard.

NOTE

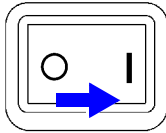
- Phase difference in an external VT (PT) or CT can cause power measurement errors. For optimum power measurement accuracy, use a VT (PT) or CT that exhibits its minimal phase difference at the operating frequency.
- To ensure safety when using a VT (PT) or CT, one side of the secondary should be grounded.

3.8 Turning the Power On and Off



Be sure to read the "Usage Notes" (p. 7) before turning the instrument on.
Connect the power cord and voltage and current measurement cables before turning the instrument on.

Turning the power on



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

The instrument performs a 10-second power-on self test.

See 3.3 (p.26)

The instrument performs a 10-second power-on self test.

When the self test finishes, the **[Wiring]** page of the Setting screen appears (initial screen). If **[Start page]** is set to **[Last Screen]** (p. 101), the last displayed Measurement screen appears.

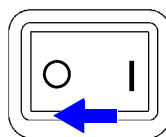
NOTE

If the self-test fails, operation stops at the self-test screen. If the fault recurs after turning the power off and on, the instrument may be damaged. Perform the following procedure:

1. Stop measuring, disconnect the measurement cables from the object being measured, and turn the instrument off.
2. Disconnect the power cord and all cables from the instrument.
3. Contact your dealer or Hioki representative.

For best precision, allow at least 30 minutes warm-up before executing zero adjustment and measuring.

Turning the power off



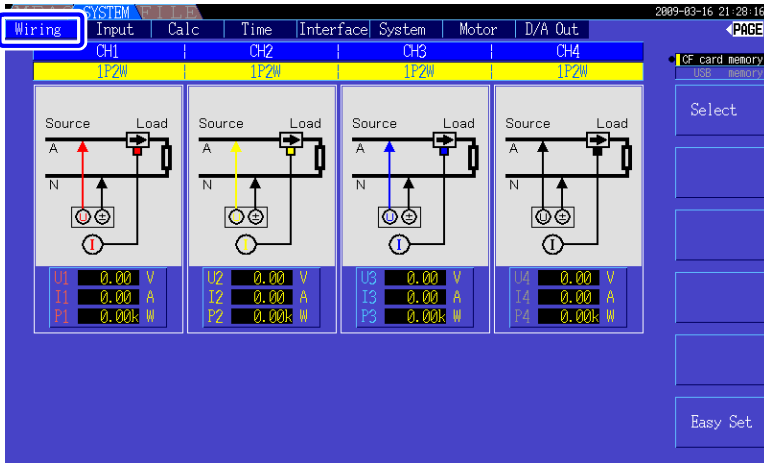
Turn the **POWER** switch off (○).

3.9 Selecting the Wiring Mode

Select the wiring mode to match the phase system(s) to be measured. Eight wiring modes are available.

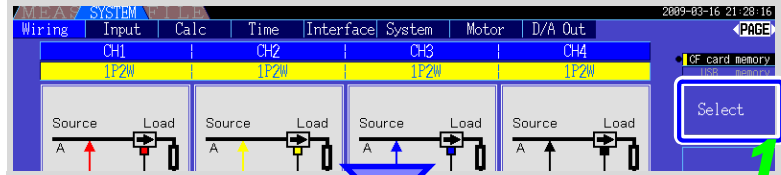
To open the [Wiring] page

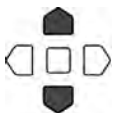
Press the **SYSTEM** key and select the **[Wiring]** page with the  .

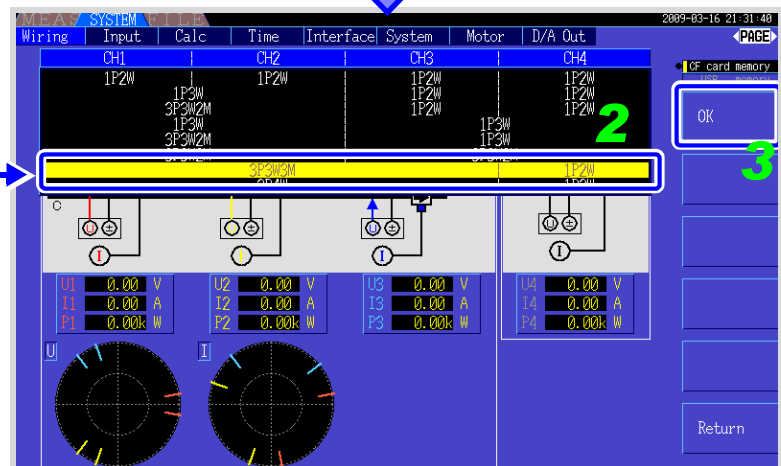


To select the wiring mode

1 Press the **F1** key to select **[Select]** (or press the **ENTER** key) to display the pull-down menu.



2  Select the wiring mode



3 To accept the selection:
 Press **F1** (or the **ENTER** key)
 To cancel the selection:
 Press **F6** (or the **ESC / On** key)

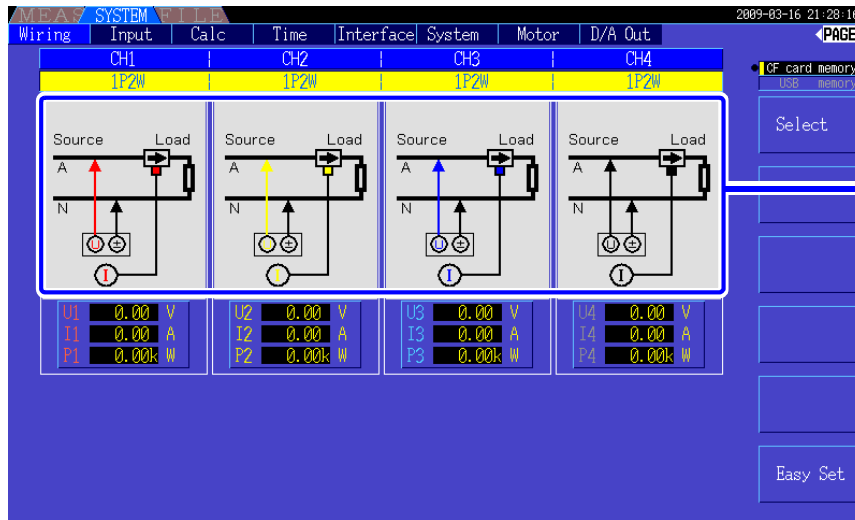
Accepting the selection displays the wiring diagram of the selected wiring mode.(p. 31)

NOTE

- To measure multiphase power, use the same type of current sensor on each phase line. For example, to measure 3-phase 4-wire power, use the same model current sensors on channels 1 to 3.
- When using a current sensor with switchable sensor rating (such as Model 9272-10), set the sensor rating to match the rating of the line.
- When the selected wiring mode uses multiple channels, channel-specific settings (such as voltage range) are linked to the first channel's settings.

Wiring configuration diagram

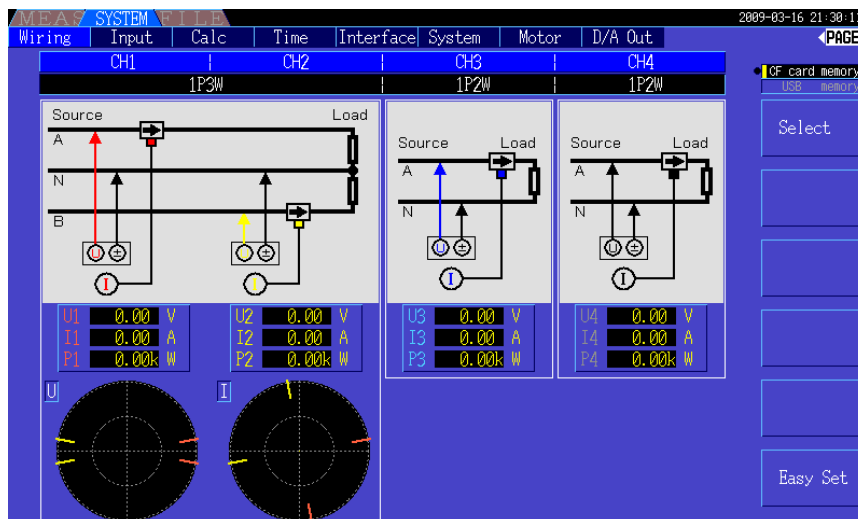
Wiring Mode 1. Single-phase, 2-wire (1P2W) × 4



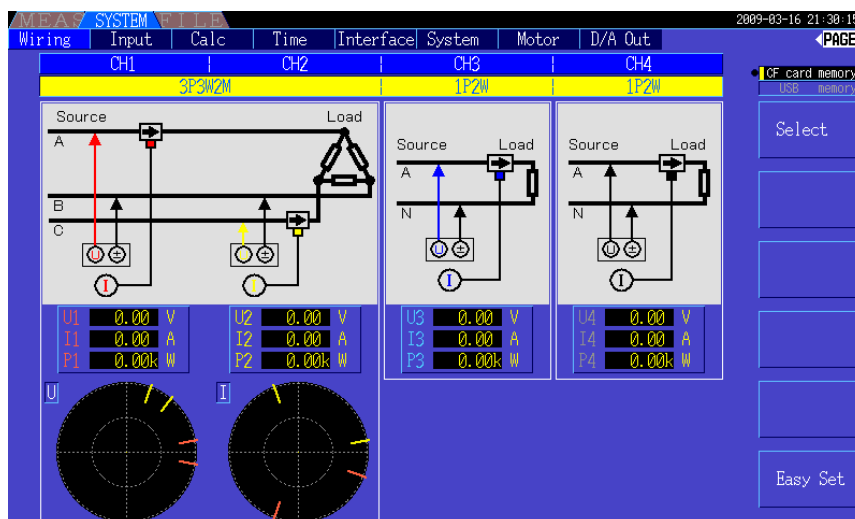
Wiring configuration diagram

See Pages 172 and 173 for additional wiring diagrams.

Wiring Mode 2. Single-phase, 3-wire (1P3W) + single-phase, 2-wire (1P2W) × 2

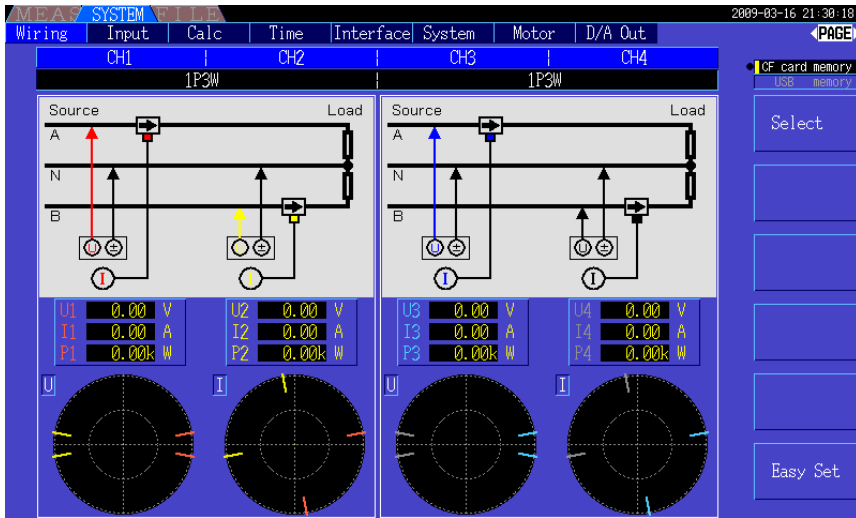


Wiring Mode 3. 3-phase, 3-wire (3P3W2M) + single-phase, 2-wire (1P2W) × 2

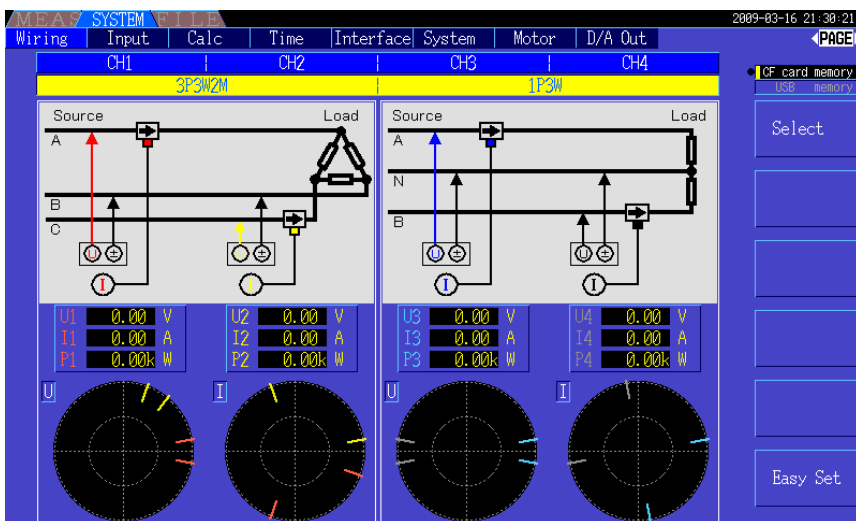


3.9 Selecting the Wiring Mode

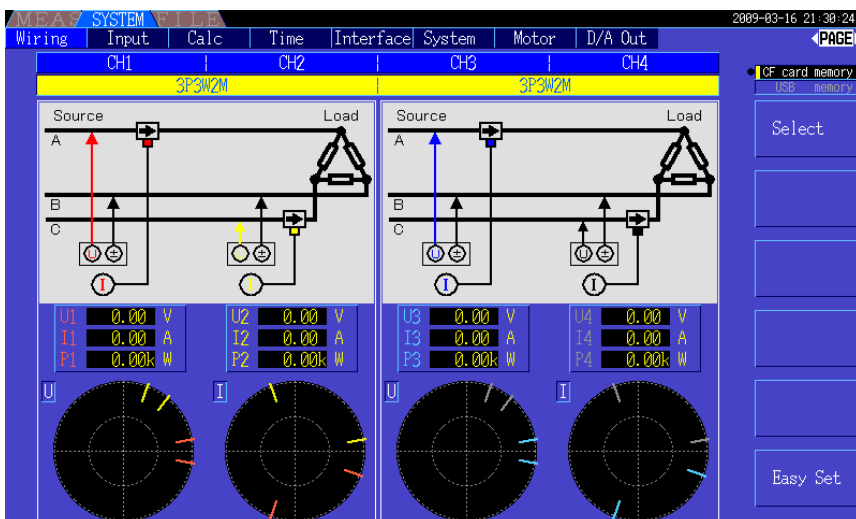
Wiring Mode 4. Single-phase, 3-wire (1P3W) × 2



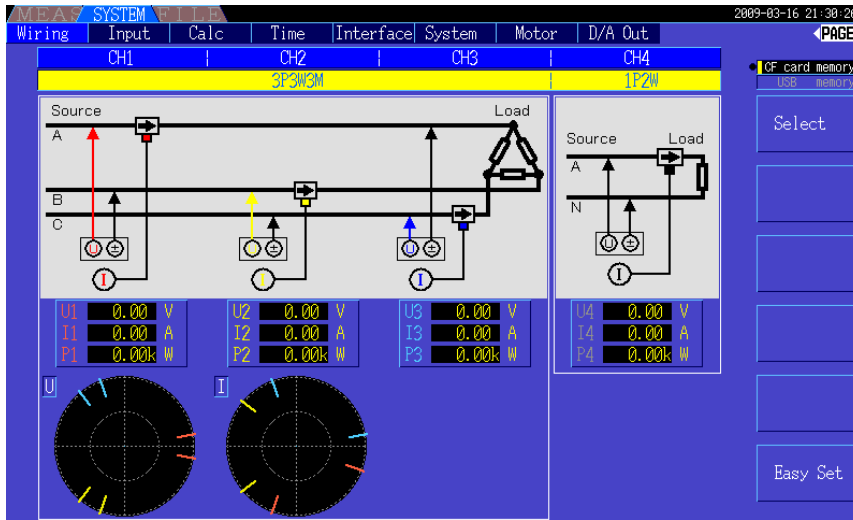
Wiring Mode 5. 3-phase, 3-wire (3P3W2M) + single-phase, 3-wire (1P3W)



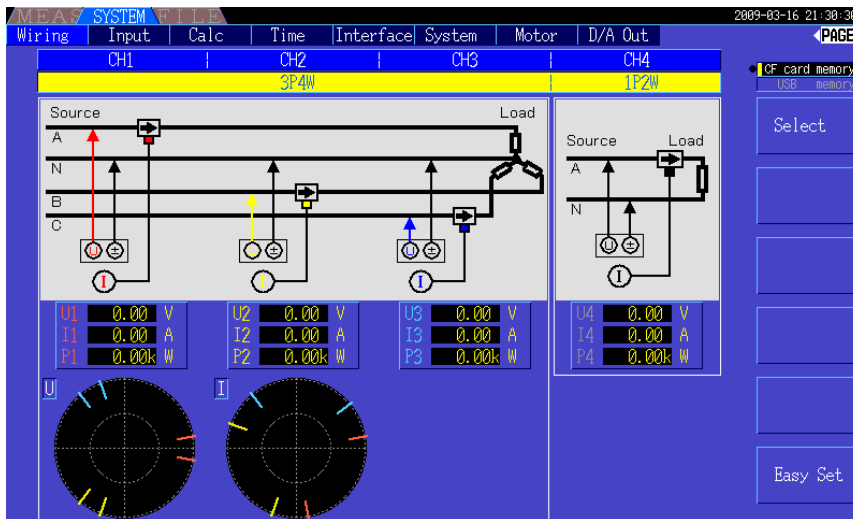
Wiring Mode 6. 3-phase, 3-wire (3P3W2M) × 2



Wiring Mode 7. 3-phase, 3-wire (3P3W3M) + single-phase, 2-wire (1P2W)



Wiring Mode 8. 3-phase, 4-wire (3P4W3M) + single-phase, 2-wire (1P2W)



3.10 Attaching to the Lines to be Measured and Zero Adjustment

Be sure to read the "Usage Notes" (p. 5) before attaching to the lines. Always perform zero adjustment before attaching to the lines.

Then attach the voltage measurement clips and current sensors to the measurement lines according to the on-screen wiring diagrams. For proper accuracy, attach to the lines exactly as shown.*

* The diagram appears when the wiring mode is selected.(p. 30)



Although the instrument can measure multiple lines at the same time, to avoid electric shock and short-circuit accidents, do not attach any unnecessary cables.

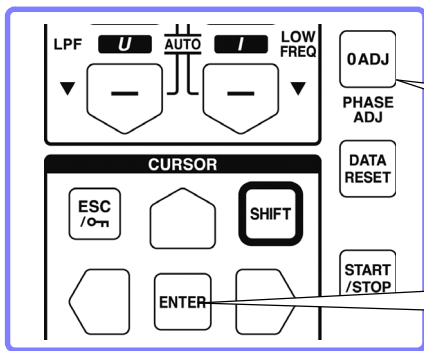


The phases are named A, B, and C on the wiring diagram display. Substitute with equivalent names such as R,S, and T or U,V, and W, as appropriate.

Zero Adjustment and Degaussing (DMAG)

To obtain the specified accuracy, after 30 minutes warm-up, perform zero-adjustment on both voltage and current measurement channels.

When using an AC/DC current sensor, perform degaussing (DMAG) along with zero adjustment.



1. Press the **MEAS** key.

2. Press the key. **[Execute Zero Adjust.]** is displayed.

3. Press the key. (**ESC** to cancel.) **[Executing zero adjustment]** is displayed for 30 seconds, until finished.

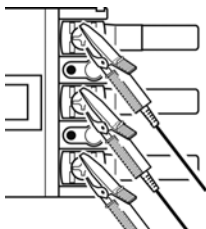


- Perform zero adjustment only after plugging the current sensor into the instrument (proper adjustment requires that the current sensor be connected).
- Perform zero adjustment before attaching to the lines to be measured (proper adjustment requires the absence of any input voltage or current).
- For optimum measurement accuracy, zero adjustment should be performed within the specified ambient temperature range.
- The operating keys are disabled during zero adjustment.
- When using a motor evaluation option, zero adjustment is not applicable for analog DC input on channels A and B. Perform the special zero adjustment from the Motor screen.

See "4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)" (p. 82)

Attach voltage measurement cables to measurement lines

Example: Secondary side of breaker



Securely clip the leads to metal parts such as load-side screw terminals or bus bars.

L9438-50 Voltage Cord

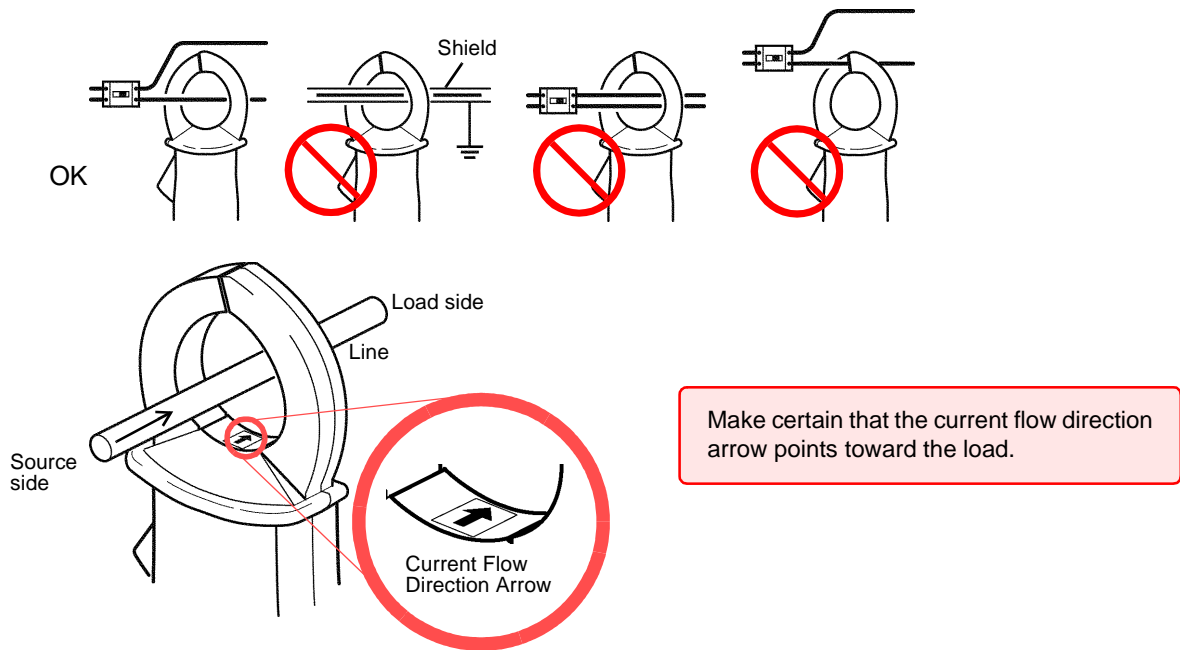
3.10 Attaching to the Lines to be Measured and Zero Adjustment

Attach current sensors to measurement lines

(Example: 9272-10)

Be sure to attach each clamp around only one conductor.

Correct measurement cannot be obtained if a clamp is attached around more than one conductor.

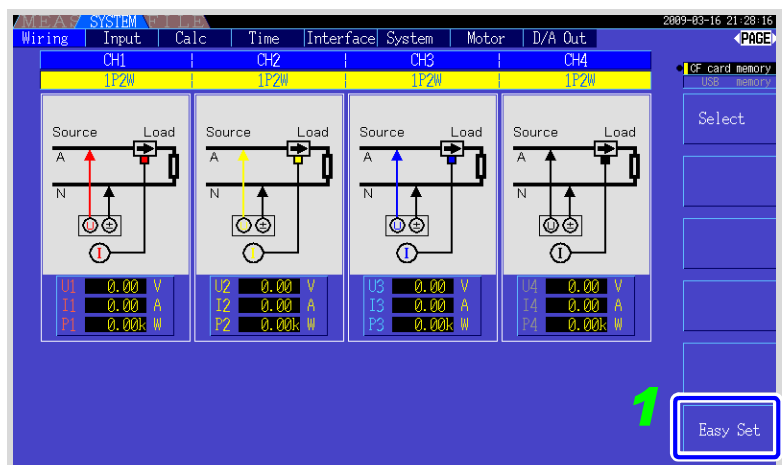


Easy set

NOTE If measurement line power is off, turn it on before performing quick setup.

1 Select **[Easy Set]** with the **[F6]** key. A confirmation dialog box appears.

2 To execute: Press **[ENTER]**
To cancel: press **[ESC/On]**.



What settings are affected by quick setup?

For accurate measurements, settings such as range and sync source must be properly configured. Executing quick setup automatically configures the following settings to the Hioki-recommended values for the selected wiring mode (phase system): voltage and current ranges, sync source, lower measurement frequency limit, integration mode, harmonic sync source and rectification system.



Execute quick setup when using the instrument the first time, and when changing to a different line configuration.

3.11 Verifying Correct Wiring (Connection Check)

3.11 Verifying Correct Wiring (Connection Check)

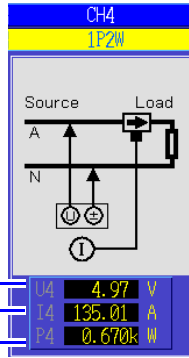
Correct attachment to the lines is necessary for accurate measurements.

Refer to the measured values and vector displays to verify that the measurement cables are correctly attached.

For 1P2W systems

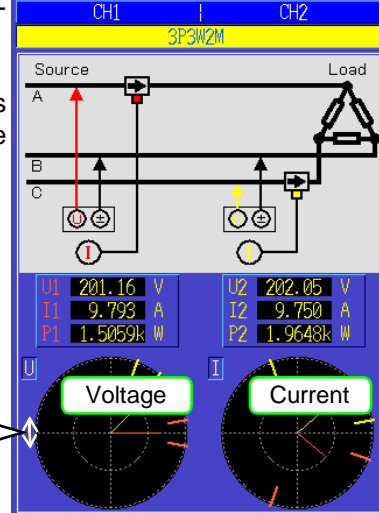
For systems other than 1P2W

Verify that an appropriate measurement value is displayed.



Measured voltage value
Measured current value
Measured active power value

- Verify that an appropriate measurement value is displayed.
- Verify that the vectors are displayed with the appropriate range.



Vector line range
Colors match the corresponding lines in the wiring diagram.

In this case

If the measured voltage value is too high or too low

If the measured current value is not correct

If the measured active power value is negative

If vectors are too short, or unequal

If vector direction (phase) or color is incorrect

Check

- Are the cables securely plugged into the voltage measurement jacks on the instrument? (p. 28)
- Are the voltage measurement cables properly attached to the lines? (p. 34)
- Are the cables securely plugged into the current measurement jacks on the instrument? (p. 28)
- Are the current sensors properly attached to the lines? (p. 35)
- Are the current sensors appropriate for the line current to be measured?
- If using the 9272-10 Clamp Sensor, is the sensor range set correctly?
- Are the voltage measurement cables properly attached to the lines? (p. 34)
- Is the arrow marker on the current sensors pointing toward the load? (p. 35)

Voltage vectors:

- Are the cables securely plugged into voltage measurement jacks on the instrument?(p. 28)
- Are the voltage measurement cable clips properly attached to the lines? (p. 34)

Current vectors:

- Are the cables securely plugged into the current measurement jacks on the instrument? (p. 28)
- Are the current sensors properly attached to the lines? (p. 35)
- Are the current sensors appropriate for the line current to be measured?
- If using the 9272-10 Clamp Sensor, is the sensor range set correctly?

Voltage vectors:

- Check that the voltage measurement clips are attached to the lines according to the wiring diagram.

Current vectors:

- Check that the current sensors are attached to the lines according to the wiring diagram.

NOTE

- The display range of the vector diagrams assumes inductive loads (such as with a motor). The vectors may appear out of range when measuring near-zero power factor, or capacitive loads.
- When measuring multiple 1P3W or 3-phase lines at the same time, vectors are not displayed correctly when the harmonic sync source frequency is different from that of the lines to be measured.
- When measuring 3P3W2M systems, the active power (P) measured on each channel may be negative.

Viewing Measurement Values

Chapter 4

4.1 Measurement Value Display Procedure

The following procedure displays measurement values.

4

Chapter 4 Viewing Measurement Values

Display Procedure (the following shows 1P2W wiring mode)

MEAS

← → Display the [CH] page

Use the F keys to select display contents

| | |
|------------------------------|------------------|
| U _{rms1} : 101.37 V | S1 : 12.536k VA |
| I _{rms1} : 123.66 A | Q1 : -8.444k var |
| P1 : 9.265k W | φ1 : -42.35 ° |
| λ1 : -0.7391 | f1 : 50.000 Hz |

- Power (F1)
- Integration (F2)
- Voltage (F3)
- Current (F4)
- Harmonics Graph (F5)
- Harmonics List (F6)



See Displays the Harmonic Graph or Harmonic List. "4.4 Viewing Harmonic Measurement Values" (p. 62)

The above screen is specific to the wiring mode (here showing four 1P2W systems) the number of measurement items displayed depends on the selected wiring mode. See Section "3.9 Selecting the Wiring Mode" (p. 30) to set the wiring mode.

4.1 Measurement Value Display Procedure

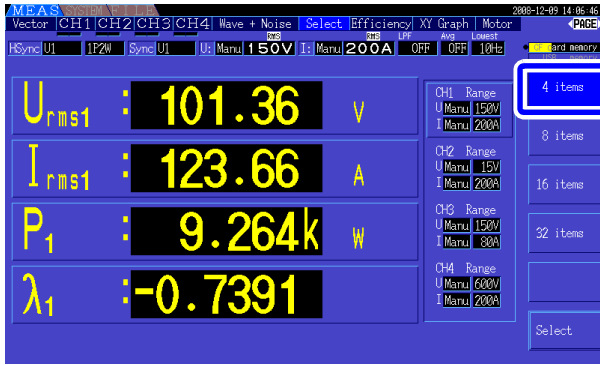
Selecting Measured Items for Display

From all measured items, select those you want to display on one screen.

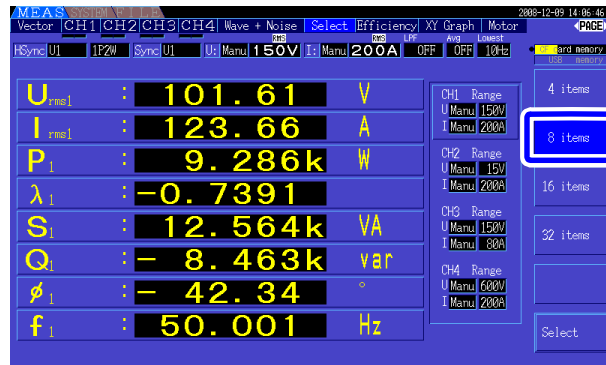
Press   to display the [Select] page.

First press an **F** key to select the number of items to be displayed.

Four-Item Display



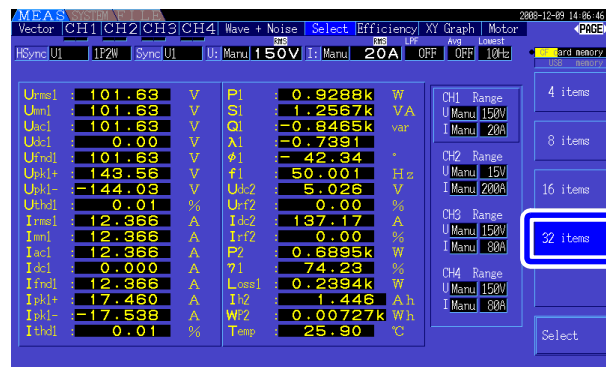
Eight-Item Display



Sixteen-Item Display



Thirtytwo-Item Display



4.1 Measurement Value Display Procedure

Display Item Selection Procedure

MEAS

Display the **[Select]** page

F6 (a blinking cursor appears)

Move the cursor to the item to change

Accept (the pull-down menu appears)

Select the item to display

Enter / **ESC** Cancel

Press **F6** when finished making changes.

The diagram illustrates the process of changing measurement items on a device screen. It shows two screenshots of the device interface. The top screenshot shows the 'MEAS' page with a 'Select' button highlighted. The bottom screenshot shows the same page with a pull-down menu open, allowing the user to select a different measurement item. The instructions are accompanied by arrow icons indicating the sequence of actions: pressing F6, moving the cursor, accepting the selection, and finally pressing F6 again to save changes.

| Item | Value | Unit |
|-------------------|---------|------|
| U _{rms1} | 101.63 | V |
| I _{rms1} | 12.366 | A |
| P ₁ | 0.9288k | W |
| Q ₁ | -0.7391 | var |

4.1 Measurement Value Display Procedure

About Valid and Displayable Ranges

The valid measurement range (the range of guaranteed accuracy) is 1% to 110% of the full-scale range (except that valid voltage is limited to 1000 V in the 1500 V scale).

The display range of this unit is between the zero suppress level to 120% of the measurement range. The following display indicates over-range measurement.

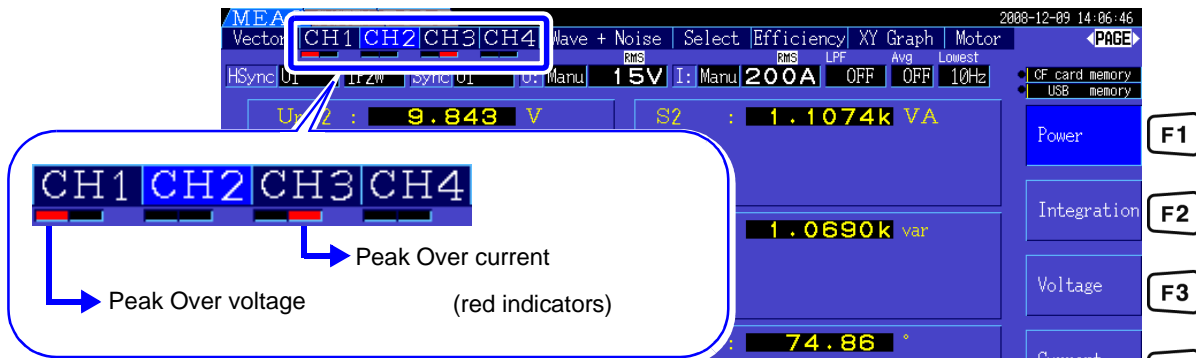
See Zero suppress level: OFF, 0.1%f.s., 0.5%f.s. (initial setting) (p. 101)



About Peak Over Indicators

Peak Over indicators light when an input voltage or current waveform peak value exceeds three times the full-scale range (except the 1500 V range, when the voltage exceeds ± 2000 V, see the figure below). The indicators are shown on all screens, so that Peak Over can be seen even on channels not currently selected.

Example. The following display indicates that the CH 1 voltage and CH 3 current are at Peak Over levels.



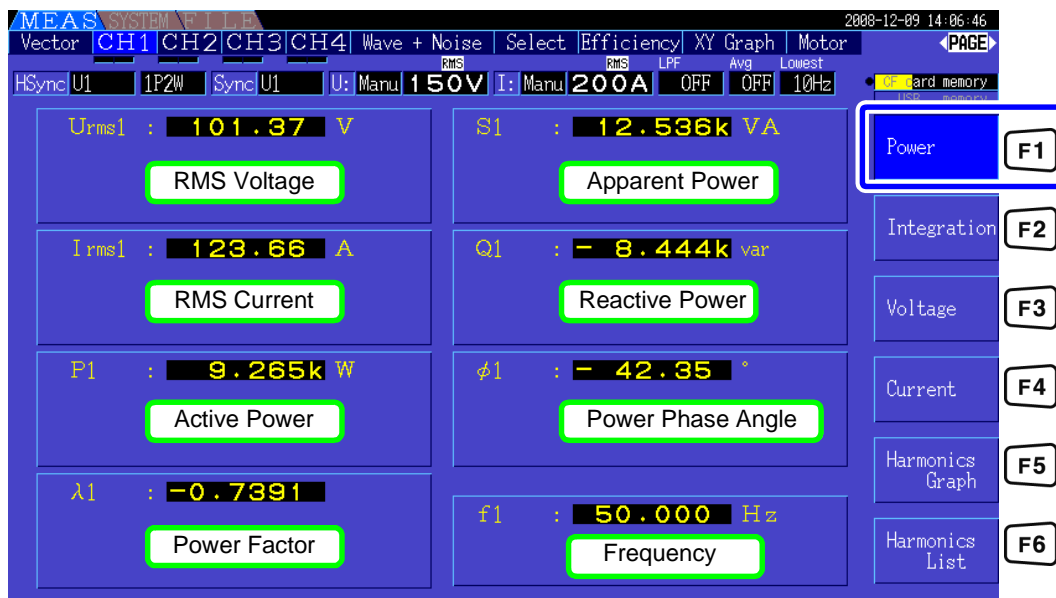
4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.1 Displaying Power Measurements

When viewing power measurements, [Power], [Voltage], and [Current] are displayed so that measured values can be confirmed. Press **MEAS** to display the Measurement screen, and select the desired [CH] page with the **◀** **▶** keys. Power measurements can be displayed in a list, and detailed voltage and current values can be displayed.

Displaying Power

Press **F1**. (The screen shows values for Wiring mode 1, four 1P2W systems.)



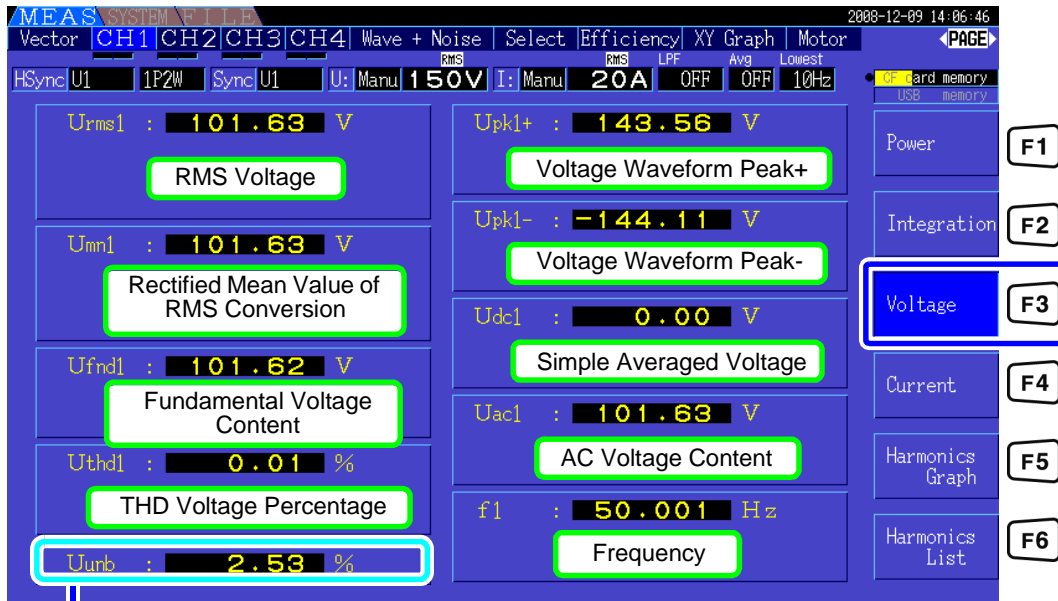
NOTE

- Average rectified RMS converted value is displayed for U_{rms} or I_{rms} according to the rectification setting. See "4.2.5 Selecting the Rectification Method" (p. 50)
- Polarity of power factor (λ), Reactive power (Q), and power phase angle (ϕ) shows the LEAD or LAG. "No polarity sign" means "LAG" and "-" means "LEAD".
- The polarity of power factor, reactive power and power phase angle may not be stable when the voltage and current has big level difference or power phase angle is around zero.
- Each channel value of effective power (P), Reactive power (Q), Apparent power (S) and power factor (λ) is meaningless in the 3P3W2M wiring. Use only the sum values (P₁₂, P₃₄, etc.)

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Displaying Voltage

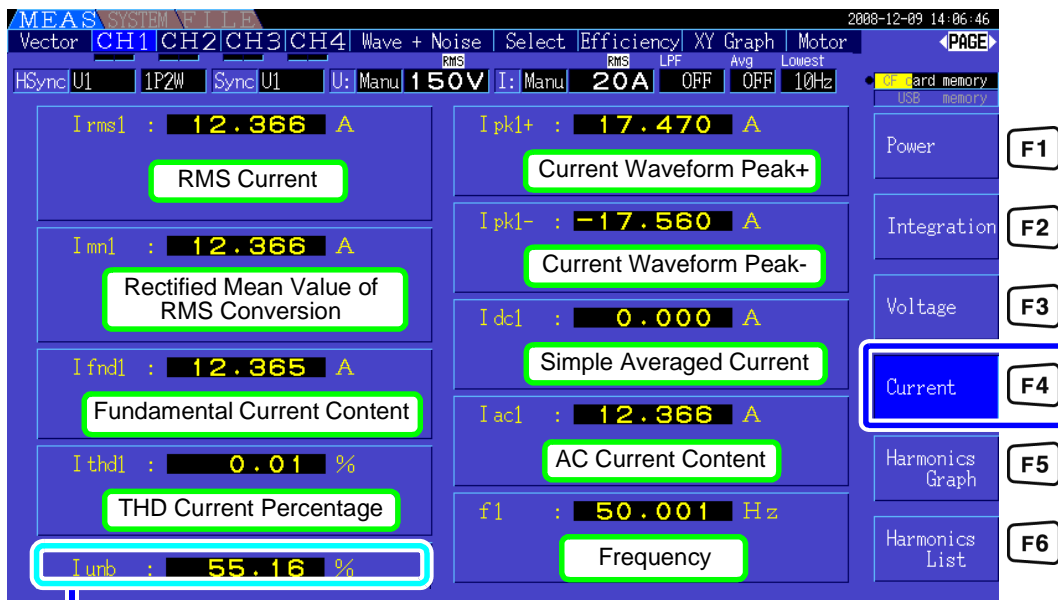
Press **F3** . (The screen shows values for Wiring mode 1, four 1P2W systems.)



When the Wiring mode is 3P3W3M or 3P4W, voltage unbalance U_{urb} [%] is displayed.

Displaying Current

Press **F4** . (The screen shows values for Wiring mode 1, four 1P2W systems.)



When the Wiring mode is 3P3W3M or 3P4W, current unbalance I_{urb} [%] is displayed.

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.2 Selecting Ranges

Measurement ranges are selected as described below.



- If the maximum voltage or current rating is exceeded, immediately stop measuring, shut off power to the measurement lines, and disconnect from the measurement object.
- Continuing to measure when maximum ratings are exceeded may damage the instrument and result in injury or death.



- The maximum input voltage is +/-2000V DC, 1500Vrms AC. Do not use the voltage exceeding it to avoid damaging the unit or injury.
- Never exceed the maximum rated input current to the current sensor, as damage to the instrument or injury or death can result.

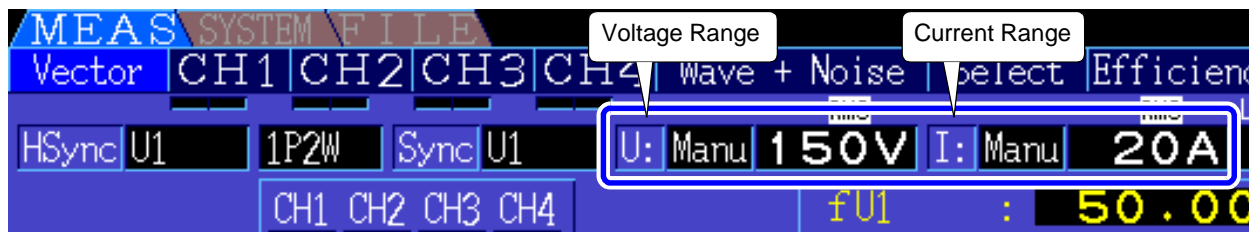
Types of Range Setting

Measurement ranges can be selected in two ways:

| | |
|----------------------|---|
| Manual range setting | Select the range manually (Press RANGE or to select the desired range.) |
| Auto-Ranging | Each voltage and current range is set automatically according to the measurement inputs for each wiring system. (Press RANGE and at the same time.) |

Range Display

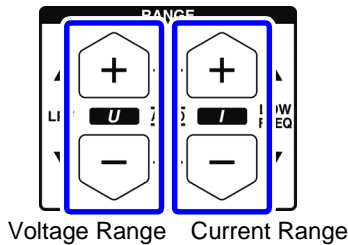
The active range selection is displayed at the locations on the Measurement screen shown below (except on the [Efficiency], [XY Graph], and [Motor] pages). Manual range selections are indicated by [Manu], and Auto-ranging selections by [Auto].



4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Range Setting Procedure

Ranges can be set on the following Measurement screen pages: [Vector], [CH] (any), [Wave + Noise], [Select], and [Input]. Change the range with the RANGE + and - keys.



For **Manual range** selection, press RANGE + or - to select the desired range.

For **Auto range** selection, press RANGE + and - at the same time.

Setting from the [Vector] Page of the Measurement Screen

MEAS

Display the [Vector] page

Select the channel to change

Press the RANGE keys to select the range

Setting from the [CH] Pages of the Measurement Screen

Select the channel to change

Press the RANGE keys to select the range

Setting from the [Wave + Noise] Page of the Measurement Screen

Display the [Wave + Noise] page

F1 Select [U/I]*

Select the channel to change

Press the RANGE keys to select the range

* Press F2 to display [CH] for changing.

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Setting from the [Select] Page of the Measurement Screen

Display the [Select] page

Select the channel to change

Press the **RANGE** keys to select the range

| Channel | U Range | I Range |
|---------|---------|---------|
| CH1 | 150V | 200A |
| CH2 | 15V | 200A |
| CH3 | 150V | 80A |
| CH4 | 600V | 200A |

Setting from the [Input] Page of the Setting Screen

Display the [Input] page

Select the channel to change

Press the **RANGE** keys to select the range (Changes the selected [U range] or [I range])

| Wiring | CH1 | CH2 | CH3 | CH4 |
|---------|------|-----|------|-------|
| U range | 150V | 15V | 300V | 1500V |
| I range | 200A | 40A | 80A | 8A |

Range ↑ F1
Range ↓ F2
All CH Set F5
AUTO F6

To change the [U range] or [I range], select it with the cursor and press **F1**, **F2**, or **F6** to change the range.

See About [All CH Set] "2.2 Basic Operations" (p. 16)

NOTE

When measuring multiple channels with a Wiring mode other than 1P2W, all channels are forced to the same range. In this case, the range of each channel is set to match the channel set to the lowest range.

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Auto-Ranging Span

This setting determines auto-ranging behavior, and can be specified for each wiring system. Select **[Wide]** if the range changes frequently due to large fluctuations.

| | |
|--------|---|
| Narrow | <ul style="list-style-type: none"> The measurement range increments by one when a Peak Over state occurs or when any RMS value exceeds 105% f.s. The measurement range decrements by one when all RMS values fall below 40% f.s. (unless a Peak Over state would result in the lower range). This is the default setting. |
| Wide | <ul style="list-style-type: none"> The measurement range increments by one when a Peak Over state occurs or when any RMS value exceeds 110% f.s. The measurement range decrements by two when all RMS values fall below 10% f.s. (unless a Peak Over state would result in the lower range). |

NOTE When Δ -Y conversion is enabled (p. 98), the range-decrementing voltage is $1/\sqrt{3}$ (approximately 0.57735) f.s.

Setting Procedure

1. Press the **[SYSTEM]** key.

2. Use the left and right arrow keys to display the **[Calc]** page.

3. Use the center and up/down arrow keys to select the **[AutoRange type]** field.

4. Press the **F1** key to select **Narrow** or the **F2** key to select **Wide**.

5. Press the **F6** key to return to the main menu.

- NOTE**
- If the range switches frequently even when the **[Wide]** setting for **[AutoRange type]** is selected, Manual range setting is recommended. See "4.2.2 Selecting Ranges" (p. 43)
 - When integration starts, the range selected at that time becomes fixed, and auto-ranging is disabled.

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.3 Selecting the Sync Source

Select the source to determine the fundamental cycle (between zero crossings) on which various calculations are to be based.

Select from the following 11 items for each Wiring mode. Press **SYSTEM** to make the setting on the Setting screen.

U1 to U4 (Default setting), I1 to I4, DC50 ms, DC100 ms, Ext*

The selected synchronization source is displayed as **[Sync]** on the Measurement screen.

* Selectable when a Model 9791 or 9793 Motor Testing Option is installed and CH B is set for pulse input.

Sync Source Setting Procedure

SYSTEM

Display the [Input] page

Select [Sync source] for the channel to be changed.

Select with the F keys

See [All CH Set] and [Next].
"2.2 Basic Operations" (p. 16)

Input

| Wiring | CH1 | CH2 | CH3 | CH4 |
|--------------|------|----------|------|-------|
| Sync source | U1 | DC 100ms | U1 | U1 |
| U range | 150V | 15V | 300V | 1500V |
| I range | RMS | RMS | RMS | RMS |
| VT rate | OFF | OFF | OFF | OFF |
| I range | 200A | 40A | 80A | 8A |
| I rect | RMS | RMS | RMS | RMS |
| CT rate | OFF | OFF | OFF | OFF |
| LPF | OFF | OFF | OFF | OFF |
| Integ mode | RMS | RMS | RMS | RMS |
| Freq measure | U | U | U | U |

DC 50ms (F1)
DC 100ms (F2)
Ext (F3)
All CH Set (F5)
Next (F6)

U1 to U4, I1 to I4, DC50ms, DC100ms (or Ext) is selectable. Ext is selectable only when motor option is equipped and CHB input type is pulse.

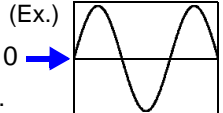
NOTE

- When measuring AC input with **[DC50 ms]** and **[DC100 ms]** settings, displayed values fluctuate and proper measurement is not possible. Select any of **[U1]** to **[U4]** or **[I1]** to **[I4]**.
- Voltage and current share the same sync source on each channel.
- [DC50 ms]** is the fastest calculation interval for DC measurements. However, if input interference (50/60-Hz power line noise) causes measurement values to fluctuate, select **[DC100 ms]**.
- When U or I is selected as a sync source, amplitude should remain at least 30% f.s.
- Also when U or I is selected as a sync source, if a frequency is applied above 5 kHz or below the minimum measurement frequency, the displayed frequency may differ from the input frequency.
For the sync source, select an input with a fundamental frequency of 0.5 Hz to 5 kHz, and specify the corresponding minimum measurement frequency.
- The measurement values may get unstable at the frequency around the lowest measurable frequency, because the synchronization is unlocked.

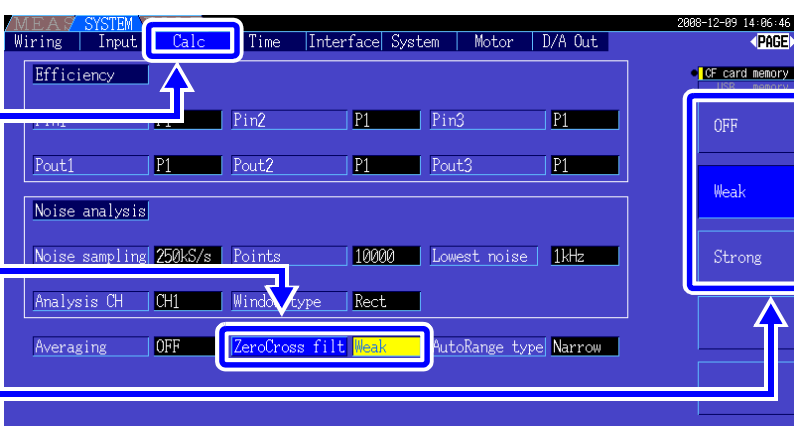
4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Setting the Zero-Crossing Filter

When U or I is selected, set the level of the zero-crossing filter.

| | | |
|--------|--|---|
| OFF | Set to display waveforms from "0". NOTE When [OFF] is selected, accuracy is undetermined, so always select the Weak or Strong setting when viewing measurement values. | (Ex.)  |
| Weak | This is the normal (default) setting. | |
| Strong | Select this setting if synchronization is lost because the input fundamental and the carrier frequency are too close together, such as when measuring an inverter secondary. | |

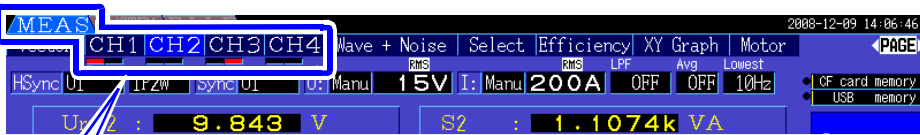
Zero-Crossing Filter Setting Procedure



Display the [Calc] page
 Select [ZeroCross filt]
 Select with the F keys

About the Sync Unlock Indicators

When a sync signal cannot be acquired,* its Sync Unlock indicator appears (see figure below). The indicators for all channels are displayed on all screens, so sync unlock events are visible even when they occur on channels that are not currently selected for display.
 Example. The following case indicates that CH 2 sync is unlocked.



| | |
|--------|---|
| Red | Indicates sync is unlocked. The channel cannot be measured accurately. |
| Yellow | "ULK" lights yellow when the frequency of any sync source channel is at or below 99% (or at or above 101%) of the harmonic sync source. In this case, the harmonics of each measured value, the fundamental content (U _{fn} d and I _{fn} d), and the total harmonic ripple distortion percentages (U _{thd} and I _{thd}) cannot be measured correctly. Example. When the frequency of the harmonic sync source is 50 Hz and the frequency of the sync source channel is 49.5 Hz or less, or 50.5 Hz or more. Harmonic sync source unlocked |

Harmonic sync source unlocked
 See "4.4.4 Selecting the Harmonic Sync Source" (p. 67)

* If the frequency of the selected sync source (input) is not between 0.5 Hz and 5 kHz, or if there is no sync source input signal, or if the input amplitude is too low (below 30% f.s.)

