HIOKI

INSTRUCTION MANUAL

3197

POWER QUALITY ANALYZER

HIOKI E. E. CORPORATION

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Introduction

Thank you for purchasing the HIOKI "Model 3197 Power Quality Analyzer." To obtain maximum performance from the instrument, please read this manual carefully, and keep it handy for future reference.

In this document, the “instrument” means the Model 3197 Power Quality Analyzer.

Optional clamp-on sensors (or clamp-on leakage sensors, (⇒ p.3)) are required to measure current with this instrument. These are called clamp sensors in the rest of this manual.
Refer to the manual provided with the clamp sensors for details.

Registered trademarks

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Confirming Package Contents

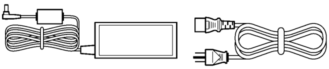
When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.

Confirm that these contents are provided.

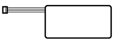
Accessories

- ☐ Model 3197 Power Quality Analyzer

- ☐ 9418-15 AC Adapter
  (AC power cord included) 1

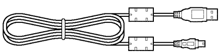


- ☐ 9459 Battery Pack 1

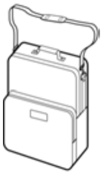


- ☐ 9438-05 Voltage Cord
  (Four black voltage cords)..........1 set

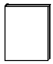
- ☐ USB Cable.. 1



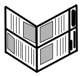
- ☐ Carrying Case.................................. 1



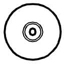
- ☐ Instruction Manual............................ 1



- ☐ Measurement Guide 1



- ☐ PC application program for Model 3197
  (CD) 1



Install these on the instrument before operating (⇒ p.37)

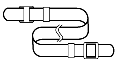
- ☐ Measurement lead labels..........1 sheet
  (For channel identification of the voltage measurement and clamp sensor leads)

(⇒ p.38)

- ☐ Input terminal labels ....1 sheet
  (Apply the appropriate labels around the input terminals according to usage)

(⇒ p.37)

- ☐ Strap ....

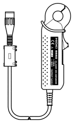
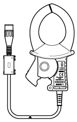
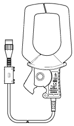
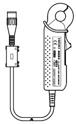
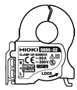
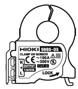


(⇒ p.38)

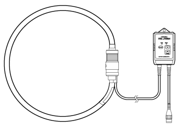
Options

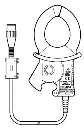
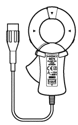
For the details, contact your supplier or Hioki representative for details.

Clamp-On Sensor Products (voltage-output type)

Clamp-On Sensors	**9660**	**9661**	**9669**	**9694**	**9695-02**	**9695-03**
						
(Rms current rating)	100	500	1000	5	50	100

Accessory: Model 9219 Connection Cable (for Models 9695-02 and -03)

Flexible Clamp-On Sensors	**9667**
	
(Rms current rating)	500, 5000

Clamp-On Leakage Sensors (for measuring leakage current)	**9657-10**	**9675**
		
(Rms current rating)	10	10

Software (PC application programs)

For computer analysis of measurement data

☐ 9624-50 PQA HiView PRO (available soon)

Power Sources

☐ 9418-15 AC Adapter (includes power cord)

☐ 9459 Battery Pack

Safety Information

DANGER **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. Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from product defects.**

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

Safety Symbols

⚠	⚠In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the instrument. The ⚠ symbol printed on the instrument indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
⎓	Indicates DC (Direct Current).
∼	Indicates AC (Alternating Current).
⏚	Indicates a grounding terminal.
I	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 an extreme 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 instrument.
NOTE	Indicates advisory items related to performance or correct operation of the instrument.

Other Symbols

	Indicates the prohibited action.
(⇒ p.)	Indicates the location of reference information.
	Indicates quick references for operation and remedies for trouble-shooting.
*	Indicates that descriptive information is provided below.
[ ]	Screen labels such as menu items, setting items, dialog titles and buttons are indicated by square brackets [ ].
SET (Bold)	Bold characters within the text indicate operating key labels.

Unless otherwise specified, "Windows" represents Windows 95, 98, Me, Windows NT4.0, Windows 2000, or Windows XP.

