HIOKI

Instruction Manual

3390

POWER ANALYZER

HIOKI E. E. CORPORATION

May 2013 Revised edition 4 3390A981-04 13-05H

600276344

Contents

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.

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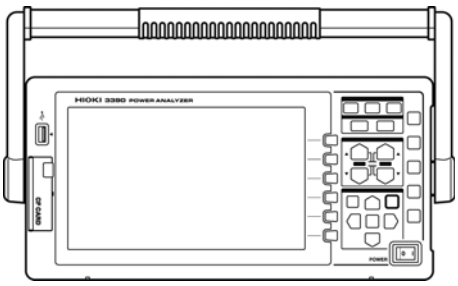
Confirming Package Contents

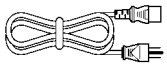
When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.

Confirm that these contents are provided.

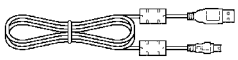
☐ 3390 POWER ANALYZER 1



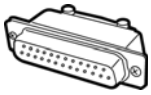
☐Grounded power cord 1



☐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

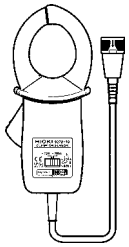
Please attach to the instrument before use. (p. 24)

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

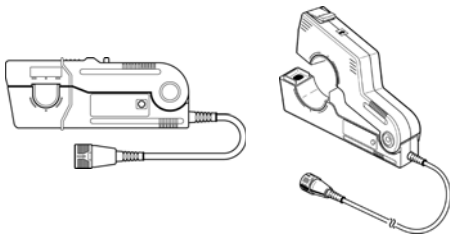
Option

Current Sensors

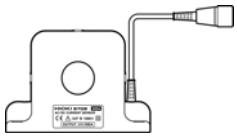
9272-10
Clamp On Sensor



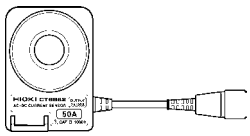
9277, 9278, 9279
Universal Clamp On CT



9709, CT6865
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
- L1000 Voltage Cord
- PW9000 Wiring Adapter
- PW9001 Wiring Adapter

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 × 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. 142)

- 9683 Connection Cable (for synchronization)

See "Connecting Multiple 3390 (Synchronized Measurements)" (p. 133)

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.

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

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).
CE	This symbol indicates that the product conforms to safety regulations set out by the EC Directive.
PS E	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, Widows 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:

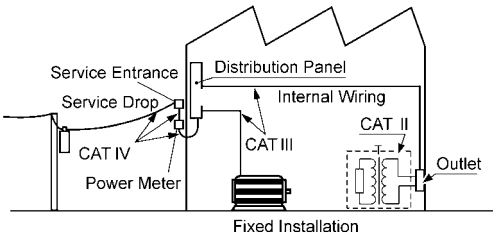
f.s. (maximum display value or scale length):	The maximum displayable value or scale length. This is usually the name of the currently selected range.
rdg. (reading or displayed value):	The value currently being measured and indicated on the measuring instrument.
dgt. (resolution):	The smallest displayable 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

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 II to CAT IV, and called measurement categories.

CAT Ⅱ :	Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.) CAT II covers directly measuring electrical outlet receptacles. CAT II covers directly measuring electrical outlet receptacles.
CAT Ⅲ :	Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.
CAT Ⅳ :	The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).

Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.
Use of a measurement instrument that is not CAT-rated in CAT II to CAT IV measurement applications could result in a severe accident, and must be carefully avoided.



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 the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

DANGER

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-condensatingStoring temperature and humidity to RH or less, Indoors only (non-condensatingTemperature 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

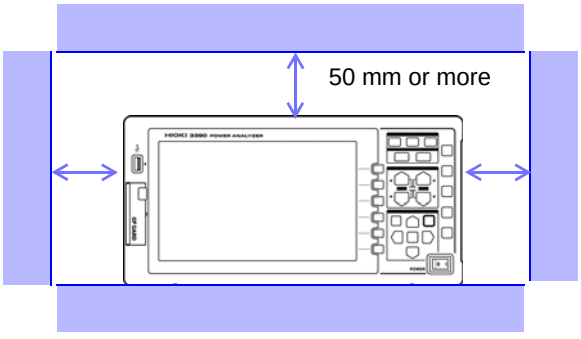
Exposed to high levels of particulate dust

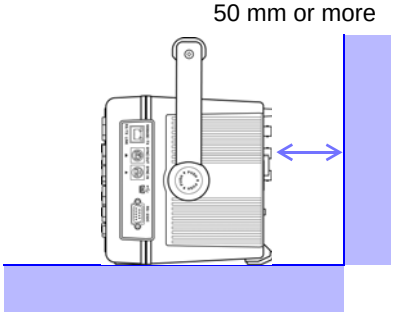
Near induction heating systems (e.g., high-frequency induction heating systems and IH cooking utensils)

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. 179) and Error Indications section "11.3 Error Indication" (p. 182) 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)

NOTE

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

Handling the 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 provided 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 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 ±0.05% rdg. ±0.05% f.s. at DC and from 0.5 Hz to 150 kHz.
- Precise measurements over a broad range of inverter carrier frequencies: ±0.2% rdg. ±0.1% f.s. at 10 kHz, and ±1.5% rdg. ±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. 145)

- 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 measuremnet channels (p. 133)

- 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. 142)

- 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. 136)

- 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. 131)

- Connect to the RS-232C interface for simultaneous temperature recording.

Printer connection support (p. 127)

- 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.107)

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.145)

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

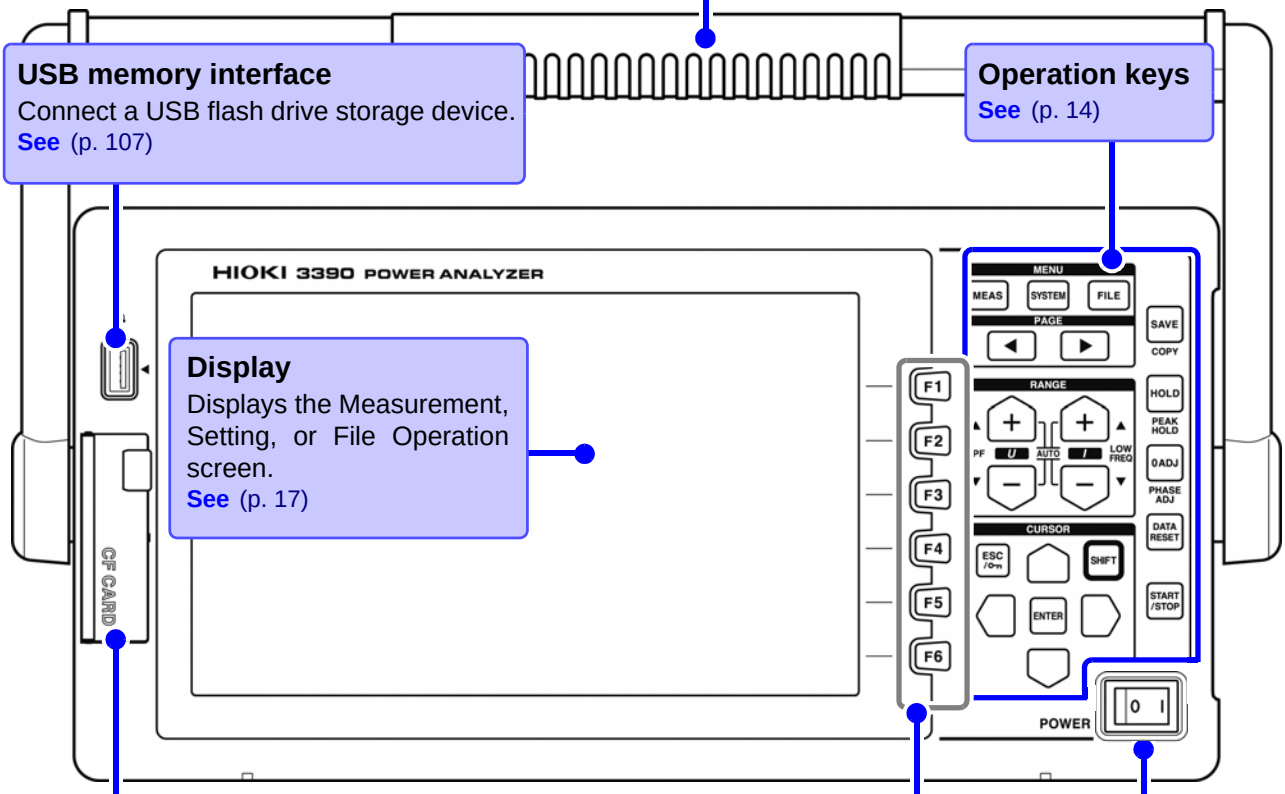
2.1 Names and Functions of Parts

Front

Handle
Use to carry the instrument, and fold it down to serve as a stand.
See Latter of this chapter

USB memory interface
Connect a USB flash drive storage device.
See (p. 107)

Operation keys
See (p. 14)



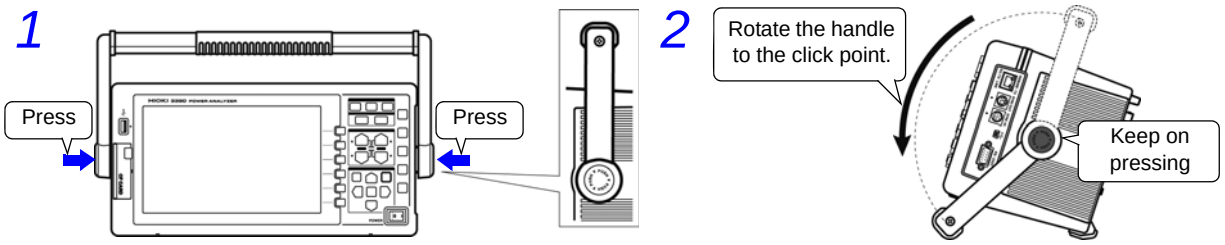
Display
Displays the Measurement, Setting, or File Operation screen.
See (p. 17)

CF card interface
Insert a CF card.
See (p. 108)

F key (Function key)
Select and change display contents and settings.
See (p. 16)

Power switch
Turns the instrument on and off.
See (p. 29)

Using the Handle as a Stand

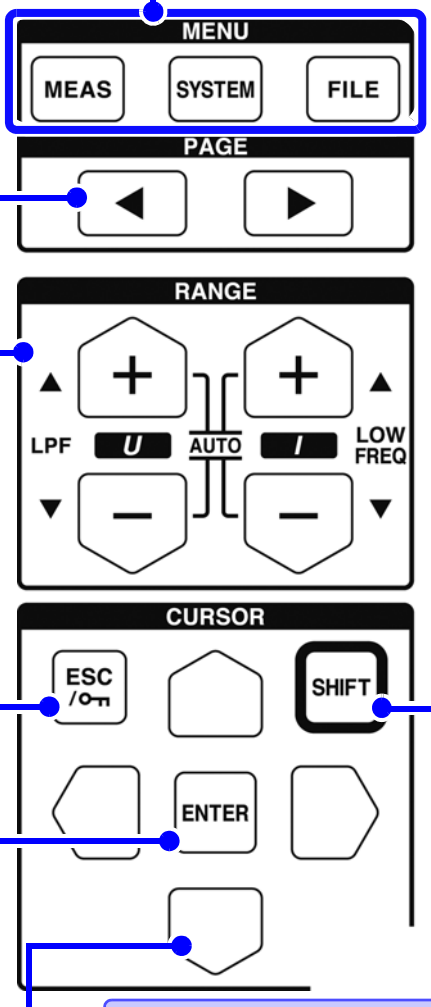


2.1 Names and Functions of Parts

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)



PAGE key
Changes the screen page.

RANGE keys
- The *U* + and – keys change the voltage measurement range, and the *I* + and – keys change the current measurement range.
- Pressing the + and – keys at the same time activates Auto Ranging (p. 44).
- These keys also set the low-pass filter (p. 52) and the lower measurement limit setting (p. 49).

ESC key
Cancels the last change to a setting, and returns it to its original state.
(Key-lock)
Hold for three seconds to toggle the key lock. The key lock state is indicated at the top of the screen.(p. 17)

ENTER key
Accepts selections and changes to settings.

CURSOR key
Move the cursors.

SAVE key
Saves data to the storage media.
See 7.5.2 (p.114)
(Screen Capture)
Press SAVE while holding the SHIFT key to capture a screen image to the specified storage media. (p. 118)

HOLD key
(Lit when running)
Toggles the peak-hold function.
See 5.3 (p.96)

0 ADJ key
Performs zero adjustment and current sensor degaussing.
See 3.10 (p.34)

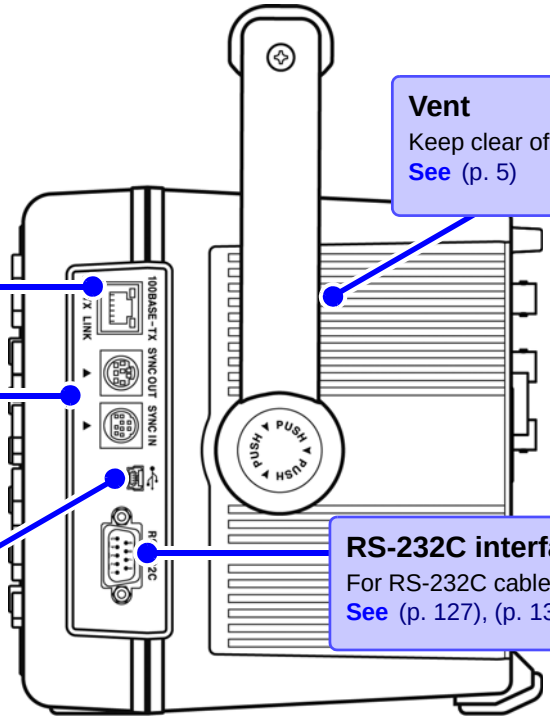
DATA RESET key
Resets the integration values.
See 4.3.1 (p.53)

SHIFT key
(Lit when running)
Activates alternate key functions.

START/STOP key
(Lit when running)
Starts and stops integration and saving operations.
To restart integration and saving: Press the **DATA RESET** key to reset integration values, then press this key. (Press the START/STOP key without resetting the integrated value if you wish to add the integration result to the previous one.)

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



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

Ethernet interface jack
For LAN connection with an Ethernet cable.
See (p. 148)

Sync interface
For synchronizing cables, as needed.
See (p. 133)

USB port
For the supplied USB cable, as needed.
See (p. 152)

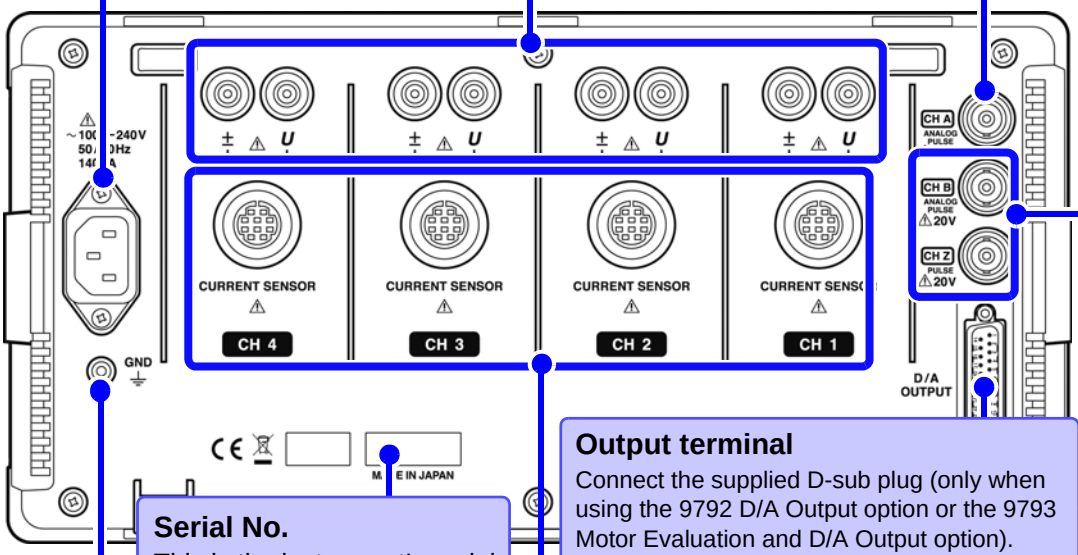
RS-232C interface
For RS-232C cable connection, as needed.
See (p. 127), (p. 131)

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. 142)



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. 136)

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. 142)

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).

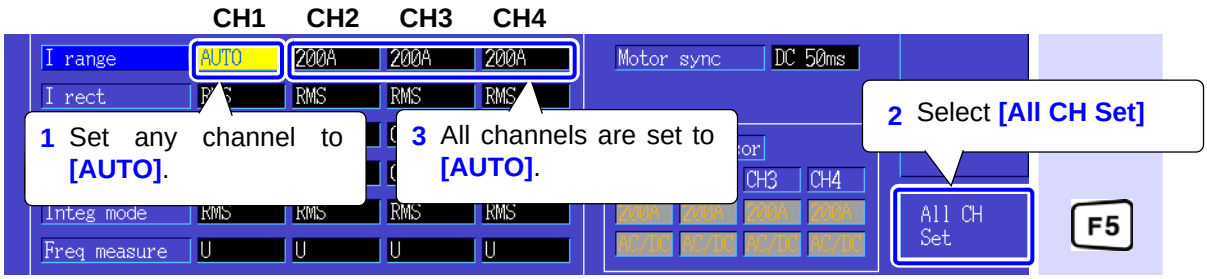
To select and change display contents and settings

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.

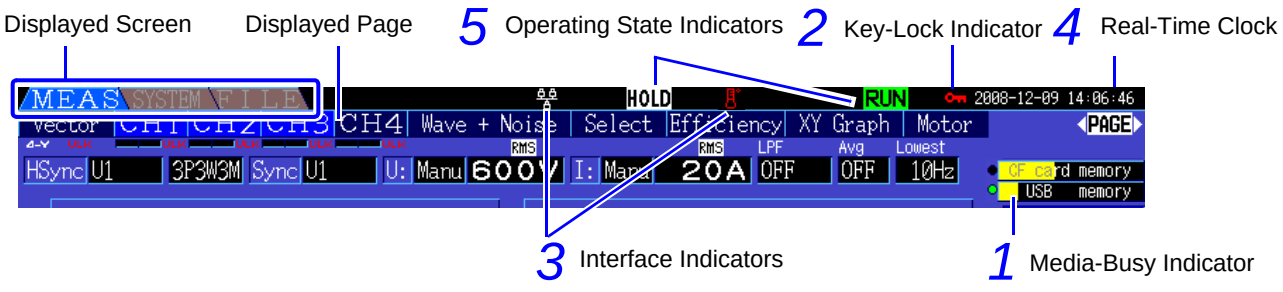
Using [All CH Set]
(For example, to enable auto-ranging on all channels.)



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 ESC key for three seconds.

3 Interface Indicators

USB	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

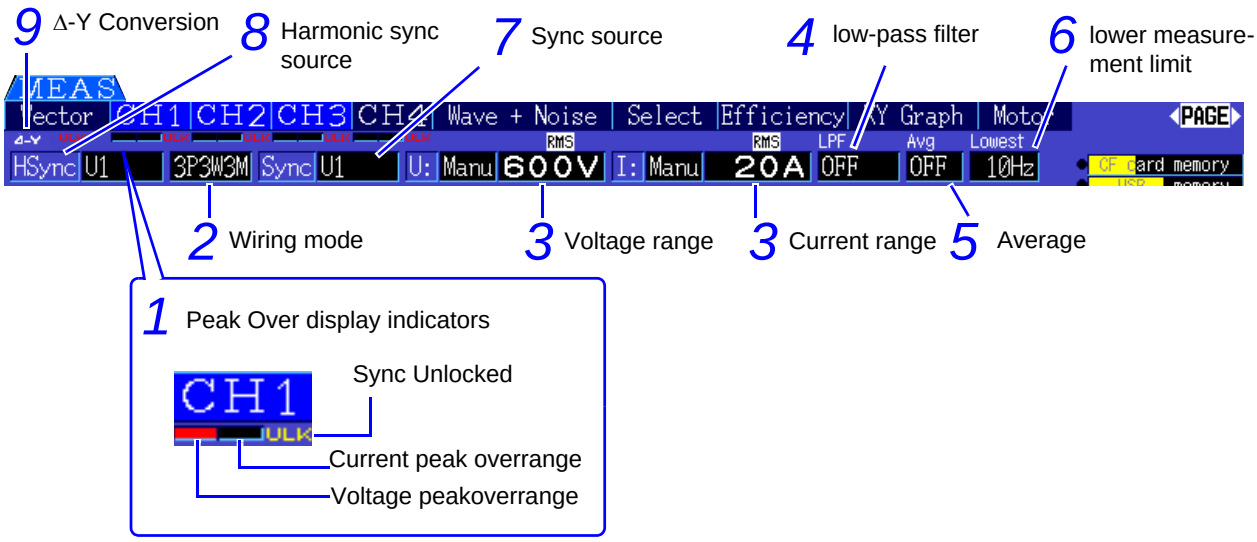
Displays the current date and time.
To set the Clock: (p. 105)

5 Operating State Indicators

WAIT	Lights during integration and recording.
RUN	Indicates integration is in progress.
STOP	Indicates integration is stopped.
HOLD	Indicates Data Hold is active.
PEAK	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 peaks 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. 95).
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. 100) 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.

[Vector]

This page displays measured voltage, current, and power on channels 1 to 4 as numerical values and as vectors.

[CH1 to CH4]

This page displays measured power, voltage and current values, integration values, and provides access to harmonic graphs and lists for each channel.

[Motor]

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

This page displays measured values for the motor analysis options.

[Wave + Noise]

This page displays voltage, current, and noise waveforms. The waveforms can be saved.

[XY Graph]

This page displays an X-Y graph of measurement parameters selected for horizontal and vertical axes.

[Select]

Select any parameter on this page for display.

[Efficiency]

This page displays the numerical values of efficiency and loss determined by calculation formulas.

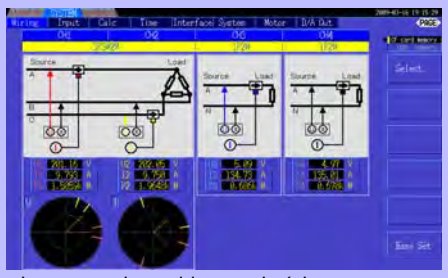
2.3 Display Items and Screen Types

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]

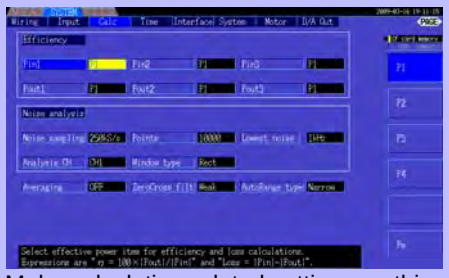
Make detailed measurement criteria settings on this page.

[D/A Out]

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

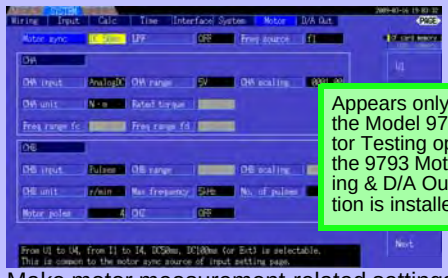
Make D/A output-related settings on this page.

[Calc]



Make calculation-related settings on this page.

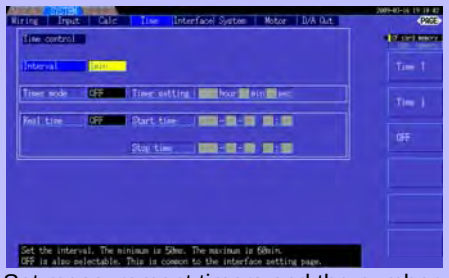
[Motor]



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.

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.

2.3 Display Items and Screen Types

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)

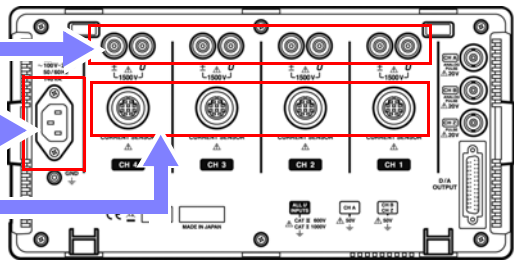
Always perform these checks before connecting, and when turning the power on.

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)

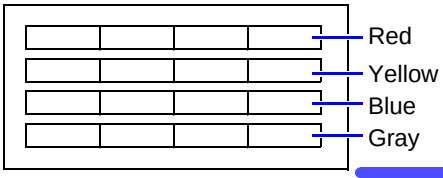
3.2 Initial Instrument Preparations

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.

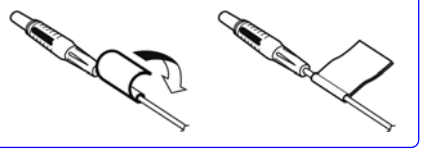
Before applying the labels
Wipe any dust from the surface of the voltage measurement cables and current sensors, and ensure that it is dry.



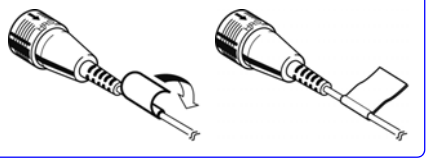
Measurement Cable Labels

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.

Apply labels to both ends of the voltage measurement cables



Apply labels to both ends of the current sensor cables.

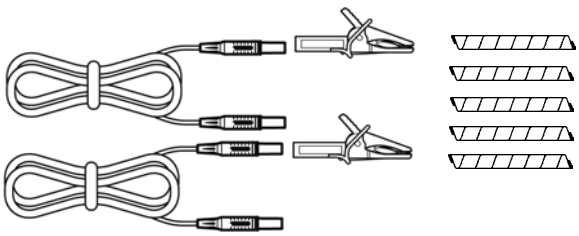


Bundle the voltage measurement cable leads with the spiral tubes

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.

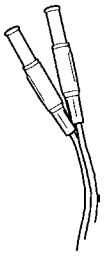
Preparation items

L9438-50 Voltage Cord

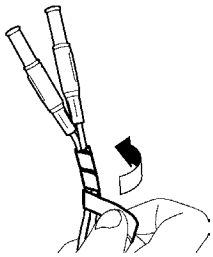


Alligator Clips (two, one each red and black)
Banana Plug Leads (two, one each red and black)
Spiral Tubes (five, for cable bundling)

Procedure

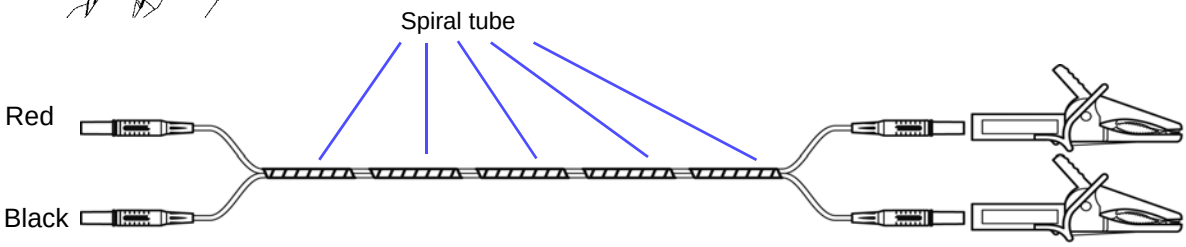


1. Hold two cable leads (one each red and black) side-by-side.
Start bundling from one end of the leads.



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 the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

1 Pre-connection inspection

Inspect the voltage measurement cables
Does any cable insulation appear damaged, or is bare metal exposed?

Metal Exposed → Do not use if damage is present, as you could receive an electric shock. Contact your dealer or Hioki representative if you find any damage.

No Metal Exposed ↓

Inspect the current sensors
Is a clamp cracked or damaged?

Yes → Do not use if damage is present, as you could receive an electric shock. Contact your dealer or Hioki representative if you find any damage.

No ↓

Inspect the instrument
Is damage to the instrument evident?

Yes → Contact your dealer or Hioki representative if you find any damage.

No ↓

2 Power-on confirmation

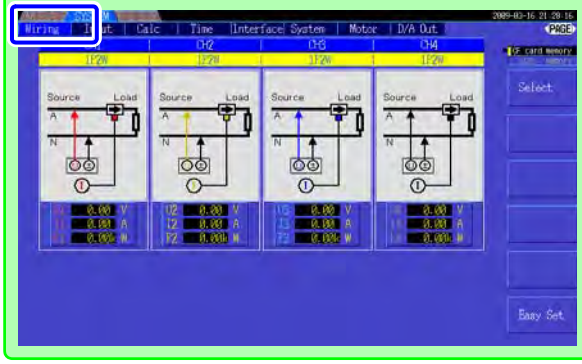
Does the self-test (model and version) display appear?
(The version number may be changed to the latest version number.)
Initial Screen

HIOKI 3390 POWER ANALYZER 1.00

No → The power cord may be damaged, or the instrument may have internal damage.
Please contact your dealer or Hioki representative.

Yes ↓

When the self-test finishes, does the **[Wiring]** page of the Setting or Measurement screen



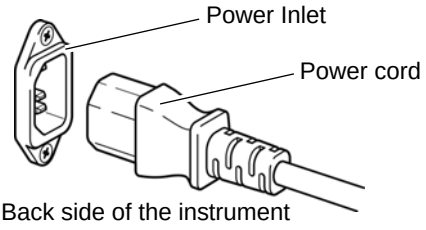
An error is displayed → The instrument may be damaged internally.
Please contact your dealer or Hioki representative.

Yes → Inspection complete

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.

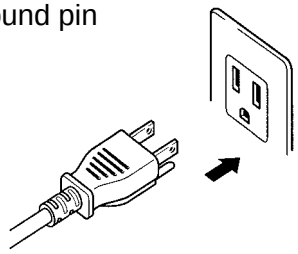
Connection Procedure



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.

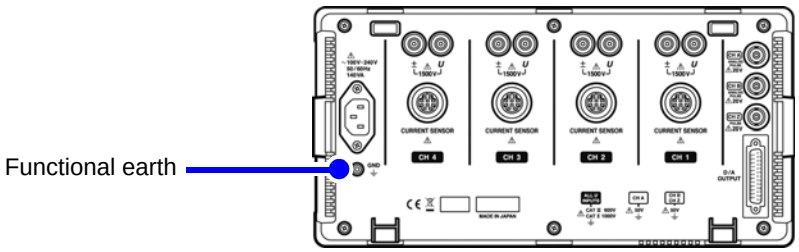
About the outlet with ground pin



Plug the power cord into the mains outlet.

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

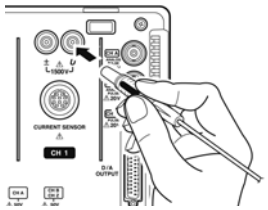
Ground the instrument's functional earth.
Connect the functional ground terminal to a clean common ground to suppress noise effects when measuring in an electrically noisy environment. When measuring AC power lines using a VT (PT), connect the PT ground to the same grounding point.



3.6 Connecting the Voltage Measurement Cables

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

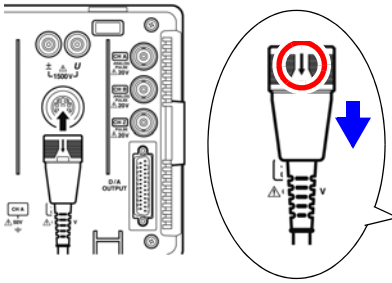


Plug the voltage cables into the appropriate channels’ voltage measurement jacks.
Insert the plugs into the terminals as far as they will go.

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)

DANGER **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.**

WARNING

- **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.**

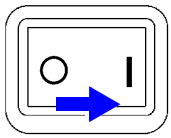
NOTE

- 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 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. 105), the last displayed Measurement screen appears.

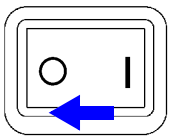
NOTE

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



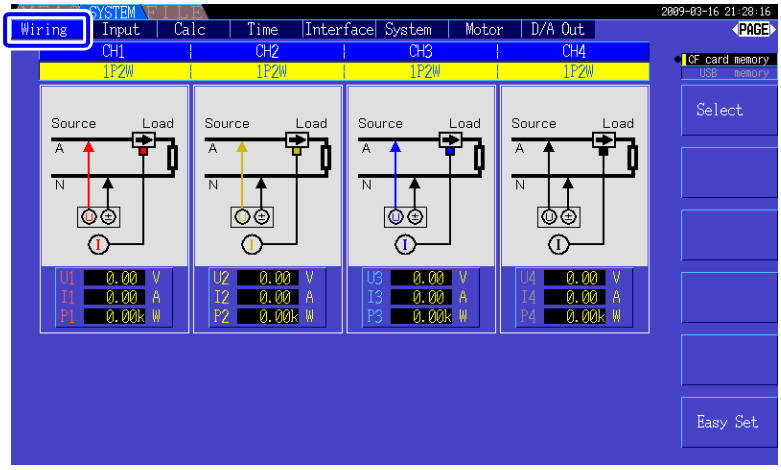
Turn the **POWER** switch off (○).

3.9 Selecting the Wiring Mode

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

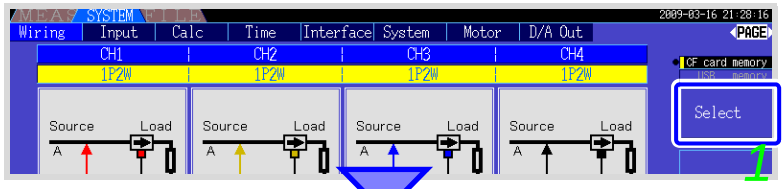
To open the [Wiring] page

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



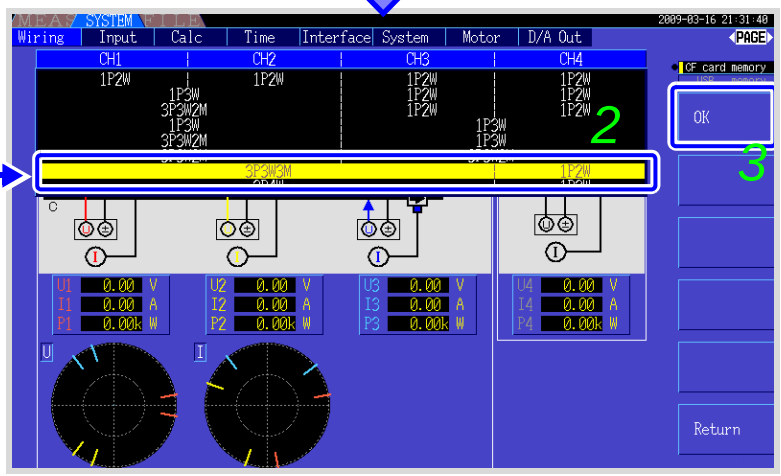
To select the wiring mode

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 key)



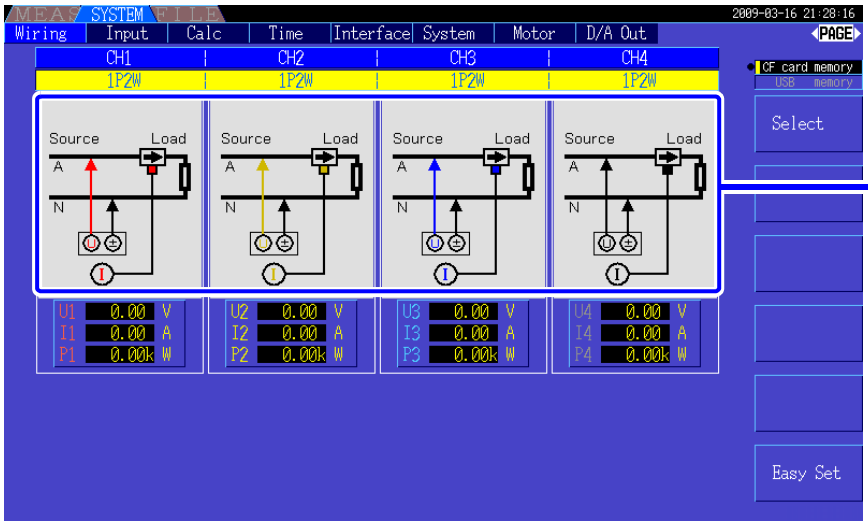
Accepting the selection displays the wiring diagram of the selected wiring mode.(p. 31)

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

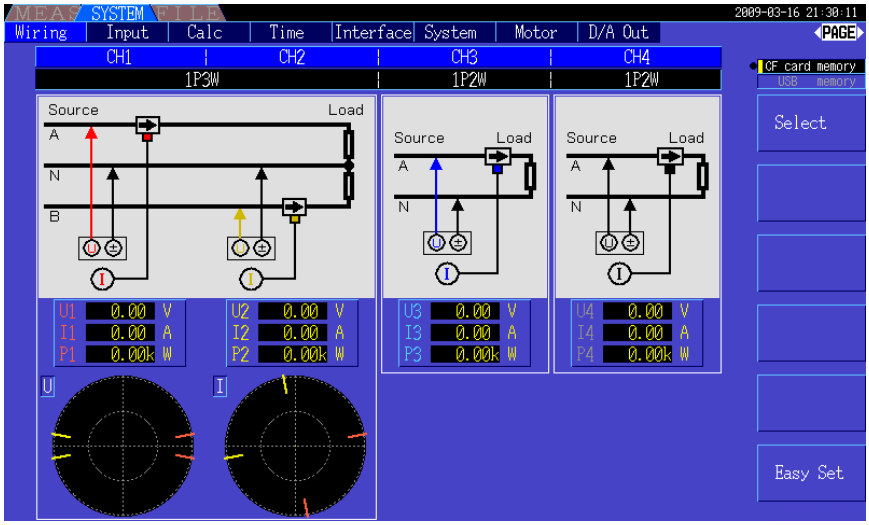
Wiring Mode 1. Single-phase, 2-wire (1P2W) × 4



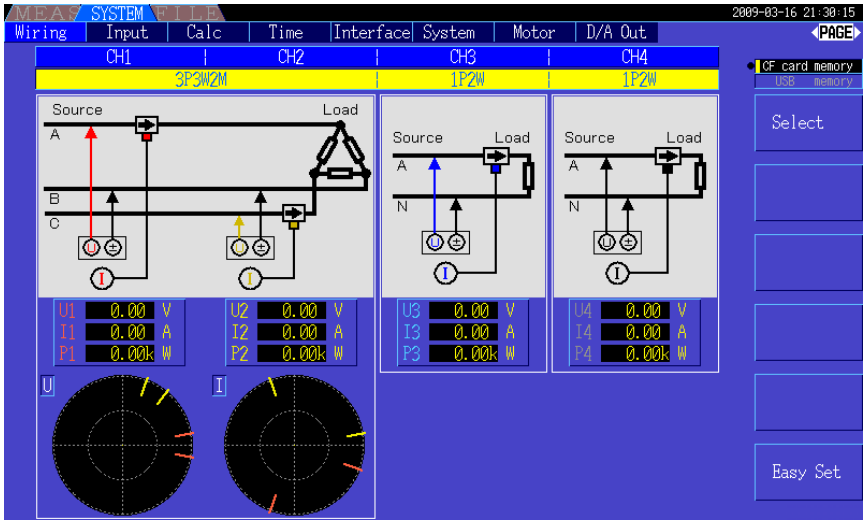
Wiring configuration diagram

See
Pages 176 and 177 for additional wiring diagrams.

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

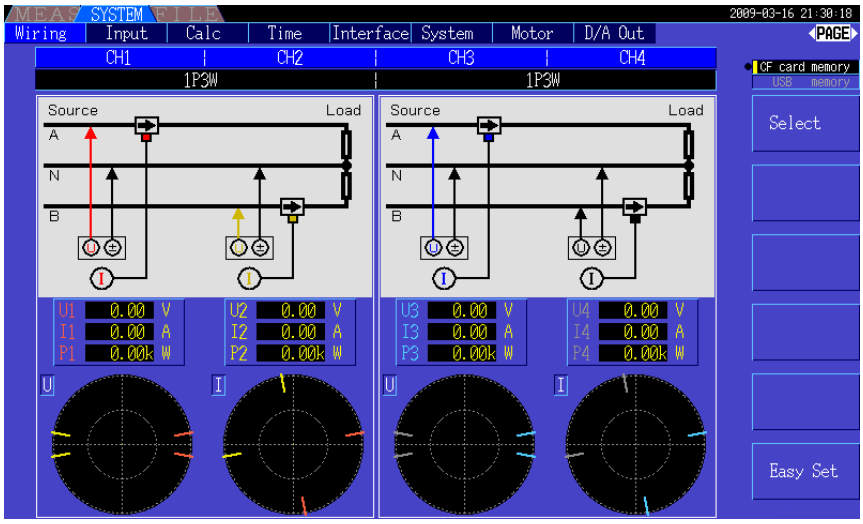


Wiring Mode 3. 3-phase, 3-wire (3P3W2M) + single-phase, 2-wire (1P2W) × 2

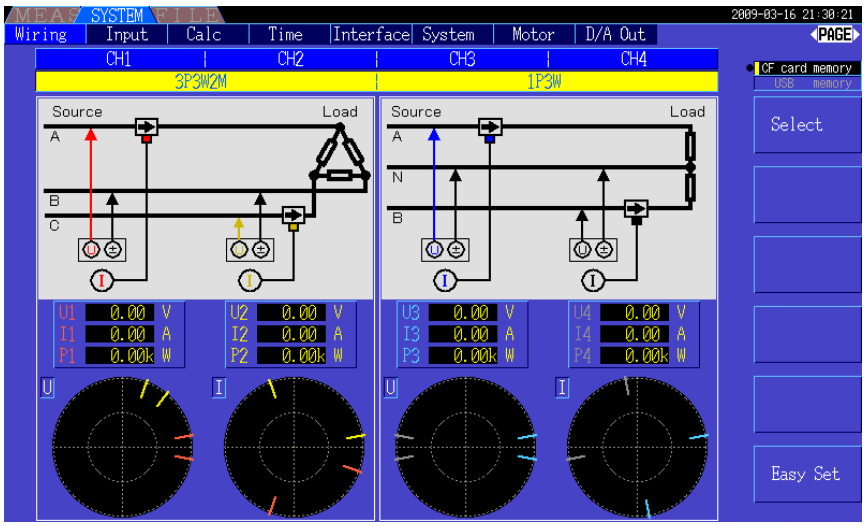


3.9 Selecting the Wiring Mode

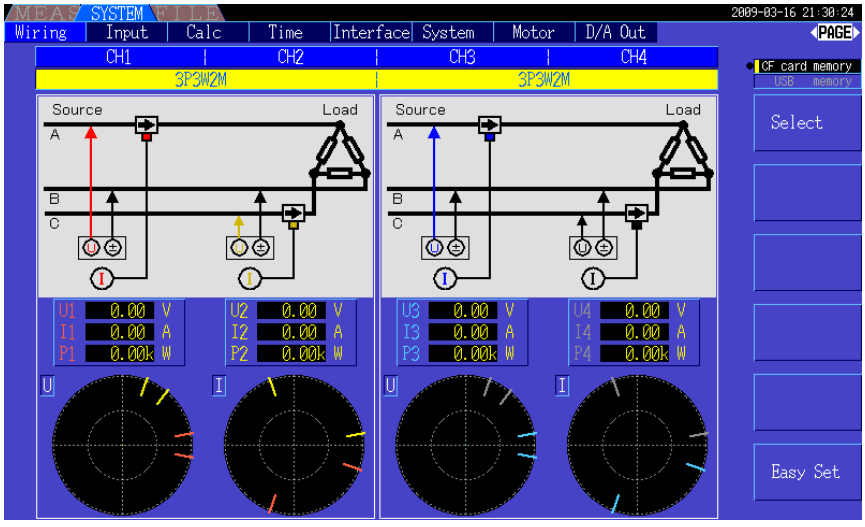
Wiring Mode 4. Single-phase, 3-wire (1P3W) × 2



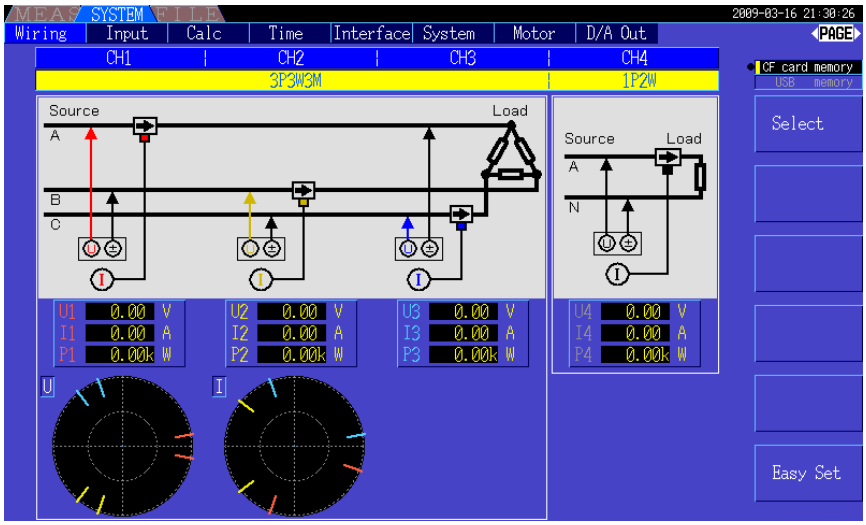
Wiring Mode 5. 3-phase, 3-wire (3P3W2M) + single-phase, 3-wire (1P3W)



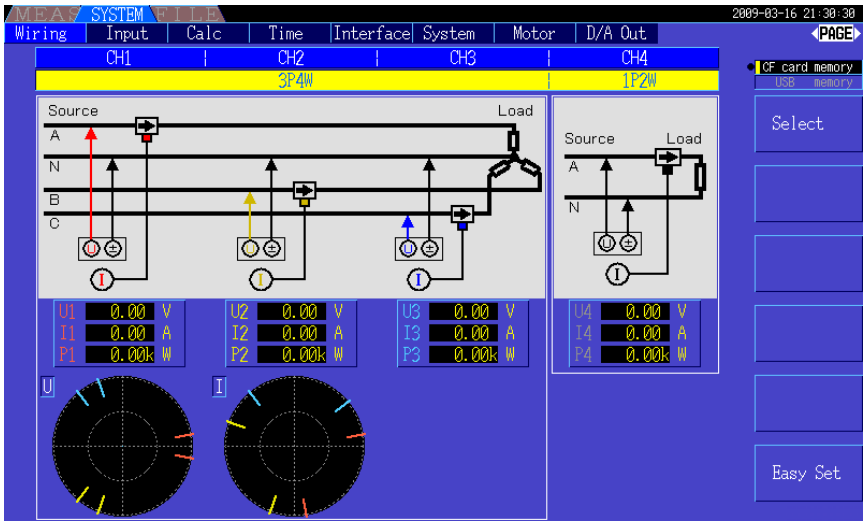
Wiring Mode 6. 3-phase, 3-wire (3P3W2M) × 2



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.*

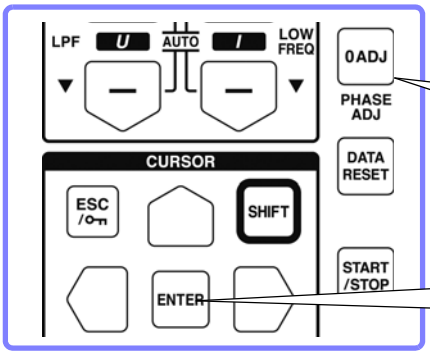
* The diagram appears when the wiring mode is selected.(p. 30)

DANGER **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.**

NOTE 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.