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.4 Frequency Measurement Settings

By configuring U or I settings for each input channel, the instrument can simultaneously measure multiple frequencies in different wiring systems.

Frequency Measurement Display System

- 0.5000 Hz → 9.9999 Hz → 10.000 Hz → 99.999 Hz → 100.00Hz → 999.99 Hz → 1.0000 kHz → 5.0000 kHz
- 0.5000 Hz ← 9.8999 Hz ← 9.900 Hz ← 98.999 Hz ← 99.00 Hz ← 989.99 Hz ← 0.9900 kHz ← 5.0000 kHz
- For other measurement input frequencies (not between 0.5 Hz and 5 kHz): “0.0000 Hz” is displayed for frequencies below 0.5 Hz, and “----- Hz” for 5 kHz and above.

Frequency Measurement Source Setting Procedure

SYSTEM

Display the [Input] page

Select [Freq measure]

Select with the F keys

MEAS Input

| Wiring | CH1 | CH2 | CH3 | CH4 |
|-------------|------|----------|------|-------|
| Sync source | UI | DC 100ms | UI | UI |
| U range | 150V | 15V | 300V | 1500V |
| U rect | RMS | RMS | RMS | RMS |
| VT rate | OFF | OFF | OFF | OFF |
| VT range | 200A | 40A | 80A | 8A |
| I rect | RMS | RMS | RMS | RMS |
| CT rate | OFF | OFF | OFF | OFF |
| LPF | OFF | OFF | OFF | OFF |
| Intax mode | DC | RMS | RMS | RMS |

Lowest freq 10Hz

Harm sync UI

THD calc THD-F

Δ-Y convert

Motor sync DC 50ms

Current sensor

CHI CH2 CH3 CH4

U F1

I F2

F3

F4

All CH Set F5

See About [All CH Set]. "2.2 Basic Operations" (p. 16)

Specify the lowest (limit) measurement frequency for frequency measurements. Set the lowest measurement frequency according to the input frequency. The setting is displayed as the [Lowest] value on the Measurement screen.

Setting the lowest measurement frequency on the Measurement screen

This setting is available on all Measurement screen pages.

MEAS

SHIFT

Press the LOW FREQ + and - keys to make the setting

MEAS

Lowest 10Hz

I rms : 12.366 A

I pk1+ : 17.470 A

LOW FREQ

SHIFT

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

Setting the Lowest Measurement Frequency on the Setting Screen

SYSTEM

Display the [Input] page

Select [Lowest freq]

Select with the F keys

Set the lowest frequency for measurement. 0.5Hz, 1Hz, 2Hz, 5Hz, 10Hz or 20Hz is selectable.

NOTE

- The frequency measurement range is 0.5 Hz to 5 kHz (within the sync frequency range). Input frequencies outside of this range cannot be measured.
- The guaranteed accuracy of frequency measurement stipulates sine wave input of at least 30% of the measurement range of the frequency measurement source. Frequency measurement may not be possible with other input signals.
- For input signals of 45 Hz and below, the data update rate depends on the input frequency.
- If a frequency is applied above 5 kHz or below the minimum measurement frequency, the displayed frequency may differ from the input frequency.

4.2.5 Selecting the Rectification Method

Select the voltage or current rectification method to be used for calculating apparent power, reactive power, and power factor. Two rectification methods are selectable for each voltage and current input. Make this selection before measurement.

| | |
|------|---|
| RMS | True root mean square value (default setting) |
| MEAN | Rectified mean value of RMS conversion |

[MEAN] and [RMS] settings for each range are made on the [CH] pages.

Setting Procedure

SYSTEM

Display the [Input] page

Select a [U rect] and [I rect] for the channel being set.

Select with the F keys

See About [All CH Set]. "2.2 Basic Operations" (p. 16)

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.6 Setting Scaling (when using VT(PT) or CT)

Set the VT or CT ratio when using an external VT(PT) or CT.

When a ratio has been set, [VT] or [CT] is displayed above each range setting on the [CH] pages.

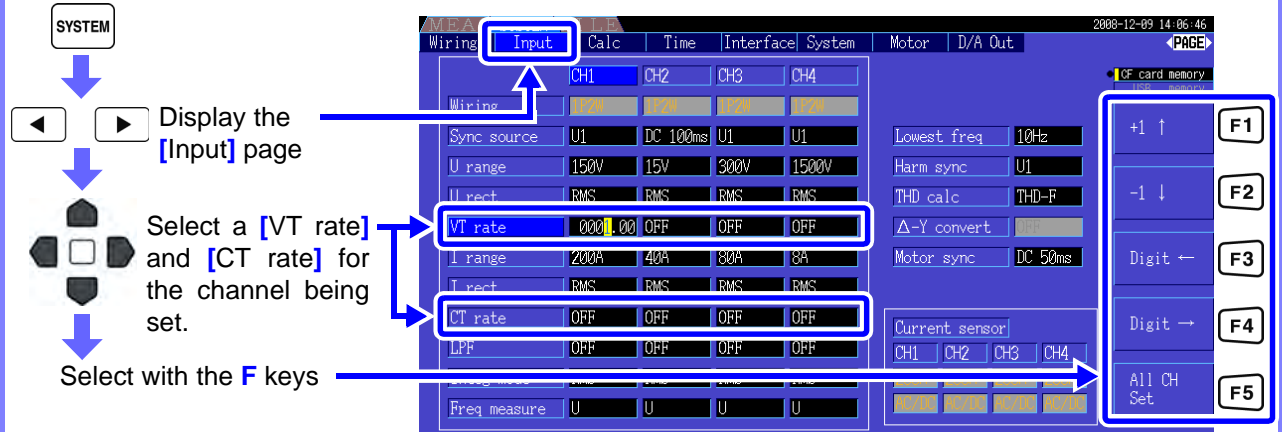


The settable range is as follows.

| | |
|---------|--|
| VT rate | OFF/ 0.01 to 9999.99 (Setting is not available when VT × CT exceeds 1.0E+06.) |
| CT rate | OFF/ 0.01 to 9999.99 (Setting is not available when VT × CT exceeds 1.0E+06.) |

NOTE When [OFF] is selected, VT and CT ratios are both 1.00.

Setting Procedure



See About [All CH Set].
"2.2 Basic Operations" (p. 16)

4.2 Viewing Power Measurements, and Changing the Measurement Configuration

4.2.7 Setting the Low-Pass Filter

The instrument includes a low-pass filter function to limit the measurement frequency range. Enable the filter to remove harmonic components or extraneous noise when measuring. Filter cut-off frequency can be selected from the following four settings, and can be set differently for each wiring system.

| | |
|---------|--|
| OFF | Specified accuracy applies only at 150 kHz and below. |
| 100 kHz | Specified accuracy applies only at 20 kHz and below. except 10 kHz to 20 kHz, add $\pm 1\%$ rdg. |
| 5 kHz | Specified accuracy applies only at 500 kHz and below. |
| 500 Hz | Specified accuracy applies only at 60 kHz and below. add $\pm 0.1\%$ f.s. |

The low-pass filter setting appears below [LPF] on the Measurement screen.

Setting the Cut-Off Frequency on the Measurement Screen

The setting can be made from the [Vector], each [CH], [Wave + Noise], and [Select] page on the Measurement screen.

Press the **LPF** **+** and **-** keys to make the setting

Selecting the Cut-Off Frequency on the Setting screen.

Select with the **F** keys

See About [All CH Set]. "2.2 Basic Operations" (p. 16)

4.3 Integration Value Observation

4.3.1 Displaying Integration Values

Current (I) and active power (P) are integrated on all channels simultaneously. Positive, negative and total values are displayed.

Displaying Integration Contents

Press **MEAS** , select a channel **[CH]** with **◀ ▶** , then press **F2** .

| | |
|-------------|---|
| RUN | Integration in progress |
| STOP | Integration stopped |
| WAIT | Waiting for integration to start by real-time clock control |

Example. With 1P2W Wiring mode selected, and DC integration mode

The screenshot shows the MEAS SYSTEM interface with the following data:

- RMS Voltage:** 12.005 V
- RMS Current:** 136.97 A
- Active Power:** 1.6444k W
- Power Factor:** 1.0000
- Integration Time Items:** Start time 2009-02-05 18:18:54, Stop time 2009-02-05 18:20:35, Elapsed time 0h 1m 41s
- Current Integration Values:** I h1+ : 2.746 Ah, I h1- : -1.105 Ah, I h1 : 1.641 Ah
- Active Power Integration Values:** WP1+ : 0.03296k Wh, WP1- : -0.01326k Wh, WP1 : 0.01970k Wh
- Frequency Measurement Source Frequency:** f1 : 0.0000 Hz

| | |
|------|--|
| Ih2+ | CH 2 positive current integration value* |
| Ih2- | CH 2 negative current integration value* |
| Ih2 | CH 2 total current integration value |

| | |
|------|--|
| WP2+ | CH 2 positive active power integration value |
| WP2- | CH 2 negative active power integration value |
| WP2 | CH 2 total active power integration value |

* Displayed only for DC integration mode

NOTE Items that can be integrated depend on the selected wiring and integration mode. See "3.9 Selecting the Wiring Mode" (p. 30), "4.3.2 Setting the Integration Mode" (p. 56)

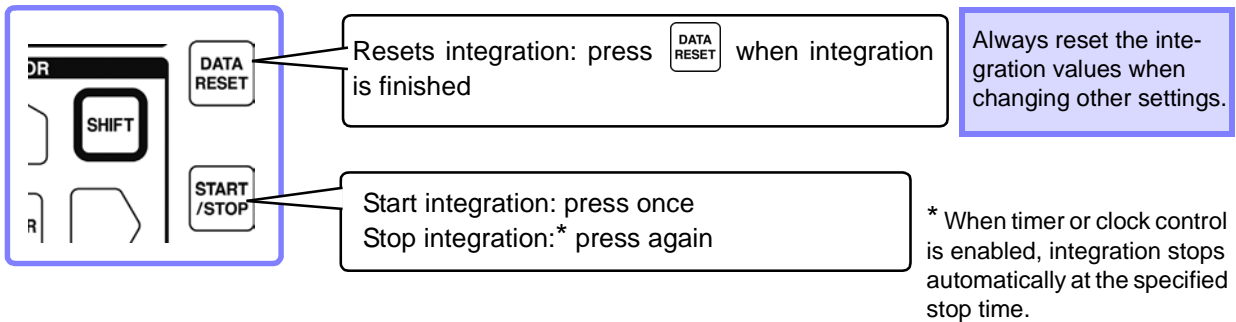
4.3 Integration Value Observation

Before Starting Integration

1. Verify that the clock is set correctly.
See "Clock" (p. 101)
2. Select the integration mode.
See 4.3.2 (p.56)
3. Set the desired time control functions (interval, timer, and clock controls).
See 4.3.4 (p.59)
Set "OFF" for time settings when integrating manually.
4. Make appropriate settings for saving to CF card, and for D/A output, as needed.
See "7.3 CF Card Formatting" (p. 106), "8.4 Using Analog and Waveform D/A Output Options (must be factory installed before shipping)" (p. 132)

Starting, Stopping, and Resetting Integration

These functions can be controlled by key operations or by communication commands.



NOTE

- Integration start, stop and value reset cannot be performed on the Setting or File Operation screens. These functions are available only on the Measurement screen.
- Remote control by USB or LAN communications can be performed using the same operations on the remote control application program screen.
See "Chapter 9 Operation with a Computer" (p. 141)

4.3 Integration Value Observation

NOTE

- Maximum integration time is 9999 hours, 59 minutes and 59 seconds, after which integration automatically stops.
- Integration start, stop and reset by the operating keys and external control act on all integration items simultaneously.
- The following physical quantities can be measured by integration for each wiring system and DC integration mode.

| Mode Name | Physical Quantities |
|---|--------------------------------------|
| 1P2WvDC Mode | Ih+, AIh-, Ih, WP+, WP-, WP |
| 1P2W | Ih, WP+, WP-, WP |
| 1P3W, 3P3W (using CH 1 and CH 2) | Ih1, Ih2, WP12+, WP12-, WP12 |
| 3P3W3M, 3P4W (using CH 1, CH 2 and CH 3) | Ih1, Ih2, Ih3, WP123+, WP123-, WP123 |

- Calculation results for each channel are integrated at 20 times per second, so integration values may differ for measurement devices with different response or sampling rates, and for different calculation methods.
- When auto-ranging is enabled for any item, the actual measurement range becomes fixed at its current setting the moment integration starts, so set the range beforehand to avoid over-range input.
- For current integration, the DC mode integrates instantaneous current, and the RMS mode integrates RMS current.
- For power integration, the DC mode integrates instantaneous power, and the RMS mode integrates active power.
- When integration is enabled (including "Wait" for clock control), settings cannot be changed other than switching screens and the Data and Peak Hold functions.
- When Data or Peak Hold is active, integration continues internally even when displayed values are fixed. Even so, it is the displayed data that is output to CF card and D/A outputs.
- Integration display values are unaffected by the Peak Hold state.
- System reset stops integration and resets integration values settings to factory defaults."6.1 Initializing the Instrument (System Reset)" (p. 101)
- If a power outage occurs during integration, integration restarts when power is restored.

4.3 Integration Value Observation

4.3.2 Setting the Integration Mode

Select the integration mode for each channel.
Two choices are available for each wiring system.

| | |
|----------------------|---|
| DC Integration Mode | Integrates instantaneous current and power values for each polarity during every sampling interval (at 500 kHz sampling frequency) Only selectable for 1P2W wiring with AC/DC current sensors (Models CT6862, CT6863, 9709, 9277, 9278, and 9279) Integration is performed simultaneously on three current values (Ih+, Ih-, and Ih) and three active power values (WP+, WP+, and WP) |
| RMS Integration Mode | Integrates RMS current and active power during every measurement interval (50 ms). Each polarity is integrated only for active power. |

Setting Procedure

Display the [Input] page

Select the channel to change

Select with the F keys

See About [All CH Set]. "2.2 Basic Operations" (p. 16)

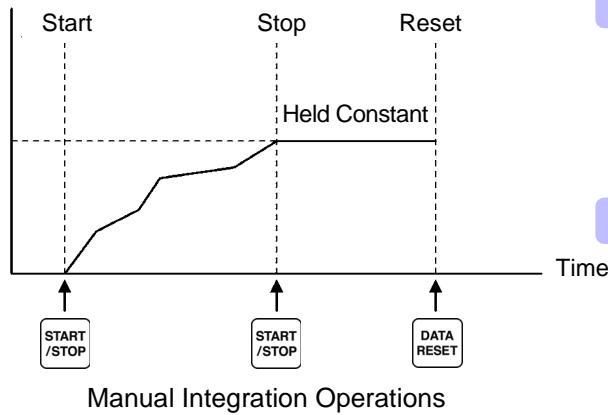
NOTE Display of THD (total harmonic distortion) or RF (ripple factor) of the measurement value is determined according to the integration mode setting. When the RMS integration mode is selected, THD is displayed, and when the DC mode is selected, RF is displayed.

4.3.3 Manual Integration Method

This method starts and stops integration by manual operation.

Procedure

Displayed Integration Value





Before starting integration

Disable (set to [OFF]) the interval, timer and clock timing control settings.

See "Integration Combined with Timing Control" (p. 59)


Start

Press .

(The  key lights green, and **RUN** is displayed to indicate the operating state.)

Stop


Press .

(The  light turns off, and **STOP** is displayed.)

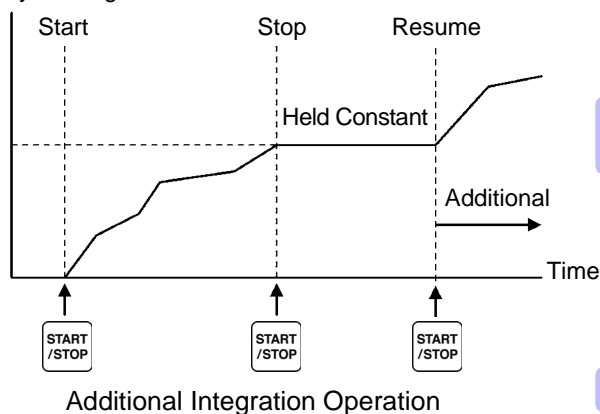
Additional integration

(resumes integration with the values acquired previously)


Press .

(The  key lights green, and **RUN** is displayed to indicate the operating state.)

Displayed Integration Value



Reset the integration value




Press .

4.3 Integration Value Observation


Saving Integration Data at Each Interval

During manual integration, integration values can be saved in combination with interval time. Measurement items selected as described in section "7.5.3 Selecting Measurement Items to Save" (p. 112) can be saved to CF card at the specified interval.
See Can be set in "Interface" page of setting screen.

Procedure

- 1.** Select the integration data to be saved at each interval.
See 7.5.3 (p.112) (Press  [Integ] to select the integration items to save.)
- 2.** Set saving (ON/OFF), and specify the folder, if needed.
See "7.5.2 Auto-Saving Measurement Data" (p. 110), "7.10.1 Creating Folders" (p. 117)
- 3.** Select the interval time.
See 5.1 (p.91)
- 4.** Press  to start saving at the selected intervals. (Press  again to stop.)

NOTE


- The data at each interval is not displayed if only interval timing is enabled. Auto-saving must also be enabled.
- The maximum integration time is 9999 hours, 59 minutes, and 59 seconds.
- When auto-saving is enabled, it is toggled by the  key. Disable auto-saving (set to [OFF]) when not needed.
See"7.5.2 Auto-Saving Measurement Data" (p. 110)
- When Data or Peak Hold is active, integration continues internally even when displayed values are fixed. Even so, it is the displayed data that is output to CF card and D/A outputs.

4.3.4 Integration Combined with Timing Control

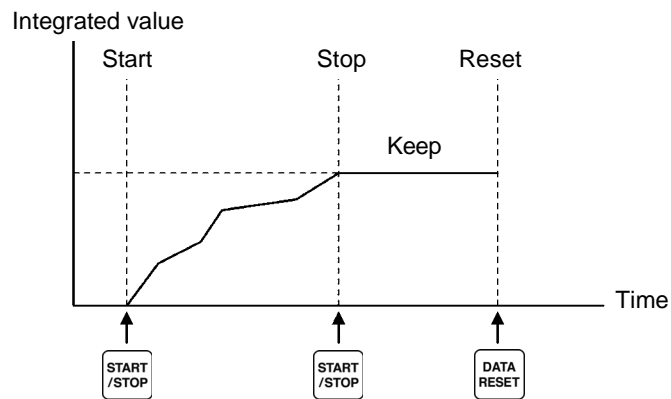
After specifying timer and clock settings, press  to cause integration to start and stop at the specified times. Integration can be controlled by the following three timing methods.

Manually Controlled Integration


Press  to start integration.

Press  again to stop integration.

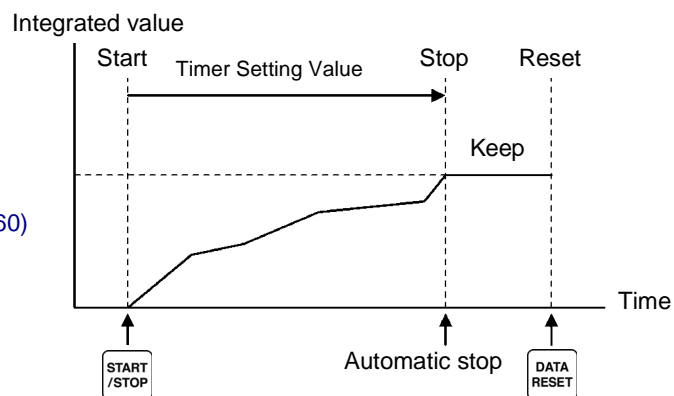
See "4.3.3 Manual Integration Method" (p. 57)




Timer-Controlled Integration

Press  to start integration. Integration stops automatically when the timer expires.

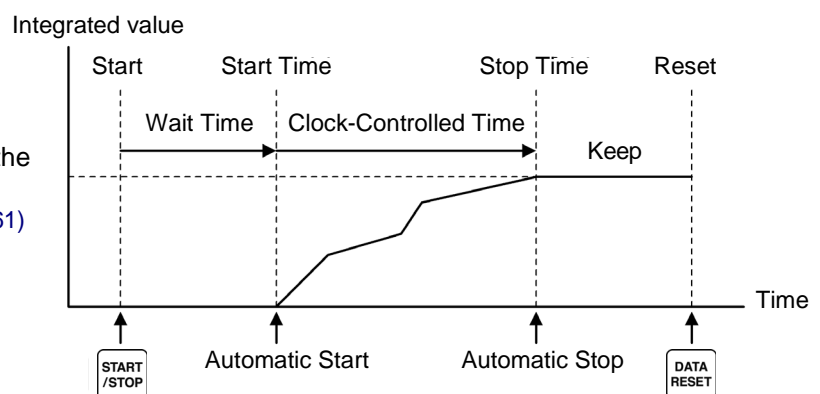
See "Timer-Controlled Integration" (p. 60)



Clock-Controlled Integration

Press . Integration starts and stops at the specified times.

See "Clock-Controlled Integration" (p. 61)



NOTE

When an interval time is enabled, activating Data or Peak Hold by pressing the **HOLD** key causes the display to update at each interval.

Also, when timer or clock control is enabled, the final measurement data is displayed at the specified stop time.

4.3 Integration Value Observation

Timer-Controlled Integration

Integration is performed for the specified duration, and stops when the timer expires. Calculation results are held constant when the timer stops.

If auto-saving is enabled, integration values are saved to CF card when integration starts and stops. If an interval time is also specified, total integration values up to that point are saved at each interval.

See "7.5.2 Auto-Saving Measurement Data" (p. 110)

Setting Procedure

Display the [Time] page

Select [Timer mode]

F2 to enable (set to [ON])

Select a [Timer setting] digit

Use the F keys to set the timer

Press **START/STOP** to start integration, which stops automatically after the set time elapses.

To interrupt integration:
Press **START/STOP** again.

- NOTE**
- Integration stops when the timer expires (or the clock stop time occurs). When this occurs before the end of an interval, the last interval is ignored.
 - Setting range is 10 seconds (“0 hour 0 min 10 sec”) to “9999 hour, 59 min 59 sec”.
 - If clock timing control is set longer than the timer setting, integration starts at the clock start time and stops when the timer has expired (the clock stop time is ignored).
 - Pressing **START/STOP** before the timer expires during timer controlled integration stops integration and retains the integration values. In this instance, pressing **START/STOP** again resumes integration and continues for the set timer duration (additional integration).

Clock-Controlled Integration

After pressing **START/STOP**, the instrument waits until the specified clock start time. Integration then begins and continues until the specified clock stop time.

If auto-saving is enabled, integration values are saved to CF card at the specified start and stop times. If an interval time is also specified, total integration values up to that point are saved after each interval.

Setting Procedure

Display the [Time] page

Select [Real time]

F2 to enable (set to [ON])

Select a [Start time] and [Stop time] digit

Use the F keys to set the timer

START/STOP (automatically starts and stops at the specified clock times)

During wait: blinks green
At the start time: lights green

To abort automatic control (while waiting):
Press **START/STOP** again.

NOTE

- Clock control settings are in 1-minute units.
- Clock setting years are AD (Christian Era), and 24-hour time (e.g., December 6th 2009, 10:16 PM appears as 2009-12-06 22:16)
- If a specified clock time has already passed, clock control is considered to be disabled (OFF).
- When integration is interrupted during clock timing control, clock control is disabled (OFF).
- If clock timing control is set longer than the timer setting, integration starts at the clock start time and stops when the timer has expired (the clock stop time is ignored).
- Integration stops after 9999 hours, 59 minutes, and 59 seconds if the time between clock start and stop times is set longer than that.
- Setting time upper limits are as follows:

| | |
|------------|------------------|
| Start Time | 2077-12-31 23:59 |
| Stop Time | 2079-12-31 23:59 |

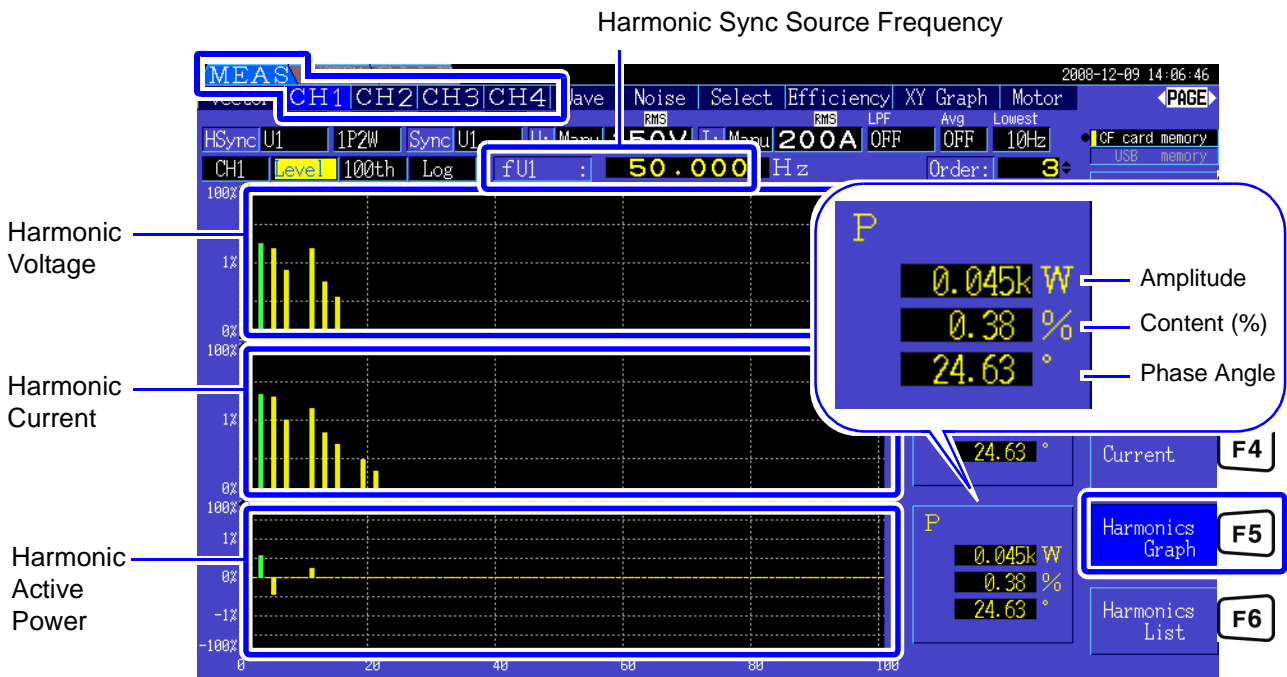
4.4 Viewing Harmonic Measurement Values

4.4.1 Displaying the Harmonic Bar Graph

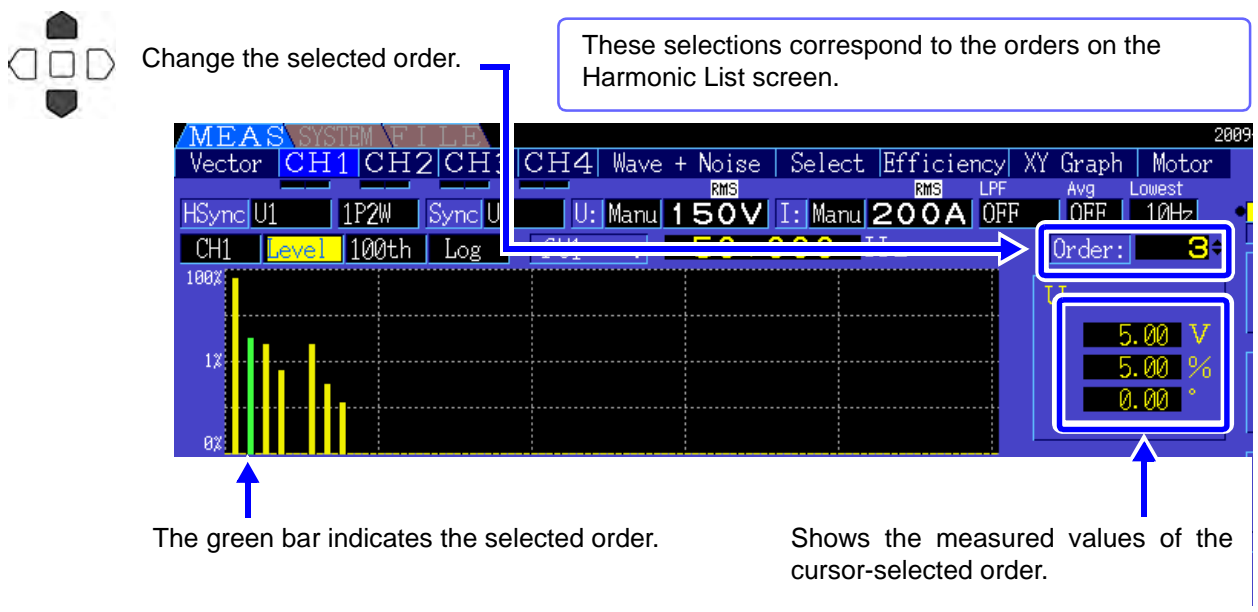
The results of harmonic analysis of voltage, current and active power on the same channel can be displayed as a bar graph. Numerical data for the cursor-selected order is also displayed.

Press **MEAS** to display the Measurement screen.

Press **◀ ▶** to select the desired **[CH]** page, and press **F5**.



Changing the Displayed Order



Changing Display Settings

Select the item

Displays the pull-down menu

Selects from the pull-down menu

Enter / Cancel

Channel Changes channels in the same wiring system.

(Example) In the 3P4W wiring

CH1, CH2, CH3, CH123

Display Contents Changes the display contents

Amplitude, Content, Phase angle

- The phase angle of harmonic active power is equivalent to the harmonic voltage-current phase difference.
- The scale of the vertical axis is a percentage of the range of the selected amplitude.
- This selection is the same as on the Harmonic List screen.

NOTE A gray bar may be displayed when phase angle is selected, indicating that the corresponding amplitude is very low (less than 0.01% f.s.).

Highest Order Display Changes the highest order displayed

100th order, 50h order, 25th order

This selection is the same as on the Harmonic List screen.

NOTE Depending on the sync frequency used for measurement, the specified maximum order may not be displayable.
 See "Highest order analysis" (p. 152)

Vertical Axis Display Type Changes the vertical axis display type.

| | |
|--------|---|
| Linear | Linear display |
| Log | Logarithmic display (allows easier viewing of small values) |

NOTE When the display content is phase angle, the **[Linear]** setting is fixed and cannot be changed.

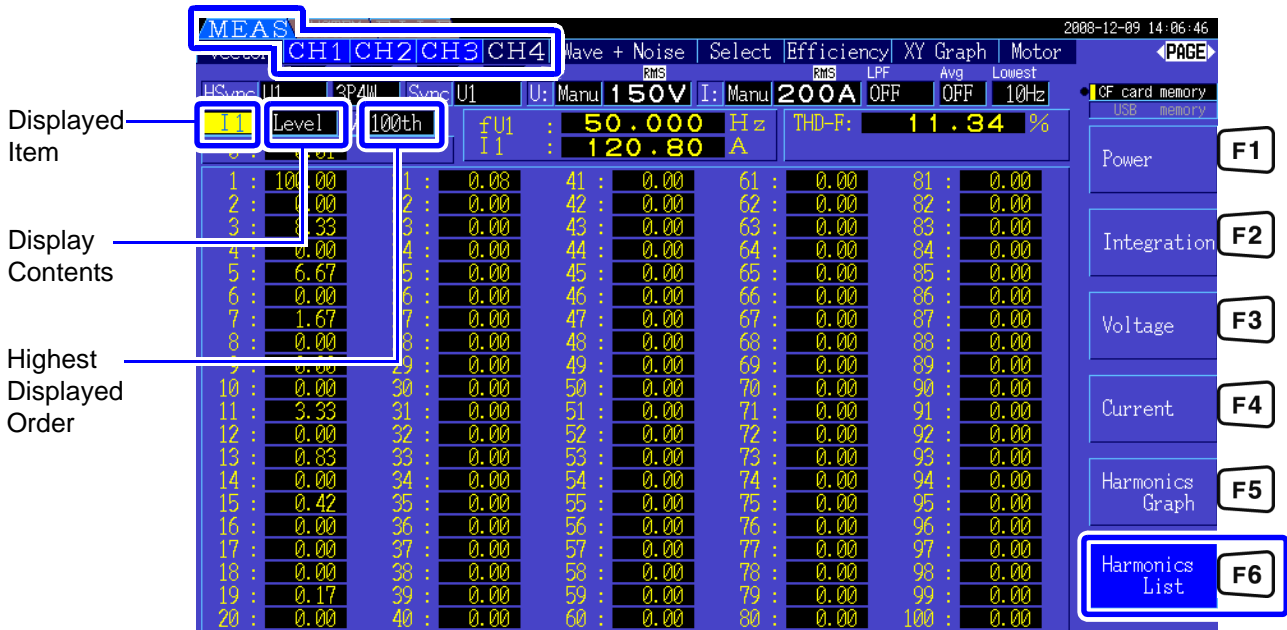
4.4 Viewing Harmonic Measurement Values

4.4.2 Displaying the Harmonic List

The results of harmonic analysis of voltage, current and active power on the same channel can be displayed as a list. Numerical data for the cursor-selected order is also displayed.

Press **MEAS** to display the Measurement screen.

Press **◀ ▶** to select the desired [CH] page, and press **F6**.



Changing Display Settings

See P.63 for the procedures to change the display settings.

Displayed Item Changes item (physical quantity) to be displayed. (Example) In the 3P4W wiring
 U1, I1, P1, U2, I2, P2, U3, I3, P3, P123

Display Contents Changes the highest order displayed
 Amplitude, content (%) and phase angle

- The phase angle of harmonic active power is equivalent to the harmonic voltage-current phase difference.
- This selection is the same as on the Harmonic Bar Graph screen.

Highest Displayed Order Changes the highest order displayed
 100th order, 50h order, 25th order

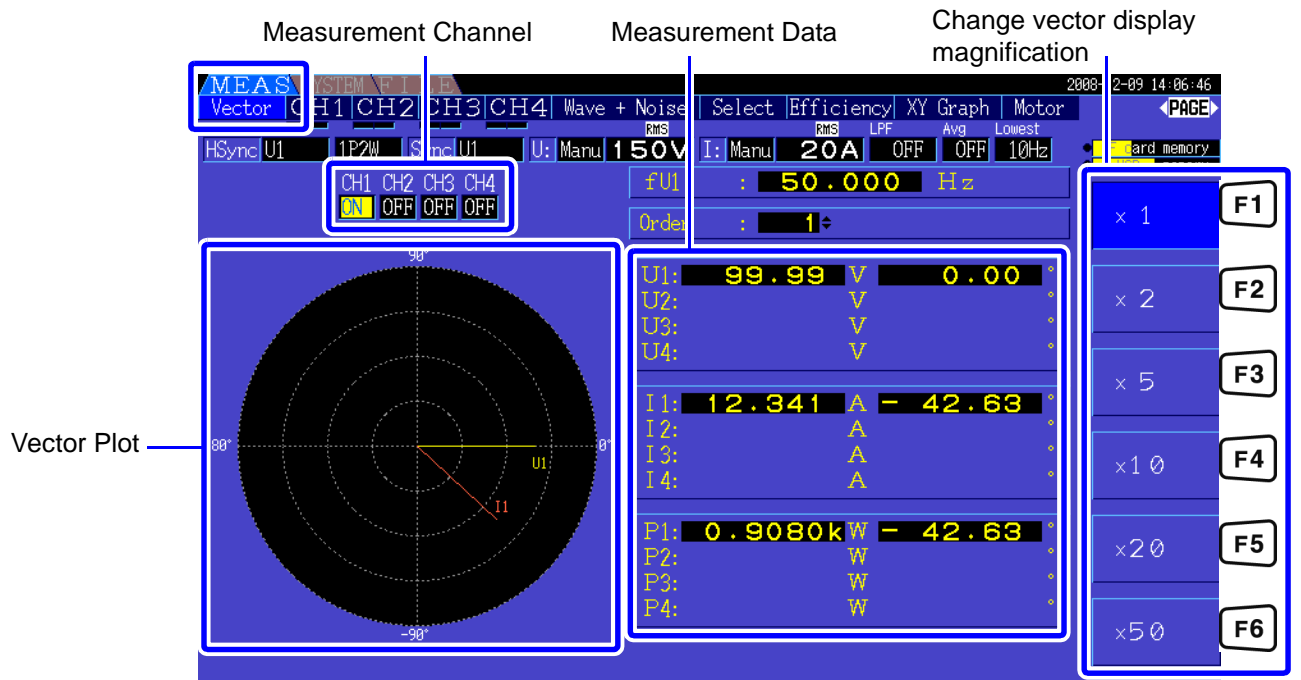
This selection is the same as on the Harmonic Bar Graph screen.

NOTE Depending on the sync frequency used for measurement, the specified maximum order may not be displayable.
 See "Highest order analysis" (p. 152)

4.4.3 Displaying Harmonic Vectors

The voltage, current, and phase angle of each harmonic order are displayed in a vector plot showing the phase relationship between voltage and current. Numerical values for the selected order are also displayed.

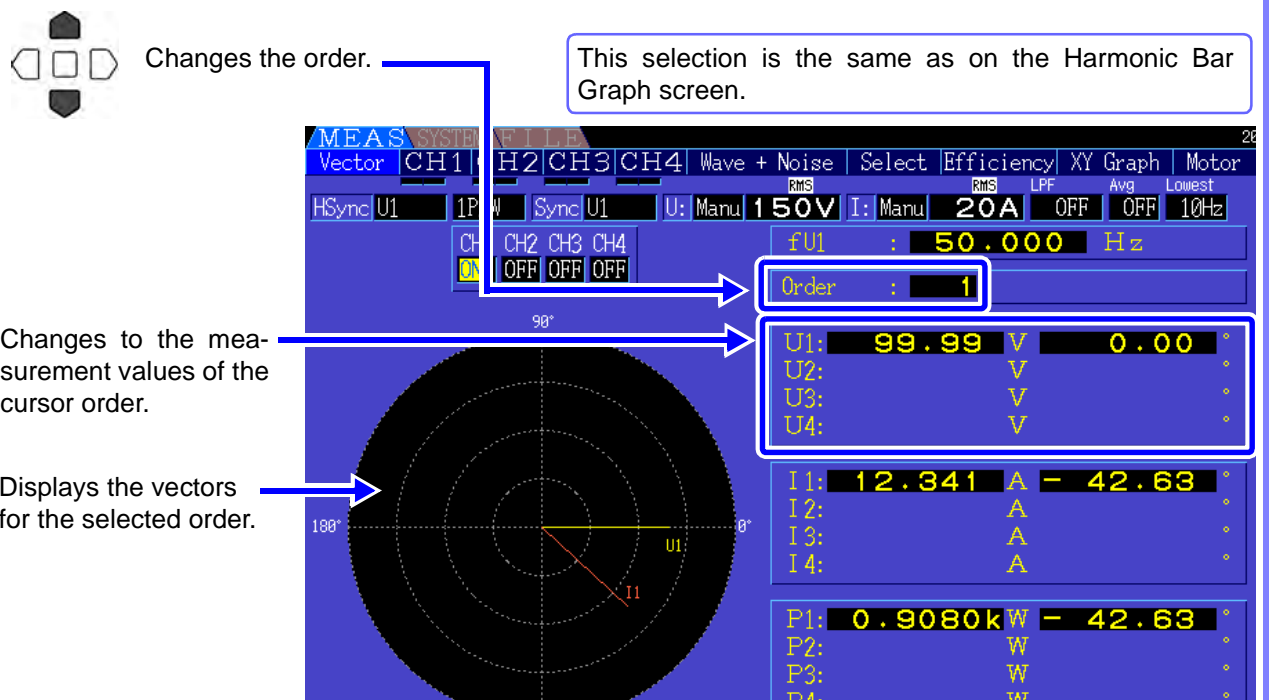
Press **MEAS** and then **◀** **▶** to select the [Vector] page.



NOTE

- Voltage and current for all channels are displayed on one screen.
- Voltage-current phase angles are determined relative to the (0°) standard of the fundamental waveform used as the harmonic sync source.
- The phase angle of harmonic active power is equivalent to the harmonic voltage-current phase difference of the same order on the same channel.

Changing the Displayed Order



4.4 Viewing Harmonic Measurement Values

Changing Display Settings

Select the item (channel)

Displays the pull-down menu

Selects from the pull-down menu

Enter / Cancel

Measurement Channel

Change the channels to be displayed. Setting channels that are not used to **[OFF]** can simplify the display.

| | |
|-----|---|
| ON | Vector and numerical values are displayed |
| OFF | Vector and numerical values are not displayed |

4.4.4 Selecting the Harmonic Sync Source

The [Harm sync src] has to be selected for harmonic analysis. Available selections depend on the input source.

- Using a measurement voltage or current input as the sync source

U1 to U4, I1 to I4

The frequency of the measurement voltage or current waveform is sampled for harmonic analysis synchronization.

For all channels, the (0°) reference point for all phase angle measurements is the fundamental waveform of the harmonic sync source.

- Using the instrument's internal fixed clock as the sync source

DC50 ms, DC100 ms

Waveforms are sampled in synchronization with the 50 ms timing used by the instrument for data update and for harmonic analysis. Use this source when no input is stable enough for synchronization. When DC100 ms is selected, 50 Hz is measured as the fifth-order harmonic, and 60 Hz as the sixth-order harmonic.

- Using an external signal as the sync source

Ext

This setting is available only when a Model 9791 Motor Testing Option or 9793 Motor Testing and D/A Output Option is installed and CH B is set for pulse input. Waveforms are sampled in synchronization with the rising edges of the pulses input on CH B to perform harmonic analysis.

See "4.8.1 Motor Input Settings" (p. 84)

SYSTEM

Display the [Input] page

Select the item

Select with the F keys

See About [Next].
"2.2 Basic Operations" (p. 16)

| Wiring | CH1 | CH2 | CH3 | CH4 |
|--------------|---------|------|-----|-------|
| sync source | DC 50ms | U2 | U3 | U4 |
| U range | 150V | 300V | 60V | 1500V |
| U rect | RMS | RMS | RMS | RMS |
| VT rate | OFF | OFF | OFF | OFF |
| I range | 200n | 00n | 20n | 200n |
| I rect | RMS | RMS | RMS | RMS |
| CT rate | OFF | OFF | OFF | OFF |
| LPF | OFF | OFF | OFF | OFF |
| Integ mode | DC | RMS | RMS | RMS |
| Freq measure | U | U | U | U |

U1 to U4, I1 to I4, DC50ms, DC100ms (or Ext) is selectable. Ext is selectable only when motor option is equipped and CHB input type is pulse.

NOTE

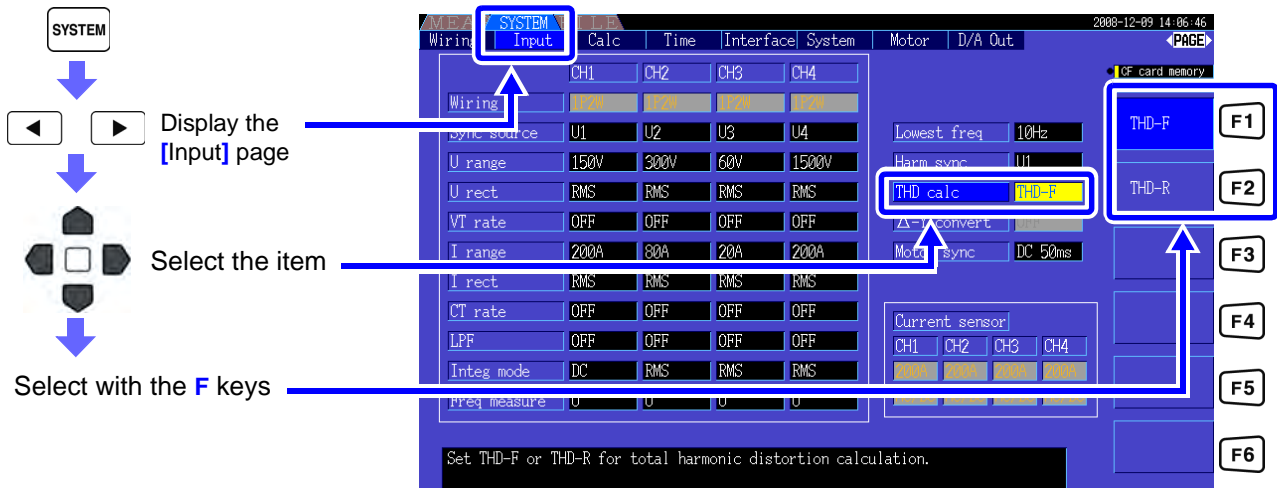
- The same harmonic sync source is shared by all channels. Harmonic analysis cannot be performed correctly on channels with input frequency different from the selected harmonic sync source.
- The harmonic sync source selected here is also used as the sync source for waveform displays.
- Correct analysis is not possible in the following situations:
 1. If the sync source signal is very distorted
 2. If the sync source signal frequency is below the lower limit of the valid range
 3. If the sync source frequency is unstable

4.4 Viewing Harmonic Measurement Values

4.4.5 Selecting the THD Calculation Method

Select whether to use THD-F or THD-R method to calculate total harmonic distortion. The selected calculation method is applicable to both harmonic voltage and current.

| | |
|-------|---|
| THD-F | The percentage of total harmonics relative to the fundamental waveform |
| THD-R | The percentage of total harmonics relative to the sum of the total harmonics and the fundamental waveform |



What is THD?
 THD is an abbreviation for total harmonic distortion: the total amount of signal distortion caused by all harmonics.

4.5 Viewing Waveforms

4.5.1 Displaying Waveforms

Waveforms of voltage and current measured on up to four channels can be displayed separately according to voltage, current, or channel.

Waveforms are sampled at 500 kS/s, with the displayed time span per screen determined by the timing of the harmonic sync source.

The waveform span displayed on one screen is determined by the [Time scale] setting.

Displaying Voltage and Current Waveforms Separately

Waveform Display Enable/Disable (p. 70)

Waveform color appears when enabled (ON).

| | | |
|-------------|---------|---------------------------|
| CH1 rms (V) | pk | Positive Peak Value (pk+) |
| 99.99 | 141.72 | |
| | -141.72 | Negative Peak Value (pk-) |
| | | RMS (rms) |

MEAS

Display the [Wave + Noise] page

F1 Select [U/I] (Current/Voltage)

U/I (F1)

CH (F2)

Noise (F3)

Wave+Noise (F4)

Save (F6)

Displaying Separate Channel Waveforms

F2 Select [CH] (Separate Channel)

Voltage Scale (Positive-only display)

Current Scale (Negative-only display)

Waveform Display Enable/Disable (p. 70)

Waveform color appears when enabled (ON).

| | | |
|-----------|---------|---------------------------|
| U rms (V) | pk | Positive Peak Value (pk+) |
| 99.99 | 141.64 | |
| | -141.69 | Negative Peak Value (pk-) |
| | | RMS (rms) |
| I rms (A) | pk | |
| 50.012 | 71.07 | |
| | -71.18 | |
| | | RMS (rms) |

MEAS

Vector CH1 CH2 CH3 CH4 Wave + Noise Select Efficiency XY Graph Motor

HSync U1 1P2W Sync U1 U: Manu 150V I: Manu 80A OFF OFF 10Hz

Time scale 4ms/div CH1 U x 1 I x 1

U rms (V) pk 141.64 -141.69

I rms (A) pk 71.07 -71.18

U rms (V) pk 0.4677k -0.4677k

I rms (A) pk 0.3554k -0.3558k

U rms (V) pk 0.0993k -0.0993k

I rms (A) pk 78.22 -78.30

U rms (V) pk 1.305k -1.305k

I rms (A) pk 28.42k -28.46k

U/I (F1)

CH (F2)

Noise (F3)

Wave+Noise (F4)

Save (F6)

4.5 Viewing Waveforms

NOTE

- Waveforms and numerical measurement values displayed at the right are not synchronized with measurement timing.
- Displayed waveform values are not the calculated RMS and peak numerical values.
- The vertical axis of the waveform is displayed as a percentage of the full-scale range of each channel, so the amplitudes of different channels are not directly comparable.
- To display waveforms starting from zero amplitude, see "Zero-Crossing Filter Setting Procedure" (p. 48).
- The waveform and noise display cannot be updated by pressing the HOLD key when the unit is under HOLD condition.

Hiding and Displaying Waveforms

Select whether to display or not display waveforms.
Available settings are [U/I] and [CH].

| | |
|-----|--------------------------|
| ON | Display waveforms |
| OFF | Do not display waveforms |

MEAS 2008-12-09 14:05:45

1|CH2|CH3|CH4| Wave + Noise | Select | Efficiency | XY Graph | Motor

HSync U1 1P2W Sync U1 U: Manu 150V I: Manu 80A OFF OFF 10Hz

Time scale 4ms/div CH1 U x 1 I x

CH1 rms (A) pk 71.03 -71.14

CH2 rms (A) pk 35.52 -35.56

CH3 rms (A) pk 17.76 -17.78

CH4 rms (A) pk 8.88 -8.89

U/I F1

CH F2

Noise F3

Wave+Noise F4

F5

Save F6

Select the channel to change

Displays the pull-down menu

Selects from the pull-down menu

Enter / Cancel

4.5.2 Resizing Waveforms

Waveforms can be reduced and enlarged for convenient viewing, and to confirm details. Make this setting using the cursor keys on the [Wave + Noise] page.

See "4.5.1 Displaying Waveforms" (p. 69)

Changing Vertical Axis Magnification

Voltage and current waveforms can be vertically resized (magnification is the same for all channels).

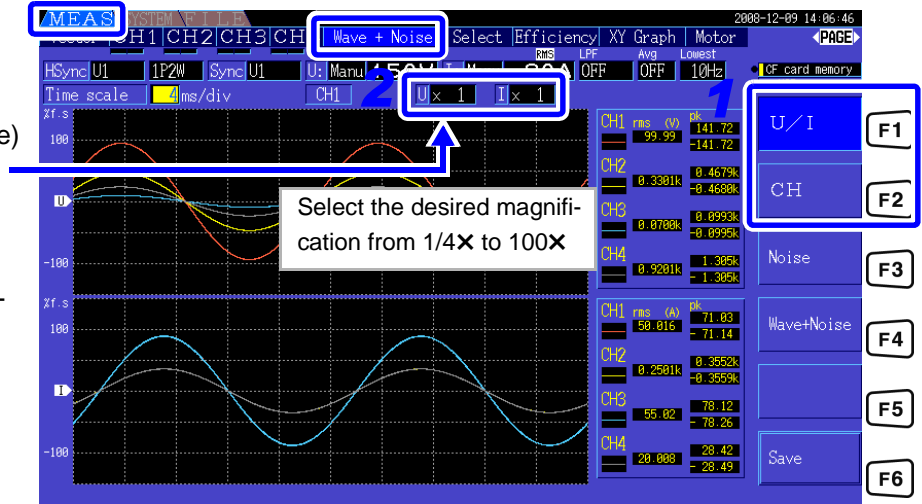
1 Press [F1] or [F2]

2 Select U (voltage) or I (current) for resizing

3 Displays the pull-down menu

Selects from the pull-down menu

Enter / [ESC / On] Cancel



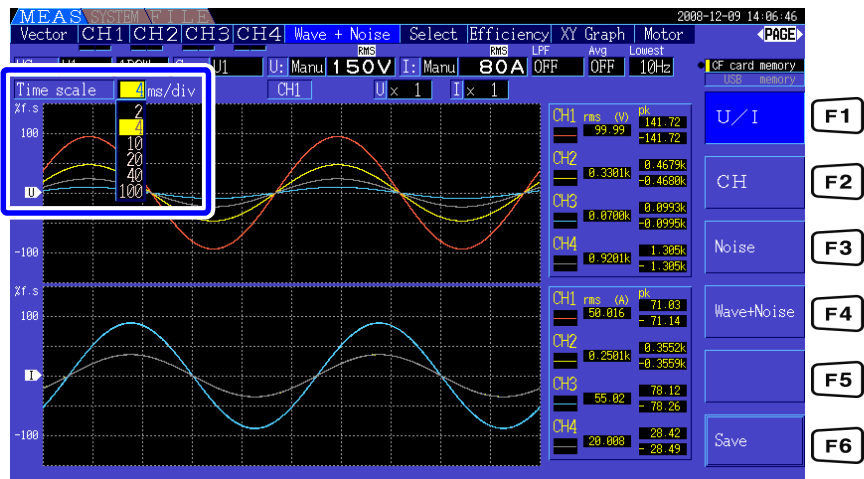
Changing Horizontal Axis Magnification (Timebase)

Select [Time scale]

Displays the pull-down menu

Selects from the pull-down menu
See Chart in below.