Accuracy

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

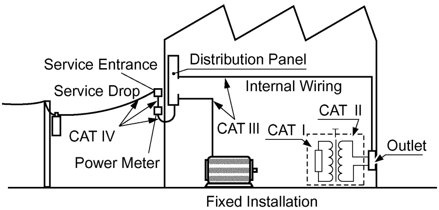
- f.s. (maximum display value or scale length)
  The maximum displayable value or scale length. This is usually the name of the currently selected range.
- rdg. (reading or displayed value)
  The value currently being measured and indicated on the measuring instrument.

Measurement categories (Overvoltage categories)

This instrument complies with CAT III (600 V) and CAT IV (300 V) safety requirements.
To ensure safe operation of measurement instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT I to CAT IV, and called measurement categories. These are defined as follows.

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

Higher-numbered categories correspond to electrical environments with greater momentary energy. So a measurement device designed for CAT III environments can endure greater momentary energy than a device designed for CAT II.
Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.
Never use a CAT I measuring instrument in CAT II, III, or IV environments.
The measurement categories comply with the Overvoltage Categories of the IEC60664 Standards.



Operating Precautions

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

Before Use

- Before using the instrument the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.
- Before using the instrument, make sure that the insulation on the 9438-05 Voltage Cord and clamp sensor leads 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:
  0 to 40°C at 80% RH or less (non-condensating)
- Temperature and humidity range for guaranteed accuracy:
  23±5°C, 80%RH or less

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

Exposed to direct sunlight
Exposed to high temperature

In the presence of corrosive or explosive gases

Exposed to liquids
Exposed to high humidity or condensation

Exposed to strong electromagnetic fields
Near electromagnetic radiators

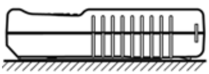
Exposed to high levels of particulate dust

Subject to vibration

Placement

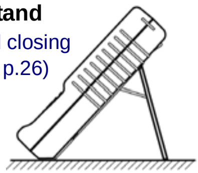
Do not place the instrument on an unstable or slanted surface.

Using without the stand



Using with the stand

See: "Opening and closing the stand"(⇒ p.26)



Handling the Instrument

⚠WARNING

- **Do not allow the instrument to get wet, and do not take measurements with wet hands. This may cause an electric shock.**
- **Never modify the instrument. Only Hioki service engineers should disassemble or repair the instrument. Failure to observe these precautions may result in fire, electric shock, or injury.**
- **To avoid electric shock when measuring live lines, wear appropriate protective gear, such as insulated rubber gloves, boots and a safety helmet.**

⚠CAUTION

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

Handling the cords and clamps

⚠DANGER

Connect the clamp-on 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.

- **To avoid short circuits and potentially life-threatening hazards, never attach the clamp to a circuit that operates at more than the maximum rated voltage to earth (9660: 300 VAC, 9661: 600 VAC, 9667: 1000 VAC, 9669: 600 VAC, 9694:300 VAC), or over bare conductors.**

Maximum rated voltage to earth	Clamp sensors
AC1000 V	9667
AC600 V	9661, 9669
AC300 V	9660, 9694, 9695-02, 9695-03, 9657-10, 9675

- **Clamp sensor and voltage cords 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.**
- **Do not allow the voltage cord clips to touch two wires at the same time. Never touch the edge of the metal clips.**
- **Use only the supplied 9438-05 Voltage Cord to connect the product input terminals to the circuit to be tested.**
- **When the clamp 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.**

CAUTION

- Avoid stepping on or pinching cables, which could damage the cable insulation.
- To avoid breaking the cables, do not bend or pull them.
- To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.
- Keep the cables well away from heat sources, as bare conductors could be exposed if the insulation melts.
- Be careful to avoid dropping the clamps 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 BNC connector, be sure to release the lock before pulling off the connector. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.