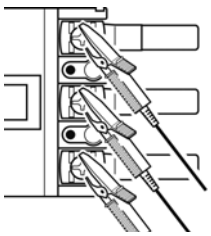
3. Press the key.(ESC /Off to cancel.)
[Executing zero adjustment] is displayed for 30 seconds, until finished.

NOTE

- 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. 83)

Attach voltage measurement cables to measurement lines

Example: Secondary side of breaker



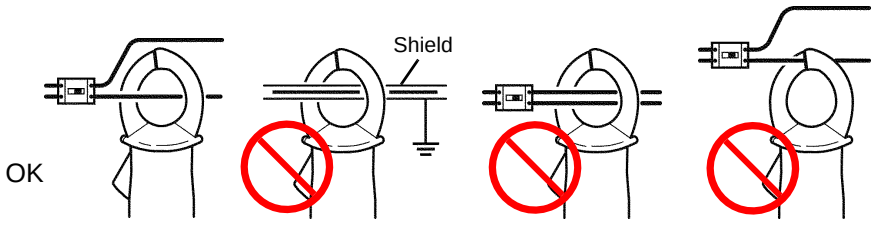
Securely clip the leads to metal parts such as load-side screw terminals or bus bars.

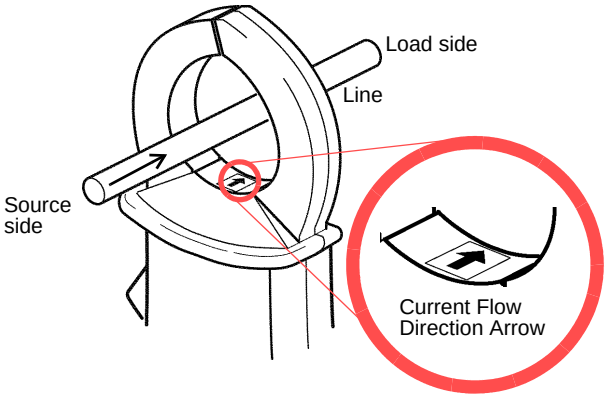
L9438-50 Voltage Cord

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.





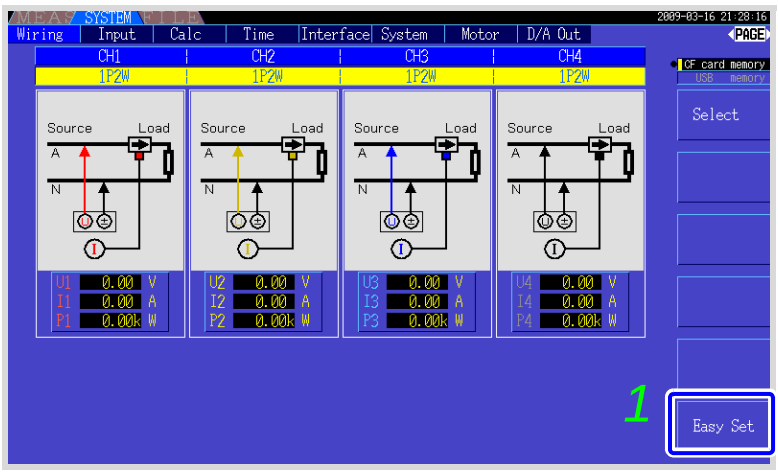
Make certain that the current flow direction arrow points toward the load.

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.



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.

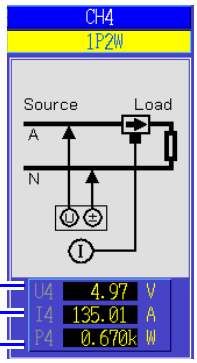
NOTE Execute quick setup when using the instrument the first time, and when changing to a different line configuration.

3.11 Verifying Correct Wiring (Connection Check)

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

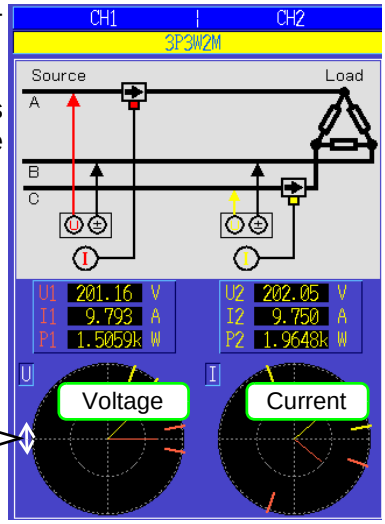
Verify that an appropriate measurement value is displayed.



Measured voltage value
Measured current value
Measured active power value

For systems other than 1P2W

- 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	Check
If the measured voltage value is too high or too low	• 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)
If the measured current value is not correct	• 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?
If the measured active power value is negative	• 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)
If vectors are too short, or unequal	**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?
If vector direction (phase) or color is incorrect	**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

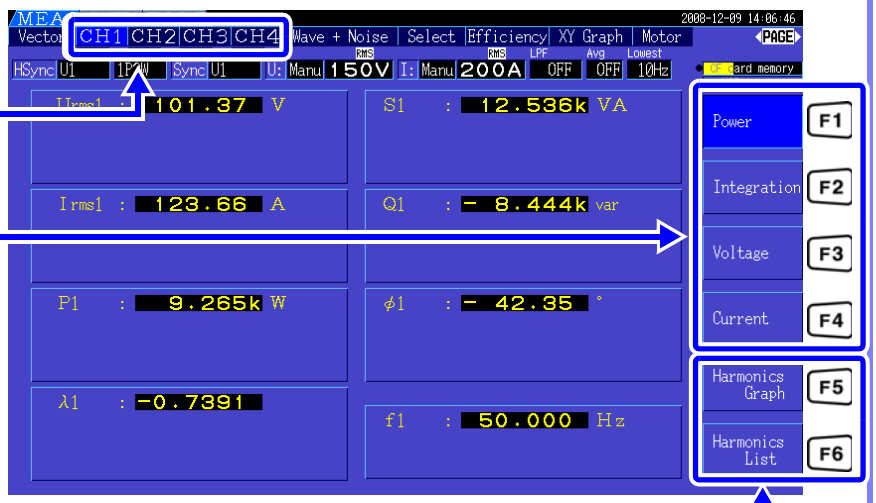
The following procedure displays measurement values.

Display Procedure (the following shows 1P2W wiring mode)

MEAS

◀ ▶ Display the **[CH]** page

Use the **F** keys to select display contents



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)
he 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.

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

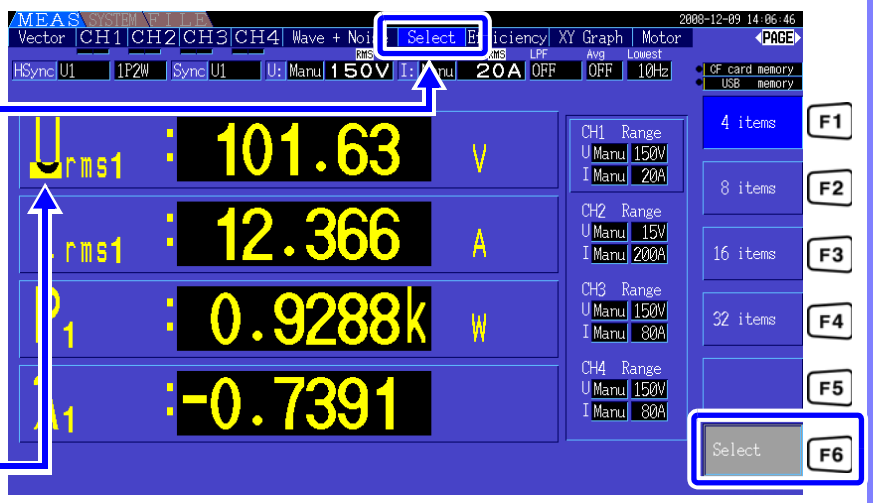
Thirtytwo-Item Display

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 /On Cancel

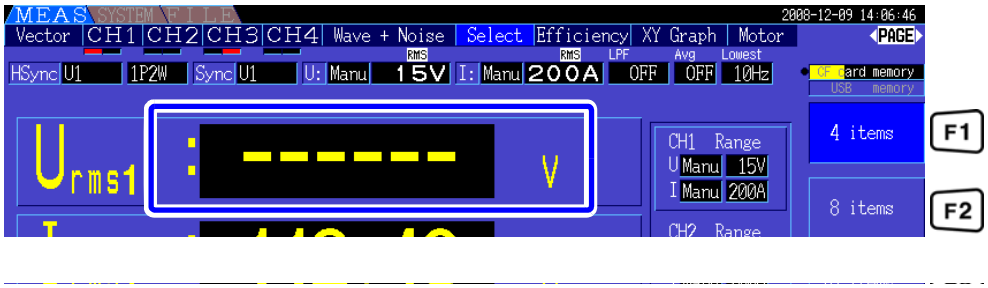
Press F6 when finished making changes.

4.1 Measurement Value Display Procedure

About Valid and Displayable Ranges

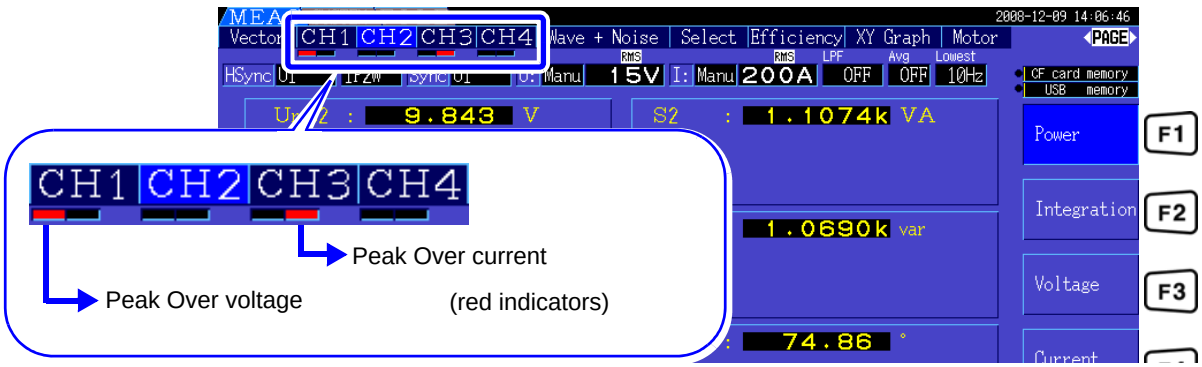
The valid measurement range (the range of guaranteed accuracy) is 1% to 110% of the full-scale range (except that valid voltage is limited to 1000 V in the 1500 V scale).
The display range of this unit is between the zero surpress level to 120% of the measurement range.
The following display indicates over-range measurement.

See Zero surpress level: OFF, 0.1%f.s., 0.5%f.s. (initial setting) (p. 105)



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.



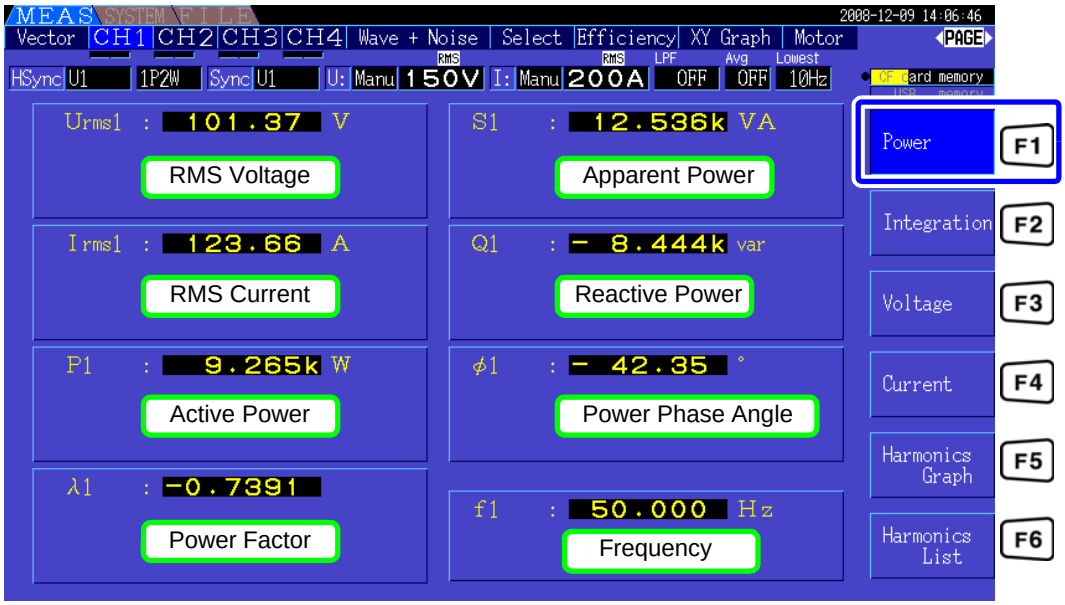
4.2 Viewing Power Measurements, and Changing the Measurement Configuration

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.)

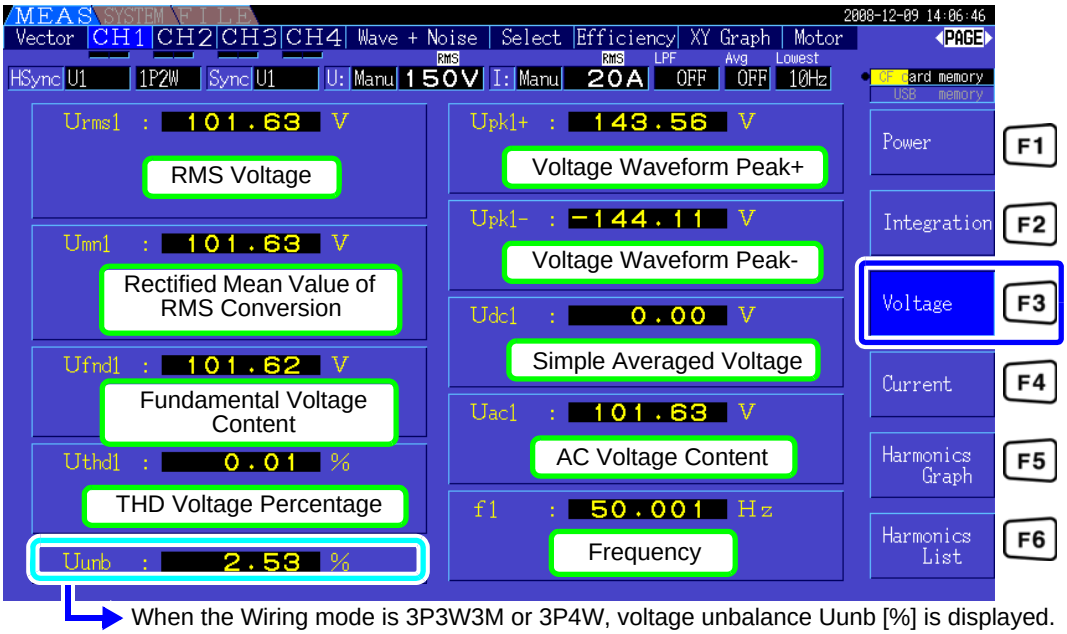


NOTE

- Average rectified RMS converted value is displayed for Urms or Irms 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.)

Displaying Voltage

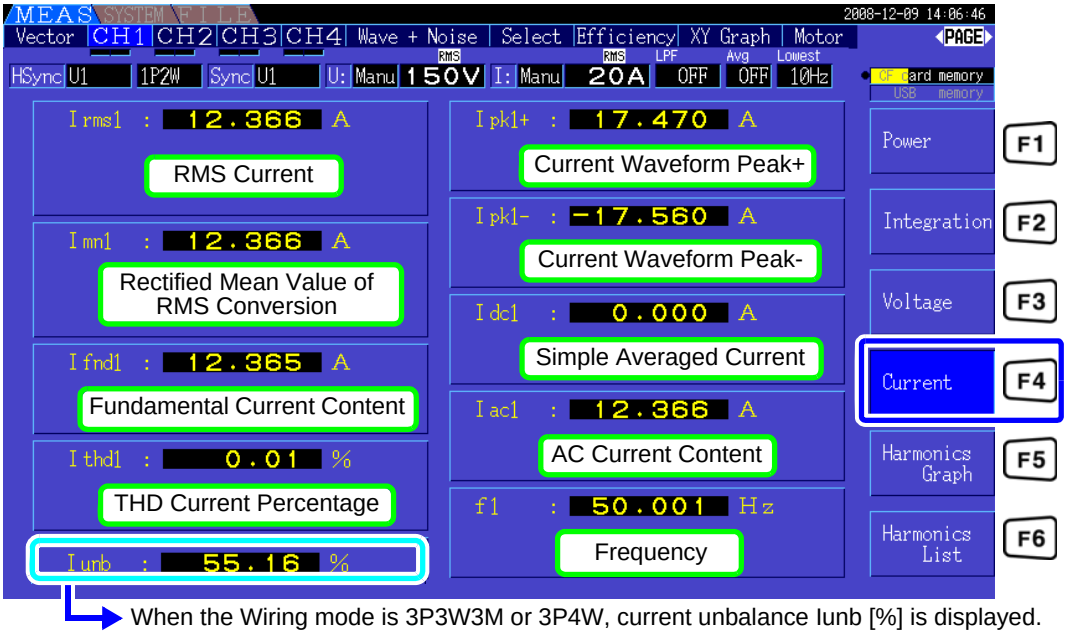
Press F3 . (The screen shows values for Wiring mode 1, four 1P2W systems.)



When the Wiring mode is 3P3W3M or 3P4W, voltage unbalance Uunb [%] 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 Iunb [%] is displayed.

4.2.2 Selecting Ranges

Measurement ranges are selected as described below.

DANGER

- **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.**

WARNING

- **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.**

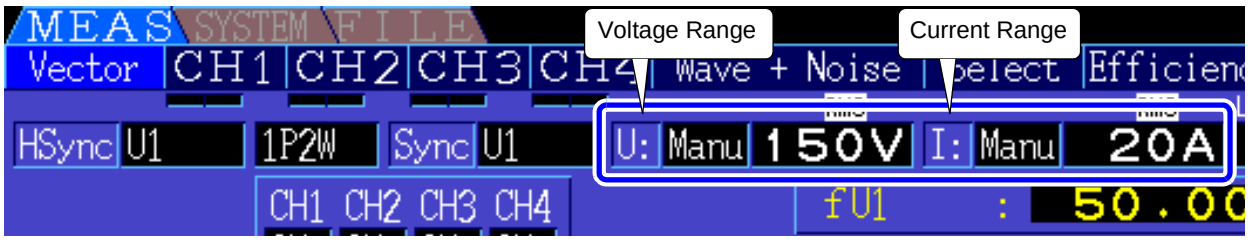
Types of Range Setting

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]**.



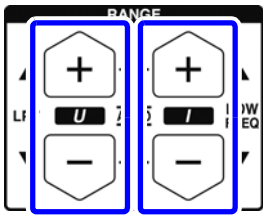
NOTE

When the CT6865 is connected as a current sensor, it is recognized as a 500A sensor, so set the CT rate to 2. Even in this case, the screen range display shows the range for the 500A sensor.

See [10.4 Measurement Item Details] "(5) With 1000 A sensor (model CT6865), only when the setting value of CT rate is 2" (p. 169)

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.



Voltage Range Current Range

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

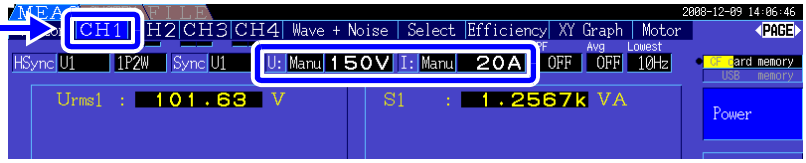
Select the channel to change

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



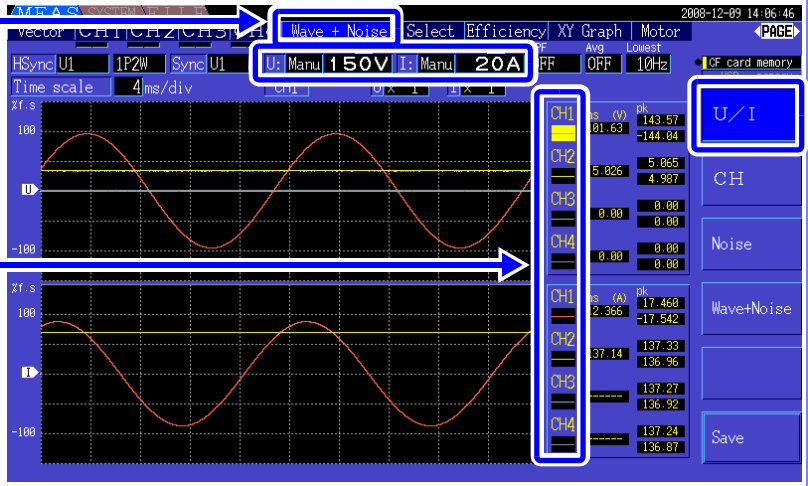
Setting from the [Wave + Noise] Page of the Measurement Screen

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

F1 Select **[U/I]***

Select the channel to change

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

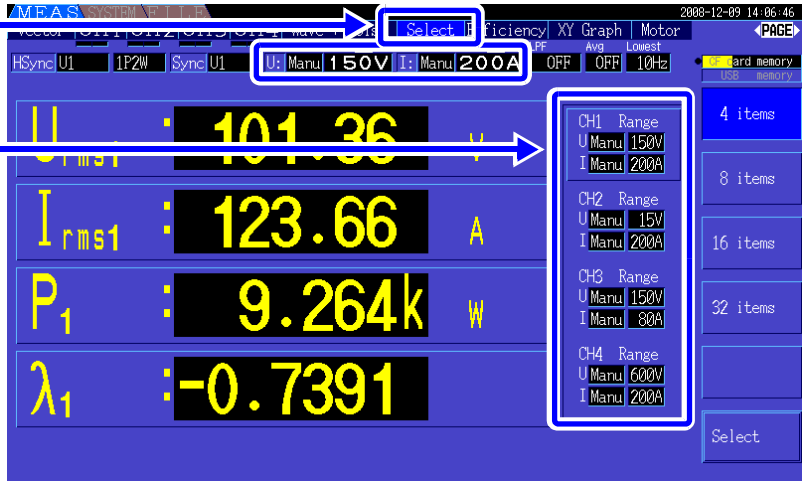


* Press F2 to display **[CH]** for changing.

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

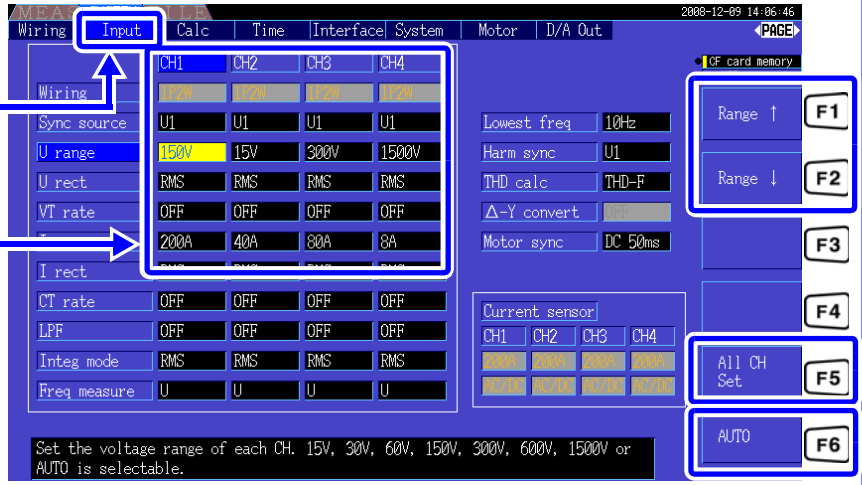
Setting from the [Input] Page of the Setting Screen

SYSTEM

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]**)



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.

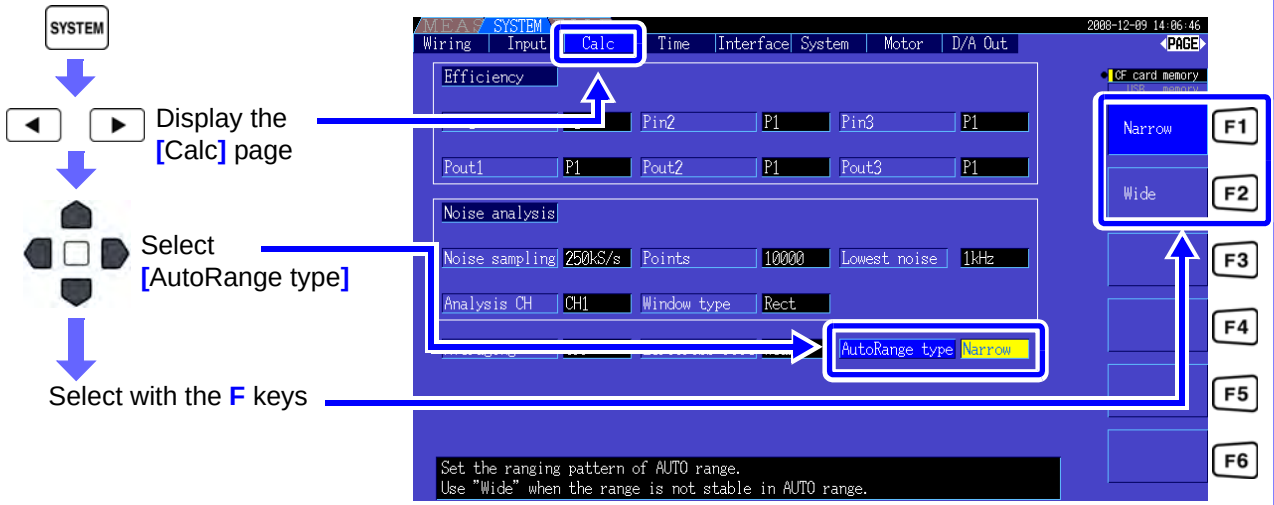
Auto-Ranging Span

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	• 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	• The measurement range increments by one when a Peak Over state occurs or when any RMS value exceeds 110% f.s. • he 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. 100), the range-decrementing voltage is $1/\sqrt{3}$ (approximately 0.57735) f.s.

Setting Procedure



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.

4.2.3 Selecting the Sync Source

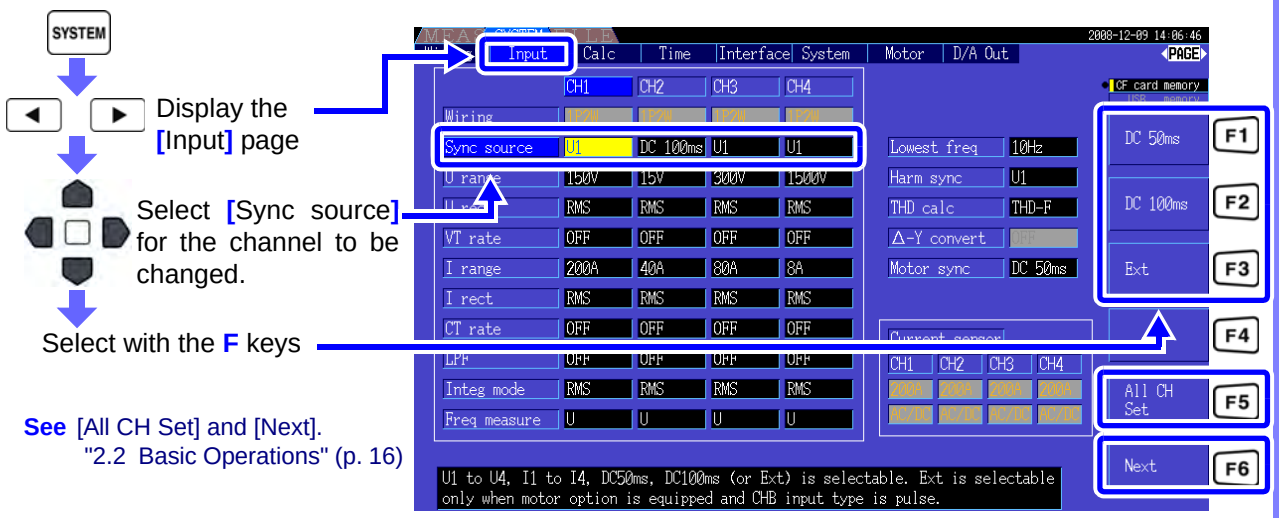
Select the source to determine the fundamental cycle (between zero crossings) on which various calculations are to be based.
As a general usage, for each wiring, select the voltage of the measurement channel for the channel measuring the alternating current, and 50 msDC for the channel measuring the direct current.
When measuring distorted alternating waveforms with a lot of noise, such as PWM waveforms, accurate measurements can be achieved by suitably combining the settings in "Setting the Zero-Crossing Filter" (p. 48).

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



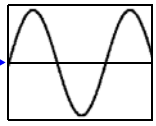
See [All CH Set] and [Next]. "2.2 Basic Operations" (p. 16)

NOTE

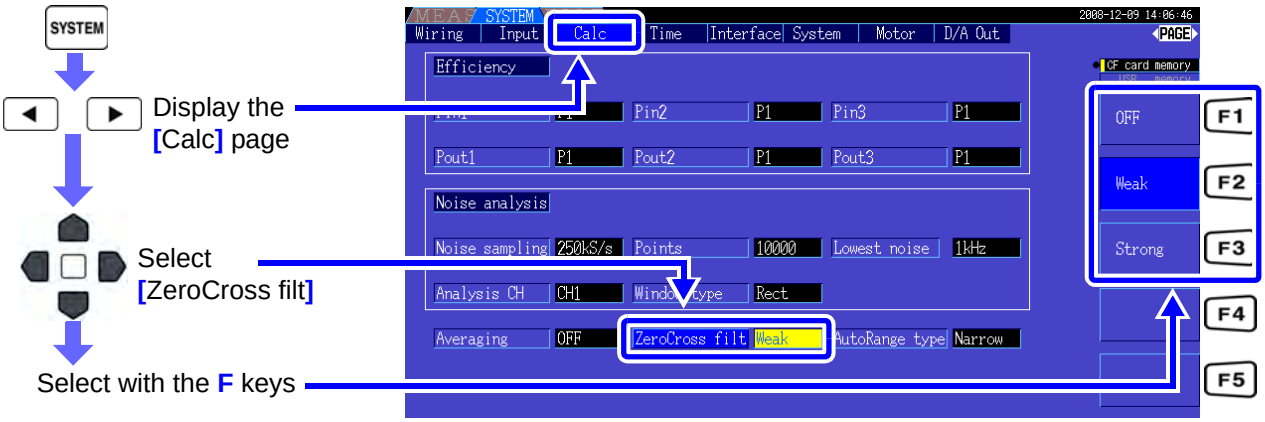
- When measuring AC input with **[DC50 ms]** and **[DC100 ms]** settings, displayed values fluctuate and proper measurement is not possible. Select any of **[U1]** to **[U4]** or **[I1]** to **[I4]**.
- Voltage and current share the same sync source on each channel.
- **[DC50 ms]** is the fastest calculation 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.

Setting the Zero-Crossing Filter

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

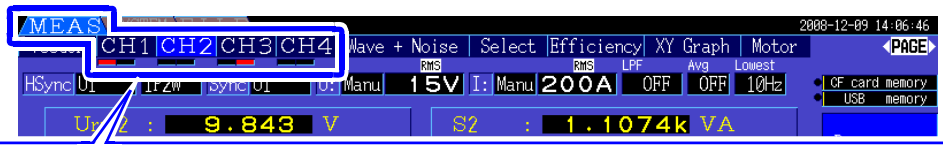
OFF	Set to display waveforms from “0”. NOTE When [OFF] is selected, accuracy is undetermined, so always select the Weak or Strong setting when viewing measurement values. (Ex.) 0 → 
Weak	This is the normal (default) setting.
Strong	Select this setting if synchronization is lost because the input fundamental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

Zero-Crossing Filter Setting Procedure



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.



Harmonic sync source unlocked

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

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 (Ufnd and Ifnd), and the total harmonic ripple distortion percentages (Uthd and Ithd) 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

* 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.)

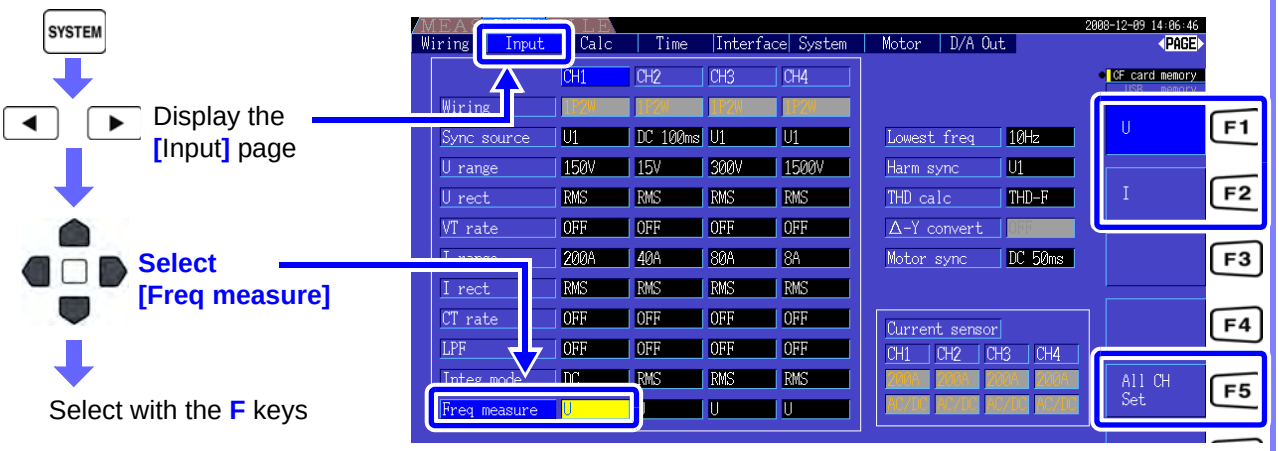
4.2.4 Frequency Measurement Settings

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

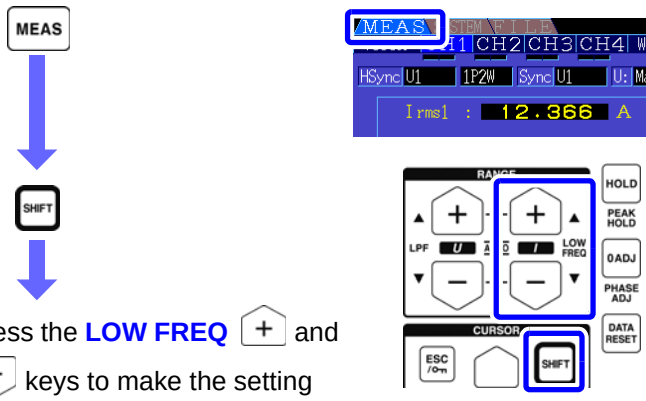


See About [All CH Set]. "2.2 Basic Operations" (p. 16)

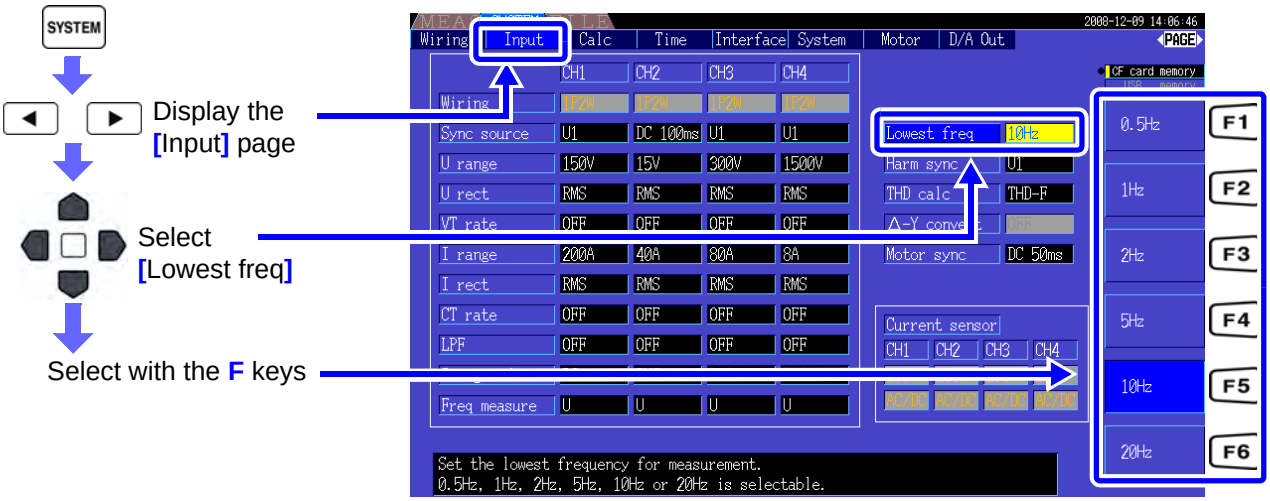
Specify the lowest (limit) measurement frequency for frequency measurements.
Set the lowest measurement frequency according to the input frequency.
The setting is displayed as the **[Lowest]** value on the Measurement screen.

Setting the lowest measurement frequency on the Measurement screen

This setting is available on all Measurement screen pages.



Setting the Lowest Measurement Frequency on the Setting Screen



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.

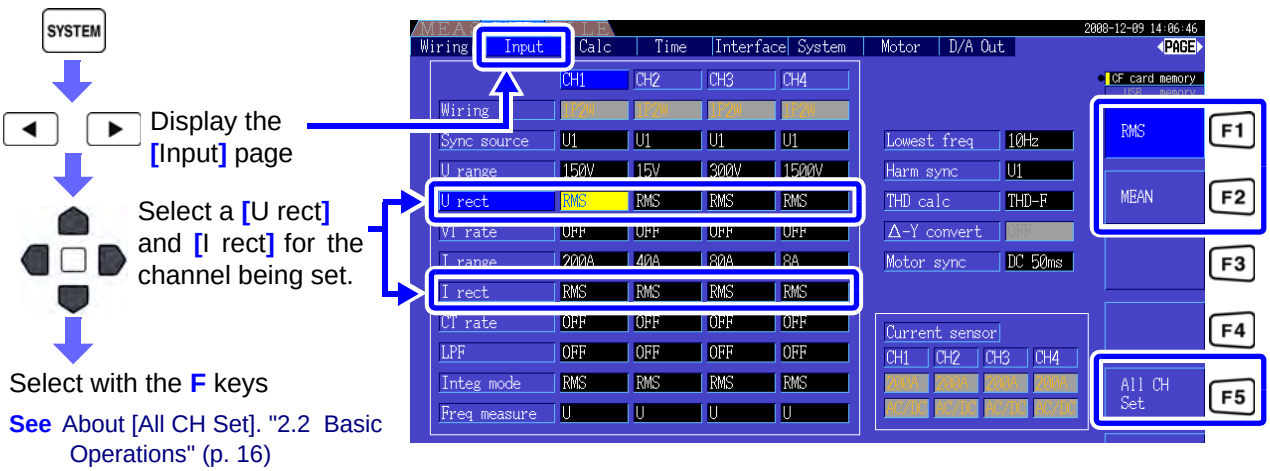
4.2.5 Selecting the Rectification Method

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. In general, select this only when measuring the inverter's secondary voltage.

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

Setting Procedure



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

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

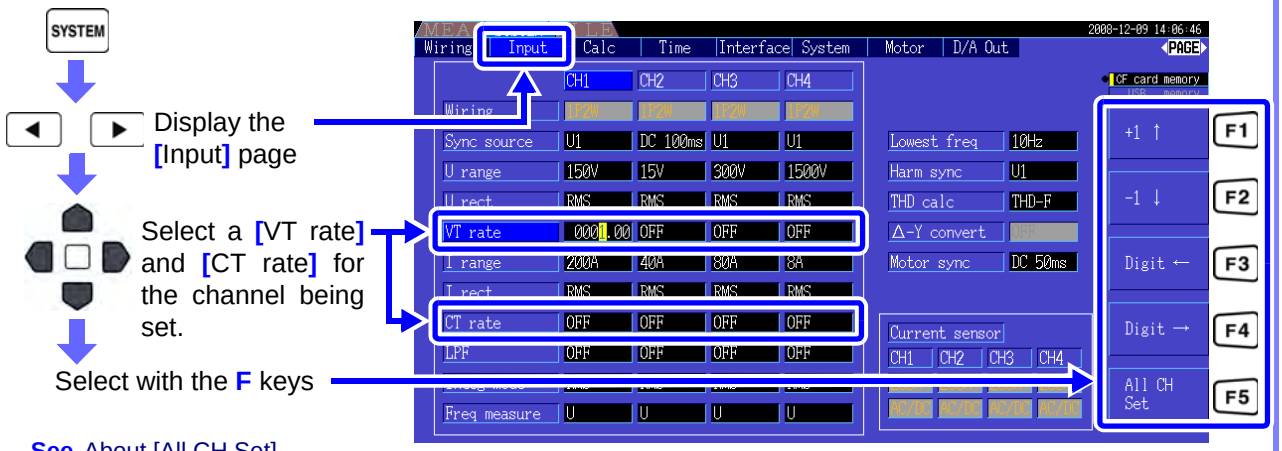
Set the VT or CT ratio when using an external VT(PT) or CT.
When a ratio has been set, **[VT]** or **[CT]** is displayed above each range setting on the [CH] pages.

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)

4.2.7 Setting the Low-Pass Filter

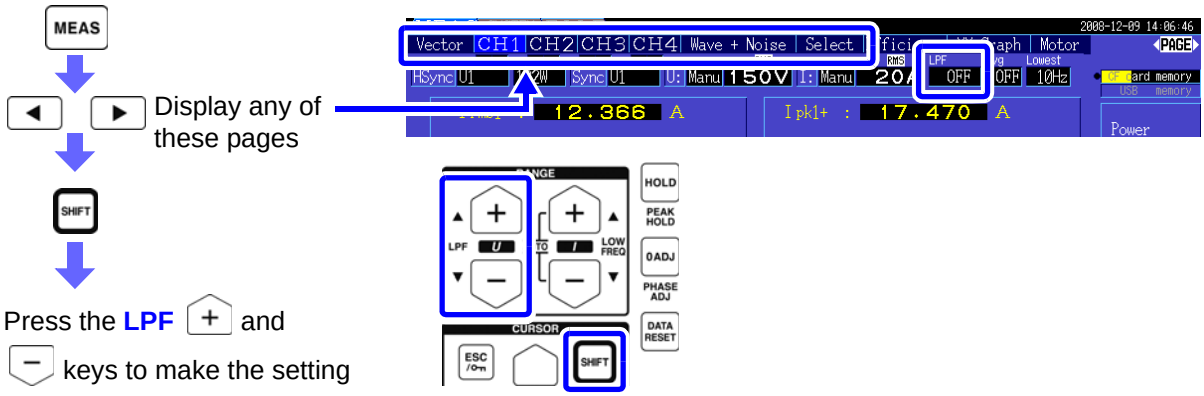
The instrument includes a low-pass filter function to limit the measurement frequency range.
Enable the filter to remove harmonic components or extraneous noise when measuring.
Filter cut-off frequency can be selected from the following four settings, and can be set differently for each wiring system.

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 ±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 ±0.1% f.s.

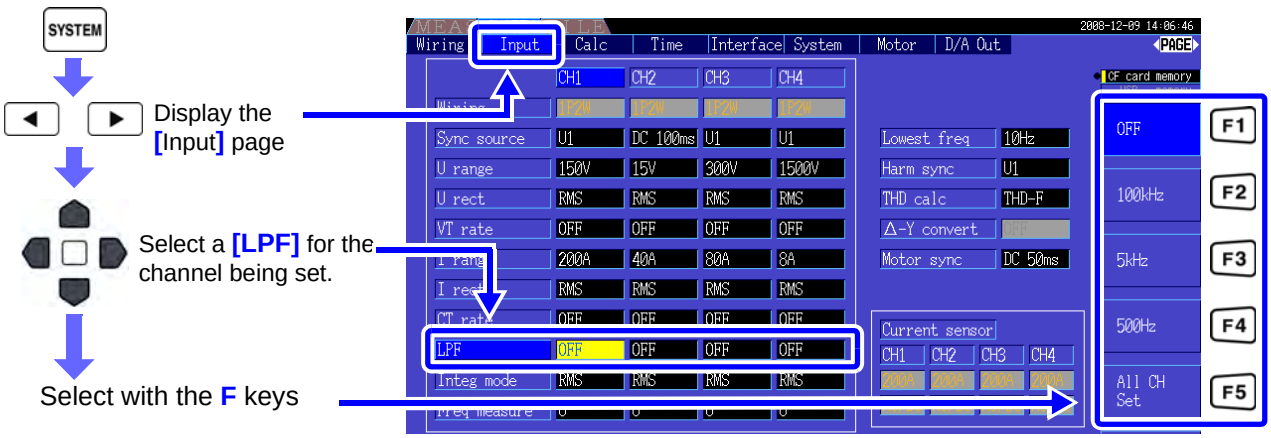
The low-pass filter setting appears below **[LPF]** on the Measurement screen.

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.



Selecting the Cut-Off Frequency on the Setting screen.