Enter / [ESC / On] Cancel



NOTE

- The waveform sampling rate is fixed at 500 kS/s.
- Available timebase selections depend on the selected number of noise analysis points, as follows.

| Selected No. of Points | Timebase Selections | | | | | |
|------------------------|---------------------|------------|-----------|------------|------------|------------|
| 1000 | 0.2 ms/div | 0.4 ms/div | 1 ms/div | 2 ms/div | 4 ms/div | 10 ms/div |
| 5000 | 1 ms/div | 2 ms/div | 5 ms/div | 10 ms/div | 20 ms/div | 50 ms/div |
| 10000 | 2 ms/div | 4 ms/div | 10 ms/div | 20 ms/div | 40 ms/div | 100 ms/div |
| 50000 | 10 ms/div | 20 ms/div | 50 ms/div | 100 ms/div | 200 ms/div | 500 ms/div |

4.6 Viewing Noise Measurement Values (FFT Function)

Perform FFT analysis on a selected channel's voltage and current to display noise up to 100 kHz as a graph and as numerical values. This function is convenient for monitoring an inverter's carrier frequency, harmonic noise ingress on commercial power lines, or DC power.

The numerical noise values can be saved to storage media.

See "7.6 Saving Waveform Data" (p. 114)

4.6.1 Displaying Noise Voltage and Current

Noise voltage and current can be displayed in separate graphs along with numerical values. Numerical noise voltage and current values at ten frequencies are displayed in order of decreasing amplitude.

| | |
|-----------------|-----------------------------------|
| Horizontal Axis | Linear frequency scale |
| Vertical Axis | Logarithmic noise amplitude scale |

Displaying Noise

MEAS

Display the [Wave + Noise] page

F3 Select [Noise]

Noise Voltage Numerical Value

| U | f (Hz) | rms (V) |
|---------|--------|---------|
| 7.4500k | 43.22 | |
| 7.6000k | 48.78 | |
| 14.450k | 28.30 | |
| 22.400k | 19.69 | |
| 15.150k | 18.49 | |
| 22.650k | 17.11 | |
| 37.400k | 16.39 | |
| 37.650k | 16.78 | |
| 7.2500k | 15.61 | |
| 7.7500k | 14.92 | |

Noise Voltage Graph

Noise Current Numerical Value

| I | f (Hz) | rms (A) |
|---------|--------|---------|
| 7.4500k | 0.8220 | |
| 7.5500k | 0.8183 | |
| 7.7500k | 0.8090 | |
| 7.2500k | 0.8089 | |
| 14.450k | 0.8097 | |
| 15.150k | 0.8095 | |
| 7.9500k | 0.8051 | |
| 7.0000k | 0.8045 | |
| 7.8500k | 0.8043 | |
| 22.650k | 0.8042 | |

Noise Current Graph

Displaying Waveforms and Noise

The waveform to be analyzed and its noise analysis results can be displayed at the same time.

MEAS

Display the [Wave + Noise] page

F4 Select [Wave + Noise]

Noise Voltage Numerical Value

| U | f (Hz) | rms (V) |
|---------|--------|---------|
| 7.6000k | 65.15 | |
| 7.4000k | 60.11 | |
| 15.050k | 31.29 | |
| 14.550k | 29.51 | |
| 22.700k | 21.99 | |
| 22.600k | 16.45 | |
| 22.300k | 16.38 | |
| 37.700k | 12.89 | |
| 22.400k | 18.77 | |
| 15.350k | 18.44 | |

Voltage and Current Waveforms

Voltage and Current Noise Graphs

Noise Current Numerical Value

| I | f (Hz) | rms (A) |
|---------|--------|---------|
| 7.6000k | 0.8277 | |
| 7.4000k | 0.8264 | |
| 15.050k | 0.8075 | |
| 14.550k | 0.8088 | |
| 22.700k | 0.8049 | |
| 15.150k | 0.8039 | |
| 2.5500k | 0.8039 | |
| 2.4500k | 0.8038 | |
| 22.600k | 0.8038 | |
| 7.9500k | 0.8037 | |

NOTE The waveform and noise display cannot be updated by pressing the HOLD key when the unit is under HOLD condition.

4.6.2 Setting the Sampling Frequency and Points

Set the FFT sampling rate and number of points according to the frequency of the noise to be analyzed. These settings are on the [Calc] page of the Setting screen.

SYSTEM

← → Display the [Calc] page

↑ Select the item

↓ Select with the F keys

MEAS SYSTEM 2008-12-09 14:06:46

Wiring Input **Calc** Time Interface System Motor D/A Out

Efficiency

Pin1 Pin2 P1 Pin3 P1

Pout1 P1 Pout2 P1 Pout3 P1

Noise analysis

Noise sampling 250k/s Points 10000 Lowest noise 1kHz

Analysis CH CH1 Window type Rect

Averaging OFF ZeroCross filt Weak AutoRange type Narrow

500k/s F1

250k/s F2

100k/s F3

50k/s F4

25k/s F5

10k/s F6

Set the sampling speed of noise analysis. Setting is limited by the lowest freq of noise. This affects freq resolution, freq range and time scale.

Sampling can be selected at the [Noise] setting on the [Wave + Noise] page of the Measurement screen. See How to display: "Displaying Noise" (p. 72)

Changing Sampling on the Measurement Screen See Screen display procedure: "Displaying Noise" (p. 72)

Select the item

Displays the pull-down menu

Selects from the pull-down menu

Enter / ESC Cancel

MEAS SYSTEM FILE

Vector CH1 CH2 CH3 CH4 Wave + Noise Select Efficiency

HSync U1 1P2W Sync U1 U: Manu 150V I: Manu 8A

Sampling 500k/s

100

10

1

0.1

0.01

4.6 Viewing Noise Measurement Values (FFT Function)

The highest frequency that can be analyzed depends on the sampling setting as follows.

| Sampling Rate | 500 kS/s | 250 kS/s | 100 kS/s | 50 kS/s | 25 kS/s | 10 kS/s |
|-------------------|----------|----------|----------|---------|---------|---------|
| Highest Frequency | 100 kHz | 50 kHz | 20 kHz | 10 kHz | 5 kHz | 2 kHz |

Also, the frequency resolution of noise analysis depends on the sampling rate setting and the number of points.

| Sampling Rate | 500 kS/s | 250 kS/s | 100 kS/s | 50 kS/s | 25 kS/s | 10 kS/s |
|---------------|----------|----------|----------|---------|---------|---------|
| Points | 500 Hz | 250 Hz | 100 Hz | 50 Hz | 25 Hz | 10 Hz |
| 1000 | 100 Hz | 50 Hz | 20 Hz | 10 Hz | 5 Hz | 2 Hz |
| 5000 | 50 Hz | 25 Hz | 10 Hz | 5 Hz | 2.5 Hz | 1 Hz |
| 10000 | 10 Hz | 5 Hz | 2 Hz | 1 Hz | 0.5 Hz | 0.2 Hz |

NOTE

- The instrument's internal anti-aliasing filter is set automatically according to the sampling setting, so that aliasing effects are suppressed even at slow sampling rates.
- Changing the sampling rate does not affect power measurements or the measurement frequency range of harmonic measurements.
- Noise analysis display updating is not linked to other measurement data such as power or harmonics.
Data saving is not synchronized with saving of power or harmonic data.
- The number of points determines the amount of time required for analysis, so larger numbers of points result in slower update times. Updating 1,000 points takes approximately 400 ms, 5,000 points approximately 1 s, 10,000 points approximately 2 s, and 50,000 points approximately 15 s.
- To analyze noise frequency details, select fast sampling or a large number of points (e.g., to analyze the difference between 50 and 60 Hz, select a frequency resolution of 10 Hz or less).
- The sampling rate setting is linked to the waveform timebase display setting.

4.6.3 Setting the Minimum Noise Frequency

Set the minimum acquisition frequency for numerical noise values according to the noise frequency to be analyzed. The lower limit can be set from 0 Hz to 10 kHz in 1-kHz steps. The setting applies to both [Noise] and [Wave + Noise]. Make this setting on the [Calc] page of the Setting screen.

Setting on the Measurement Screen

See Screen display procedure: "4.6.1 Displaying Noise Voltage and Current" (p. 72)

The screenshot shows the instrument's measurement screen with the following elements:

- Top Bar:** MEAS, Vector, CH1|CH2|CH3|CH4, Wave + Noise, Select, Efficiency, XY Graph, Motor, 2009-03-16 21:42:35, PAGE.
- Parameters:** HSync U1, 1P2W, Sync U1, U: Manu 150V, I: Manu 10A, LPF, Avg, Lowest.
- Time scale:** 2ms/div, CH, U, I.
- Plots:** Two FFT plots. The top plot is for voltage (U) and the bottom plot is for current (I). Both plots show a peak at approximately 50 kHz.
- Right Panel:** U/I, CH, Noise, Wave+Noise, Save, F1, F2, F3, F4, F5, F6.
- Left Panel:** Navigation instructions: Select [Lowest Noise], Enter, Select the numerical value, Enter / ESC Cancel.
- Setting:** A blue box highlights 'Lowest noise' in the right panel, with a blue arrow pointing to it from the left.

4.6 Viewing Noise Measurement Values (FFT Function)

Settings on the Setting Screen

SYSTEM

← → Display the [Calc] page

Select the item

Select with the F keys

MEAS SYSTEM 2008-12-09 14:06:46

Wiring Input **Calc** Time Interface System Motor D/A Out

Efficiency

Pin2 P1 Pin3 P1

Pout1 P1 Pout2 P1 Pout3 P1

Noise analysis

Lowest noise 1kHz

Analysis CH CH1 Window type Rect

Averaging OFF ZeroCross filt Weak AutoRange type Narrow

f ↑ F1

f ↓ F2

F3

F4

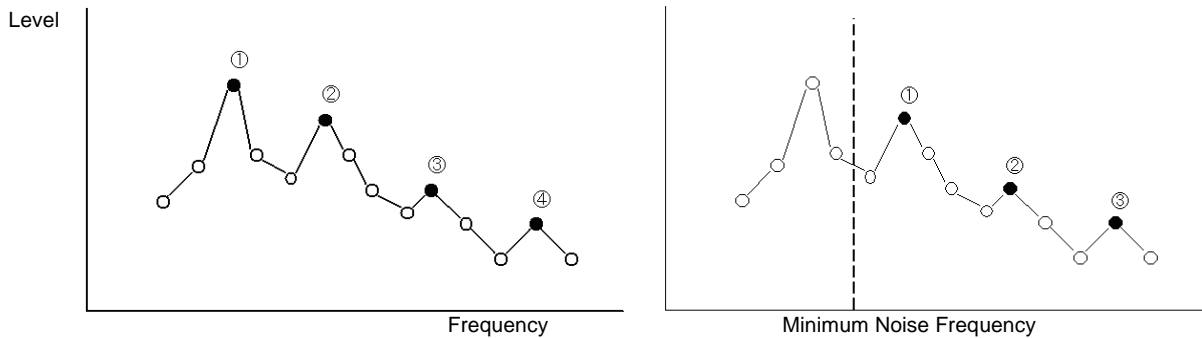
F5

F6

CF card memory

Set the lowest frequency of noise peak search between 0kHz and 10kHz. This setting is limited by the sampling speed of noise.

A numerical noise value is recognized as a peak value when its amplitude is greater than the levels of the next lower- and higher-frequency points in voltage and current FFT calculation results, and the ten highest peak values are acquired. In this case, frequencies below the set minimum noise frequency are ignored.



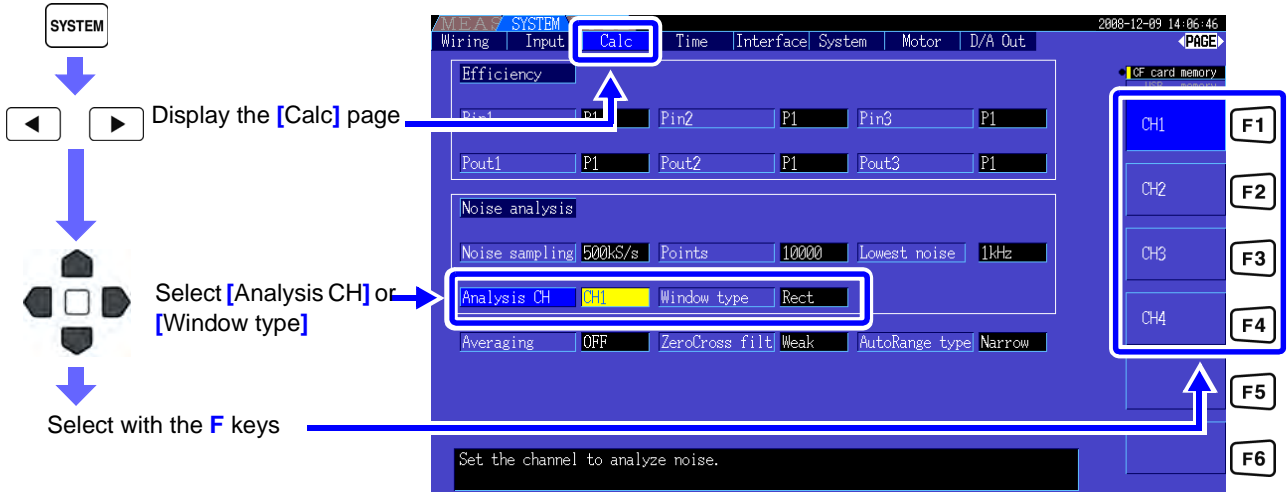
NOTE

The range of available settings for the minimum noise frequency depends on the noise sampling rate setting.

| Noise Sampling Rate | 500 kS/s | 250 kS/s | 100 kS/s | 50 kS/s | 25 kS/s | 10 kS/s |
|-------------------------|-------------|----------|----------|------------|------------|------------|
| Minimum Noise Frequency | 0 to 10 kHz | | | 0 to 9 kHz | 0 to 4 kHz | 0 to 1 kHz |

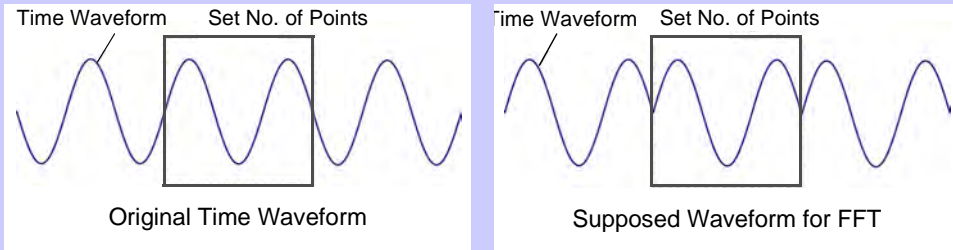
4.6.4 Measurement Channel and Window Function Settings

Select the measurement channels and Window function for noise analysis calculations.



What is a Window type?

Noise analysis is performed by applying FFT calculations to a specific interval of a waveform defined by the specified number of points at the specified sampling rate. The processing of an extracted interval of a waveform is called "Window processing." The FFT calculation of the specified waveform interval is supposed to be repeated periodically. On this instrument, the displayed waveform is shown with the defined window.



When the number of points specified for FFT calculation does not coincide with the measurement waveform period, the edges of the waveform within the window become discontinuous (called "leakage errors"), and non-existent noise is detected. The Window type provide means of suppressing leakage errors by smoothly connecting the edges of the waveforms.

Measurement Ch Select the measurement channel for noise analysis calculations.

CH1, CH2, CH3, CH4

Window type Select a Window type.

| | |
|-------------|--|
| Rectangular | This type of window function is effective when the measurement waveform period is an integer multiple of the FFT calculation interval. |
| Hann | This type of window function is effective when the rectangular window is not, and when frequency resolution is the primary concern. |
| Flat-Top | This type of window function is effective when the rectangular window is not, and when amplitude resolution is the primary concern. |

4.7 Viewing Efficiency and Loss Measurement Values

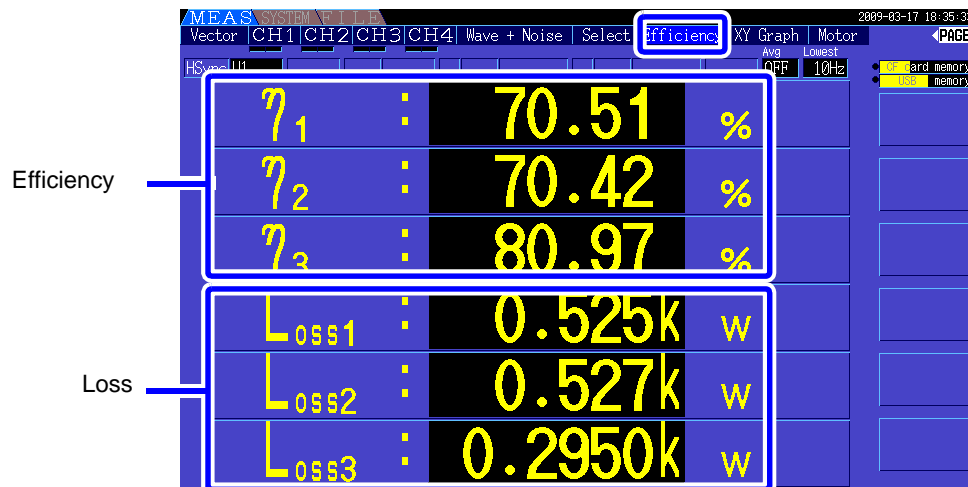
This instrument uses active power and motor power values to calculate and display efficiency (η [%]) and loss [W]. For example, inverter input-output efficiency and internal loss, and motor input-output efficient and loss, as well as total efficiency, can be calculated by a single instrument.

NOTE

- Motor power (Pm) measurement requires the Model 9791 Motor Testing Option or the 9793 Motor Testing & D/A Output Option.
- Measurement values may be scattered when measuring severely fluctuating or transient loads.
- On wiring systems with different power ranges, calculations use the data from the highest power range.
- On wiring system with different sync sources, calculations use the most recent data at calculation time.

4.7.1 Displaying Efficiency and Loss

Press **MEAS** and then **◀** **▶** to select the **[Efficiency]** page.



NOTE

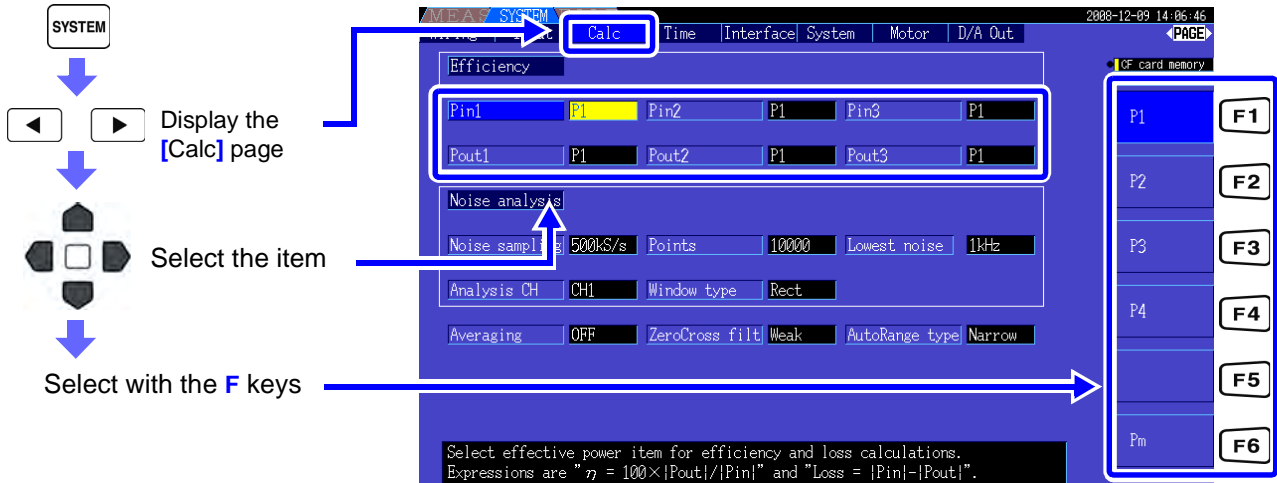
- The display range for Efficiency (η [%]) is 0.00% to 200.00%.
- The display range for Loss [W] is 0 to $\pm 120\%$ of the power range.

4.7.2 Selecting the Calculation Formula

Up to three formulas (η_1 to η_3 , and Loss1 to Loss3) can be selected for Efficiency (η) and Loss calculations. Select the calculation items from all Pin and Pout active power values to be applied to the following formulas.

$$\eta = 100 \times |Pout|/|Pin|$$

$$Loss = |Pin| - |Pout|$$



NOTE [Pm] can be selected when the Model 9791 or 9793 Motor Testing Option is installed, and with the following settings.

| | |
|------------|-----------------|
| CH A units | mN•m, N•m, kN•m |
| CH B units | r/min |

4.7.3 Measurement Examples

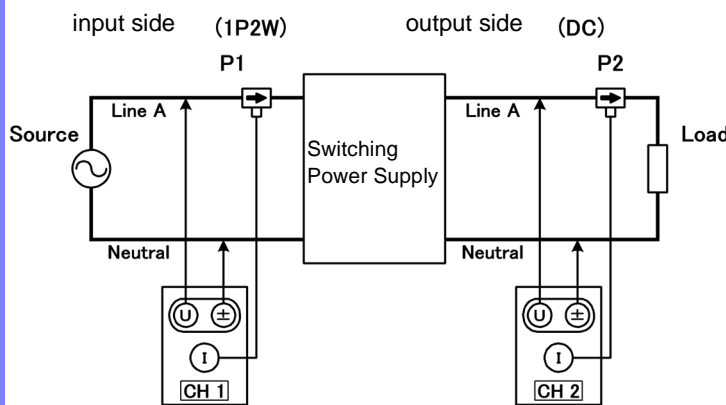
Here is an efficiency and loss measurement example.

Before measuring, perform the preparations in "Chapter 3 Measurement Preparations" (p. 23)), and make the appropriate connections and settings.

Measuring Efficiency and Loss of a Switching Power Supply

Example. The input and output sides of the switching power supply are connected to CH 1 and CH 2 of the instrument, respectively.

Connection Example

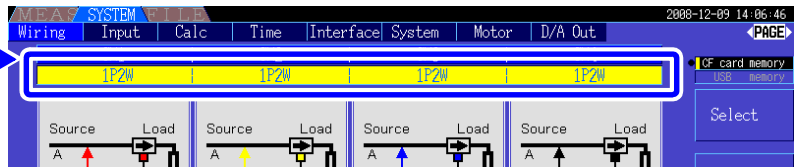


Required items:

- L9438-50 Voltage Cord(2)
- 9272-10 Clamp On Sensor(1)input side
- 9277 Universal Clamp On CT (1) .output side

Wiring Mode Setting

Wiring Mode 1
[1P2W] x 4 systems



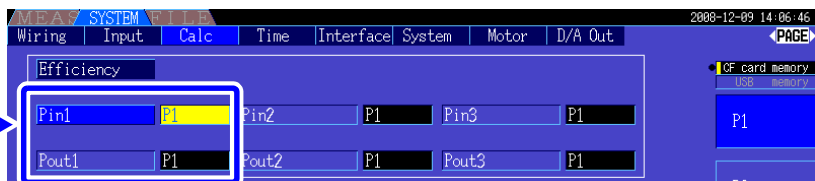
Calculation Formula Setting

Calculation Formula

$$\eta_1 = 100 \times |P2|/|P1|$$

$$\text{Loss1} = |P1| - |P2|$$

Set Pin1 to P1,
and Pout1 to P2

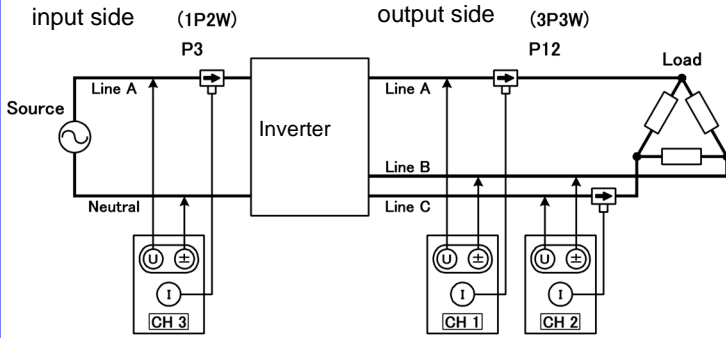


4.7 Viewing Efficiency and Loss Measurement Values

Measuring Efficiency and Loss of an Inverter

Example. Inverter input is connected to CH 3, and the outputs are connected to CH 1 and CH 2 of the instrument.

Connection Example

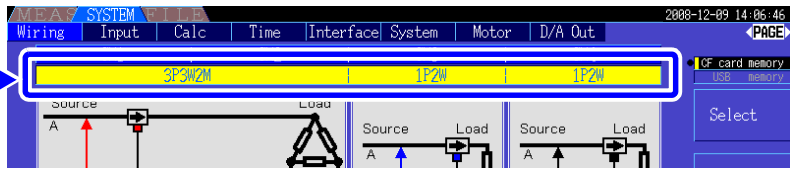


Required items:

- L9438-50 Voltage Cord(2)
- 9272-10 Clamp On Sensor(1).....input side
- 9278 Clamp On Sensor (2).....output side

Wiring Mode Setting

Wiring Mode 3
[3P3W2M] + [1P2W] x 2 systems



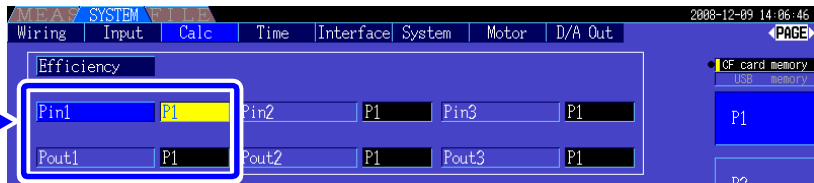
Calculation Formula Setting

Calculation Formula

$$\eta_1 = 100 \times |P12|/|P3|$$

$$\text{Loss}_1 = |P3| - |P12|$$

Set Pin1 to P3,
and Pout1 to P12



Measuring Efficiency and Loss of an Inverter and Motor

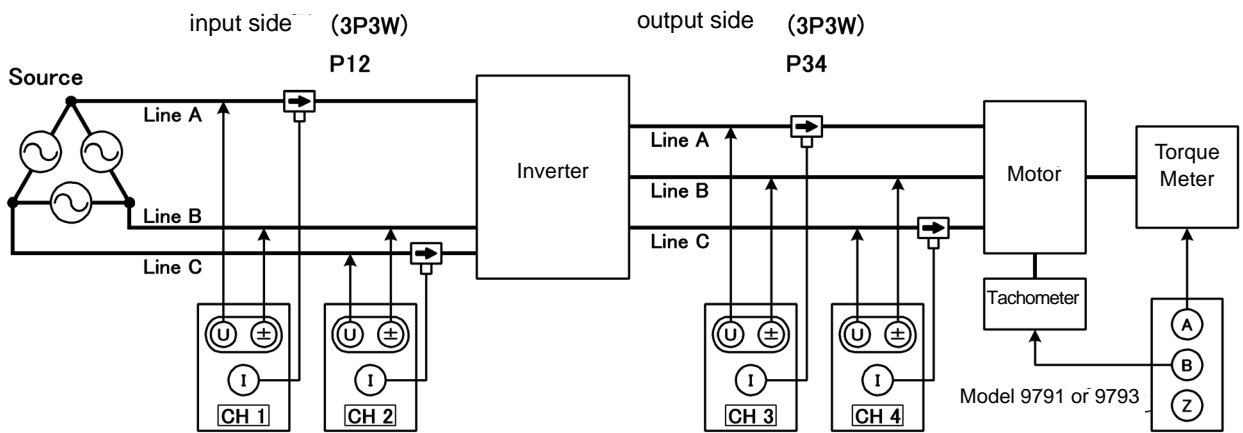
Example. Inverter inputs are connected to CH 1 and CH 2, inverter outputs to CH 3 and CH 4 of the instrument, analog output from the tachometer to rotation signal input CH B, and analog output from the torque meter to torque signal input CH A.

See How to connect torque meter or tachometer: 8.5 (p.138)

Connection Example

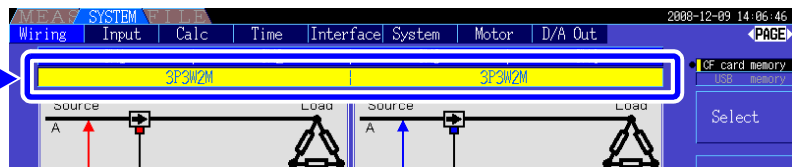
Required items:(Requires Model 9791 Motor Testing Option or 9793 Motor Testing & D/A Output Option)

- L9438-50 Voltage Cord(4)
- 9272-10 Clamp On Sensor(2).....input side
- 9709 AC/DC Current Sensor (2)output side
- Tachometer(1).....With pulse output capability
- Torque Meter(1)
- L9217 Connection Cord(2)



Wiring Mode Setting

Wiring Mode 6
[3P3W2M] x 2 systems



Calculation Formula Setting

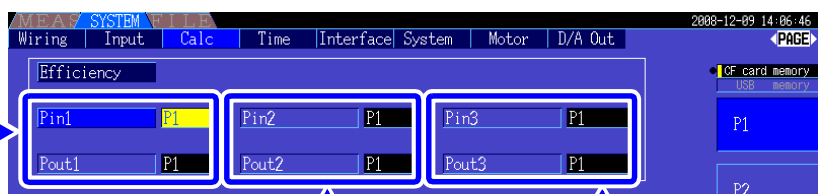
Calculation Formula

Inverter $\eta_1 = 100 \times |P34|/|P12|$, Loss1 = $|P12| - |P34|$

Motor $\eta_2 = 100 \times |Pm|/|P34|$, Loss2 = $|P34| - |Pm|$

Total $\eta_3 = 100 \times |Pm|/|P12|$, Loss3 = $|P12| - |Pm|$

Set Pin1 to P12,
and Pout1 to P34



Set Pin2 to P34,
and Pout2 to Pm

Set Pin3 to P12,
and Pout3 to Pm

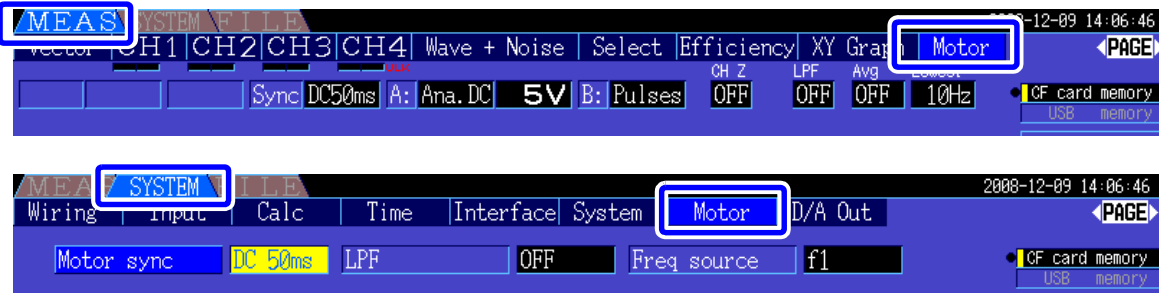
NOTE

The torque meter and tachometer should have the fastest possible output response time.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

Motor analysis is available when the Model 9791 Motor Testing Option or 9793 Motor Testing & D/A Output Option (afterwards called the motor analysis function) is installed.

When the motor analysis function is installed, the [Motor] page appears on the Measurement and Setting screens.

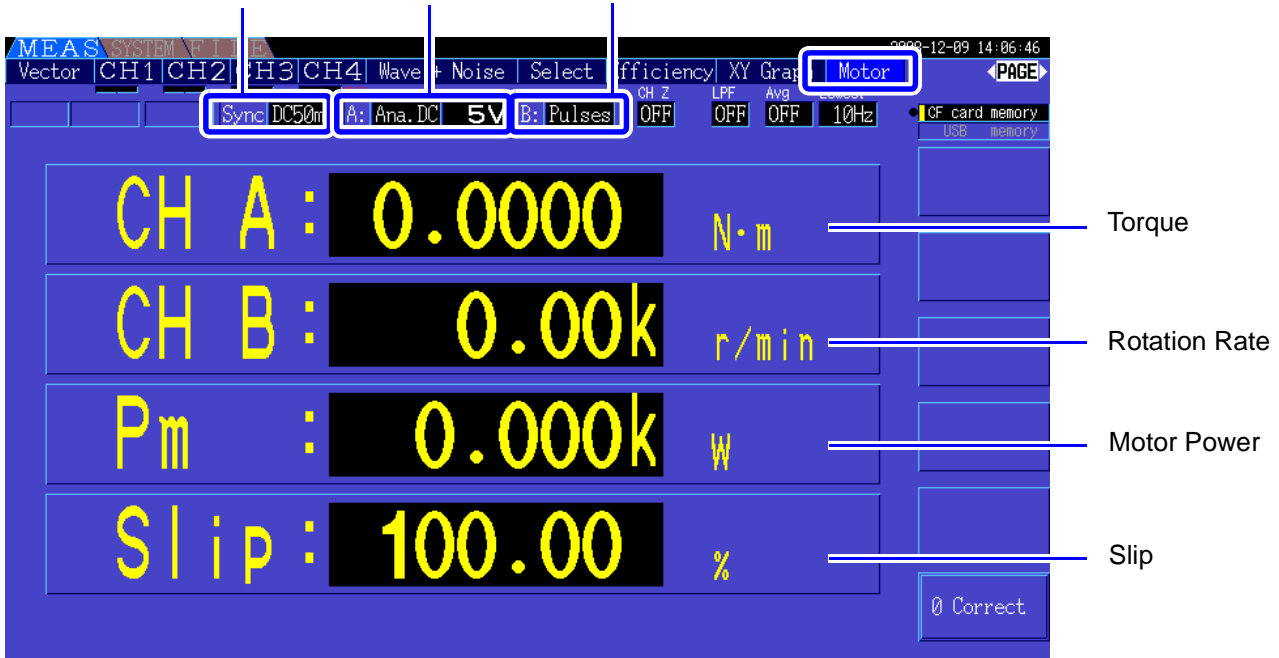


The motor analysis function acquires signals from rotation-sensing devices such as a torque sensor and rotary encoder and measures motor analysis items (torque, rotation rate, motor power and slip). Motor efficiency, total efficiency and loss can be calculated when combined with the "4.7 Viewing Efficiency and Loss Measurement Values" (p. 77) functions.

Setting the Motor Sync Source

Press [MEAS] and then [Left Arrow] [Right Arrow] to select the [Motor] page.

Motor Sync Source Setting CH A Range Setting CH B Range Setting



See Motor measurements can be displayed simultaneously with motor input voltage and current, power measurements and motor efficiency. "Selecting Measured Items for Display" (p. 38)

- NOTE**
- When [CH A] measurement units are set to [V] and [Hz], or [CH B] units are set to other than [r/min], motor power [P_m] display is always disabled ("OFF").
 - When [CH B] measurement units are set to [V], slip cannot be calculated, and [- - - - -] is displayed.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

Executing Zero Adjustment

Execute zero adjustment to compensate for input signal bias before measuring analog DC voltage on CH A or CH B.

If a non-zero value is displayed for torque or rotation rate when no torque or rotation is occurring, execute zero adjustment before applying any torque or rotation input.



NOTE

- This particular zero adjustment function applies only to the motor analysis options, so the other input channels (CH 1 to CH 4) are unaffected. To execute zero adjustment on those channels, see section "3.10 Attaching to the Lines to be Measured and Zero Adjustment" (p. 34).
- Zero adjustment is only applicable to analog DC input channels.
- The maximum zero adjustment span is $\pm 10\%$ of the full-scale range, outside of which no adjustment occurs.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

4.8.1 Motor Input Settings

Set to suit the motor to be measured, or the connected torque sensor or tachometer.

See "8.5 Using the Motor Testing Option (when specified before factory shipping, for motor analysis)" (p. 138)

Basic Operating Procedure

The diagram shows the Motor Input Settings screen with the following sections and navigation instructions:

- Motor Sync Source:** Motor sync is set to DC 50ms.
- Low-Pass Filter:** LPF is set to OFF.
- Input Frequency Source:** Freq source is set to f1.
- CHA (Torque input setting):** CHA input is AnalogDC, CHA range is 5V, CHA scaling is 0001.00, CHA unit is N·m, Rated torque is blank.
- CHB (Revolution signal input setting):** CHB input is Pulses, CHB range is blank, CHB scaling is blank, CHB unit is r/min, Max frequency is 5kHz, No. of pulses is 2, Motor poles is 4 CHZ.

Navigation instructions:

- Press **SYSTEM** to display the [Motor] page.
- Use the left and right arrow keys to select the item.
- Press the **F** keys (F1-F6) to select with the F keys.

Selecting the Motor Sync Source

Select the source of the signal that determines the period to serve as the basis for motor analysis calculations. Motor analysis items are measured according to the period of the source selected here.

U1, U4, I1, I4, DC50 ms (Default setting), DC100 ms, Ext

See "4.2.3 Selecting the Sync Source" (p. 47)

The selected motor sync source is displayed as **[Sync]** on the Motor screen.

NOTE

- All motor analysis items depend on the same sync source.
- When measuring motor efficiency in combination with the functions of section "4.7 Viewing Efficiency and Loss Measurement Values" (p. 77), select the same sync source as that of the motor voltage and current input channels. Optimum measurement accuracy is possible when the calculation periods are the same.
- [Ext]** is only selectable when CH B is set for pulse input.

Low-Pass Filter (LPF) Settings

When CH A or CH B is set for Analog DC input, enable the filter to suppress harmonic noise. Measurements should normally be made with the filter disabled (OFF), but it should be enabled (ON) when measurement values are destabilized by the effects of external electrical noise.

ON, OFF (Default setting)

NOTE

- The LPF setting is the same for CH A and CH B. Independent setting is not available.
- When CH A is set for frequency input and CH B is set for pulse input, the LPF setting has no effect.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

Selecting the Input Frequency Reference Source

To calculate motor slip, select a reference source for measuring the motor input frequency.

f1, f2, f3, f4

See "4.2.4 Frequency Measurement Settings" (p. 49)

Slip Calculation Formula

| CH B Measurement Units | Calculation Formula |
|------------------------|---|
| When [Hz] | $100 \times \frac{\text{Input Frequency} - \text{CH B Display Value}}{\text{Input Frequency}}$ |
| When [r/min] | $100 \times \frac{2 \times 60 \times \text{Input Frequency} - \text{CH B Display Value} \times \text{Set No. of Poles}}{2 \times 60 \times \text{Input Frequency}}$ |

NOTE

- To calculate slip, set CH B to suit the rotation input signal.
- As the input frequency, select the most stable signal from the voltage and current supplied to the motor.

Setting Torque Input (CH A)

Select the type of input signal from the torque sensor connected to CH A.

CHA input

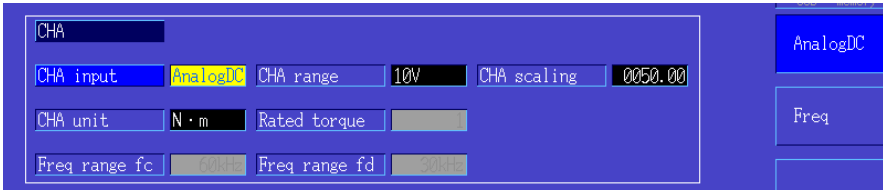
| | |
|----------|---|
| AnalogDC | When the sensor outputs a DC voltage proportional to the torque |
| Freq | When the sensor outputs a frequency proportional to the torque |

Available setting items depend on the state of the following settings.

When [AnalogDC] is selected

When [CHA input] is set to [AnalogDC], set these three items to suit the sensor: [CHA range], [CHA scaling], and [CHA unit].

Example. When the rated torque is 500N·m and the torque sensor's output range is ±10 V.



| | |
|-------------|------|
| CHA range | 10 V |
| CHA scaling | 50 |
| CHA unit | N·m |

CHA range Select to suit the output voltage of the torque sensor.

1 V Range, 5 V Range, 10 V Range,

NOTE

The CH A range can be selected with the voltage range keys from the Motor page of the Measurement screen.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

CHA scaling Settable from 0.01 to 9999.99.
 The measurement value displayed for CH A = CH A input voltage × CH A scaling value.
 Set [CHA unit] according to the torque value that corresponds to one volt of torque sensor output.
 (Scaling value = max. rated torque of sensor ÷ output scale voltage value)
 In this example, the scaling value is 50.
 (50 = 500 N•m ÷ 10)

| | |
|----------------|------|
| +1, -1 | 10 V |
| Digit←, Digit→ | 50 |

CHA unit Set to suit the torque sensor.

| | |
|------|---|
| V | Select to display raw input voltage. |
| mN•m | Select this for torque sensors rated at 1 mN•m to 999 mN•m per volt output. |
| N•m | Select this for torque sensors rated at 1 N•m to 999 N•m per volt output. |
| kN•m | Select this for torque sensors rated at 1 kN•m to 999 kN•m per volt output. |

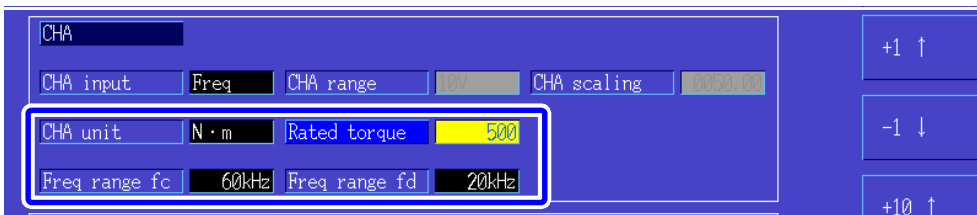
NOTE When CH A units are set to [V], motor power [Pm] is not displayed.

When [Freq] is selected

When [CHA input] is set to [Freq], make these four settings to suit the sensor: [CHA unit], [Rated torque], [Freq range fc], and [Freq range fd].

Example 1. Using a torque sensor rated at 500 N•m for an output span of 60 kHz ±20 kHz

| | |
|---------------|--------|
| CHA unit | N•m |
| Rated torque | 500 |
| Freq range fc | 60 kHz |
| Freq range fd | 20 kHz |



Example 2. Using a torque sensor rated at 2 kN•m, with maximum positive rated torque providing 15 kHz output, and maximum negative rated torque providing 5 kHz output

| | |
|---------------|--------|
| CHA unit | kN•m |
| Rated torque | 2 |
| Freq range fc | 10 kHz |
| Freq range fd | 5 kHz |

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

CHA unit Set to suit the connected torque sensor.

Hz, mN•m, N•m, kN•m

NOTE

- When CH A units are set to [Hz], motor power [Pm] is not displayed.
- Select fc+fd for frequencies below 100 kHz, and fc-fd for frequencies above 1 kHz. Setting beyond the numerical value limits is not possible.

Rated torque Enter an integer from 1 to 999. Set the maximum rated torque of the torque sensor in the corresponding CH A units.

Freq range fc Set a value between 1 kHz to 100 kHz in 1 kHz steps.

Freq range fd Set fc to the center frequency corresponding to zero torque, and set fd to the frequency corresponding to maximum rated torque.

Setting the Rotation Signal Input (CH B)

Select the type of rotation signal to be applied to CH B

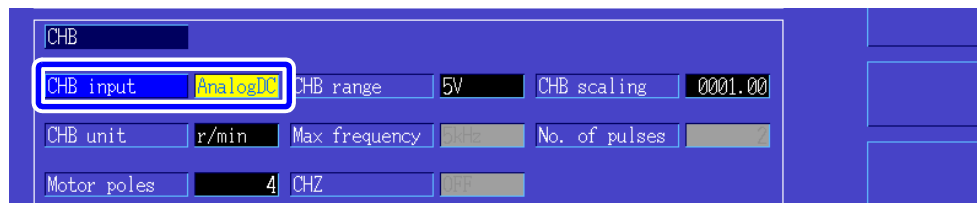
CHB input

| | |
|-----------|---|
| Analog DC | For DC voltage proportional to the rotation rate |
| Pulse | For pulse signals proportional to the rotation rate |

Available setting items depend on the state of the following settings.

When [Analog DC] is selected

When [CHB input] is set to [AnalogDC], set these three items to suit the rotation signal: [CHB range], [CHB scaling], and [CHB unit].



CHB range Select to suit the applied rotation signal voltage input.

1 V, 5 V, 10 V

CHB scaling Settable from 0.01 to 9999.99. The measurement value displayed for CH B = CH B input voltage × CH B scaling value. Set [CH B Units] according to the rotation rate that corresponds to one volt of rotation signal.

CHB unit Always select r/min when measuring motor power (Pm).

V, Hz, r/min

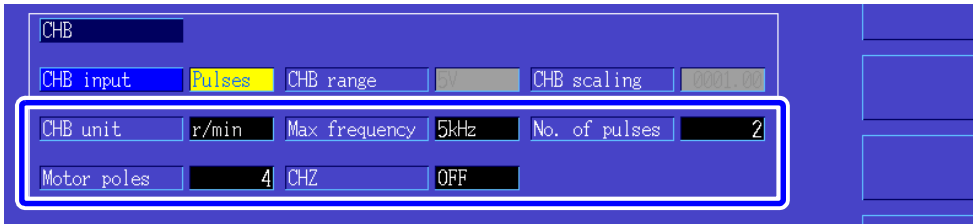
NOTE

- The CH B range can be selected with the current range keys from the Motor page of the Measurement screen.
- Set the number of motor poles when measuring the slip.(p. 88)

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

When [Pulses] is selected

When [CHB input] is set to [Pulses], make these five settings to suit the rotation signal: [CHB unit], [Max frequency], [No. of pulses], [Motor poles], and [CHZ].



CHB unit Always select [r/min] when measuring motor power (Pm).

Hz, r/min

NOTE

The measurement range when CH B units are set to Hz is 0.5 Hz to 5 kHz.

Measurement values are calculated as $\frac{\text{No. of Poles} \times \text{Pulse Input Frequency}}{2 \times \text{Pulse Count Setting}}$

When the pulse signal input frequency is higher than the measurement range, set the appropriate pulse count.

Max frequency Determine the full-scale measurement value for CH B.
(When CH B is set for D/A Output, this setting is the full-scale value.)

100 Hz, 500 Hz, 1 kHz, 5 kHz

Pulse Count Set the number of pulses per mechanical rotation, from 1 to 60,000.
Available setting values are multiples of half the number of motor poles.
(For a incremental type rotary encoder that provides 1000 pulses per rotation, set to 1000.)

| | |
|---|--|
| +1/2 the number of motor poles, -1/2 the number of motor poles | Increment or decrement by 1/2 the number of motor poles. |
| +1/2 × 10 times the number of motor poles, -1/2 × 10 times the number of motor poles | Increment or decrement by 1/2 × 10 times the number of motor poles. |
| +1/2 × 100 times the number of motor poles, -1/2 × 100 times the number of motor poles | Increment or decrement by 1/2 × 100 times the number of motor poles. |

No. of Motor Poles Set the number of motor poles as an even number between 2 and 98.
(The slip calculation and the rotation signal input as the frequency corresponding to the mechanical rotation angle are converted to the frequency corresponding to the electrical angle.)

| | |
|----------|-------------------------------|
| +2, -2 | Increment or decrement by 2. |
| +10, -10 | Increment or decrement by 10. |

NOTE

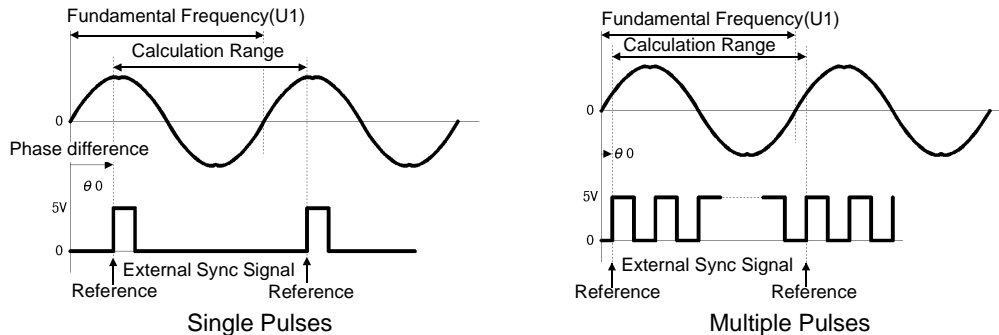
- The motor pole setting is enabled by pressing **F5** (Set). Be sure to press **F5** (Set) after changing the setting.
- When using pulse synchronization with an electrical angle (motor input voltage, or the same frequency as the current frequency), set the number of motor poles at CH B input to 2.

CHZ Make CH Z settings.
Enable (set to ON) to use the original rotation angle (usually called the Z phase) signal to reset pulse division to zero.

| | |
|-----|--|
| ON | Use CH Z. |
| OFF | Ignore CH Z (no connection to CH Z jack) |

4.8.2 Measuring Motor Electrical Angle

If the [Harm sync src] is set to [Ext] when pulses are input to CH B for the rotation signal, voltage and current phase shift based on the pulses can be seen.



Measuring Electrical Angle with Multiple Pulses



- Use of the original signal (Z phase) is recommended. The original (CH Z) signal serves as a reference pulse for consistent phase measurements.
- When multiple pulses are used as the rotation signal input without the original (CH Z) signal, the reference pulse is determined upon synchronization, so upon resynchronization after sync unlock occurs, a different pulse may become the reference standard.

NOTE



- Harmonic analysis by synchronization with the rotation signal input pulse requires that the pulse count be an integer multiple of the input frequency. For example, a 4-pole motor requires a pulse count that is an integer multiple of two, and a 6-pole motor requires a pulse count that is an integer multiple of three.
- When a motor with wye internal wiring is measured as a 3P3W3M wiring system, the voltage and current phase angles can be measured using the Δ -Y conversion function.

4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)

Phase Zero Adjustment (PHASE ADJ)

Press  and then  to correct (zero) any phase difference between the rotation signal input pulse and U1 fundamental content.

NOTE

- Phase zero adjustment is available only when CH B is set for pulse input and [Harm sync src] is set to [Ext]. Otherwise, performing this key operation has no effect.
- When harmonic synchronization is unlocked, this key operation has no effect.
- Press  and then  to clear the correction value.

Electrical Angle Measurement Example

- 1.** Without providing current to a motor, rotate it from the load side while measuring the voltage induced at its input terminals.
- 2.** Perform phase zero adjustment.
(Zero out any phase difference between the fundamental waveform of the induced voltage input as U1 and the pulse signal.)
- 3.** Without providing current to a motor, rotate it from the load side while measuring the voltage induced at its input terminals.
Apply current to rotate the motor.
(The voltage-current phase angle measured by the instrument is the electrical angle based on the induced voltage phase.)

NOTE

Phase difference is affected by the rotation input signal pulse waveform and the instrument's internal circuit delay, which cause measurement errors when measuring frequencies much different from that at which phase zero adjustment was performed.

Operating Functions

Chapter 5

5.1 Timing Control Functions



Three types of timing controls are available: interval, count-down timer, and real-time clock settings. Timing control can be applied to CF card saving and integration operations.

See "4.3 Integration Value Observation" (p. 53), "7.5.2 Auto-Saving Measurement Data" (p. 110)


| | |
|--------------------------------|--|
| Interval timing control | Controls repeating operations at a specific interval. |
| Timer timing control | Controls operation for a specific count-down time. Combine with interval timing to specify the duration of interval timing operation. |
| Real-time clock timing control | Controls operation between specific real-time start and stop times. Combined with interval timing to specify when interval timing operation begins and ends. |

NOTE



Before starting integration and saving using timing control functions

- Before using automatic saving or integration, ensure that the real-time clock is correctly set (p. 101).
- The timing control cannot be set to CF card saving and integration independently.
- Integration is always active, so when a timing control function is active, **RUN** appears on the display. When timing control has stopped, press  to reset integration and clear the **STOP** indicator.
- Even when a timing control function is enabled, you must press  to begin operation.

About interval timing control

- If the timer or clock control is not active, integration automatically stops at 9999 hours, 59 minutes, and 59 seconds. In this case, press  to reset the integration value and restart integration.
- Interval timing is not available when the interval time setting is longer than the timer or clock (start/stop) settings.
- When the ending time of the timer or clock settings is different from the ending time of the last interval, the timer or clock setting has priority.
- When changing the interval setting, the number of recordable data items (p. 112) also changes (longer intervals allow more data items to be recorded).

About timer timing control

- When clock control settings define a time span longer than the timer setting, integration starts at the specified clock start time, and stops when the timer setting has elapsed (any clock control stop time is ignored).
- During integration and before the timer stops, pressing  interrupts integration but retains the integration value. In this case, pressing  again resumes integration until the timer stops ("additional integration").