Before Turning Power On

WARNING

Battery Pack Operation

- **For battery operation, use only the HIOKI Model 9459 Battery Pack. We cannot accept responsibility for accidents or damage related to the use of any other batteries.**

See: "Charge the 9459 Battery Pack"(⇒ p.40)
"9.3 Battery Pack Replacement and Disposal" (⇒ p.168)

AC Adapter Operation

- **Use only the supplied Model 9418-15 AC Adapter(SA130A-1225V-S, SINO AMERICAN). AC adapter input voltage range is 100 to 240 VAC (with ±10% stability) at 50/60 Hz. To avoid electrical hazards and damage to the instrument, do not apply voltage outside of this range.**
- **Turn the instrument off before connecting the AC adapter to the instrument and to AC power.**
- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord only to a 3-contact (two-conductor + ground) outlet.**
- **Before turning the instrument on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.**

See: "3.2 Connecting the AC Adapter" (⇒ p.41)

Input and Measurement Precautions

DANGER

- **The maximum input voltage is as follows:**
  Voltage input section: 780 Vrms, 1103 V peak.Current input section: 1.7 Vrms, 2.4 V peak
  Attempting to measure voltage in excess of the maximum input could destroy the instrument and result in personal injury or death.
- **The maximum rated voltage between the inputs and ground is 600 Vrms AC.To avoid damage to the instrument and personal injury, never attempt to measure voltage that exceeds this rated voltage above ground.**

CAUTION

- The voltage input terminals U1, U2, and U3 are not isolated from one another.
  To avoid electric shock accidents, use care to prevent wires from inadvertently touching the wrong input terminals whenever voltage is present.
- Note that the instrument may be damaged if current or voltage exceeding the selected measurement range is applied for a long time
- When the power is turned off, do not apply voltage or current to the voltage input terminals or clamp sensor. Doing so may damage the product.
- To prevent damage to the instrument and sensor, never connect or disconnect a sensor while the power is on, or while the sensor is clamped around a conductor.

NOTE

Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.

Measurement values

- To ensure measurements are precise, warm up the instrument for at least 30 minutes after plugging it in.
- This instrument is designed to measure commercial power lines with a frequency of 50 or 60 Hz. It cannot measure power lines of other frequencies or power lines where the waveforms are controlled using an inverter.
- This instrument cannot measure power lines with superposed direct current.
- This instrument uses algorithms to measure values for input voltage and current waveforms using (see the specifications). On device using different operation principles or algorithms differ, differences in measurement values may result.
- When the display value for voltage or current is less than 1% of the range, zero is displayed.

Using VT and CT

NOTE

- When the voltage or current for the power line being measured exceeds the maximum rated input for this device, use an external PT or CT.
- When using an external PT or CT, make sure you use a device with a minimal phase difference. By setting the PT or CT ratio, you can read measurement values directly.

Instrument Storage

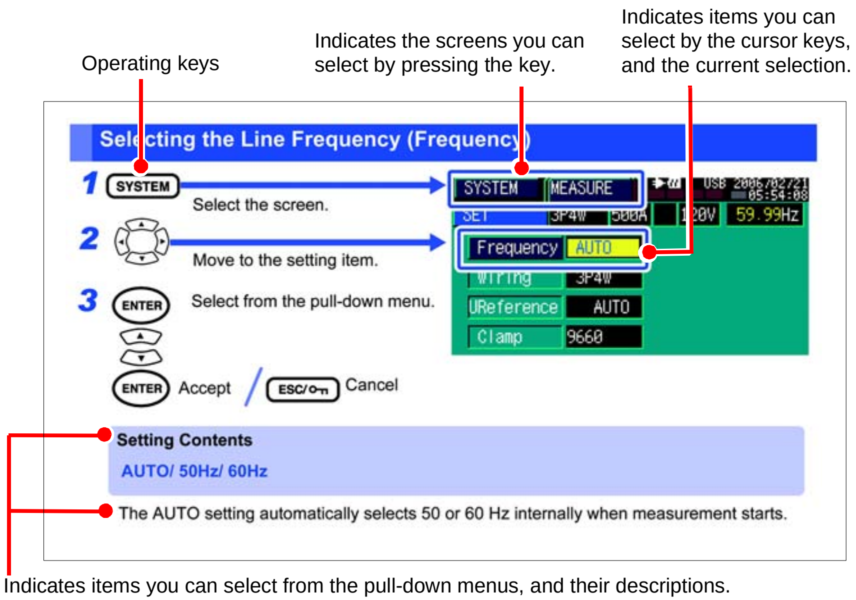
- The storage temperature range is -10 to 50°C at relative humidity not exceeding 80%.
- The battery pack should be removed when the instrument is stored. Store the battery pack in a cool place.
- The instrument should be recalibrated before use after long-term storage.