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

4.3 Integration Value Observation

4.3.1 Displaying Integration Values

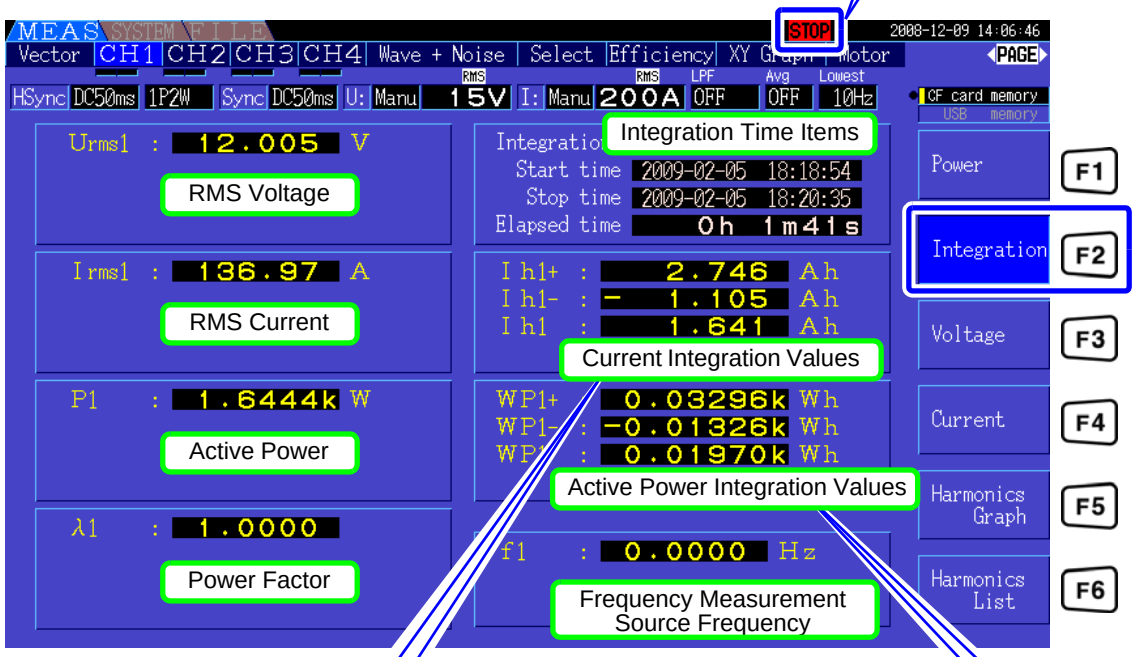
Current (I) and active power (P) are integrated on all channels simultaneously. Positive, negative and total values are displayed.

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



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

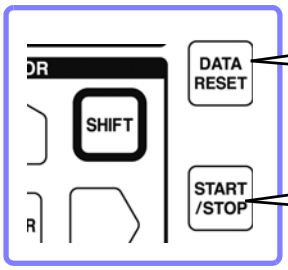
NOTE Items that can be integrated depend on the selected wiring and integration mode.
See "3.9 Selecting the Wiring Mode" (p. 30), "4.3.2 Setting the Integration Mode" (p. 56)

Before Starting Integration

1. Verify that the clock is set correctly.
   See "Clock" (p. 105)
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. 110), "8.4 Using Analog and Waveform D/A Output Options (must be factory installed before shipping)" (p. 136)

Starting, Stopping, and Resetting Integration

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



Resets integration: press DATA RESET when integration is finished

Always reset the integration values when changing other settings.

Start integration: press once
Stop integration:* press again

* When timer or clock control is enabled, integration stops automatically at the specified stop time.

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. 145)

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

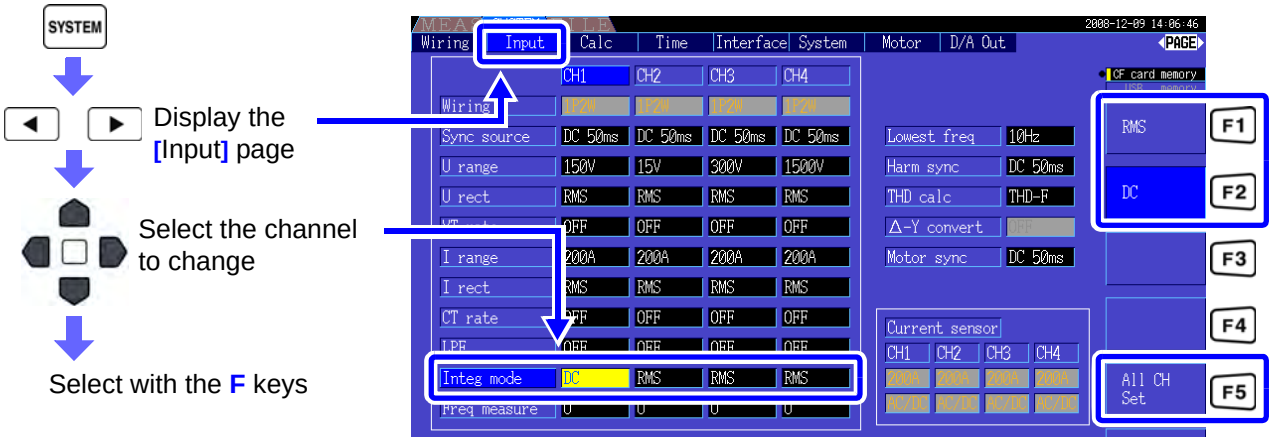
- Calculation results for each channel are integrated at 20 times per second, so integration values may differ for measurement devices with different response or sampling rates, and for different calculation methods.
- When auto-ranging is enabled for any item, the actual measurement range becomes fixed 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. 105)
- If a power outage occurs during integration, integration restarts when power is restored.

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



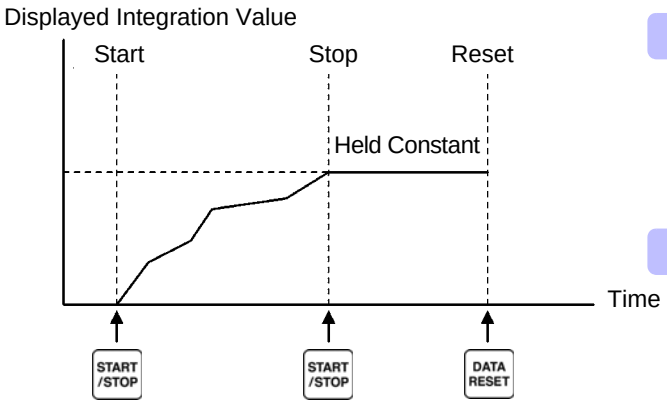
See About [All CH Set]. "2.2 Basic Operations" (p. 16)

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



Manual Integration Operations

Before starting integration

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

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

Start

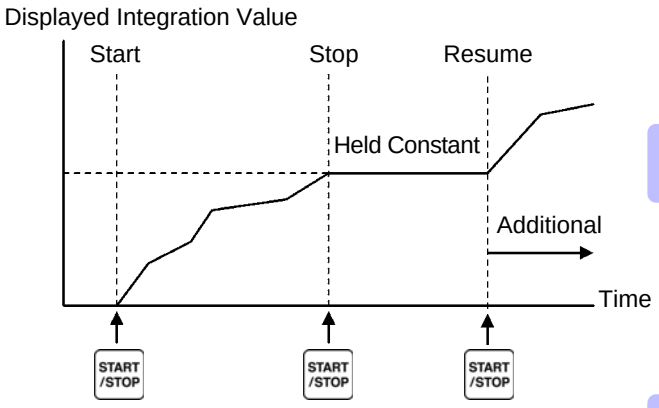
Press START /STOP .

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

Stop

Press START /STOP again.

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



Additional Integration Operation

Additional integration

(resumes integration with the values acquired previously)

Press START /STOP again.

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

Reset the integration value

Press DATA RESET when finished integration.

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. 116) 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.116) (Press F2 **[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. 114), "7.10.1 Creating Folders" (p. 121)
3. Select the interval time.
   See 5.1 (p.93)
4. Press START /STOP to start saving at the selected intervals. (Press START /STOP 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 START /STOP key. Disable auto-saving (set to [OFF]) when not needed.
  See"7.5.2 Auto-Saving Measurement Data" (p. 114)
- 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

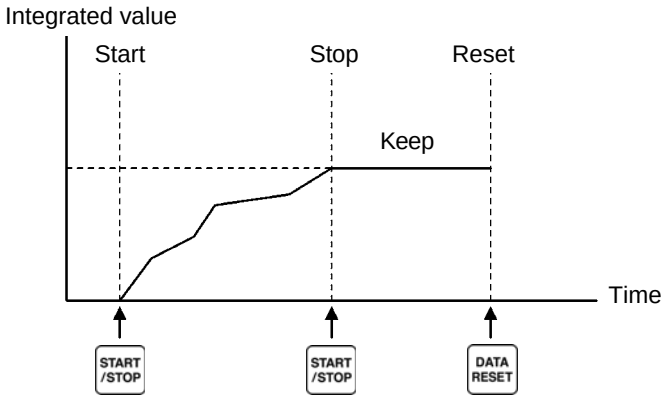
After specifying timer and clock settings, press START /STOP to cause integration to start and stop at the specified times. Integration can be controlled by the following three timing methods.

Manually Controlled Integration

Press START /STOP to start integration.

Press START /STOP again to stop integration.

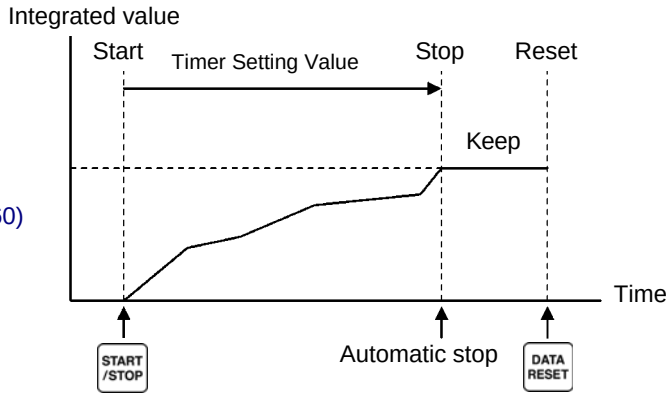
See "4.3.3 Manual Integration Method" (p. 57)



Timer-Controlled Integration

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

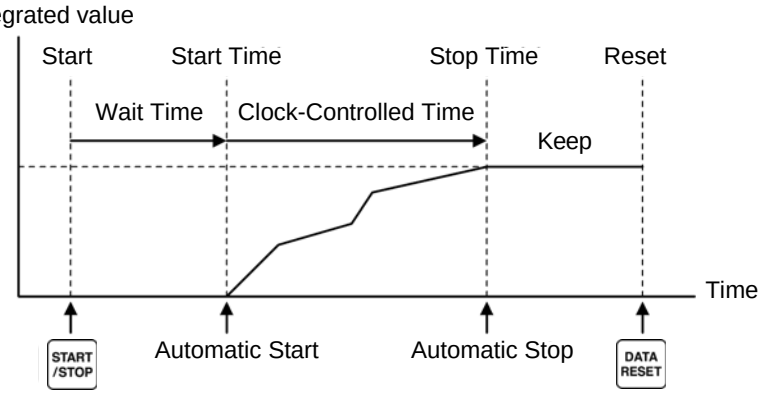
See "Timer-Controlled Integration" (p. 60)



Clock-Controlled Integration

Press START /STOP .
Integration starts and stops at the specified times.

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



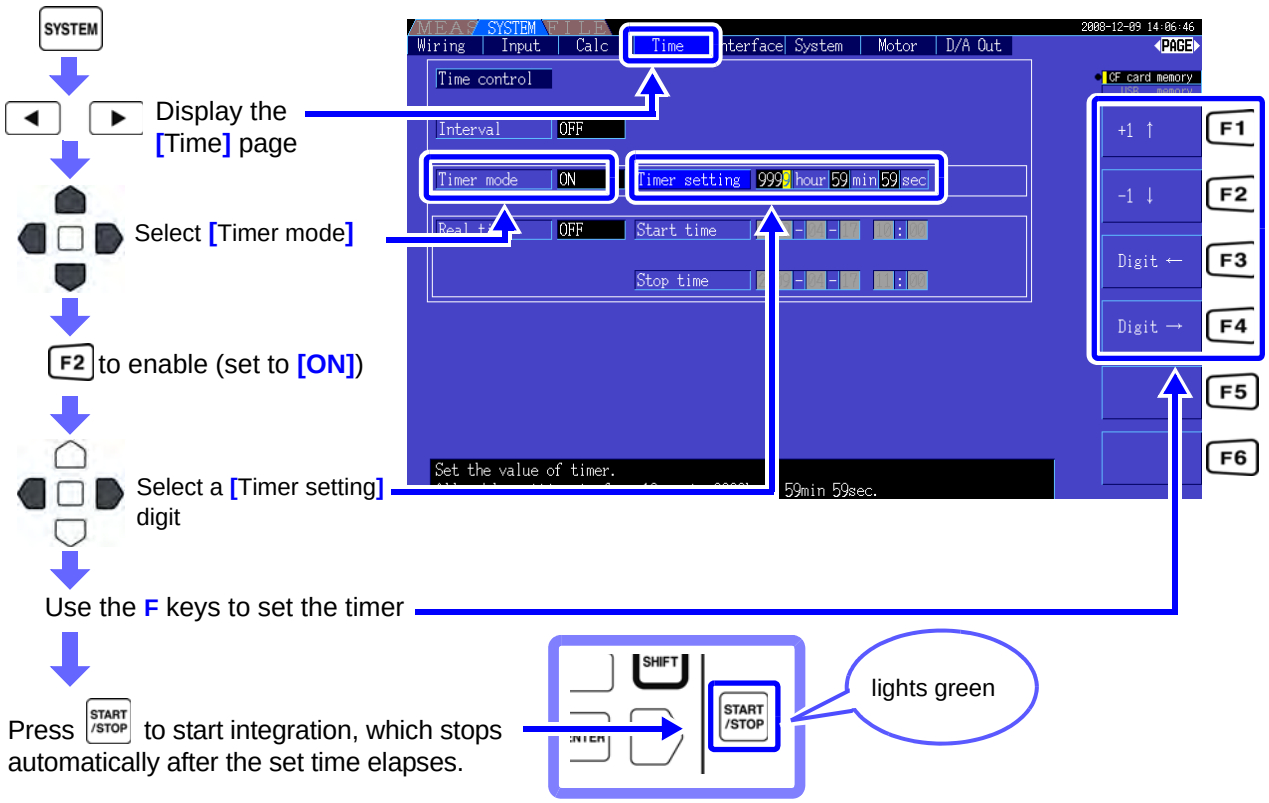
NOTE When an interval time is enabled, activating Data or Peak Hold by pressing the **HOLD** key causes the display to update at each interval.
Also, when timer or clock control is enabled, the final measurement data is displayed at the specified stop time.

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. 114)

Setting Procedure



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

SYSTEM

◀ ▶ Display the [Time] page

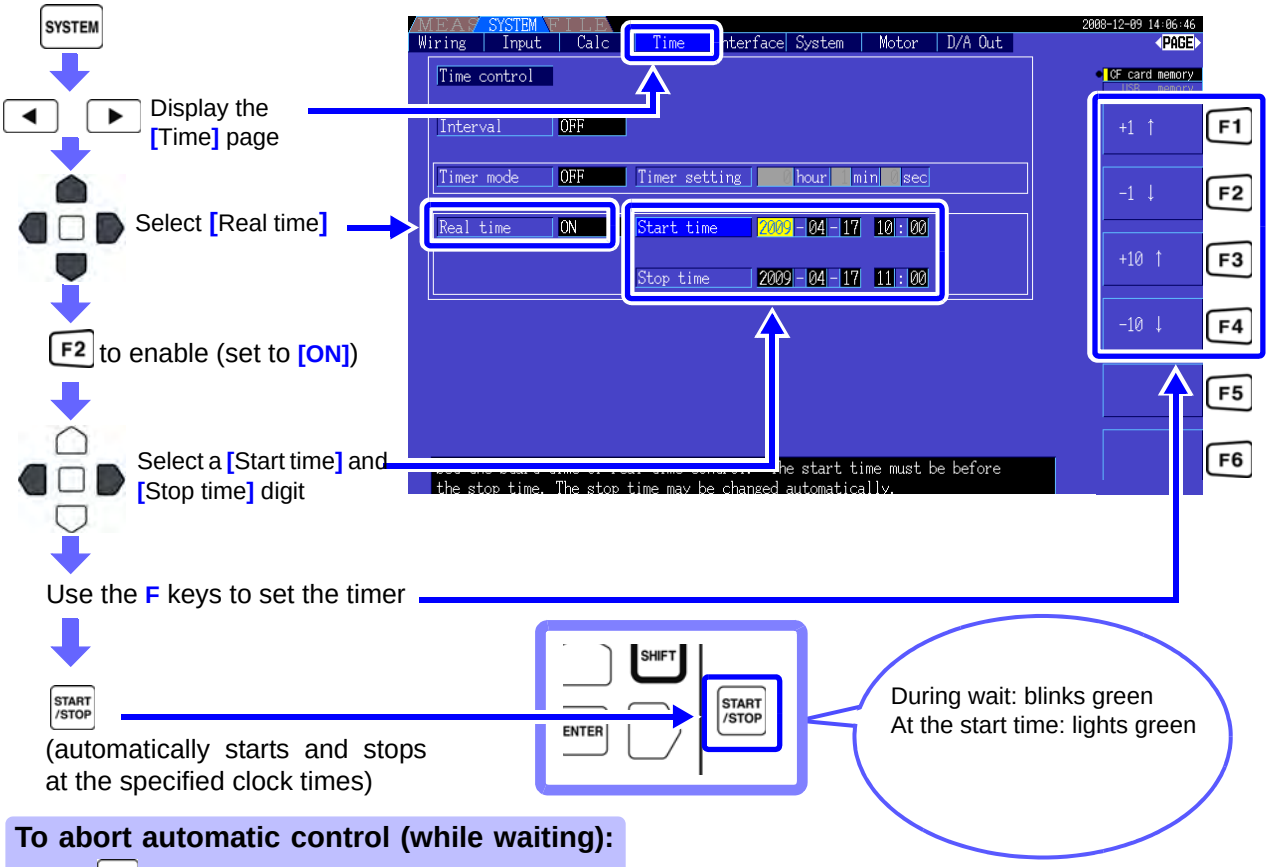
Select [Real time]

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)



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

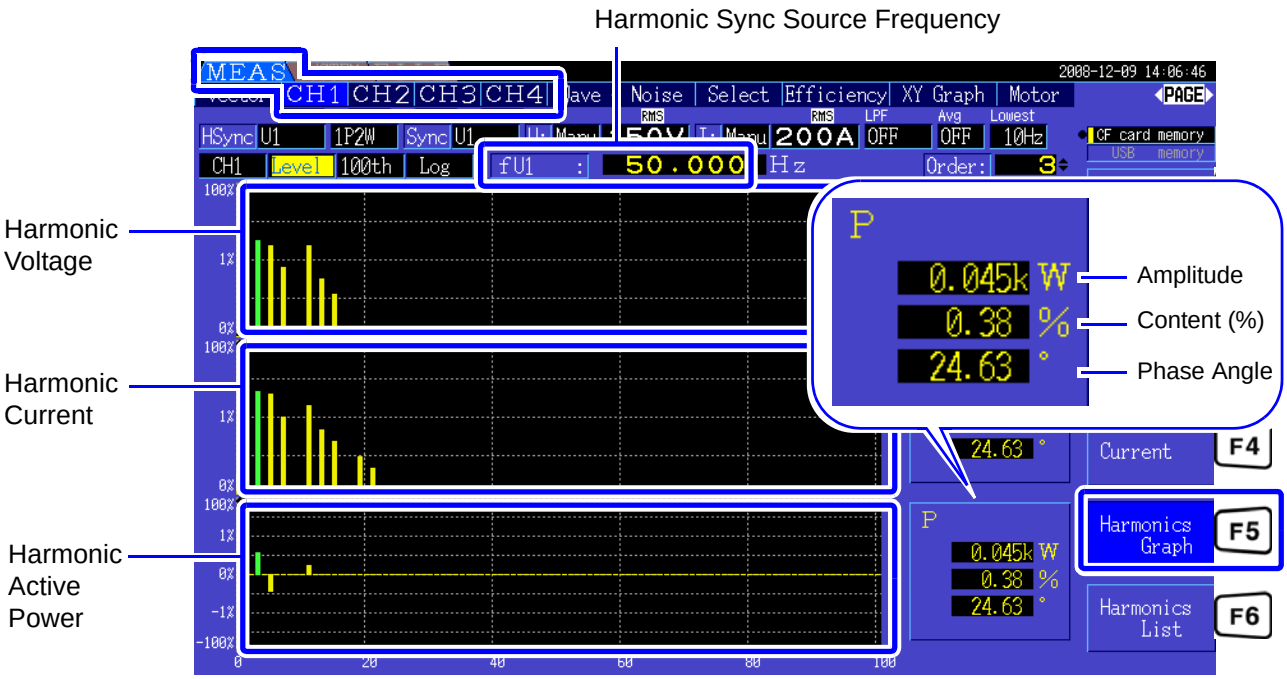
4.4 Viewing Harmonic Measurement Values

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.

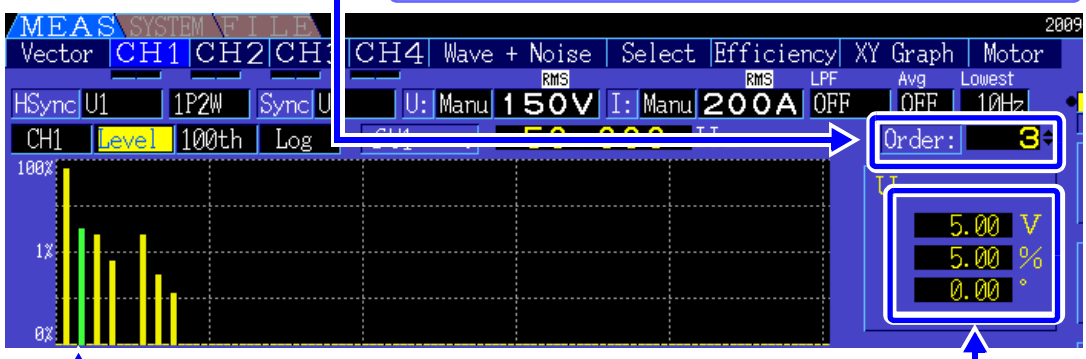
Press ◀ ▶ to select the desired **[CH]** page, and press F5 .



Changing the Displayed Order

Change the selected order.

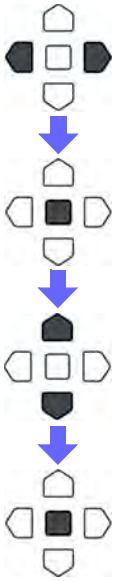
These selections correspond to the orders on the Harmonic List screen.



The green bar indicates the selected order.

Shows the measured values of the cursor-selected order.

Changing Display Settings

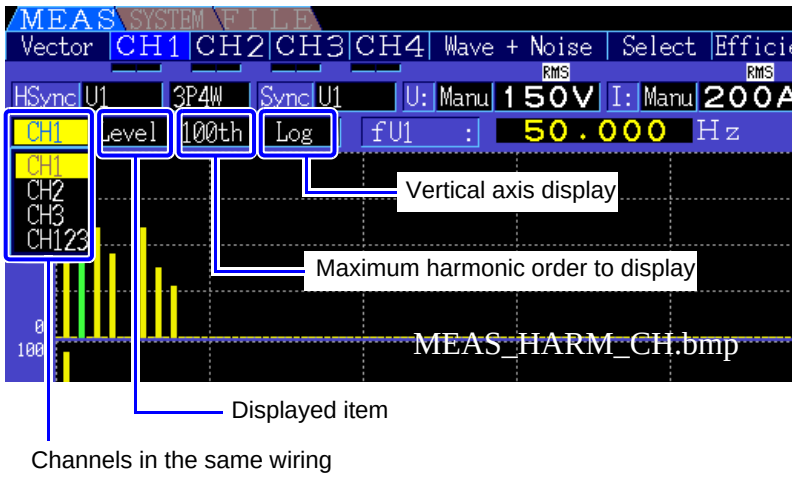


Select the item

Displays the pull-down menu

Selects from the pull-down menu

Enter / ESC /On 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. 156)

Vertical Axis Display Type

Changes the vertical axis display type.

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

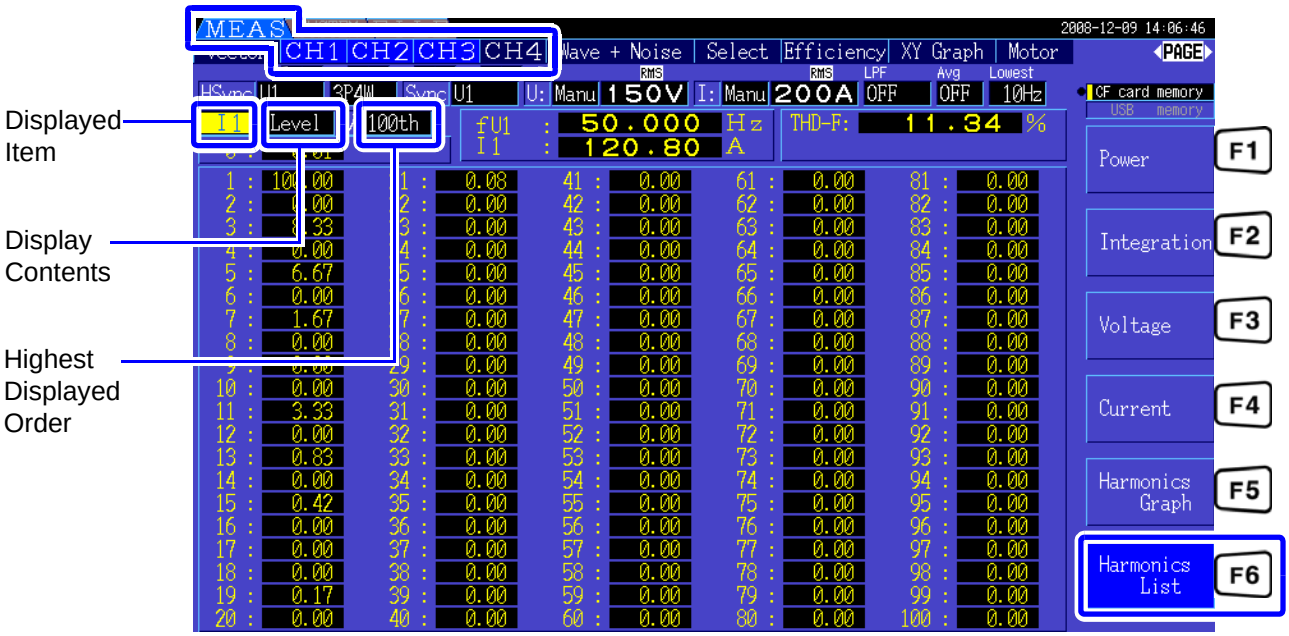
NOTE When the display content is phase angle, the **[Linear]** setting is fixed and cannot be changed.

4.4.2 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

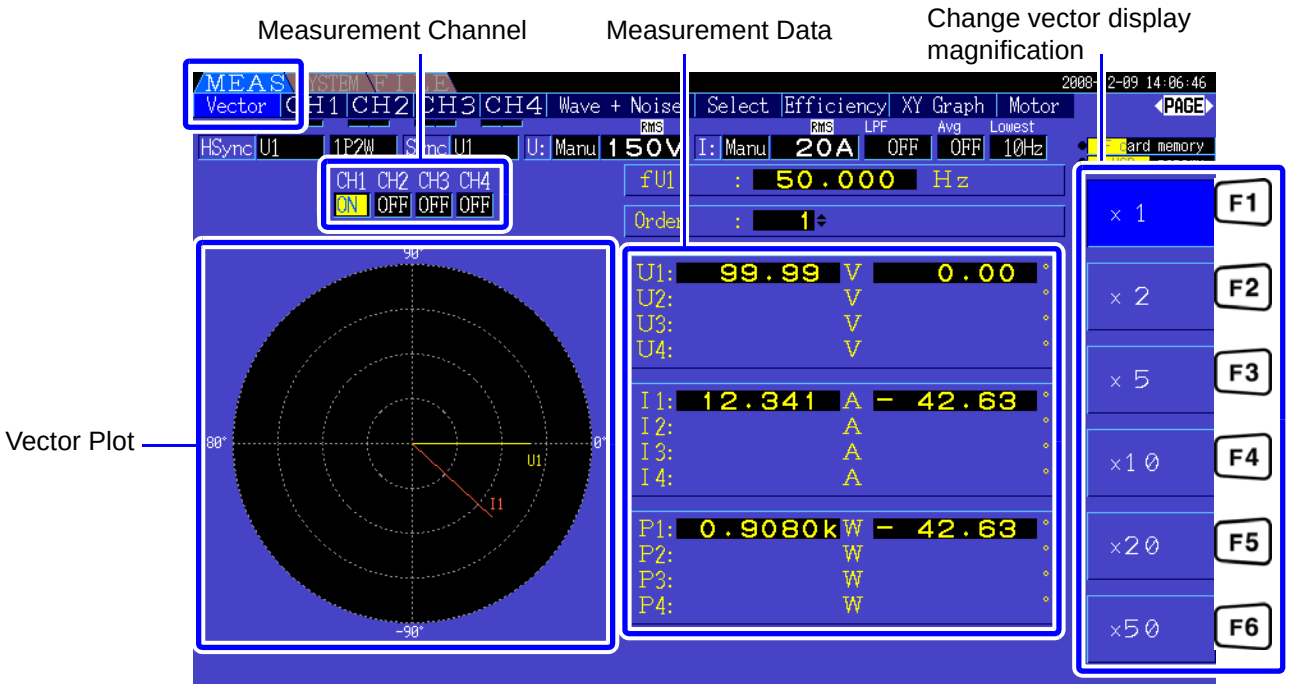
This selection is the same as on the Harmonic Bar Graph screen.

NOTE Depending on the sync frequency used for measurement, the specified maximum order may not be displayable.
See "Highest order analysis" (p. 156)

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.

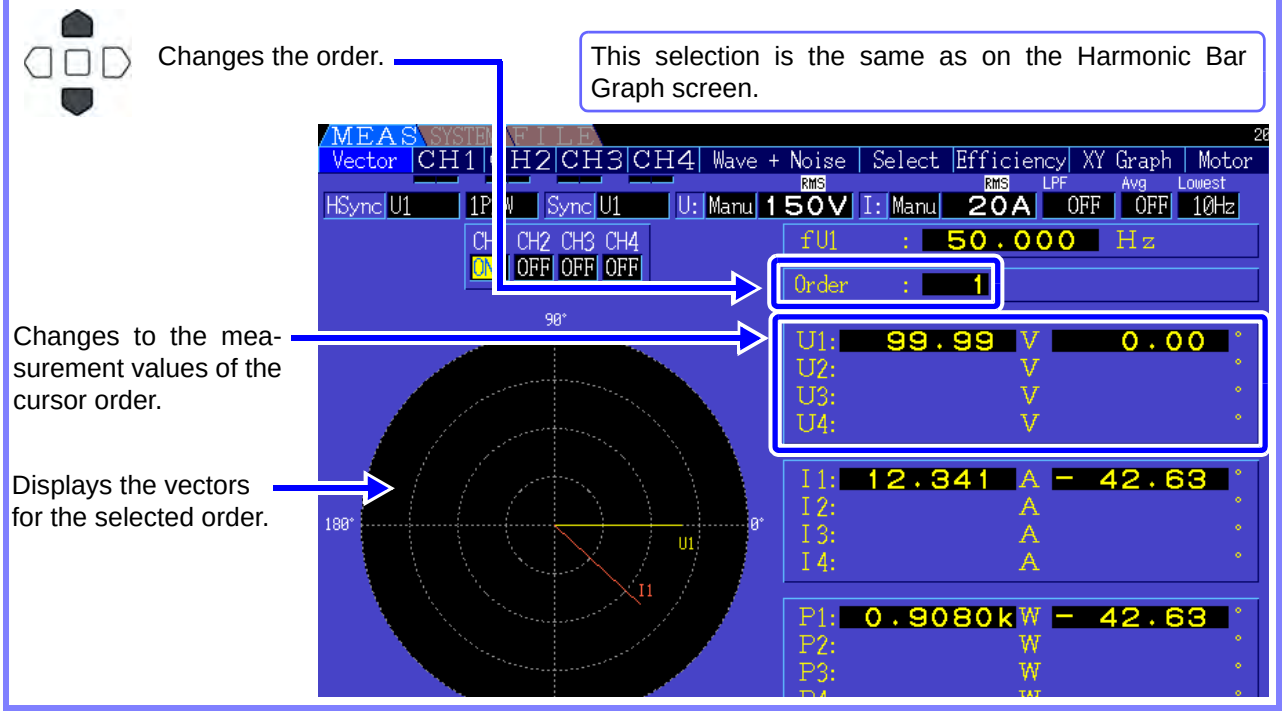
Press MEAS and then ◀ ▶ to select the [Vector] page.



NOTE

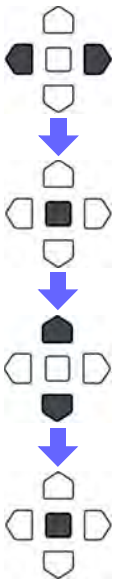
- Voltage and current for all channels are displayed on one screen.
- Voltage-current phase angles are determined relative to the (0°) standard of the fundamental waveform used as the harmonic sync source.
- The phase angle of harmonic active power is equivalent to the harmonic voltage-current phase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

Changing the Displayed Order



4.4 Viewing Harmonic Measurement Values

Changing Display Settings

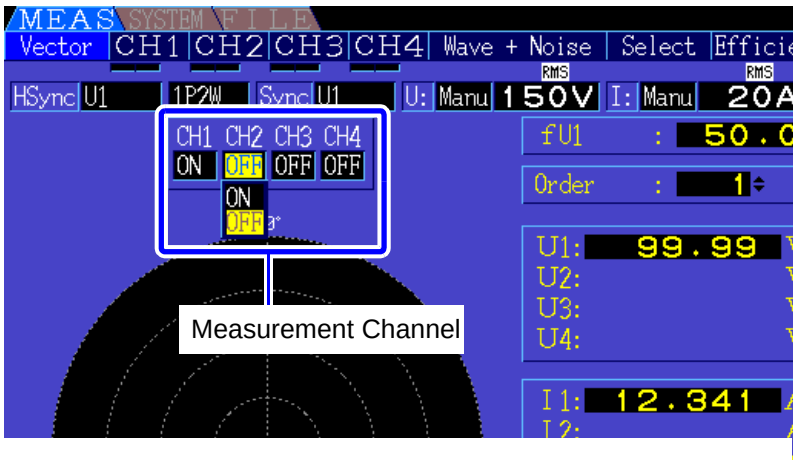


Select the item (channel)

Displays the pull-down menu

Selects from the pull-down menu

Enter / ESC /On 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

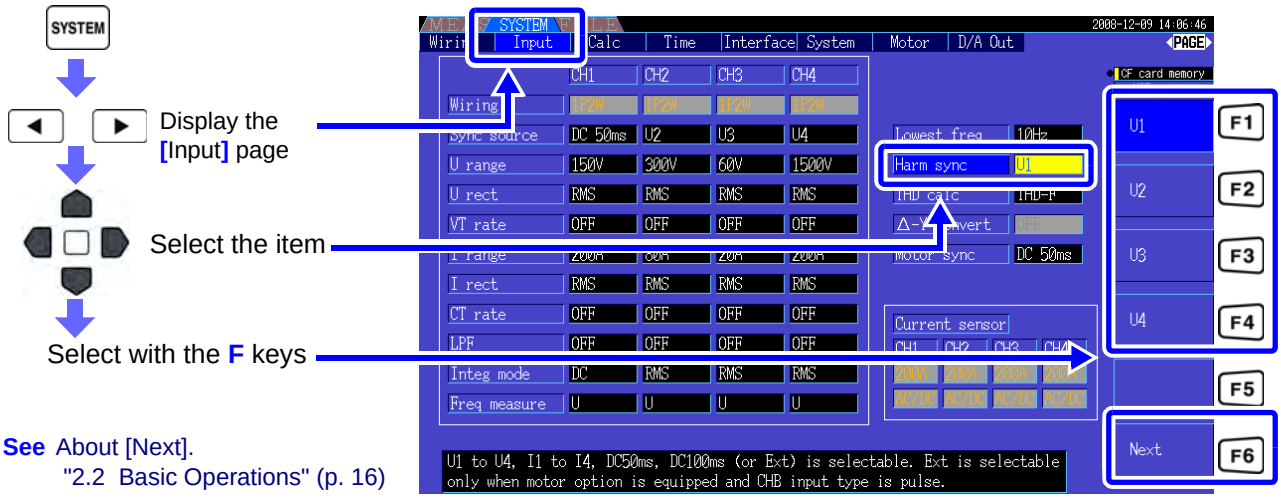
DC50 ms, DC100 ms

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. 85)



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

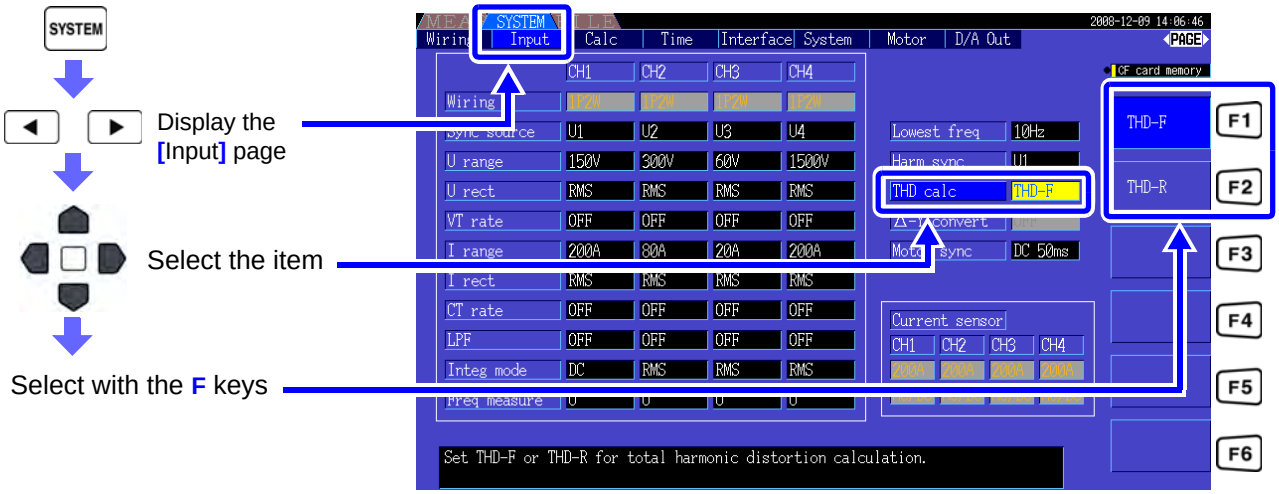
NOTE

- 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

4.4.5 Selecting the THD Calculation Method

Select whether to use THD-F or THD-R method to calculated 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



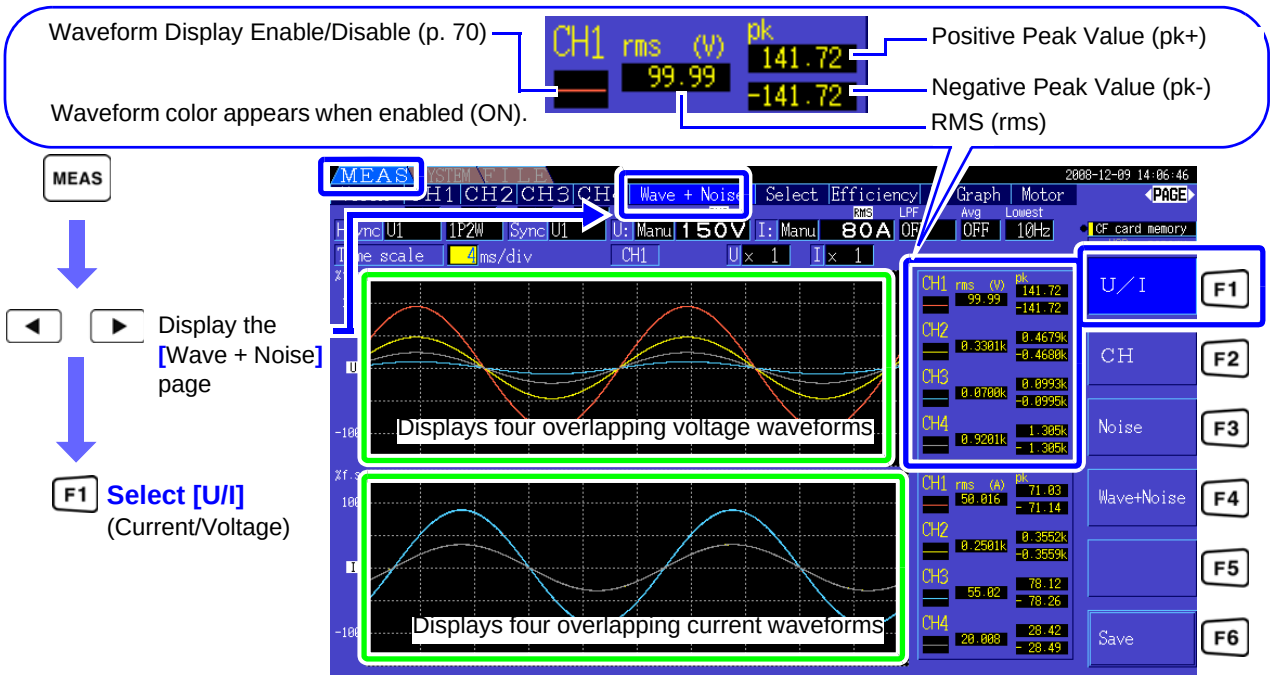
What is THD?
THD is an abbreviation for total harmonic distortion: the total amount of signal distortion cause by all harmonics.

4.5 Viewing Waveforms

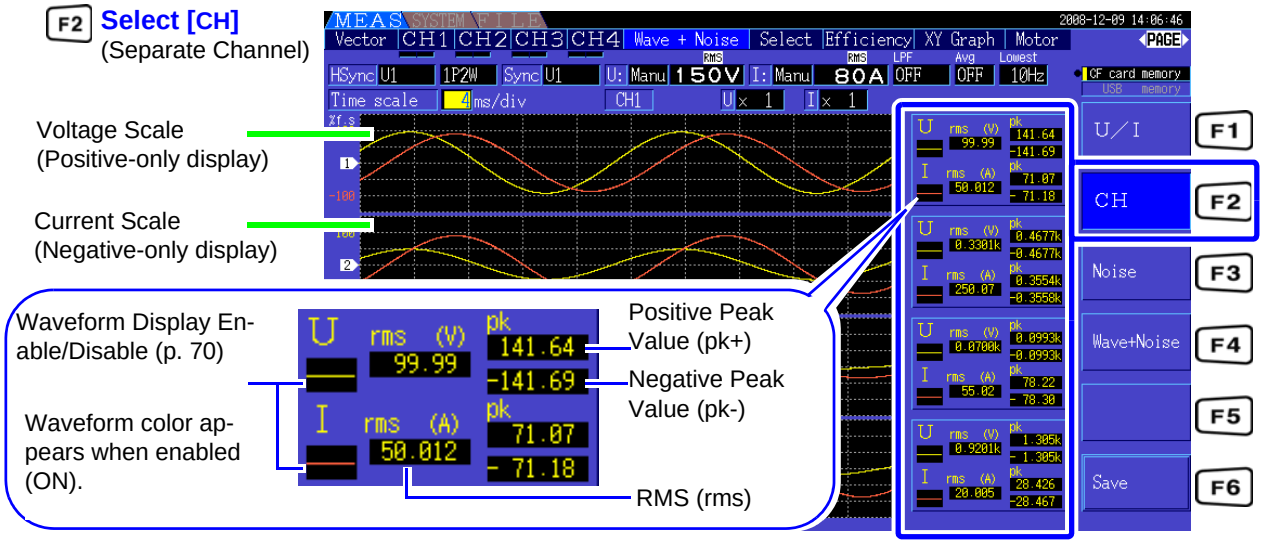
4.5.1 Displaying Waveforms

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



Displaying Separate Channel 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].

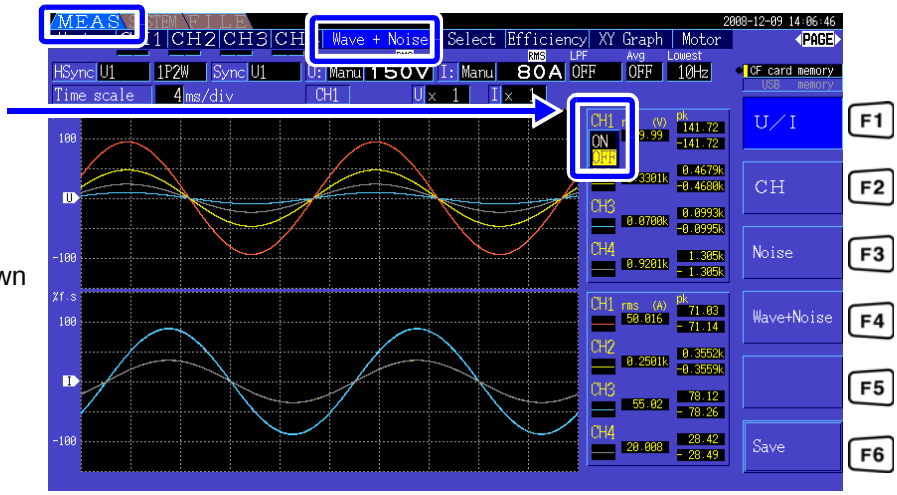
ON	Display waveforms
OFF	Do not display waveforms

Select the channel to change

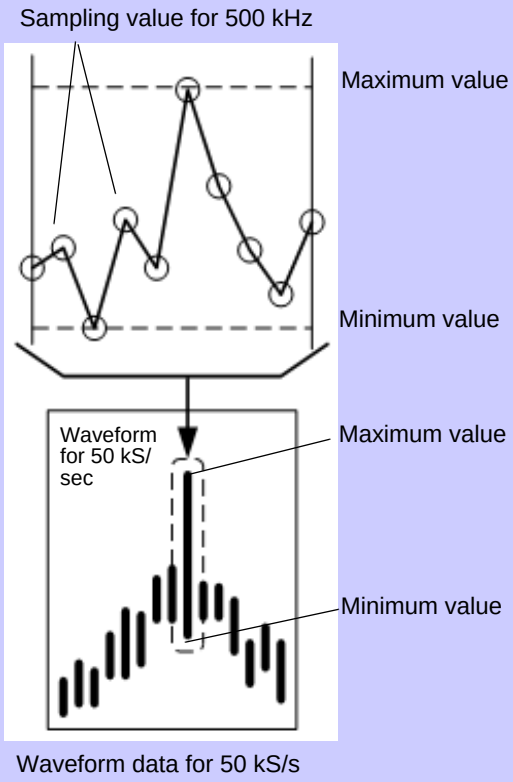
Displays the pull-down menu

Selects from the pull-down menu

Enter / ESC /On Cancel



The waveform displayed on the screen or the waveform data saved in "Saving Waveform Data" (p. 118) always uses the Peak-Peak compressed waveform data sampled at 500 kS/s.
Therefore, even if the sampling frequency is set low, an accurate envelope with peak information of the waveform before compression can be recreated.
The data of saved waveform data is linked to the same number of points for noise analysis, and for each point, the maximum value and minimum value in the picture on the left are both saved.