About clock timing control

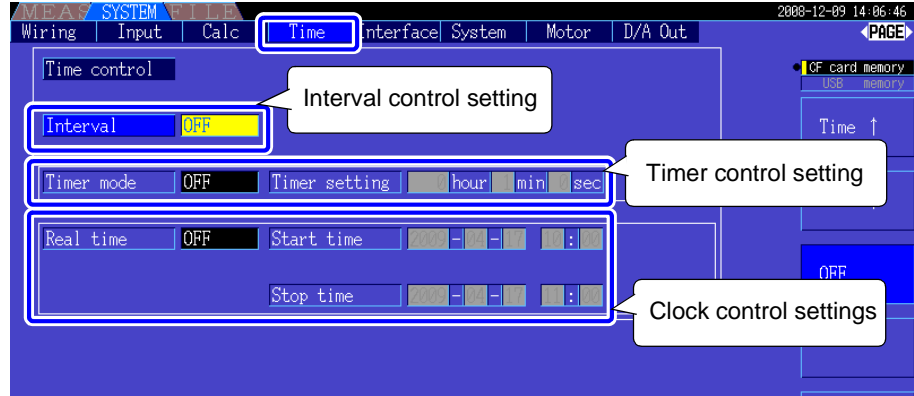
- When clock control is enabled for a time span longer than the timer setting, integration begins at the specified clock start time, and stops when the timer setting has elapsed (any clock control stop time is ignored).
- When the set time has elapsed, real-time control is considered disabled **[OFF]**.
- When integration is interrupted during the clock control period, clock control is disabled **[OFF]**.

See the graph in "4.3.4 Integration Combined with Timing Control" (p. 59) for integration operations.

Setting Method

Press **SYSTEM** and the **◀ ▶** keys to display the **[Time]** page.

- 1  Select the item
- 2 Use **F** keys to set.



Interval

(The interval setting is also available on the **[Interface]** page.)

| | |
|--------------|---|
| Time↑/ Time↓ | Select an interval time from 50, 100, 200, or 500 ms; or 1, 5, 10, 15, or 30 s; or 1, 5, 10, 15, 30, or 60 min. |
| OFF | Interval time control is disabled. |

Timer mode/ Real time

| | |
|-----|--|
| ON | Timer control / clock control is enabled. |
| OFF | Timer control / clock control is disabled. |

Timer setting

Set the count-down timer. Settable range is 10 s to 9999 h 59 m 59 s.

| | |
|----------------|------------------------------------|
| +1↑/ -1↓ | Increments/decrements by 1. |
| +10↑/ -10↓ | Increments/decrements by 10. |
| Digit←/ Digit→ | Moves to the [hour] digits. |

Start time Stop time

Set start and stop times for clock timing. Select the year and the 24-hour time (e.g., 16 December, 2009 10:16 PM → **[2009/12/06 22:16]**)

| | |
|------------|------------------------------|
| +1↑/ -1↓ | Increments/decrements by 1. |
| +10↑/ -10↓ | Increments/decrements by 10. |

5.2 Averaging Function

Performs averaging on all instantaneous measurement values, including harmonics.

- NOTE**
- Peak, integration, and FFT peak values are excluded.
 - When averaging is enabled, averaging is applied to all data being saved.

Averaging Setting Procedure

Press **SYSTEM** and the **◀ ▶** keys to display the **[Calc]** page.

1  Select the item

2 Use **F** keys to set.



| | |
|------|--|
| OFF | Averaging is disabled. |
| FAST | Averaging is enabled. Response time* is 0.2 s. |
| MID | Averaging is enabled. Response time is 1.0 s. |
| SLOW | Averaging is enabled. Response time is 5.0 s. |

* Period to be within the accuracy when the input changes from 0% to 100%f.s.

Averaging Method

- Index averaging (applicable to 50 ms data update rate)
- Averaging is applied to voltage (U), current (I), and power (P), before performing calculations.
- For the harmonics, RMS values and percentage are calculated in average to instantaneous values, and the phase angle is calculated in average of real part and imaginary part after FFT calculation.
- Phase differences, distortion ratios and unbalance ratios are calculated from the data averaged as above.

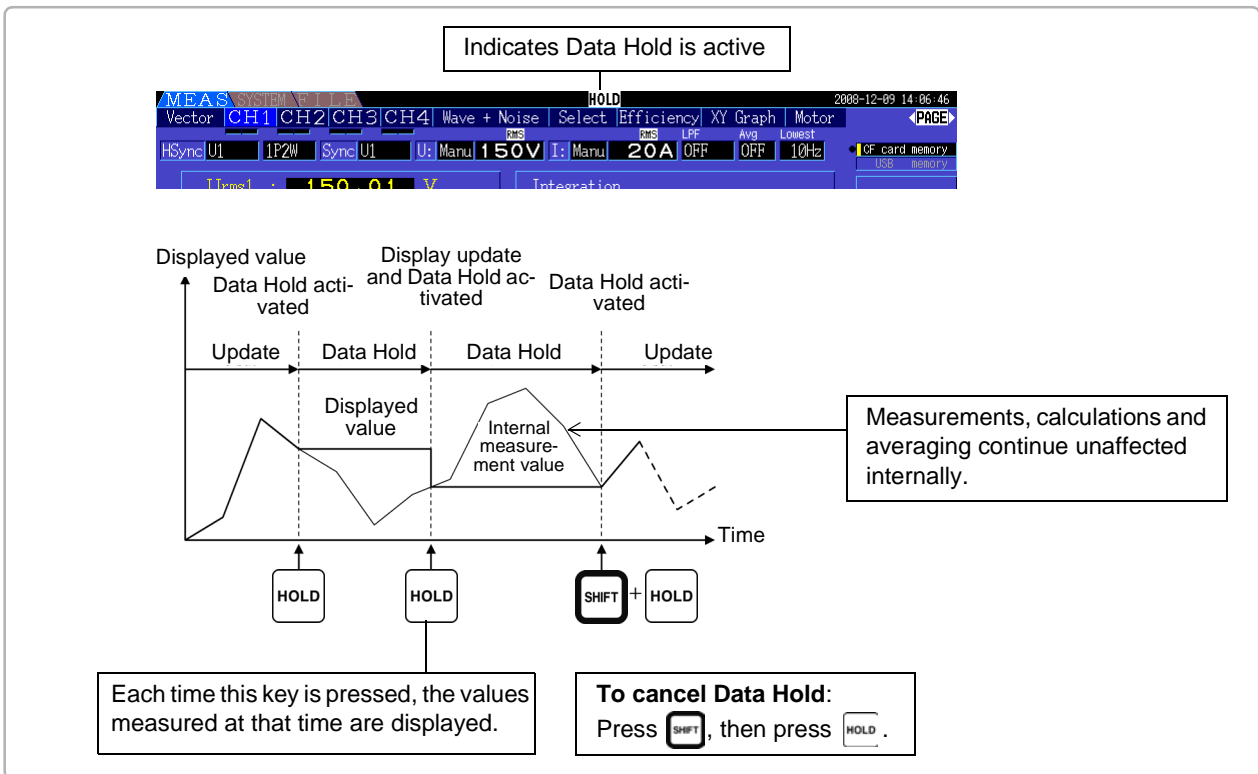
5.3 Data Hold and Peak Hold Functions

5.3.1 Data Hold Function

Pressing **HOLD** disables updating of all displayed measurement values and waveforms. In this state, data on other screens can be viewed as it was when **HOLD** was pressed.

The data update of internal measurement values is not synchronized to the display update. The internal measurement values are updated in 50ms (internal data update rate). The waveform and noise data is updated at the calculation completion. However, the waveform and noise display is not updated.

While data hold is active, **HOLD** is displayed and the **HOLD** key lights red.



Display data update

After pressing **HOLD**, the display data is next updated at the end of the measurement interval or when an external sync signal is received.

Output data

When the display is HOLD, the HOLD value is keep on outputting for the D/A output, CF card save and communication. However, the waveform output continues to output the instantaneous data regardless to the HOLD status.

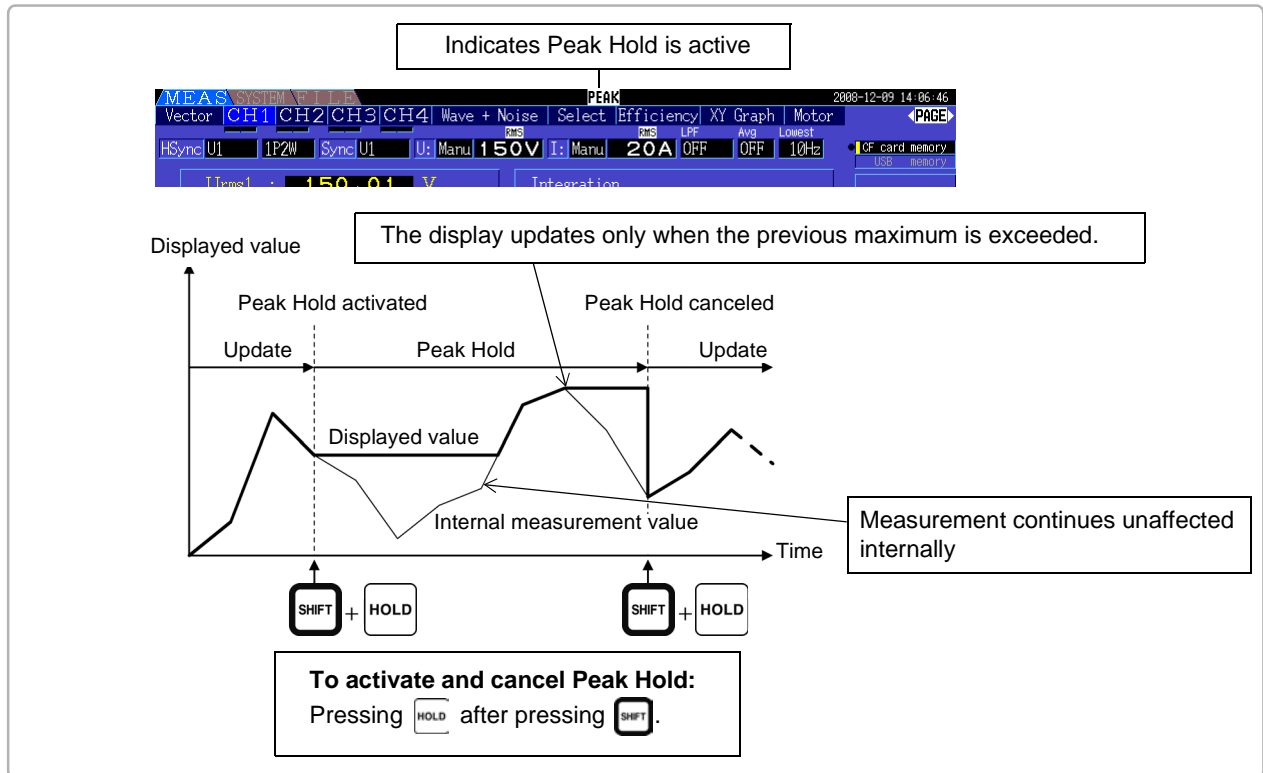
NOTE

- Clock and integration times and Peak Over display are unaffected by the Data Hold function.
- Data Hold and Peak Hold functions cannot be activated simultaneously.
- Settings cannot be changed while Hold is active.
- When AUTO ranging is enabled, the range is fixed at that used when **HOLD** is pressed.
- **HOLD** key operation is recognized before and during use of the timer control functions.
 - When an interval time is set: the display updates at each interval, and display data is held for the duration of the interval.
 - When the timer or clock control is set: the display updates and holds the values at the stop time.
- When auto-saving at a specified interval, data is saved immediately before display update.

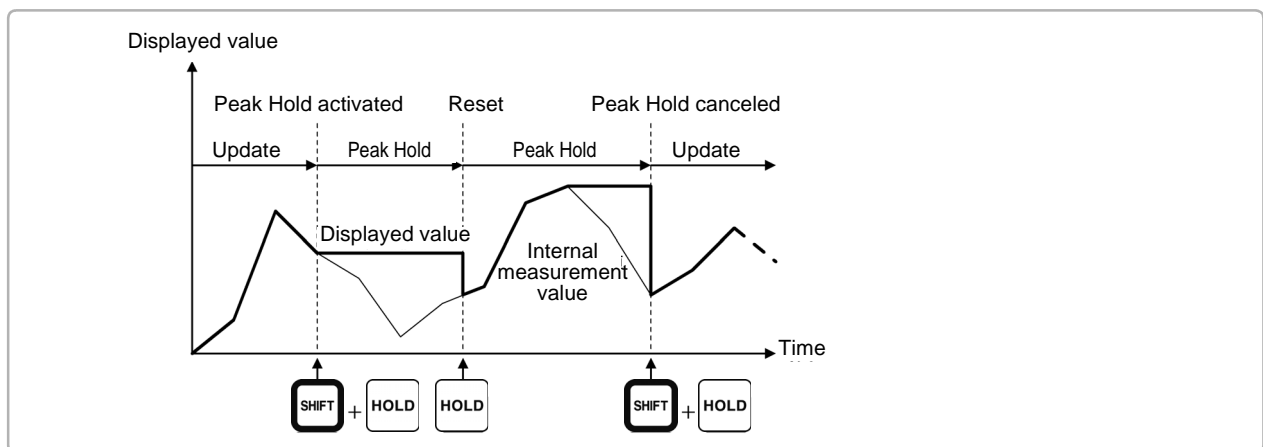
5.3.2 Peak Hold Function

Pressing **HOLD** after pressing **SHIFT** activates the Peak Hold state, in which only those items that exceed their previous maximum values are updated. This is convenient, for example, to measure motor inrush current.

When Peak Hold is active, **PEAK** is displayed and the **HOLD** key lights red.



Pressing **HOLD** when Peak Hold is active resets the peak values and resumes with new peaks from that point.



Display data update

After pressing **HOLD**, the display data is next updated at the end of the measurement interval or when an external sync signal is received.
(Updating of internal measurement values is not synchronized with display data update, but at the 50-ms internal data update rate, and waveform and noise data are updated when calculation finishes.)

Output data

When the display is HOLD, the HOLD value is keep on outputting for the D/A output, CF card save and communication. However, the waveform output continues to output the instantaneous data regardless to the HOLD status.

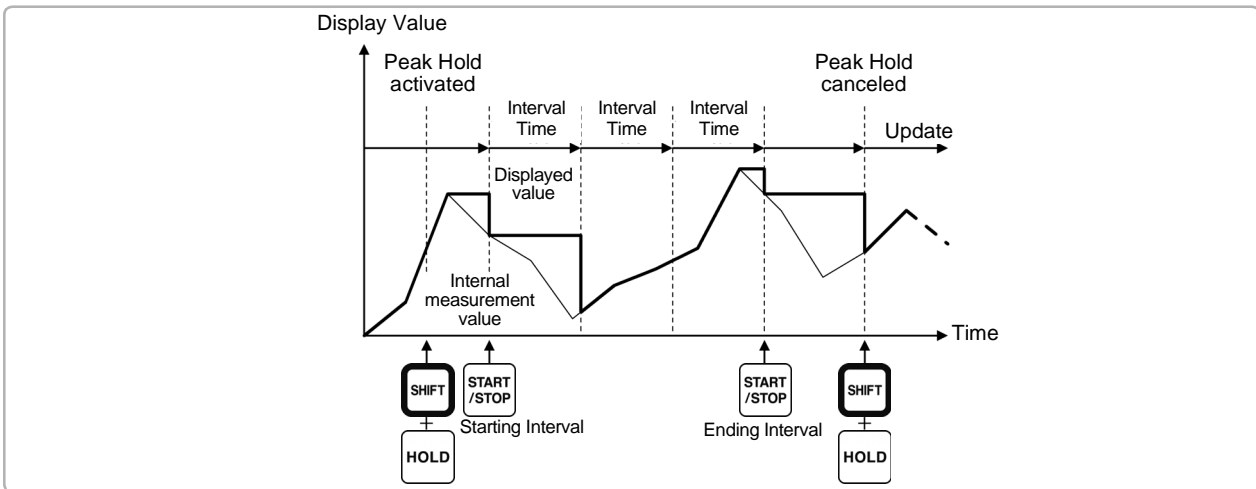
5.3 Data Hold and Peak Hold Functions

NOTE

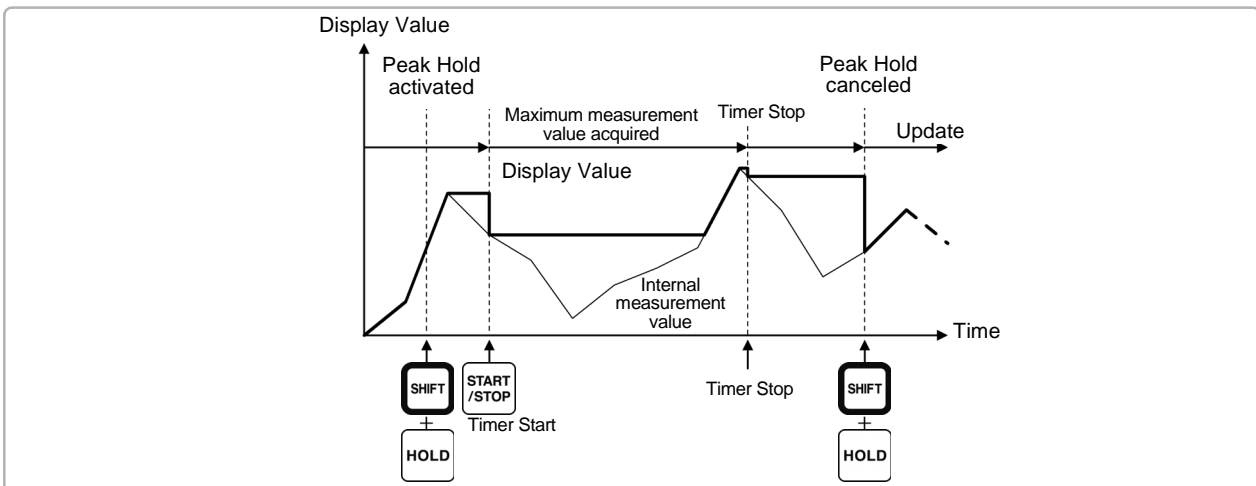
- Waveform displays and integration values are unaffected by Peak Hold.
- When averaging is enabled, the maximum value is recognized only after measured values have been averaged.
- Data Hold and Peak Hold functions cannot be activated simultaneously.
- The display shows [- - - - -] for over-range values. In this case, temporarily cancel Peak Hold and switch to the appropriate range.
- Maximum values for Peak Hold are absolute values, so if -60 W is measured after +50 W, the absolute value of -60 W is larger, and the display shows [-60W].
- Settings cannot be changed while Peak Hold is active.
- When auto-saving at a specified interval, data is saved immediately before the display update.

Using Peak Hold with Timing Control Functions

When the **interval timer** is used, the maximum value within each interval is displayed.



When the **timer or clock control** is enabled, the maximum value between starting and stopping times is displayed (and held).



NOTE

- The Peak Hold function can be enabled either before or during timing control operation. However, when timing control is active, the maximum value is obtained only after the time the Peak Hold function is enabled.
- The time of maximum input occurrence is not displayed.
- See "5.1 Timing Control Functions" (p. 91) for details about settings for the interval, timer and clock timing controls.

5.4 X-Y Plot Function

Select parameters for x and y (horizontal and vertical) axes in the basic measurement items to create simple X-Y graphs. Plot screens can be saved and printed as screen capture images.

XY Graph Display

Press **MEAS** and **◀ ▶** key to display the **[XY Graph]** page

X-Y graph plotting starts, and proceeds at the display update rate.

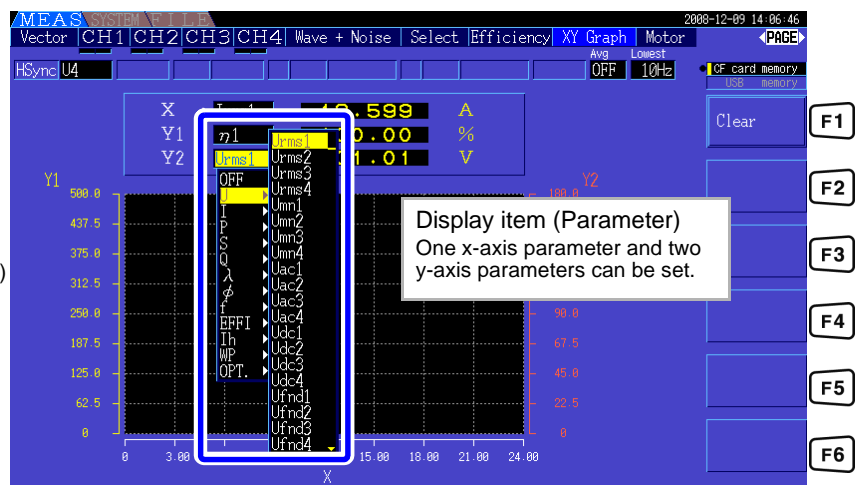
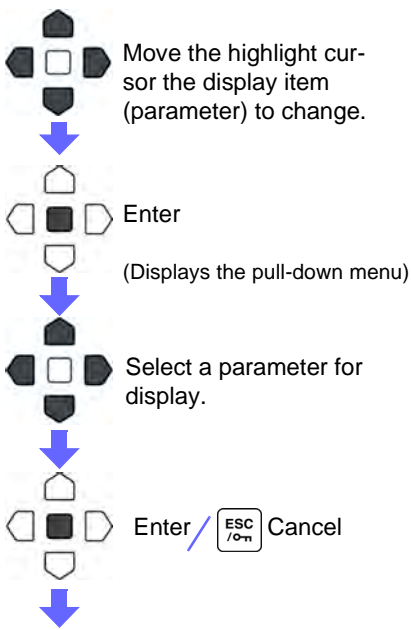


Press **F1** to clear and restart plotting.

NOTE

- Plotted data is not stored in memory, so it is lost when the screen is changed.
- When the items with AUTO ranging is selected, the data is cleared when the internal range is switched in AUTO ranging.

Display Setting Procedure



Displayed data is cleared, and plotting restarts.

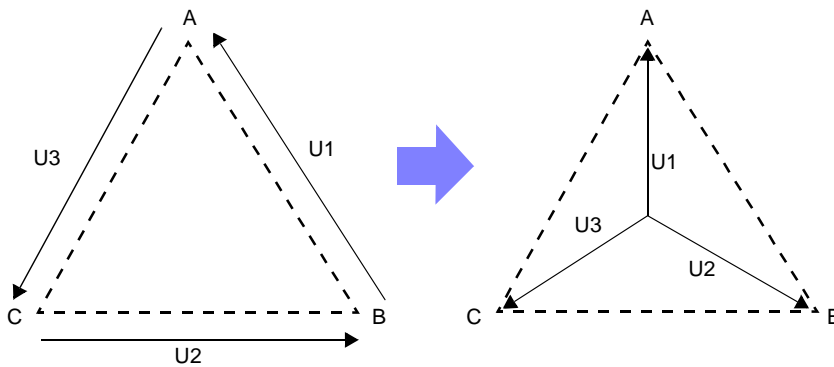
5.5 Δ-Y Conversion Function

For 3P3W3M wiring systems (wiring mode 7 on p.33), Δ (Delta) wiring configuration values are converted to Y (Wye) wiring values ('star' configuration) so that measured values are equivalent to those of 3P4W lines.

When this function is enabled, even when a motor has internal Wye wiring and the central (neutral) point is inaccessible, it can be measured using phase voltage to emulate the Wye configuration.

Δ-Y conversion analyzes voltage waveforms after performing vector conversion using a virtual neutral. Although voltage waveforms, voltage measurement values, and harmonic voltages are all input as line voltages, they are calculated as phase voltages.

Illustration of Δ-Y conversion



Setting Procedure

SYSTEM

Display the [Input] page

Select [Δ-Yconvert]

Use F keys to select

Set the Δ-Y conversion.
This is valid only when the wiring is "3P3W3M, 1P2W".

The Measurement screen appears as follows.



NOTE

- Δ-Y conversion is only selectable for 3P3W3M wiring.
- When Δ-Y conversion is enabled, the vector diagram on the Wiring screen is the same as that for 3P4W (instead of the 3P3W3M vector diagram).
- When auto-ranging voltage and Δ-Y conversion are enabled, the range-switching level for the next lower range is calculated to be $1/\sqrt{3}$ times (approx. 0.57735 times) the full-scale range value.

See "Auto-Ranging Span" (p. 46)

Changing System Settings

Chapter 6

On the **[System]** page, view the instrument's version information and change settings such as display language, beep sounds, and screen colors.

[System] Page Display


Press **SYSTEM** followed by **◀** **▶** to display the **[System]** page.

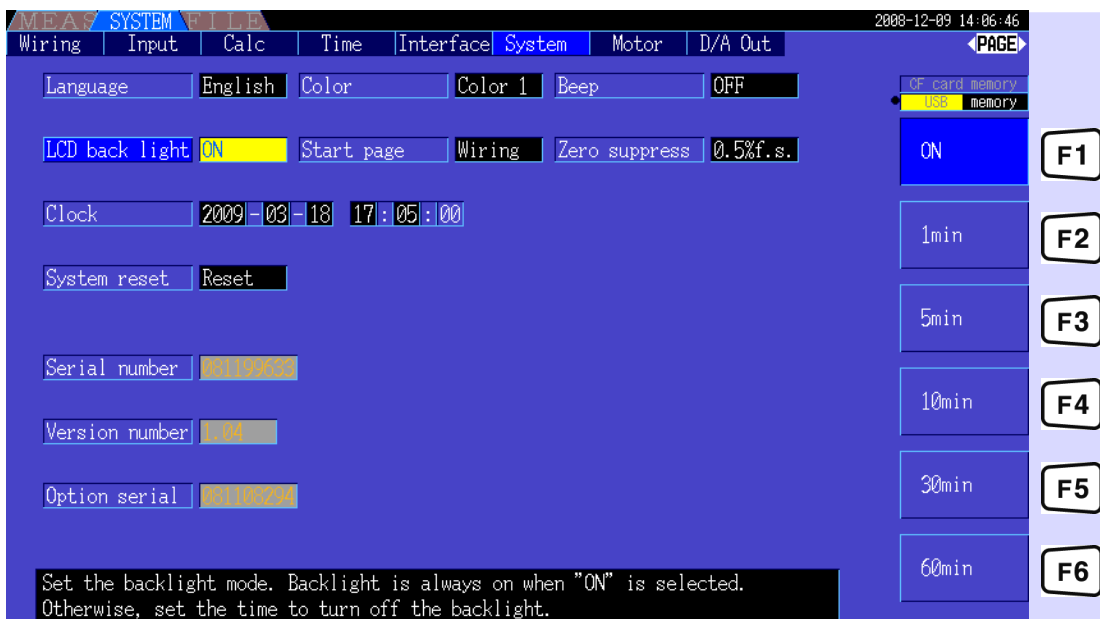
The screenshot shows the [System] page with the following callouts and settings:

- Select screen colors. (p. 100)**: Points to the 'Color' field.
- Enable/disable beep sounds. (p. 100)**: Points to the 'Beep' field.
- Select the display language. (p. 100)**: Points to the 'Language' field.
- Set LCD backlighting. (p. 100)**: Points to the 'LCD back light' field.
- Set the system's real-time clock. (p. 101)**: Points to the 'Clock' field.
- Execute system reset. (p. 101)**: Points to the 'System reset' field.
- View the instrument's serial number.**: Points to the 'Serial number' field.
- View the instrument's firmware version number.**: Points to the 'Version number' field.
- View option serial numbers. (Not displayed when the option is not installed.)**: Points to the 'Option serial' field.
- Select the startup (initial) screen. (p. 101)**: Points to the 'Start page' field.
- Configure zero suppression. (p. 101)**: Points to the 'Zero suppress' field.

The screenshot also shows a menu bar with 'MEAS', 'SYSTEM', and 'FILE' tabs, and a sub-menu with 'Wiring', 'Input', 'Calc', 'Time', 'Interface', 'System', 'Motor', and 'D/A Out'. The 'System' option is highlighted with a blue box.

Setting Item Descriptions

Use the  keys to select an item, and the **F** keys to change its setting.



Language Select the language for the display.

| | |
|----------|----------|
| Japanese | Japanese |
| English | English |
| Chinese | Chinese |

Color Select the screen color scheme.

| | |
|--------|---|
| Color1 | Dark green |
| Color2 | Light blue |
| Color3 | Black (with white text) |
| Color4 | Dark blue |
| Mono | Monochrome (with black text) This setting is ideal for screen captures and printing. |

Beep Set to enable or disable key-press beep sounds.

| | |
|-----|---------------------|
| ON | Beeps are enabled. |
| OFF | Beeps are disabled. |

LCD back light The backlight can be set to turn off after a period of key inactivity. The screen reappears upon pressing any key.

| | |
|---------------------------------|--|
| ON | The screen backlight remains on. |
| 1min/5min/10min/ 30min/60min | The screen blanks after the selected period of inactivity. |

6.1 Initializing the Instrument (System Reset)

Start page

Select the screen to appear when the instrument is turned on.

| | |
|----------|--|
| Wiring | Initially display the wiring screen. |
| Last scr | Initially displays the Measurement screen that was displayed when the instrument was turned off. |

Zero suppress

This setting establishes a level below which values are treated as zero for data acquisition purposes.

| | |
|-------------------|---|
| OFF | Zero suppression is disabled. |
| 0.1%f.s./0.5%f.s. | Measured values below the selected level are treated as zero. |

Clock

Sets the internal real-time clock. Data is saved and managed according to this setting.

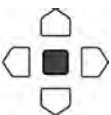
| | |
|-----------|--|
| +1↑/-1↓ | Increments/decrements by 1. |
| +10↑/-10↓ | Increments/decrements by 10. |
| Set | Press to apply setting changes (resets seconds to 00). |

6.1 Initializing the Instrument (System Reset)

If the instrument operates abnormally, see “Before sending the unit to repair”.
If the cause cannot be determined, perform a system reset.

1  Select the item

2 Press **[F1]** **[Reset]**.
(A dialog box appears.)

3  Enter / **[ESC / On]** Cancel



NOTE System reset returns all except the display language and communication settings to their factory defaults. All measurement data is erased from the screen and from internal memory.
See "6.2 Factory Default Settings" (p. 102)

Power-On Reset

To return all instrument settings to their factory defaults, hold the **[SHIFT]** key while turning the power on. This is called a 'power-on reset'. All settings including the display language and communication settings are initialized.

6.2 Factory Default Settings

The factory default settings are as follows.3

| Setting Item | | Default Setting | Setting Item | Default Setting |
|------------------------|----------------|-------------------|----------------------------|-----------------|
| Wiring | | Mode 1 (1P2W x 4) | Folder | HI3390 |
| Sync source | | U1, U2, U3, U4 | RS connection* | OFF |
| U range | | 600 V | RS com speed* | 38400bps |
| U rect | | RMS | IP address* | 192.168.1.1 |
| VT rate | | OFF | Subnet mask* | 255.255.255.0 |
| I range | | Sensor Rating | DefaultGateway* | 0.0.0.0 |
| I rect | | RMS | Language* | Japanese |
| CT rate | | OFF | Color | Color1 |
| LPF (Input) | | OFF | Beep | ON |
| Integ mode | | RMS | LCD back light | ON |
| Freq measure | | U | Start page | Wiring |
| Lowest freq | | 10 Hz | Zero suppress | 0.5%f.s. |
| Harm sync src | | U1 | Motor Sync | DC 50 ms |
| THD calc | | THD-F | LPF (Motor Testing Option) | OFF |
| Δ -Y convert | | OFF | Freq source | f1 |
| Efficiency | Pin1 to Pin3 | P1 | CHA input | AnalogDC |
| | Pout1 to Pout3 | P1 | CHA range | 5 V |
| Noise | Sampling | 250 kS/s | CHA scaling | 1.0 |
| | Points | 10000 | CHA unit | N• m |
| | Lowest noise | 1 kHz | Rated torque | 1 |
| | Analysis CH | CH1 | Freq range fc | 60 kHz |
| | Window type | Rect | Freq range fd | 30 kHz |
| Averaging | | OFF | CHB input | Pulses |
| ZeroCross filt | | Weak | CHB range | 5 V |
| AutoRange type | | Narrow | CHB scaling | 1.0 |
| Interval | | 1min | CHB unit | r/min |
| Timer mode | | OFF | Max frequency | 5 kHz |
| Timer setting | | 1min | No. of pulses | 2 |
| Real time | | OFF | Motor poles | 4 |
| Sync control | | Master | CHZ | OFF |
| Sync event | | HOLD | Wave output | ON |
| Media (Manual saving) | | CF Card | Freq f.s. | 5 kHz |
| Folder (Manual saving) | | HI3390 | Integ f.s. | 1/1 |
| Auto save | | OFF | Output items CH1 to CH16 | Urms1 |

* Items not initialized by System Reset (initialized only by Power-On Reset, p.101).

NOTE

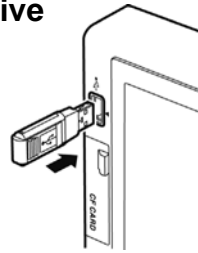
Settings for measurement display and recording data are also initialized.

Data Saving and File Operations

Chapter 7

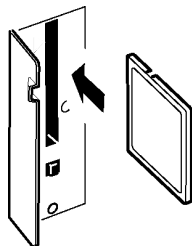
The instrument supports saving of setting configurations, measurement data, waveform data, and screen images to CF card or USB flash drive (only setting configurations can be reloaded).

USB Flash Drive

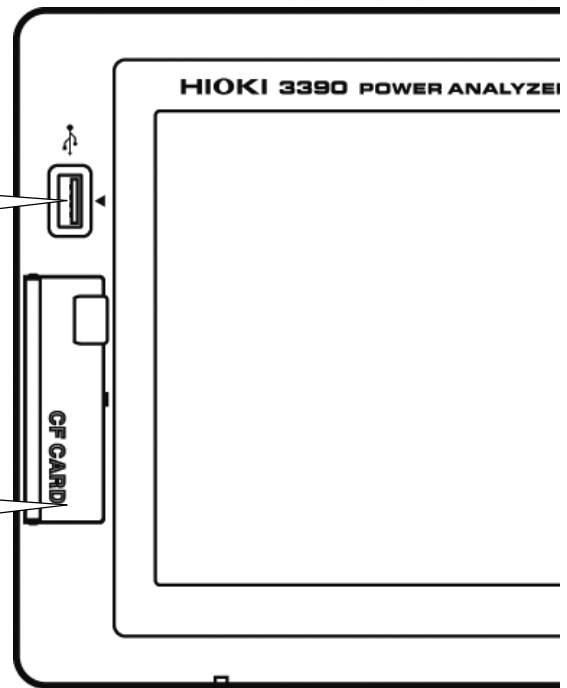


| | |
|--------------------------|------------------------|
| Connector | USB type A |
| Electrical specification | USB2.0 |
| Power supply | 500 mA maximum |
| No. of ports | 1 |
| Compatible USB device | USB Mass Storage Class |

CF Card



| | |
|-------------------------|--|
| Slot | TYPE1 x 1 |
| Supported card | CompactFlash memory card (at least 32 MB) |
| Max. supported capacity | Up to 2 GB |
| Data format | MS-DOS(FAT16/ FAT32) format |



•: supported x: not supported

| Storable Content | CF card | USB flash drive | See |
|------------------------------|---------|-----------------|----------|
| Manual save measurement data | • | • | (p. 108) |
| Auto-save measurement data | • | x | (p. 110) |
| Save waveforms | • | • | (p. 114) |
| Save screen image | • | • | (p. 114) |
| Save setting configuration | • | • | (p. 115) |
| Load setting configuration | • | • | (p. 115) |
| Copy files and folders | • | • | (p. 118) |

Important

- Use only PC Cards sold by Hioki. Compatibility and performance are not guaranteed for PC cards made by other manufacturers. You may be unable to read from or save data to such cards.

Hioki options

PC cards (CF card + adapter)

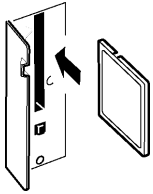
- 9726 PC CARD 128M
 - 9727 PC CARD 256M
 - 9728 PC CARD 512M
 - 9729 PC CARD 1G
 - 9830 PC CARD 2G
- (adapter is not used with this Analyzer)

- Format new CF cards before use. See "7.3 CF Card Formatting" (p. 106)

7.1 Inserting and Removing Storage Media

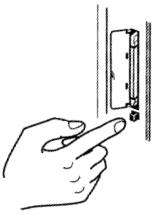
Insert and remove CF cards and USB flash drives as follows.

CF card



To insert a CF card

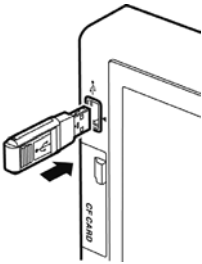
Open the CF card slot cover, and with the ▲ mark pointing toward the screen, insert the card in the direction shown by the arrow as far as it will go.



To remove a CF card

Open the CF card slot cover, press the eject button so that it pops out, then press it again to eject the CF card.

USB flash drive



Insert a USB flash drive in the USB port on the front of the instrument (and just pull it out to remove).

- Do not insert any device other than a USB flash drive.
- Not all commercially available USB flash drives are compatible.

CAUTION

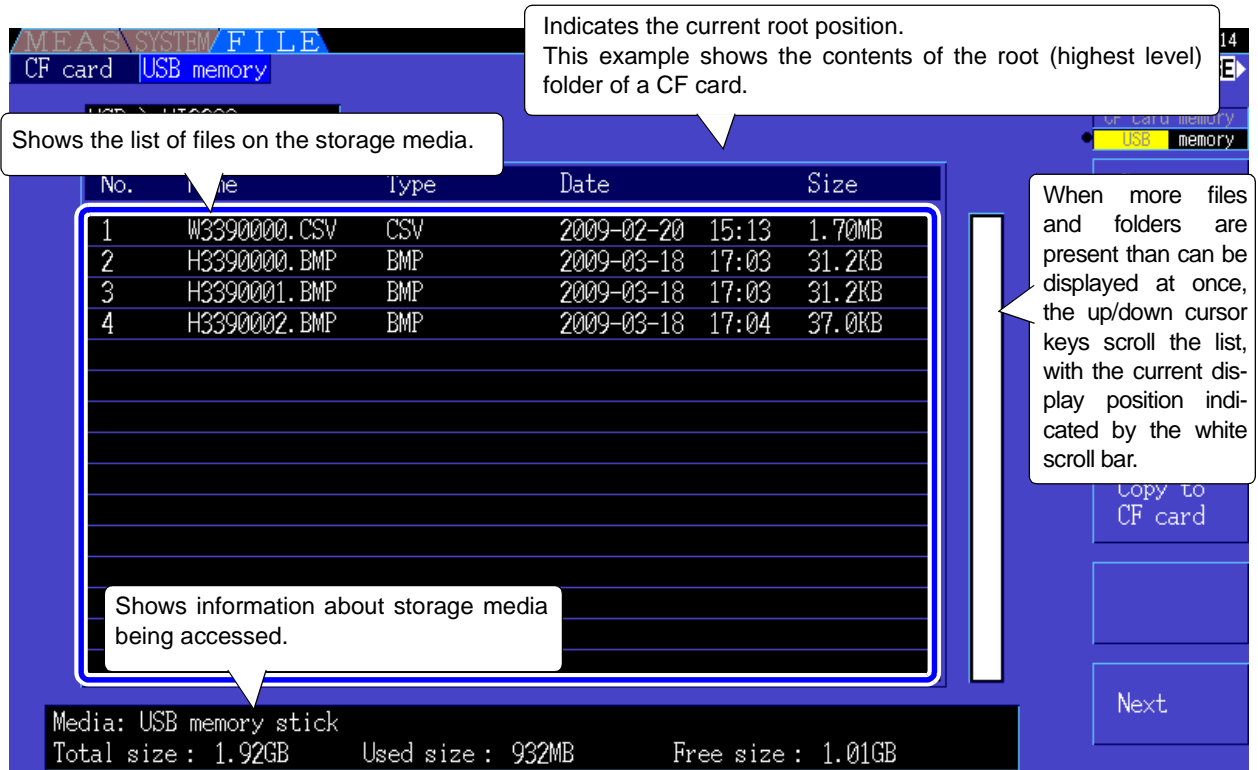
- Hioki cannot recover data from damaged or faulty storage media resulting from abnormalities. We are also unable to provide compensation for such data loss, regardless of the contents or cause of the failure or damage. We recommend making backups of all important data.
- Avoid forcing insertion of storage media backwards or in the wrong orientation, as this could damage the media or instrument.
- The Media-Busy indicators (p. 17) light green when storage media is being accessed. Do not turn the instrument off while an indicator is lit. Also avoid removing storage media while it is being accessed, as that may corrupt stored data.
- Remove the storage media when transporting the instrument. Otherwise, the instrument or media could be damaged.
- Do not move the instrument with a USB flash drive installed. Otherwise, the instrument or media could be damaged.
- Some USB flash drives are easily affected by static electricity. Be careful handling the USB flash drive to avoid damage to the drive or instrument malfunctions due to static electricity.
- Some USB flash drives may prevent the instrument from turning on when inserted. In this case, turn the instrument on before inserting the USB flash drive. We recommend testing a USB flash drive before use.

NOTE

Storage media have a limited usable lifetime. After long-term use, data reading and writing will fail, at which time the media must be replaced.

7.2 The File Operation Screen

The File Operation screen is described below.



NOTE

The File Operation screen is not available during auto-saving.

About File Types

The following file data types may be stored.

| Name | Type (file extension) | Description |
|--------------|-----------------------|--|
| M3390nnn.CSV | CSV | Manually saved measurement data |
| MMDDnnkk.CSV | CSV | Auto-saved measurement data |
| W3390nnn.CSV | CSV | Waveform data |
| H3390nnn.BMP | BMP | Screen capture image data |
| xxxxxxx.SET | SET | Setting configuration data |
| xxxxxxx | Folder → | Folder (no extension) |
| xxxxxxx | ??? | Files cannot be used and saved on this unit. |

- In this table, 'nnn' and 'nn' indicate a serial number (000 to 999 or 00 to 99) within the same folder, and 'kk' is a serial number of a split file when the file size exceeds 100 MB. MMDD indicate month and day.
- Setting configuration files can be optionally assigned names (up to eight characters)

Changing Folders, Selecting the Root Folder

- From the root, press **ENTER** or the right cursor key to display the contents of the currently selected folder.
- Press the left cursor key to return to the root folder.
- Folders within folders other than the root are not accessible.

7.3 CF Card Formatting

Format a CF card if it is not already formatted (initialized).
 Insert the CF card to be formatted (p. 104), and start formatting.

Formatting procedure

FILE

Display the [CF card] page

F6

F3
 (The format confirmation dialog appears.)

To execute: ENTER

To cancel: ESC / ON

(When formatting is finished, [Completed !] appears)

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
 Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Next

Next

NOTE Formatting erases any data stored on the CF card so that it cannot be recovered. Execute only after confirming that no important files will be lost. We recommend keeping a backup of any precious data stored on a CF card.

Upgrade F4

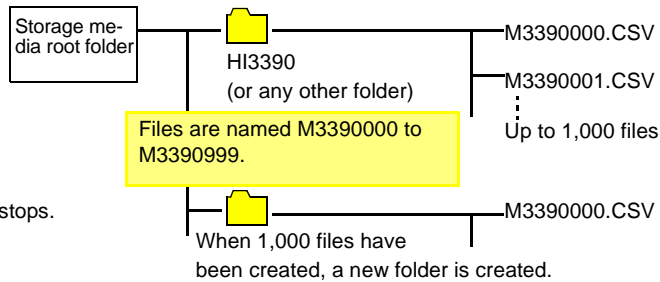
This key is not used other than when upgrading the firmware.

7.4 Saving Operations

Manual Saving (p. 108)

| | |
|------------------|----------------------------|
| Save destination | CF card USB flash drive |
| Saving method | Press SAVE . |

- When the storage media is full, saving stops.

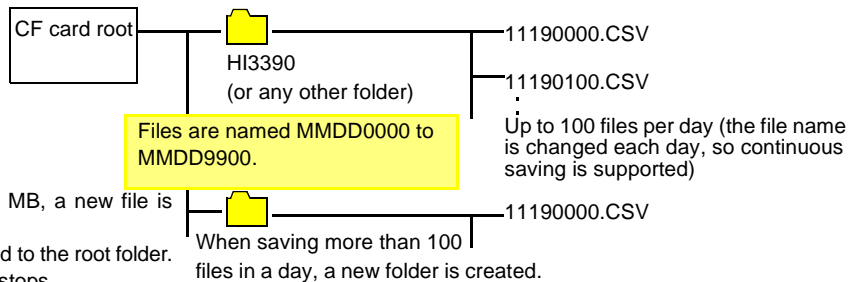


A new file is created when any of the following are changed:
Save destination folder
Wiring mode
Measurement objects to be saved

Auto-saving (p. 110)

| | |
|------------------|---|
| Save destination | CF card |
| Saving method | Automatically, according to timing control settings |

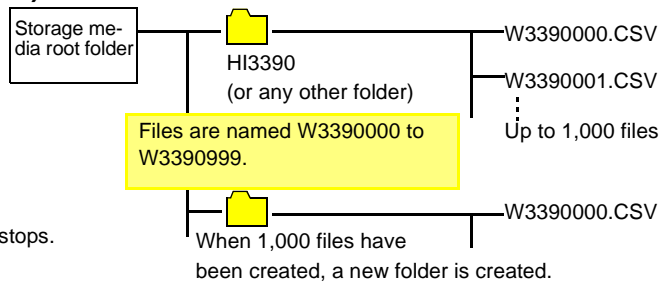
- When an auto-saved file exceeds 100 MB, a new file is created and saving continues.
- Up to 100 files per day can also be saved to the root folder.
- When the storage media is full, saving stops.



Waveform Data Saving (p. 114)

| | |
|------------------|--|
| Save destination | CF card USB flash drive |
| Saving method | Press F6 on the [Wave + Noise] page of the Setting screen |

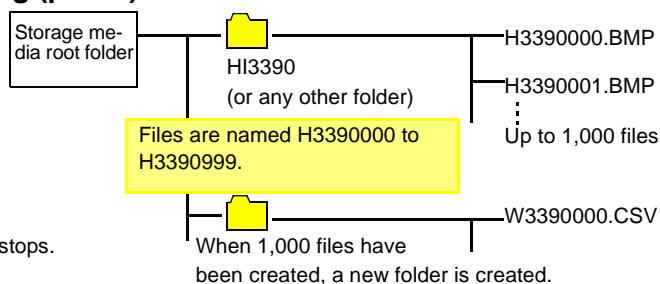
- When the storage media is full, saving stops.



Screen Capture Image Saving (p. 114)

| | |
|------------------|--|
| Save destination | CF card USB flash drive |
| Saving method | Display the screen to save, and press SHIFT and SAVE . |

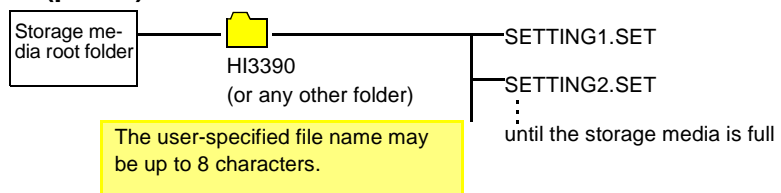
- When the storage media is full, saving stops.



Saving Setting Configurations (p. 115)

| | |
|------------------|---|
| Save destination | CF card USB flash drive |
| Saving method | Move to a folder on the File Operations screen, and press F1 . |

- Files can also be saved to the root folder.
- When the storage media is full, saving stops.



NOTE

The maximum number of files to save in the root for manual save, waveform and screen copy is 512 files in FAT16 format and 1000 files in FAT32 format.

7.5 Measurement Data Saving

Measurement data can be saved either manually or automatically. All measurement values including harmonics and peak values of FFT functions can be selected for saving. Files are saved in CSV format.

NOTE Both manual and auto-saving are disabled while accessing storage media (Media-Busy indicator lights green, (p. 17)).

7.5.1 Manually Saving Measurement Data

Press **SAVE** to save values measured at the time the key is pressed. Specify the items to save beforehand.

- Saving Procedure**
1. Select the measurement items to save. (Refer to 7.5.3 (p.112))
 2. Select the save destination media and folder.
 3. Press **SAVE** when you want to save. (The specified folder is automatically created and data saved.)

| | |
|-------------------|--|
| Save destination: | CF card or USB flash drive |
| File names: | Auto-generated, with CSV extensions M3390nnn.CSV ('nnn' is a serial number from 000 to 999 in the same folder) Example: M3390000.CSV |
| Remarks: | A new file is created the first time, after which data is added to the same file. However, when the save destination, wiring mode, or measurement items to save is changed, a new file is created and subsequent data saved to that. |

NOTE

- Saved CSV files are only intended to be reloaded.
- The displayed data and saved data may not be equivalent due to the timing difference when saving the data by pressing the **SAVE** key. Use the HOLD function to save the same data.

Selecting the Save Destination

Display the **[Interface]** page

Select **[Media]**

Select with the **F** keys

CF card **F1**

USB mem. **F2**

F3

F4

F5

F6

NOTE When auto-saving is enabled, manual saving is not available.

Selecting the Destination Folder and Measurement Items to Save

SYSTEM

Display the [Interface] page

For manual saving: [Folder]
For auto-saving: [Folder]
(Can be set when the auto save mode is ON.)

F1
(A dialog appears)

keys to select characters

Enter characters with the F keys

Enter: F6
Cancel: ESC / ⏏

Interface

Folder HI3390

Folder

Folder

Items to save 35/30000

Interval 1min

RS connection OFF RS com speed 38400bps

LAN DefaultGateway 0.0.0.0

IP address 192.168.1.1 Subnet mask 255.255.255.0

Set the folder for manual saving. Folder name is 8 characters in maximum. Open name input dialog by F1 key.

Manual saving

Media CF card Manual saving

Auto save mode OFF

Folder HI3390

Items to save 35/2

Interval OFF

RS connection OFF

LAN DefaultGateway 0.0.0.0

IP address 192.168.1.1 Subnet mask 255.255.255.0

Select characters by cursor keys. Enter a character at cursor position by F1 or ENTER. Change the character position by F4 and F5.

Input F1
BS F2
Del F3
Pos ← F4
Pos → F5
OK F6

Dialog box setting items

| | |
|-----------|--|
| Input | Enters the character at the cursor position. (The same as <input type="button" value="ENTER"/> .) |
| BS | Deletes the character before the cursor position. |
| Del | Deletes the character at the cursor position. |
| Pos←/Pos→ | Moves the cursor position. |
| OK | Accepts the entered file name. After accepting, closes the dialog. |

NOTE

- When auto-saving is enabled, manual saving is not available.
- Folder names can be up to eight characters.

7.5.2 Auto-Saving Measurement Data

Each measurement value can be automatically saved at the specified time. Items that have been specified beforehand are saved.

Saving Procedure

1. Select the measurement items to be saved.
(See 7.5.3 (p.112))
2. Enable auto-saving and select the destination folder (as necessary).
(See Setting Auto-Saving below, and "Selecting the Destination Folder and Measurement Items to Save" (p. 109).)
3. Set the save time.
(See 5.1 (p.91))
4. Press **START/STOP** to start auto-saving (and press **START/STOP** again to stop).
(The specified folder is automatically created, and data saved therein.)

| | |
|-------------------|--|
| Save destination: | CF card |
| File names: | Automatically generated from the starting date, with CSV extension. MMDDnnkk.CSV (MM: year, DD: day, nn: serial number from 00 to 99 in same folder, kk: consecutive number of file division when file size exceeds 100 MB) Example: 11040000.CSV (for the first file saved on November 4) |

NOTE

- Interval-saved CSV files are only for reloading.
- While auto-saving is enabled, manual saving, waveform saving and screen capture are not available.
- If the auto save is started while saving in manual, waveform, or screen copy, the several data may be missed.

Setting Auto-Saving

Display the **[Interface]** page

Select **[Auto save mode]**

F2

The data save destination can be specified only when auto-saving is enabled.

NOTE

- The maximum number of data points that can be recorded (p. 112) depends in the interval time (longer intervals allow recording more data points).
- When auto-saving is disabled (**[OFF]**), the **[Folder]** cannot be set.
- Folder names can be up to eight characters.