CD Handling

CAUTION

- Always hold the disc by the edges, so as not to make fingerprints on the disc or scratch the printing.
- Never touch the recorded side of the disc. Do not place the disc directly on anything hard.
- Do not wet the disc with volatile alcohol or water, as there is a possibility of the label printing disappearing.
- To write on the disc label surface, use a spirit-based felt pen. Do not use a ball-point pen or hard-tipped pen, because there is a danger of scratching the surface and corrupting the data. Do not use adhesive labels.
- Do not expose the disc directly to the sun's rays, or keep it in conditions of high temperature or humidity, as there is a danger of warping, with consequent loss of data.
- To remove dirt, dust, or fingerprints from the disc, wipe with a dry cloth, or use a CD cleaner. Always wipe radially from the inside to the outside, and do no wipe with circular movements. Never use abrasives or solvent cleaners.
- Hioki shall not be held liable for any problems with a computer system that arises from the use of this CD, or for any problem related to the purchase of a Hioki product.

Operating Procedure Descriptions in this Manual



Overview Chapter 1

1.1 Product Overview

The 3197 Power Quality Analyzer is a measurement instrument designed to detect power line anomalies and to analyze the power quality of power lines.

Power lines can be monitored and recorded for anomalies over long periods, and the causes of anomalies can be analyzed by comparing measurements with particular standard characteristics. In addition, utilizing remote computer control, abnormal events at a remote site can be noticed as soon as they occur. Measurement data recorded in internal memory can be transferred to a computer for analysis by PC application program for Model 3197.

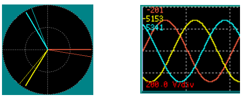
Power Quality Deterioration

Flickering light bulbs, short bulb life, malfunctioning office machines, intermittent device operation, overheating of equipment with capacitively compensated reactance, overloads, opposite- and missing-phase relays sometimes occur.

Connect the instrument to the lines to be measured.

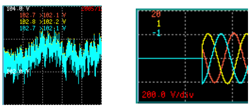
Verify the vectors and waveforms of three-phase power sources.

Three-phase voltage/ current waveform and vector displays



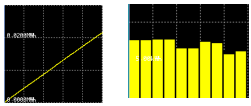
Observe voltage fluctuations of commercial power and determine the occurrence of events.

Power quality measurement



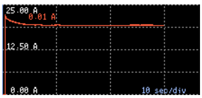
Verify energy consumption and load demand at distribution panels.

Energy consumption and demand measurement



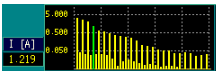
Verify inrush current, such as upon motor startup.

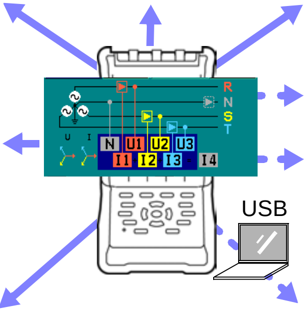
Inrush current measurement



Verify conditions of harmonic power and distortion

Harmonic measurement





Capture images of measurement conditions.

Display screens can be captured as BMP files.(⇒ p.52)

Remote Control

The instrument can be remotely controlled by a computer using the supplied USB cable and special-purpose PC application programs.

Data transfer and analysis

Transfer data to a computer connected to the instrument by USB cable, and view measurement data using the supplied PC application program for Model 3197. (⇒ p.127)

Optional analytical application programs are also available for precise data analysis.

1.2 Features

Supports various power line wiring configurations

Measures three channels of voltage and current.
With just one instrument, measure voltage, current and power on single-phase 2-wire, single-phase 3-wire, three-phase 3-wire and three-phase 4-wire systems.
Neutral current in three-phase 4-wire systems is available by calculation.