NOTE

- To shorten the time it takes to renew the waveform display, decrease the number of points for noise analysis. The quickest display renewal is 1000 points.
- Changing the settings for waveform display and noise analysis do not affect the electric power or the sampling for harmonic measurement.

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).

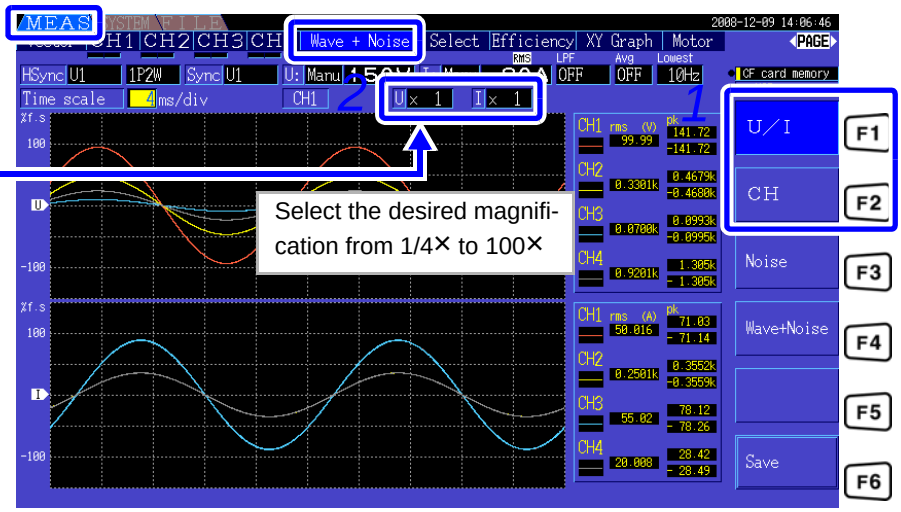
1 Press F1 or F2

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

3 Displays the pull-down menu

Selects from the pull-down menu

Enter / ESC Cancel



Changing Horizontal Axis Magnification (Timebase)

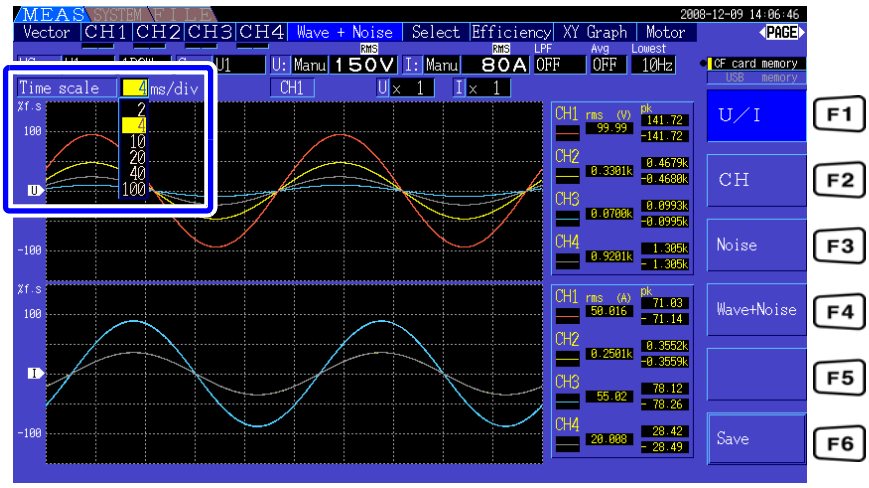
Select [Time scale]

Displays the pull-down menu

Selects from the pull-down menu

See Chart in below.

Enter / ESC 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. 118)

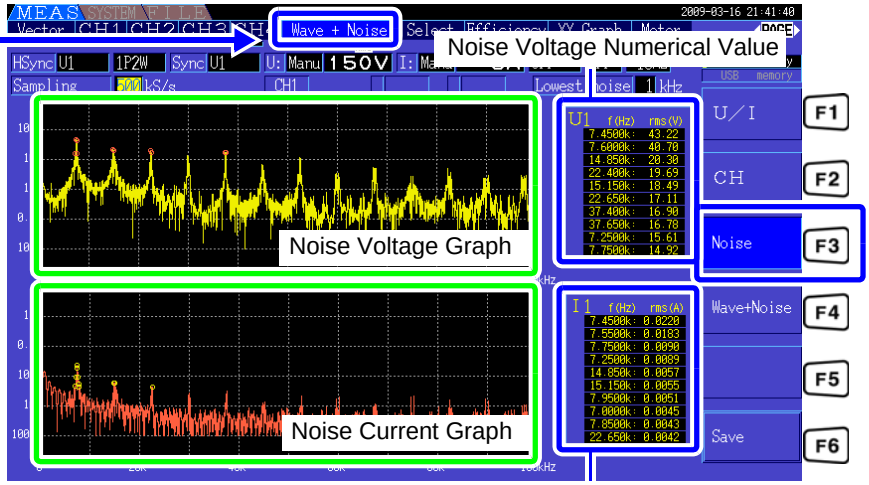
4.6.1 Displaying Noise Voltage and Current

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]

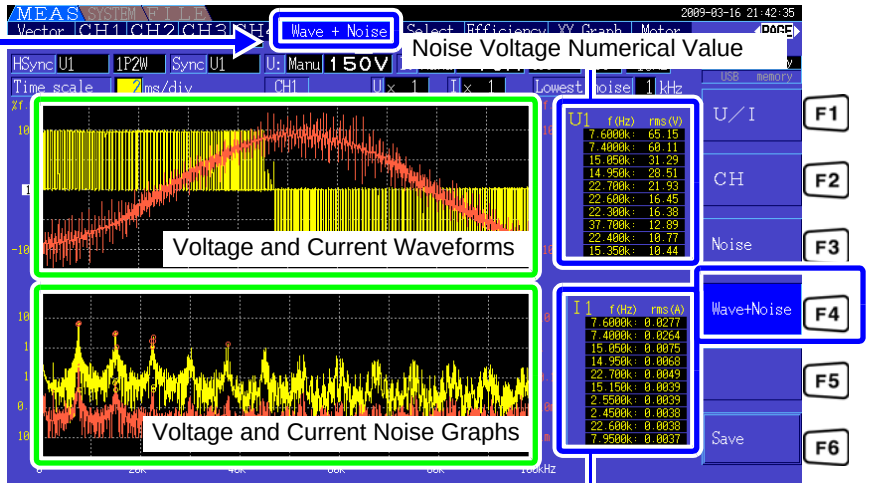


Noise Current Numerical Value

Displaying Waveforms and Noise

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

MEAS → ◀ ▶ Display the [Wave + Noise] page → F4 **Select [Wave + Noise]**



Noise Current Numerical Value

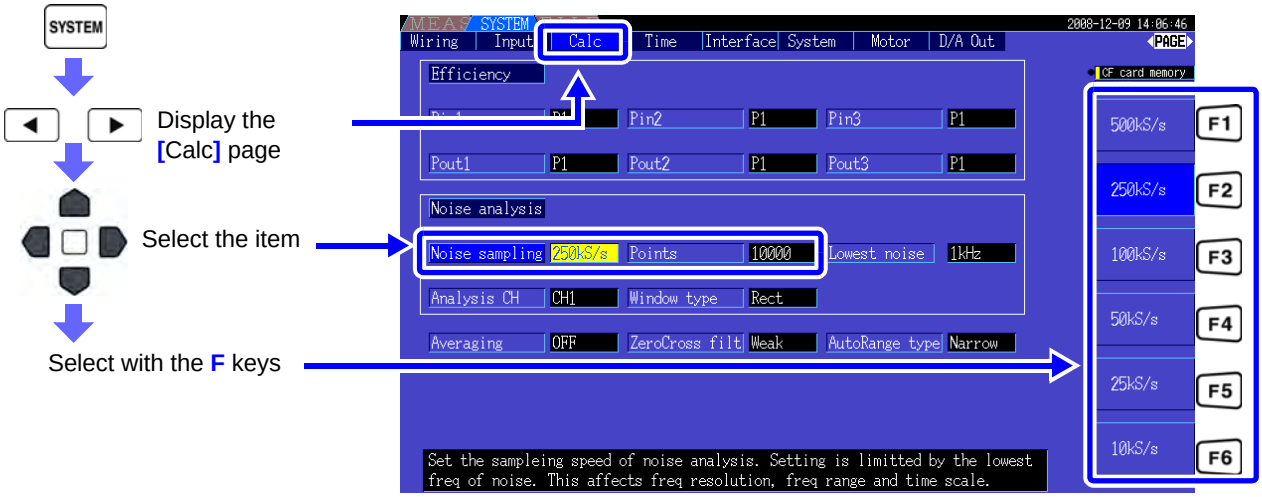
Waveform Colors

Voltage	Yellow
Current	Red

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

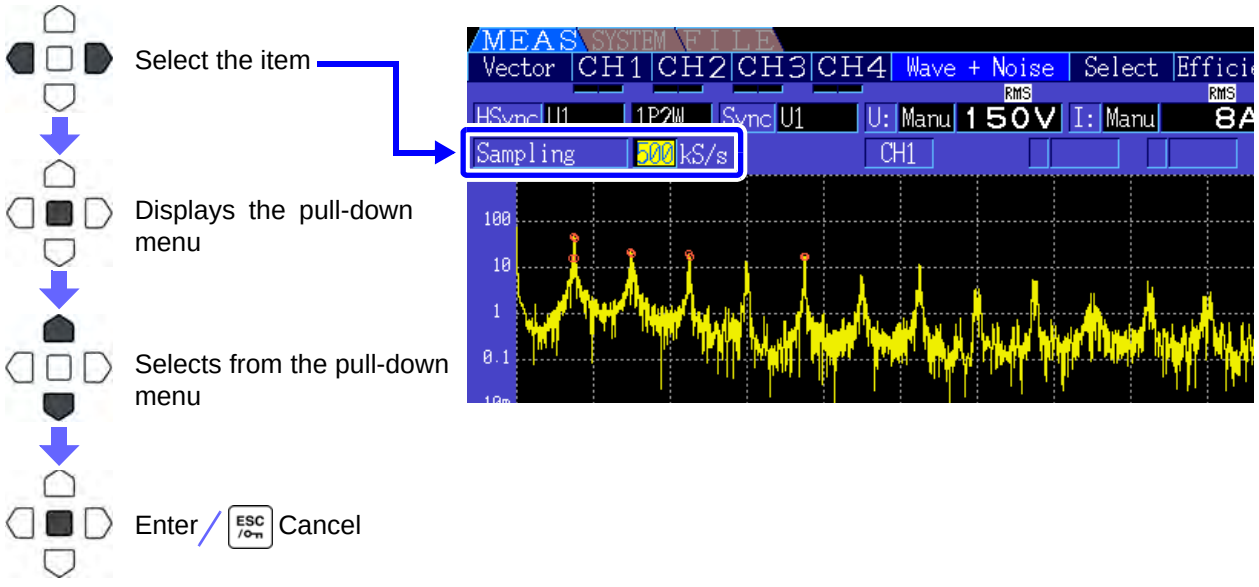
Set the FFT sampling rate and number of points according to the frequency of the noise to be analyzed. These settings are on the [Calc] page of the Setting screen.



Sampling can be selected at the [Noise] setting on the [Wave + Noise] page of the Measurement screen.
See How to display: "Displaying Noise" (p. 73)

Changing Sampling on the Measurement Screen

See Screen display procedure:"Displaying Noise" (p. 73)



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 / Points	500 kS/s	250 kS/s	100 kS/s	50 kS/s	25 kS/s	10 kS/s
1000	500 Hz	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz
5000	100 Hz	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz
10000	50 Hz	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz
50000	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

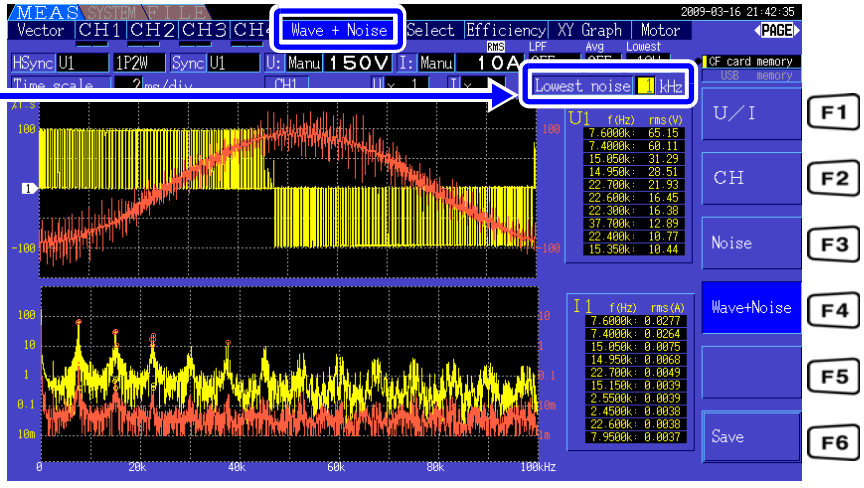
See Screen display procedure:"4.6.1 Displaying Noise Voltage and Current" (p. 73)

Select [Lowest Noise]

Enter

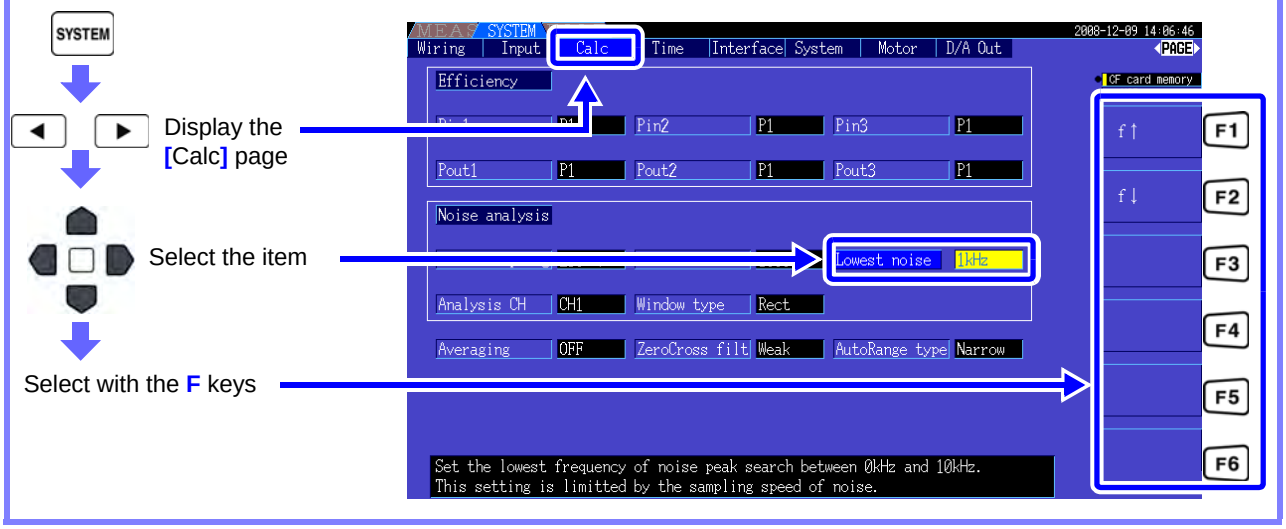
Select the numerical value

Enter / ESC/On Cancel

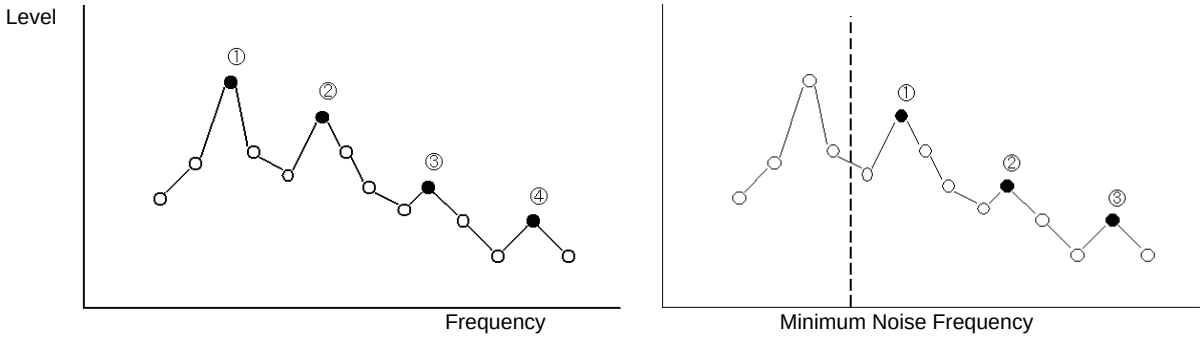


4.6 Viewing Noise Measurement Values (FFT Function)

Settings on the Setting Screen



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.

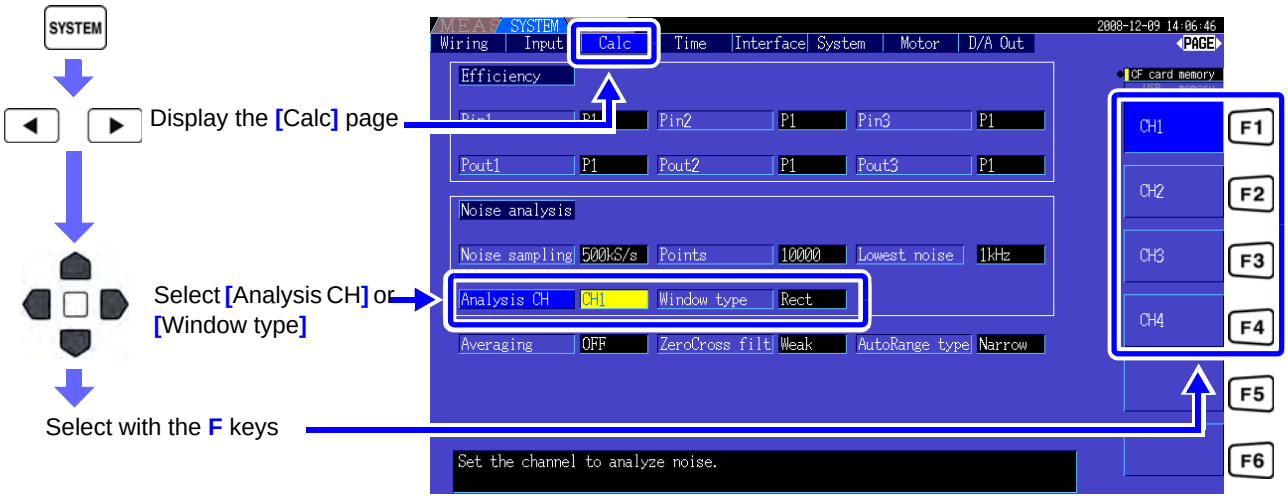


NOTE The range of available settings for the minimum noise frequency depends on the noise sampling rate setting.

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

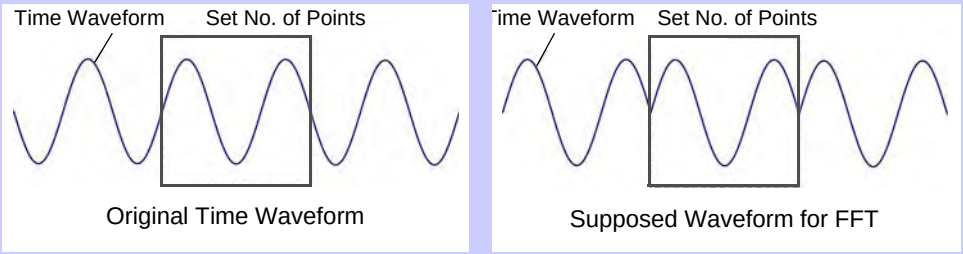
4.6.4 Measurement Channel and Window Function Settings

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

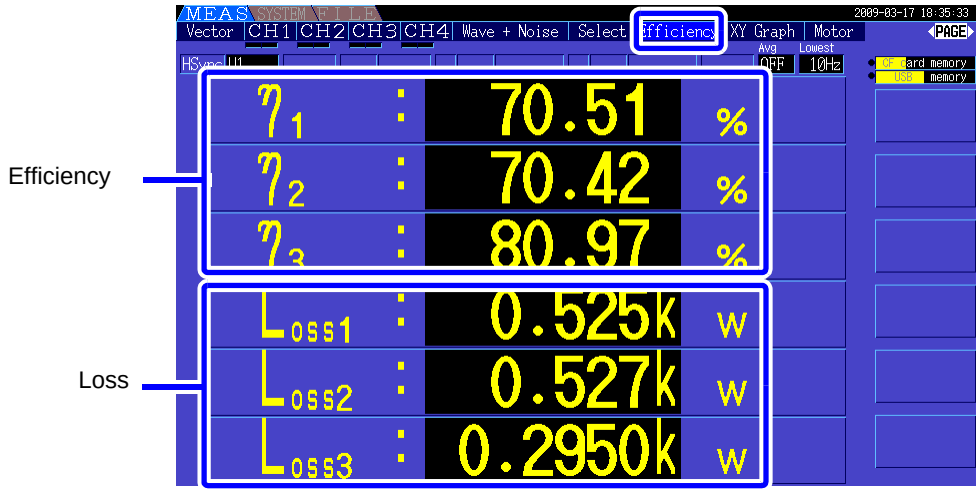
This instrument uses active power and motor power values to calculate and display efficiency (η [%]) and loss [W]. For example, inverter input-output efficiency and internal loss, and motor input-output efficient and loss, as well as total efficiency, can be calculated by a single instrument.

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.
- When either one of the output power is a direct current (DC), making the synchronized source setting for the channel to measure DC the same as the alternating current side can suppress the unevenness of the efficient measurement value. E.g., in the following connection example (p. 80) on "Measuring Efficiency and Loss of a Switching Power Supply" in general the CH1 synchronization source is set to U1, while the CH2 synchronization source is set to 50 msDC, but when the fluctuation is great and there is unevenness in the efficient measurement value, set the CH2 synchronization source to U1 same as CH1.

4.7.1 Displaying Efficiency and Loss

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



NOTE

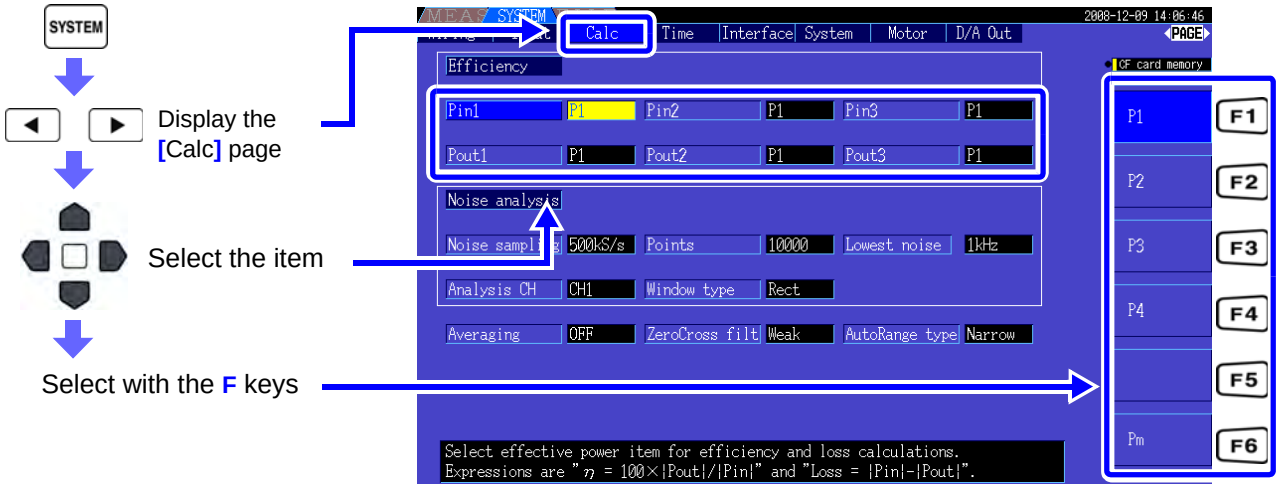
- The display range for Efficiency (η [%]) is 0.00% to 200.00%.
- The display range for Loss [W] is 0 to ±120% of the power range.

4.7.2 Selecting the Calculation Formula

Up to three formulas (η1 to η3, 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

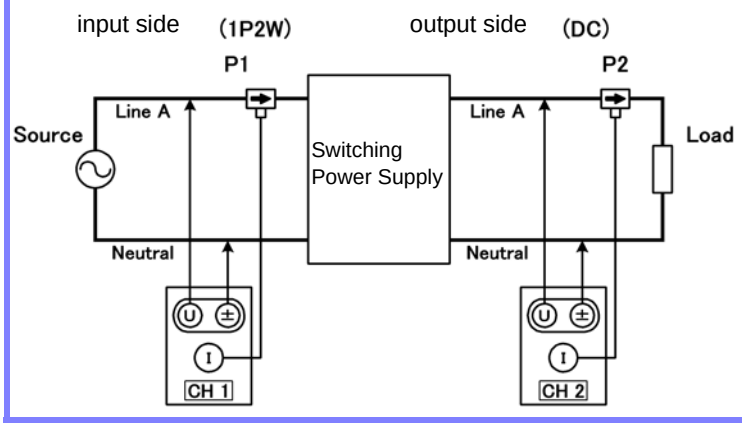
4.7.3 Measurement Examples

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.

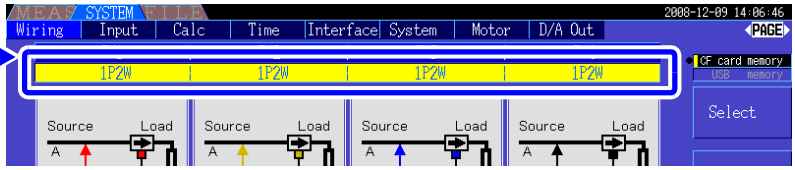
Connection Example



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] × 4 systems

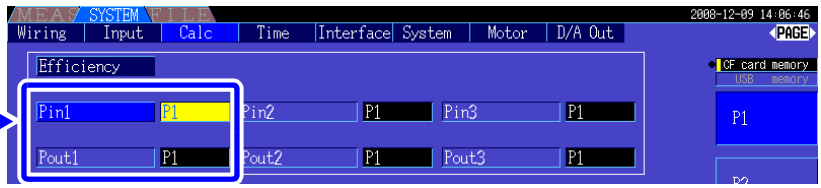


Calculation Formula Setting

Calculation Formula

η1 = 100 × |P2|/|P1|
Loss1 = |P1| - |P2|

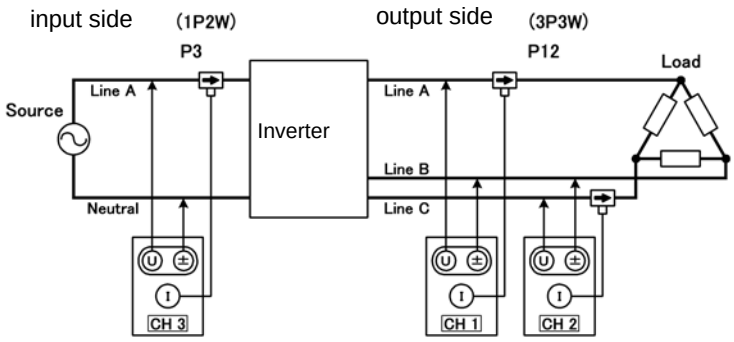
Set Pin1 to P1,
and Pout1 to P2



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.

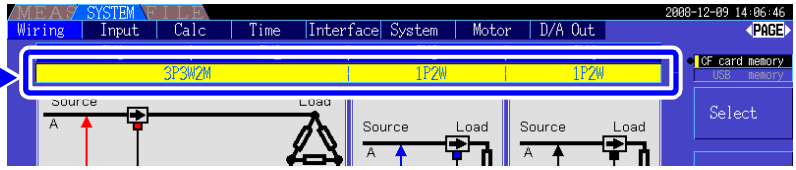
Connection Example



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] × 2 systems

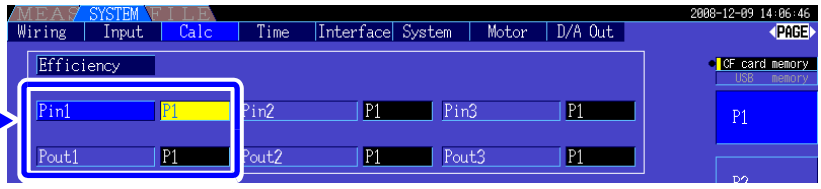


Calculation Formula Setting

Calculation Formula

η1 = 100 × |P12|/|P3|
Loss1 = |P3| - |P12|

Set Pin1 to P3,
and Pout1 to P12



Measuring Efficiency and Loss of an Inverter and Motor

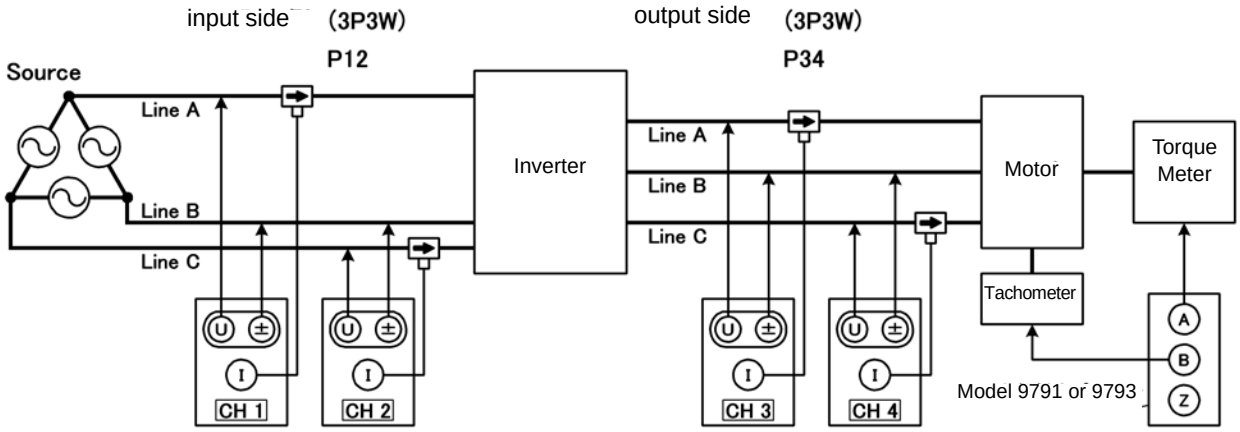
Example. Inverter inputs are connected to CH 1 and CH 2, inverter outputs to CH 3 and CH 4 of the instrument, analog output from the tachometer to rotation signal input CH B, and analog output from the torque meter to torque signal input CH A.

See How to connect torque meter or tachometer: 8.5 (p.142)

Connection Example

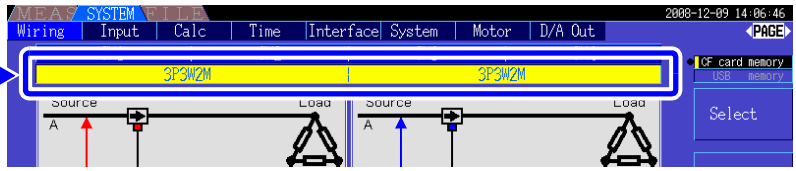
Required items:(Requires Model 9791 Motor Testing Option or 9793 Motor Testing & D/A Output Option)

- 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] × 2 systems

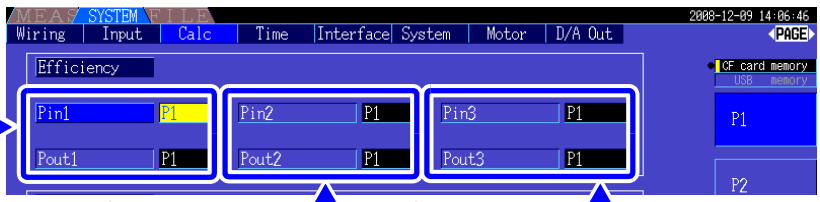


Calculation Formula Setting

Calculation Formula

Inverter η1 = 100 × |P34|/|P12|, Loss1 = |P12| - |P34|
Motor η2 = 100 × |Pm|/|P34|, Loss2 = |P34| - |Pm|
Total η3 = 100 × |Pm|/|P12|, Loss3 = |P12| - |Pm|

Set Pin1 to P12,
and Pout1 to P34



Set Pin2 to P34,
and Pout2 to Pm

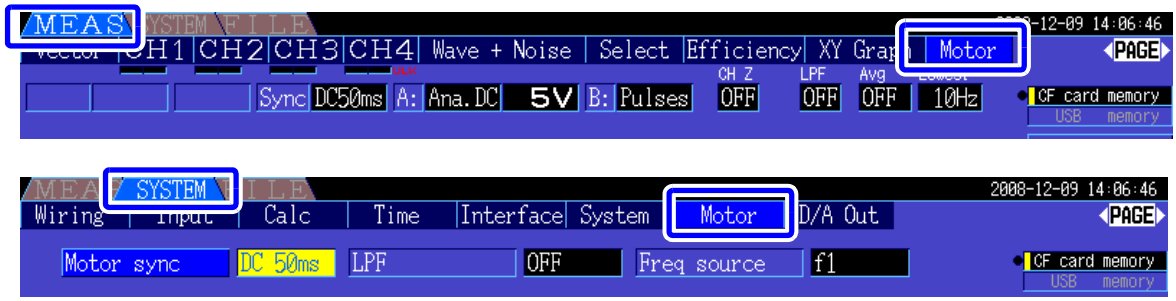
Set Pin3 to P12,
and Pout3 to Pm

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.

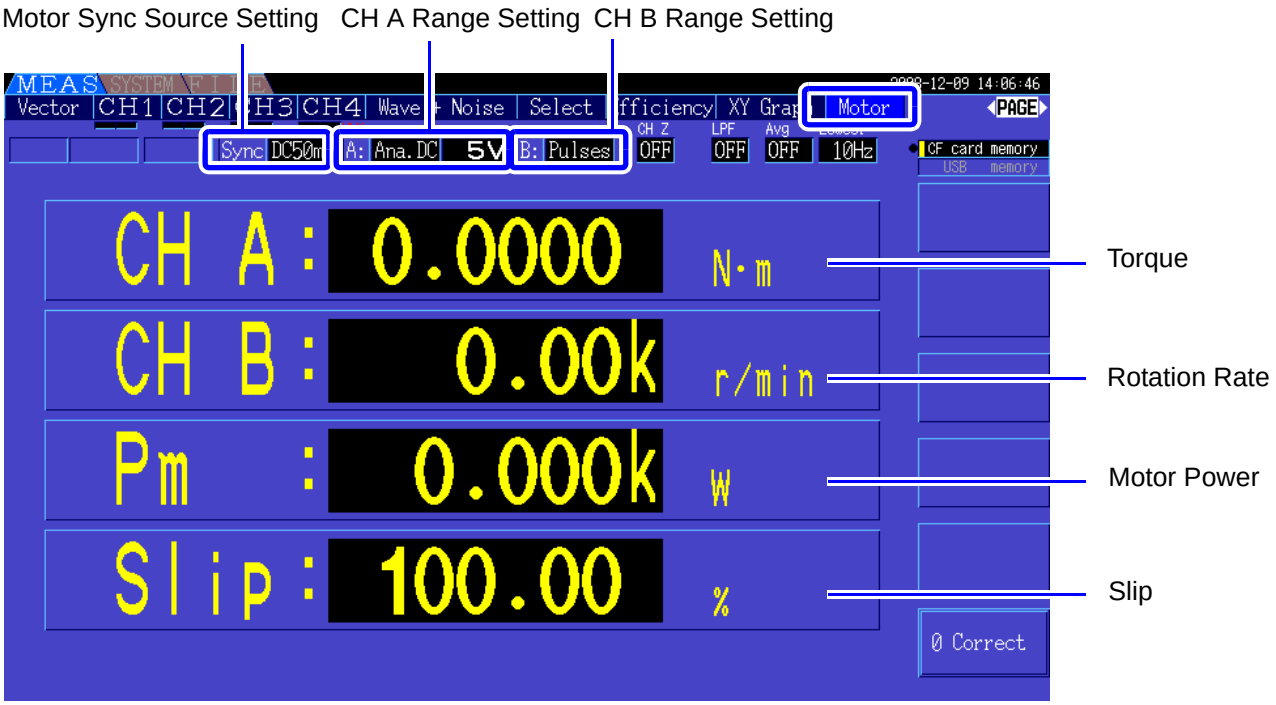
When the motor analysis function is installed, the **[Motor]** page appears on the Measurement and Setting screens.



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. 78) functions.

Setting the Motor Sync Source

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



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

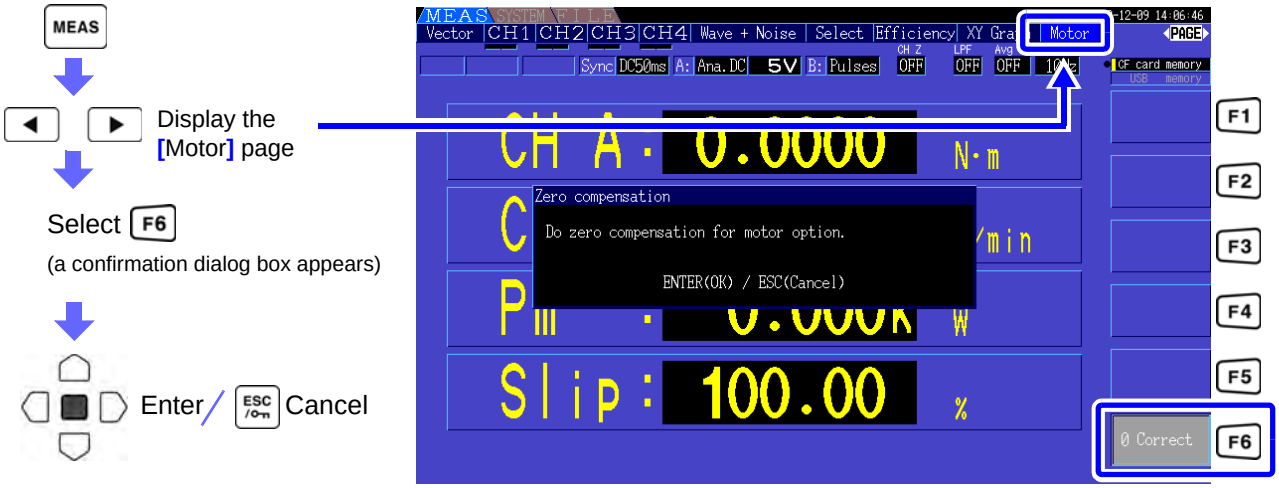
- When **[CH A]** measurement units are set to **[V]** and **[Hz]**, or **[CH B]** units are set to other than **[r/min]**, motor power **[Pm]** display is always disabled ("OFF").
- When **[CH B]** measurement units are set to **[V]**, slip cannot be calculated, and **[- - - - - -]** is displayed.

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.



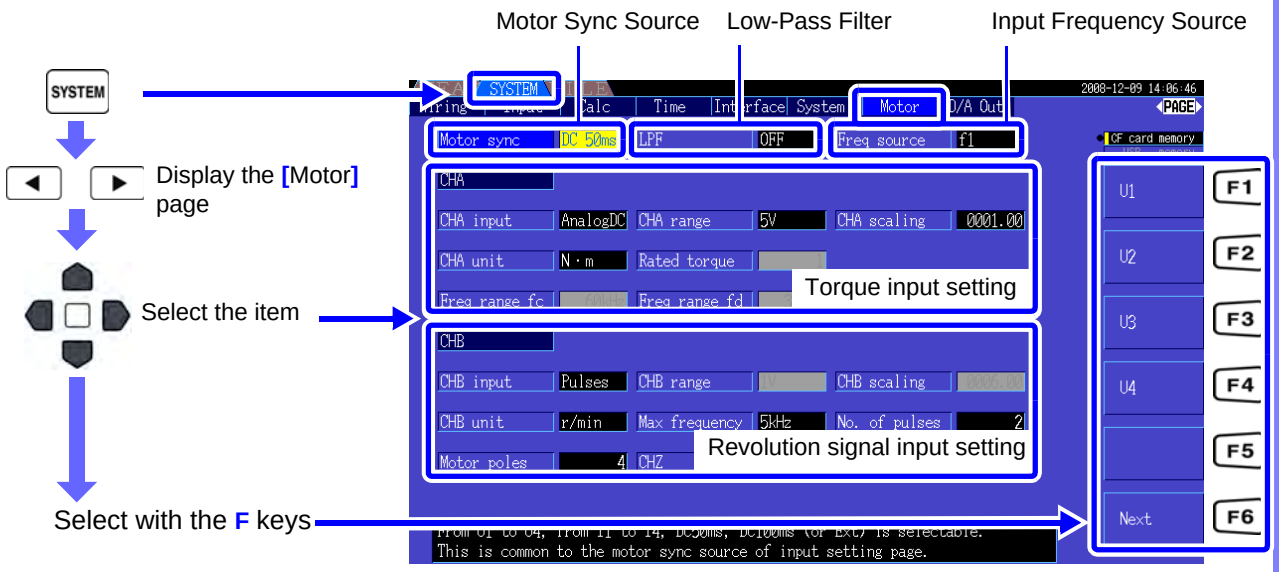
NOTE

- 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 ±10% of the full-scale range, outside of which no adjustment occurs.

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. 142)

Basic Operating Procedure



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. 78), 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.

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

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

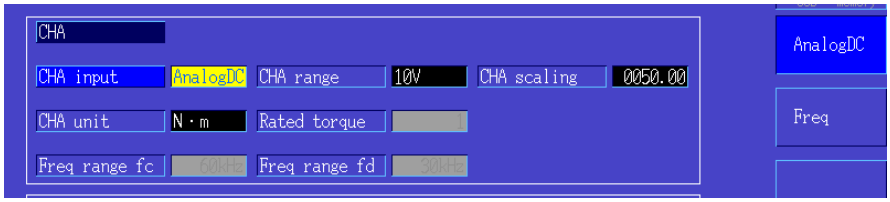
AnalogDC	When the sensor outputs a DC voltage proportional to the torque
Freq	When the sensor outputs a frequency proportional to the torque

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.

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.

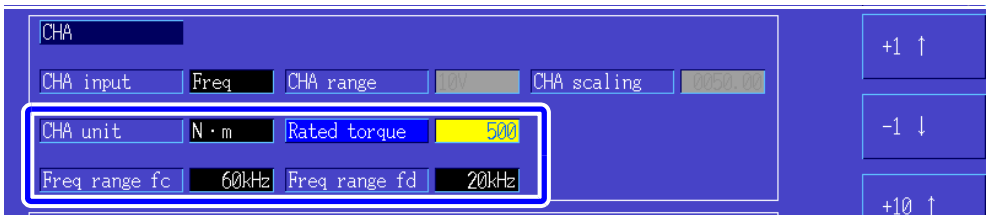
NOTE When CH A units are set to [V], motor power [Pm] is not displayed.

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

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

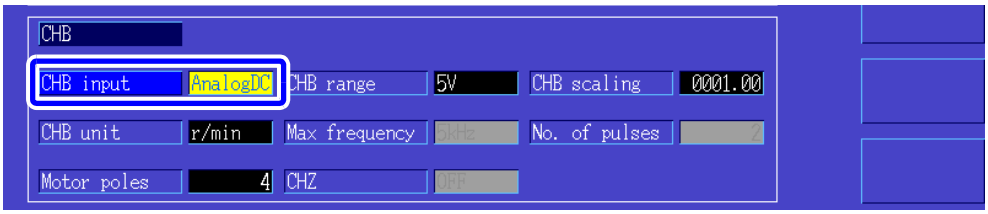
CHB input

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.

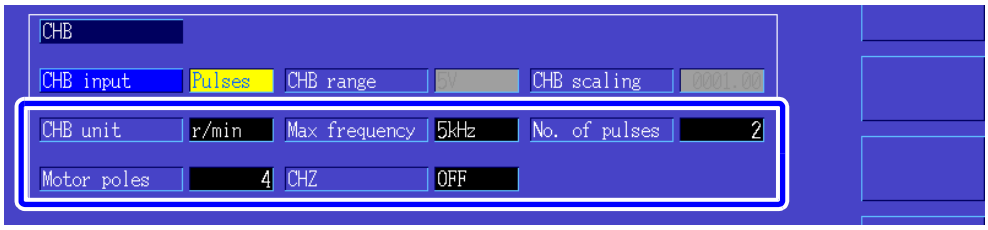
CHB unit Always select r/min when measuring motor power (Pm).

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. 89)

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.
For the digits displayed for rotation and motor power, the value calculated under the frequency set here is determined as full-scale.
Select a higher value closest to the maximum value of the voltage frequency inputted in the motor.
E.g., when a maximum voltage of 133 Hz inputs in the motor, select 500 Hz.
(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

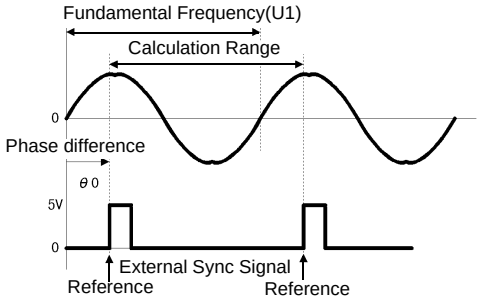
- The motor pole setting is enabled by pressing F5 (Set). Be sure to press F5 (Set) after changing the setting.
- When using pulse synchronization with an electrical angle (motor input voltage, or the same frequency as the current frequency), set the number of motor poles at CH B input to 2.