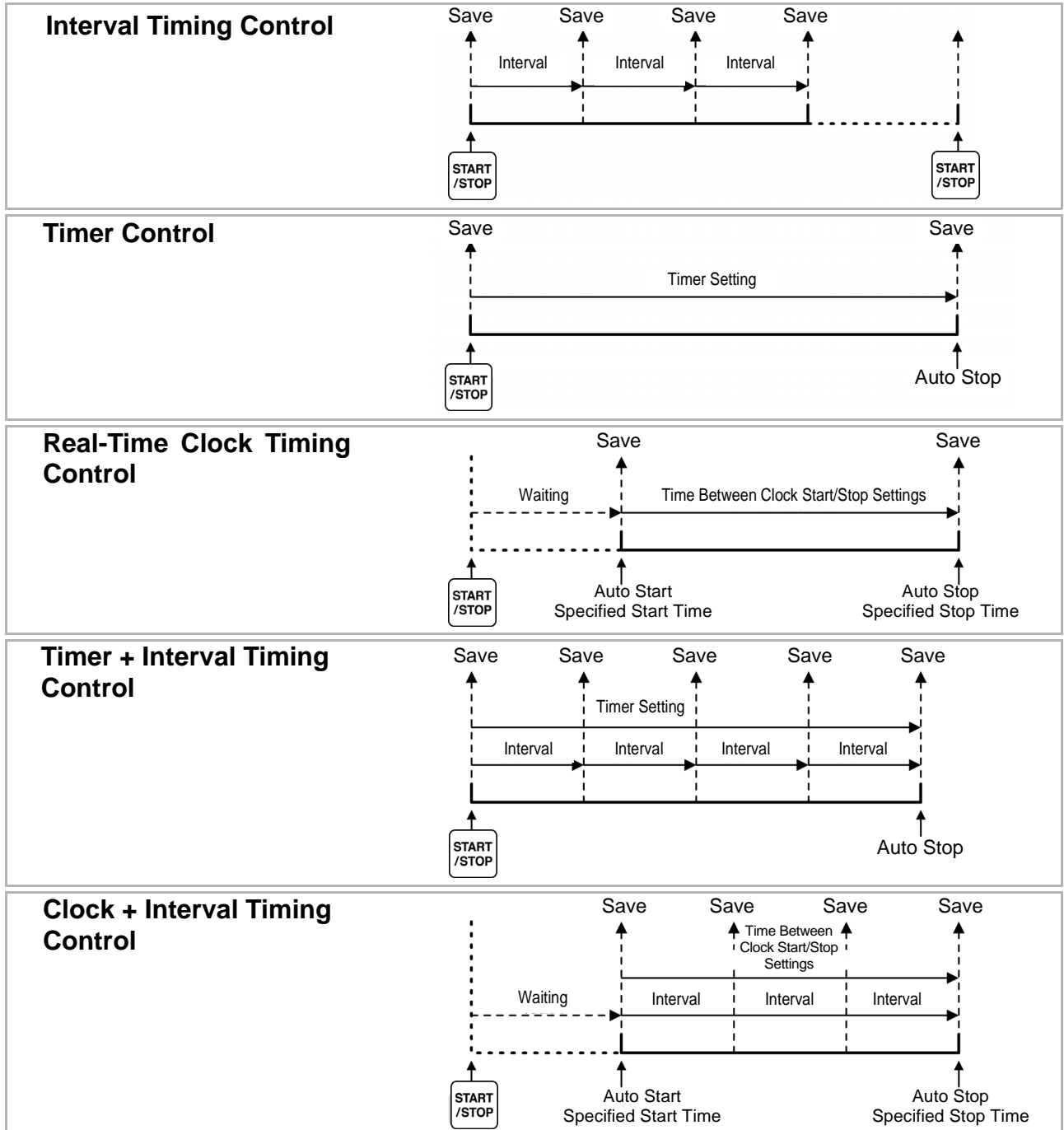


Remaining available recording time


When **[Auto save mode]** is enabled, the remaining available recording time on the selected media is displayed. The displayed remaining time is an approximation calculated from the storage media capacity, number of recording items, and interval time.

Auto-Saving Operations

Timing controls available for auto-saving are as follows.



NOTE

- Settings cannot be changed while timing controls are enabled. Also, when auto-ranging is enabled along with timing control, the range that is active when  is pressed remains fixed.
- The all data is saved in the same file under timing control. When integration is reset, data is saved to a new file at the next start time.
- When the timer stop time and the interval ending time do not match, the timer stop time has priority, and the last interval is truncated.
- When the clock control stop time and the interval ending time do not match, the clock control stop time has priority, and the last interval is truncated.
- When the storage media becomes full during auto-saving, an error is displayed and saving stops. In that case, auto-saving can be resumed (using an automatically named file with the same name) by replacing the CF card with another (formatted) CF card.

See To OFF the interval. (p. 92)

7.5.3 Selecting Measurement Items to Save

The items to be saved to storage media can be selected.

The number of items that can be recorded depends on the interval timing setting.

| | | | | | | |
|--------------------------|------|-------|-------|-------|------|-------|
| Interval | 50ms | 100ms | 200ms | 500ms | 1s | Other |
| Maximum recordable items | 130 | 260 | 520 | 1300 | 2600 | 5000 |

Setting Procedure

Display the [Interface] page

Select [Items to save]

Select measurement contents with the F keys.

Press **F6** to select Noise peak, Temp, ChA, ChB, Pm, and Slip.

Select the items to be saved.

Set by F keys*
(Press **ENTER** to toggle off/on.)

Press **F6** (or **ESC/On**) to return to the previous page.
"O" indicates ON, blank indicates OFF, and "-" indicates not selectable.

No. of items to record
Indicates the number of data items enabled (set to "ON")

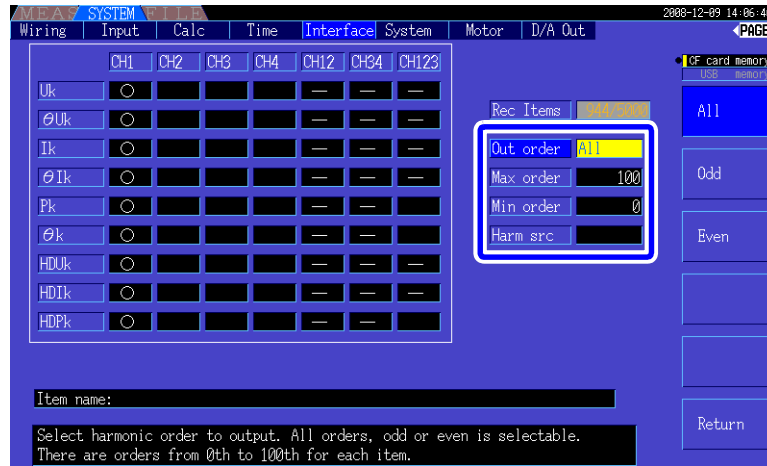
Maximum recording quantity
determined by the interval setting

*: Setting Contents

| | |
|------------|--|
| OFF | Saving disabled |
| ON | Saving enabled |
| All CH set | Sets all channels ON or OFF (not displayed when [Other] is selected). See "Using [All CH Set]" (p. 16) |
| All OFF | Sets all selected items OFF. |
| All ON | Sets all selected items ON. |

When [Harmonic] is Selected

When [Harmonic] is selected for measurement contents to be saved, the output, highest, and lowest orders can be selected in addition to the items to be saved.



Out order

Select the orders for output.

| | |
|--------|------------------------------------|
| All | Selects all harmonic orders. |
| Odd | Selects only odd harmonic orders. |
| Even | Selects only even harmonic orders. |
| Return | Returns to previous page. |

Max order

Set the highest order to be output. Settable range is 0 to 100. This setting must be higher than the lowest order setting.

| | |
|-----------|-------------------------------|
| +1↑/-1↓ | Increment or decrement by 1. |
| +10↑/-10↓ | Increment or decrement by 10. |
| 100th | Sets to the 100th order. |

Min order

Set the lowest order to be output. Settable range is 0 to 100. This setting must be lower than the highest order setting.

| | |
|-----------|-------------------------------------|
| +1↑/-1↓ | Increment or decrement by 1. |
| +10↑/-10↓ | Increment or decrement by 10. |
| 0th | Sets the zero order (DC component). |

**Harm src
(Harmonic source)**

This setting stores the measured frequency of the harmonic sync source.

7.6 Saving Waveform Data

This operation saves the waveform displayed on the **[Wave + Noise]** page as a CSV file.

Setting Procedure

MEAS

Display the **[Wave + Noise]** page

F6
(saves the waveform at this moment)

| CH | rms (V) | pk |
|-----|---------|----------|
| CH1 | 99.99 | 141.72 |
| CH2 | 0.3381k | -141.72 |
| CH3 | 0.4579k | -0.4580k |
| CH4 | 0.0708k | -0.0993k |
| CH1 | 0.9281k | -1.305k |
| CH2 | 50.016 | 71.03 |
| CH3 | 0.2581k | -71.14 |
| CH4 | 0.3553k | -0.3559k |
| CH1 | 55.02 | 78.12 |
| CH2 | 28.42 | -78.26 |
| CH3 | 28.42 | 28.42 |
| CH4 | 28.49 | -28.49 |

Save destination: CF card, USB flash drive
(Save destination setting is the same as for Manual saving, (p. 108))

File names: Auto generated, with CSV extension
W3390nnn.CSV ("nnn" is serial number 000 to 999 within the same folder)
Example: W3390000.CSV

NOTE Waveform saving is not possible when auto-saving is enabled.

7.7 Saving Screen Capture Images

The currently displayed screen can be saved as a 256-color bmp bitmap file (BMP file name extension). If a printer is connected, monochrome printing is available. (p. 123)

Press **SHIFT** and **SAVE** to save a bitmap image of the current screen to the specified media.

Save destination: CF card, USB flash drive
(Save destination setting is the same as for Manual saving, (p. 108))

RS Connection: Printer
See "8.1 Connecting a Printer (to print captured screen images)" (p. 123)

File names: Auto generated, with CSV extension
H3390nnn.CSV ("nnn" is serial number 000 to 999 within the same folder)
Example: H3390000.CSV

NOTE

- Screen capture is not available when auto-saving is enabled.
- To save screen images to a CF card or USB flash drive, confirm that the **[RS connection]** on the **[Interface]** page of the Setting screen is not set to **[Printer]**. Otherwise, data is output only to the printer.
See"Making Printer Settings on the Instrument" (p. 125)

7.8 Saving Setting Configurations

Various instrument settings can be saved to storage media as "settings" files.

Save Procedure (Example: saving to a CF card folder)

FILE

Display the **[CF card]** page

keys to select a folder

or **ENTER** to open a folder

F1
(A dialog appears.)

keys to select a character

Enter characters with the **F** keys.

Enter: **F6**

Cancel: **ESC**

CF card

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Save setting **F1**

Load setting **F2**

Make folder **F3**

Copy to USB drive **F4**

F5

Next **F6**

CF card

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
Total size: 60.7MB Used size: 50.0KB Free size: 60.7MB

Input **F1**

BS **F2**

Del **F3**

Pos ← **F4**

Pos → **F5**

OK **F6**

File name: **SETTING**

0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z ^ _ !
% & ' () ~
()

Dialog Box Setting Items

| | |
|------------|--|
| Input | Enter the character at the cursor position. (Same as ENTER) |
| BS | Deletes the character to the left. |
| Del | Deletes the character at the cursor position. |
| Pos ←/Pos→ | Moves the cursor position. |
| OK | Accepts the entered file name. The dialog closes when accepted. |

| | |
|-------------------|---|
| Save destination: | CF card, USB flash drive (Save destination setting is the same as for Manual saving, (p. 108)) |
| File names: | User-named (up to eight characters), file name extension is SET Example: SETTING1.SET |

NOTE

- Language and communications settings are not saved.
- Setting configuration saving is not available during auto-saving.
- Folders within folders cannot be selected.

7.9 Reloading Setting Configurations

Previously saved settings can be reloaded from setting configuration files.

Loading Procedure (Example: loading a setting configuration file from a CF card folder)

FILE

Display the **[CF card]** page

keys to select a folder

or **ENTER** to open a folder

keys to select a setting configuration file

F2 (or **ENTER**)
(A dialog appears.)

Enter: **ENTER** .

Cancel: **ESC** / **On** .

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-02-06 18:20 | |
| 2 | HI9793 | Folder→ | 2009-02-06 18:36 | |

| No. | Name | Type | Date | Size |
|-----|--------------|---------|------------------|--------|
| 1 | H3390000.BMP | BMP | 2009-03-17 13:56 | 35.8KB |
| 2 | H3390001.BMP | BMP | 2009-03-17 13:56 | 35.8KB |
| 3 | SETTING.SET | Setting | 2009-03-17 13:56 | 968B |

NOTE If a setting configuration requires some combination of options, it will not load unless those same options are present.

7.10 File and Folder Operations

7.10.1 Creating Folders

Both auto-saving and manual saving require that a save destination folder be created.
Insert storage media before creating folders. (p. 104)

Creation Procedure

FILE

Display the [CF card] page

F3 (A dialog appears.)

keys to select a character

Enter characters with the F keys.

Enter: F6.

Cancel: ESC / On.

CF card

Media: CF card
Total size: 60.7MB Used size: 0B Free size: 60.7MB

Media: CF card
Total size: 60.7MB Used size: 0B Free size: 60.7MB

Dialog Box Setting Items

| | |
|------------|--|
| Input | Enter the character at the cursor position. (Same as <input type="button" value="ENTER"/>) |
| BS | Deletes the character to the left. |
| Del | Deletes the character at the cursor position. |
| Pos ←/Pos→ | Moves the cursor position. |
| OK | Accepts the entered file name. The dialog closes when accepted. |

- NOTE**
- Folder names may be up to eight characters.
 - Folders can only be created in the root folder.

7.10.2 Copying Files and Folders

Files can be copied between a CF card and USB flash drive.
 Insert the CF card and USB flash drive before copying. (p. 104)

File Copying Procedure (Example: copying the root files from a CF card to a folder on a USB flash drive)

FILE

Display the **[CF card]** page

keys to select the file

F4
 (The USB flash drive root folder contents appear in the dialog)

Press **ENTER** to accept

keys to select the folder to copy

ENTER or **ENTER** to open a folder

Copy: **F1** (or **ENTER**)
 Cancel Copy: **F6** (or **ESC/OFF**)
 (A dialog appears when copying is finished.)

ENTER

If a duplicate file name exists:
 A dialog appears to confirm overwriting.

To overwrite: **ENTER**

To cancel copying: **ESC/OFF**

Cannot overwrite the files saved in manual or auto saving (read only file.)

NOTE

- Files can be copied from folders on the source storage media.
- Files and folders can be copied to the root folder on the destination storage media.
- If a duplicate file exists at the destination, an error is displayed. Change the folder name and try again.
 See "7.10.4 Renaming Files and Folders" (p. 121)

Folder Copying Procedure (Example: copying a folder from a CF card to a USB flash drive)

FILE

Display the [CF card] page

keys to select the folder

F4 (A dialog appears.)

Copy: ENTER

Cancel Copy: ESC / ON

(A dialog appears when copying is finished.)

ENTER

CF card

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Save setting (F1)
Load setting (F2)
Make folder (F3)
Copy to USB drive (F4)
Next (F6)

If a duplicate folder exists :
If a duplicate folder exists at the destination, an error is displayed. Change the folder name and try again.
[See "7.10.4 Renaming Files and Folders" \(p. 121\)](#)

NOTE Folders can only be copied to the root folder.

7.10.3 Deleting Files and Folders

Files can be deleted from storage media.
Insert the storage media before deleting files. (p. 104)

Deleting Procedure (Example: deleting a file (or folder) from a CF card)

FILE

Display the [CF card] page

keys to select the file/folder to delete

Delete: **F2**

Cancel Deletion: **ESC / ⏏**

(The selected file or folder is deleted. Deleting a folder also deletes any files within it.)

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
 Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Buttons: Rename (F1), Delete (F2), Format (F3), Update (F4), Next (F6)

NOTE To delete a file within a folder, open the folder and select the file.
 See "Changing Folders, Selecting the Root Folder" (p. 105)

7.10.4 Renaming Files and Folders

Files on storage media can be renamed.
 Insert the storage media before renaming a file. (p. 104)

Renaming Procedure (Example: renaming a file (or folder) on a CF card)

FILE

Display the [CF card] page

keys to select the file or folder to rename

F1
(A dialog appears)

keys to select a character

Enter characters with the **F** keys.

Enter: **F6**

Cancel: **ESC** / **On**

CF card SB memory

| No. | Name | Type | Date | Size |
|-----|--------|---------|------------------|------|
| 1 | HI3390 | Folder→ | 2009-03-17 13:56 | |

Media: CF card
 Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Rename **F1**

Delete **F2**

Format **F3**

Update **F4**

F5

Next **F6**

CF card USB memory

| No. | Name | Type | Date | Size |
|-----|--------|------|------------------|------|
| 1 | HI3390 | | 2009-03-17 13:56 | |

Media: CF card
 Total size: 60.7MB Used size: 111KB Free size: 60.6MB

Input **F1**

BS **F2**

Del **F3**

Pos ← **F4**

Pos → **F5**

OK **F6**

Dialog Box Setting Items

| | |
|------------|--|
| Input | Enter the character at the cursor position. (Same as ENTER) |
| BS | Deletes the character to the left. |
| Del | Deletes the character at the cursor position. |
| Pos ←/Pos→ | Moves the cursor position. |
| OK | Accepts the entered file name. The dialog closes when accepted. |

NOTE

- Folder names may be up to eight characters.
- To rename a file within a folder, open the folder and select the file.
 See "Changing Folders, Selecting the Root Folder" (p. 105)

Connecting External Devices Chapter 8

8.1 Connecting a Printer (to print captured screen images)

Connect the Hioki 9670 Printer to the instrument's RS-232C interface to print captured screen images.
See [Printer option](#) (p. 2)



WARNING

Because electric shock and instrument damage hazards are present, always follow the steps below when connecting the printer.

- Always turn off the instrument and the printer before connecting.
- A serious hazard can occur if a wire becomes dislocated and contacts another conductor during operation. Make certain connections are secure.



CAUTION

- To use a cable other than the Hioki 9638 RS-232C Cable, the instrument-side connector body must be a molded type. The instrument's structure does not support metal plugs (with angled, instead of straight connector body).
- Avoid printing in hot or humid environments, as printer life could be greatly shortened.

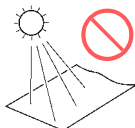
NOTE

- The instrument is able to initialize the 9670 Printer automatically.
- The instrument's RS-232C interface supports only Hioki 9670 Printer.
- See the manuals provided with the printer for operating instructions.

Handling and Storing Recording Paper

The recording paper is thermally and chemically sensitized.

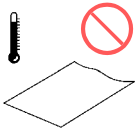
Observe the following precautions to avoid paper discoloration and fading.



Avoid exposure to direct sunlight.



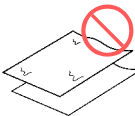
Avoid exposure to volatile organic solvents like alcohol, ethers and ketones.



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.

8.1 Connecting a Printer (to print captured screen images)

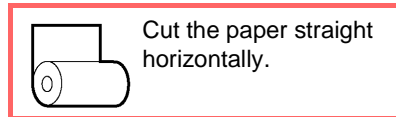
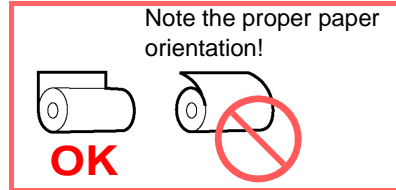
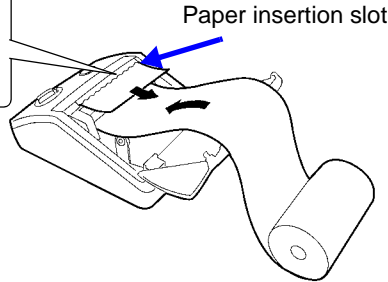
8.1.1 Printer Preparation and Connection

Loading Hioki 9237 Recording Paper in the Printer

Required items: Hioki 9237 Recording Paper

Procedure

Lift the printer head cover and load the paper through the insertion slot.



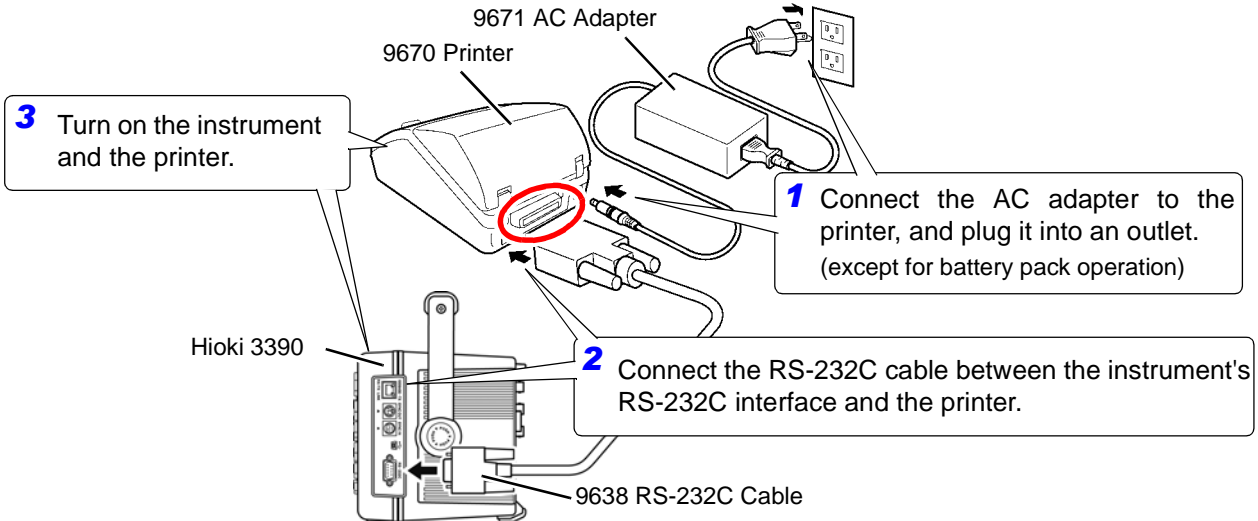
NOTE

- Use only Hioki-specified recording paper. Other papers may degrade performance or prevent printing.
- Paper jams may occur if the paper is skewed in the roller.
- Printing is not possible if the front and back of the recording paper are reversed.

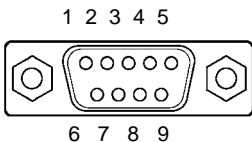
Connecting the Printer to the Instrument

Required items: Hioki 9671 AC Adapter (for Hioki 9670; not needed for battery pack operation), and 9638 RS-232C Cable

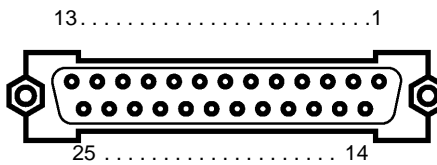
Procedure



RS232C Interface Pin-Out



Instrument Interface (9-pin)



Printer Interface (25-pin)

| Circuit | Signal | Pin No. | Pin No. | Signal | Circuit |
|---------------------------------|--------|---------|---------|--------|---------------------------------|
| Receive data | RxD | 2 | 2 | TxD | Transmit data |
| Transmit data | TxD | 3 | 3 | RxD | Receive data |
| Common ground for signal return | GND | 5 | 7 | GND | Common ground for signal return |
| Request to send | RTS | 7 | 4 | RTS | Request to send |
| Clear to send | CTS | 8 | 5 | CTS | Clear to send |

8.1 Connecting a Printer (to print captured screen images)

8.1.2 Settings to Use Printer

Making Printer Settings on the Instrument

Select the [Interface] page of the Setting screen.

Setting Procedure

SYSTEM

Display the [Interface] page

Select [RS connection]

F2

Select [RS com speed]

Use the F keys to select RS-232 speed (for printing).

Press F6 to perform. Printer auto set

Press ENTER.

Turn the printer off and back on.

About printer auto-setup
 Printer auto-setup makes the following printer settings automatically:
 Baud rate : RS-232 speed set on the instrument.
 International char : Display language set on the instrument.
 Auto Power Off : Disabled (OFF)

RS com speed

Printing speed indications are as follows.

| | |
|----------|-----------------------|
| 9600bps | Slow printing |
| 19200bps | Medium-speed printing |
| 38400bps | Fast printing |

NOTE

- Printer auto-setup supports only printer baud rates of 9600, 19200, and 38400 bps. Set the printer's baud rate to any of these speeds before auto-setup.
- When changing "RS connection", turn off and on the power of the instrument.

8.1 Connecting a Printer (to print captured screen images)

Model 9670 Printer Settings

See the instruction manual supplied with the printer for details.

- Following are setting examples for the printer to be used with the instrument.

```
BL-80RS II/RSII [VX.XX] XXXX/XX/XX
SANEI ELECTRIC INC.
*****
```

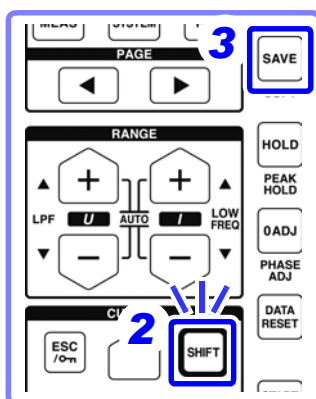
```
Data input = Serial
International char = U.S.A
Print mode = Graphic
Character set = 24Dot ANK Gothic type
Select switch = Available (ON)
Baud rate = 19200bps
Bit length = 8 bit
Parity= Non
Data control = SBUSY
Paper selection = Normal paper
Upright/inverted = Upright printing
Auto Power Off = Invalidation (OFF)
Battery mode= Invalidation (OFF)
Interface = RS232C
shr=0119 temp=026 shvp=718
```

- Factory default settings include Japanese (language), 9600 bps (baud rate), and auto power off (after 90 minutes).
- When executing printer auto-setup (p. 125), the language, baud rate and auto power off settings are automatically made from the instrument.
- Be aware that changing other settings may prevent printing screen captures.

8.1.3 Printing Screen Captures

To capture and print an image of the screen:

Procedure



1. Display the screen to be printed.

2. Press  (blue key)

3. Press .

An image of the screen (as it appears when the key is pressed) is printed out.

NOTE

- Screen capture images can be saved as image files to a CF card or USB flash drive (p. 114), instead of sending to the printer. To do this, set the **[RS connection]** (p. 125) to any setting other than Printer.
- Screen capture is disabled during printing. Wait for printing to finish before capturing another screen.
- Do not change the settings of **[RS connection]** and "RS com speed" as well as do not execute "Printer auto set" while printing.

8.2 Connecting a Thermometer (to acquire temperature data)

Temperature data can be acquired from a thermometer connected to the instrument's RS-232C interface. Acquired data can be displayed and saved to CF card together with other measurement data.



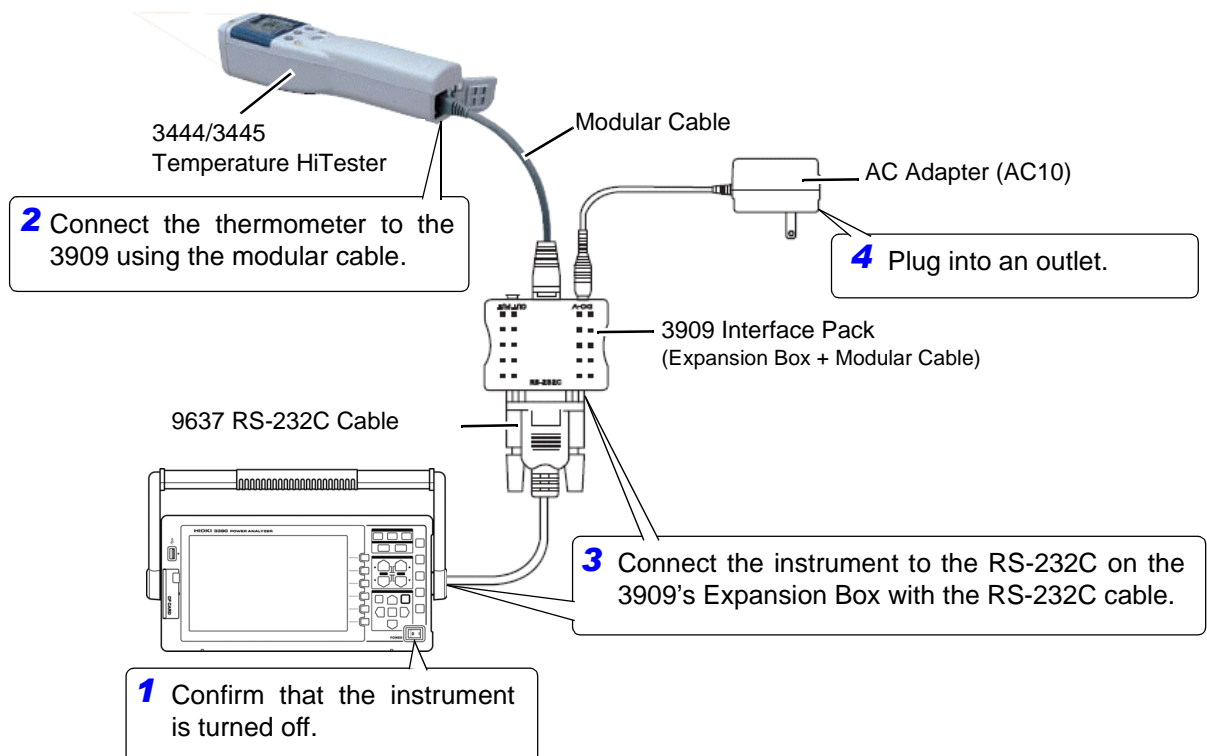
We recommend using the following models with known compatibility:

- 3444 Temperature HiTester+3909 Interface Pack+9637 RS-232C Cable
- 3445 Temperature HiTester+3909 Interface Pack+9637 RS-232C Cable

Connecting a Thermometer to the Instrument

Required items: Hioki 9637 RS-232C Cable, 3444 Temperature HiTester (or 3445 Temperature HiTester), 3909 Interface Pack, AC Adapter (AC10, accessories for Models 3444 and 3445)

Procedure



8.2 Connecting a Thermometer (to acquire temperature data)

Thermometer Settings on the Instrument

Make settings on the **[Interface]** page of the Setting screen.

Setting Procedure

The diagram illustrates the steps to reach the 'Thermo' setting:

- Press **[SYSTEM]** to display the **[Interface]** page.
- Use the navigation keys to select **[RS connection]**.
- Press **[F3]** to select **Thermo** as the RS connection type.

The screenshot shows the 'Interface' page with the following settings:

- Sync control: Master
- Media: CF card
- Folder: HI3390
- Auto save mode: OFF
- Items to save: 35/5000
- Interval: 1min
- RS connection: **Thermo**
- RS com speed: 2400bps
- IP address: 192.168.1.1
- Subnet mask: 255.255.255.0

On the right side of the screen, function keys F1 through F6 are visible, with F3 highlighted.

NOTE

- Turn off and on the power again after changing **[RS connection]**.
- When the **[RS connection]** is set to Thermometer, the communications speed is fixed at 2400 bps.
- When there is no communication with the thermometer, or when no temperature data can be acquired, measurement data is displayed as "-----".

Unit Setting for Temperature

Press **[SYSTEM]**, **[ESC / On]** and **[F3]** keys simultaneously, so that the unit for temperature can be selected between deg.C and deg.F.

Acquiring Temperature Data

Turn on the thermometer and the instrument.

When thermometer measurement starts, temperature data is acquired by the instrument.

NOTE

- See the instruction manual supplied with the thermometer for operating details.
- During temperature measurement, the Hold function on the thermometer is disabled. Use the instrument's Hold functions instead. "5.3.1 Data Hold Function" (p. 94)

To display the temperature, select **[OPT.] - [Temp]** as the **[Select]** on the **[Select]** page of the Measurement screen.

See "Selecting Measured Items for Display" (p. 38)

Saving Temperature Data

Refer to "Chapter 7 Data Saving and File Operations" (p. 103).

8.3 Connecting Multiple 3390 (Synchronized Measurements)

Up to four 3390 can be connected with optional Hioki 9683 Connection Cable (for synchronous measurements). When so connected, one 3390 operates as master over the others set as slaves, providing multi-instrument synchronous measurements.

The maximum delay of synchronization is 5µs/connection and is 5µs+50ms for synchronization event. The timing control functions can be applied to synchronous measurements.

See "5.1 Timing Control Functions" (p. 91)

The slave 3390s are synchronized by the master 3390 for the following operations.

- Clock and data update timing (slaves match clock and data update timing)
- Timing control, integration start/stop and data reset (the **START/STOP** and **DATA RESET** keys on the master also control the slaves)
- Events (select from data hold, data saving, or screen capture)

CAUTION

- To avoid damaging the instrument, do not insert or remove connectors while the power is on.
- Establish a one-point common earth ground point for all instruments in the measurement system. Different grounding points could allow dangerous potential differences between the GND terminals of the master and slaves. If sync cables are connected under such conditions, malfunctions or damage could occur.

NOTE

Display the MEAS screen on both master and slave units, when executing time control, integration start/stop, data reset, and HOLDing event.

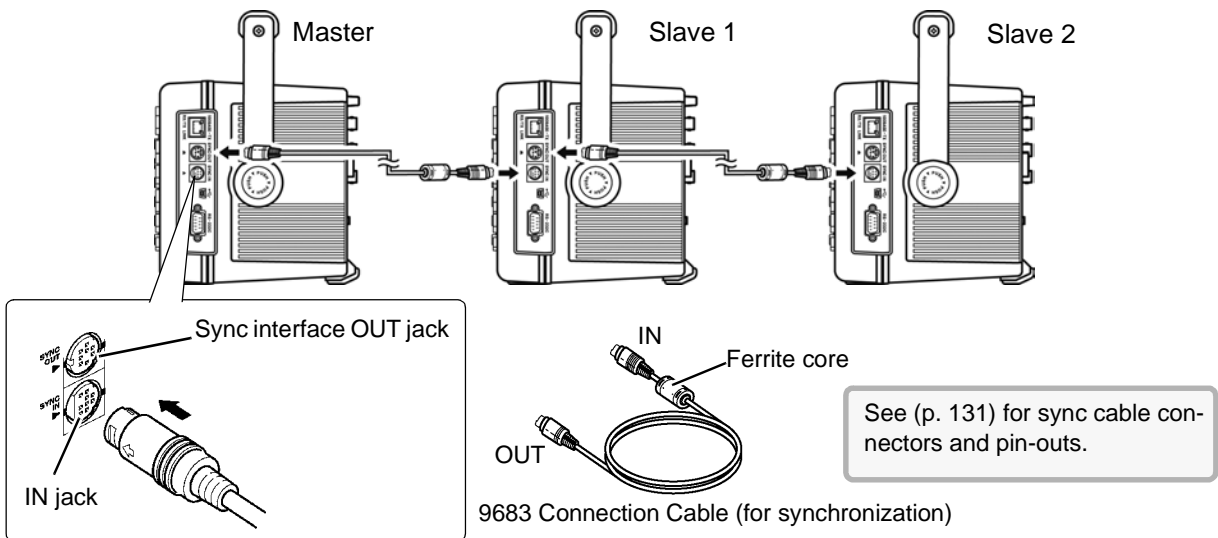
Connecting Multiple 3390 with Sync Cables

This description uses an example of three 3390.

Required items: Three 3390s, two Model 9683 Connection Cables

Procedure

1. Verify that all 3390s are turned off.
2. As shown below, connect the sync cables between the OUT and IN terminals of the master and each slave.
3. Turn each instrument on in the following order: master, slave 1, slave 2 (turn the instruments off in the reverse order).



NOTE

- As a single measurement system, settings are made only on the master.
- During synchronous control, the 9683 Connection Cable conduct control signals. Never disconnect a sync cable during synchronous control, as the control signals would be interrupted.
- The IN and OUT ends of the 9683 Connection Cable are different. Do not apply excessive insertion force.
- Turning slaves on first may result in synchronization errors.

8.3 Connecting Multiple 3390 (Synchronized Measurements)

Instrument Settings for Synchronous Measurement

Set each instrument to be either the master or a slave. These settings are made on the **[Interface]** page of the Setting screen.

Setting Procedure

Display the **[Interface]** page

Select **[Sync control]**

Select with the **F** keys

Select **[Sync event]**

Select with the **F** keys

Reboot the instrument when changing from master to slave.

Sync event Select the events to be synchronized (master settings are reflected on the slaves)

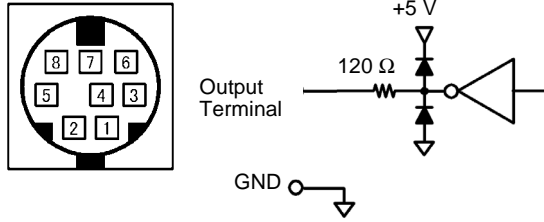
| | |
|------|---|
| HOLD | Pressing HOLD on the master activates Data Hold on all instruments. |
| SAVE | Pressing SAVE on the master executes manual saving on all instruments. |
| COPY | Pressing SHIFT + SAVE on the master captures the screen image on all instruments. |

- NOTE**
- The RTC clock time, timer, and clock control start and stop times cannot be set on the slave instruments.
 - Selecting **[SAVE]** or **[COPY]** as a synchronized event sets the manual save destination folder appropriately and records data on each 3390. See "7.5.1 Manually Saving Measurement Data" (p. 108), "7.7 Saving Screen Capture Images" (p. 114)
 - To save measurement data to storage media with an interval time control combination, set the same interval setting on the master and all slaves, and enable auto-saving (set to ON). In this case, selecting **[SAVE]** as a synchronous event has no effect. See "5.1 Timing Control Functions" (p. 91), "7.5.2 Auto-Saving Measurement Data" (p. 110)
 - Confirm no error display on the slave unit's screen when executing the synchronization event.

8.3 Connecting Multiple 3390 (Synchronized Measurements)

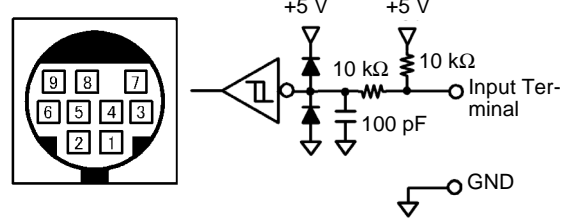
Sync Cable Pin-Outs

Sync Output (OUT): 8-pin mini-DIN plug pin configuration



| Pin No. | I/O | Function |
|---------|-----|---|
| 1 | O | Data Reset 0 for data reset |
| 2 | O | Start/Stop Integration 0: Start, 1: Stop |
| 3 | O | 1-s clock |
| 4 | O | Event 0 for valid event |
| 5 | I | Master/Slave setting |
| 6 | - | Unused |
| 7 | I/O | GND |
| 8 | I/O | GND |

Sync Input (IN): 9-pin mini-DIN plug pin configuration



| Pin No. | I/O | Function |
|---------|-----|---|
| 1 | I | Data Reset 0 for data reset |
| 2 | I | Start/Stop Integration 0: Start, 1: Stop |
| 3 | I | 1-s clock |
| 4 | I | Event 0 for valid event |
| 5 | O | Master/Slave setting |
| 6 | - | Unused |
| 7 | I/O | GND |

8.4 Using Analog and Waveform D/A Output Options (must be factory installed before shipping)

The instrument can provide analog (p. 135) or waveform output (p. 135) using one of the following D/A output options (specified before factory shipping).

- 9792 D/A Output Option
- 9793 Motor Testing & D/A Output Option

Both output options provide 16 output channels selectable from the basic measurement items.



WARNING

To avoid electric shock and short circuits, turn the instrument and measurement line power off before connecting or disconnecting D/A outputs.



CAUTION

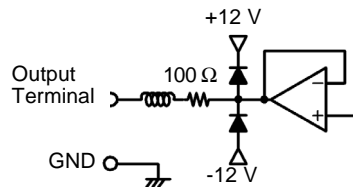
- To avoid damage to the instrument, do not short-circuit or apply voltage between outputs.
- The outputs are not isolated from one another.

8.4.1 Connecting Application-Specific Devices to the Instrument

Use a mating D-sub connector to connect the D/A outputs to the desired device (oscilloscope, data logger/recorder).

To be safe, always turn off the instrument and devices before making connections. Turn the instrument and devices on after confirming the connections.

Output Circuit



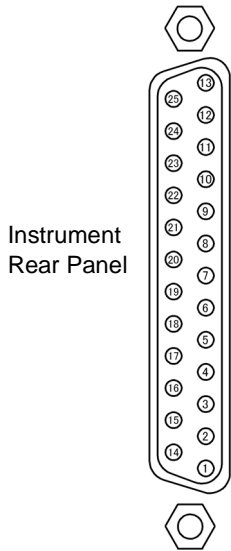
NOTE

The impedance of each output is approximately 100 Ω , so the inputs of the recording, DMM or other device to be connected should be high impedance (at least 1 M Ω).

See "Chapter 10 Specifications" (p. 149)

8.4 Using Analog and Waveform D/A Output Options (must be factory installed before)

D/A Output Connector Pin-Out

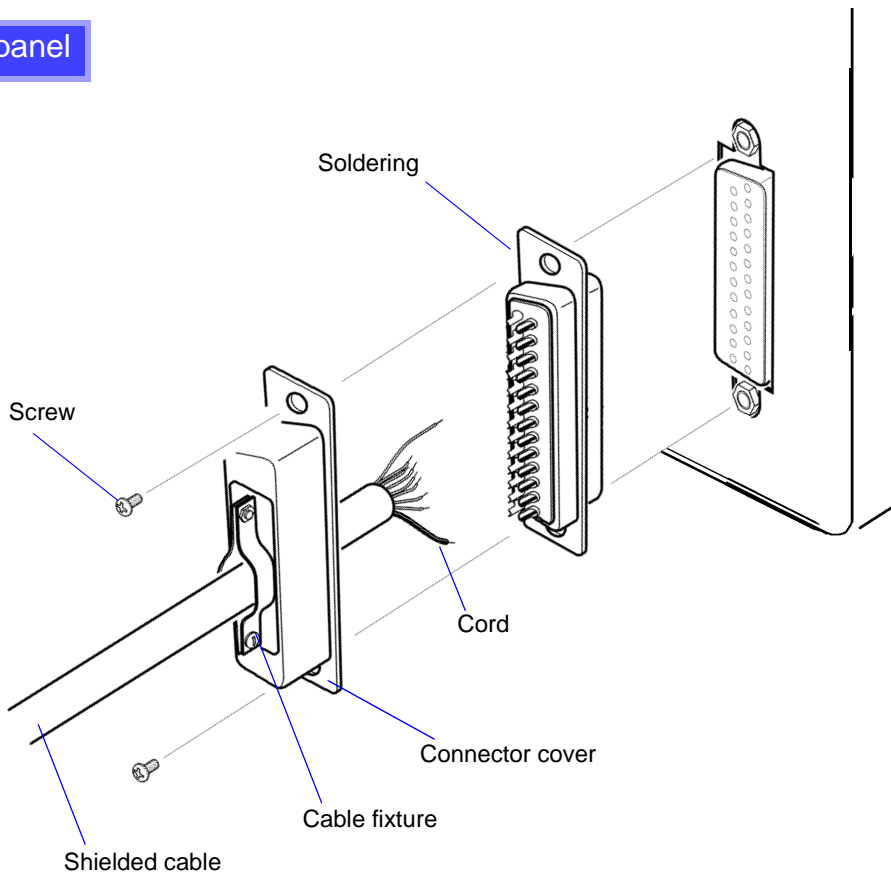


| Pin No. | Output () waveform output content | Pin No. | Output |
|---------|------------------------------------|---------|--------|
| 1 | GND | 14 | GND |
| 2 | D/A1 (U1) | 15 | D/A9 |
| 3 | D/A2 (I1) | 16 | D/A10 |
| 4 | D/A3 (U2) | 17 | D/A11 |
| 5 | D/A4 (I2) | 18 | D/A12 |
| 6 | D/A5 (U3) | 19 | D/A13 |
| 7 | D/A6 (I3) | 20 | D/A14 |
| 8 | D/A7 (U4) | 21 | D/A15 |
| 9 | D/A8 (I4) | 22 | D/A16 |
| 10 | GND | 23 | GND |
| 11 | GND | 24 | GND |
| 12 | GND | 25 | GND |
| 13 | GND | | |

How to connect D/A output terminals

Use the supplied connector (DB-25P-NR, D819678-2R Japan Aviation Electronics Industry,Ltd) or equivalent connector to connect to the external control and output terminals.

Rear panel



NOTE

- Solder the cord securely.
- Fix the connector and connector cover by the supplied screws (M2.6x6).
- Hold the connector cover when connecting or disconnecting the connector.
- Use the shielded cable for output and external control.
- Connect to the connector cover or cable fixture if the cable's shield is not grounded.

8.4.2 Output Item Selection

Select the items for D/A output. Up to 16 items can be selected.
Make the settings on the [D/A Out] page of the Setting screen.

Setting Procedure

SYSTEM

Display the [D/A Out] page

Select [Wave output]

Select with the F keys

ON: Enable waveform output
OFF: Disable waveform output

Select a channel to be set.

F1 (the pull-down menu appears)

Select parameter items (sub parameter last)

Enter: F1 or ENTER
Cancel: F6 or ESC/On

D/A Out

Wave output ON

Output items

CH1 CH9 Urms1

CH2 CH10 Urms1

CH3 CH11 Urms1

CH4 CH12 Urms1

CH5 CH13 Urms1

CH6 CH14 Urms1

CH7 CH15 Urms1

CH8 CH16 Urms1

Set the waveform monitor output mode. When the mode is ON, the output items are fixed as in below. CH1:U1, CH2:I1, ... CH7:U4, CH8:I4

Wave output ON

Freq f.s. 5kHz

Integ f.s. 1/1

Output items

CH1 CH9 Urms1

CH2 CH10 Urms1

CH3 CH11 Urms1

CH4 CH12 Urms1

CH5 CH13 Urms1

CH6 CH14 Urms1

CH7 CH15 Urms1

CH8 CH16 Urms1

Main parameter

Sub parameter

Pull-Down Menu

Select the sub parameter.

Freq f.s. Set this to output frequency in the analog output.

100 Hz, 500 Hz, 1 kHz, 5 kHz

When a motor analysis option is installed, this is the same as the maximum motor measurement frequency setting. ("Max frequency" (p. 88))

Integ f.s. Set for analog outputs. ("About Full-Scale Integration" (p. 135))

1/10, 1/2, 1/1, 5, 10, 50, 100, 500, 1000, 5000, 10000

- NOTE**
- Waveform output can be selected only for channels D/A1 to D/A8. Channels D/A9 to D/A16 are for analog output only.
 - Items selected on the MEAS, SYSTEM or FILE screen are always output.

8.4 Using Analog and Waveform D/A Output Options (must be factory installed before)

About Analog Outputs

- Instrument measurement values are output as level-converted DC voltages.
- Voltage and current (sensor) inputs are isolated from the outputs.
- Select a basic measurement item for each of up to 16 outputs, or for up to eight waveform outputs.
- Long-term trend recording is available by connecting a data logger or recorder.

| Specifications | |
|------------------------|--|
| Output voltage | ±5 V DC (approx. ±12 V max. See "Output Level" (p. 136) for the output ratings of each item) |
| Output impedance | 100 Ω ±5 Ω |
| Output update rate | 50 ms (depending on data update rate of selected item) |
| Full-scale frequency | 100 Hz, 500 Hz, 1 kHz, 5 kHz (same as the maximum motor measurement frequency setting) |
| Full-scale integration | (1/10, 1/2, 1/1, 5, 10, 50, 100, 500, 1000, 5000, 10000) × range |

NOTE

- Positive and negative over-range voltages are approximately +6 and -6 V, respectively. (For voltage and current peaks are about 5.3 V.)
- Maximum output voltage is approximately ±12 V.
- When using VT or CT ratio, the output is ±5 V DC at the "VT/CT ratio × range".
- When HOLDing, peak HOLDing or averaging, the output value is the result of these functions.
- During data hold when an interval time is set, outputs are updated after each interval.
- When auto-ranging is enabled, the analog output levels change with auto-ranging. Be careful to avoid range conversion mistakes when measuring rapidly fluctuating values. Such mistakes can be avoided by using a fixed, manually selected range.
- Harmonic analysis data other than the basic measurement items is not available for output.

About Full-Scale Integration

The full-scale value is set for the analog output in integration. For example, when the integration value is less than the full scale value, the time for the integration value to reach full-scale is long, so D/A output voltage changes slowly. Conversely, when the integration value is larger than the full-scale value, the time to reaching the full-scale value becomes short, and D/A output voltage changes quickly. The full scale value of integrated power can be changed for the D/A output by setting the integration full scale.

About Waveform Outputs

- Output signals are waveforms of the instantaneous values of input voltages and currents.
- Voltage inputs and current sensor inputs are mutually isolated.
- Combine with an oscilloscope to observe waveforms of phenomena such as device inrush current.

| Specifications | |
|--------------------|---------------------------------|
| Output voltage | ±2 V Crest Factor 2.5 or higher |
| Output impedance | 100 Ω ±5 Ω |
| Output update rate | 500 kHz |

NOTE

- D/A1: U1, D/A2: I1, D/A3: U2, D/A4: I2, D/A5: U3, D/A6: I3, D/A7: U4, D/A8: I4
- Waveform clipping occurs at approximately ±7 V.
- Maximum output voltage is approximately ±12 V.
- When using VT or CT ratio, the output is ±2V at "VT/CT ratio × range".
- Waveform output consists of uninterrupted instantaneous values, regardless of data hold, peak hold, or averaging operations.
- When auto-ranging is enabled, the analog output levels change with auto-ranging. Be careful to avoid range conversion mistakes when measuring rapidly fluctuating values. Such mistakes can be avoided by using a fixed range.

8.4 Using Analog and Waveform D/A Output Options (must be factory installed before

8.4.3 Output Level

Full-scale D/A output span is ± 5 V DC. This corresponds to the full-scale measurement input spans as follows.

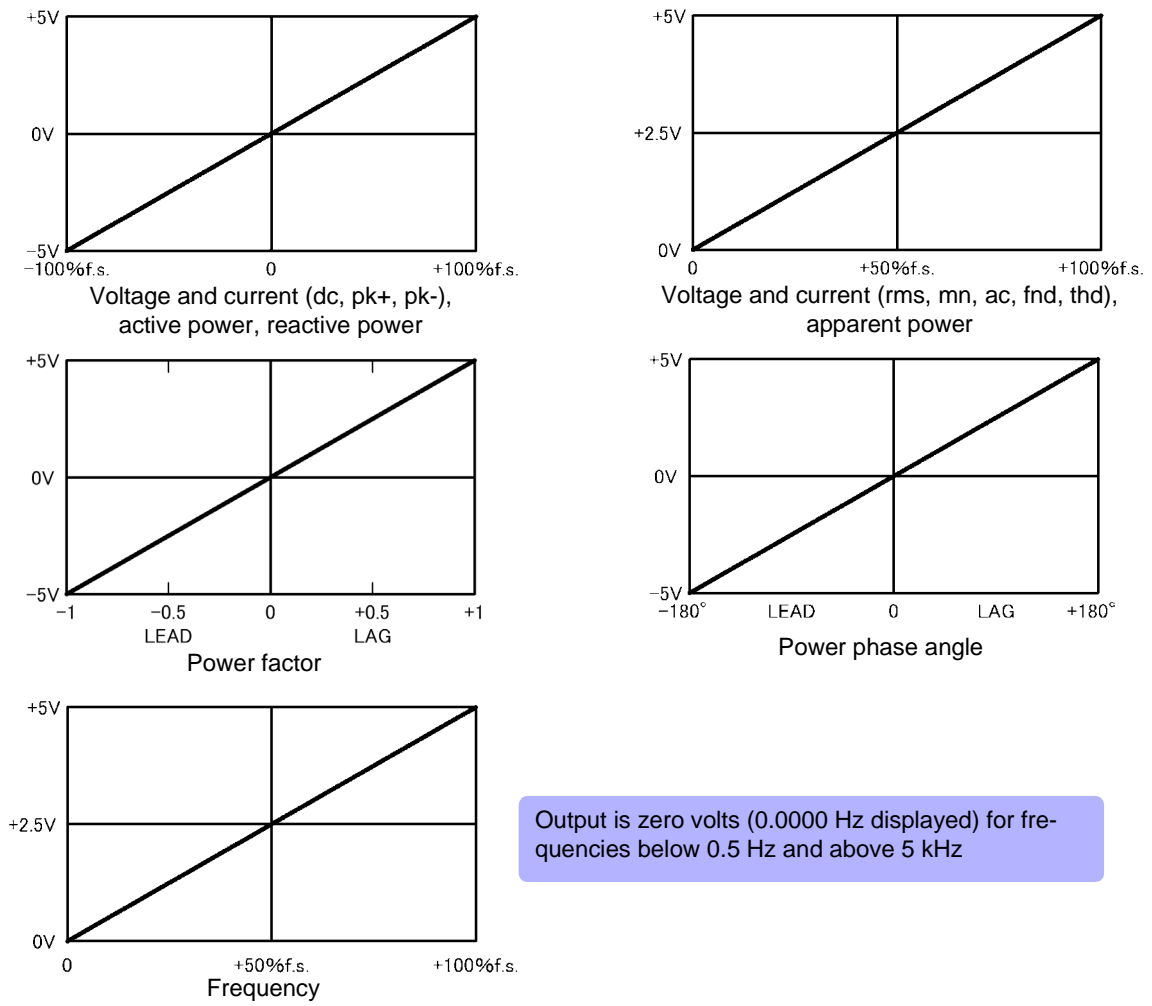
| Selected Output Item | Full Scale |
|---|---|
| Voltage and current of each channel, Sum of voltage and current (dc, pk+ and pk- for each U1 to U4, I1 to I4, U12, U34, U123, I12, I34, or I123) Motor analysis options, temperature (chA, Pm, Temp) | Measurement range (with polarity) D/A output value -100%f.s. to 0 to +100%f.s. → -5 V to 0 to +5 V |
| Voltage and current of each channel, Sum of voltage and current (rms, mn, ac and fnd of each U1 to U4, I1 to I4, U12, U34, U123, U12, I34 or I123) Motor analysis options (chB) | Measurement range (with polarity) D/A output value 0 to +100%f.s. → 0 to +5 V |
| Active, reactive, and apparent power on each channel (P1 to P4, Q1 to Q4, S1 to S4) Apparent power has no polarity | (voltage range) × (current range) For example, measuring in the 300 V and 10 A ranges supports 3 kW full-scale active power measurements. Active power D/A output value -3 kW to 0 to +3 kW → -5 V to 0 to +5 V Apparent power D/A output value 0 to +3 kVA → 0 to +5 V |
| Sum of active power, reactive power and apparent power in the 1P3W, 3P3W2M or 3P3W3M measurement. (P12, P34, Q12, Q34, S12, S34, P123, Q123, S123) Apparent power has no polarity | (voltage range) × (current range) × 2 For example, measuring in the 300 V and 10 A ranges supports 6 kW full-scale active power measurement. Active power D/A output value -6 kW to 0 to +6 kW → -5 V to 0 to +5 V Apparent power D/A output value 0 to +6 kVA → 0 to +5 V |
| Sum of active power, reactive power and apparent power in the 3P4W measurement. (P123, Q123, S123) Power factor has no polarity | (voltage range) × (current range) × 3 For example, measuring in the 300 V and 10 A ranges supports 9 kW full-scale active power measurement. Active power D/A output value -9 kW to 0 to +9 kW → -5 V to 0 to +5 V Apparent power D/A output value 0 to +9 kVA → 0 to +5 V |
| Power factor (λ) | Power factor D/A output value -1 to 0 to +1 → -5 V to 0 to +5 V |
| Power phase angle (ϕ) | Power phase angle D/A output value -180° to 0 to +180° → -5 V to 0 to +5 V |
| Efficiency (η) | Efficiency D/A output value 0 to 200% → 0 to +5 V |
| Current integration (Ih) | (current range) × (full-scale integration) For example, integrating for one hour in the 10 A range supports 10 Ah full-scale current integration measurement. Current integration D/A output value -10 Ah to 0 to +10 Ah → -5 V to 0 to +5 V |
| Active power integration (WP) in 1P2W | (voltage range) × (current range) × (full-scale integration) For example, integrating for one hour in the 300 V and 10 A ranges supports 3 kW full-scale active power integration measurements. Active power integration D/A output value -3 kWh to 0 to +3 kWh → -5 V to 0 to +5 V |
| Active power integration (WP) in 1P3W, 3P3W2M, and 3P3W3M | (voltage range) × (current range) × (full-scale integration) × 2 For example, integrating for one hour in the 300 V and 10 A ranges supports 6 kWh full-scale active power integration measurements. Active power integration D/A output value -6 kWh to 0 to +6 kWh → -5 V to 0 to +5 V |
| Active power integration (WP) in 3P4W | (voltage range) × (current range) × (full-scale integration) × 3 For example, integrating for one hour in the 300 V and 10 A ranges supports 9 kWh full-scale active power integration measurements. Active power integration D/A output value -9 kWh to 0 to +9 kWh → -5 V to 0 to +5 V |
| Frequency (f1 to f4) | Full-scale frequency is full scale. |

NOTE

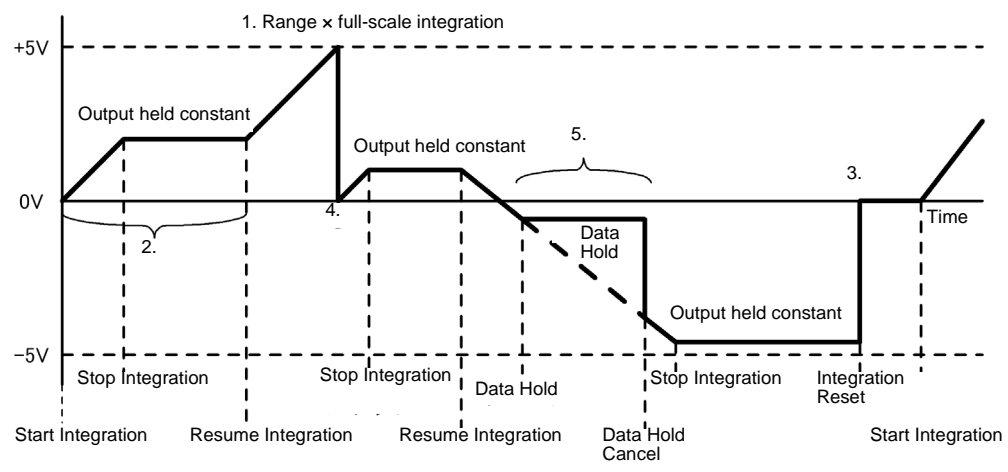
Refer to “10.4.1 Basic Measurement Items (p. 162) for items not listed in the above.

8.4 Using Analog and Waveform D/A Output Options (must be factory installed before)

8.4.4 D/A Output Examples



Output is zero volts (0.0000 Hz displayed) for frequencies below 0.5 Hz and above 5 kHz



Current and Active Power Integration

1. Analog output of the integration value is 5 V, which is the product of measurement range x full-scale integration.
For example, when full-scale integration is set to 10 with the 300 W range, 3 kWh (300W x10), 6 kWh (300W x 10 x 2), and 9 kWh (300 W x 10 x 3) are all output as 5 V. (Multiples of -3 kWh are -5 V.)
2. Analog output changes when integration starts, and is held constant after integration stops.
3. The integration value is reset, and analog output becomes 0 V.
4. When the integration value exceeds ±5 V, analog output becomes 0 V and changes proceed from there.
5. When the data hold is activated during integration, analog output is held constant. However, when data hold is canceled, analog output returns to the actual integration value.

8.5 Using the Motor Testing Option (when specified before factory shipping, for motor analysis)

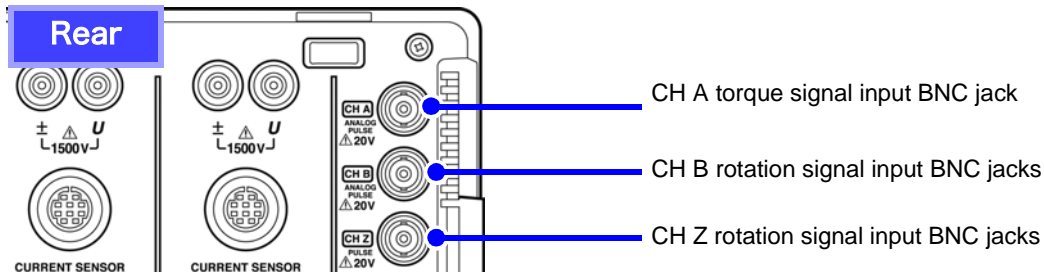
Motor analysis can be performed when the Hioki 9791 Motor Testing Option or the 9793 Motor Testing & D/A Output Option (referred to below as the motor analysis function) is installed.

Use the motor analysis function to measure torque, rotation rate, motor power and slip by acquiring signals from a tachometer, torque sensor or (incremental) revolution encoder.

Connecting a Torque Meter and Tachometer

When the motor analysis function is installed, apply torque signals to the CH A jack, and rotary encoder signals to CH B and CH Z jacks (isolated BNC jacks are on the rear of the instrument).

CH A, CH B and CH Z jacks are isolated to support torque meters and tachometers with different ground potentials.



WARNING

To avoid electric shock and damage to the instrument, observe the following when connecting to the CH A torque signal input BNC jack and the CH B and CH Z rotary signal input BNC jacks.

- Before connecting, turn off the instrument and any devices to be connected.
- Do not exceed the maximum input signal ratings.
- A serious accident could result if a plug falls out and contacts another conductor during operation. Ensure that all connections are secure.

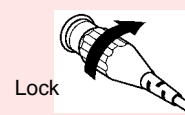
CAUTION

When disconnecting a BNC plug, always grip the plug and release the lock before pulling it out. Attempting to pull out a plug without releasing the lock, or pulling hard on the cable, will damage the connectors.

Connect the instrument and input devices using Hioki L9217 Connection Cords.

Guide pins on instrument jack

Notches on BNC plug



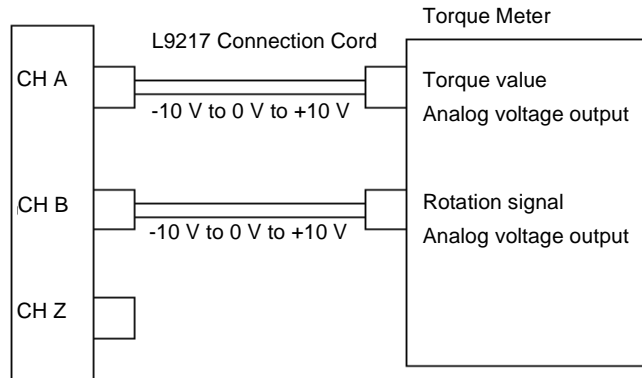
Required items: Hioki L9217 Connection Cords (as needed), input devices

Procedure

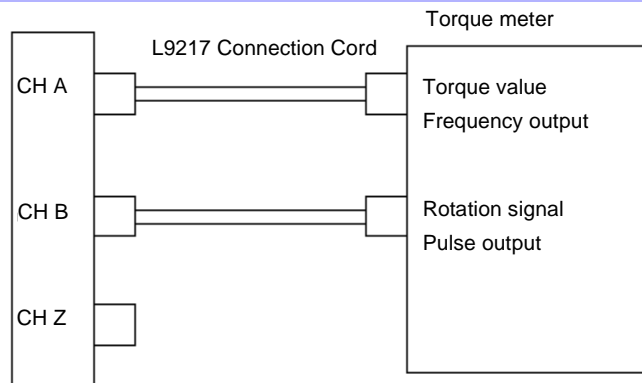
1. Confirm that the instrument and input devices are turned off.
2. As shown in the examples on the next page, connect the output jacks on the input devices to the instrument using the connection cords.
3. Turn the instrument on.
4. Turn the connected devices on.

8.5 Using the Motor Testing Option (when specified before factory shipping, for motor)

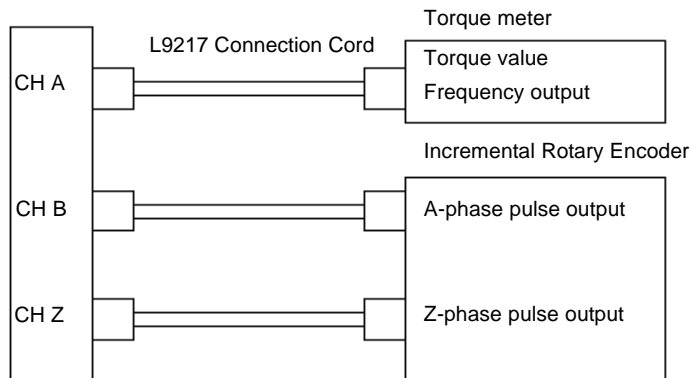
Example 1. Connecting a torque meter that provides analog torque values and rotation signals



Example 2. Connecting a torque meter that provides torque values as frequency and rotation signals as pulses



Example 3. Connecting a torque meter that provides torque values as frequency and incremental rotary encoder signals



NOTE

- CHPulse measurement is not available with CH Z only. Always use pulse input to CH B in combination with CH Z.
- When using CH Z (original position signal or Z-phase), apply a train of at least four pulses to CH B.

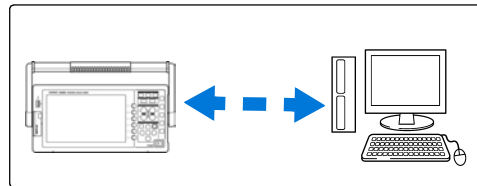
Motor Analysis Settings on the Instrument, Displaying Measured Values

See section "4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)" (p. 82) for measurement displays and instrument setting procedures.

Operation with a Computer

Chapter 9

The instrument includes standard USB and Ethernet interfaces to connect a computer for remote control. The instrument can be controlled by communication commands, and measurement data can be transferred to the computer using the dedicated application program.



Ethernet ("LAN") Connection Capabilities

- Control the instrument remotely by internet browser. (p. 146)
- Control the instrument remotely with communication commands (by creating a program and connecting to the TCP/IP communication command port)
- Control the instrument remotely using the dedicated application program to transfer measurement data to the computer.

USB Connection Capabilities

- Control the instrument remotely using the dedicated application program to transfer measurement data to the computer (the program's USB driver must be installed on the computer).

NOTE

Download the application program (with operating manual) and the communication command manual from Hioki's web page (<http://www.hioki.com>).

9.1 Control and Measurement via Ethernet ("LAN") Interface

Remote control is available by internet browser. Measurement data is transferred to the computer by using the dedicated software.

Before communicating, configure the instrument's LAN settings for the network environment, and connect the instrument to a computer with the Ethernet cable.

- NOTE**
- See the application program's operating manual for operating procedures.
 - See the command communication manual for command communication procedures. (Both are downloadable from <http://www.hioki.com>).

9.1.1 LAN Settings and Network Environment Configuration

Configure the Instrument's LAN Settings

- NOTE**
- Make these settings before connecting to a network. Changing settings while connected can duplicate IP addresses of other network devices, and incorrect address information may otherwise be presented to the network.
 - The instrument does not support DHCP (automatic IP address assignment) on a network.

Making Network Settings

Diagram illustrating the navigation steps:

- 1. Press **SYSTEM**.
- 2. Use left/right arrows to **Display the [Interface] page**.
- 3. Use the directional pad to **select a setting item**.
- 4. Press **F** keys to **Select with the F keys**.

Reboot the instrument when changing the network settings.

| | |
|-------------|----------------------------|
| +1↑/-1↓ | Increment/decrement by 1 |
| +10↑/-10↓ | Increment/decrement by 10 |
| +100↑/-100↓ | Increment/decrement by 100 |

9.1 Control and Measurement via Ethernet ("LAN") Interface

Setting Items

- IP address** Identifies each device connected on a network. Each network device must be set to a unique address. The instrument supports IP version 4, with IP addresses indicated as four decimal octets, e.g., "192.168.0.1".
- Subnet mask** This setting is used to distinguish the address of the network from the addresses of individual network devices. The normal value for this setting is the four decimal octets "255.255.255.0".
- Default Gateway** When the computer and instrument are on different but overlapping networks (subnets), this IP address specifies the device to serve as the gateway between the networks. If the computer and instrument are connected one-to-one, no gateway is used, and the instrument's default setting "0.0.0.0" can be kept as is.

Network Environment Configuration

Example 1. Connecting the instrument to an existing network

To connect to an existing network, the network system administrator (IT department) has to assign settings beforehand.

Some network device settings must not be duplicated.

Obtain the administrator's assignments for the following items, and write them down.

| | |
|-----------------|-------|
| IP Address | _____ |
| Subnet Mask | _____ |
| Default Gateway | _____ |

Example 2. Connecting multiple instruments to a single computer using a hub

When building a local network with no outside connection, the following private IP addresses are recommended.

Configure the network using addresses 192.168.1.0 to 192.168.1.24

IP Address Computer:192.168.1.1
 Power Analyzers: assign to each instrument in order 192.168.1.2, 192.168.1.3, 192.168.1.4, ...

Subnet Mask 255.255.255.0

Default Gateway 0.0.0.0

Example 3. Connecting one instrument to a single computer using the 9642 LAN Cable

The 9642 LAN Cable can be used with its supplied connection adapter to connect one instrument to one computer, in which case the IP address is freely settable. Use the recommended private IP addresses.

IP Address Computer:192.168.1.1
 Power Analyzers:192.168.1.2 (Set to a different IP address than the computer.)

Subnet Mask 255.255.255.0

Default Gateway 0.0.0.0

9.1 Control and Measurement via Ethernet ("LAN") Interface

9.1.2 Instrument Connection

Connect the instrument to the computer using an Ethernet LAN cable.

Required items: **When connecting the instrument to an existing network**

(prepare any of the following):

- Straight-through Cat 5, 100BASE-TX-compliant Ethernet cable (up to 100 m, commercially available). For 10BASE communication, a 10BASE-T-compliant cable may also be used.
- Hioki 9642 LAN Cable (option)

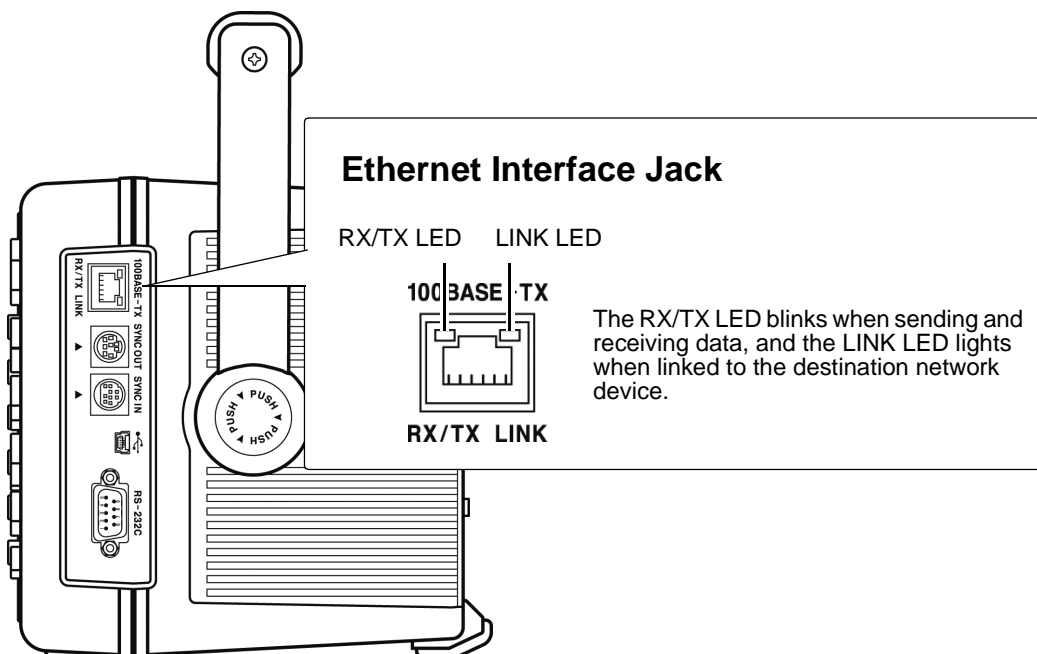
When connecting one instrument to a single computer

(prepare one of the following):

- 100BASE-TX-compliant cross-over cable (up to 100 m)
- 100BASE-TX-compliant straight-through cable with cross-over adapter (up to 100 m)
- Hioki 9642 LAN Cable (option)

Instrument Ethernet ("LAN") interface

The Ethernet interface jack is on the right side.

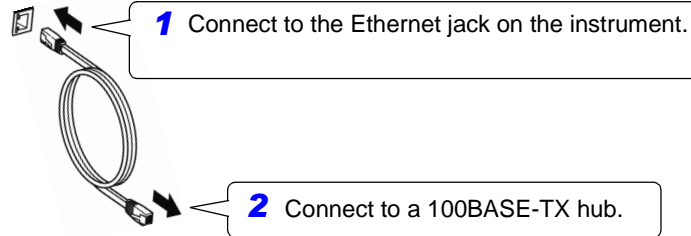


9.1 Control and Measurement via Ethernet ("LAN") Interface

Connecting the Instrument to a Computer with an Ethernet ("LAN") Cable

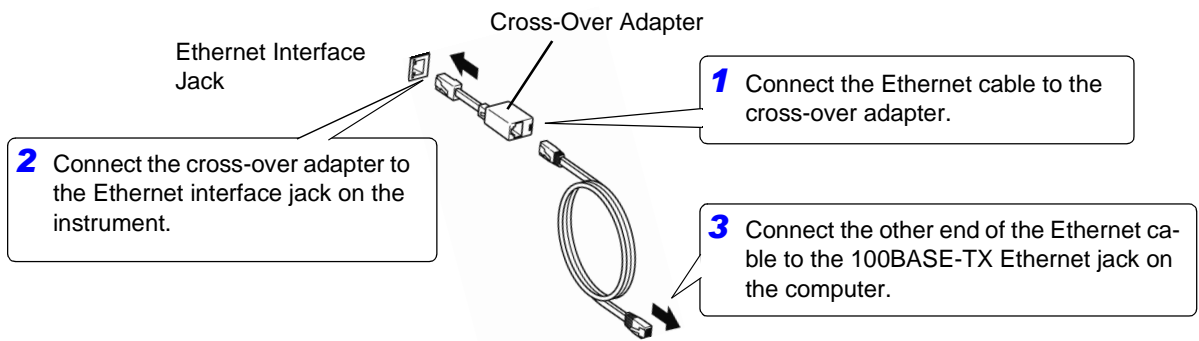
Connect by the following procedure.

When connecting the instrument to an existing network (connect the instrument to a hub)

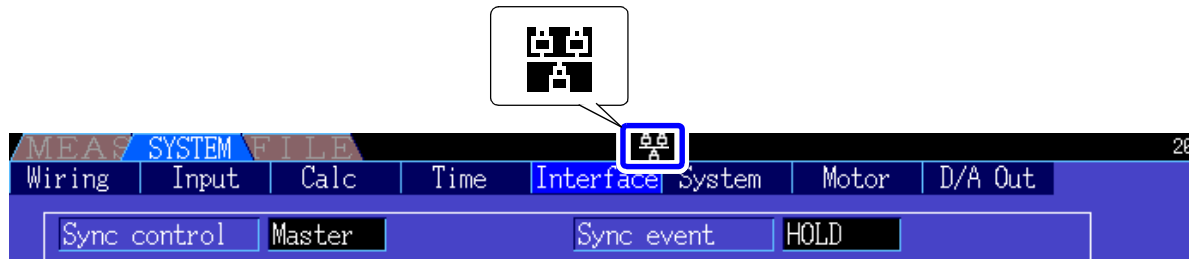


When connecting the instrument to a single computer (connect the instrument to the computer)

Use the Hioki 9642 LAN Cable and cross-over adapter (9642 accessory)



When the Ethernet connection is established, the LAN indicator appears at the top of the screen, as shown below.



9.2 Remote Control of the Instrument by Internet Browser

The instrument includes a standard HTTP server function that supports remote control by an internet browser on a computer. The instrument's display screen and control panel keys are emulated in the browser. Operating procedures are the same as on the instrument.

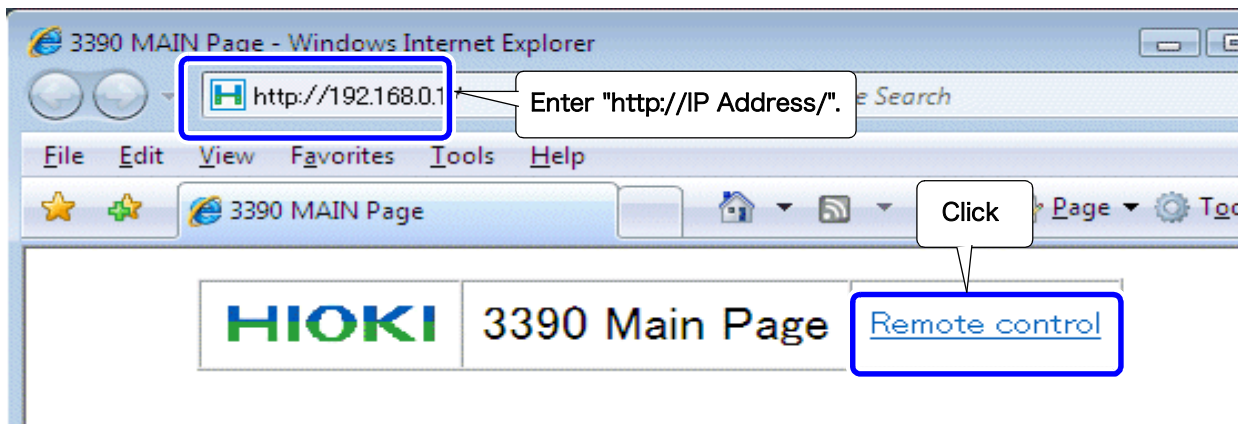
NOTE

- For remote control of the instrument by the browser, Java may need to be installed, depending on the computer environment. If needed, download and install JRE (the Java run-time environment) from <http://www.java.com>.
- The browser (Internet Explorer) security level should be set to Medium or Medium-high.
- Unintended operations may occur if remote control is attempted from multiple computers simultaneously. Use one computer at a time for remote control.

9.2.1 Connecting to the Instrument

Launch Internet Explorer (afterwards called IE), and enter "http://" followed by the IP address assigned to the instrument in the browser's address bar.


For example, if the instrument's IP address is 192.168.0.1, enter as follows.



When the Main page appears as illustrated, the connection to the instrument has been established. Click the [[Remote control](#)] link to jump to the Remote Control page.

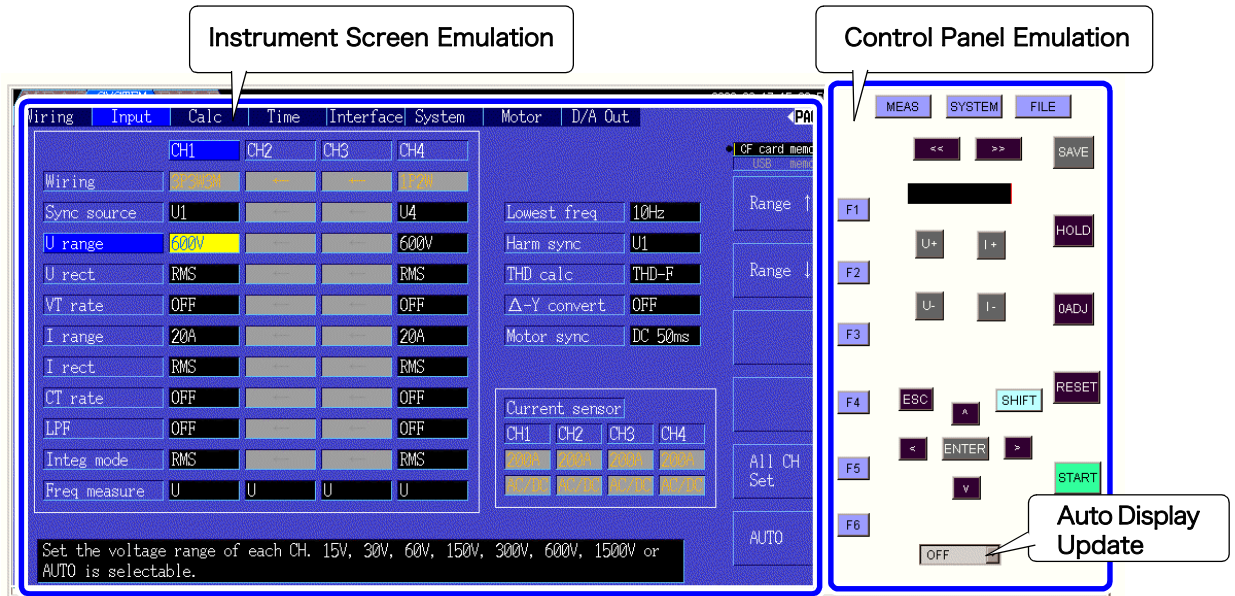


What if the Main Page does not display?

- Check the network settings on the instrument and the IP address of the computer.
[See "9.1.1 LAN Settings and Network Environment Configuration" \(p. 142\)](#)
- Check that the LINK LED in the Ethernet internet jack is lit, and that  (the LAN indicator) is displayed on the instrument's screen.
[See "9.1.2 Instrument Connection" \(p. 144\)](#)

9.2.2 Operating Procedure

The instrument's screen and control panel emulations appear in the browser. Click on the control panel keys to perform the same operations as the instrument keys. To enable automatic browser screen updating, set the Update Time in the Auto Update menu.



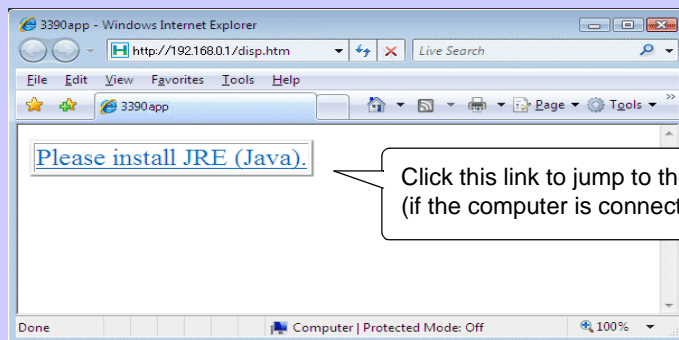
Auto Display Update Settings

The instrument screen emulation updates at the specified interval.

- OFF, 0.5s, 1s, 2s, 10s, 60s



What if the following message appears?



- Is the browser's security restriction set too high, or is Java being inhibited by security software?
Change the browser's security setting to Medium or Medium-high.
- Is Java installed on the computer?
Install Java.

NOTE

The communication may become slow in the Java6 installed environment. In this case, please set not to keep the temporarily internet file from the Java dialog in the control panel of the computer.

9.3 Control and Measurement via USB Interface

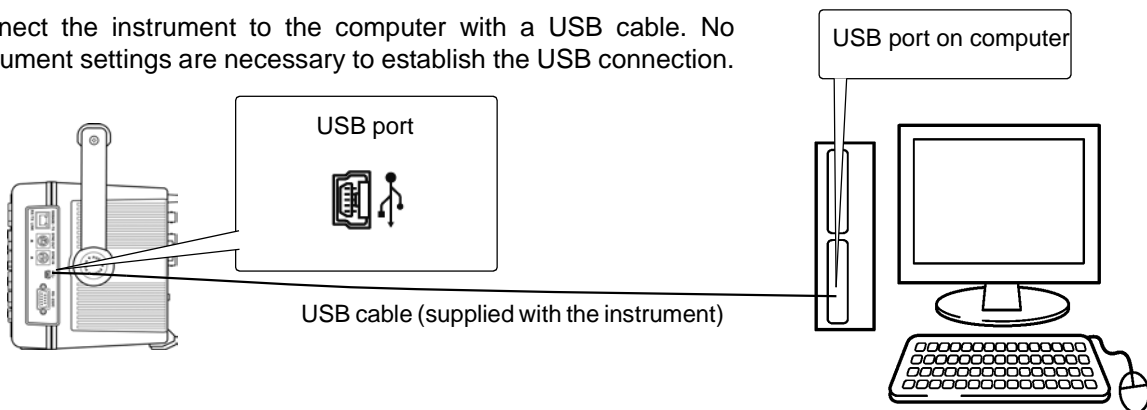
The instrument can be remotely controlled and measurement data transferred to a computer using a standard USB connection.

NOTE

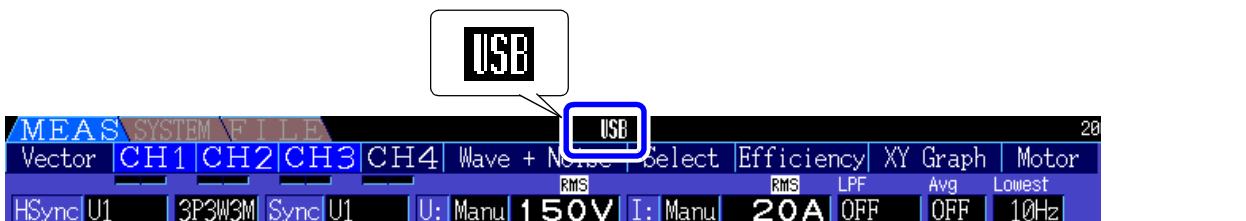
- Install the dedicated software to a computer before connecting this instrument to a computer.
- A dedicated application program can be downloaded from Hioki's web site (<http://www.hioki.com>). See the application program's manual for operating procedures.
- To connect the instrument to a computer the first time, a dedicated USB driver must be installed. This driver is provided with the above application program.
(Compatible to the Windows2000, XP and Vista (32-bit))

9.3.1 Connecting to the Instrument

Connect the instrument to the computer with a USB cable. No instrument settings are necessary to establish the USB connection.



The USB indicator is displayed when the connection to the computer is established.



CAUTION

- To avoid faults, do not disconnect or reconnect the USB cable during instrument operation.
- Connect the instrument and the computer to a common earth ground. Using different grounds could result in potential difference between the instrument and the computer. Potential difference on the USB cable can result in malfunctions and faults.

NOTE

If both the instrument and computer are turned off the power while connected by the USB cable, turn on the power of the computer first. It is not able to communicate if the instrument is turned on the power first.

9.3.2 After Connecting

Install the USB driver on the computer before running the dedicated application program.

Before disconnecting the USB cable from the computer, click the "Safely Remove Hardware" icon in the navigation tray and select the instrument to be disconnected.

Specifications Chapter 10

10.1 General Specifications

Environmental Safety Specifications

| | |
|------------------------------------|--|
| Operating environment | Indoors, up to 2000 m (6562-ft.) Pollution degree 2 |
| Storage temperature and humidity | -10 to 55°C (14 to 131°F) 80% RH or less (non-condensating) |
| Operating temperature and humidity | 0 to 40°C (32 to 104°F) 80% RH or less (non-condensating) |
| Dielectric strength | @50/60 Hz, for 15 s 5.312 kVrms AC (1 mA sense current) Between voltage measurement jacks and instrument chassis 3.32 kVrms AC (1 mA sense current) Between voltage and current measurement jacks, and interface jacks 370 Vrms AC (1 mA sense current) 9791, 9793input terminal (CH A, CH B, CH Z) - 3390to instrument chassis, Between channels A, B, and Z |
| Applicable standards | Safety : EN61010 EMC : EN61326 Class A EN61000-3-2 EN61000-3-3 |
| Rated supply voltage | 100 V to 240 VA Anticipated transient overvoltage: 2500 V (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) |
| Rated supply frequency | 50/ 60 Hz |
| Maximum rated power | 140 VA |
| Dimensions | Approx. 340 Wx 170 H x 157 D mm (13.39" W x 6.69" H x 6.18" D) (excluding protrusions) |
| mass | Approx. 4.8 kg (169.3 oz.) (with Model 9793 installed) |
| Backup battery life | Clock, settings and integration values (Lithium battery), (Litium battery) , Approx. 10 years @23°C |

Accessories and Options Specifications

| | |
|--|---|
| Accessories | <ul style="list-style-type: none"> • Instruction Manual 1 • Power cord 1 • Measurement Guide 1 • USB cable (USB 2.0, with ferrite core, approx. 0.9 m) 1 • Measurement cable label sheet 2 • D-sub connector (for Model 9792 and 9793 D/A output options) 1 |
| Special-order options (pre-shipping installation only) | 9791 Moter Testing Option 9792 D/A Output Option 9793 Moter Testing & D/A Output Option |
| Current measurement option | 9272-10 Clamp-On Sensor 9277 Universal Clamp-On CT 9278 Universal Clamp-On CT 9279 Universal Clamp-On CT 9709 AC/DC Current Sensor CT6862 AC/DC Current Sensor CT6863 AC/DC Current Sensor |
| Voltage measurement option | L9438-50 Voltage Cord/Voltage Measurement Cable Leads (banana male-to-male with alligator clip, one each red and black, about 3m long) 9243 Grabber Clip (one each red and black) |
| Printer option | 9670 Printer 9671 AC Adapter (for Model 9670) 9638 RS-232C Cable (for Printer) 9237 Recording Paper (80 mm - 25 m, 4 rolls) |
| Computer connection option | 9642 LAN Cable 9726 PC Card 128MB (128MB CompactFlash Card + Adapter) 9727 PC Card 256MB (256MB CompactFlash Card + Adapter) 9728 PC Card 512MB (512MB CompactFlash Card + Adapter) 9729 PC Card 1GB (1GB CompactFlash Card + Adapter) 9830 PC Card 2GB (2GB CompactFlash Card + Adapter) |
| Other Options | 9794 Carrying Case L9217 Connection Cord (Insulated BNC male-to-male, 1.5 m (for Model 9791 and Model 9793) 9683 Connection Cable (for synchronization 1.5 m) |

Basic Specifications

1. Power Measurement Input Specifications

| Measurement line type Single-phase 2-wire (1P2W), Single-phase 3-wire (1P3W), 3-phase, 3-wire (3P3W2M, 3P3W3M), 3-phase, 4-wire (3P4W) | | | | |
|--|--------|------|--------|------|
| | CH1 | CH2 | CH3 | CH4 |
| Mode 1 | 1P2W | 1P2W | 1P2W | 1P2W |
| Mode2 | 1P3W | | 1P2W | 1P2W |
| Mode3 | 3P3W2M | | 1P2W | 1P2W |
| Mode4 | 1P3W | | 1P3W | |
| Mode5 | 3P3W2M | | 1P3W | |
| Mode6 | 3P3W2M | | 3P3W2M | |
| Mode7 | 3P3W3M | | | 1P2W |
| Mode8 | 3P4W | | | 1P2W |

| | |
|---------------------------------|--|
| Number of input channels | Voltage 4 channels U1 to U4 Current 4 channels I1 to I4 |
| Measurement input terminal type | Voltage Plug-in jacks (safety jacks) Current Dedicated custom connectors |
| Input methods | Voltage isolated inputs, resistive dividers Current Insulated current sensors (voltage output) |
| Voltage range | 1500 V, 600 V, 300 V, 150 V, 60 V, 30 V, 15 V @selectable for each measured wiring system |
| Current range | 20 A, 8 A, 4 A, 2 A (20 A with 9272-10) 20 A, 8 A, 4 A, 2 A, 0.8 A, 0.4 A (20 A with 9277) 200 A, 80 A, 40 A, 20 A, 8 A, 4 A (200 A with 9272-10, 9278 and CT6863) 50 A, 20 A, 10 A, 5 A, 2 A, 1 A (CT6862) 500 A, 200 A, 100 A, 50 A, 20 A, 10 A (9279 and 9709) selectable for each measurement channel (however, the same sensor type must be used for each channel in multiphase wiring systems) |
| Crest factor | 3 (Voltage, Current) Except 1500 V range: 1.33 |
| Input resistance (50/60 Hz) | Voltage input section 2 M Ω \pm 40 k Ω (differential inputs) Current sensor input section 1 M Ω \pm 50 k Ω |
| Maximum input voltage | Voltage input section 1500 V, \pm 2000 V _{peak} Current sensor input section 5 V, \pm 10 V _{peak} |
| Maximum rated voltage to earth | Voltage input terminal 1000 V (50/60 Hz) Measurement Categories III 600 V (anticipated transient overvoltage 6000 V) Measurement Categories II 1000 V (anticipated transient overvoltage 6000 V) |
| Measurement method | Simultaneous digital sampling of voltage and current, simultaneous zero-crossing calculation method |
| Sampling | 500 kHz/ 16bit |
| Measurement frequency range | DC, 0.5 Hz to 150 kHz |
| Synchronization frequency range | 0.5 Hz to 5 kHz Selectable lower limit measurement frequency (0.5 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz) |
| Synchronization source | U1 to U4, I1 to I4, Ext (with the motor evaluation option installed and CH B set for pulse input), DC (50 or 100 ms fixed) Selectable for each measurement channel (U/I of each channel must be the same as the sync source) The zero-crossing filter automatically matches the digital LPF when U or I is selected. Two filter levels (strong or mild) Operation and accuracy are undetermined when the zero-crossing filter is disabled (off). Operation and accuracy are undetermined when U or I is selected and measured input is below 30% f.s. |
| Data update interval | 50 ms |
| LPF | OFF, 500 Hz, 5 kHz, 100 kHz (selectable for each wiring system) 500 Hz.... Accurate to 60 Hz or better, With specified accuracy to +0.1% f.s. 5 kHz Accurate to 500 Hz or better 100 kHz.. Accurate to 20 kHz or better, (add 1% rdg. from 10 kHz to 20 kHz) |
| Polarity discrimination | Voltage/current zero-crossing timing comparison method Zero-crossing filter provided by digital LPF |
| Measurement items | Voltage (U), Current (I), active power (P), apparent power (S), reactive power (Q), power factor (λ), power phase angle (Φ), frequency (f), efficiency (η), loss (Loss), voltage ripple factor (U _{rf}), current ripple factor (I _{rf}), current integration (I _h), power integration (WP), peak voltage (U _{pk}), peak current (I _{pk}) |

1.Power Measurement Input Specifications

| Accuracy | Voltage(U) | Current(I) | Active power(P) |
|--------------------|----------------------|----------------------|----------------------|
| DC | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. |
| 0.5 Hz to 30 Hz | ±0.1%rdg.±0.2%f.s. | ±0.1%rdg.±0.2%f.s. | ±0.1%rdg.±0.2%f.s. |
| 30 Hz to 45 Hz | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. |
| 45 Hz to 66 Hz | ±0.05%rdg.±0.05%f.s. | ±0.05%rdg.±0.05%f.s. | ±0.05%rdg.±0.05%f.s. |
| 66 Hz to 1 kHz | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. | ±0.1%rdg.±0.1%f.s. |
| 1 kHz to 10 kHz | ±0.2%rdg.±0.1%f.s. | ±0.2%rdg.±0.1%f.s. | ±0.2%rdg.±0.1%f.s. |
| 10 kHz to 50 kHz | ±0.3%rdg.±0.2%f.s. | ±0.3%rdg.±0.2%f.s. | ±0.4%rdg.±0.3%f.s. |
| 50 kHz to 100 kHz | ±1.0%rdg.±0.3%f.s. | ±1.0%rdg.±0.3%f.s. | ±1.5%rdg.±0.5%f.s. |
| 100 kHz to 150 kHz | ±20%f.s. | ±20%f.s. | ±20%f.s. |

From 0.5 to 10 Hz, voltage, current and active power values are for relative comparison only
 From 10 to 16 Hz and over 220 V, voltage and active power values are for relative comparison only
 From 30 kHz to 100 kHz and over 750 V, voltage and active power values are for relative comparison only
 From 100 kHz to 150 kHz and over 22000/f [kHz], voltage and active power values are for relative comparison only
 Over 1000 V, voltage and active power values are for relative comparison only
 For current and active power measurements, combine the accuracy of the current sensor with the above accuracies

| | |
|---|--|
| Period of guaranteed accuracy | 6 months (and 1.5 times specified accuracy for one year) |
| Conditions of Guaranteed Accuracy | Temperature and humidity for guaranteed accuracy: 23±3°C, 80%RH or less Warm-up time 30 minutes or more Input Within the specified ranges when the fundamental wave is synchronized with the sync source, for sine wave input, power factor of one, zero ground voltage, after zero adjustment |
| Temperature coefficient | ±0.01%f.s./ °C (for DC, add ±0.01% f.s./°C) |
| Effect of common mode voltage | ±0.01%f.s. or less (with 1000 V @50/60 Hz applied between voltage measurement jacks and chassis) |
| Magnetic field interference | ±1%f.s. or less (in 400 A/m magnetic field, DC and 50/60 Hz) |
| Power factor influence | ±0.15%f.s. or less (45 Hz to 66 Hz with power factor = 0.0) with 500 Hz LPF, add ±0.45% f.s. |
| Susceptibility to conducted electromagnetic field | @3 V, current and active power not more than ±6% f.s., where f.s. current is the rated primary-side current of the current sensor f.s. active power equals the voltage range × the rated primary-side current of the current sensor |
| Susceptibility to radiated electromagnetic field | @10 V/m, current and active power not more than ±6% f.s., where f.s. current is the rated primary-side current of the current sensor, and f.s. active power equals the voltage range × the rated primary-side current of the current sensor |
| Effective measuring range | Voltage, Current, Power 1% to 110% of the range |
| Total display area | Voltage, Current, Power Voltage, current and power: from zero-suppression range setting to 120% |
| Zero-suppression ranges | Selectable OFF, 0.1 or 0.5% f.s. When OFF, non-zero values may be displayed even with no measurement input |
| Zero adjustment | Voltage ±10%f.s., current ±10% f.s. with no more than ±4 mV zero-adjustment compensation |
| Waveform peak measurement range | Within ±300% of each voltage and current range |
| Waveform peak measurement accuracy | Within ±2% f.s. of voltage and current display accuracy |

2.Frequency Measurement Specifications

| | |
|--------------------------|--|
| Measurement channels | Four (f1 to f4) |
| Measurement source | Select U/I for each measurement channel |
| Measurement method | Reciprocal method + zero-crossing sample value correction |
| Measuring range | Synchronous range from 0.5 Hz to 5 kHz (with 0.0000 Hz unmeasurable time) Selectable lower limit measurement frequency (0.5 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz) |
| Data update interval | 50 ms (measurement-frequency-dependent at 45 Hz and below) |
| Accuracy | ±0.05% rdg. ±1 dgt. (sine wave, amplitude at least 30% of measurement range) |
| Numerical display format | 0.5000 Hz to 9.9999 Hz, 9.900 Hz to 99.999 Hz, 99.00 Hz to 999.99 Hz, 0.9900 kHz to 5.0000 kHz |

3.Integration Measurement Specifications

| | |
|-------------------|---|
| Measurement Mode | Selectable RMS or DC for each wiring mode (DC is selectable only for 1P2W wiring and AC/DC sensors) |
| Measurement items | Current integration (Ih+, Ih-, and Ih), active power integration (WP+, WP-, and WP) Ih+ and Ih- only for DC mode measurements, and Ih only for RMS mode measurements |

10.1 General Specifications

3. Integration Measurement Specifications

| | |
|---------------------------|--|
| Measurement method | Digital calculation from each current and active power phase (when averaging, calculates with previous average value) In DC mode: calculates current value at every sample, and integrates instantaneous power independent of polarity In RMS mode: Integrates current effective values between measurement intervals, and polarity-independent active power value |
| Measurement Interval | 50 ms data update interval |
| Display resolution | 999999 (6 digits + decimal) |
| Measuring range | 0 to ± 9999.99 TAh / TWh (limited to maximum integration time of 9999 hours, 59 minutes, and 59 seconds) Integration stops when either maximum integration value or time is exceeded. |
| Integration time accuracy | $\pm 50\text{ppm} \pm 1\text{dgt.}$ (0°C to 40°C) |
| Integration accuracy | \pm (current and active power accuracy) \pm integration time accuracy |
| Backup function | Integration automatically resumes after power outages. |

4. Harmonic Measurement Specifications

| Number of measurement channels | 4 Channels Harmonic measurements not available for multiple systems with different frequencies. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------|---|---------------------------------|------------------|----------------|-----------------|---|-------------------|----------------|---|-------------------|-----------------|---|------------------|------------------|---|------------------|------------------|---|------------------|-------------------|----|------------------|--------------------|----|-----------------|--------------------|----|-----------------|
| Measurement items | Harmonic rms voltage, harmonic voltage percentage, harmonic voltage phase angle, harmonic rms current, harmonic current percentage, harmonic current phase angle, harmonic active power, harmonic power percentage, harmonic voltage-current phase difference, total harmonic voltage distortion, total harmonic current distortion, voltage imbalance, current imbalance | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Measurement method | Zero-crossing synchronous calculation (all channels in same window), with gap Fixed 500 kHz/s sampling, after digital anti-aliasing filter Equal thinning between zero crossings (with interpolation calculation) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Synchronization source | U1 to U4, I1 to I4, External (with motor evaluation option installed and CH B set for pulse input), DC selectable (50 or 100 ms) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FFT calculation word length | 32 bits | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anti-aliasing filter | Digital filter (variable according to sync frequency) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Windows | Rectangular | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Synchronization frequency range | As specified for power measurements | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data update interval | 50 ms (measurement-frequency-dependent at 45 Hz and below) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase zero adjustment | Provided by key operation or external control command (only with external sync source) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Highest order analysis | <table border="1"> <thead> <tr> <th>Synchronization frequency range</th> <th>Window waveforms</th> <th>Analysis order</th> </tr> </thead> <tbody> <tr> <td>0.5 Hz to 40 Hz</td> <td>1</td> <td>100th</td> </tr> <tr> <td>40 Hz to 80 Hz</td> <td>1</td> <td>100th</td> </tr> <tr> <td>80 Hz to 160 Hz</td> <td>2</td> <td>80th</td> </tr> <tr> <td>160 Hz to 320 Hz</td> <td>4</td> <td>40th</td> </tr> <tr> <td>320 Hz to 640 Hz</td> <td>8</td> <td>20th</td> </tr> <tr> <td>640 Hz to 1.2 kHz</td> <td>16</td> <td>10th</td> </tr> <tr> <td>1.2 kHz to 2.5 kHz</td> <td>32</td> <td>5th</td> </tr> <tr> <td>2.5 kHz to 5.0 kHz</td> <td>64</td> <td>3th</td> </tr> </tbody> </table> | Synchronization frequency range | Window waveforms | Analysis order | 0.5 Hz to 40 Hz | 1 | 100 th | 40 Hz to 80 Hz | 1 | 100 th | 80 Hz to 160 Hz | 2 | 80 th | 160 Hz to 320 Hz | 4 | 40 th | 320 Hz to 640 Hz | 8 | 20 th | 640 Hz to 1.2 kHz | 16 | 10 th | 1.2 kHz to 2.5 kHz | 32 | 5 th | 2.5 kHz to 5.0 kHz | 64 | 3 th |
| Synchronization frequency range | Window waveforms | Analysis order | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.5 Hz to 40 Hz | 1 | 100 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 Hz to 80 Hz | 1 | 100 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 Hz to 160 Hz | 2 | 80 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 160 Hz to 320 Hz | 4 | 40 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 320 Hz to 640 Hz | 8 | 20 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 640 Hz to 1.2 kHz | 16 | 10 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.2 kHz to 2.5 kHz | 32 | 5 th | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.5 kHz to 5.0 kHz | 64 | 3 th | | | | | | | | | | | | | | | | | | | | | | | | | | |

Accuracy

| Frequency | Voltage(U), Current(I), Active Power(P) |
|------------------|---|
| 0.5 Hz to 30 Hz | $\pm 0.4\% \text{rdg.} \pm 0.2\% \text{f.s.}$ |
| 30 Hz to 400 Hz | $\pm 0.3\% \text{rdg.} \pm 0.1\% \text{f.s.}$ |
| 400 Hz to 1 kHz | $\pm 0.4\% \text{rdg.} \pm 0.2\% \text{f.s.}$ |
| 1 kHz to 5 kHz | $\pm 1.0\% \text{rdg.} \pm 0.5\% \text{f.s.}$ |
| 5 kHz to 10 kHz | $\pm 2.0\% \text{rdg.} \pm 1.0\% \text{f.s.}$ |
| 10 kHz to 13 kHz | $\pm 5.0\% \text{rdg.} \pm 1.0\% \text{f.s.}$ |

Not specified for sync frequencies of 4.3 kHz and higher
Add the LPF accuracy to the above when using LPF.