CH Z Input Select the signal to input in CH Z

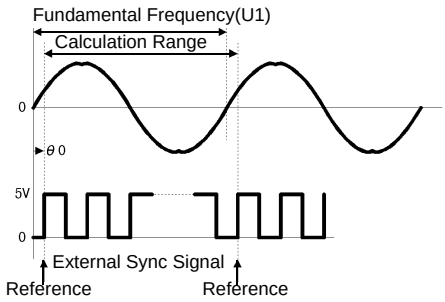
OFF	Ignore CH Z (no connection to CH Z jack).
Z Phase	Select this when inputting the original signal (generally known as Z Phase) pulse of the rotating angle. Used in [4.8.2 Measuring Motor Electrical Angle] and zero-clear the pulse counts of the CHB with this pulse when using multiple pulses of the CHB.
B Phase	Select this when inputting the B Phase pulse of the rotary encoder. Used in [4.8.3 Detecting the Motor Rotation Direction]

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.



Single Pulses



Multiple Pulses

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.

Phase Zero Adjustment (PHASE ADJ)

Press SHIFT and then 0 ADJ 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 SHIFT and then DATA RESET 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

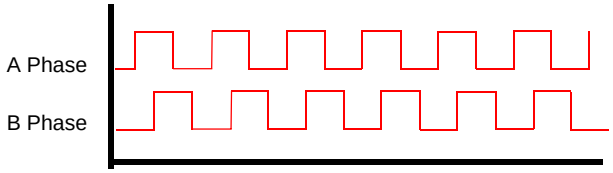
Phase difference is affected by the rotation input signal pulse waveform and the instrument's internal circuit delay, which cause measurement errors when measuring frequencies much different from that at which phase zero adjustment was performed.

4.8.3 Detecting the Motor Rotation Direction

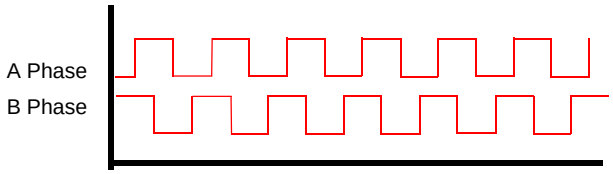
When the A phase pulse and the B phase pulse of the incremental-type rotary encoder are input in the CH B and CH Z rotation signal input jacks, the rotation direction of the axis can be detected and polar code can be assigned to the number of rotations.
This function is added as software version after Ver1.09.

When the setting [B Phase] for CH Z input is selected, the rotation direction is detected.
Rotation direction is determined by another directional level (High/Low) in the detection timing of rise/fall of A Phase pulse and B Phase pulse.

Normal rotation
Polar code for number of rotation is +



Counter rotation
Polar code for number of rotation is -



The rotation direction detected is assigned as a polar code to the measurement value of the number of rotations, and also reflected in the motor power [Pm] measurement value.

NOTE Rotation direction detection and acquisition of original signal (Z Phase pulse) cannot be performed simultaneously.
Use the original signal (Z Phase pulse) when measuring the motor electrical angle using multiple pulses.

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. 114)

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. 105).
- 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 DATA RESET to reset integration and clear the STOP indicator.
- Even when a timing control function is enabled, you must press START /STOP 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 DATA RESET 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. 116) 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 START /STOP interrupts integration but retains the integration value. In this case, pressing START /STOP 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]**.

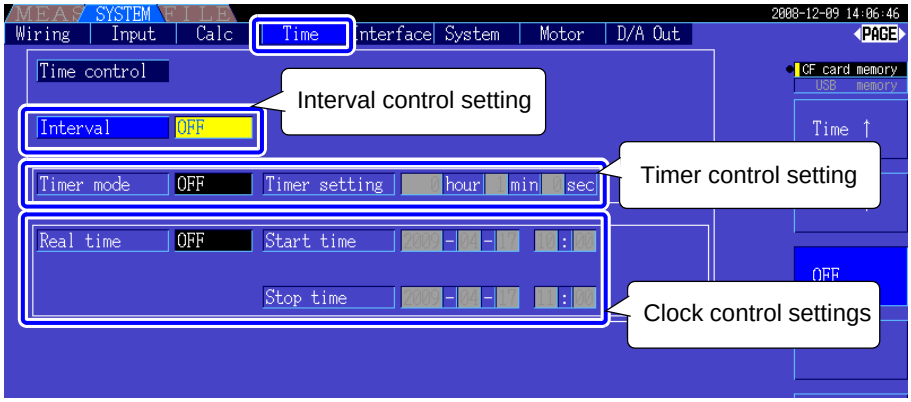
See the graph in "4.3.4 Integration Combined with Timing Control" (p. 59) for integration operations.

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 and motor sync source.

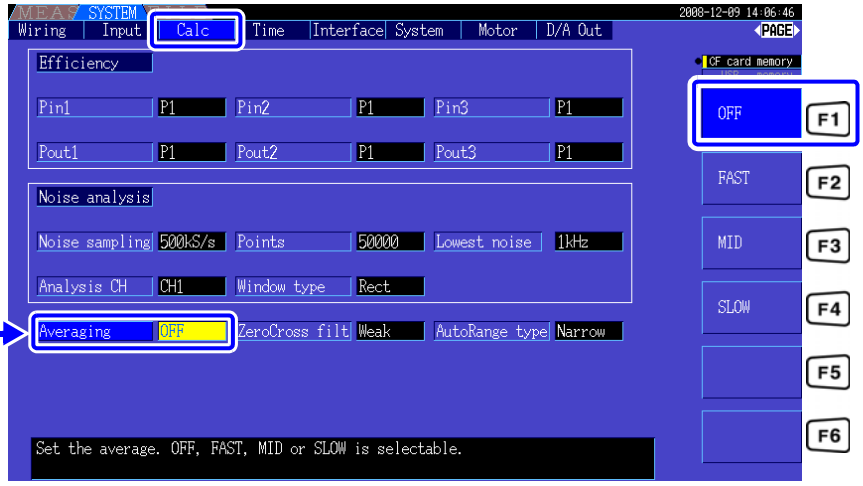
NOTE
- Peak, integration, and FFT peak values are excluded.
- When averaging is enabled, averaging is applied to all data being saved.

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

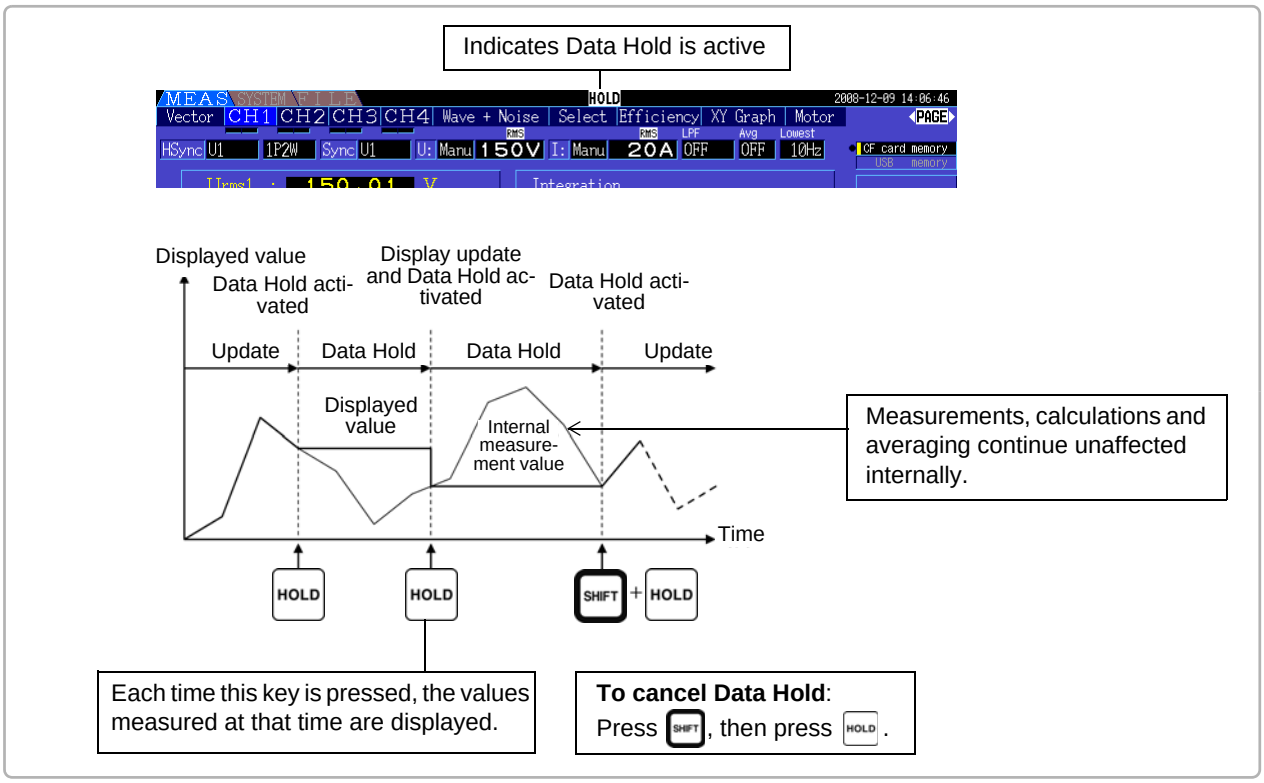
- Index averaging (applicable to 50 ms data update rate)
- Averaging is applied to voltage (U), current (I), and power (P), before performing calculations.
- For the harmonics, RMS values and percentage are calculated in average to instantaneous values, and the phase angle is calculated in average of 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.

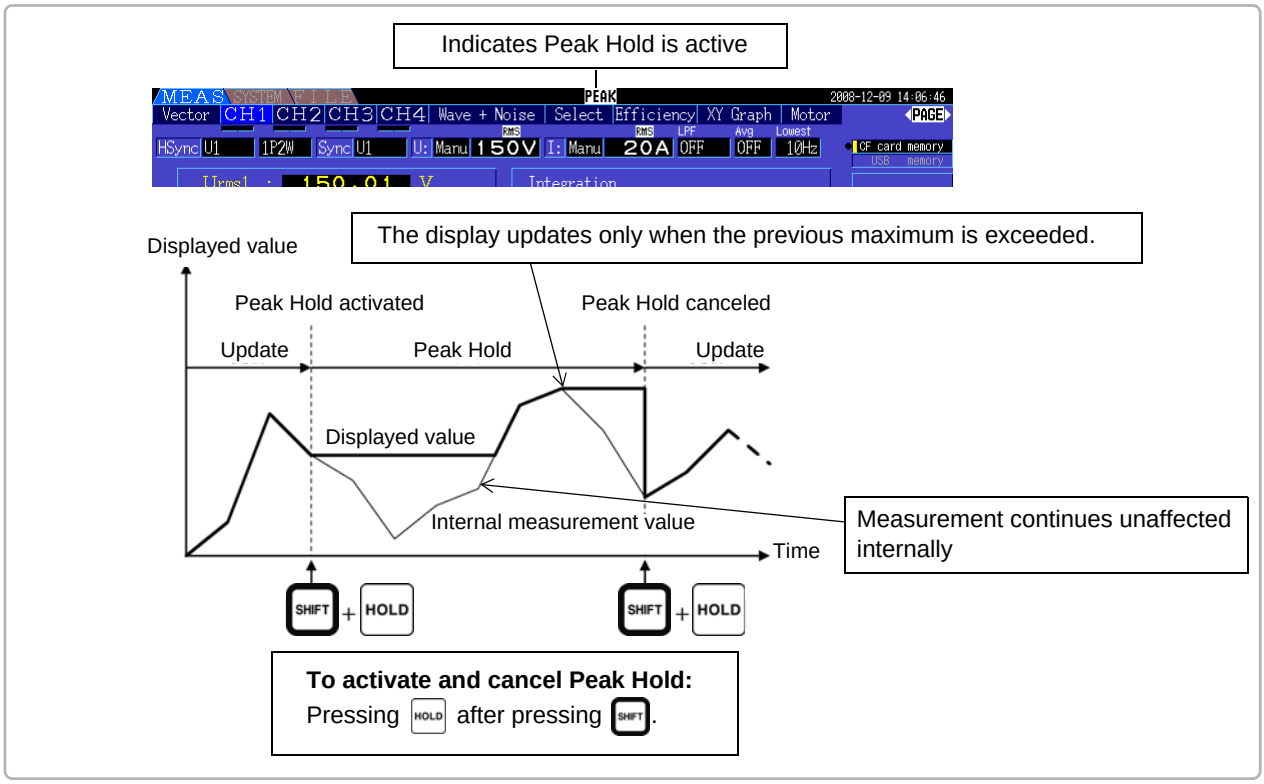
NOTE

- 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.

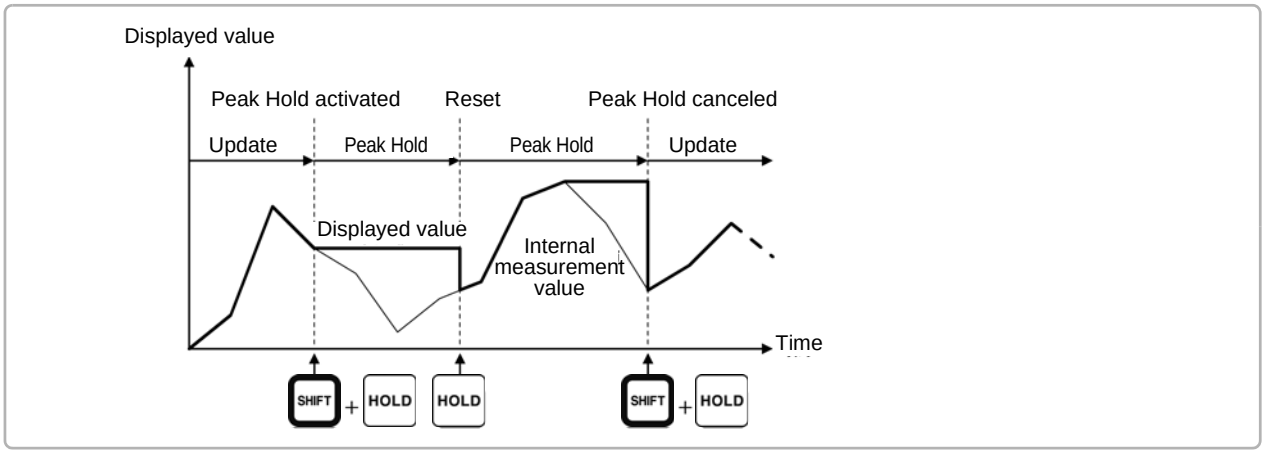
5.3.2 Peak Hold Function

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

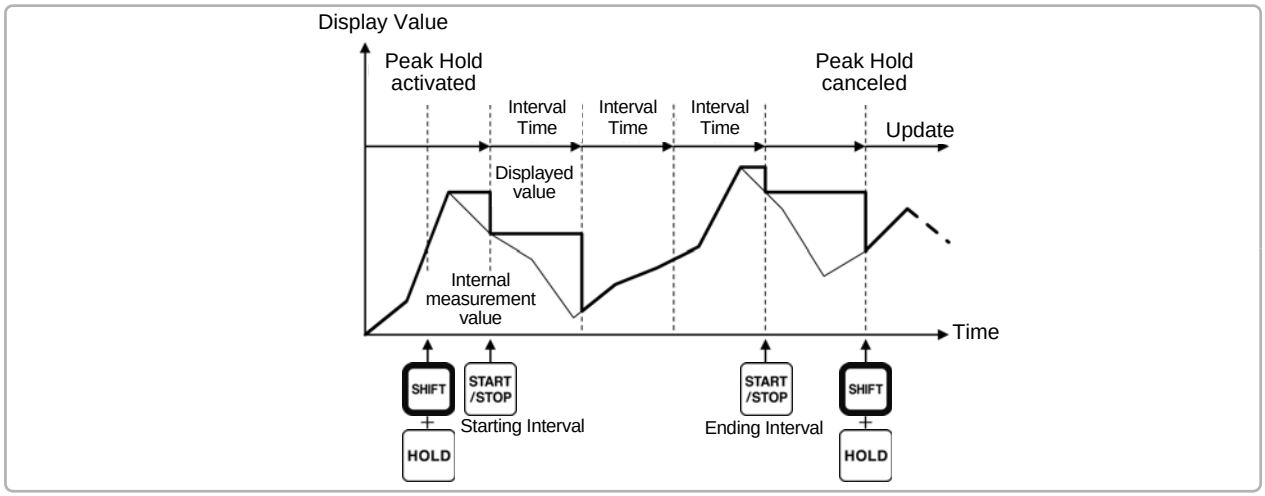
When the display is HOLD, the HOLD value is keep on outputting for the D/A output, CF card save and communication. However, the waveform output continues to output the instantaneous data regardless to the HOLD status.

NOTE

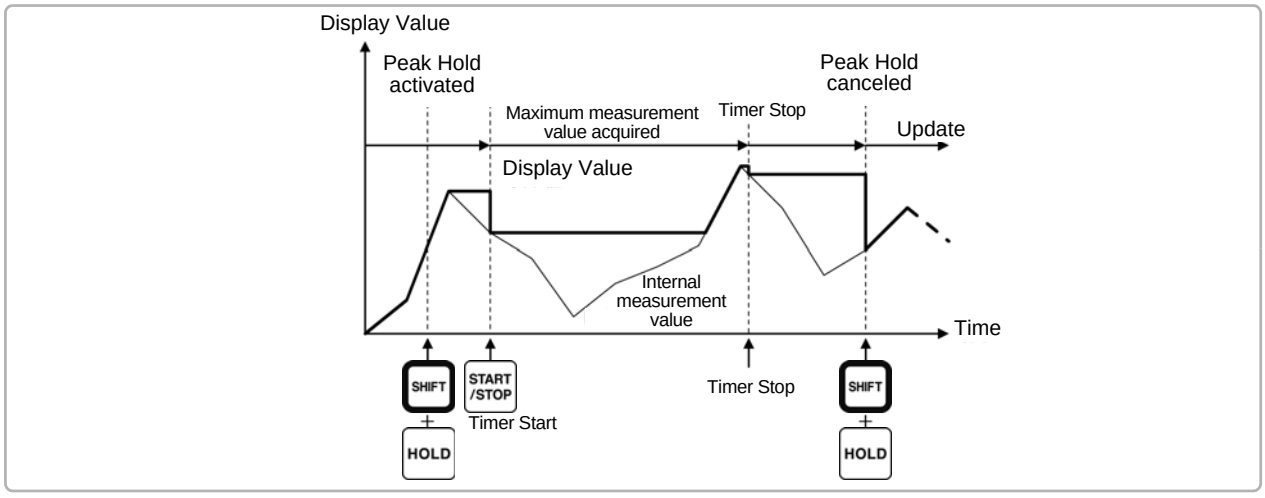
- Waveform displays and integration values are unaffected by Peak Hold.
- When averaging is enabled, the maximum value is recognized only after measured values have been averaged.
- Data Hold and Peak Hold functions cannot be activated simultaneously.
- The display shows **[- - - - - -]** for over-range 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. 93) for details about settings for the interval, timer and clock timing controls.

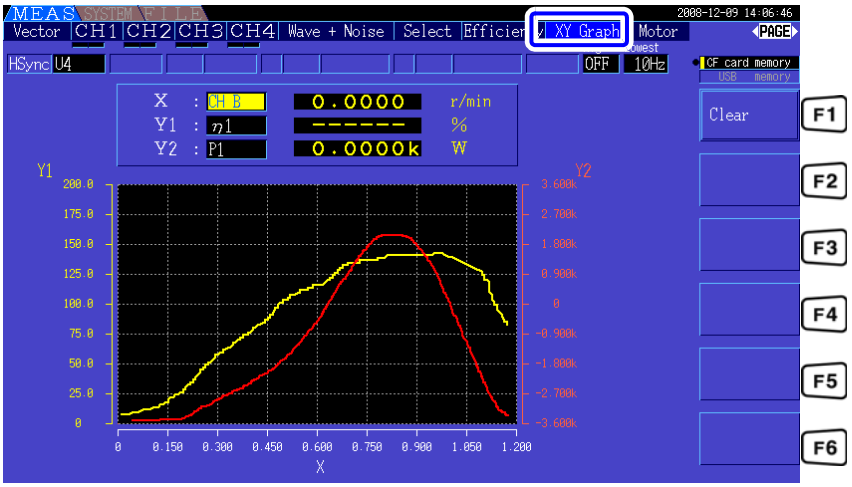
5.4 X-Y Plot Function

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

Move the highlight cursor the display item (parameter) to change.

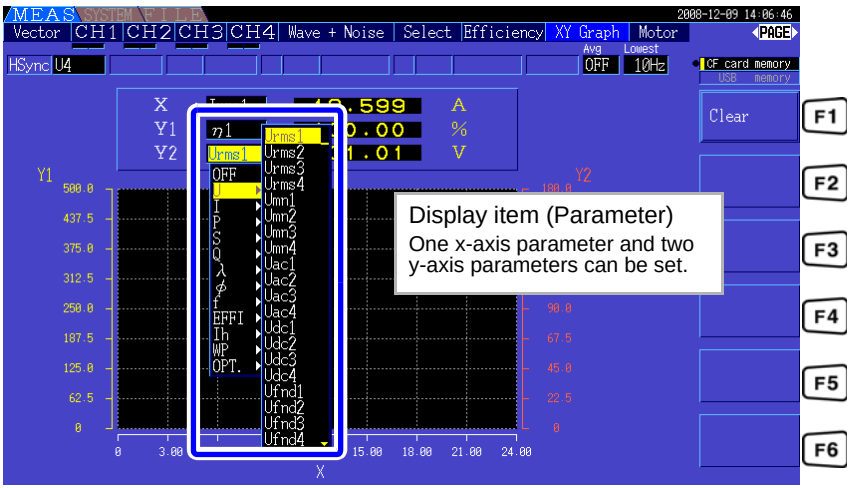
Enter

(Displays the pull-down menu)

Select a parameter for display.

Enter / ESC /On Cancel

Displayed data is cleared, and plotting restarts.



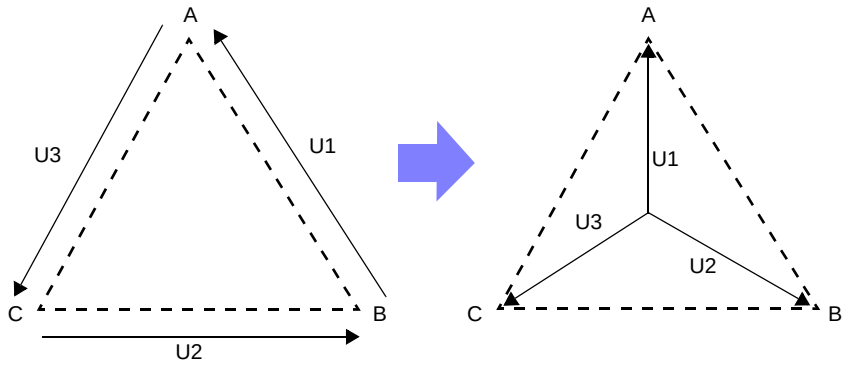
5.5 Δ-YConversion Function

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.

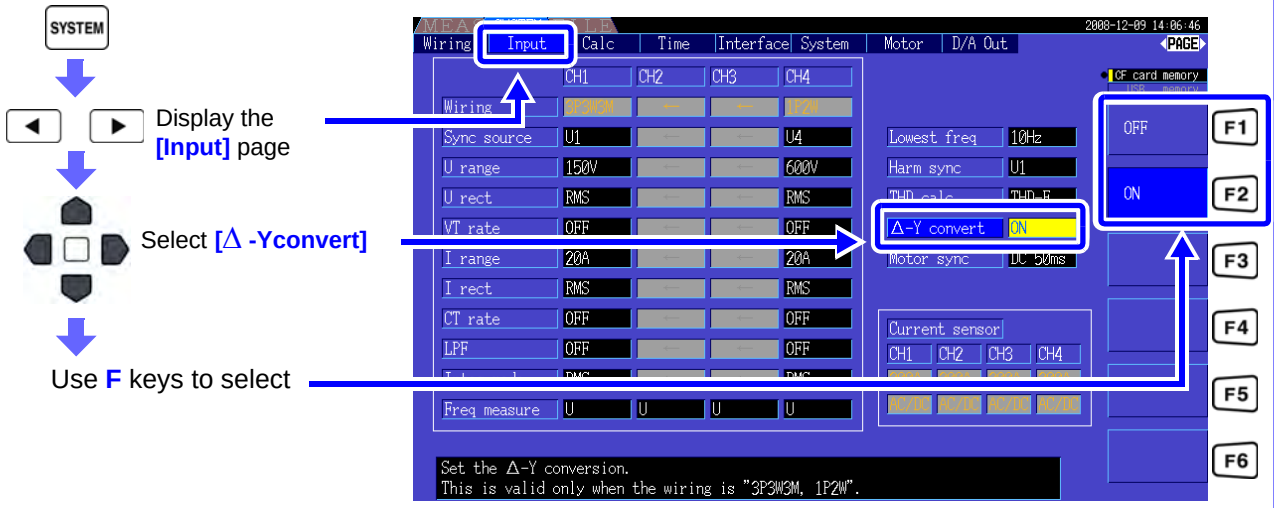
When this function is enabled, even when a motor has internal Wye wiring and the central (neutral) point is inaccessible, it can be measured using phase voltage to emulate the Wye configuration.

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



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)

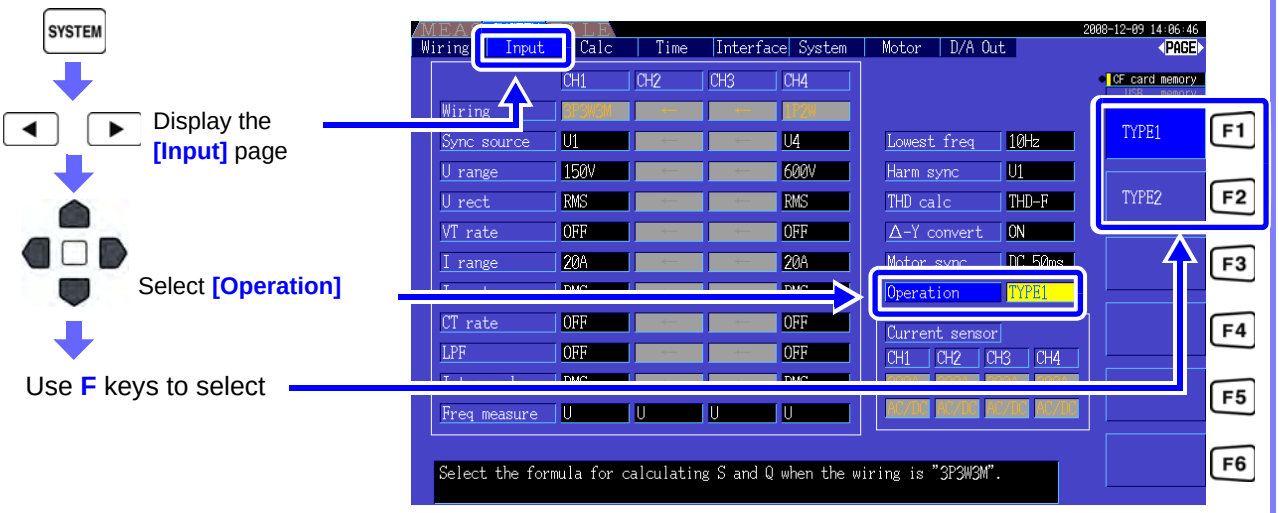
5.6 Selecting the Calculation Method

A function to change the calculation methods of apparent power and reactive power when the wiring is 3P3W3M (refer to [Wiring Mode 7. 3-phase, 3-wire (3P3W3M) + single-phase, 2-wire (1P2W)](p. 33). When measuring the PWM waveform using the setting for rectification method "MEAN", it can improve the mutual compatibility with measurement values of other wattmeter.
This function is added as software version after Ver1.09.

There are two types of settings, TYPE1 and TYPE2, and both are only valid during 3P3W3M wiring.

TYPE 1	3P3W3M calculation method for 3390 Standard until Ver1.08.
TYPE 2	Calculation method to improve the mutual compatibility with 3V3A wiring of other power meter. Under sine wave input, there is no difference from the calculation results of TYPE1, but when the PWM waveform is measured using the setting for rectification method "MEAN", the values of S123, Q123, ϕ 123, and λ 123 is closer to the power meter for 3V3A wiring than TYPE1.

Setting Procedure



NOTE

- Use TYPE1 for general use. Use TYPE2 when mutual compatibility is necessary, such as when changing from the device currently in use.
- All measurement values are not affected except for values of S123, Q123, ϕ 123, and λ 123.
- When the Δ-Y conversion function is ON, there is no difference between the calculation results of TYPE1 and TYPE2 even with PWM waveform.

5.6 Selecting the Calculation Method

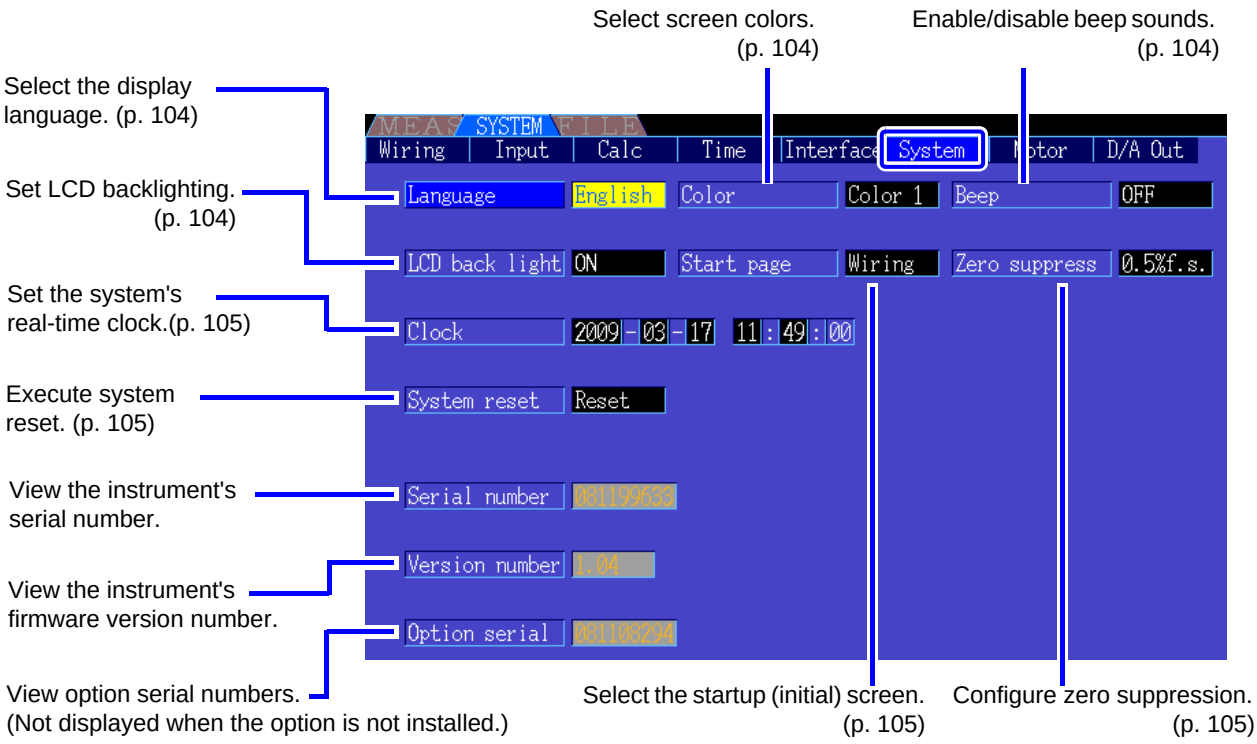
Changing System Settings

Chapter 6

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

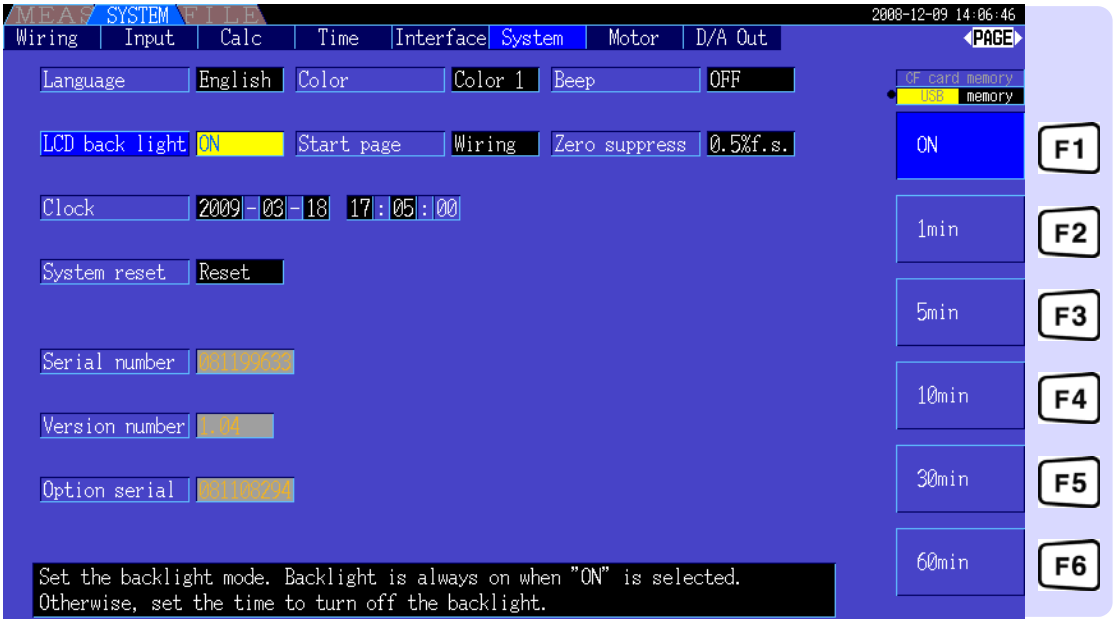
[System] Page Display

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



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.

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).

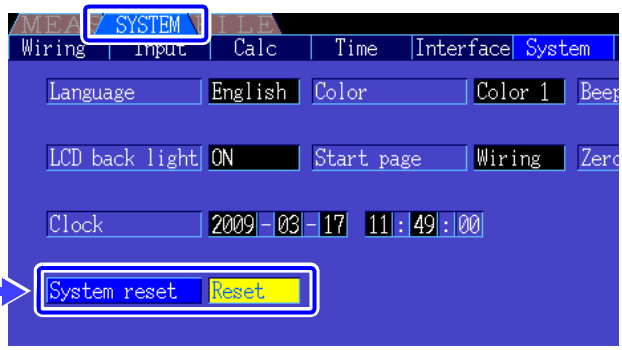
6.1 Initializing the Instrument (System Reset)

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. 106)

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

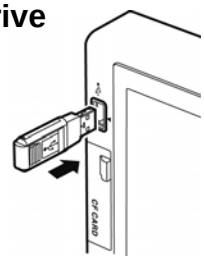
* Items not initialized by System Reset (initialized only by Power-On Reset, p.105).

NOTE Settings for measurement display and recording data are also initialized.

Data Saving and File Operations Chapter 7

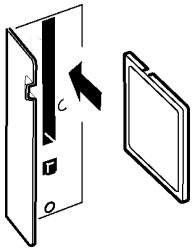
The instrument supports saving of setting configurations, measurement data, waveform data, and screen images to CF card or USB flash drive (only setting configurations can be reloaded).

USB Flash Drive

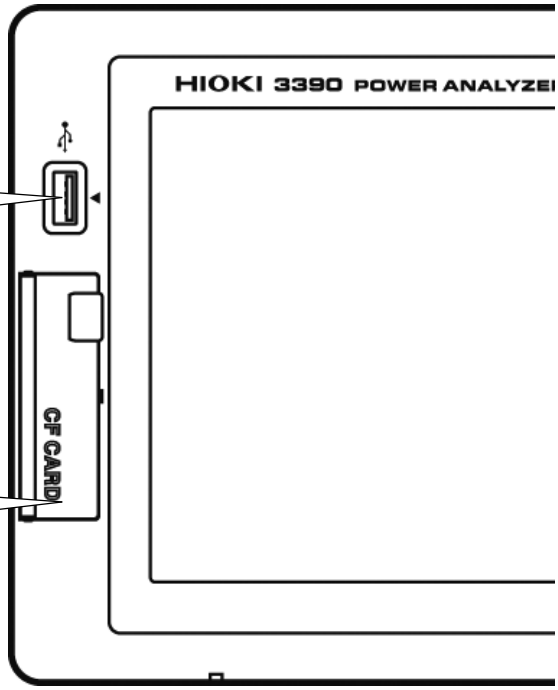


Connector	USB type A
Electrical specification	USB2.0
Power supply	500 mA maximum
No. of ports	1
Compatible USB device	USB Mass Storage Class

CF Card



Slot	TYPE1 × 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 ×: not supported

Storable Content	CF card	USB flash drive	See
Manual save measurement data	•	•	(p. 112)
Auto-save measurement data	•	×	(p. 114)
Save waveforms	•	•	(p. 118)
Save screen image	•	•	(p. 118)
Save setting configuration	•	•	(p. 119)
Load setting configuration	•	•	(p. 119)
Copy files and folders	•	•	(p. 122)

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.

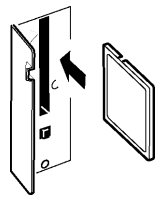
  Hioki options
  PC cards (CF card + adapter)
  9726 PC CARD 128M
  9727 PC CARD 256M
  9728 PC CARD 512M
  9729 PC CARD 1G
  9830 PC CARD 2G
  (adapter is not used with this Analyzer)

- Format new CF cards before use.
  See"7.3 CF Card Formatting" (p. 110)

7.1 Inserting and Removing Storage Media

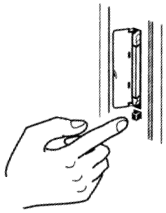
Insert and remove CF cards and USB flash drives as follows.

CF card



To insert a CF card

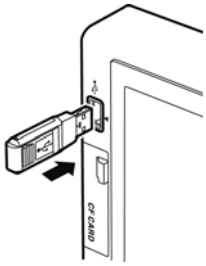
Open the CF card slot cover, and with the ▲ mark pointing toward the screen, insert the card in the direction shown by the arrow as far as it will go.



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

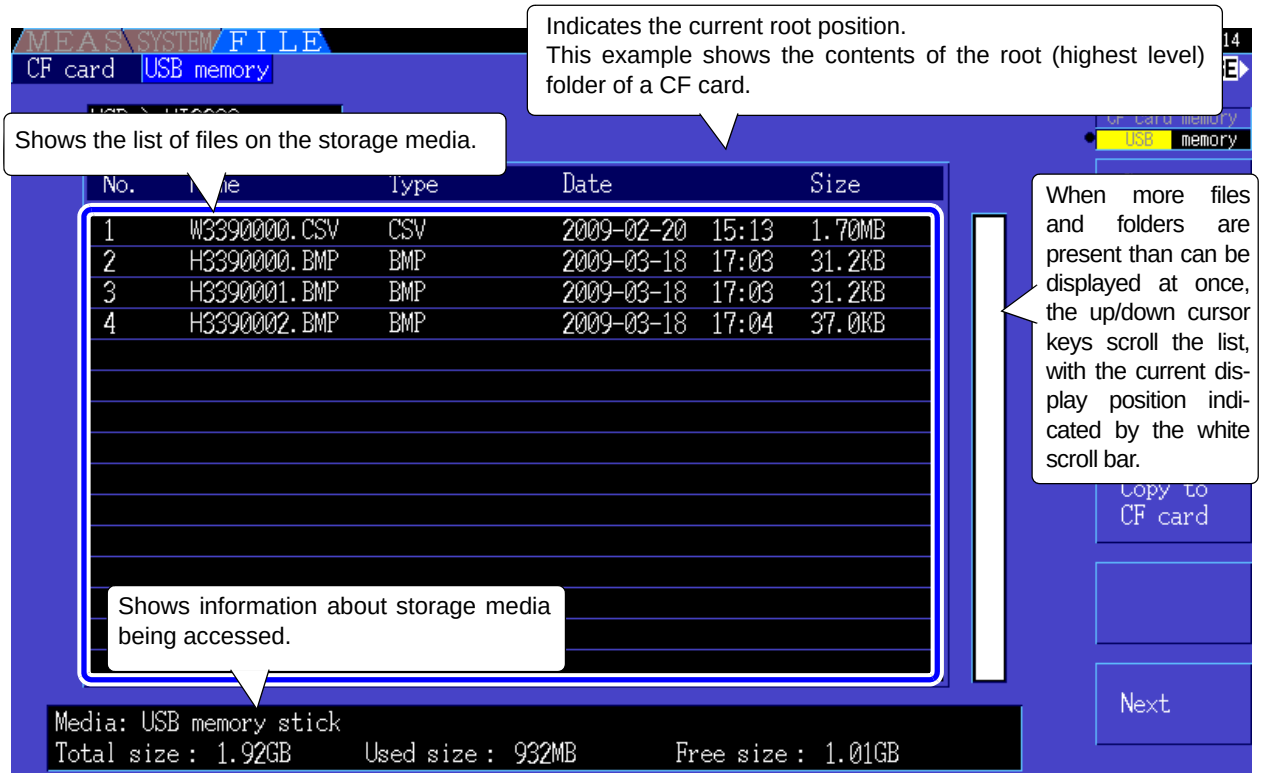
- Hioki cannot recover data from damaged or faulty storage media resulting from abnormalities. We are also unable to provide compensation for such data loss, regardless of the contents or cause of the failure or damage. We recommend making backups of all important data.
- Avoid forcing insertion of storage 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
xxxxxxxx.SET	SET	Setting configuration data
xxxxxxxx	Folder →	Folder (no extension)
xxxxxxxx	???	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. 108), and start formatting.

Formatting procedure

FILE

◀ ▶ Display the **[CF cord]** page

F6

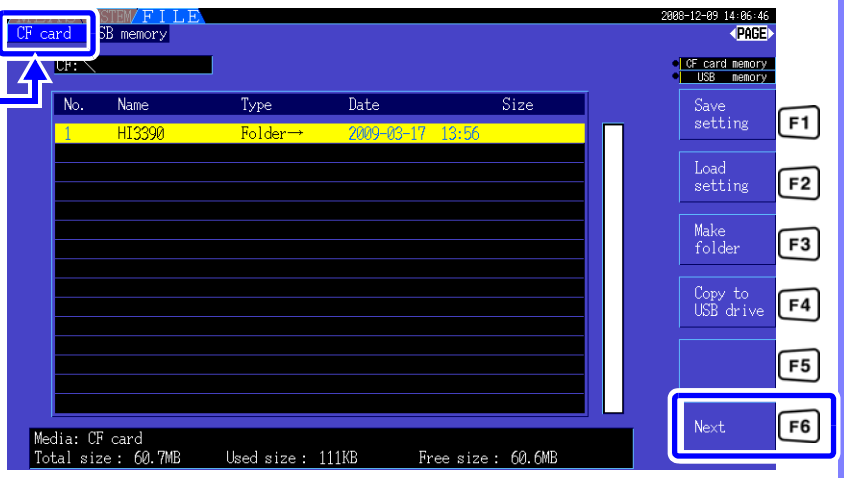
F3

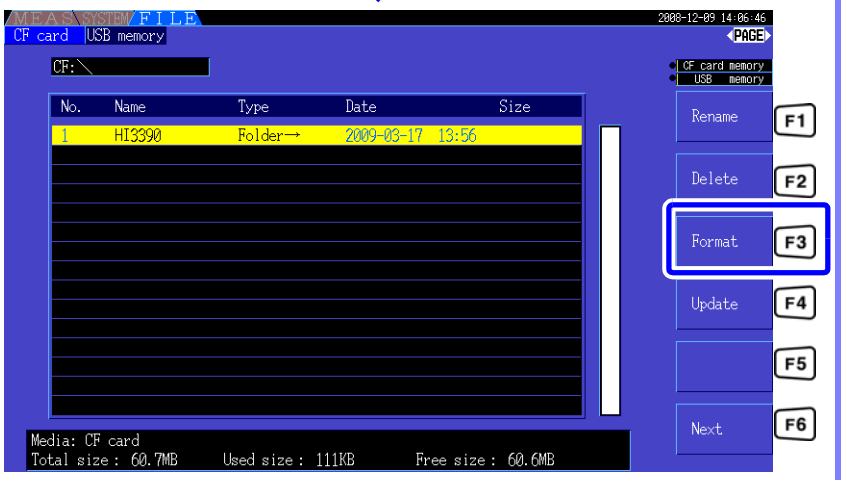
(The format confirmation dialog appears.)

To execute: ENTER

To cancel: ESC

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





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

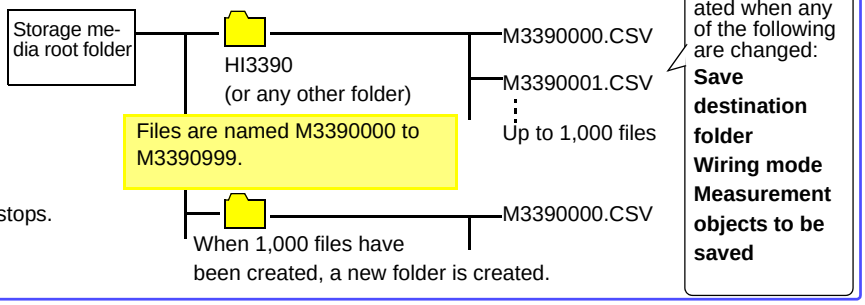
This key is not used other than when upgrading the firmware.

7.4 Saving Operations

Manual Saving (p. 112)

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

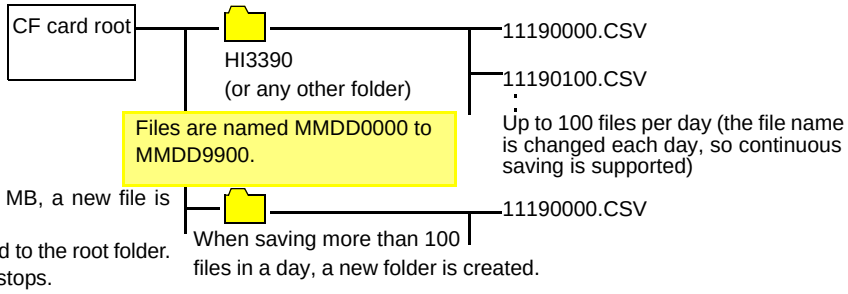
- When the storage media is full, saving stops.