5.Noise Measurement Specifications

| | |
|-----------------------------|--|
| Calculation channels | 1(Select one from CH1 to CH4) |
| Calculation parameters | Voltage/Current |
| Calculation type | RMS spectrum |
| Calculation method | Fixed 500 kHz/s sampling, thinning after digital anti-aliasing filter |
| FFT calculation word length | 32 bits |
| FFT data points | 1,000, 5,000, 10,000, or 50,000 (according to displayed waveform recording length) |
| Anti-aliasing filter | Automatic digital filter (varies with maximum analysis frequency) |
| Windows | Rectangular, Hanning, flat-top |
| Data update interval | Determined by FFT points within approx. 400 ms, 1s, 2s, or 15 s, with gap |
| Highest analysis frequency | 100 kHz, 50 kHz, 20 kHz, 10 kHz, 5 kHz, 2 kHz |
| Frequency resolution | 0.2 Hz to 500 Hz (Determined by FFT points and maximum analysis frequency) |
| Noise amplitude measurement | Calculates the ten highest level and frequency voltage and current peak values (local maxima). In FFT calculation results, peak values are recognized when data levels on either side are lower. The lower noise frequency limit can be specified. |

6. Motor Evaluation Option Specifications (Models 9791 and 9793)

| | |
|-----------------------------------|--|
| Number of input channels | 3 channels CH A..... Analog DC input, Frequency input CH B..... Analog DC input, Pulse input CH Z..... Pulse input |
| Measurement input jacks | Insulated BNC jacks |
| Input impedance (DC) | 1 M Ω \pm 100 k Ω |
| Input methods | Isolated and differential inputs (not isolated between channels B and Z) |
| Measurement parameters | Voltage, torque, rotation rate, frequency, slip, and motor power |
| Maximum input voltage | \pm 20 V (during analog, frequency, and pulse input) |
| Maximum rated voltage to earth | 50 V (50/ 60 Hz) Measurement category I, 50 V (500 V anticipated transient overvoltage) |
| Period of guaranteed accuracy | 6 months (and 1.5 times specified accuracy for one year) |
| Conditions of Guaranteed Accuracy | Temperature and humidity for guaranteed accuracy 80%RH or less Warm-up time30 minutes or more Input With 0 V to ground, after zero adjustment |

(1)Analog DC Input (CH A/ CH B)

| | |
|-----------------------------------|---|
| Measurement range | \pm 1 V, \pm 5 V, \pm 10 V (when inputting analog DC) |
| Valid input range | 1% to 110%f.s. |
| Sampling | 10 kHz / 16bit |
| Response time | 1 ms (measuring zero to full scale, with LPF off) |
| Measurement method | Simultaneous digital sampling and zero-crossing synchronous calculation system (cumulative average of intervals between zero crossings) |
| Synchronization source | Same as 3390 power measurement input specification (common to CH A and CH B) |
| Measurement accuracy | \pm 0.1%rdg. \pm 0.1%f.s. |
| Temperature coefficient | \pm 0.03%f.s./ $^{\circ}$ C |
| Effect of common mode voltage | Not more than \pm 0.01% f.s. (with 50 V [DC or 50/60 Hz] between measurement jacks and 3390 chassis) |
| Effect of external magnetic field | Not more than \pm 0.1% f.s. (at 400 A/m DC and 50/60 Hz magnetic fields) |
| LPF | OFF/ ON (OFF: 4 kHz, ON: 1 kHz) |
| Total display area | Zero-suppression range setting \pm 120% |
| Zero adjustment | Zero-corrected input offset of voltage \pm 10% f.s. or less |

(2) Frequency Input (CH A only)

| | |
|----------------------------|--------------------------------------|
| Valid amplitude range | \pm 5 Vpeak |
| Max. measurement frequency | 100 kHz |
| Measurement range | 1 kHz to 100 kHz |
| Synchronization source | 3390 Same as accuracy specifications |
| Data output interval | According to synchronization source |
| Measurement accuracy | \pm 0.05%rdg. \pm 3dgt. |
| Total display area | 1.000 kHz to 99.999 kHz |

10.1 General Specifications

(3) Pulse Input (CH B only)

| | |
|--------------------------------|--|
| Detection level | Not more than 0.5 V Low, and at least 2.0 V High |
| Measurement range | 1 Hz to 200 kHz (at 50% duty) |
| Division setting range | 1 to 60000 |
| Measurement frequency range | 0.5 Hz to 5.0 kHz (limited to measured pulse frequency divided by selected no. of divisions) |
| Minimum detectable pulse width | 2.5 μ s or better |
| Measurement accuracy | $\pm 0.05\%$ rdg. ± 3 dgt. |

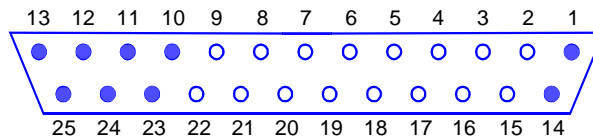
(4) Pulse Input (CH Z only)

| | |
|--------------------------------|---|
| Detection level | Not more than 0.5 V Low, and at least 2.0 V High |
| Measurement range | 0.1 Hz to 1 kHz |
| Minimum detectable pulse width | 2.5 μ s or better |
| Settings | OFF/ON (when ON, division of CH B is cleared on rising edges) |

7. D/A Output Option Specifications (Models 9792 and 9793)

| | |
|-----------------------------------|--|
| Number of output channels | 16 channels |
| Output contents | Selectable waveform/analog outputs (from basic measurement parameters) Waveform output only on Channels 1 to 8 |
| Output connector | One 25-pin female D-sub |
| D/A conversion resolution | 16 bits (polarity + 15 bits) |
| Output accuracy | Analog output Measurement accuracy $\pm 0.2\%$ f.s. (DC level) Waveform output Measurement accuracy $\pm 0.5\%$ f.s. (rms level within synchronous frequency range) |
| Output update interval | Analog output 50 ms (according to input data update interval of selected parameter) Waveform output 500 kHz |
| Output voltage | Analog output ± 5 V DC nom. (approx. ± 12 V DC max.) Waveform output ... ± 2 V (crest factor at least 2.5) |
| Output impedance | 100 Ω ± 5 Ω |
| Period of guaranteed accuracy | 6 months (1.5 times specified accuracy for one year) |
| Conditions of Guaranteed Accuracy | Temperature and humidity: 23 \pm 3 $^{\circ}$ C 80% RH or less Warm-up time: 30 minutes or more, After zero adjustment of the 3390 |
| Temperature Coefficient | $\pm 0.05\%$ f.s./ $^{\circ}$ C |

Pinout



| Pin No. | Output (Waveform) | Pin No. | Output (Waveform) |
|---------|-------------------|---------|-------------------|
| 1 | GND | 14 | GND |
| 2 | D/A1 (U1) | 15 | D/A9 |
| 3 | D/A2 (I1) | 16 | D/A10 |
| 4 | D/A3 (U2) | 17 | D/A11 |
| 5 | D/A4 (I2) | 18 | D/A12 |
| 6 | D/A5 (U3) | 19 | D/A13 |
| 7 | D/A6 (I3) | 20 | D/A14 |
| 8 | D/A7 (U4) | 21 | D/A15 |
| 9 | D/A8 (I4) | 22 | D/A16 |
| 10 | GND | 23 | GND |
| 11 | GND | 24 | GND |
| 12 | GND | 25 | GND |
| 13 | GND | -- | ----- |

8. Display Specifications

| | |
|------------------------------|--|
| Languages | Japanese, English |
| Display type | 9-inch TFT color LCD (800×480 dots) |
| Dot pitch | 0.246(V) mm×0.246(H) mm |
| LCDbacklight | Always ON, Auto OFF (after 1, 5, 10, 30, or 60 minutes) |
| Display numerical resolution | 99999 counts (999999 counts for integration) 99999 counts (999999 counts) |
| Display refresh interval | Measurement values: 200 ms (independent of internal data update interval) Waveforms, FFT:..... screen-dependent |
| Screens | Measurement, Setting, and File Operation screens |

9. External Interface Specifications

(1) USB Interface (Functions)

| | |
|------------------------|---|
| Connector | Mini-B receptacle |
| Compliance standard | USB2.0 (Full Speed/High Speed) |
| No. of ports | 1 |
| Class | Individual (USB488h) |
| Connection destination | Computer (Windows 2000, XP, Vista 32bit only) |
| Function | Data transfer, remote operation and command control Not for simultaneous use with Ethernet: USB has priority when both interfaces used |

(2) USB Memory Interface

| | |
|----------------------------|---|
| Connector | USB type A connector |
| Compliance standard | USB2.0 |
| USB power supply | 500 mA maximum |
| No. of ports | 1 |
| USB storage device support | USB Mass Storage Class |
| Recordable content | Save and load settings files Copy measurement values and recorded data (from CF card) Save waveform data Screen captures |

(3) LAN Interface

| | |
|---------------------|--|
| Connector | RJ-45 connector × 1 |
| Compliance standard | IEEE802.3 compliant |
| Transmission method | 10BASE-T/ 100BASE-TX Auto detected |
| Protocol | TCP/IP |
| Function | HTTP server (remote operation), Dedicated port (data transfer and command control) Not for simultaneous use with USB (functions): USB has priority when both interfaces used |

(4) CF Card Interface

| | |
|---------------------------|---|
| Slot | One Type 1 |
| Compatible card | CompactFlash memory card (32MB or higher) |
| Supported memory capacity | Up to 2 GB |
| Data format | MS-DOS format (FAT16/ FAT32) |
| Recordable content | Save and load settings files Save measurement voltage and auto-recorded data (CSV format) Copy measurements/recorded data (from USB storage) Save waveform data Screen captures |

(5) RS-232C Interface

| | |
|------------------------|--|
| Method | RS-232C, [EIA RS-232D], [CCITT V.24], [JIS X5101] compliant |
| Connector | D-sub9 pin connector ×1 |
| Connection destination | Printer, Temperature tester |
| Communication format | Full duplex, start-stop synchronization, 8-bit data, no parity, one stop bit, hardware flow control, CR+LF delimiter |
| Communication speeds | 2400, 9600, 19200, 38400bps (2400 bps for thermometers) |

(6) Synchronization Control Interface

| | |
|-------------------|---|
| Signal contents | One-second clock, integration start/stop, DATA RESET, EVENT |
| Connector types | IN: One 9-pin female mini-DIN jack OUT: One 8-pin female mini-DIN jack |
| Signal | 5V CMOS |
| Max. input | ±20 V |
| Max. signal delay | 2 μs (rising edge) |

10.2 Functions Specifications

1. AUTO range Function

| | |
|-------------------|--|
| Function | Automatically selects voltage and current ranges according to measured amplitude on each phase. |
| Operating states | Selectable on or off for each phase system |
| Auto-ranging span | Wide/Narrow (common to all wiring systems) Wide: when a phase system's peak-over or rms value is above 110% f.s., increments one range, and, when all rms values within the phase system are below 10% f.s., decrements two ranges (except when peak-over occurs in the lower range, in which case no range decrementing occurs). Narrow:.... when a wiring system peak over or rms value is above 105% f.s., increments one range, and, when all rms values within the wiring system are below 40% f.s., decrements one range (except when peak-over occurs in the lower range, in which case no range decrementing occurs). When Δ -Y conversion is enabled, the range-decrementing voltage is $1/\sqrt{3}$ (approximately 0.57735) f.s. |

2. Timing Control Functions

| | |
|-----------------|---|
| Interval | OFF, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 5 s, 10 s, 15 s, 30 s 1 min, 5 min, 10 min, 15 min, 30 min, 60 min Setting determines the maximum data-saving capacity |
| Timing controls | OFF, Timer, RTC Timer: 10 s to 9999:59:59 [h:m:s] (in seconds) Real-Time Clock: Start and stop times (in minutes) |

3. Hold Functions

(1) Hold

| | |
|---------------|---|
| Function | Stops all updating of displayed measurement values and waveforms, and holds display. However, the clock and peak-over display continue to be updated. Disabled when the peak-hold function is enabled. |
| Data updating | The next display data update occurs when the HOLD key is pressed again, at the end of the measurement interval, or when an external sync signal is detected. Internal data is updated every 50 ms (independent of the display data update interval). Waveform and noise data are updated when calculation finishes. |
| Output data | Held values are present at D/A output and are saved to CF card (although waveform output continues). With auto-saving enabled, data is saved immediately before it is updated. |
| Display | The HOLD indicator appears when Hold is active. |
| Backup | Not applicable (the function is deactivated upon recovery from power outages.) |

(2) Peak Hold

| | |
|---------------|--|
| Function | All measurement values are updated to display the maximum value for each measurement. However, displayed waveforms and integration values continue to be updated with instantaneous values. When averaging is enabled, maximum values are displayed after averaging. Cannot be used together with the display-hold function. |
| Data updating | Displayed data is cleared when the HOLD key is pressed again, at the end of the measurement interval, or when an external sync signal is detected. Internal data is updated every 50 ms (independent of the display refresh interval). |
| Output data | Held values are present at D/A output and are saved to CF card (although waveform output continues). With auto-saving enabled, data is saved immediately before it is updated. |
| Display | The PEAK HOLD indicator appears when Peak Hold is active. |
| Backup | Not applicable (the function is deactivated upon recovery from power outages.) |

4. Calculation Functions

(1) Rectification System

| | |
|----------|---|
| Function | Select which voltage and current values to used for calculating apparent and reactive power, and power factor |
| Method | rms/ mean (voltage and current in each phase system) |

(2) Scaling

| | |
|---------------|---|
| VT (PT) ratio | OFF/ 0.01 to 9999.99 (Settings for which VT×CT exceeds 1.0E+06 are disallowed.) |
| CT ratio | OFF/ 0.01 to 9999.99 (Settings for which VT×CT exceeds 1.0E+06 are disallowed.) |
| Display | An indicator is displayed when scaling. |

(3) Average

| | |
|---------------|---|
| Function | Averages all instantaneous measurement values including harmonics (but not peak, integration, or FFT noise values). When averaging is enabled, the averaged data is saved. |
| Method | Indexed average (applied at 50 ms data update intervals) Averaged voltage (U), current (I), and power (P) values are used for calculations. rms values are averaged for harmonic amplitude, and instantaneous values are averaged for relative harmonic content. Phase angle is calculated from the average real and imaginary components after FFT. Phase difference, distortion and imbalance are calculated from the above data after averaging. Ripple factor is calculated from averaging the differences in peak values. |
| Response time | OFF, FAST, MID, SLOW (time remains within specified accuracy when input changes from 0 to 100% f.s.) Corresponding response times are 0.2, 1.0, and 5 s |
| Display | The AVG indicator is displayed when averaging is enabled. |

(4) Efficiency and Loss Calculations

| | |
|--|--|
| Function | Efficiency η [%] and Loss [W] are calculated from active power values measured on each phase and system. |
| Calculation items | Active power (P) of each phase and system Motor power (P _m) when motor evaluation option 9791 or 9793 is installed |
| Calculation accuracy | Measurements applied to formulas are handled as 32-bit floating point values. When calculating parameters between wiring systems with different power ranges, the higher range is used. |
| Calculation rate | At every 50 ms data update interval When calculating between wiring systems having different sync sources, the most recent data is used at calculation time. |
| Maximum no. of simultaneous calculations | Efficiency and loss, by three formulas |
| Calculation method | Parameters specified for P _{in} and P _{out} are applied as follows $\eta = 100 \times P_{out} / P_{in} $, Loss = $ P_{in} - P_{out} $ |

(5) Δ - Y Calculation

| | |
|--------------------|--|
| Function | For 3P3W3M systems, converts between line-to-line voltage and phase voltage waveforms using a virtual center point. All voltage parameters including harmonics such as true rms voltage are calculated as phase voltage waveforms. |
| Calculation method | $U_{1s} = (U_{1s} - U_{3s})/3$, $U_{2s} = (U_{2s} - U_{1s})/3$, $U_{3s} = (U_{3s} - U_{2s})/3$ |

5. Display Functions

(1) Wiring Check screen

| | |
|----------------|--|
| Function | The wiring diagram and voltage/current vectors are displayed for the selected wiring system(s). The correct range for the wiring system is shown on the vector display, to confirm proper measurement cable connections. |
| Start-up mode | The Wiring Check screen can be set to always appear upon start-up (Start-Up Screen setting). |
| Basic settings | Selects auto-ranging for voltage and current on each wiring system, and sets each value to its default. Not available when integration or the Hold function is enabled. |

(2) Independent wiring system display mode

| | |
|-----------|---|
| Function | Displays power and harmonic measurement values for channels 1 to 4. A composite measurement line pattern is displayed for each system. |
| DMM | Basic, voltage, current, and power measurement parameter screens |
| Harmonics | Bar Graph, List or Vector screen |

(3) Display Selections

| | |
|----------------|--|
| Function | Select to display any 4, 8, 16, or 32 of the basic measurement parameters. |
| Display Layout | 4, 8, 16, or 32 parameters, Independently set for each screen |

(4) Efficiency and Loss Screen

| | |
|----------------|---|
| Function | The efficiency and loss obtained by the specified calculation formulas are displayed numerically. |
| Display Layout | Three efficiency and three loss values. |

(5) Waveform & Noise Screen

| | |
|----------|---|
| Function | Voltage and current waveforms sampled at 500 kHz and noise measurements are displayed compressed on one screen. |
|----------|---|

(5) Waveform & Noise Screen

| | | | | | |
|-------------------|---|--------|--------|---------|---------|
| Trigger | Synchronized with the harmonic sync source | | | | |
| Recording length | 1000 / 5000 / 10000 / 50000 xAll voltage and current channels | | | | |
| Compression ratio | 1/1, 1/2, 1/5, 1/10, 1/25, 1/50 (peak-to-peak compression) Also, peak-to-peak compression enables drawing 500-dot (vertical) screen images | | | | |
| Noise sampling | 500 kS/s, 250 kS/s, 100 kS/s, 50 kS/s, 25 kS/s, 10 kS/s (according to compression ratio) | | | | |
| Recording time | sampling/Recording length | 1000 | 5000 | 10000 | 50000 |
| | 500kS/s | 2 ms | 10 ms | 20 ms | 100 ms |
| | 250kS/s | 4 ms | 20 ms | 40 ms | 200 ms |
| | 100kS/s | 10 ms | 50 ms | 100 ms | 500 ms |
| | 50kS/s | 20 ms | 100 ms | 200 ms | 1000 ms |
| | 25kS/s | 40 ms | 200 ms | 400 ms | 2000 ms |
| | 10kS/s | 100 ms | 500 ms | 1000 ms | 5000 ms |

(6) X-Y Plot Screen

| | |
|-----------------|---|
| Function | Select horizontal and vertical axes from the basic measurement items to display on the X-Y graphs. Dots are plotted at the data update interval, and is not saved. Drawing data can be cleared. |
| Horizontal axis | 1 data item (gauge display available) |
| Vertical axis | 2 data items (gauge display available) |

(7) Motor Screen (only with Model 9791 or 9793 motor evaluation option)

| | |
|----------------|--|
| Function | Displays motor evaluation measurement values |
| Display Layout | Four numerical values |

6. Auto-Save Functions

| | |
|-------------------------|--|
| Function | Each value is stored to CF card during every measurement interval. Can be controlled by timer or real-time clock |
| Save destinations | Off, CF card (not available for USB storage) The destination folder can be specified. |
| Saved items | Any measured values including harmonics and noise value data |
| Max. no. of saved items | Interval-setting-dependent |
| Data format | CSV file format |
| File name | Automatically generated using starting date and time, with CSV extension |

7. Manual Saving Functions

(1) Measurement Data

| | |
|-------------------|--|
| Function | Pressing the SAVE key saves each measurement value at that moment to the save destination. A new file is created the first time data is saved, and subsequent saves are made to that file. |
| Save destinations | USB memory/CF card Able to specify the folder to save. |
| Saving items | Saved items: any measured values including harmonics and noise value data |
| Screen Capture | CSV file format |
| File name | Automatically created with CSV extension |

(2) Screen Capture

| | |
|-------------------|---|
| Function | The COPY key (SHIFT+SAVE) captures and saves a bitmap image of the display to the save destination |
| Save destinations | Printer, USB memory, CF card (Printing can be selected only when a printer is connected to the RS232C port.) When USB memory stick or CF card is selected, the destination folder can be selected. |
| Data format | Compressed BMP format (256-color), with only black and white printing |
| File name | Automatically created with BMP file name extension |

(3) Settings Data

| | |
|-------------------|---|
| Function | Settings specified on the FILE screen are saved as a file on the save destination. Saved settings files can then be reloaded to restore a previous setting configuration (except for language and communications settings). |
| Save destinations | USB memory/CF card Able to specify the folder to save. |

(3) Settings Data

| | |
|-----------|--|
| File name | Automatically created with SET file name extension |
|-----------|--|

8. Synchronous Control Function

| | |
|------------------------|--|
| Function | Synchronous measurements are available by using sync cables to connect one Model 3390 as a master and one or more as slaves. Clocks and data updates are synchronized when the slave instrument is turned on. Afterwards, resynchronization is performed at each second of the clock (disabled when the slave is started while the master is off). When internal settings match, auto-save is available while synchronized. |
| Synchronized Items | Clock, data update interval (except for FFT calculations), integration start/stop, data reset, certain events |
| Event items | Hold, manual save, screen capture |
| Synchronization Timing | Clock, data update interval: within 10 s after power-on by a slave 3390 Start/stop, data reset, event: Upon key-press and communications operations on the master 3390 |
| Synchronization delay | Maximum 5 μ s per connection. Maximum synchronization delay of an event is +50 ms |

9. Temperature Measurement Functions

| | |
|------------------------|--|
| Function | Acquires temperature measurement values from an RS-232C-equipped thermometer Merely attaching a device may be inadequate, as the raw numeric data returned from the thermometer is used |
| Supported thermometers | Hioki RS-232C-equipped thermometers |
| Number of channels | 1 |
| Range | $\pm 500.00^{\circ}\text{C}$ (single range, independent of thermometer setting) |
| Temperature units | $^{\circ}\text{C}$ $^{\circ}\text{F}$ |
| Data acquisition rate | Approx. once per second (actual update rate is thermometer-dependent) |

10. External Printer Output Functions

| | |
|-------------------|--|
| Function | Prints a screen image on a printer connected to the RS-232C interface |
| Supported printer | HIOKI 9670 |
| Output contents | Screen capture |
| Printer setup | The printer is automatically set up by key-presses on the Setting screen |

11. Other functions

| | |
|--------------------------|---|
| Real-Time Clock function | Auto-calendar, leap-year correcting 24-hour clock |
| RTC accuracy | ± 3 s per day @25 $^{\circ}\text{C}$ |
| Sensor recognition | Current sensors are automatically recognized when connected Sensor range and connection state are detected, and warning indicators displayed as needed |
| Warning indicators | When peak over occurs on voltage and current measurement channels When no sync source is detected Warning indicators for all channels are displayed on all pages of the MEAS screen. |
| Key-lock | Toggles on/off by holding the ESC key for three seconds. A key-lock indicator is displayed when the keys are locked. |
| System reset | Returns all settings to factory defaults However, language and communications settings are unaffected. |
| Power-on reset | Holding the DATA RESET key when turning the power on returns all settings, including language and communications settings, to factory defaults. |
| File operations | Media content list display, format media, create folders, delete files and folders, copy between storage media |

10.3 Setting Specifications

1. Input Settings

| Wiring modes | CH1 | CH2 | CH3 | CH4 |
|--------------|--------|------|--------|------|
| Mode 1 | 1P2W | 1P2W | 1P2W | 1P2W |
| Mode 2 | 1P3W | | 1P2W | 1P2W |
| Mode 3 | 3P3W2M | | 1P2W | 1P2W |
| Mode 4 | 1P3W | | 1P3W | |
| Mode 5 | 3P3W2M | | 1P3W | |
| Mode 6 | 3P3W2M | | 3P3W2M | |
| Mode 7 | 3P3W3M | | | 1P2W |
| Mode 8 | 3P4W | | | 1P2W |

| | |
|-----------------------------------|--|
| Synchronization source | U1 to U4, I1 to I4, Ext (when channel B is set for pulse input with a motor evaluation option installed) DC (50 ms/100 ms) @Selectable on all wiring systems |
| Voltage range | AUTO, 1500 V, 600 V, 300 V, 150 V, 60 V, 30 V, 15 V |
| Voltage rectification method | RMS / MEAN (voltage value used to calculate apparent and reactive power, and power factor) |
| Current range | AUTO, 20 A, 8 A, 4 A, 2 A (20 A with 9272-10) AUTO, 20 A, 8 A, 4 A, 2 A, 0.8 A, 0.4 A (20 A with 9277) AUTO, 200 A, 80 A, 40 A, 20 A, 8 A, 4 A (200 A with 9272-10, 9278 and CT6863) AUTO, 50 A, 20 A, 10 A, 5 A, 2 A, 1 A (CT6862) AUTO, 500 A, 200 A, 100 A, 50 A, 20 A, 10 A (9279, 9709) |
| Current rectification method | RMS/ MEAN (current value used to calculate apparent and reactive power, and power factor) |
| VT(PT) ratio | OFF/ 0.01 to 9999.99(setting not available if VT×CT ratio exceeds 1.0E+06) |
| CTratio | OFF/ 0.01 to 9999.99(setting not available if VT×CT ratio exceeds 1.0E+06) |
| LPF | OFF, 500 Hz, 5 kHz, 100 kHz |
| Lower limit measurement frequency | 0.5 Hz, 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz |
| Frequency measurement | Select U or I for f1, f2, f3, and f4 |
| Integration mode | RMS/ DC |

2. Calculation and Recording Settings

| | |
|-------------------------|---|
| Average | OFF, FAST, MID, SLOW |
| Interval | OFF, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 5 s, 10 s, 15 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, 60 min |
| Timer control | Elapsed time / Real-time clock Timer: Off, 10 s to 9999:59:59 [hhhh:mm:ss] (in 1 s units) Real-time clock:OFF, start and stop times (YMD-hms, in 1 min units) |
| Zero suppression | OFF, 0.1%/ 0.5%f.s. |
| Zero-crossing filter | Off, mild or strong |
| Auto-ranging span | Wide or narrow |
| Efficiency calculations | Three items (select from all active power values) $\eta=100 \times \text{Pout} / \text{Pin} $ |
| Loss calculations | Three items (select from all active power values) $\text{Loss}= \text{Pin} - \text{Pout} $ |
| Δ - Y Conversion | OFF/ ON |

3. Harmonic Settings

| | |
|------------------|---|
| Harmonic | U1 to U4, I1 to I4, Ext (when channel B is set for pulse input with a motor evaluation option installed) DC (50 ms/100 ms) Settings common to all channels |
| TTHD calculation | THD-F/ THD-R |

4. Noise Analysis Settings

| | |
|-----------------------------|--------------------------------|
| Measurement channels | Select one of channels 1 to 4 |
| Windows | Rectangular, Hanning, flat-top |
| Lower limit noise frequency | 0 kHz to 10 kHz |

5. D/A Output Settings (with D/A output option Model 9792 or 9793)

| | |
|----------------------------------|---|
| Waveform output | Off or On (See separate specifications for Model 9793 when enabled [ON]) |
| Output items | Select one basic measurement item for each output channel. Only selectable for channels 9 to 16 when waveform output is enabled [ON] (Channels 1 to 8 provide waveform output only) |
| Full-scale frequency integration | 100 Hz, 500 Hz, 1 kHz, 5 kHz (same as max. measurement frequency setting for motor) |
| Full scale | 1/10, 1/2, 1/1, 5, 10, 50, 100, 500, 1000, 5000, 10000 × range |

6. Motor Measurement Settings (with motor evaluation option Model 9791 or 9793)

| | |
|------------------------------|--|
| Synchronization source | U1 to U4, I1 to I4, Ext (with channel B set for pulse input), DC (50ms/100ms) Common to channels A and B |
| CHA Input | Analog DC or frequency |
| CHArange | ± 1 V, ± 5 V, ± 10 V (for analog DC only) |
| Frequency range | Select f_c and f_d for frequency range $f_c \pm f_d$ [Hz] (frequency measurement only) 1 kHz to 98 kHz in 1 kHz units, where $f_c + f_d < 100$ kHz and $f_c - f_d > 1$ kHz) |
| CHAScaling | 0.01 to 9999.99(for analog DC only) |
| Rated torque | 1 to 999 (frequency measurement only) |
| CHA Unit | Analog DC: V, N• m, mN• m, kN• m Frequency: Hz, N• m, mN• m, kN• m |
| CHB Input | Analog DC or pulse |
| CHB range | ± 1 V, ± 5 V, ± 10 V (for analog DC only) |
| Motor poles | 2 to 9 8(pulse input only) |
| Max. measurement frequency | 100 Hz, 500 Hz, 1 kHz, 5 kHz (pulse input only) Same as full-scale D/A output frequency setting |
| CHBScaling | 0.01 to 9999.99 (for analog DC only) |
| Pulse count | Integer multiple of half the number of motor poles, from 1 to 60000 (pulse input only) |
| CHB | Analog DC: V, Hz, r/ min Pulse: Hz, r/ min |
| CHZ | OFF/ ON (pulse input only) |
| Measurement frequency source | f1 to f4 (for slip calculations) |
| LPF | OFF/ ON |

7. Interface Settings

| | |
|--------------------------------|---|
| Synchronization control | Master/slave |
| Synchronous event items | HOLD, SAVE, COPY |
| Saving Data | Select the items to record (Max. number of items is limited according to the interval setting.) |
| Auto-save | OFF/ ON (CF card) |
| Data save destination | Destination folder |
| Manual save destination | USB memory, CF card (selected folder) |
| RS-232C connection destination | Printer, Temperature tester |
| RS-232C communications speed | 2400bps, 9600bps, 19200bps, 38400bps(2400 bps for thermometers) |
| IP address | Four 3-digit octets (0 to 255) |
| Subnet mask | Four 3-digit octets (0 to 255) |
| Default gateway | Four 3-digit octets (0 to 255) |
| Temperature units setting | Fahrenheit |

8. System Settings

| | |
|---------------------------|---|
| Display language | Japanese, English |
| Beep sound | OFF/ ON |
| Screen color schemes | Color1, Color2, Color3, Color4, Mono |
| Start-up screen selection | Wiring or Last-displayed screen (Measurement screens only) |
| LCD backlight | ON, 1 min, 5 min, 10 min, 30 min, 60 min |
| Clock setting | Year, month, day, hour and minute setting, and zero-second adjustment |
| System reset | Reset |
| Serial number indication | Displayed |
| Version indication | Software version displayed |

10.4 Measurement Item Details

1. Basic Measurement Items

| Measurement items | | Symbol | Unit | Mode 1 1P2W+1P2W +1P2W+1P2W | Mode 2,3 1P3W/3P3W2M +1P2W+1P2W | Mode 4,5,6 1P3W/3P3W2M +1P3W/3P3W2M | Mode 7,8 3P3W3M/3P4W +1P2W | Display range | Polarity (+/-) | |
|-------------------|--|-------------|------------|-----------------------------------|---------------------------------------|---|----------------------------------|------------------|-------------------|---|
| Frequency | | f | Hz | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.5000 to 5.0000k | |
| Voltage | RMS | Urms | V | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | U Range | zero to 120% | |
| | Voltage MEAN | Umn | V | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | ↓ | zero to 120% | |
| | AC component | Uac | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | |
| | Simple average | Udc | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | ● |
| | Fundamental wave component | Ufnd | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | |
| | wave peak + | Upk+ | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 300% | ● |
| | wave peak - | Upk- | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 300% | ● |
| | THD/ripple rate*6 | Uthd Urf | % | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 500.00 | |
| Unbalance factor | Uunb | % | | | | 123 | | 0.00 to 100.00 | | |
| Current | RMS | Irms | A | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | I Range | zero to 120% | |
| | Current MEAN | Imn | A | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | ↓ | zero to 120% | |
| | AC component | Iac | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | |
| | Simple average | Idc | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | ● |
| | Fundamental wave component | Ifnd | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 120% | |
| | wave peak+ | Ipk+ | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 300% | ● |
| | wave peak- | Ipk- | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 300% | ● |
| | THD/ripple rate*6 | Ithd Irf | % | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 500.00 | |
| Unbalance factor | Iunb | % | | | | 123 | | 0.00 to 100.00 | | |
| Effective power | P | W | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | P Range | zero to 120% | ● | |
| Apparent power | S | VA | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | ↓ | zero to 120% | | |
| Reactive power | Q | var | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | ↓ | zero to 120% | ● | |
| Power factor | λ | | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | 0.00 to 180.00 | 0.0000 to 1.0000 | ● | |
| Phase angle | Voltage phase angle | θU | ° | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 180.00 | ● |
| | Current phase angle | θI | ° | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 180.00 | ● |
| | power phase angle | φ | ° | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | | 0.00 to 180.00 | ● |
| Integration | Integ. current in positive direction*1 | Ih+ | Ah | 1, 2, 3, 4 | 3, 4 | | 4 | I Range | zero to 100% *5 | |
| | Integ. current in negative direction*1 | Ih- | Ah | 1, 2, 3, 4 | 3, 4 | | 4 | ↓ | zero to 100% *5 | △ |
| | Sum of integ. Current | Ih | Ah | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | ↓ | zero to 100% *5 | ● |
| | Energy in positive direction*1 | WP+ | Wh | 1, 2, 3, 4 | 3, 4, 12 | 12, 34 | 4, 123 | P Range | zero to 100% *5 | |
| | Energy in negative direction*1 | WP- | Wh | 1, 2, 3, 4 | 3, 4, 12 | 12, 34 | 4, 123 | ↓ | zero to 100% *5 | △ |
| Sum of energy | WP | Wh | 1, 2, 3, 4 | 3, 4, 12 | 12, 34 | 4, 123 | ↓ | zero to 100% *5 | ● | |
| Efficiency | η | % | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | | 0.00 to 200.00 | | |
| Loss | Loss | W | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | P Range | zero to 120% | ● | |
| Temperature*2 | Temp | ° | ----- | ----- | ----- | ----- | | 0.00 to 500.00 | ● | |
| Motor *3 | Torque | CH A | *4 | ----- | ----- | ----- | ----- | A Range | zero to 120% | ● |
| | Rotation speed | CH B | *4 | ----- | ----- | ----- | ----- | B Range | zero to 120% | ● |
| | Motor power | Pm | W | ----- | ----- | ----- | ----- | Pm Range | zero to 120% | ● |
| | Slip | Slip | % | ----- | ----- | ----- | ----- | | 0.00 to 100.00 | ● |

*1. DC integration mode

*2. Temp only when a thermometer is selected as RS-232C destination

*3. Requires motor evaluation option Model 9791 or 9793

*4. Can be changed with unit selection No zero suppression when the frequency or pulse is set.

*5. Forward, reverse and combined values should be same range, and are displayed with the number of digits available for any maximum value

*6. THD when the integration mode is RMS, and rf when the integration mode is DC,

zero indicates zero-suppression setting, and values less than zero are zero suppressed

P range is -3. See power range configuration. Pm range = (range A × range B / 10), × 1/1000 for mN · m, or × 1000 for kN · m) Range

A when channel A measures frequency at rated torque setting value

Range B when channel B measures pulses at maximum measurement frequency setting value [Hz]

2.Harmonic Measurement Items

| Measurement items | Symbol | Unit | Mode 1 1P2W+1P2W +1P2W+1P2W | Mode 2,3 1P3W/3P3W2M +1P2W+1P2W | Mode 4,5,6 1P3W/3P3W2M +1P3W/3P3W2M | Mode 7,8 3P3W3M/3P4W +1P2W | Display range | | Pola rity (+/-) |
|---|--------|------|-----------------------------------|---------------------------------------|---|----------------------------------|---------------|----------------|-----------------------|
| Harmonic voltage | Uk | V | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | U Range | 0 to 120% | |
| Harmonic voltage phase angle | θUk | ° | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 180.00 | ● |
| Harmonic current | Ik | A | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | I Range | 0 to 120% | |
| Harmonic current phase angle | θIk | ° | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 180.00 | ● |
| Harmonic active power | Pk | W | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | P Range | 0 to 120% | ● |
| Phase difference of harmonic voltage and harmonic current | θk | ° | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | | 0.00 to 180.00 | ● |
| Harmonic voltage content | HDUk | % | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 500.00 | |
| Harmonic current content | HDIk | % | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | 1, 2, 3, 4 | | 0.00 to 500.00 | |
| Harmonic power content | HDPk | % | 1, 2, 3, 4 | 1, 2, 3, 4, 12 | 1, 2, 3, 4, 12, 34 | 1, 2, 3, 4, 123 | | 0.00 to 500.00 | ● |

3.Noise Measurement Items

| Measurement items | Symbol | Unit | Display range | |
|-------------------|-----------------|------|--------------------------------|--|
| Voltage noise | U _{Nf} | Hz | 0 to Maximum frequency setting | Ten measurements in descending order of U _N |
| | U _N | V | 0 to 120% of U range | |
| Current noise | I _{Nf} | Hz | 0 to Maximum frequency setting | Ten measurements in descending order of I _N |
| | I _N | A | 0 to 120% of I range | |

4.Power Range Configurations

(1)With 20A sensors

| Current/Phase (Wiring) System/ Voltage | | 15.000 V | 30.000 V | 60.000 V | 150.00 V | 300.00 V | 600.00 V | 1.5000 kV |
|---|---------------------|----------|----------|----------|----------|----------|----------|-----------|
| 400.00 mA | 1P2W | 6.0000 | 12.000 | 24.000 | 60.000 | 120.00 | 240.00 | 600.00 |
| | 1P3W 3P3W(2M/3M) | 12.000 | 24.000 | 48.000 | 120.00 | 240.00 | 480.00 | 1.2000k |
| | 3P4W | 18.000 | 36.000 | 72.000 | 180.00 | 360.00 | 720.00 | 1.8000k |
| 800.00 mA | 1P2W | 12.000 | 24.000 | 48.000 | 120.00 | 240.00 | 480.00 | 1.2000k |
| | 1P3W 3P3W(2M/3M) | 24.000 | 48.000 | 96.00 | 240.00 | 480.00 | 0.9600k | 2.4000k |
| | 3P4W | 36.000 | 72.000 | 144.00 | 360.00 | 720.00 | 1.4400k | 3.6000k |
| 2.0000 A | 1P2W | 30.000 | 60.000 | 120.00 | 300.00 | 600.00 | 1.2000k | 3.0000k |
| | 1P3W 3P3W(2M/3M) | 60.000 | 120.00 | 240.00 | 600.00 | 1.2000k | 2.4000k | 6.0000k |
| | 3P4W | 90.00 | 180.00 | 360.00 | 0.9000k | 1.8000k | 3.6000k | 9.000k |
| 4.0000 A | 1P2W | 60.000 | 120.00 | 240.00 | 600.00 | 1.2000k | 2.4000k | 6.0000k |
| | 1P3W 3P3W(2M/3M) | 120.00 | 240.00 | 480.00 | 1.2000k | 2.4000k | 4.8000k | 12.000k |
| | 3P4W | 180.00 | 360.00 | 720.00 | 1.8000k | 3.6000k | 7.2000k | 18.000k |
| 8.0000 A | 1P2W | 120.00 | 240.00 | 480.00 | 1.2000k | 2.4000k | 4.8000k | 12.000k |
| | 1P3W 3P3W(2M/3M) | 240.00 | 480.00 | 0.9600k | 2.4000k | 4.8000k | 9.600k | 24.000k |
| | 3P4W | 360.00 | 720.00 | 1.4400k | 3.6000k | 7.2000k | 14.400k | 36.000k |
| 20.000 A | 1P2W | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 1P3W 3P3W(2M/3M) | 600.00 | 1.2000k | 2.4000k | 6.0000k | 12.000k | 24.000k | 60.000k |
| | 3P4W | 0.9000k | 1.8000k | 3.6000k | 9.000k | 18.000k | 36.000k | 90.00k |

Active power (P) units are [W], apparent power (S) units are [VA], and reactive power (Q) units are [VAR]

10.4 Measurement Item Details

(2) With 50A sensors

| Current/Phase (Wiring) System/ Voltage | | 15.000 V | 30.000 V | 60.000 V | 150.00 V | 300.00 V | 600.00 V | 1.5000 kV |
|---|---------------------|----------|----------|----------|----------|----------|----------|-----------|
| 1.0000 A | 1P2W | 15.000 | 30.000 | 60.000 | 150.00 | 300.00 | 600.00 | 1.5000k |
| | 1P3W 3P3W(2M/3M) | 30.000 | 60.000 | 120.00 | 300.00 | 600.00 | 1.2000k | 3.0000k |
| | 3P4W | 45.000 | 90.00 | 180.00 | 450.00 | 0.9000k | 1.8000k | 4.5000k |
| 2.0000 A | 1P2W | 30.000 | 60.000 | 120.00 | 300.00 | 600.00 | 1.2000k | 3.0000k |
| | 1P3W 3P3W(2M/3M) | 60.000 | 120.00 | 240.00 | 600.00 | 1.2000k | 2.4000k | 6.0000k |
| | 3P4W | 90.00 | 180.00 | 360.00 | 0.9000k | 1.8000k | 3.6000k | 9.000k |
| 5.0000 A | 1P2W | 75.000 | 150.00 | 300.00 | 750.00 | 1.5000k | 3.0000k | 7.5000k |
| | 1P3W 3P3W(2M/3M) | 150.00 | 300.00 | 600.00 | 1.5000k | 3.0000k | 6.0000k | 15.000k |
| | 3P4W | 225.00 | 450.00 | 0.9000k | 2.2500k | 4.5000k | 9.000k | 22.500k |
| 10.000 A | 1P2W | 150.00 | 300.00 | 600.00 | 1.5000k | 3.0000k | 6.0000k | 15.000k |
| | 1P3W 3P3W(2M/3M) | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 3P4W | 450.00 | 0.9000k | 1.8000k | 4.5000k | 9.000k | 18.000k | 45.000k |
| 20.000 A | 1P2W | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 1P3W 3P3W(2M/3M) | 600.00 | 1.2000k | 2.4000k | 6.0000k | 12.000k | 24.000k | 60.000k |
| | 3P4W | 0.9000k | 1.8000k | 3.6000k | 9.000k | 18.000k | 36.000k | 90.00k |
| 50.000 A | 1P2W | 750.00 | 1.5000k | 3.0000k | 7.5000k | 15.000k | 30.000k | 75.000k |
| | 1P3W 3P3W(2M/3M) | 1.5000k | 3.0000k | 6.0000k | 15.000k | 30.000k | 60.000k | 150.00k |
| | 3P4W | 2.2500k | 4.5000k | 9.000k | 22.500k | 45.000k | 90.00k | 225.00k |

Active power (P) units are [W], apparent power (S) units are [VA], and reactive power (Q) units are [VAR]

(3)With 200 A sensors

| Current/Phase (Wiring) System/ Voltage | | 15.000 V | 30.000 V | 60.000 V | 150.00 V | 300.00 V | 600.00 V | 1.5000 kV |
|---|---------------------|----------|----------|----------|----------|----------|----------|-----------|
| 4.0000 A | 1P2W | 60.000 | 120.00 | 240.00 | 600.00 | 1.2000k | 2.4000k | 6.0000k |
| | 1P3W 3P3W(2M/3M) | 120.00 | 240.00 | 480.00 | 1.2000k | 2.4000k | 4.8000k | 12.000k |
| | 3P4W | 180.00 | 360.00 | 720.00 | 1.8000k | 3.6000k | 7.2000k | 18.000k |
| 8.0000 A | 1P2W | 120.00 | 240.00 | 480.00 | 1.2000k | 2.4000k | 4.8000k | 12.000k |
| | 1P3W 3P3W(2M/3M) | 240.00 | 480.00 | 0.9600k | 2.4000k | 4.8000k | 9.600k | 24.000k |
| | 3P4W | 360.00 | 720.00 | 1.4400k | 3.6000k | 7.2000k | 14.400k | 36.000k |
| 20.000 A | 1P2W | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 1P3W 3P3W(2M/3M) | 600.00 | 1.2000k | 2.4000k | 6.0000k | 12.000k | 24.000k | 60.000k |
| | 3P4W | 0.9000k | 1.8000k | 3.6000k | 9.000k | 18.000k | 36.000k | 90.00k |
| 40.000 A | 1P2W | 600.00 | 1.2000k | 2.4000k | 6.0000k | 12.000k | 24.000k | 60.000k |
| | 1P3W 3P3W(2M/3M) | 1.2000k | 2.4000k | 4.8000k | 12.000k | 24.000k | 48.000k | 120.00k |
| | 3P4W | 1.8000k | 3.6000k | 7.2000k | 18.000k | 36.000k | 72.000k | 180.00k |
| 80.000 A | 1P2W | 1.2000k | 2.4000k | 4.8000k | 12.000k | 24.000k | 48.000k | 120.00k |
| | 1P3W 3P3W(2M/3M) | 2.4000k | 4.8000k | 9.600k | 24.000k | 48.000k | 96.00k | 240.00k |
| | 3P4W | 3.6000k | 7.2000k | 14.400k | 36.000k | 72.000k | 144.00k | 360.00k |
| 200.00 A | 1P2W | 3.0000k | 6.0000k | 12.000k | 30.000k | 60.000k | 120.00k | 300.00k |
| | 1P3W 3P3W(2M/3M) | 6.0000k | 12.000k | 24.000k | 60.000k | 120.00k | 240.00k | 600.00k |
| | 3P4W | 9.000k | 18.000k | 36.000k | 90.00k | 180.00k | 360.00k | 0.9000M |

Active power (P) units are [W], apparent power (S) units are [VA], and reactive power (Q) units are [VAR]

(4) With 500 A sensors

| Current/Phase (Wiring) System/ Voltage | | 15.000 V | 30.000 V | 60.000 V | 150.00 V | 300.00 V | 600.00 V | 1.5000 kV |
|---|---------------------|----------|----------|----------|----------|----------|----------|-----------|
| 10.000 A | 1P2W | 150.00 | 300.00 | 600.00 | 1.5000k | 3.0000k | 6.0000k | 15.000k |
| | 1P3W 3P3W(2M/3M) | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 3P4W | 450.00 | 0.9000k | 1.8000k | 4.5000k | 9.000k | 18.000k | 45.000k |
| 20.000 A | 1P2W | 300.00 | 600.00 | 1.2000k | 3.0000k | 6.0000k | 12.000k | 30.000k |
| | 1P3W 3P3W(2M/3M) | 600.00 | 1.2000k | 2.4000k | 6.0000k | 12.000k | 24.000k | 60.000k |
| | 3P4W | 0.9000k | 1.8000k | 3.6000k | 9.000k | 18.000k | 36.000k | 90.00k |
| 50.000 A | 1P2W | 750.00 | 1.5000k | 3.0000k | 7.5000k | 15.000k | 30.000k | 75.000k |
| | 1P3W 3P3W(2M/3M) | 1.5000k | 3.0000k | 6.0000k | 15.000k | 30.000k | 60.000k | 150.00k |
| | 3P4W | 2.2500k | 4.5000k | 9.000k | 22.500k | 45.000k | 90.00k | 225.00k |
| 100.00 A | 1P2W | 1.5000k | 3.0000k | 6.0000k | 15.000k | 30.000k | 60.000k | 150.00k |
| | 1P3W 3P3W(2M/3M) | 3.0000k | 6.0000k | 12.000k | 30.000k | 60.000k | 120.00k | 300.00k |
| | 3P4W | 4.5000k | 9.000k | 18.000k | 45.000k | 90.00k | 180.00k | 450.00k |
| 200.00 A | 1P2W | 3.0000k | 6.0000k | 12.000k | 30.000k | 60.000k | 120.00k | 300.00k |
| | 1P3W 3P3W(2M/3M) | 6.0000k | 12.000k | 24.000k | 60.000k | 120.00k | 240.00k | 600.00k |
| | 3P4W | 9.000k | 18.000k | 36.000k | 90.00k | 180.00k | 360.00k | 0.9000M |
| 500.00 A | 1P2W | 7.5000k | 15.000k | 30.000k | 75.000k | 150.00k | 300.00k | 750.00k |
| | 1P3W 3P3W(2M/3M) | 15.000K | 30.000k | 60.000k | 150.00k | 300.00k | 600.00k | 1.5000M |
| | 3P4W | 22.500K | 45.000k | 90.00k | 225.00k | 450.00k | 0.9000M | 2.2500M |

Active power (P) units are [W], apparent power (S) units are [VA], and reactive power (Q) units are [VAR]

10.5 Calculation Formula Specifications

1. Calculation Formulas for Basic Measurement Items

| Items \ Phase System | 1P2W | 1P3W | 3P3W2M | 3P3W3M | 3P4W |
|------------------------------------|--|--|--------|---|------|
| Voltage RMS | $Urms(i) = \sqrt{\frac{1}{M} \sum_{s=0}^{M-1} (U(i)s)^2}$ | $Urms_{12} = \frac{1}{2}(Urms_1 + Urms_2)$ $Urms_{34} = \frac{1}{2}(Urms_3 + Urms_4)$ | | $Urms_{123} = \frac{1}{3}(Urms_1 + Urms_2 + Urms_3)$ | |
| Voltage MEAN | $Umn(i) = \frac{\pi}{2\sqrt{2}M} \sum_{s=0}^{M-1} U(i)s $ | $Umn_{12} = \frac{1}{2}(Imn_1 + Imn_2)$ $Umn_{34} = \frac{1}{2}(Imn_3 + Imn_4)$ | | $Umn_{123} = \frac{1}{3}(Umn_1 + Umn_2 + Umn_3)$ | |
| Voltage AC component | $Uac(i) = \sqrt{(Urms(i))^2 - (Udc(i))^2}$ | | | | |
| Voltage simple average | $Udc(i) = \frac{1}{M} \sum_{s=0}^{M-1} U(i)s$ | | | | |
| Voltage fundamental wave component | Harmonic voltage $UI(i)$ for harmonic calculation formulas | | | | |
| Peak voltage | $Upk+(i) = U(i)s \quad \text{Maximum } M \text{ value}$ $Upk-(i) = U(i)s \quad \text{Minimum } M \text{ value}$ | | | | |
| THD Voltage Percentage | $Uthd(i) \text{ in harmonic calculation formulas}$ | | | | |
| Voltage ripple rate | $\frac{ (Upk+(i) - Upk-(i)) }{(2 \times Udc(i))} \times 100$ | | | | |
| Voltage unbalance factor | | | | $Uunb_{123} = \sqrt{\frac{1 - \sqrt{3 - 6\beta}}{1 + \sqrt{3 - 6\beta}}} \times 100$ $\beta = \frac{U_{12}^4 + U_{23}^4 + U_{31}^4}{(U_{12}^2 + U_{23}^2 + U_{31}^2)^2}$ <small>U_{12}, U_{23}, and U_{31} are fundamental rms voltages (between lines) obtained from harmonic calculations. For 3P4W systems, voltage balance is detected from phase voltage, but is converted to voltage between lines for calculations.</small> | |

(i) : Measurement channel
M : Number of synchronous samples
s : Sample (data point) number

| Items \ Phase System | 1P2W | 1P3W | 3P3W2M | 3P3W3M | 3P4W |
|------------------------------------|--|--|--------|--|---|
| Current RMS | $I_{rms(i)} = \sqrt{\frac{1}{M} \sum_{s=0}^{M-1} (I(i)_s)^2}$ | $I_{rms12} = \frac{1}{2}(I_{rms1} + I_{rms2})$ $I_{rms34} = \frac{1}{2}(I_{rms3} + I_{rms4})$ | | $I_{rms123} = \frac{1}{3}(I_{rms1} + I_{rms2} + I_{rms3})$ | |
| Current MEAN | $I_{mn(i)} = \frac{\pi}{2\sqrt{2}M} \sum_{s=0}^{M-1} I(i)_s $ | $I_{mn12} = \frac{1}{2}(I_{mn1} + I_{mn2})$ $I_{mn34} = \frac{1}{2}(I_{mn3} + I_{mn4})$ | | $I_{mn123} = \frac{1}{3}(I_{mn1} + I_{mn2} + I_{mn3})$ | |
| Current AC component | $I_{ac(i)} = \sqrt{(I_{rms(i)})^2 - (I_{dc(i)})^2}$ | | | | |
| Current simple average | $I_{dc(i)} = \frac{1}{M} \sum_{s=0}^{M-1} I(i)_s$ | | | | |
| Current fundamental wave component | Harmonic current $I(i)$ in harmonic calculation formulas | | | | |
| Peak current | $I_{pk+(i)} = I(i)_s \quad \text{Maximum } M \text{ value}$ $I_{pk-(i)} = I(i)_s \quad \text{Minimum } M \text{ value}$ | | | | |
| THD Current Percentage | $I_{thd(i)} \text{ in harmonic calculation formulas}$ | | | | |
| Current ripple rate | $\frac{ (I_{pk+(i)} - I_{pk-(i)}) }{(2 \times I_{dc(i)})} \times 100$ | | | | |
| Current unbalance factor | | | | $I_{unb123} = \frac{\sqrt{1 - \sqrt{3 - 6\beta}}}{\sqrt{1 + \sqrt{3 - 6\beta}}} \times 100$ $\beta = \frac{I_{12}^4 + I_{23}^4 + I_{31}^4}{(I_{12}^2 + I_{23}^2 + I_{31}^2)^2}$ | $I_{12}, I_{23}, \text{ and } I_{31} \text{ are fundamental rms currents (between lines) obtain from harmonic calculations. For 3P3W3M and 3P4W systems, these are converted to current between lines for calculations.}$ |

(i) : Measurement channel
M : Number of synchronous samples
s : Sample (data point) number

10.5 Calculation Formula Specifications

| Phase System Items | 1P2W | 1P3W | 3P3W2M | 3P3W3M | 3P4W |
|-----------------------|---|--|--|---|------|
| Active power | $P_{(i)} = \frac{1}{M} \sum_{s=0}^{M-1} (U_{(i)s} \times I_{(i)s})$ | $P_{12} = P_1 + P_2$ $P_{34} = P_3 + P_4$ | | $P_{123} = P_1 + P_2 + P_3$ | |
| | <ul style="list-style-type: none"> For 3P3W3M and 3P4W systems, phase voltage is used for waveform voltage $U(i)s$. (3P3W3M: $U_{1s}=(U_{1s}-U_{3s})/3$, $U_{2s}=(U_{2s}-U_{1s})/3$, $U_{3s}=(U_{3s}-U_{2s})/3$) The polarity sign for active power indicates power flow direction: positive (+P) for forward power (consumption), and negative (-P) for reverse power (regeneration), and indicates net current flow for power. | | | | |
| Apparent power | $S_{(i)} = U_{(i)} \times I_{(i)}$ | $S_{12} = S_1 + S_2$ $S_{34} = S_3 + S_4$ | $S_{12} = \frac{\sqrt{3}}{2}(S_1 + S_2)$ $S_{34} = \frac{\sqrt{3}}{2}(S_3 + S_4)$ | $S_{123} = S_1 + S_2 + S_3$ | |
| | <ul style="list-style-type: none"> Select $U(i)$ and $i(i)$ from rms/mn. For 3P3W3M and 3P4W waveforms, $U(i)$ is phase voltage. | | | | |
| Reactive power | $Q_{(i)} = si_{(i)} \sqrt{S_{(i)}^2 - P_{(i)}^2}$ | $Q_{12} = Q_1 + Q_2$ $Q_{34} = Q_3 + Q_4$ | | $Q_{123} = Q_1 + Q_2 + Q_3$ | |
| | <ul style="list-style-type: none"> The polarity sign (si) for reactive power (Q) is indicated by [none] for lag or [-] for lead. The polarity sign ($si(i)$) for each channel (i) is acquired from lag or lead of the voltage waveform $U(i)s$ and current waveform $I(i)s$. For 3P3W3M and 3P4W waveforms, $U(i)s$ is phase voltage. (3P3W3M: $U_{1s}=(U_{1s}-U_{3s})/3$, $U_{2s}=(U_{2s}-U_{1s})/3$, $U_{3s}=(U_{3s}-U_{2s})/3$) | | | | |
| Power factor | $\lambda_{(i)} = si_{(i)} \left \frac{P_{(i)}}{S_{(i)}} \right $ | $\lambda_{12} = si_{12} \left \frac{P_{12}}{S_{12}} \right $ $\lambda_{34} = si_{34} \left \frac{P_{34}}{S_{34}} \right $ | | $\lambda_{123} = si_{123} \left \frac{P_{123}}{S_{123}} \right $ | |
| | <ul style="list-style-type: none"> The polarity (si) for power factor (λ) is indicated by [no sign] for lag or [-] for lead. The polarity sign ($si(i)$) for each channel (i) is acquired from lag or lead of the voltage waveform $U(i)s$ and current waveform $I(i)s$. Polarities si_{12}, si_{34}, and si_{123} are acquired from reactive power values Q_{12}, Q_{34}, and Q_{123}, respectively. | | | | |
| Power phase angle | $\phi_{(i)} = si_{(i)} \cos^{-1} \lambda_{(i)} $ | $\phi_{12} = si_{12} \cos^{-1} \lambda_{12} $ $\phi_{34} = si_{34} \cos^{-1} \lambda_{34} $ | | $\phi_{123} = si_{123} \cos^{-1} \lambda_{123} $ | |
| | <ul style="list-style-type: none"> The polarity sign ($si(i)$) for each channel (i) is acquired from lag or lead of the voltage waveform $U(i)s$ and current waveform $I(i)s$. Polarities si_{12}, si_{34}, and si_{123} are acquired from reactive power values Q_{12}, Q_{34}, and Q_{123}, respectively. | | | | |