Auto-saving (p. 114)

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

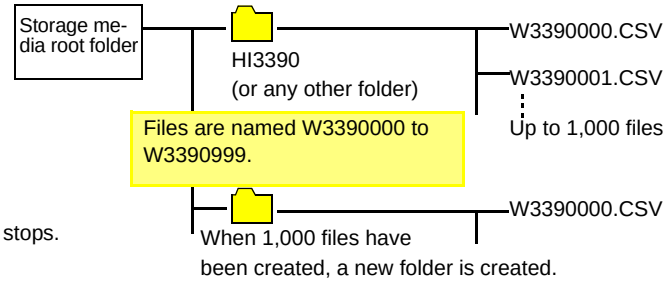
- When an auto-saved file exceeds 100 MB, a new file is created and saving continues.
- Up to 100 files per day can also be saved to the root folder.
- When the storage media is full, saving stops.



Waveform Data Saving (p. 118)

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

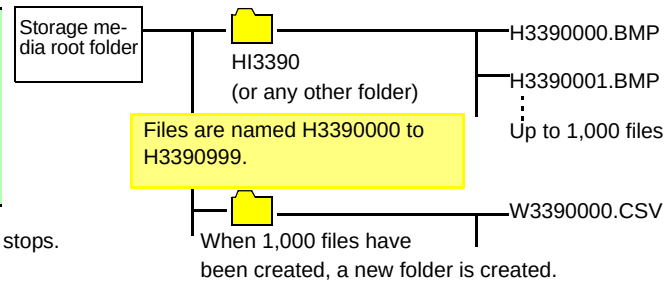
- When the storage media is full, saving stops.



Screen Capture Image Saving (p. 118)

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

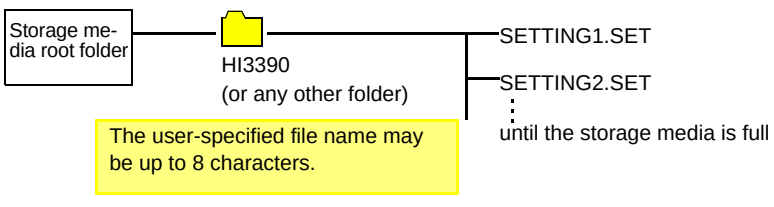
- When the storage media is full, saving stops.



Saving Setting Configurations (p. 119)

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.

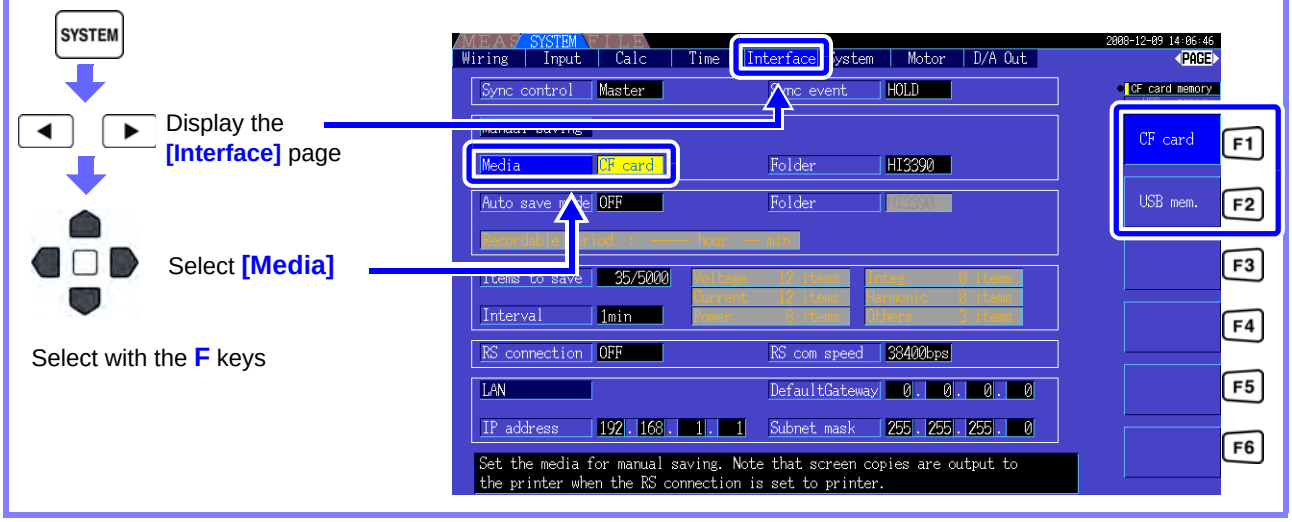
Saving Procedure

1. Select the measurement items to save.
   (Refer to 7.5.3 (p.116))
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



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

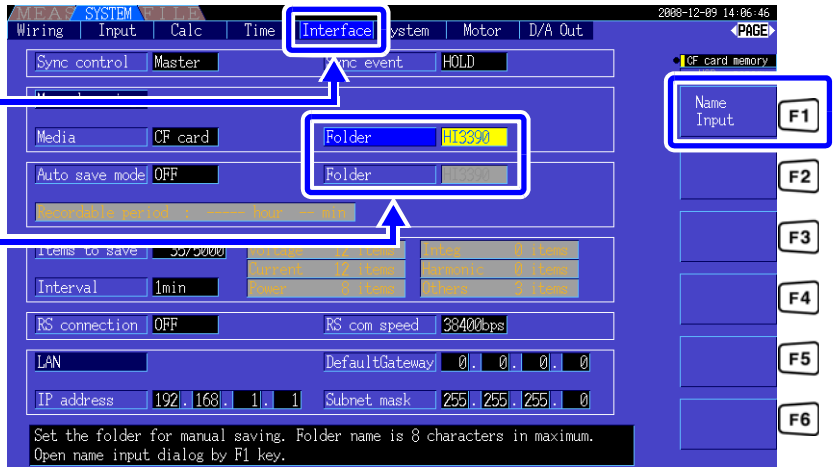
For manual saving:
[Folder]
For auto-saving:
[Folder]
(Can be set when the auto save mode is ON.)

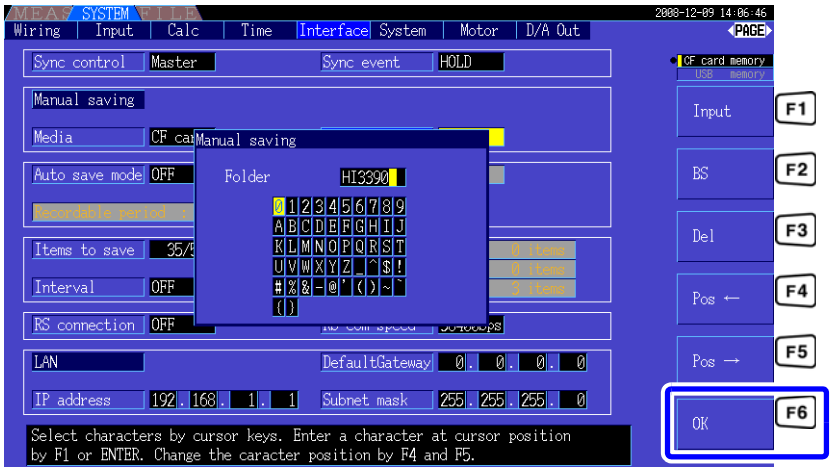
F1
(A dialog appears)

keys to select characters

Enter characters with the **F** keys

Enter: F6
Cancel: ESC /On





Dialog box setting items

Input	Enters the character at the cursor position. (The same as 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

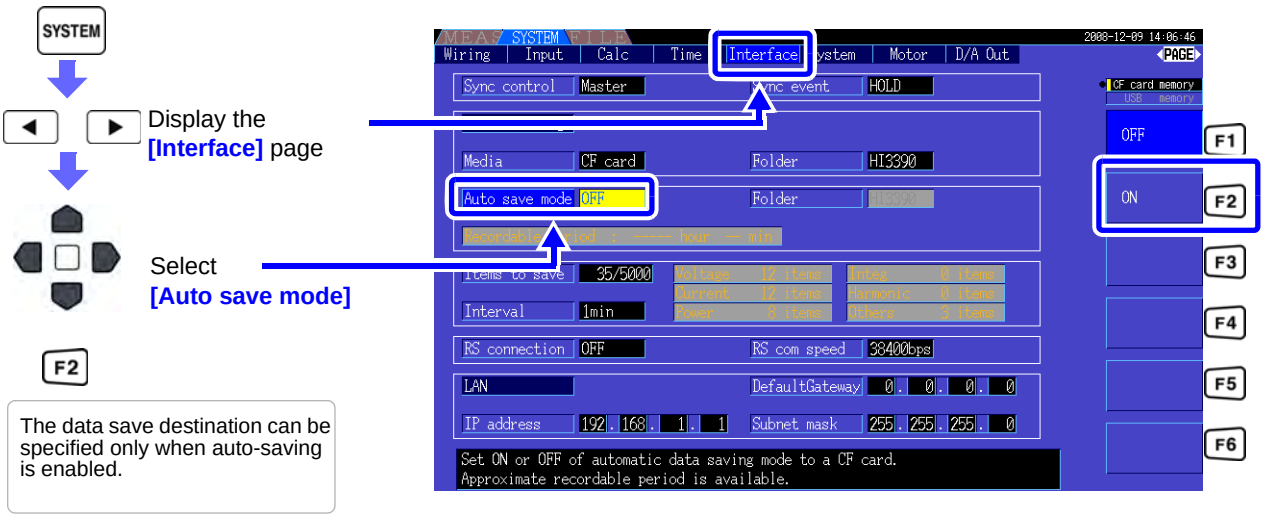
1. Select the measurement items to be saved.
   (See 7.5.3 (p.116))
2. Enable auto-saving and select the destination folder (as necessary).
   (See Setting Auto-Saving below, and "Selecting the Destination Folder and Measurement Items to Save" (p. 113).)
3. Set the save time.
   (See 5.1 (p.93))
4. Press 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



NOTE

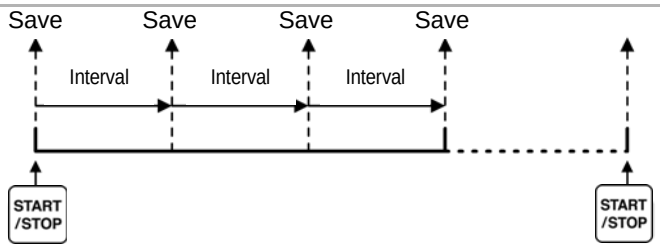
- The maximum number of data points that can be recorded (p. 116) depends in the interval time (longer intervals allow recording more data points).
- When auto-saving is disabled ([OFF]), the [Folder] cannot be set.
- Folder names can be up to eight characters.

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.

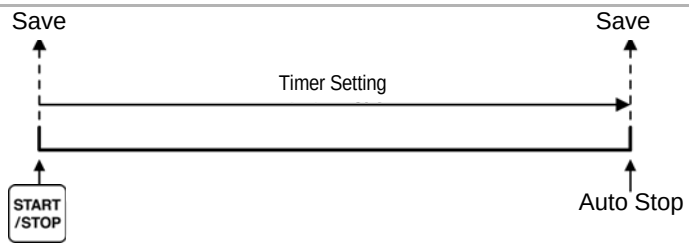
Auto-Saving Operations

Timing controls available for auto-saving are as follows.

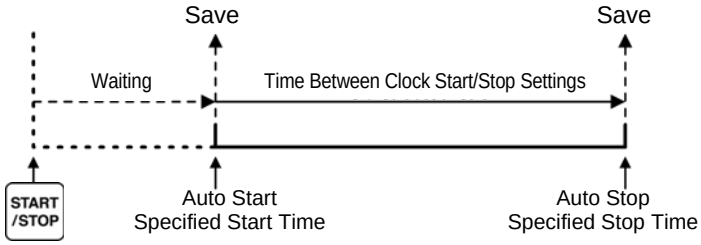
Interval Timing Control



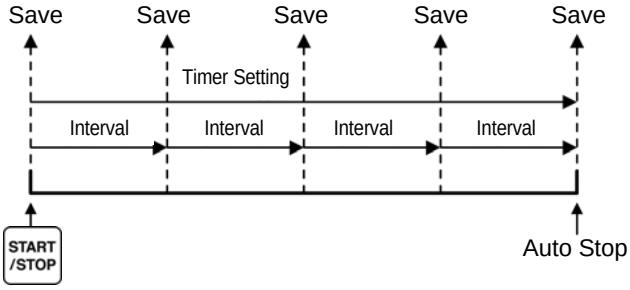
Timer Control



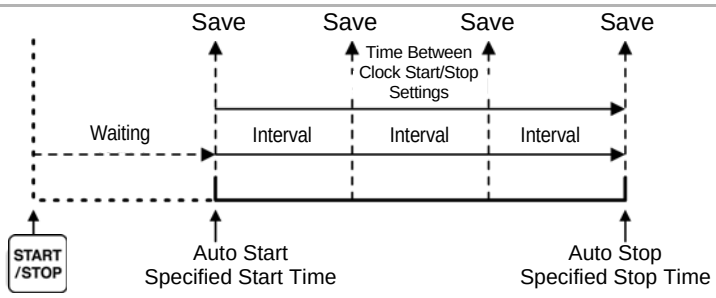
Real-Time Clock Timing Control



Timer + Interval Timing Control



Clock + Interval Timing Control



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 START /STOP 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. 94)

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

SYSTEM

◀ ▶ Display the **[Interface]** page

Select **[Items to save]**

Select measurement contents with the **F** keys.

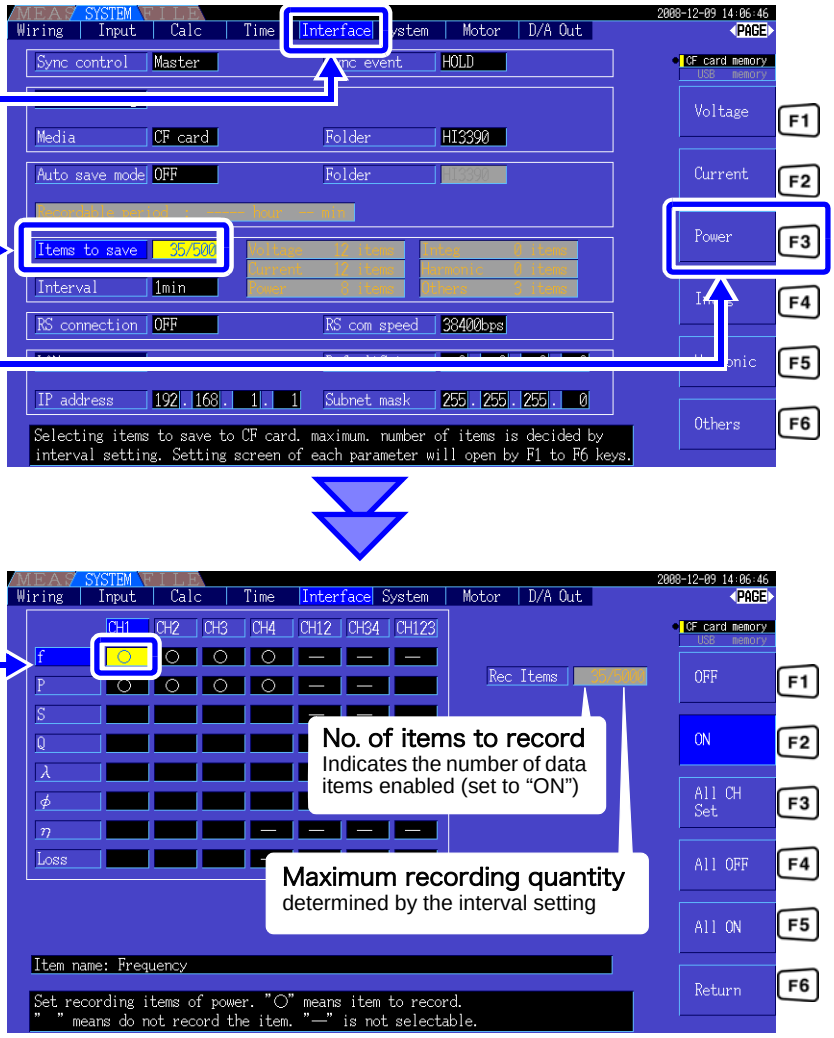
Press F6 to select Noise peak, Temp, ChA, ChB, Pm, and Slip.

Select the items to be saved.

Set by **F** keys*

(Press ENTER to toggle off/on.)

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

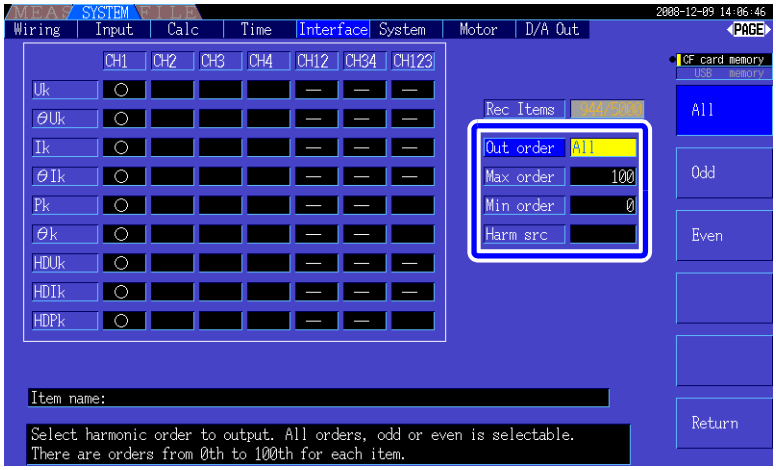


*: Setting Contents

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.

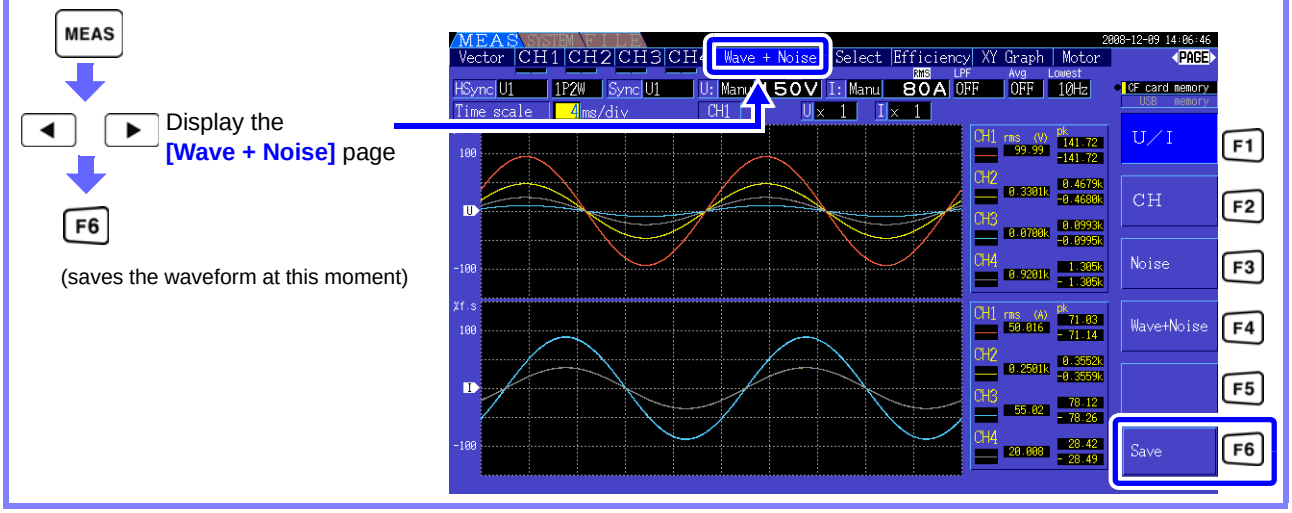
+1↑/-1↓	Increment or decrement by 1.
+10↑/-10↓	Increment or decrement by 10.
0th	Sets the zero order (DC component).

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



Save destination:	CF card, USB flash drive (Save destination setting is the same as for Manual saving, (p. 112))
File names:	Auto generated, with CSV extension W3390nnn.CSV ("nnn" is serial number 000 to 999 within the same folder) Example: W3390000.CSV

NOTE
- Item where the screen display is OFF is not saved.
- Waveform saving is not possible when auto-saving is enabled.
- Waveform data is saved as Peak-Peak compressed Max/Min data set.
  See"4.5.1 Displaying Waveforms" (p. 69)

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. 127)

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

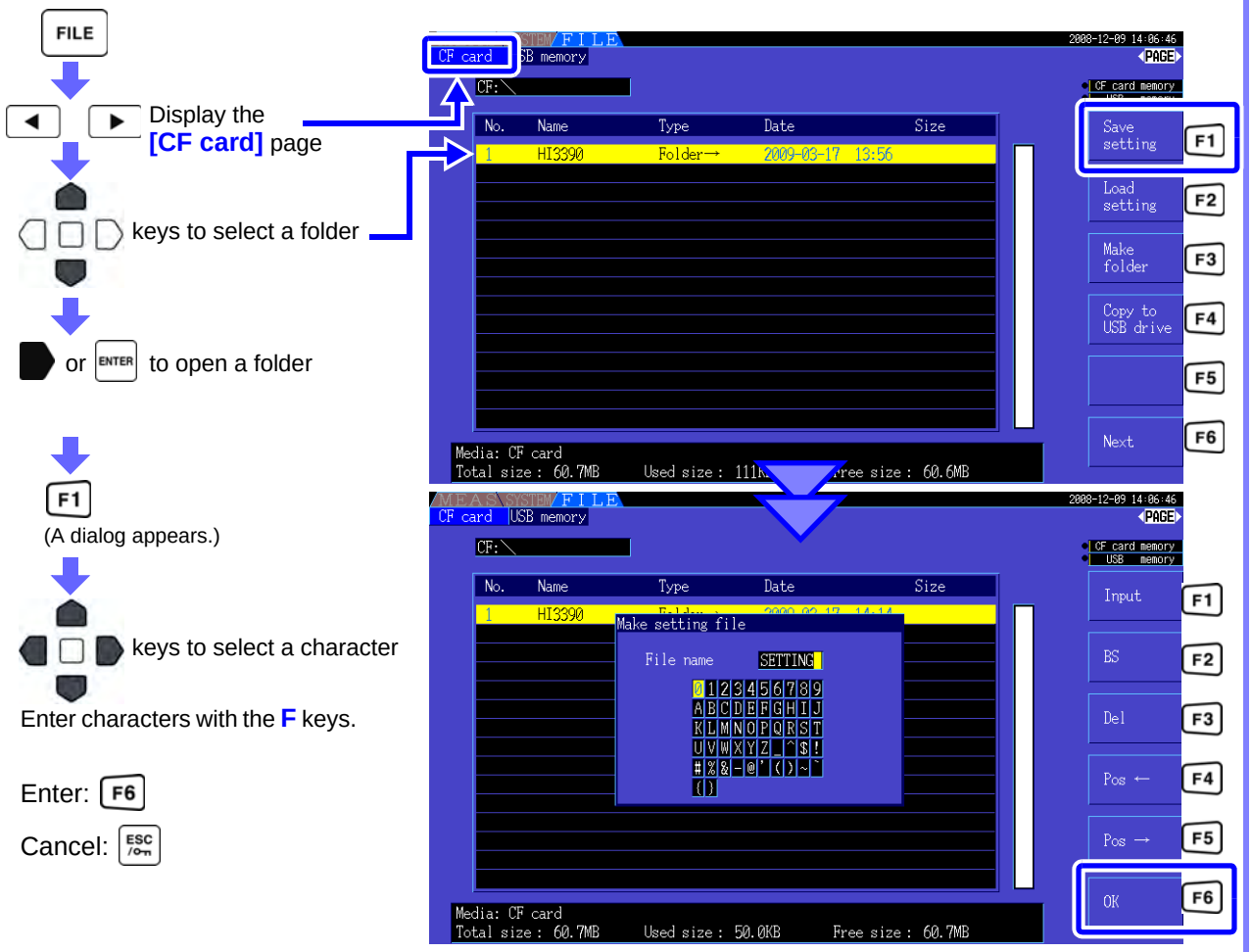
Save destination:	CF card, USB flash drive (Save destination setting is the same as for Manual saving, (p. 112))
RS Connection:	Printer **See** "8.1 Connecting a Printer (to print captured screen images)" (p. 127)
File names:	Auto generated, with CSV extension H3390nnn.CSV ("nnn" is serial number 000 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. 129)

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)



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. 112))
File names:	User-named (up to eight characters), file name extension is SET Example: SETTING1.SET

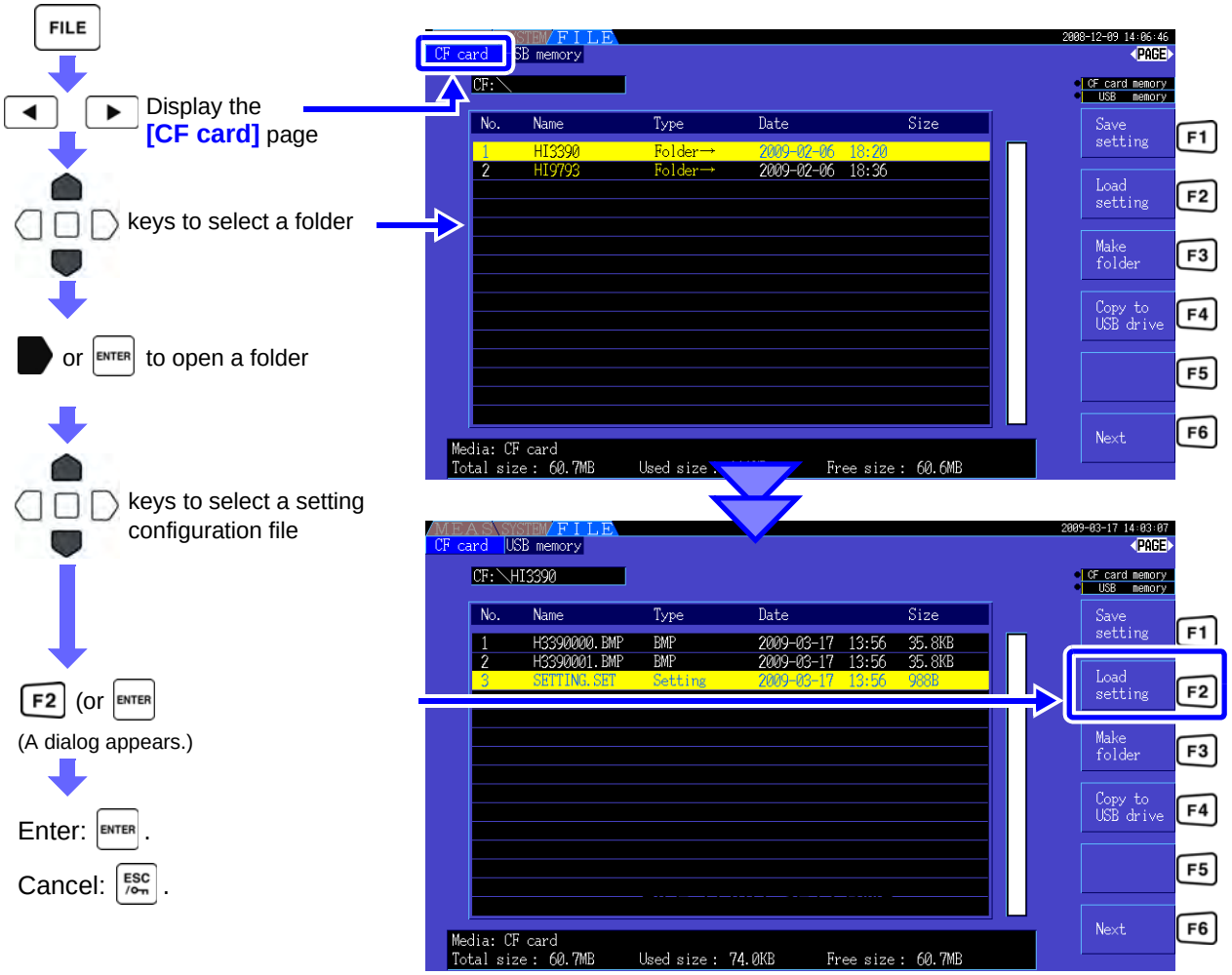
NOTE

- 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)



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. 108)

Creation Procedure

FILE

◀ ▶ Display the **[CF card]** page

F3

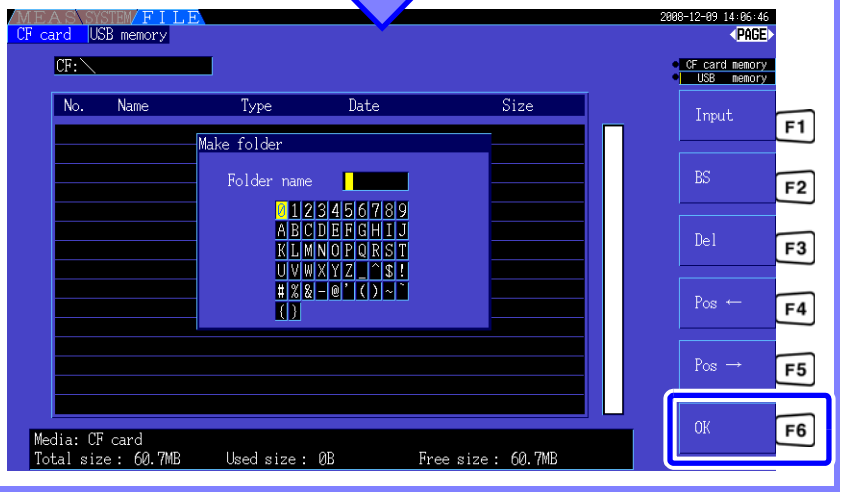
(A dialog appears.)

keys to select a character

Enter characters with the **F** keys.

Enter: F6.

Cancel: ESC.



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.
- 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. 108)

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

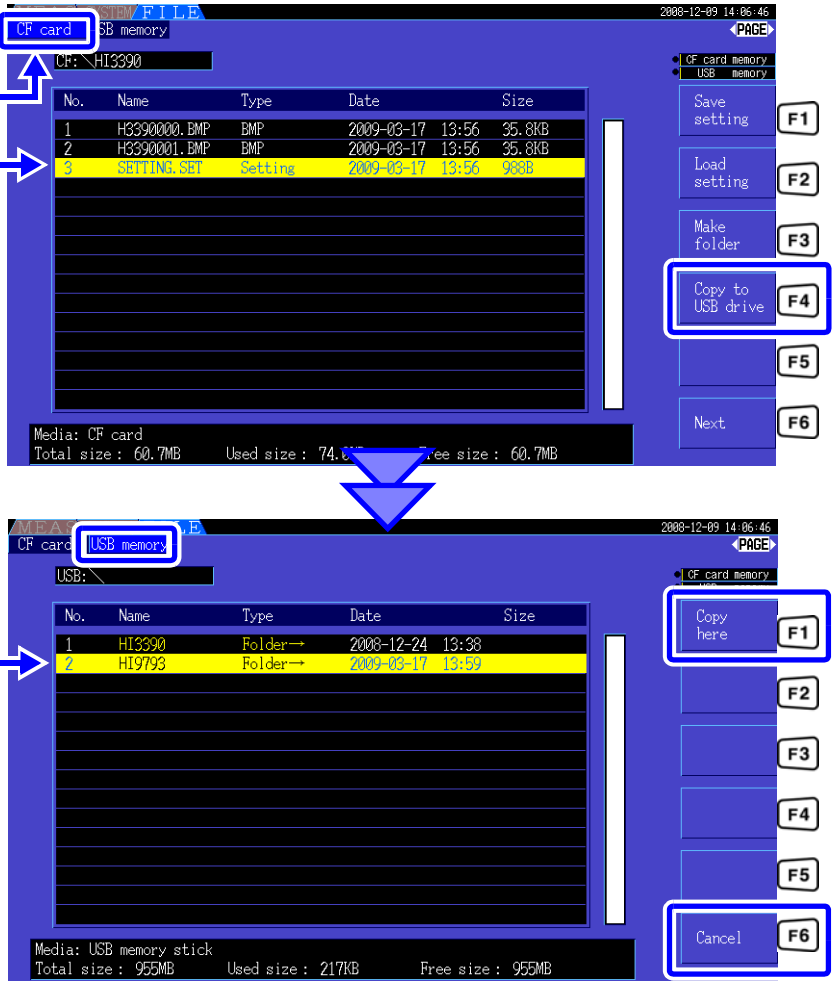
► or ENTER to open a folder

Copy: F1 (or ENTER)

Cancel Copy: F6 (or ESC)

(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
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. 125)

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

(A dialog appears when copying is finished.)

ENTER

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. 125)

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. 108)

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

FILE

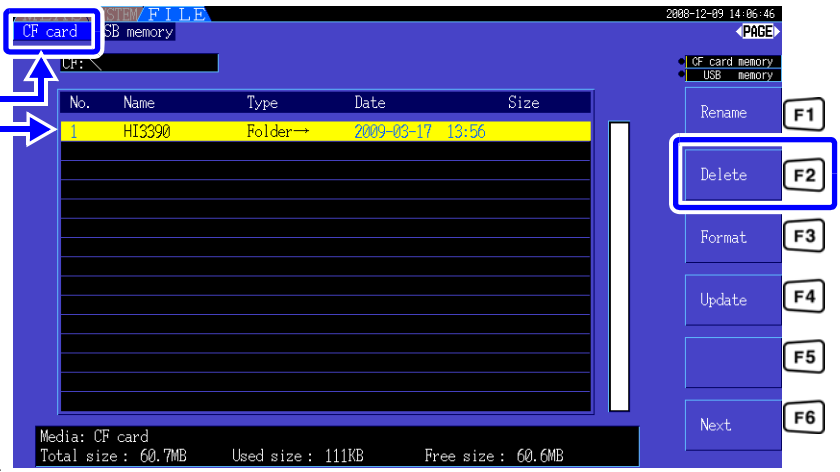
◀ ▶ Display the **[CF card]** page

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.)



NOTE To delete a file within a folder, open the folder and select the file.
See "Changing Folders, Selecting the Root Folder" (p. 109)

7.10.4 Renaming Files and Folders

Files on storage media can be renamed.
Insert the storage media before renaming a file. (p. 108)

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

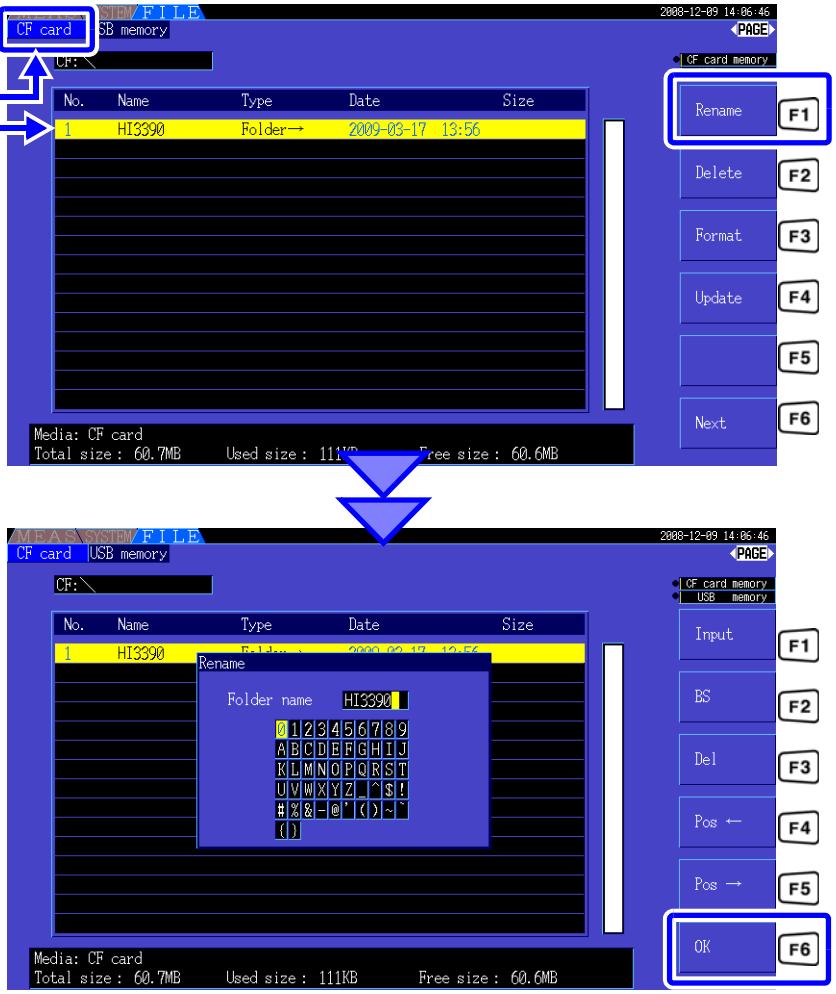
(A dialog appears)

keys to select a character

Enter characters with the **F** keys.

Enter: F6

Cancel: ESC



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. 109)

7.10 File and Folder Operations

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.
SeePrinter 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

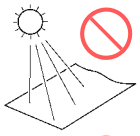
- To use a cable other than the Hioki 9638 RS-232C Cable, the instrument-side connector body must be a molded type. The instrument's structure does not support metal plugs (with angled, instead of straight connector body).
- Avoid printing in hot or humid environments, as printer life could be greatly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

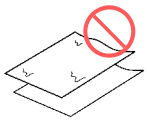
Handling and Storing Recording Paper

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

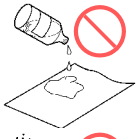


Avoid exposure to direct sunlight.

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



Avoid stacking with wet Diazo copy paper.



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

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

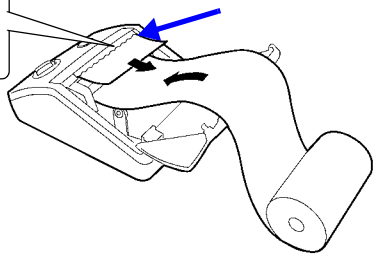
8.1.1 Printer Preparation and Connection

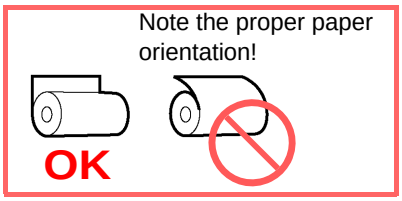
Loading Hioki 9237 Recording Paper in the Printer

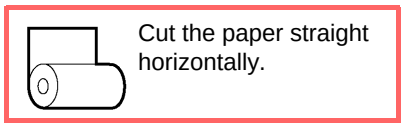
Required items: Hioki 9237 Recording Paper

Procedure

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





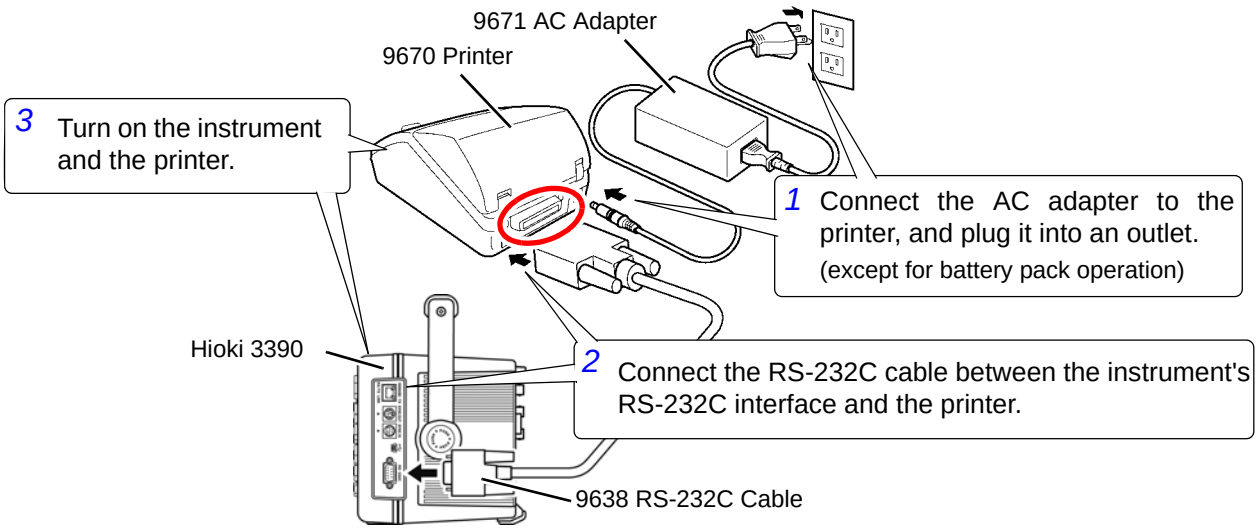


NOTE
- Use only Hioki-specified recording paper. Other papers may degrade performance or prevent printing.
- Paper jams may occur if the paper is skewed in the roller.
- Printing is not possible if the front and back of the recording paper are reversed.

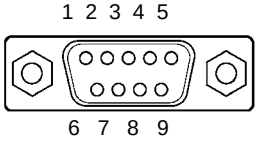
Connecting the Printer to the Instrument

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

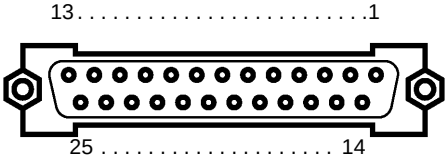
Procedure



RS232C Interface Pin-Out



Instrument Interface (9-pin)



Printer Interface (25-pin)

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

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

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

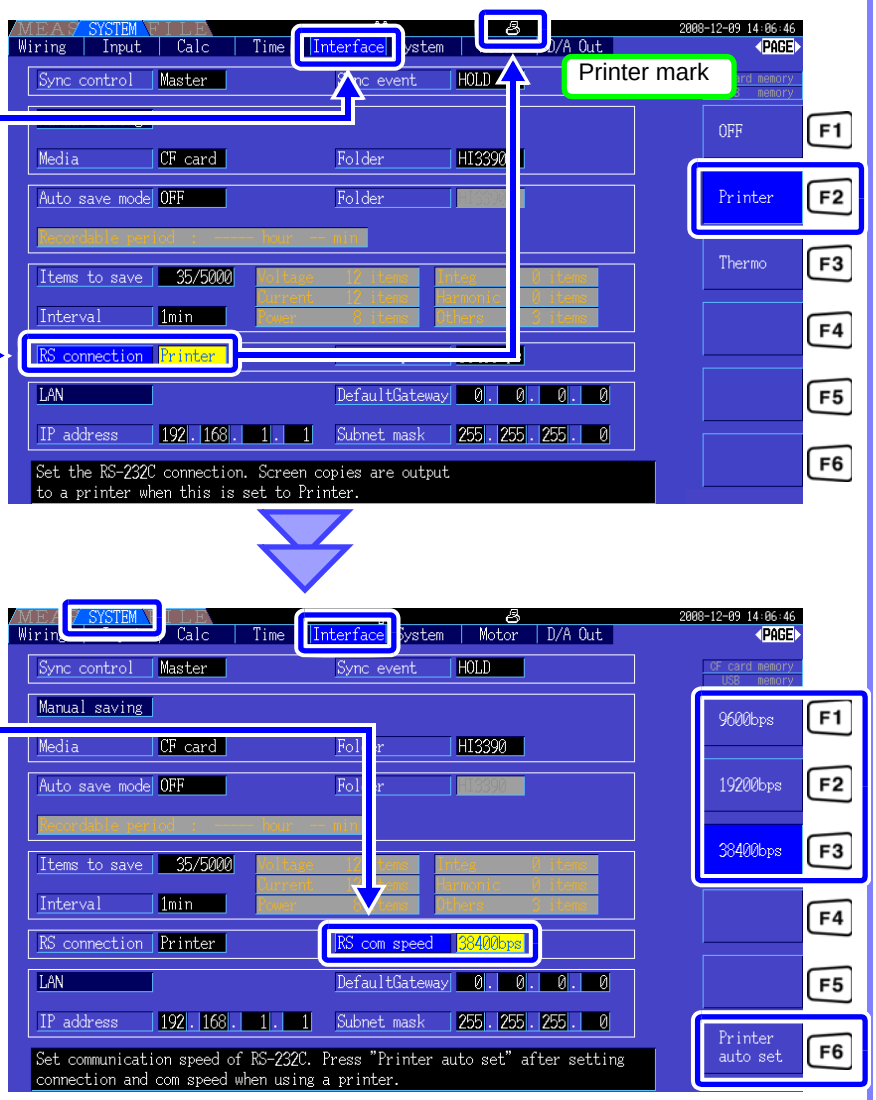
Select **[RS com speed]**

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 Powr 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.

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.

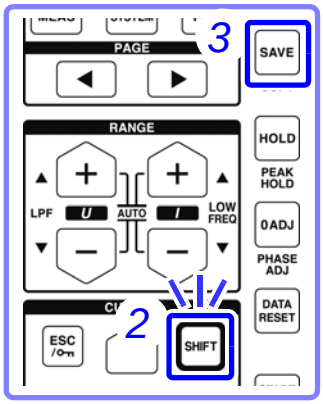
  BL-80RS II/RSII [VX.XX] XXXX/XX/XX
  SANEI ELECTRIC INC.
  ****
  Data input = Serial
  International char = U.S.A
  Print mode = Graphic
  Character set = 24Dot ANK Gothic type
  Select switch = Available (ON)
  Baud rate = 19200bps
  Bit length = 8 bit
  Parity= Non
  Data control = SBUSY
  Paper selection = Normal paper
  Upright/inverted = Upright printing
  Auto Power Off = Invalidity (OFF)
  Battery mode= Invalidity (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. 129), 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 SHIFT (blue key)
3. Press SAVE.

   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. 118), instead of sending to the printer. To do this, set the **[RS connection]** (p. 129) 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.