(i) : Measurement channel
M : Number of synchronous samples
s : Sample (data point) number

2.Motor Evaluation Calculation Formulas

| Items | Setting Units | Calculation Formulas | |
|---|---|--|---|
| chA | V (DC Voltage) | $\frac{1}{M} \sum_{s=0}^{M-1} A_s$ | |
| | N• m, mN• m, or kN• m common to all measurements (torque) | For Analog DC | A [V] x channel A scaling setting |
| | | For Frequency | $\frac{(\text{Measurement freq.} - fc \text{ setting value}) \times \text{rated torque setting value}}{fd \text{ setting value}}$ |
| <i>M</i> :Number of synchronous samples, <i>S</i> :Sample (data point) number | | | |
| chB | V (DC Voltage) | $\frac{1}{M} \sum_{s=0}^{M-1} B_s$ | |
| | Hz (Frequency) | For Analog DC | B [V] x channel B scaling setting |
| | | Pulse input | $\frac{\text{set no. of poles} \times \text{pulse frequency}}{2 \times \text{set no. of pulses}} \times 1$ |
| | r/min (rotation rate) | For Analog DC | B [V] x channel B scaling setting |
| Pulse input | | $\frac{2 \times 60 \times \text{frequency[Hz]} (\text{calculated from above Pulse Input value} \times 1)}{\text{set no. of poles}}$ | |
| Pm | N• m (Ch A units) | $(\text{Ch A display value}) \times \frac{2 \times \pi \times (\text{Ch B display value})}{60}$ | |
| | mN• m (Ch A units) | $(\text{Ch A display value}) \times \frac{2 \times \pi \times (\text{Ch B display value})}{60 \times 1000}$ | |
| | kN• m (Ch A units) | $(\text{Ch A display value}) \times \frac{2 \times \pi \times (\text{Ch B display value}) \times 1000}{60}$ | |
| | Calculation is disabled when Ch A units are not those specified above, and when Ch B units are set to other than r/min. | | |
| Slip | Hz (Ch B units) | $100 \times \frac{\text{frequency} - \text{Ch B display value}}{\text{input frequency}} \times \frac{\text{Ch B display value} \times 1000}{\text{input frequency}}$ | |
| | r/min (Ch B units) | $100 \times \frac{2 \times 60 \times \text{input frequency} - \text{Ch B display value} \times \text{set no. of poles}}{2 \times 60 \times \text{Input frequency}}$ | |
| | Select an input frequency (<i>f</i> ₁ to <i>f</i> ₄) | | |

3. Harmonic Measurement Calculation Formulas

| Phase System Items | 1P2W | 1P3W | 3P3W2M | 3P3W3M | 3P4W |
|---|---|---|--------|---|--------------|
| Harmonic voltage | $U_{k(i)} = \sqrt{(U_{kr(i)})^2 + (U_{ki(i)})^2}$ | | | | |
| Harmonic voltage Phase angle | $\theta U_{k(i)} = \tan^{-1} \left(\frac{U_{kr(i)}}{-U_{ki(i)}} \right)$ | | | | |
| Harmonic current | $I_{k(i)} = \sqrt{(I_{kr(i)})^2 + (I_{ki(i)})^2}$ | | | | |
| Harmonic current Phase angle | $\theta I_{k(i)} = \tan^{-1} \left(\frac{I_{kr(i)}}{-I_{ki(i)}} \right)$ | | | | |
| Harmonic effective power | $P_{k(i)} = U_{kr(i)} \times I_{kr(i)} + U_{ki(i)} \times I_{ki(i)}$ | | | $P_{k1} = \frac{1}{3}(U_{kr1} - U_{kr3}) \times I_{kr1} + \frac{1}{3}(U_{ki1} - U_{ki3}) \times I_{ki1}$ $P_{k2} = \frac{1}{3}(U_{kr2} - U_{kr1}) \times I_{kr2} + \frac{1}{3}(U_{ki2} - U_{ki1}) \times I_{ki2}$ $P_{k3} = \frac{1}{3}(U_{kr3} - U_{kr2}) \times I_{kr3} + \frac{1}{3}(U_{ki3} - U_{ki2}) \times I_{ki3}$ $P_{k4} = U_{kr4} \times I_{ki4} + U_{ki4} \times I_{kr4}$ | Same as 1P2W |
| | ----- | $P_{k12} = P_{k1} + P_{k2}$ $P_{k34} = P_{k3} + P_{k4}$ | | $P_{k123} = P_{k1} + P_{k2} + P_{k3}$ | |
| Harmonic reactive power (only used internally) | $Q_{k(i)} = U_{kr(i)} \times I_{ki(i)} - U_{ki(i)} \times I_{kr(i)}$ | | | $Q_{k1} = \frac{1}{3}(U_{kr1} - U_{kr3}) \times I_{ki1} - \frac{1}{3}(U_{ki1} - U_{ki3}) \times I_{kr1}$ $Q_{k2} = \frac{1}{3}(U_{kr2} - U_{kr1}) \times I_{ki2} - \frac{1}{3}(U_{ki2} - U_{ki1}) \times I_{kr2}$ $Q_{k3} = \frac{1}{3}(U_{kr3} - U_{kr2}) \times I_{ki3} - \frac{1}{3}(U_{ki3} - U_{ki2}) \times I_{kr3}$ $Q_{k4} = U_{kr4} \times I_{ki4} - U_{ki4} \times I_{kr4}$ | Same as 1P2W |
| | ----- | $Q_{k12} = Q_{k1} + Q_{k2}$ $Q_{k34} = Q_{k3} + Q_{k4}$ | | $Q_{k123} = Q_{k1} + Q_{k2} + Q_{k3}$ | |
| Harmonic voltage Current phase angle | $\theta_{k(i)} = \theta I_{k(i)} - \theta U_{k(i)}$ | | | | |
| | ----- | $\theta_{k12} = \tan^{-1} \left(\frac{Q_{k12}}{P_{k12}} \right)$ $\theta_{k34} = \tan^{-1} \left(\frac{Q_{k34}}{P_{k34}} \right)$ | | $\theta_{k123} = \tan^{-1} \left(\frac{Q_{k123}}{P_{k123}} \right)$ | |

(i) : Measurement channel

k : Order of analysis

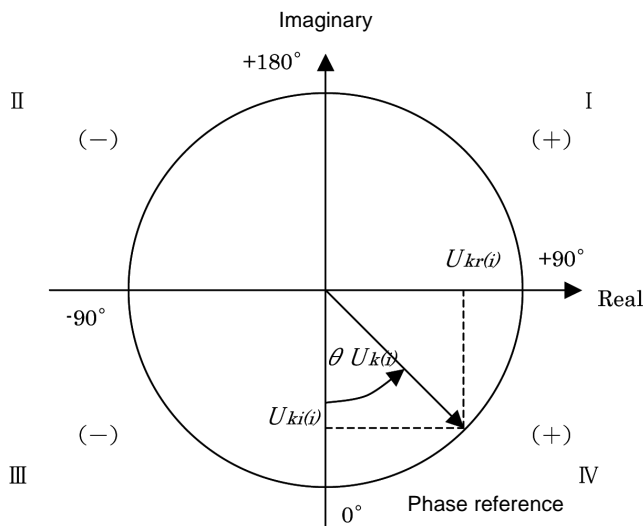
r : Real part of complex result of FFT

i : Imaginary part of complex result of FFT

Harmonic voltage phase angle and harmonic current phase angle are corrected to the fundamental waveform of the harmonic sync source that serves as a phase reference point of 0° (except when an external harmonic sync source is used).

| Phase System Items | 1P2W | 1P3W | 3P3W2M | 3P3W3M | 3P4W |
|--------------------------|--|------|--------|--------|------|
| Harmonic voltage content | $U_{hd_{k(i)}} = \frac{U_k}{U_1} \times 100$ | | | | |
| Harmonic current content | $I_{hd_{k(i)}} = \frac{I_k}{I_1} \times 100$ | | | | |
| Harmonic power content | $P_{hd_{k(i)}} = \frac{P_k}{P_1} \times 100$ | | | | |
| THD Voltage Percentage | $U_{thd(i)} = \frac{\sqrt{\sum_{k=2}^K (U_k)^2}}{U_1} \times 100$ (with THD-F setting), or $\frac{\sqrt{\sum_{k=2}^K (U_k)^2}}{\sqrt{\sum_{k=1}^K (U_k)^2}} \times 100$ (with THD-R setting) | | | | |
| THD Current Percentage | $I_{thd(i)} = \frac{\sqrt{\sum_{k=2}^K (I_k)^2}}{I_1} \times 100$ (with THD-F setting), or $\frac{\sqrt{\sum_{k=2}^K (I_k)^2}}{\sqrt{\sum_{k=1}^K (I_k)^2}} \times 100$ (with THD-R setting) | | | | |

(i) : Measurement channel
 k : Order of analysis
 K : Maximum analysis order (depending on sync frequency)



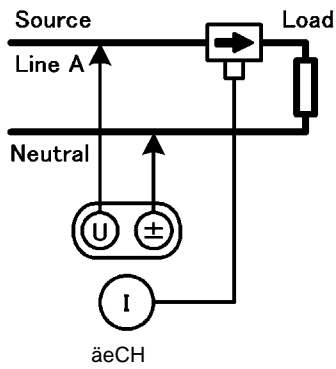
Example: for harmonic voltage

| | |
|--------------------------------|---|
| I | $\tan^{-1} \left(\frac{U_{kr(i)}}{-U_{ki(i)}} \right) + 180^\circ$ |
| II, III | $\tan^{-1} \left(\frac{U_{kr(i)}}{-U_{ki(i)}} \right)$ |
| IV | $\tan^{-1} \left(\frac{U_{kr(i)}}{-U_{ki(i)}} \right) - 180^\circ$ |
| $U_{kr(i)} = 0, U_{kr(i)} < 0$ | $+90^\circ$ |
| $U_{kr(i)} = 0, U_{kr(i)} > 0$ | -90° |
| $U_{kr(i)} < 0, U_{kr(i)} = 0$ | $+180^\circ$ |
| $U_{kr(i)} = 0, U_{kr(i)} = 0$ | 0° |

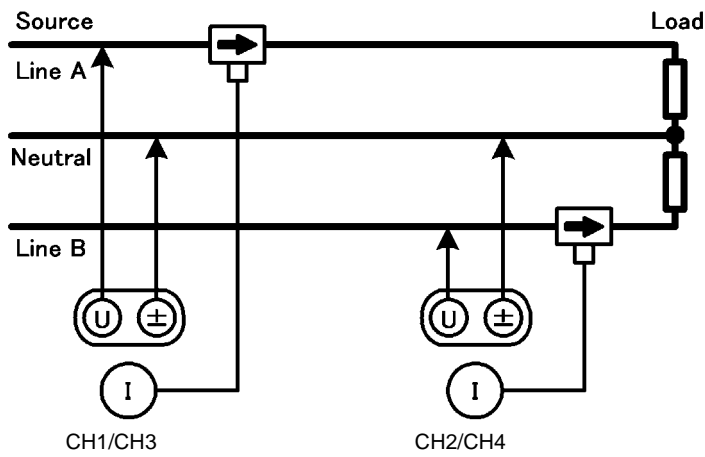
10.5 Calculation Formula Specifications

4. Wiring System Diagrams

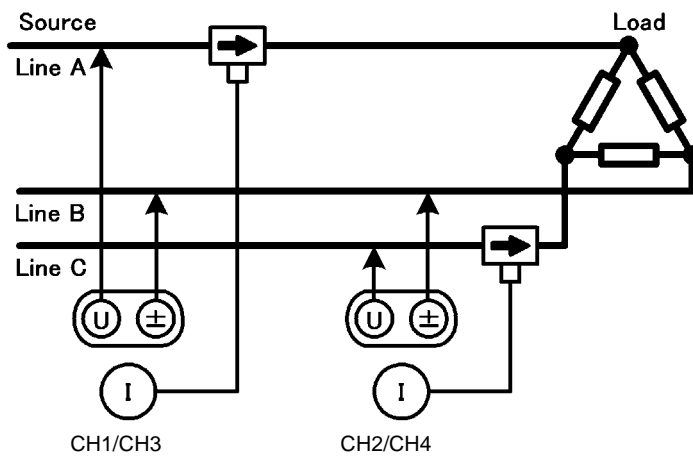
Single Phase 2-wire (1P2W)



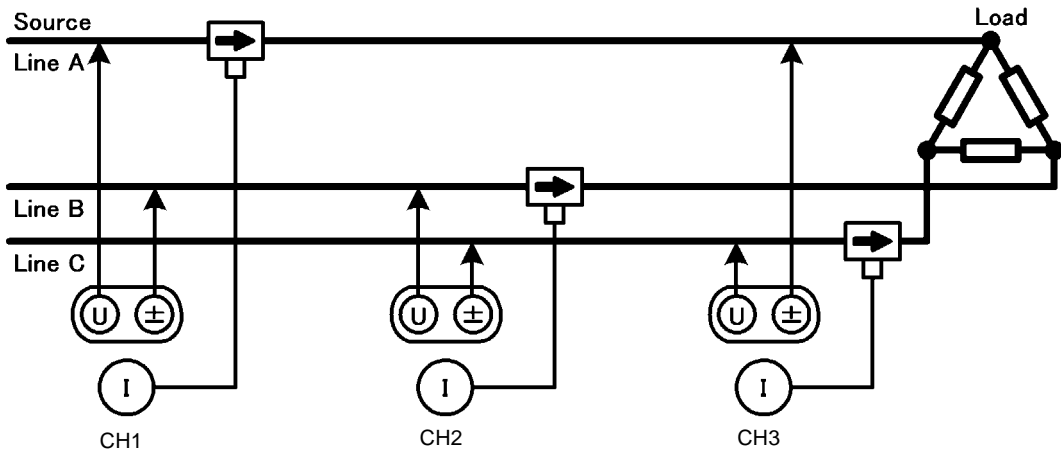
Single Phase 3-wire (1P3W)



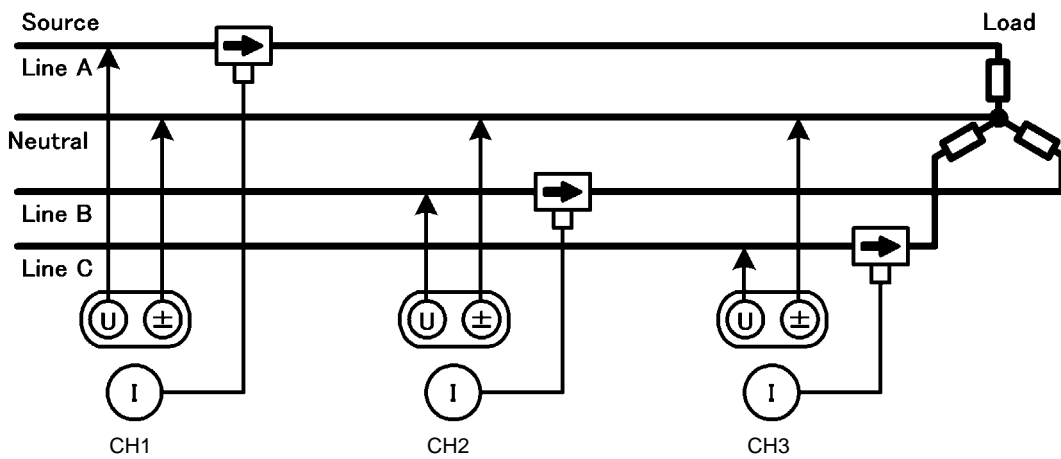
3-Phase, 3-Wire, 2-Measurement (3P3W2M)



3-Phase, 3-Wire, 3-Measurement (3P3W3M)



3-Phase, 4-Wire (3P4W)



Maintenance and Service

Chapter 11

11

Chapter 11 Maintenance and Service

11.1 Cleaning

NOTE

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

11.2 Trouble Shooting

Before requesting instrument repair or inspection, please read "Before returning for repair" (p. 176) and Section "11.3 Error Indication" (p. 177).

Inspection and Repair

WARNING

Touching any of the high-voltage points inside the instrument is very dangerous. Do not attempt to modify, disassemble or repair the instrument; as fire, electric shock and injury could result.

CAUTION

If the protective functions of the instrument are damaged, either remove it from service or mark it clearly so that others do not use it inadvertently. The instrument contains a built-in backup lithium battery, which offers a service life of about ten years. If the date and time deviate substantially when the instrument is switched on, it is the time to replace that battery. Contact your dealer or Hioki representative.

NOTE

- If damage is suspected, check the "Before returning for repair" (p. 176) section before contacting your dealer or Hioki representative. However, in the following cases, immediately stop using the instrument, unplug the power cord and contact your dealer or Hioki representative.
 - When the nature of the damage is clearly evident
 - When measurement is impossible
 - After long-term storage in adverse conditions such as high temperature or humidity
 - After being subject to severe shock during transport
 - After severe exposure to water, oil, or dust (internal insulation can be degraded by oil or water, causing increase hazard of electric shock or fire)
- If measurement settings cannot be saved, contact Hioki for repair.

Transporting the instrument

Transporting

Pack the instrument so that it will not sustain damage during shipping, and include a description of existing damage. We do not take any responsibility for damage incurred during shipping.




11.2 Trouble Shooting

Replaceable Parts and Useful Life

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 | Useful Life | Remarks |
|------------------------------------|----------------------|--|
| Electrolytic Capacitors | Approx. 10 years | The useful life of electrolytic capacitors depends on the operating environment. Periodic replacement is necessary. |
| Lithium battery | Approx. 10 years | The instrument contains a built-in backup lithium battery, which offers a service life of about ten years. If the date and time deviate substantially when the instrument is switched on, or backup error is returned in self-test, it is the time to replace that battery. Contact your dealer or Hioki representative. |
| Fan motor | Approx. 50,000 hours | Periodic replacement is necessary. |
| LCD backlight (to half brightness) | Approx. 50,000 hours | Periodic replacement is necessary. |

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 unplugged? Is it properly connected? | Confirm that the power cord is properly connected. See "3.4 Connecting the Power Cord" (p. 27) |
| Keys do not work. | Are the keys locked? | Hold  for three seconds to disable the key-lock function. |
| Cannot print. | Is the recording paper properly loaded? Are the printer settings (e.g., communication speed and interface type) correct? Is the printer connected properly with the correct cable? | See "8.1 Connecting a Printer (to print captured screen images)" (p. 123) |
| The MENU key is lit, but the screen is blank | The LCD backlight is set to turn off after a specified interval. "LCD back light" (p. 100) | Press any key. |
| Voltage or current measurement values are not displayed | Are the voltage measurement and current sensor cables connected properly? | Check connections and wiring. See "3.6 Connecting the Voltage Measurement Cables" (p. 28), "3.11 Verifying Correct Wiring (Connection Check)" (p. 36) |
| | Is the proper input channel displayed (e.g., when measuring input on CH1, is the [CH1] page displayed)? | Press   to change the input channel page. See "4.2 Viewing Power Measurements, and Changing the Measurement Configuration" (p. 41) |
| Frequency measurement is impossible, measured values are unstable | Is the input frequency within the range 0.5 Hz to 5 kHz? | Verify the input frequency using the noise measurement function. See "4.6 Viewing Noise Measurement Values (FFT Function)" (p. 72) |
| | Is the input frequency below the lower limit setting? | Set the lower limit frequency for measurement. See "4.2.3 Selecting the Sync Source" (p. 47) |
| | Is the sync source input correct? Is the range of the sync source input too high? | Check the sync source settings. See "4.2.3 Selecting the Sync Source" (p. 47), "4.2.2 Selecting Ranges" (p. 43) |


When no apparent cause can be established

Perform a system reset.

This will return all settings to their factory defaults.

See "6.1 Initializing the Instrument (System Reset)" (p. 101)

11.3 Error Indication

An error indicator appears when an error occurs. Refer to the corresponding countermeasure for each case. Press  to clear the error indicator.



| Error display | Cause | Remedy |
|---|---|---|
| FPGA initializing error | FPGA boot error. | Repair is required. Contact your dealer or Hioki representative. |
| Sub CPU initializing error. | Sub CPU boot error. | |
| DRAM error. | DRAM error. | |
| SRAM error. | SRAM error. | |
| Invalid FLASH SUM. | Firmware checksum error. | |
| Invalid Adjustment SUM. | Adjusted value checksum error. | |
| Invalid Backupped values. | Backed up system variable invalid. | |
| Sub CPU DRAM error. | Sub CPU DRAM error. | |
| Integrating. | Attempted to change settings while integrating. | Stop integration, and change the setting after resetting the integration value. |
| Waiting or halting for integration. | Attempted to change settings while awaiting (or stopping) integration. | See "4.3 Integration Value Observation" (p. 53) |
| Holding. | Attempted to change settings during Data Hold. | Change the setting after canceling Data or Peak Hold. |
| Peak holding. | Attempted to change settings during Peak Hold. | See "5.3 Data Hold and Peak Hold Functions" (p. 94) |
| This operation is effective in [MEAS] tab only. | Attempted to start/stop integration or saving, perform data reset, or activate Data or Peak Hold from the Setting or File Operation screen. | Change to the Measurement screen, and try again. |
| Failed to load the program. | Firmware update file not found, or bad checksum. | The firmware update file may be corrupted. Obtain another copy of the file, and try again. |
| Cannot change wiring. Different current sensors are in same system. | Wiring mode selection is inhibited by incorrect sensor combination. | Check current sensor connections. See "3.9 Selecting the Wiring Mode" (p. 30) |
| Some CH could not be changed in one lump. | Channel setting changes inhibited in the [All Ch] batch setting. | Select the current range, VT ratio, CT ratio and integration mode for each channel. |
| Cannot change the VT value. VT x CT exceeds the full scale (1.0E+06). | Attempted VT ratio setting would cause over-range VTx CT value. | Set values that do not exceed the VTx CT limit (1.0E+06). |
| Cannot change the CT value. VT x CT exceeds the full scale (1.0E+06). | Attempted CT ratio setting would cause over-range VTx CT value. | See "4.2.6 Setting Scaling (when using VT(PT) or CT)" (p. 51) |
| Cannot add any recording item. Exceeding the maximum number of recording items. | Too many items selected for recording within the selected interval setting. | Set a longer interval. |
| Cannot change the output orders. Exceeding the maximum number of orders. | Harmonic orders selected for output (including highest and lowest order settings) would produce too many items. | See "5.1 Timing Control Functions" (p. 91) |
| Cannot change the interval. Too many recording items are selected. Reduce the items to change interval. | Attempted to set the interval too short for the currently selected recording items. | Select fewer recording items. See "7.5.3 Selecting Measurement Items to Save" (p. 112) |

11.3 Error Indication

| Error display | Cause | Remedy |
|---|---|--|
| Cannot change the lowest noise frequency. Change the noise sampling speed. | Attempted to set the minimum noise frequency at or above the maximum frequency (determined by the noise sampling rate). | Increase the noise sampling rate setting, or set the minimum noise frequency setting below the maximum frequency. See "4.6.2 Setting the Sampling Frequency and Points" (p. 73) "4.6.3 Setting the Minimum Noise Frequency" (p. 74) |
| Cannot change the noise sampling speed. Change the lowest noise frequency. | Attempted to set the maximum frequency (determined by the noise sampling rate) below the minimum noise frequency. | Decrease the minimum noise frequency setting. See "4.6.3 Setting the Minimum Noise Frequency" (p. 74) |
| Cannot change the setting under slave mode. | Attempted to set the clock, timer or clock control settings with Slave mode enabled. | Clock, timer, and clock start/stop settings cannot be changed while Slave mode is enabled. See "8.3 Connecting Multiple 3390 (Synchronized Measurements)" (p. 129) |
| Cannot change the setting in 3-phase measurement. | Attempted to select DC integration on a non-1P2W channel. | DC integration is only available with 1P2W wiring systems with an AC/DC current sensor connected. See "4.3.2 Setting the Integration Mode" (p. 56) |
| Cannot set DC when AC sensor is connected. | Attempted to select DC integration on a channel with an AC current sensor. | |
| Not enough free capacity in CF card. | Not enough space on CF card. | Delete unneeded files, or replace storage media (new CF card must be formatted). |
| Not enough free capacity in USB memory stick. | Not enough space on USB drive. | |
| Cannot create a file or folder. Too many files or folders in root. | Possibly too many file or folders in the root folder. | Delete unneeded files and folders, or specify another folder as the file copy destination. See "7.4 Saving Operations" (p. 107) "7.10 File and Folder Operations" (p. 117) |
| CF card is not inserted. | CF card not found. | Check that a CF card or USB drive is inserted. See "7.1 Inserting and Removing Storage Media" (p. 104) |
| USB memory stick is not connected. | USB drive not found. | |
| invalid character is used in the folder name. | Attempted an operation with folder name contains an invalid character, entered by computer or malfunction. | Try again from the computer. |
| invalid character is used in the file name. | Attempted an operation with file name contains an invalid character, entered by computer or malfunction. | |
| Skip copying file named with the invalid character. | A file name within the folder contains an invalid character. | File(s) not copied. Perform the copy operation from the computer. |
| Failed to access to the folder. | Cannot access non-existent folder. | - |
| Failed to access to the file. | Cannot access non-existent file. | - |
| Cannot create a file name automatically. | Automatic file name creation stopped. | Specify a different destination folder, or create a new folder for saving, or delete unneeded files, or replace storage media (new CF card must be formatted). See "7.10 File and Folder Operations" (p. 117) |
| Skip copying file named with the invalid character. | Attempted to open a computer-created folder that is not within the root folder. | Try again from the computer. |
| Skip copying folder not under the root folder. | During folder copy, attempted to copy a folder containing another folder. | File(s) not copied. Perform the copy operation from the computer. |
| Cannot create a folder not under the root folder. | Attempted to create a folder not in the root folder. | Create a folder directly in the root folder. See "7.10.1 Creating Folders" (p. 117) |

| Error display | Cause | Remedy |
|--|--|---|
| Cannot copy a folder not under the root folder. | Attempted to copy a folder within a non-root folder. | Try again from the computer. |
| Cannot delete a folder not under the root folder. | Attempted to delete a non-root folder. | |
| Cannot delete a folder having another folder. | Attempted to delete a folder containing another folder. | |
| Skip copying a file having invalid character and folder not under the root folder. | During folder copy, attempted to copy a file or folder with an invalid name. | File or folder not copied. Perform the copy operation from the computer. |
| Input the name. | No file or folder name has been specified. | Enter a file or folder name. See "Chapter 7 Data Saving and File Operations" (p. 103) |
| Invalid setting file. | "Load Setting File" attempted without a valid setting configuration file selected (wrong file type, or corrupted or incompatible content). | Select a valid setting configuration file. Settings cannot be loaded unless instrument options and save settings are the same as when saved. See "7.9 Reloading Setting Configurations" (p. 116) |
| Cannot find the firmware update file in the root. | Attempted firmware update without an update file. | Copy the update file to the root folder of the storage media, and try again. |
| Cannot find either CF card or USB memory stick. | CF card or USB drive not found when copying files and folders. | Confirm that the storage media is inserted. See "7.1 Inserting and Removing Storage Media" (p. 104) |
| Cannot copy the folder. Same file name already exists. | When copying a folder, a duplicate file name was found on the destination. | Select a different name for the file or folder. See "7.10.4 Renaming Files and Folders" (p. 121) |
| Cannot delete the file having invalid character file name in this folder. | Attempted to delete a folder containing a file with an invalid character in its name, entered by computer or malfunction. | Try again from the computer. |
| Cannot copy the file. Same folder name already exists. | The name of a file to be copied or created as a setting configuration file duplicates an existing folder name. | Select a different name for the file or folder. See "7.10.4 Renaming Files and Folders" (p. 121) |
| Copy after changing the folder name. Same folder name already exists. | The name of a folder to be copied duplicates an existing folder name in the root folder of the storage media. | Select a different folder name. See "7.10.4 Renaming Files and Folders" (p. 121) |
| CF card is not ready. Failed to save. | Cannot save because CF card not found. | Check that a CF card or USB drive is inserted. See "7.1 Inserting and Removing Storage Media" (p. 104) |
| USB memory stick is not ready. Failed to save. | Cannot save because USB drive not found. | |
| Cannot move to [FILE] TAB during auto saving. | Attempted to open the File Operation screen during auto-saving. | The File Operation screen cannot be opened during auto-saving. Wait until auto-saving is finished. |
| Cannot execute during auto saving. | Attempted manual saving, waveform saving, or screen capture during auto-saving. | Manual saving, waveform saving, and screen capture are not available during auto-saving. Wait until auto-saving is finished. |
| Cannot execute during outputting data. | Attempted to print a screen capture image while the printer is busy. | Try again when printing is finished. |
| Failed to copy. Or, there is a file cannot be copied. | A problem occurred while copying. | Try again from the computer. |

11.3 Error Indication

| Error display | Cause | Remedy |
|--|---|--|
| Different sensors! Cannot change the wiring in the setting file. | Attempted to load an incompatible setting configuration file. | Settings cannot be loaded unless instrument options and saved items are the same as those installed and selected when saved. See "7.9 Reloading Setting Configurations" (p. 116) |
| D/A option is different. | Attempted to load an incompatible setting configuration file. | |
| Motor option is different. | Attempted to load an incompatible setting configuration file. | |
| Inconsistent items to save | Attempted to load an incompatible setting configuration file. | |
| CF card error! This card is not supported. | Incompatible CF card found. | Use a Hioki CF card option. See "Chapter 7 Data Saving and File Operations" (p. 103) |
| USB memory stick error! This memory stick is not supported. | Incompatible CF card found. | Use a Hioki CF card option. See "Chapter 7 Data Saving and File Operations" (p. 103) |
| Failed to write. | Writing to storage media failed. | Try again. |
| Failed to read. | Reading from storage media failed. | |
| Failed to save while calculating the waveform data | Attempted to save a waveform while it is being created. | Try again after the waveform is created (when the timer mark disappears). |
| Failed to create a file. | File creation failed for unknown reason. | Try again. |
| Failed to create a folder. | Folder creation failed for unknown reason. | |
| Printer error! | Attempted printer auto-setup without a printer connected, or with printer turned off. | Check that the printer is connected and turned on. See "8.1.1 Printer Preparation and Connection" (p. 124) |
| Unknown error! | An unknown error has occurred. | Clear this error by pressing any key except  or  once. If the error recurs, contact your dealer or Hioki representative. |

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

NOTE If the measurement lines are energized when the instrument is turned on, the instrument may be damaged or an error message may appear, so before energizing the lines, turn the instrument on and confirm that no error message is displayed.

11.4 Disposing of the Instrument

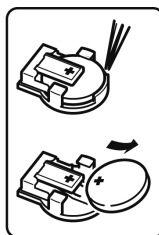
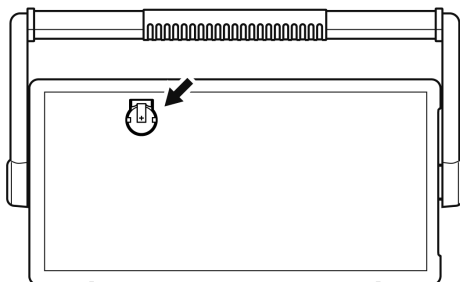
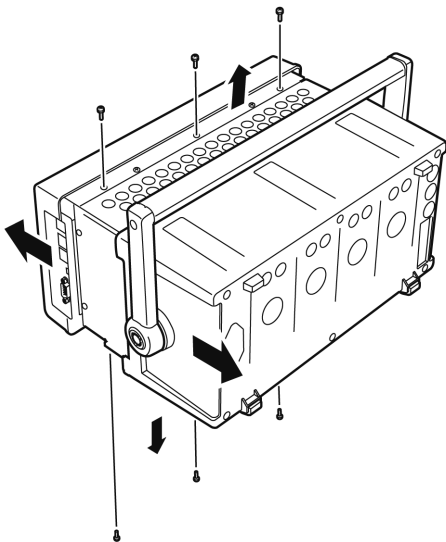
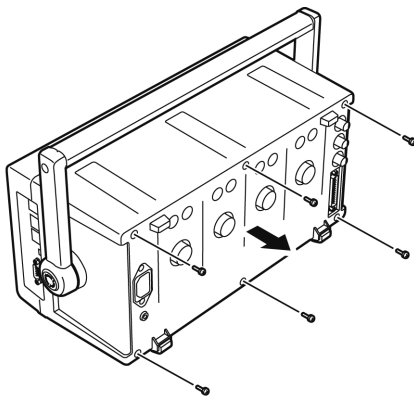
When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.

Dispose the other options appropriately.

! WARNING

- To avoid electric shock, turn off the power switch and disconnect the power cord and measurement cables before removing the lithium battery.
- Battery may explode if mistreated. Do not short-circuit, recharge, disassemble or dispose of in fire.
- Keep batteries away from children to prevent accidental swallowing.

Tools required: One No. 2 Phillips screw-driver, tweezers



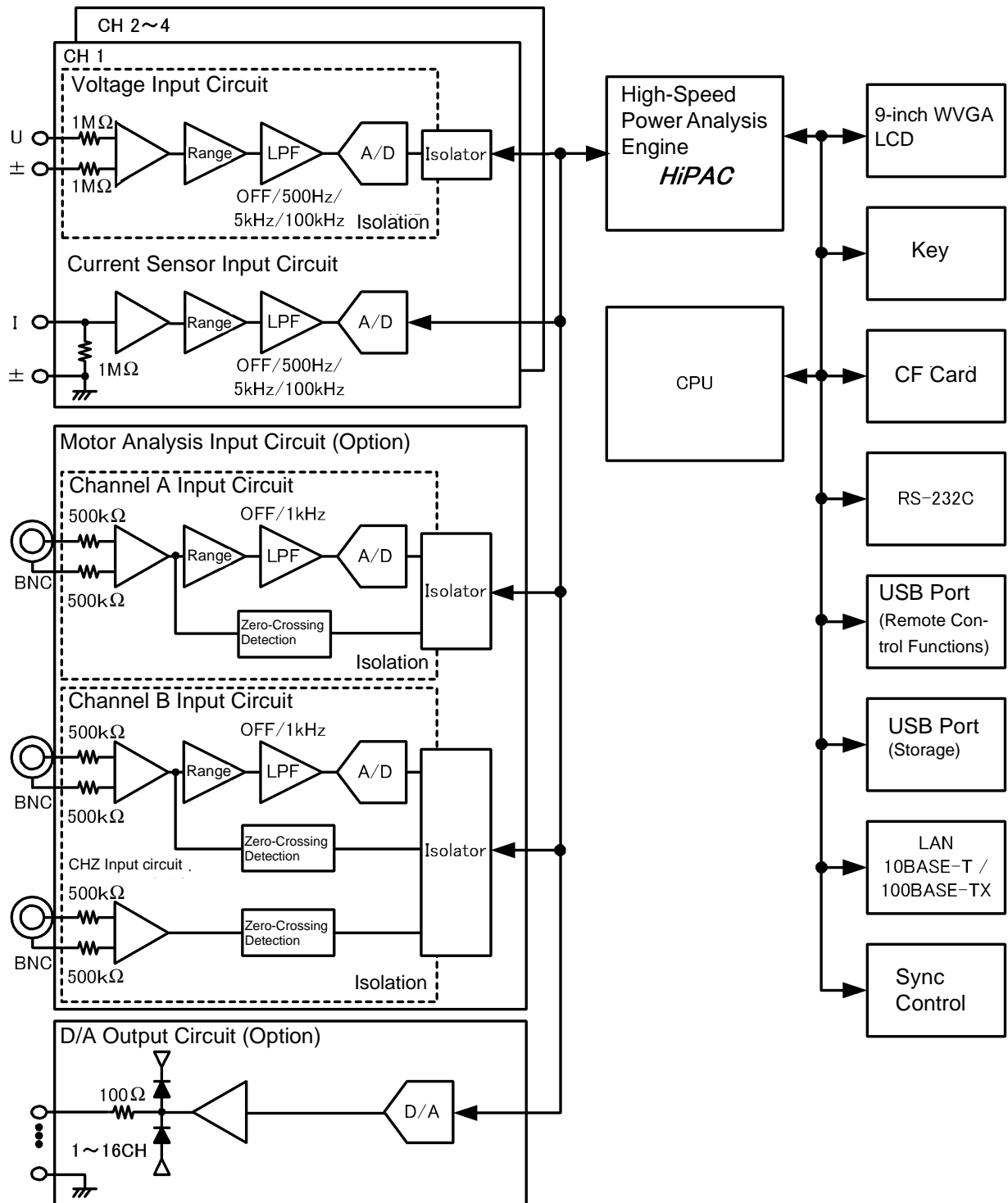
1. Turn the instrument's power switch off.
2. Disconnect the power cord and all cables.
3. Remove the six Phillips head screws in the rear cover, and remove the cover by sliding it back.
4. Remove the six Phillips head screws around the front panel, and remove the panel.
5. Insert the tweezers between the battery and its holder on the internal board, and lift the battery to remove it.

CALIFORNIA, USA ONLY

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

Appendix

Appendix 1 Block Diagram



Appendix2 Measurement Data Saving Format

Header Structure

Headers (item names saved at the head of the file) when measurement data is saved by manual or auto-saving are as follows.

- Selected items are output in order from the top of the table, and from left to right.
- Measurement data is output after the last line of the header, in the same sequence as the header.
- The first three items (Data, Time, and Status) are always output regardless of selected items.

| Output Item | | Header Item and Alignment | | | |
|-----------------------------------|--------------------------------------|-------------------------------|--------|--------|---------|
| Year, Month, and Day | | Date | | | |
| Time | | Time | | | |
| Status | | Status | | | |
| Elapsed Time | | Laptime | | | |
| Elapsed Time (ms) | | Laptime (ms) | | | |
| Voltage | RMS | Urms1 to Urms4 | Urms12 | Urms34 | Urms123 |
| | Voltage MEAN | Umn1 to Umn4 | Umn12 | Umn34 | Umn123 |
| | AC component | Uac1 to Uac4 | | | |
| | Simple average | Udc1 to Udc4 | | | |
| | Fundamental wave component | Ufnd1 to Ufnd4 | | | |
| | wave peak + | PUpk1 to PUpk4 | | | |
| | wave peak - | MUpk1 to MUpk4 | | | |
| | THD/ripple rate | Uthd1 to Uthd4 / Urf1 to Urf4 | | | |
| | Unbalance factor | Uunb123 | | | |
| Current | RMS | Irms1 to Irms4 | Irms12 | Irms34 | Irms123 |
| | Current MEAN | Imn1 to Imn4 | Imn12 | Imn34 | Imn123 |
| | AC component | Iac1 to Iac4 | | | |
| | Simple average | Idc1 to Idc4 | | | |
| | Fundamental wave component | Ifnd1 to Ifnd4 | | | |
| | wave peak + | PIpk1 to PIpk4 | | | |
| | wave peak - | MIpk1 to MIpk4 | | | |
| | THD/ripple rate | Ithd1 to Ithd4 / Irf1 to Irf4 | | | |
| | Unbalance factor | Iunb123 | | | |
| Effective power | P1 to P4 | P12 | P34 | P123 | |
| Apparent power | S1 to S4 | S12 | S34 | S123 | |
| Reactive power | Q1 to Q4 | Q12 | Q34 | Q123 | |
| Power factor | PF1 to PF4 | PF12 | PF34 | PF123 | |
| Phase angle | DEG1 to DEG4 | DEG12 | DEG34 | DEG123 | |
| Frequency | FREQ1 to FREQ4 | | | | |
| Integration | Integ. current in positive direction | PIH1 to PIH4 | PIH12 | PIH34 | PIH123 |
| | Integ. current in negative direction | MIH1 to MIH4 | MIH12 | MIH34 | MIH123 |
| | Sum of integ. Current | IH1 to IH4 | IH12 | IH34 | IH123 |
| | Energy in positive direction | PWP1 to PWP4 | PWP12 | PWP34 | PWP123 |
| | Energy in negative direction | MWP1 to MWP4 | MWP12 | MWP34 | MWP123 |
| | Sum of energy | WP1 to WP4 | WP12 | WP34 | WP123 |
| Efficiency | Eff1 to Eff3 | | | | |
| Loss | Loss1 to Loss3 | | | | |
| Temperature | Temp | | | | |
| Motor | ExtA | ExtB | Pm | Slip | |
| Harmonic Measurement Items | | | | | |
| Harmonic Frequency | HFREQ | | | | |

| | | | | | | |
|--------------------------------|---------------------|---------------------------|----------|----------|-----------|------|
| Level | 0th Order Voltage | HU1L000 to HU4L000 | HU12L000 | HU34L000 | HU123L000 | |
| | 0th Order Current | HI1L000 to HI4L000 | HI12L000 | HI34L000 | HI123L000 | |
| | 0th Order Power | HP1L000 to HP4L000 | HP12L000 | HP34L000 | HP123L000 | |
| Content | 0th Order Voltage | HU1D000 to HU4D000 | HU12D000 | HU34D000 | HU123D000 | |
| | 0th Order Current | HI1D000 to HI4D000 | HI12D000 | HI34D000 | HI123D000 | |
| | 0th Order Power | HP1D000 to HP4D000 | HP12D000 | HP34D000 | HP123D000 | |
| Phase angle | 0th Order Voltage | HU1P000 to HU4P000 | HU12P000 | HU34P000 | HU123P000 | |
| | 0th Order Current | HI1P000 to HI4P000 | HI12P000 | HI34P000 | HI123P000 | |
| | 0th Order Power | HP1P000 to HP4P000 | HP12P000 | HP34P000 | HP123P000 | |
| ••• | nth Order | the last three digits = n | | | | |
| Level | 100th Order Voltage | HU1L100 to HU4L100 | HU12L100 | HU34L100 | HU123L100 | |
| | 100th Order Current | HI1L100 to HI4L100 | HI12L100 | HI34L100 | HI123L100 | |
| | 100th Order Current | HP1L100 to HP4L100 | HP12L100 | HP34L100 | HP123L100 | |
| Content Percentage | 100th Order Voltage | HU1D100 to HU4D100 | HU12D100 | HU34D100 | HU123D100 | |
| | 100th Order Current | HI1D100 to HI4D100 | HI12D100 | HI34D100 | HI123D100 | |
| | 100th Order Current | HP1D100 to HP4D100 | HP12D100 | HP34D100 | HP123D100 | |
| Phase angle | 100th Order Voltage | HU1P100 to HU4P100 | HU12P100 | HU34P100 | HU123P100 | |
| | 100th Order Current | HI1P100 to HI4P100 | HI12P100 | HI34P100 | HI123P100 | |
| | 100th Order Current | HP1P100 to HP4P100 | HP12P100 | HP34P100 | HP123P100 | |
| Noise Measurement Items | | | | | | |
| Noise | Voltage | UNf01 | UN01 | to | UNf10 | UN10 |
| | Current | INf01 | IN01 | to | INf10 | IN10 |

About Status Data

The status data indicates the measurement state when the data was saved, and is displayed as a 32-bit hexadecimal digit, as follows.

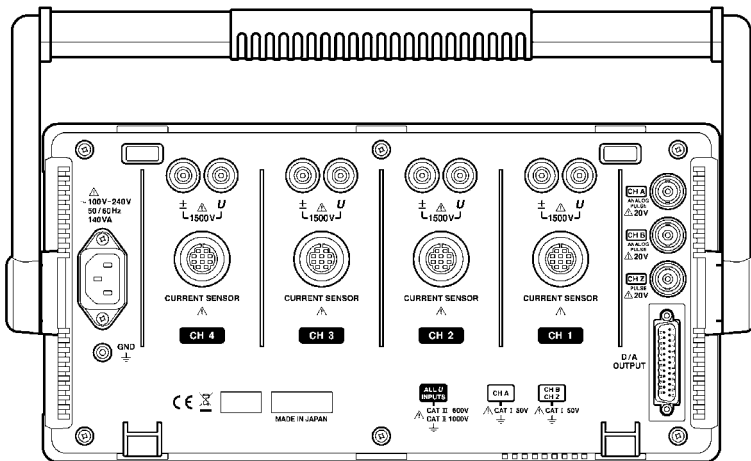
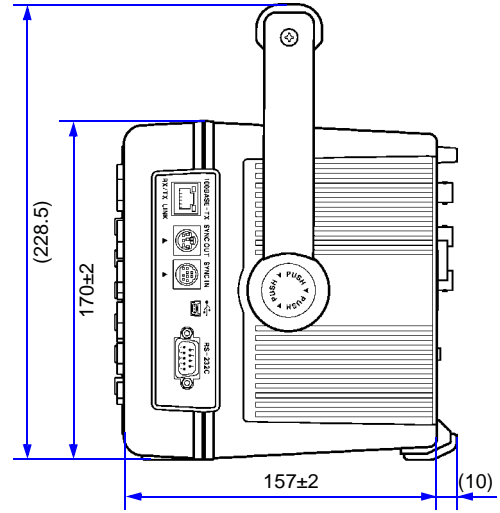
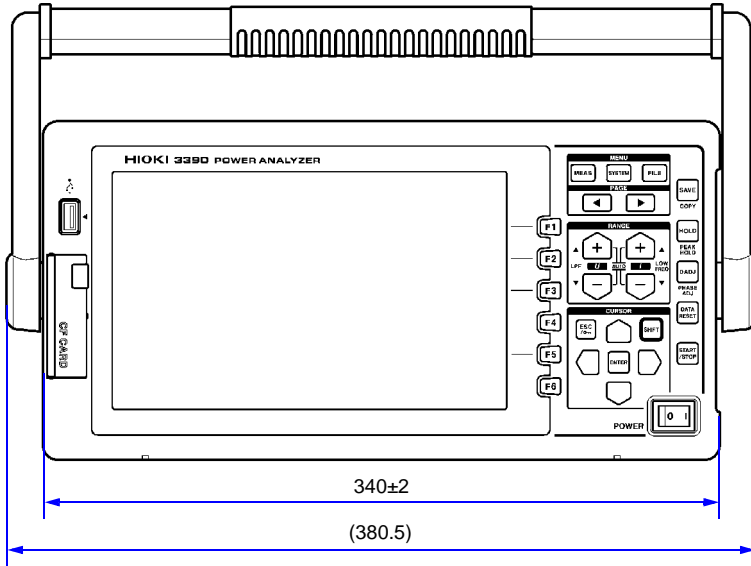
| | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|
| bit 31 | bit 30 | bit 29 | bit 28 | bit 27 | bit 26 | bit 25 | bit 24 |
| HM4 | HM3 | HM2 | HM1 | MRB | MRA | MPB | MPA |
| bit 23 | bit 22 | bit 21 | bit 20 | bit 19 | bit 18 | bit 17 | bit 16 |
| ULM | --- | UCU | HUL | UL4 | UL3 | UL2 | UL1 |
| bit 15 | bit 14 | bit 13 | bit 12 | bit 11 | bit 10 | bit 9 | bit 8 |
| RI4 | RI3 | RI2 | RI1 | RU4 | RU3 | RU2 | RU1 |
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
| PI4 | PI3 | PI2 | PI1 | PU4 | PU3 | PU2 | PU1 |

- HMx : Invalid harmonic parameter (no harmonic sync)
- MRx : Motor analysis options A and/or B over range
- MPx : Motor analysis options A and/or B peak over
- ULM : Motor analysis options A and/or B sync unlocked
- UCU : Calculation Impossible (e.g., measurement data is invalid immediately after changing ranges)
- HUL : Harmonic sync unlocked
- ULx : Channel x sync unlocked
- Rlx : Channel x current over range
- RUx : Channel x voltage over range
- Plx : Channel x current peak over
- PUx : Channel x voltage peak over
- (x is a channel number)

Measurement Value Data Format

| | |
|----------------------------|---|
| General Measurement Values | ±□□□□□□E±□□ 6-digit decimal mantissa and 2-digit exponent ("+" sign and leading zero are omitted for mantissa.) |
| Integration Value | ±□□□□□□□E±□□ 7-digit decimal mantissa and 2-digit exponent ("+" sign and leading zero are omitted for mantissa.) |
| Time | YYYY/MM/DD □□□□/□□/□□ HH:MM:SS □□:□□:□□ Elapsed Time □□□□:□□:□□ Elapsed Time (ms) □□□ |
| Error state | Input out of range +9999.9E+99 |

Appendix3 Physical Illustration

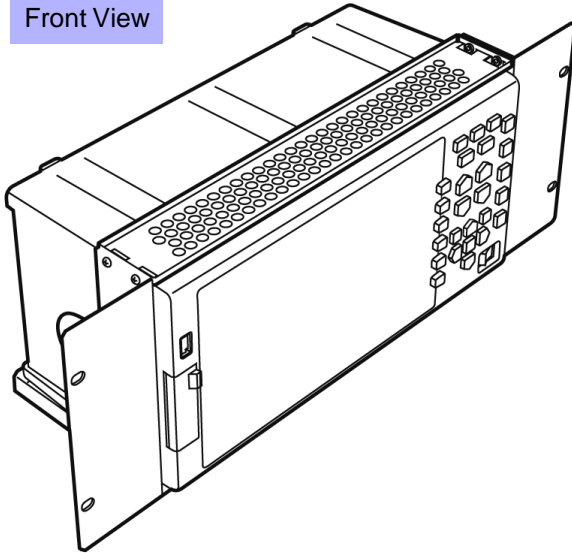


(Unit: mm)

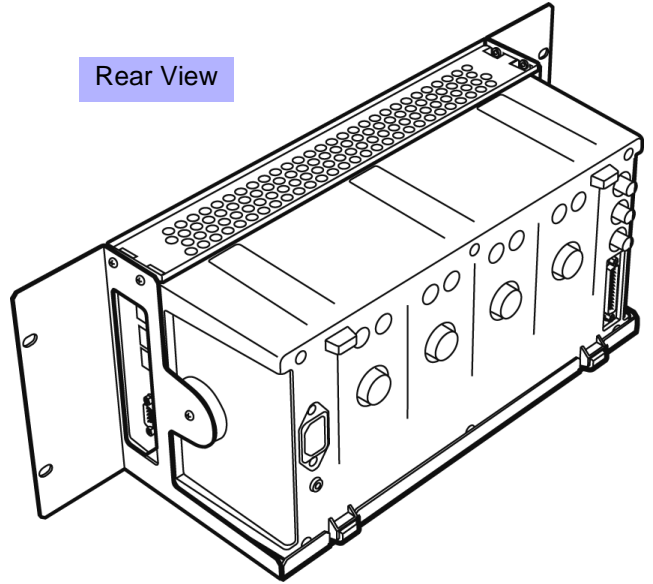
Appendix4 Rack Mounting

The illustrated rack mounting brackets are available. Contact your dealer or Hioki representative.

Front View



Rear View



A6

Appendix 4 Rack Mounting

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HIOKI

DECLARATION OF CONFORMITY

Manufacturer's Name: HIOKI E.E. CORPORATION
Manufacturer's Address: 81 Koizumi, Ueda, Nagano 386-1192, Japan
Product Name: POWER ANALYZER
Model Number: 3390
Options: 9791 MOTOR TESTING OPTION
9792 D/A OUTPUT OPTION
9793 MOTOR TESTING & D/A OUTPUT OPTION
L9438-50 VOLTAGE CORD
L9217 CONNECTION CORD
9243 GRABBER CLIP

The above mentioned product conforms to the following product specifications:

Safety: EN61010-1:2001
EN61010-031:2002+A1:2008

EMC: EN61326-1:2006
Class A equipment
Equipment intended for use in industrial location
EN61000-3-2:2006
EN61000-3-3:2008

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC.

HIOKI E.E. CORPORATION



Atsushi Mizuno

Director of Quality Assurance

3 December 2010

3390A999-01

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