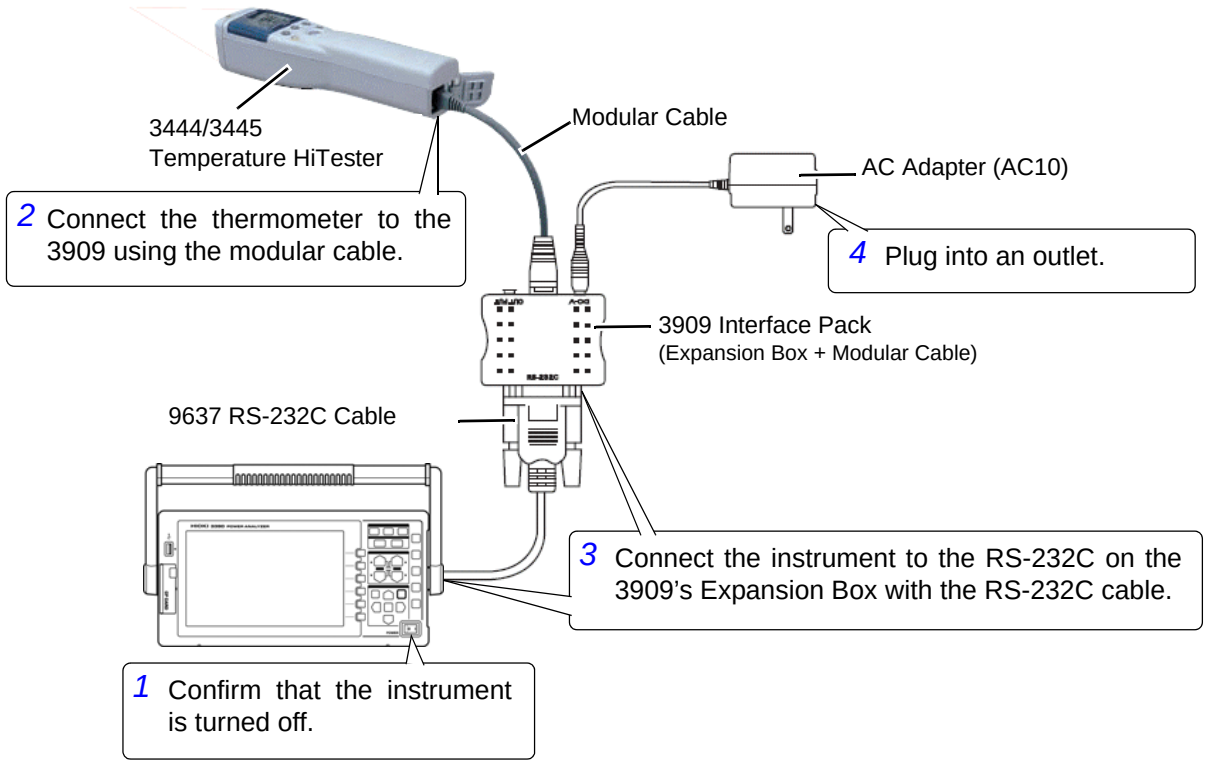
We recommend using the following models with known compatibility:

- 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)

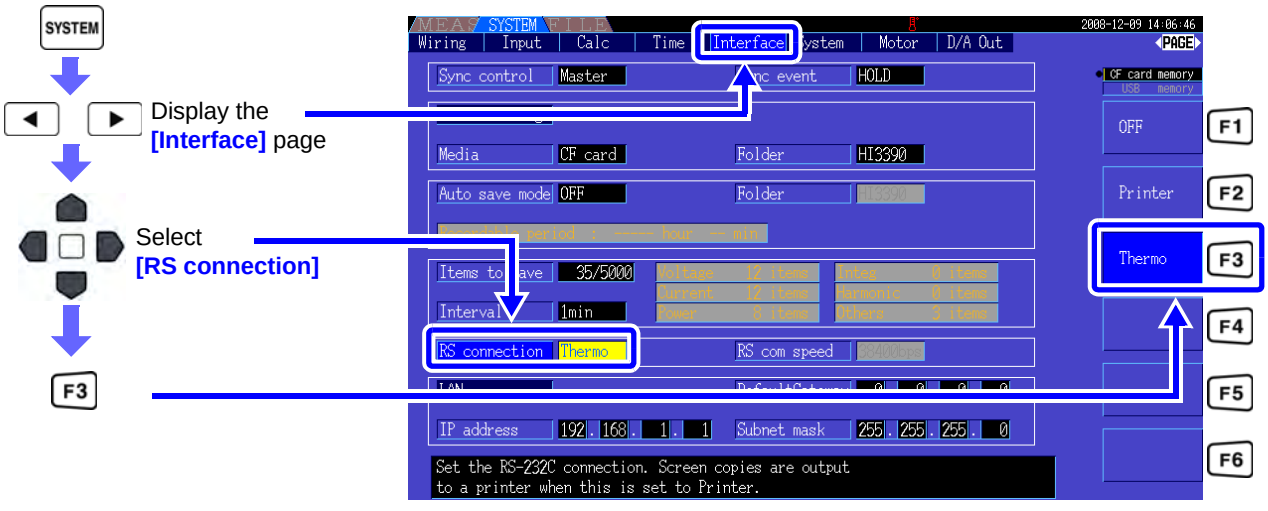
Procedure



Thermometer Settings on the Instrument

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

Setting Procedure



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, and F3 keys simultaneously, so that the unit fortemperature 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 acquire 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. 96)

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. 107).

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. 93)

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.

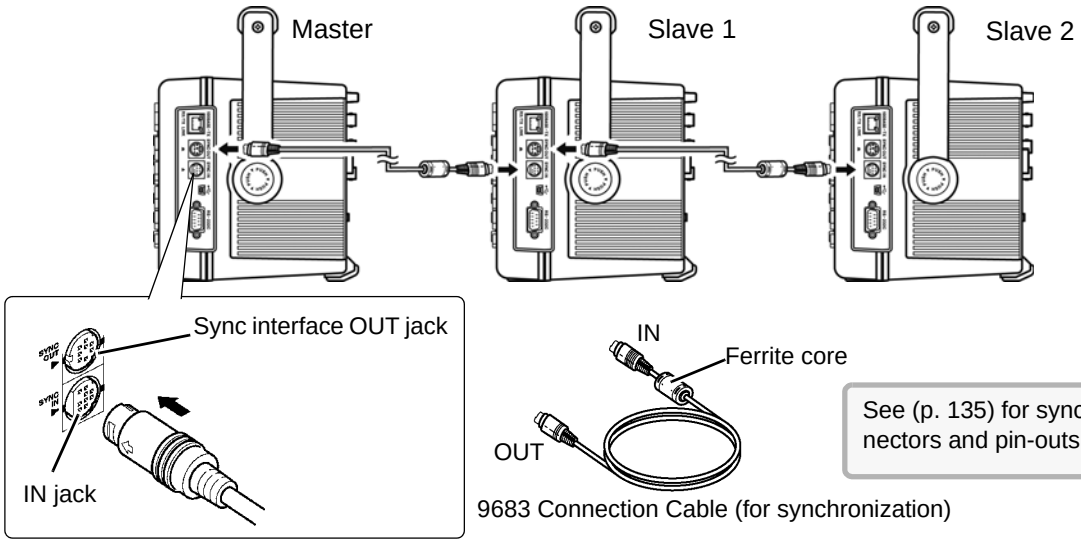
NOTE Display the MEAS screen on both master and slave units, when executing time control, integration start/stop, data reset, and HOLDing event.

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).



9683 Connection Cable (for synchronization)

See (p. 135) for sync cable connectors and pin-outs.

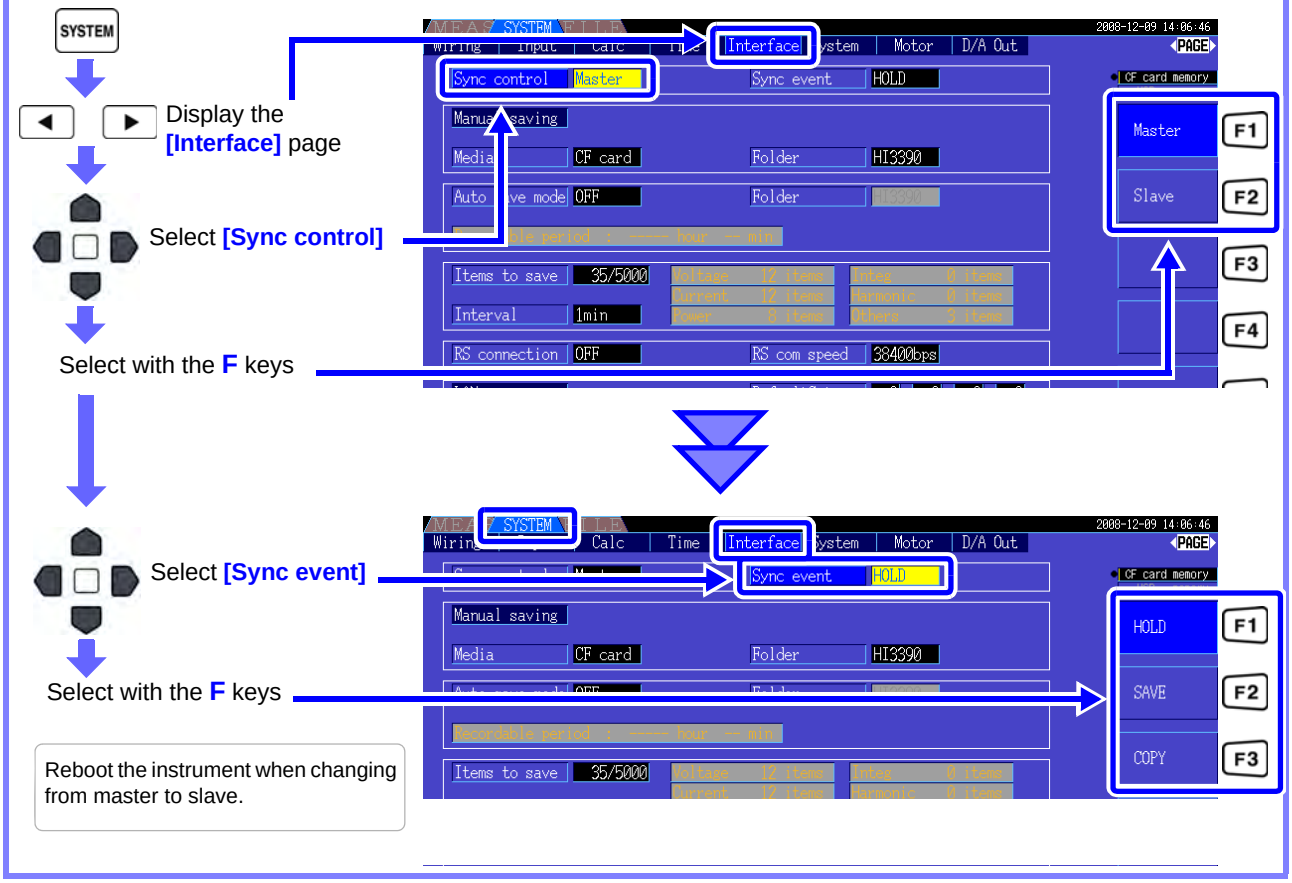
NOTE

- 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.

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



Sync event Select the events to be synchronized (master settings are reflected on the slaves)

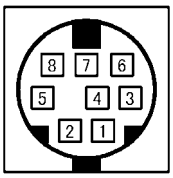
HOLD	Pressing HOLD on the master activates Data Hold on all instruments.
SAVE	Pressing SAVE on the master executes manual saving on all instruments.
COPY	Pressing SHIFT + SAVE on the master captures the screen image on all instruments.

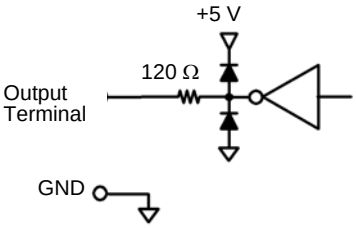
NOTE

- 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. 112), "7.7 Saving Screen Capture Images" (p. 118)
- 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. 93), "7.5.2 Auto-Saving Measurement Data" (p. 114)
- Confirm no error display on the slave unit's screen when executing the synchronization event.

Sync Cable Pin-Outs

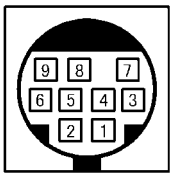
Sync Output (OUT): 8-pin mini-DIN plug pin configuration

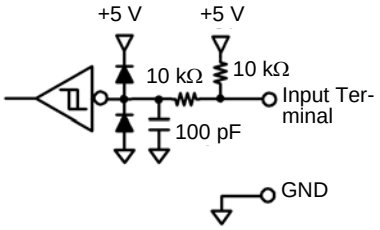




Pin No.	I/O	Function
1	O	Data Reset 0 for data reset
2	O	Start/Stop Integration 0: Start, 1: Stop
3	O	1-s clock
4	O	Event 0 for valid event
5	I	Master/Slave setting
6	-	Unused
7	I/O	GND
8	I/O	GND

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. 139)or waveform output (p. 139) 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.**

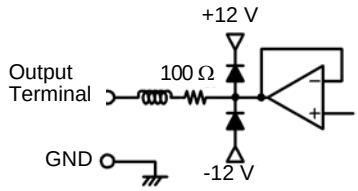
CAUTION

- 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.

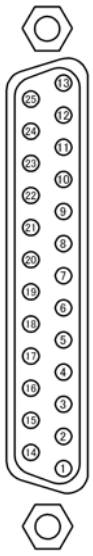
Output Circuit



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 MΩ).
See "Chapter 10 Specifications" (p. 153)

D/A Output Connector Pin-Out

Instrument Rear Panel

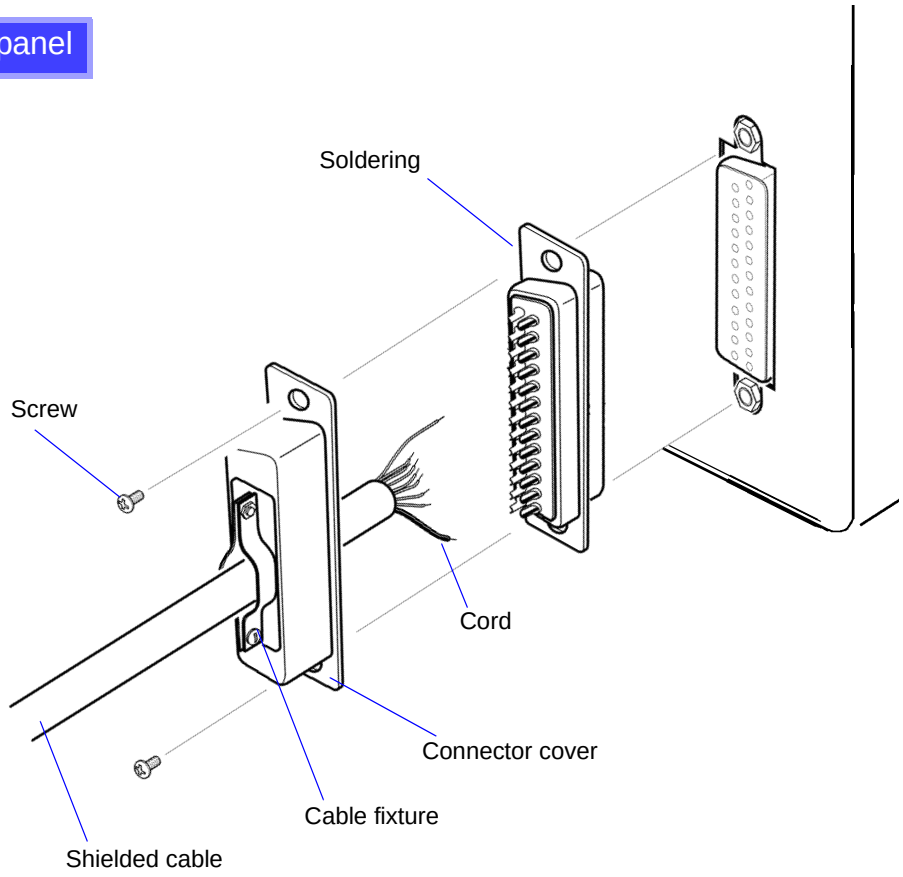


Pin No.	Output ( ) waveform output content	Pin No.	Output
1	GND	14	GND
2	D/A1 (U1)	15	D/A9
3	D/A2 (I1)	16	D/A10
4	D/A3 (U2)	17	D/A11
5	D/A4 (I2)	18	D/A12
6	D/A5 (U3)	19	D/A13
7	D/A6 (I3)	20	D/A14
8	D/A7 (U4)	21	D/A15
9	D/A8 (I4)	22	D/A16
10	GND	23	GND
11	GND	24	GND
12	GND	25	GND
13	GND		

How to connect D/A output terminals

User 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



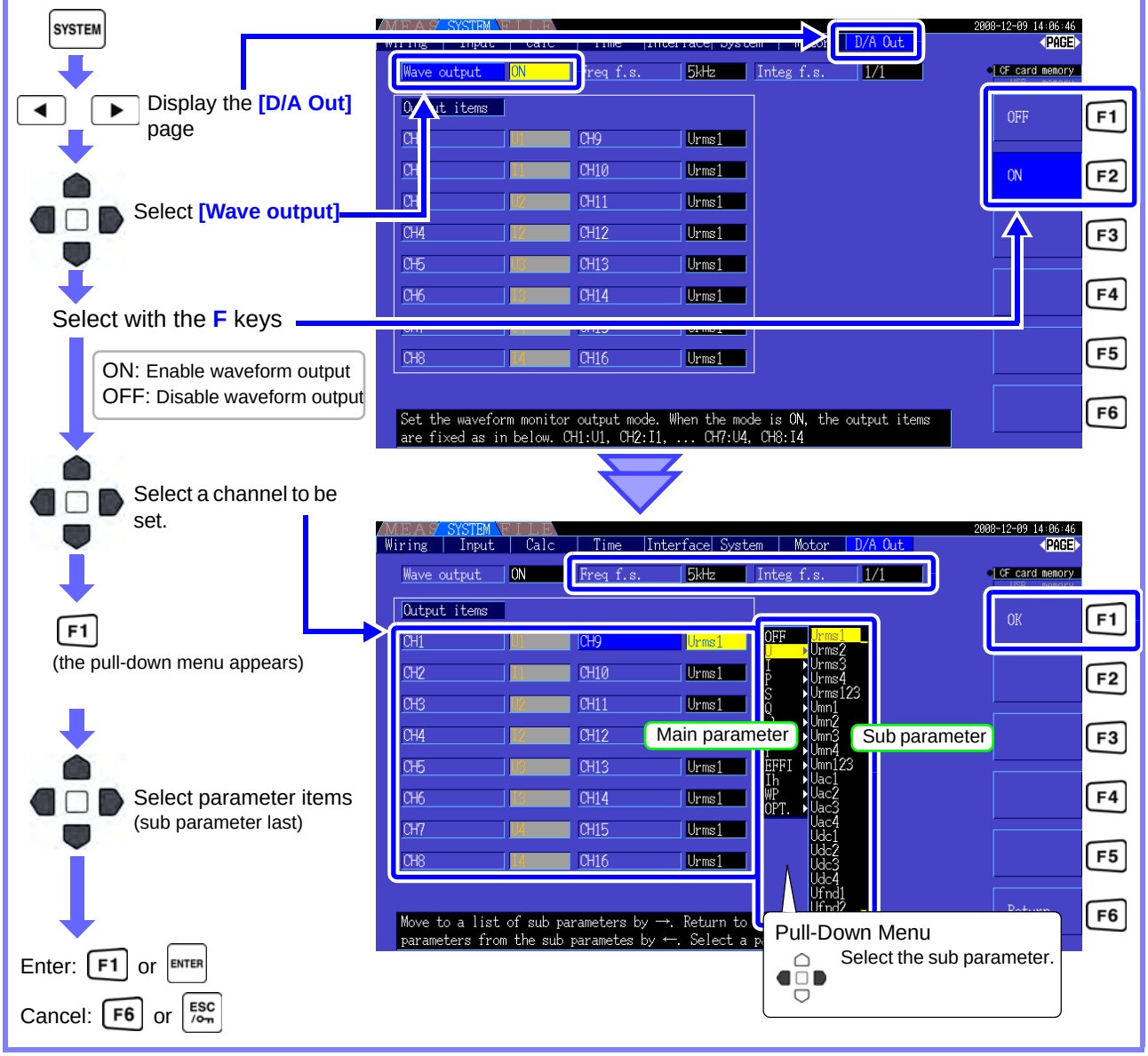
NOTE

- 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



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. 89))

Integ f.s. Set for analog outputs. ("About Full-Scale Integration" (p. 139))

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.

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. 140) 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 that can possibly be output from malfunction, etc. 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 that can possibly be output from malfunction, etc. 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.

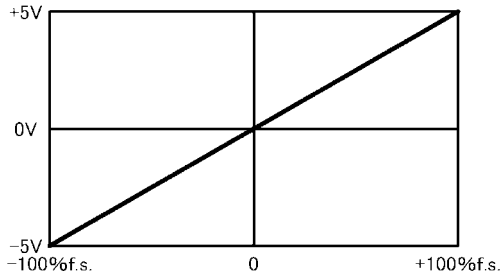
8.4.3 Output Level

Full-scale D/A output span is ±5 V DC. This corresponds to the full-scale measurement input spans as follows.

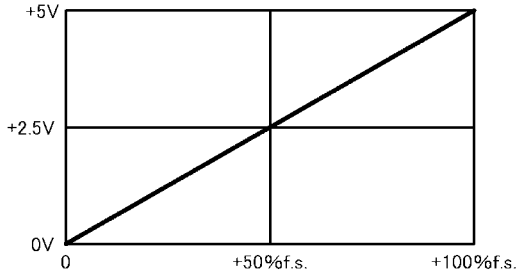
Selected Output Item	Full Scale
Voltage and current of each channel, Sum of voltage and current (dc, pk+ and pk- for each U1 to U4, I1 to I4, U12, U34, U123, I12, I34, or I123) Motor analysis options, temperature (chA, Pm, Temp)	Measurement range (with polarity) D/A output value -100%f.s. to 0 to +100%f.s. → -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 → -5V 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. 166) for items not listed in the above.

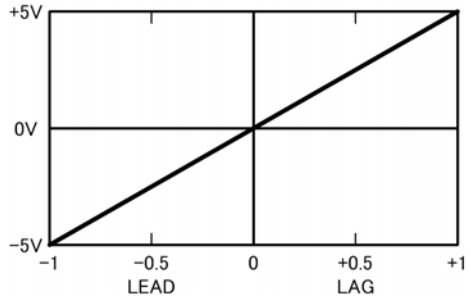
8.4.4 D/A Output Examples



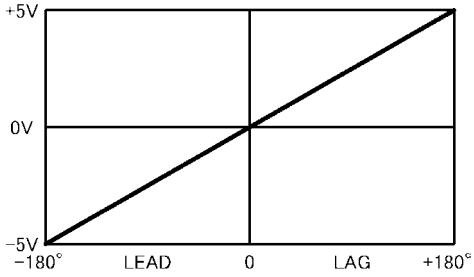
Voltage and current (dc, pk+, pk-), active power, reactive power



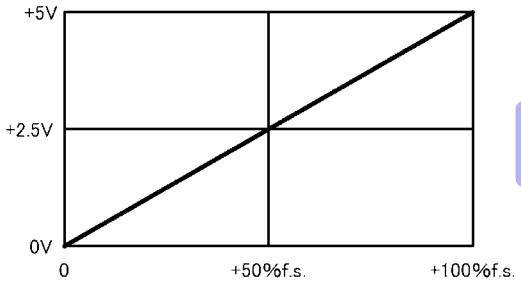
Voltage and current (rms, mn, ac, fnd, thd), apparent power



Power factor

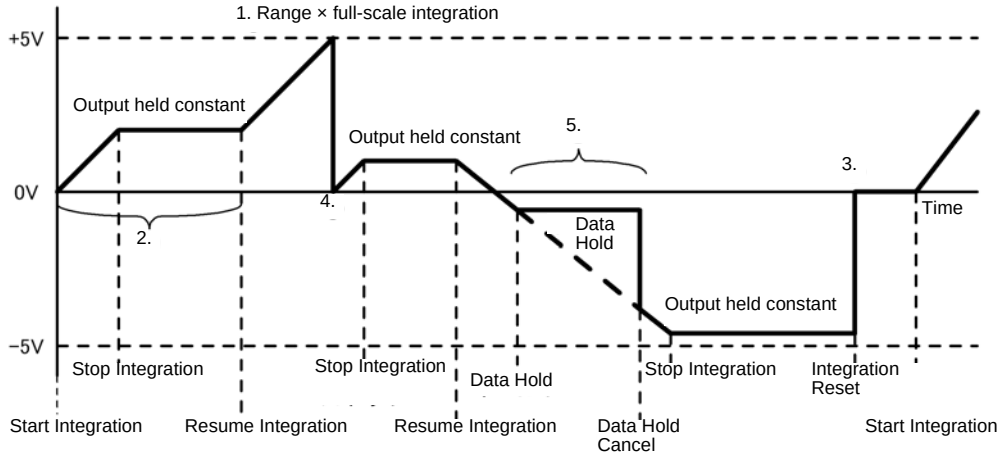


Power phase angle



Frequency

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 × full-scale integration.
   For example, when full-scale integration is set to 10 with the 300 W range, 3 kWh (300W ×10), 6 kWh (300W × 10 × 2), and 9 kWh (300 W × 10 × 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.

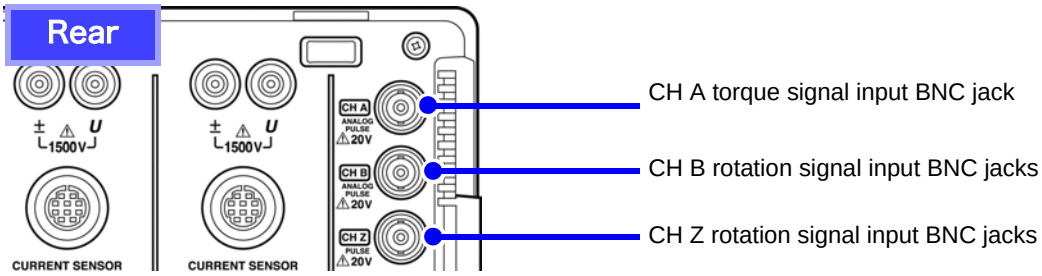
8.5 Using the Motor Testing Option (when specified before factory shipping, for motor analysis)

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

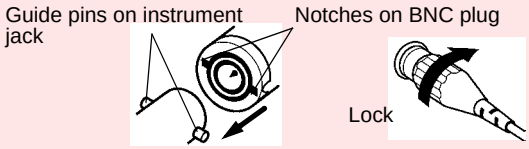
To avoid electric shock and damage to the instrument, observe the following when connecting to the CH A torque signal input BNC jack and the CH B and CH Z rotary signal input BNC jacks.

- **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.

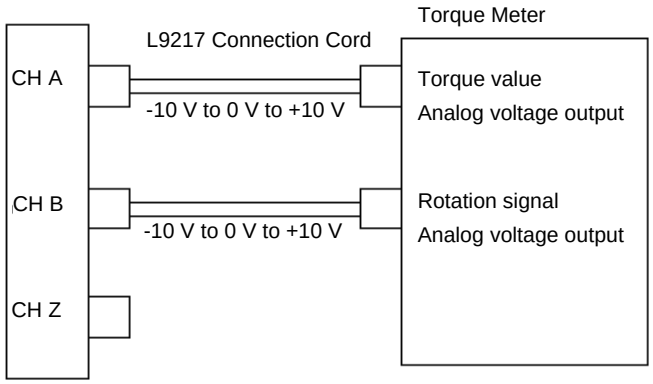


Required items: Hioki L9217 Connection Cords (as needed), input devices

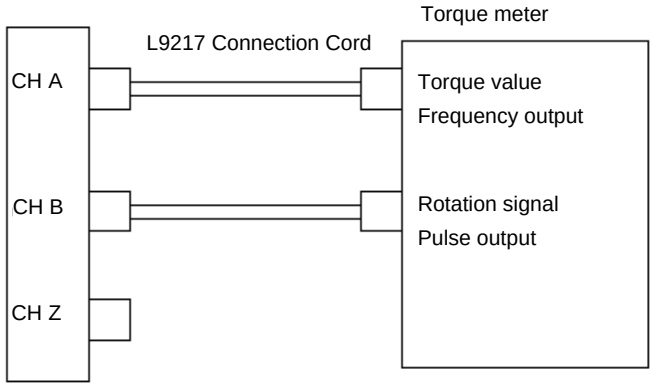
Procedure

1. Confirm the that 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.

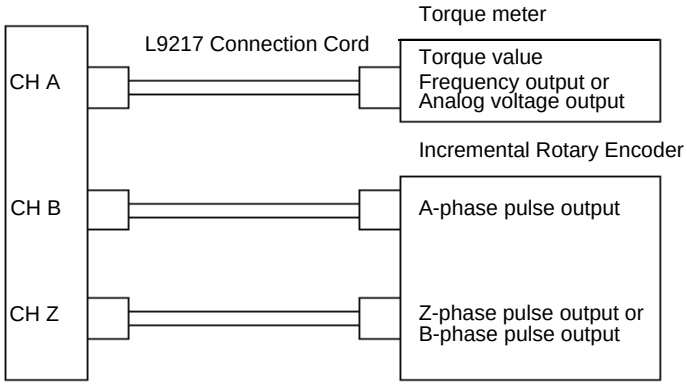
Example 1. Connecting a torque meter that provides analog torque values and rotation signals



Example 2. Connecting a torque meter that provides torque values as frequency and rotation signals as pulses



Example 3. Connecting the torque meter that provides torque values and the incremental rotary encoder



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

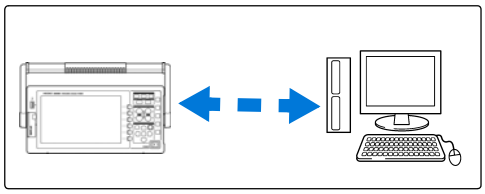
See section "4.8 Viewing Motor Measurement Values (With Hioki 9791 or 9793 installed)" (p. 83) for measurement displays and instrument setting procedures.

8.5 Using the Motor Testing Option (when specified before factory shipping, for motor

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. 150)
- **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.

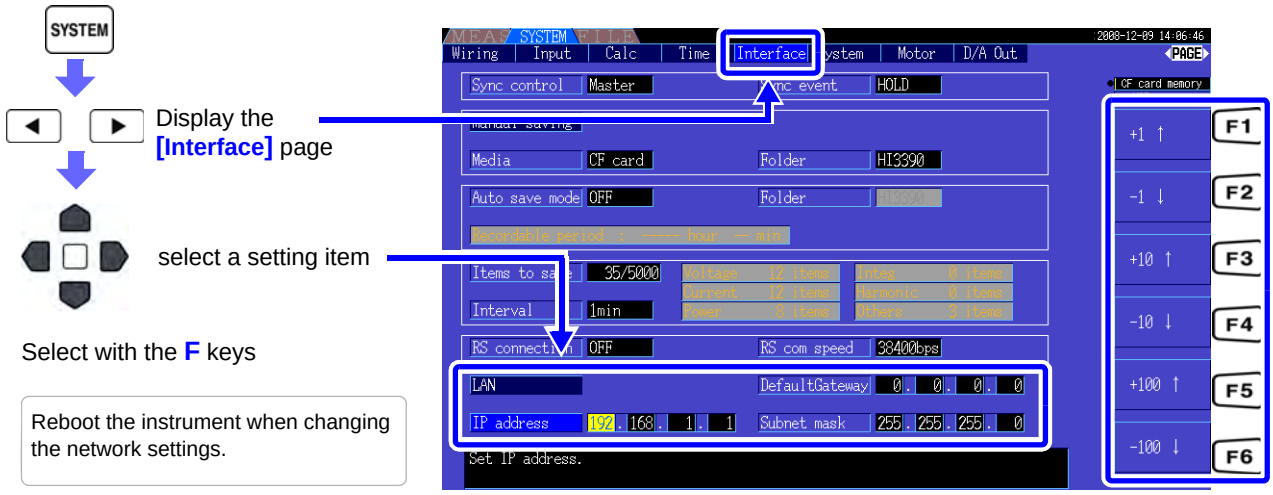
NOTE
- See the application program's operating manual for operating procedures.
- See the command communication manual for command communication procedures. (Both are downloadable from http://www.hioki.com).

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



+1↑/-1↓	Increment/decrement by 1
+10↑/-10↓	Increment/decrement by 10
+100↑/-100↓	Increment/decrement by 100

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

9.1.2 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)

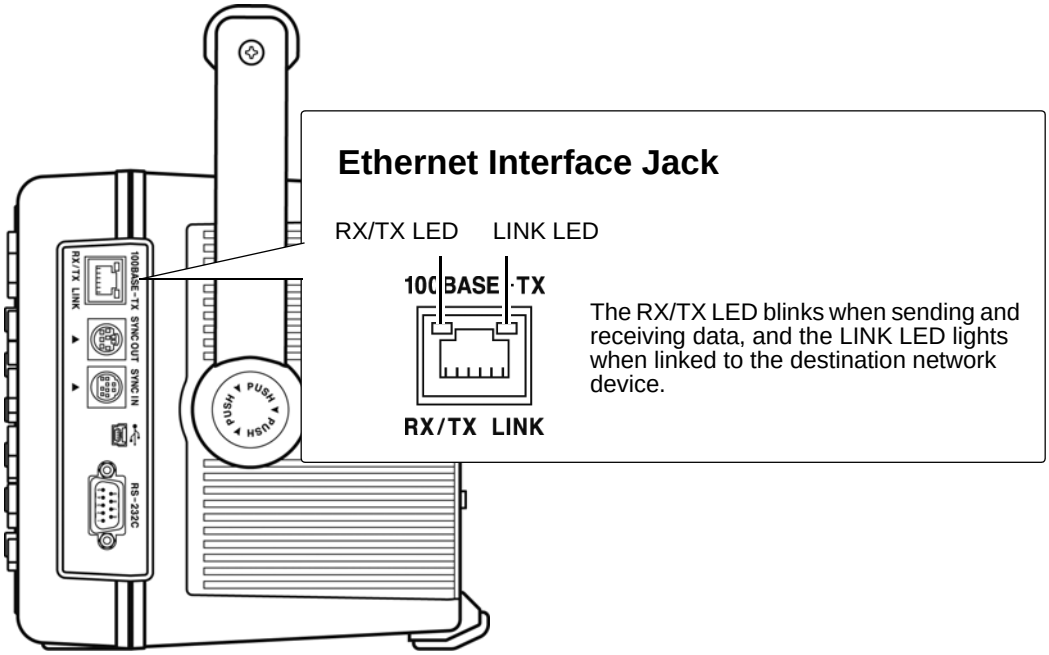
When connecting one instrument to a single computer

(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

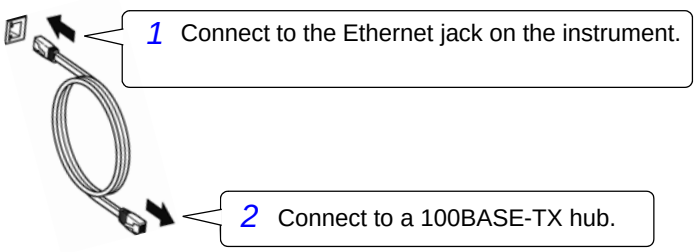
The Ethernet interface jack is on the right side.



Connecting the Instrument to a Computer with an Ethernet ("LAN") Cable

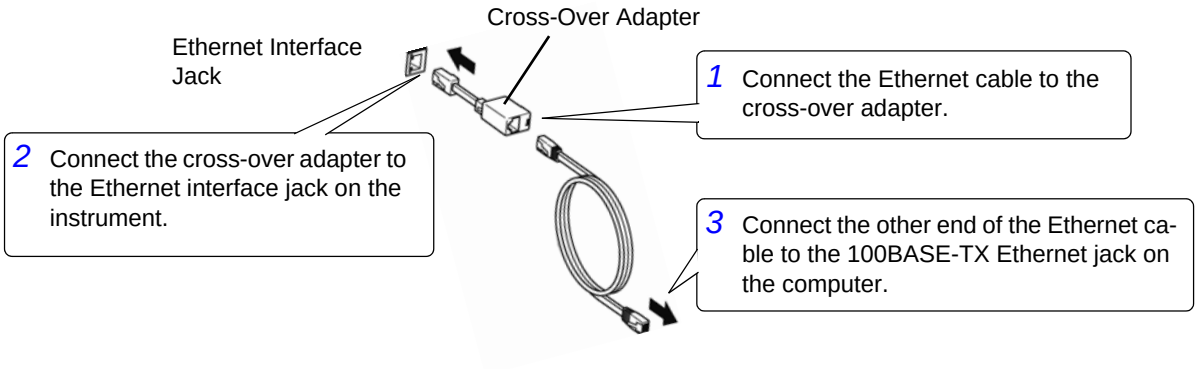
Connect by the following procedure.

When connecting the instrument to an existing network (connect the instrument to a hub)

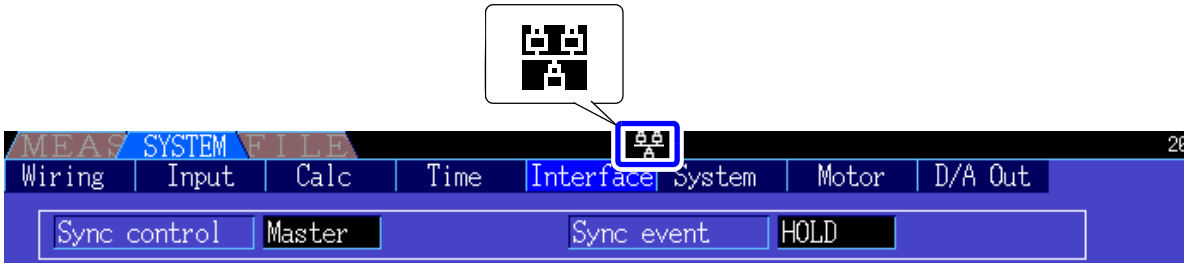


When connecting the instrument to a single computer (connect the instrument to the computer)

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

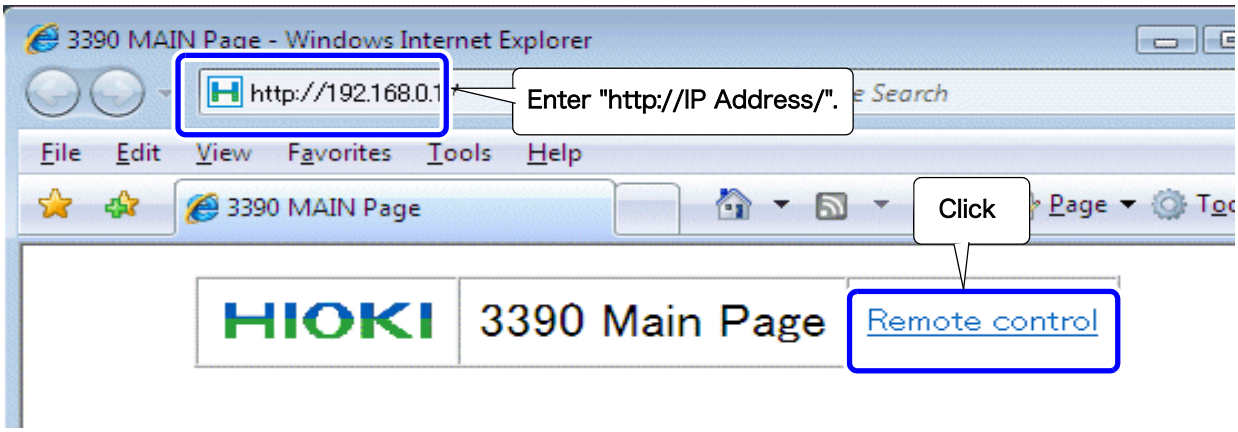
The instrument includes a standard HTTP server function that supports remote control by an internet browser on a computer. The instrument's display screen and control panel keys are emulated in the browser. Operating procedures are the same as on the instrument.

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.



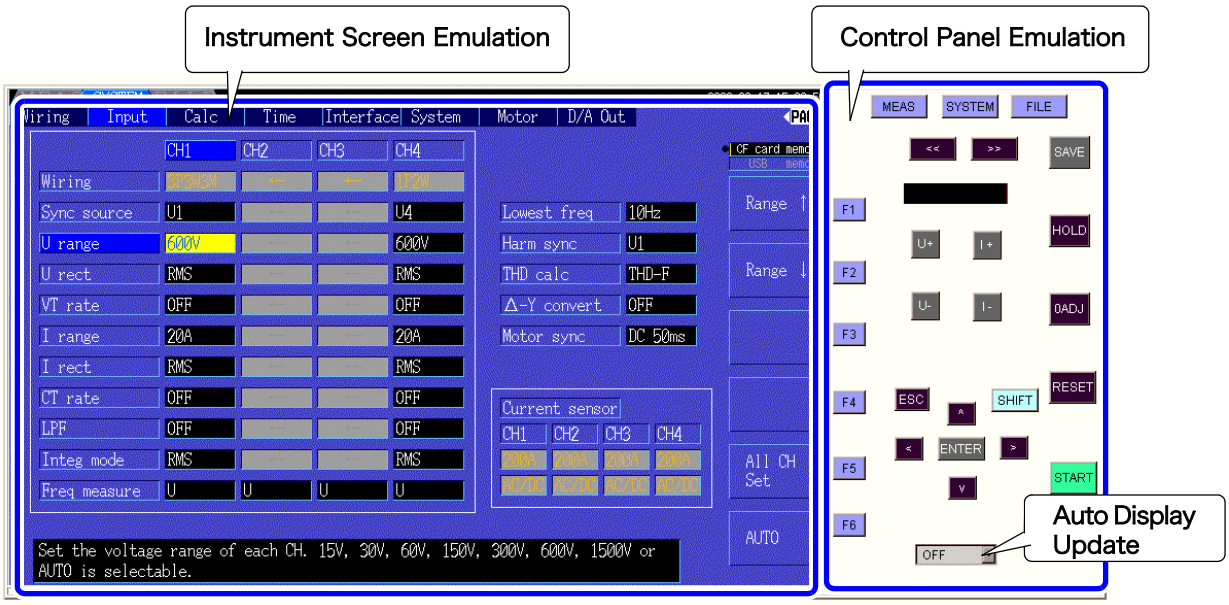
When the Main page appears as illustrated, the connection to the instrument has been established.
Click the **[Remote control]** link to jump to the Remote Control page.

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. 146)
- 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. 148)

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.

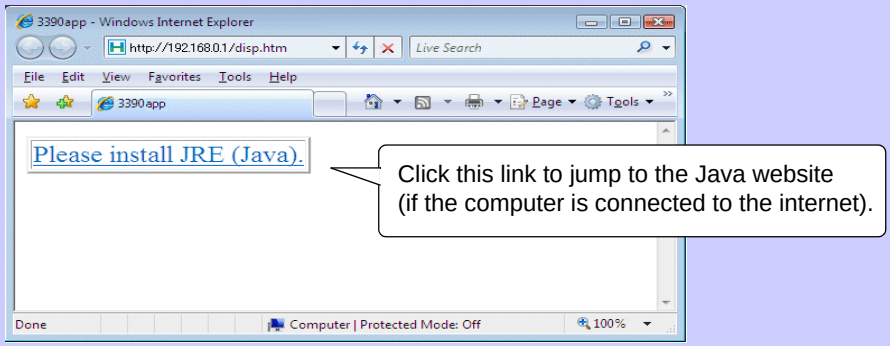


Auto Display Update Settings

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 becomes slow in the Java6 installed environment.
In this case, please set not to keep the temporally internet file from the Java dialog in the control panel of the computer.

9.3 Control and Measurement via USB Interface

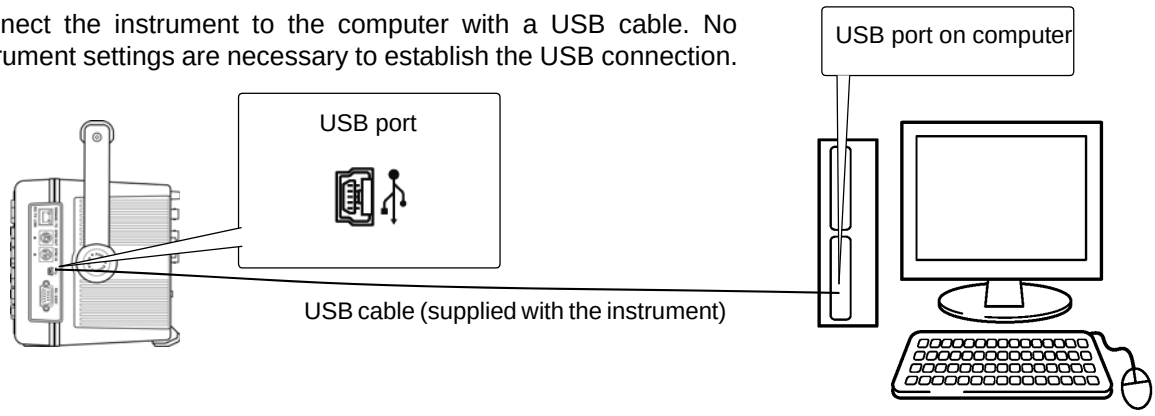
The instrument can be remotely controlled and measurement data transferred to a computer using a standard USB connection.

NOTE

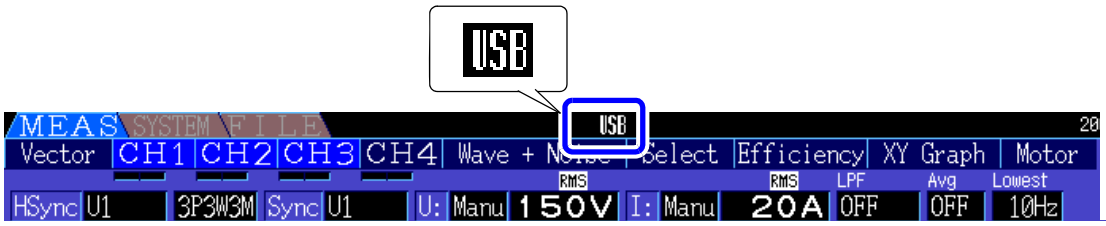
- Install the dedicated software to a computer before connecting this instrument to a computer.
- A dedicated application program can be downloaded from Hioki's web site (http://www.hioki.com). See the application program's manual for operating procedures.
- To connect the instrument to a computer the first time, a dedicated USB driver must be installed. This driver is provided with the above application program.
  (Compatible to the Windows7(32-bit, 64-bit), 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 inter-face 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 W× 170 H × 157 D mm (13.39" W × 6.69" H × 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	• 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 Motor Testing Option 9792 D/A Output Option 9793 Motor 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 CT6865 AC/DC Current Sensor
Voltage measurement option	L9438-50 Voltage CordVoltage Measurement Cable Leads (banana male-to-male with alligator clip, one each red and black, about 3m long) L1000 Voltage Cord Voltage Measurement Cable Leads (1 each for red, yellow, blue, and gray, and 4 black, cord length approx. 3 m, with alligator clips) PW9000 Wiring Adapter (for 3P3W) PW9001 Wiring Adapter (for 3P4W) 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)

10.1 General Specifications

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 MΩ ±40 kΩ (differential inputs) Current sensor input section1 MΩ ±50 kΩ
Maximum input voltage	Voltage input section 1500 V, ±2000 Vpeak Current sensor input section 5 V, ±10 Vpeak
Maximum rated voltage to earth	Voltage input terminal1000 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 (Urf, current ripple factor (Irf), current integration (Ih), power integration (WP), peak voltage (Upk), peak current (Ipk)

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 time30 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

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	±50ppm±1dgt. (0°C to 40°C)
Integration accuracy	± (current and active power accuracy) ± 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	

Synchronization frequency range	Window waveforms	Analysis order
0.5 Hz to 40 Hz	1	100th
40 Hz to 80 Hz	1	100th
80 Hz to 160 Hz	2	80th
160 Hz to 320 Hz	4	40th
320 Hz to 640 Hz	8	20th
640 Hz to 1.2 kHz	16	10th
1.2 kHz to 2.5 kHz	32	5th
2.5 kHz to 5.0 kHz	64	3th

Accuracy

Frequency	Voltage(U), Current(I), Active Power(P)
0.5 Hz to 30 Hz	±0.4%rdg.±0.2%f.s.
30 Hz to 400 Hz	±0.3%rdg.±0.1%f.s.
400 Hz to 1 kHz	±0.4%rdg.±0.2%f.s.
1 kHz to 5 kHz	±1.0%rdg.±0.5%f.s.
5 kHz to 10 kHz	±2.0%rdg.±1.0%f.s.
10 kHz to 13 kHz	±5.0%rdg.±1.0%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 MΩ ±100 kΩ
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	±20 V (during analog, frequency, and pulse input)
Maximum rated voltage to earth	50 V (50/ 60 Hz) 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	±1 V, ±5 V, ±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	±0.1%rdg. ±0.1%f.s.
Temperature coefficient	±0.03%f.s./°C
Effect of common mode voltage	Not more than ±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 ±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 ±120%
Zero adjustment	Zero-corrected input offset of voltage ±10% f.s. or less

(2) Frequency Input (CH A only)

Valid amplitude range	±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	±0.05%rdg. ±3dgt.
Total display area	1.000 kHz to 99.999 kHz

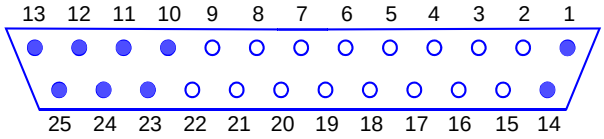
(3) Pulse Input (CH B only)

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 µs or better
Measurement accuracy	±0.05%rdg. ±3dgt.

(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 200 kHz
Minimum detectable pulse width	2.5 µs or better
Settings	OFF/Z Phase/B Phase (clear counts of CHB in rising edge during Z Phase, detect polar code for number of rotations during B Phase)

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 ±0.2%f.s. (DC level) Waveform output....Measurement accuracy±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±3°C 80% RH or less Warm-up time:..... 30 minutes or more, After zero adjustment of the 3390
Temperature Coefficient	±0.05%f.s./°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 7 (32bit, 64bit), 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 compliamt
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-232CInterface

Method	RS-232C, [EIA RS-232D], [CCITT V.24], [JIS X5101] compliamt
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. Signed items are compared for absolute 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 (Pm) 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 η = 100 × |Pout| / |Pin|, Loss = |Pin| - |Pout|

(5) Δ - YCalculation

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	U1s = (U1s-U3s)/3, U2s = (U2s-U1s)/3, U3s =U3s-U2s)/3

(6) Selecting the Calculation Method

Function	Select the calculation method used to calculate the apparent power and reactive power during 3P3W3M wiring. Only affect measurement values S123, Q123, ϕ123, λ123
Calculation method	TYPE1/TYPE 2 (only valid when wiring is 3P3W3M)

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.
Trigger	Synchronized with the harmonic sync source
Recording length	1000 / 5000 / 10000 / 50000 ×All 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

(2) Screen Capture

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.
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 μs 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	±500.00°C(single range, independent of thermometer setting)
Temperature units	°C °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°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	<table><tr><th></th><th>CH1</th><th>CH2</th><th>CH3</th><th>CH4</th></tr><tr><td>Mode 1</td><td>1P2W</td><td>1P2W</td><td>1P2W</td><td>1P2W</td></tr><tr><td>Mode 2</td><td colspan="2">1P3W</td><td>1P2W</td><td>1P2W</td></tr><tr><td>Mode 3</td><td colspan="2">3P3W2M</td><td>1P2W</td><td>1P2W</td></tr><tr><td>Mode 4</td><td colspan="2">1P3W</td><td colspan="2">1P3W</td></tr><tr><td>Mode 5</td><td colspan="2">3P3W2M</td><td colspan="2">1P3W</td></tr><tr><td>Mode 6</td><td colspan="2">3P3W2M</td><td colspan="2">3P3W2M</td></tr><tr><td>Mode 7</td><td colspan="3">3P3W3M</td><td>1P2W</td></tr><tr><td>Mode 8</td><td colspan="3">3P4W</td><td>1P2W</td></tr></table>
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) η=100 × |Pout|/|Pin|
Loss calculations	Three items (select from all active power values) Loss=|Pin| - |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 cannels	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	100 Hz, 500 Hz, 1 kHz, 5 kHz (same as max. measurement frequency setting for motor)
Full-scale integration	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)
CHAScalling	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, ± 5V, ±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
CHBScalling	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 Input	OFF/ Z-phase / B-phase (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%	
	Curret 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+		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 to180.00	●
	Current phase angle	θI	°	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4		0.00 to180.00	●
	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	WP+	Wh	1, 2, 3, 4	3, 4, 12	12, 34	4, 123	P Range	zero to 100% *5	
	Energy in negative direction	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		Polarity (+/-)
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]

(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]

(5) With 1000 A sensor (model CT6865), only when the setting value of CT rate is 2

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
20.000A (10.000A)	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
40.000A (20.000A)	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
100.00A (50.000A)	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
200.00A (100.00A)	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
400.00A (200.00A)	1P2W	6.0000k	12.000k	24.000k	60.000k	120.00k	240.00k	600.00k
	1P3W 3P3W (2M/3M)	12.000k	24.000k	48.000k	120.00k	240.00k	480.00k	1.2000M
	3P4W	18.000k	36.000k	72.000k	180.00k	360.00k	720.00k	1.8000M
1.0000kA (500.00A)	1P2W	15.000k	30.000k	60.000k	150.00k	300.00k	600.00k	1.5000M
	1P3W 3P3W (2M/3M)	30.000k	60.000k	120.00k	300.00k	600.00k	1.2000M	3.000M
	3P4W	45.000k	90.00k	180.00k	450.00k	0.9000M	2.4000M	4.5000M

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	$Umn_{(i)} = \frac{\pi}{2\sqrt{2}}\frac{1}{M}\sum_{S=0}^{M-1}\lvert U(i)s\rvert$	$Umn_{12} = \frac{1}{2}(Imn_1 + Imn_2)$ $Umn_{34} = \frac{1}{2}(Imn_3 + Imn_4)$		$Umn_{123} = \frac{1}{3}(Umn_1 + Umn_2 + Umn_3)$	
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 *U1(i)* for harmonic calculation formulas				
Peak voltage	$Upk+(i) = U(i)s$ Maximum *M* value $Upk-(i) = U(i)s$ Minimum *M* value				
THD Voltage Percentage	*Uthd(i)* in harmonic calculation formulas				
Voltage ripple rate	$\frac{\lvert(Upk+(i) - Upk-(i))\rvert}{(2\times\lvert Udc_{(i)}\rvert)}\times 100$				
Voltage unbalance factor				$Uunb_{123} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}}\times 100$ $\beta = \frac{U_{12}^4 + U_{23}^4 + U_{31}^4}{(U_{12}^2 + U_{23}^2 + U_{31}^2)^2}$ 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.	

(i) : ..... Measurement channel
M : ..... Number of synchronous samples
s : ..... Sample (data point) number

Items \ Phase System	1P2W	1P3W	3P3W2M	3P3W3M	3P4W
Current RMS	$Irms_{(i)} = \sqrt{\frac{1}{M}\sum_{S=0}^{M-1}(I_{(i)s})^2}$	$Irms_{12} = \frac{1}{2}(Irms_1 + Irms_2)$ $Irms_{34} = \frac{1}{2}(Irms_3 + Irms_4)$		$Irms_{123} = \frac{1}{3}(Irms_1 + Irms_2 + Irms_3)$	
Current MEAN	$Imn_{(i)} = \frac{\pi}{2\sqrt{2}}\frac{1}{M}\sum_{S=0}^{M-1}\lvert I_{(i)s}\rvert$	$Imn_{12} = \frac{1}{2}(Imn_1 + Imn_2)$ $Imn_{34} = \frac{1}{2}(Imn_3 + Imn_4)$		$Imn_{123} = \frac{1}{3}(Imn_1 + Imn_2 + Imn_3)$	
Current AC component	$Iac_{(i)} = \sqrt{(Irms_{(i)})^2 - (Idc_{(i)})^2}$				
Current simple average	$Idc_{(i)} = \frac{1}{M}\sum_{s=0}^{M-1} I_{(i)s}$				
Current fundamental wave component	Harmonic current *I1(i)* in harmonic calculation formulas				
Peak current	$Ipk+(i) = I_{(i)s}$ Maximum *M* value $Ipk-(i) = I_{(i)s}$ Minimum *M* value				
THD Current Percentage	*Ithd(i)* in harmonic calculation formulas				
Current ripple rate	$\frac{\lvert(Ipk+(i) - Ipk-(i))\rvert}{(2\times\lvert Idc_{(i)}\rvert)} \times 100$				
Current unbalance factor				$Iunb_{123} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ $\beta = \frac{I_{12}^4 + I_{23}^4 + I_{31}^4}{(I_{12}^2 + I_{23}^2 + I_{31}^2)^2}$ I_{12}, I_{23}, and I_{31} 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

Items \ Phase System	1P2W	1P3W	3P3W2M	3P3W3M	3P4W
Active power	$P(i) = \frac{1}{M}\sum_{s=0}^{M-1}(U(i)s \times I(i)s)$	$P_{12} = P_1 + P_2$ $P_{34} = P_3 + P_4$		$P_{123} = P_1 + P_2 + P_3$	
	• For 3P3W3M and 3P4W systems, phase voltage is used for waveform voltage $U(i)s$. (3P3W3M:*U1s=(U1s-U3s)*/3, *U2s=(U2s-U1s)*/3, *U3s=(U3s-U2s)/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	$S(i) = U(i) \times I(i)$	$S_{12} = S1 + S2$ $S_{34} = S3 + S4$	$S_{12} = \frac{\sqrt{3}}{2}(S_1 + S_2)$ $S_{34} = \frac{\sqrt{3}}{2}(S_3 + S_4)$	When calculation method TYPE1 is selected $S_{123} = S_1 + S_2 + S_3$ When calculation method TYPE2 is selected $S_{123} = \frac{\sqrt{3}}{3}(U_1 \times I_1 + U_2 \times I_3 + U_3 \times I_2)$	$S_{123} = S_1 + S_2 + S_3$
	• Select *U(i)* and *i(i)* from rms/mn. • Use phase voltage for voltage U(i) during 3P3W3M and 3P4W wirings for calculation method TYPE1.				
Reactive power	$Q(i) = si(i)\sqrt{S(i)^2 - P(i)^2}$	$Q_{12} = Q_1 + Q_2$ $Q_{34} = Q_3 + Q_4$		When calculation method TYPE1 is selected $Q_{123} = Q_1 + Q_2 + Q_3$ When calculation method TYPE2 is selected $Q_{123} = Si_{123}\sqrt{S_{123}^2 - P_{123}^2}$	$Q_{123} = Q_1 + Q_2 + Q_3$
	• 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. Use phase voltage for voltage waveform U(i)s during 3P3W3M and 3P4W wirings for calculation method TYPE1. (*3P3W3M:U1s=(U1s-U3s)/3*, *U2s=(U2s-U1s)/3*, *U3s=(U3s-U2s)/3*) • Use calculation method TYPE2's S123 for S123 under 3P3W3M wiring for calculation method TYPE2, and obtain the polarity sign si123 from the sign for Q123 of calculation method TYPE1.				
Power factor	$\lambda(i) = si(i)\left\lvert\frac{P(i)}{S(i)}\right\rvert$	$\lambda_{12} = si12\left\lvert\frac{P_{12}}{S_{12}}\right\rvert$ $\lambda_{34} = si34\left\lvert\frac{P_{34}}{S_{34}}\right\rvert$		$\lambda_{123} = si_{123}\left\lvert\frac{P_{123}}{S_{123}}\right\rvert$	
	• 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 *si12, si34*, and *si123* are acquired from reactive power values *Q12, Q34*, and *Q123*, respectively.				
Power phase angle	$\phi(i) = si(i)\cos^{-1}\lvert\lambda(i)\rvert$	$\phi_{12} = si12\cos^{-1}\lvert\lambda_{12}\rvert$ $\phi_{34} = si34\cos^{-1}\lvert\lambda_{34}\rvert$		$\phi_{123} = si123\cos^{-1}\lvert\lambda_{123}\rvert$	
	• 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 *si12, si34*, and *si123* are acquired from reactive power values *Q12, Q34*, and *Q123*, 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)	$\frac{1}{M}\sum_{s=0}^{M-1} As$	
	N• m, mN• m, or kN• m common to all measurements (torque)	For Analog DC	A [V] × channel A scaling setting
		For Frequency	$\frac{\text{(Measurement freq. – } fc \text{ setting value)} \times \text{rated torque setting value)}}{fd \text{ setting value}}$
	M :Number of synchronous samples, *S* :Sample (data point) number		
chB	V (DC Voltage)	$\frac{1}{M}\sum_{s=0}^{M-1} Bs$	
	Hz (Frequency)	For Analog DC	B [V] × channel B scaling setting
		Pulse input	$si \frac{\text{set no. of poles} \times \text{pulse frequency}}{2 \times \text{set no. of pulses}}$ *1 Polarity sign si is obtained from the rise/fall edge and logic level (High/Low) of A Phase pulse and B Phase pulse.
	r/min (rotation rate)	For Analog DC	B [V] × channel B scaling setting
		Pulse input	$\frac{2 \times 60 \times \text{freuency[Hz] (calculated from above Pulse Input value *1)}}{\text{set no. of poles}}$
Pm	N• m (Ch A units)	(Ch A display value) × $\frac{2 \times \pi \times \text{(Ch B display value)}}{60}$	
	mN• m (Ch A units)	(Ch A display value) × $\frac{2 \times \pi \times \text{(Ch B display value)}}{60 \times 1000}$	
	kN• m (Ch A units)	(Ch A display value) × $\frac{2 \times \pi \times \text{(Ch B display value)} \times 1000}{60}$	
	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)	$100 \times \frac{\text{frequency - |Ch B display value|}}{\text{input frequency}}$	
	r/min (Ch B units)	$100 \times \frac{2 \times 60 \times \text{input frequency - |Ch B display value|} \times \text{set no. of poles}}{2 \times 60 \times \text{Input frequency}}$	
	Select an input frequency (f_1 to f_4)		

3.Harmonic Measurement Calculation Formulas

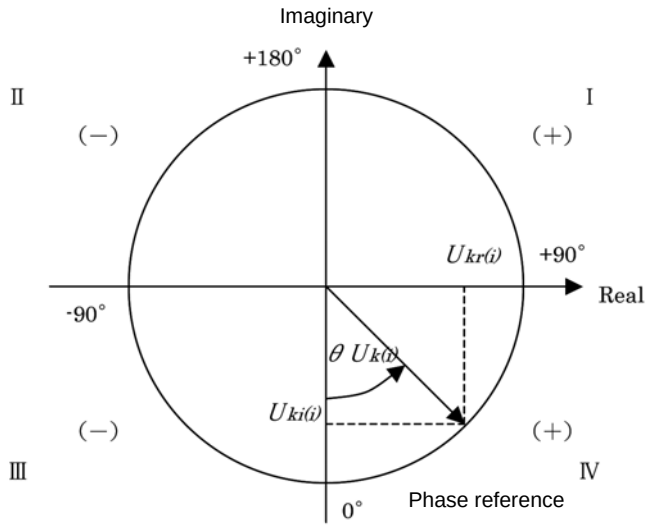
<table>
<tr><th>Items \ Phase System</th><th>1P2W</th><th>1P3W</th><th>3P3W2M</th><th>3P3W3M</th><th>3P4W</th></tr>
<tr><td>Harmonic voltage</td><td colspan="5">$U_{k(i)} = \sqrt{(U_{kr(i)})^2 + (U_{ki(i)})^2}$</td></tr>
<tr><td>Harmonic voltage Phase angle</td><td colspan="5">$\theta U_{k(i)} = tan^{-1}\left(\frac{U_{kr(i)}}{-U_{ki(i)}}\right)$</td></tr>
<tr><td>Harmonic current</td><td colspan="5">$I_{k(i)} = \sqrt{(I_{kr(i)})^2 + (I_{ki(i)})^2}$</td></tr>
<tr><td>Harmonic current Phase angle</td><td colspan="5">$\theta I_{k(i)} = tan^{-1}\left(\frac{I_{kr(i)}}{-I_{ki(i)}}\right)$</td></tr>
<tr><td rowspan="2">Harmonic effective power</td><td colspan="3">$P_{k(i)} = U_{kr(i)} \times I_{kr(i)} + U_{ki(i)} \times I_{ki(i)}$</td><td>$P_{k1} = \frac{1}{3}(U_{kr1} - U_{kr3}) \times I_{kr1} + \frac{1}{3}(U_{ki1} - U_{ki3}) \times I_{ki1}$
$P_{k2} = \frac{1}{3}(U_{kr2} - U_{kr1}) \times I_{kr2} + \frac{1}{3}(U_{ki2} - U_{ki1}) \times I_{ki2}$
$P_{k3} = \frac{1}{3}(U_{kr3} - U_{kr2}) \times I_{kr3} + \frac{1}{3}(U_{ki3} - U_{ki2}) \times I_{ki3}$
$P_{k4} = U_{kr4} \times I_{ki4} + U_{ki4} \times I_{kr4}$</td><td>Same as 1P2W</td></tr>
<tr><td>------</td><td colspan="2">$P_{k12} = P_{k1} + P_{k2}$
$P_{k34} = P_{k3} + P_{k4}$</td><td>$P_{k123} = P_{k1} + P_{k2} + P_{k3}$</td><td></td></tr>
<tr><td rowspan="2">Harmonic reactive power (only used internally)</td><td colspan="3">$Q_{k(i)} = U_{kr(i)} \times I_{ki(i)} - U_{ki(i)} \times I_{kr(i)}$</td><td>$Q_{k1} = \frac{1}{3}(U_{kr1} - U_{kr3}) \times I_{ki1} - \frac{1}{3}(U_{ki1} - U_{ki3}) \times I_{kr1}$
$Q_{k2} = \frac{1}{3}(U_{kr2} - U_{kr1}) \times I_{ki2} - \frac{1}{3}(U_{ki2} - U_{ki1}) \times I_{kr2}$
$Q_{k3} = \frac{1}{3}(U_{kr3} - U_{kr2}) \times I_{ki3} - \frac{1}{3}(U_{ki3} - U_{ki2}) \times I_{kr3}$
$Q_{k4} = U_{kr4} \times I_{ki4} - U_{ki4} \times I_{kr4}$</td><td>Same as 1P2W</td></tr>
<tr><td>------</td><td colspan="2">$Q_{k12} = Q_{k1} + Q_{k2}$
$Q_{k34} = Q_{k3} + Q_{k4}$</td><td>$Q_{k123} = Q_{k1} + Q_{k2} + Q_{k3}$</td><td></td></tr>
<tr><td rowspan="2">Harmonic voltage Current phase angle</td><td colspan="5">$\theta_{k(i)} = \theta I_{k(i)} - \theta U_{k(i)}$</td></tr>
<tr><td>------</td><td colspan="2">$\theta_{k12} = tan^{-1}\left(\frac{Q_{k12}}{P_{k12}}\right)$
$\theta_{k34} = tan^{-1}\left(\frac{Q_{k34}}{P_{k34}}\right)$</td><td>$\theta_{k123} = tan^{-1}\left(\frac{Q_{k123}}{P_{k123}}\right)$</td><td></td></tr>
</table>

(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).

Items \ Phase System	1P2W	1P3W	3P3W2M	3P3W3M	3P4W
Harmonic voltage content	$Uhd_{k(i)} = \frac{U_k}{U_1} \times 100$				
Harmonic current content	$Ihd_{k(i)} = \frac{I_k}{I_1} \times 100$				
Harmonic power content	$Phd_{k(i)} = \frac{P_k}{P_1} \times 100$				
THD Voltage Percentage	$Uthd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K} (U_k)^2}}{U_1} \times 100$ (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	$Ithd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K} (I_k)^2}}{I_1} \times 100$ (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)

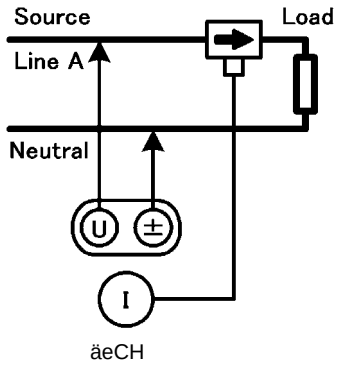


Example: for harmonic voltage

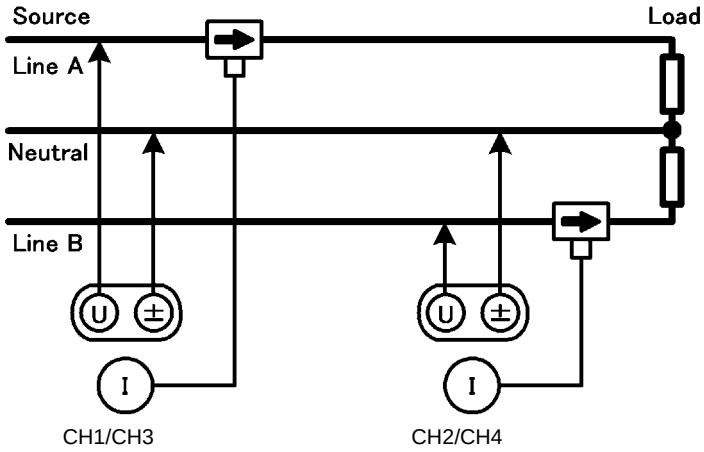
I	$\tan^{-1}\left(\frac{U_{kr(i)}}{-U_{ki(i)}}\right) + 180°$
II, III	$\tan^{-1}\left(\frac{U_{kr(i)}}{-U_{ki(i)}}\right)$
IV	$\tan^{-1}\left(\frac{U_{kr(i)}}{-U_{ki(i)}}\right) - 180°$
$U_{kr(i)} = 0, U_{kr(i)} < 0$	+90°
$U_{kr(i)} = 0, U_{kr(i)} > 0$	-90°
$U_{kr(i)} < 0, U_{kr(i)} = 0$	+180°
$U_{kr(i)} = 0, U_{kr(i)} = 0$	0°

4.Wiring System Diagrams

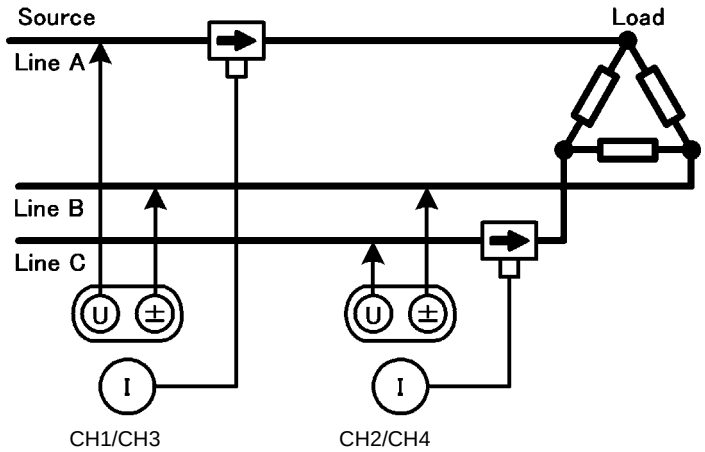
Single Phase 2-wire (1P2W)



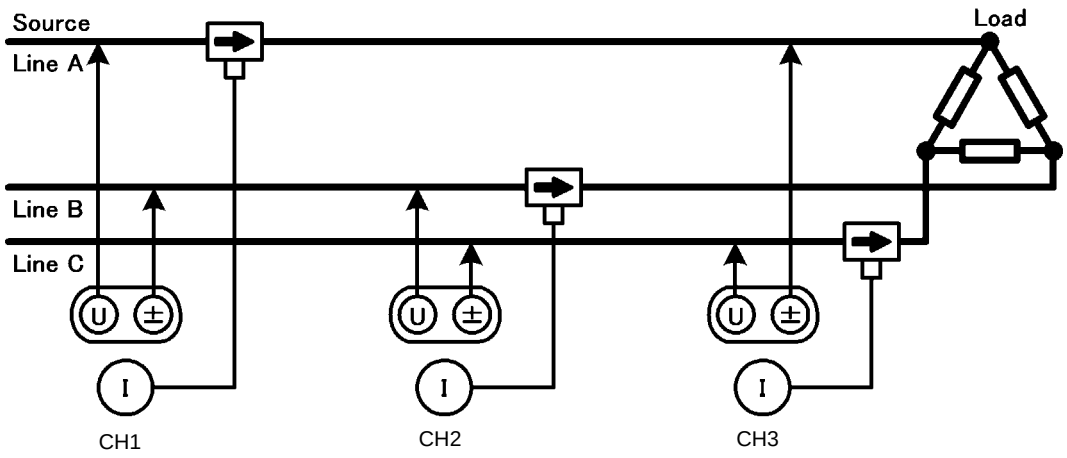
Single Phase 3-wire (1P3W)



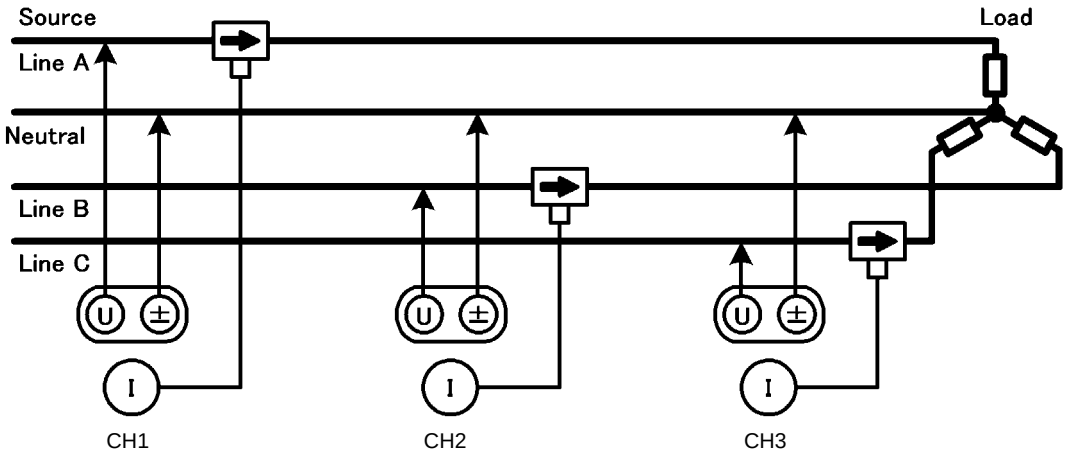
3-Phase, 3-Wire, 2-Measurement (3P3W2M)



3-Phase, 3-Wire, 3-Measurement (3P3W3M)



3-Phase, 4-Wire (3P4W)



Maintenace and Service Chapter11

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. 180) and Section "11.3 Error Indication" (p. 182).

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. 180) 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.

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 ESC/Off for three seconds to disable the key-lock function.
Setting cannot be changed.	Is the integration operation is progress or stopped?	Reset the integration value (DATA RESET). **See** "4.3 Integration Value Observation" (p. 53)
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. 127)
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. 104)	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)
Effective power is not displayed.	Are the settings for voltage range/current range, and zero-suppression correct?	Set appropriate values for voltage range/current range. When the input is too small in relation to the range, set the zero-suppression to 0.1% or OFF. **See** "4.2.2 Selecting Ranges" (p. 43) **See** "Chapter 6 Changing System Settings" (p. 103)

Symptom	Check Item, or Cause	Remedy and Reference
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. 73)
	Is the input frequency below the lower limit setting?	Set the lower limit frequency for measurement. **See** "4.2.4 Frequency Measurement Settings" (p. 49)
	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)
	Is the measurement target a largely distorted waveform such as PWM?	Set the zero-crossing filter to "Strong". **See** 4.2.3 "Setting the Zero-Crossing Filter" (p. 48)
3-phase voltage is measured low	Is the phase voltage measured under the Δ-Y conversion function?	Turn OFF the Δ-Y conversion function. **See** "5.5 Δ-YConversion Function" (p. 100)
Power measurement value is strange.	Is the wiring correct?	Check that the wiring is correct. **See** "3.11 Verifying Correct Wiring (Connection Check)" (p. 36)
	Is the rectification method and LPF correct?	Set the correct rectification method. Try turning OFF the LPF if the LPF is set. **See** "4.2.5 Selecting the Rectification Method" (p. 50) **See** "4.2.7 Setting the Low-Pass Filter" (p. 52)
Current does not show 0 even with no input	Is a low current range used under the universal Clamp-on CT? Could be due to high frequency noise of current sensor.	Set the LPF to 100kHz and then carry out zero adjust. **See** "4.2.7 Setting the Low-Pass Filter" (p. 52) **See** "3.10 Attaching to the Lines to be Measured and Zero Adjustment" (p. 34)
Apparent power and reactive power of the inverter's secondary side are different from other measuring devices Voltage value is displayed high	Is the rectification method the same as other measuring devices?	Set the rectification method same as other measuring devices. **See** "4.2.5 Selecting the Rectification Method" (p. 50)
	Calculation method may be different.	Set the calculation method to TYPE2. **See** "5.6 Selecting the Calculation Method" (p. 101)
Number of motor rotations cannot be measured	Is the pulse output the voltage output? Pulse of the open collector output cannot be detected.	Select a voltage output suitable for the setting of the CH B pulse input. **See** 10.1 -6 "(3) Pulse Input (CH B only)" (p. 158)
	Is there noise in the pulse output?	Confirm the cable wiring. Ground the encoder providing the pulse output. Condition may improve when the common side of the signal is grounded.
An unusually big value is recorded in the saved data	Is the range exceeded?	Select an appropriate range setting. **See** "4.2.2 Selecting Ranges" (p. 43) **See** "Appendix2 Measurement Data Saving Format" (p. A2)

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. 105)

11.3 Error Indication

An error indicator appears when an error occurs. Refer to the corresponding countermeasure for each case. Press ESC /On 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 Backuped 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. **See** "4.3 Integration Value Observation" (p. 53)
Waiting or halting for integration.	Attempted to change settings while awaiting (or stopping) integration.	
Holding.	Attempted to change settings during Data Hold.	Change the setting after canceling Data or Peak Hold. **See** "5.3 Data Hold and Peak Hold Functions" (p. 96)
Peak holding.	Attempted to change settings during Peak Hold.	
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 × CT exceeds the full scale (1.0E+06).	Attempted VT ratio setting would cause over-range VT× CT value.	Set values that do not exceed the VT× CT limit (1.0E+06). **See** "4.2.6 Setting Scaling (when using VT(PT) or CT)" (p. 51)
Cannot change the CT value. VT × CT exceeds the full scale (1.0E+06).	Attempted CT ratio setting would cause over-range VT× CT value.	
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. **See** "5.1 Timing Control Functions" (p. 93)
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.	
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. 116)

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. 74) "4.6.3 Setting the Minimum Noise Frequency" (p. 75)
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. 75)
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. 133)
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. 111) "7.10 File and Folder Operations" (p. 121)
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. 108)
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 automaticaly.	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. 121)
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. 121)

11.3 Error Indication

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. 107)
Invalid setteing 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. 120)
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. 108)
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. 125)
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. 125)
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. 125)
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. 108)
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 saveing.	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.

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. 120)
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 supprted.	Incompatible CF card found.	Use a Hioki CF card option. See "Chapter 7 Data Saving and File Operations" (p. 107)
USB memory stick error! This memory stick is not supprted.	Incompatible CF card found.	Use a Hioki CF card option. See "Chapter 7 Data Saving and File Operations" (p. 107)
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. 128)
Synchronized signals cannot be detected.	Synchronized signals cannot be detected from the master when setting the slave.	Confirm that the master is connected with synchronized cable and that the master is turned ON. See "8.3 Connecting Multiple 3390 (Synchronized Measurements)" (p. 133) When not using the synchronization function, set the synchronization control setting to [Master].
Unknown error!	An unknown error has occurred.	Clear this error by pressing any key except SHIFT or SAVE 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.

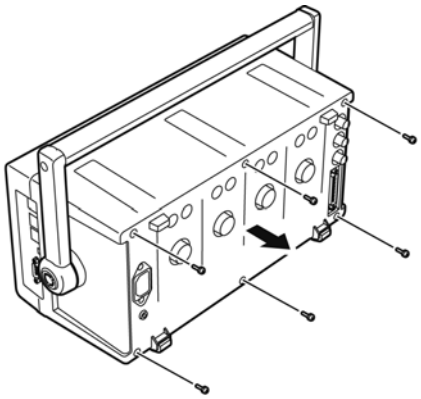
11.4 Disposing of the Instrument

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.**

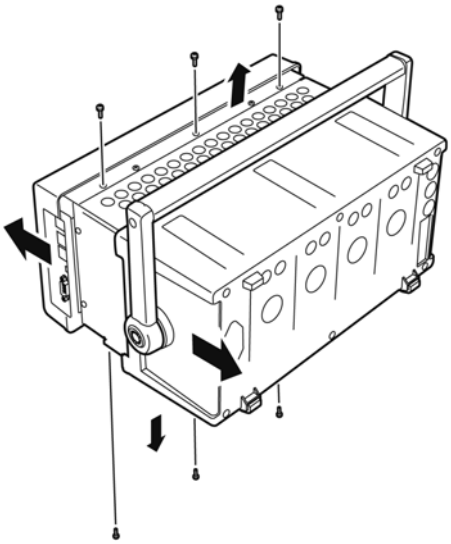
Tools required: One No. 2 Phillips screwdriver, tweezers



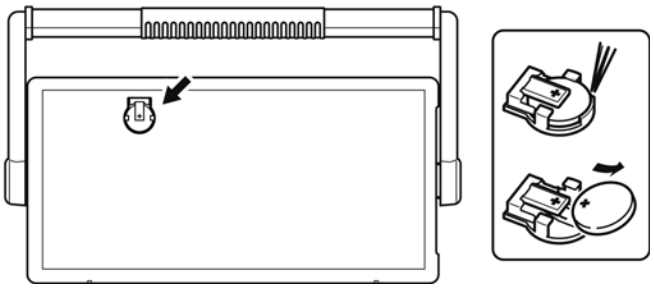
1. Turn the instrument's power switch off.

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.

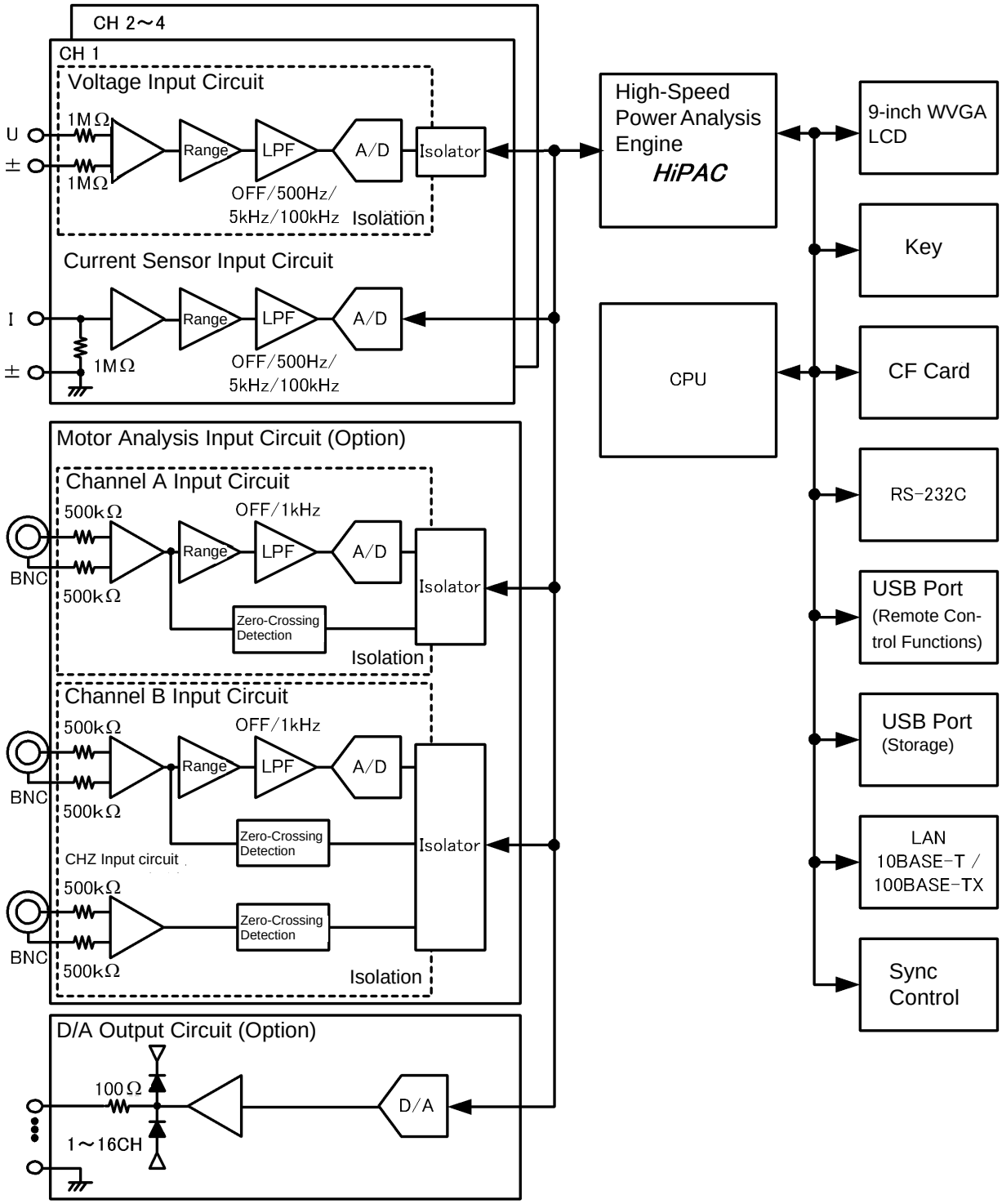


5. Insert the tweezers between the battery and its holder on the internal board, and lift the battery to remove it.

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

Appendix1 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 Percent-age	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.

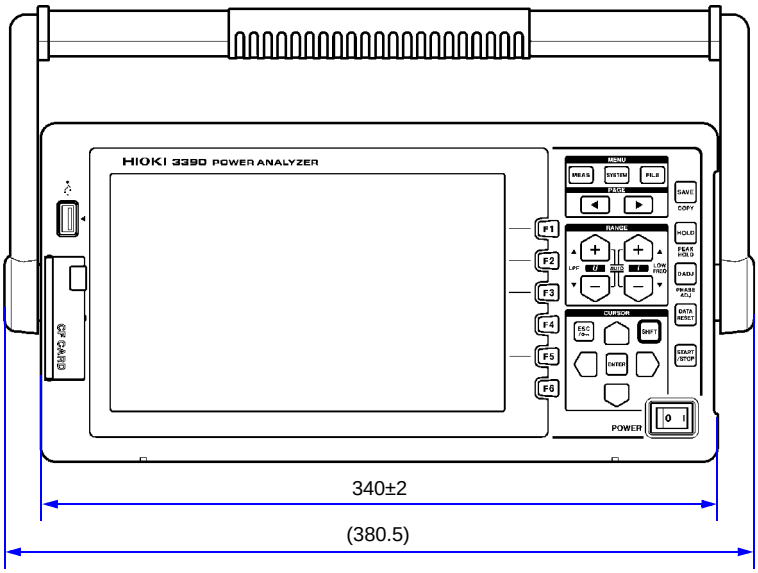
bit 31	bit 30	bit 29	bit 28	bit 27	bit 26	bit 25	bit 24
HM4	HM3	HM2	HM1	MRB	MRA	MPB	MPA
bit 23	bit 22	bit 21	bit 20	bit 19	bit 18	bit 17	bit 16
ULM	----	UCU	HUL	UL4	UL3	UL2	UL1
bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
RI4	RI3	RI2	RI1	RU4	RU3	RU2	RU1
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
PI4	PI3	PI2	PI1	PU4	PU3	PU2	PU1

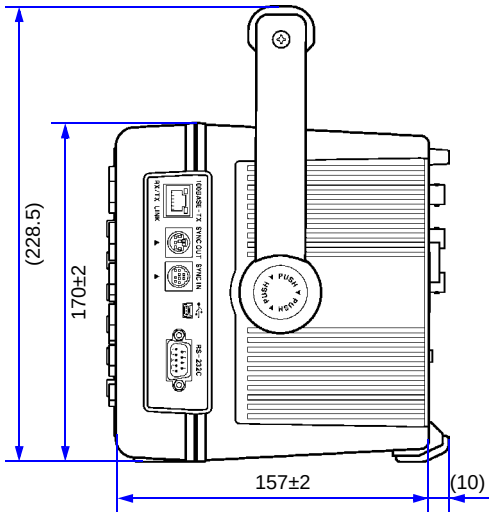
HMx : Invalid harmonic parameter (no harmonic sync)
MRx : Motor analysis options A and/or B over range
MPx : Motor analysis options A and/or B peak over
ULM : Motor analysis options A and/or B sync unlocked
UCU : Calculation Impossible (e.g., measurement data is invalid immediately after changing ranges)
HUL : Harmonic sync unlocked
ULx : Channel x sync unlocked
RIx : Channel x current over range
RUx : Channel x voltage over range
PIx : Channel x current peak over
PUx : Channel x voltage peak over
(x is a channel number)

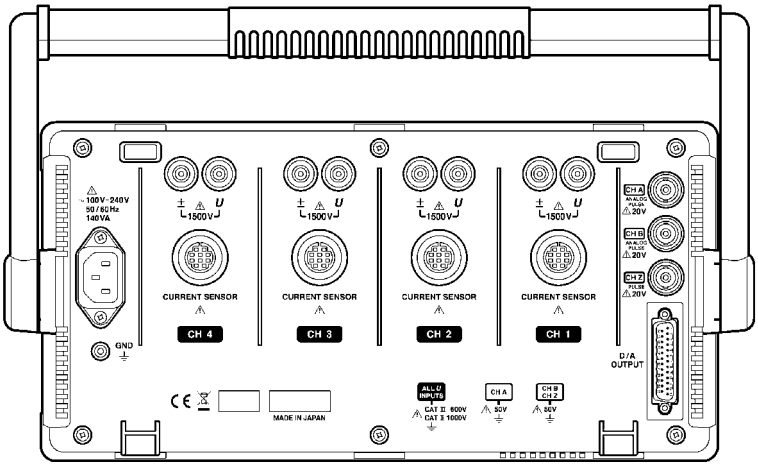
Measurement Value Data Format

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





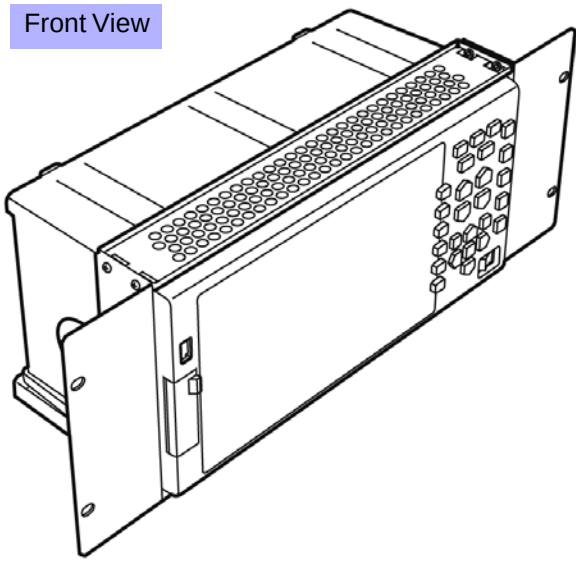


(Unit: mm)

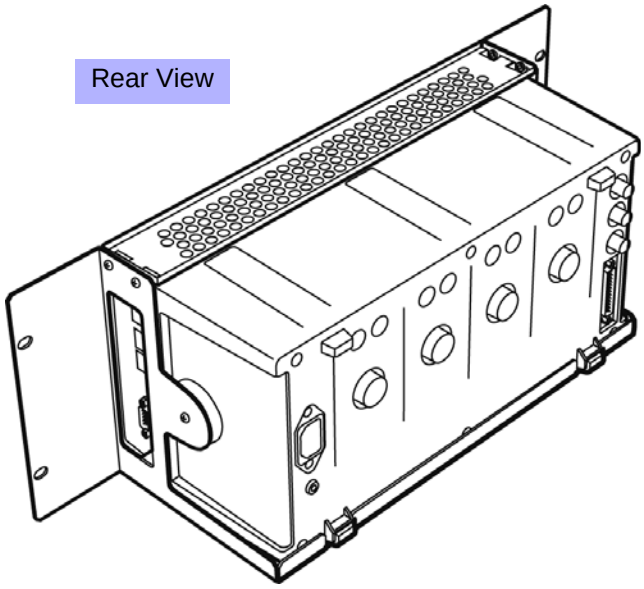
Appendix4 Rack Mounting

The illustrated rack mounting brackets are available. Contact your dealer or Hioki representative.

Front View



Rear View



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- All reasonable care has been taken in the production of this manual, but if you find any points which are unclear or in error, please contact your supplier or the International Sales and Marketing Department at Hioki headquarters.
- In the interests of product development, the contents of this manual are subject to revision without prior notice.
-

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