Vector multi-meter function

Measurement line wiring connections can be checked from the initial screen.
Verify phase detection (vector check), measure voltage and current, and check for miswired connections on a single screen.

Basic Setup

Use "Basic Setup" to configure settings for the wiring configuration connections and the clamp sensors to be used. Standard line frequencies and voltages are detected and set automatically. The default settings can be used for detecting typical events.

Automatic data recording compression function

This function begins recording at one-second intervals and automatically lengthens the recording interval to up to an hour as internal memory fills. This function helps to ensure that suitable data quantities are acquired for analysis, whether the overall measurement period is short or long. This function supports continuous measurement sessions of up to about 125 days.

Broad selection of clamp sensors

Select from our present line of voltage-output type clamp sensors
- Clamp-on sensor Models 9660, 9661, 9669, 9694, 9695-02, 9695-03
- Clamp-on leak sensor Models 9657-10, 9675
- Flexible clamp-on sensor Model 9667

Simultaneous measurement of various power quality parameters

The following power quality parameters can be simultaneously measured and recorded.

- Transient overvoltage (impulse)
- Voltage swells, voltage dips, interruptions, frequency, voltage, voltage waveform peaks, current, current waveform peaks, active power, apparent power, reactive power, power factor, displacement power factor, voltage unbalance factor, harmonic voltage, harmonic current, harmonic power, fundamental voltage phase difference, fundamental current phase difference, total harmonic voltage distortion factor (THD-F), K factor, active power value, reactive power value, active power demand, reactive power demand

See: "Detecting Anomalies and Phenomena Due to Drops in Power Quality" (⇒ p.A8)

Display time series plots of rms values and voltage fluctuations

Record and display fluctuations in various power quality parameters as a time series plot.
Display and record calculated maximum, average and minimum values during each measurement interval.
Rms voltage is calculated for one waveform shifted by half of a cycle, and is recorded and displayed as a time series plot of voltage fluctuations to detect voltage swell, voltage dip and interruption events.

Measure demand and energy consumption

Measure polarity-specific demand parameters such as consumption, regeneration, lag, lead and energy consumption. Demand and energy consumption can be verified on a time series plot.

Event detection function

Set thresholds at which to detect and record events while measuring.
Detected events can be analyzed using the event monitor, event list or event waveform display.
Event detection is available for voltage swells, voltage dips (instantaneous dips), interruptions, inrush current, transient overvoltage, timed and manually triggered events.

Measure inrush current

Measure motor startup current. Rms current is recorded for 30 seconds and displayed graphically.

Internal memory with backup battery preserves recorded measurement data

Measurement data is recorded into the 4 MB internal memory and retained by a lithium-ion battery that should not require replacement for about 10 years. So data is preserved even during power outages.

Color LCD included

The instrument includes a 4.7-inch color STN liquid crystal display. Numerical values, waveforms and graphs are clearly displayed.

Select from three display languages

Select Japanese, English or Chinese display text. Help messages describing the settings appear in the selected language

Selectable channel (input terminal) colors

Select from five channel color schemes.
Match the screen display colors (waveforms, vectors and numerical values) to the input terminal and measurement lead labels.

AC adapter and rechargeable battery pack included

The AC adapter and NiMH rechargeable battery pack are included as standard accessories. The battery can be charged whether the instrument is turned on or off, and powers the instrument for up to six hours of continuous operation.

Hand-held design

The instrument weighs only 1.2 kg, and the rubber grip makes it comfortably hand portable.

USB 2.0 interface and PC application program for Model 3197 are included

The instrument can be remotely controlled, and data can be transferred and analyzed on a computer using the supplied USB cable and special-purpose PC application programs.

Detect wiring connections

Detection of phases, disconnected voltage cords and reverse-connected clamp sensors can be determined from the Wiring Confirmation screen, so miswiring can be avoided when measuring.

Optional data analysis application programs (pending)

Detailed analysis of measurement data recorded by the instrument is available with the optional Model 9624-50 PQA-HiView PRO data analysis application programs.

1.3 Measurement Flowchart

Flow process descriptions are also on page 19 to page 21 .

First Steps Upon Unpacking

See: 3.1 (⇒ p.37)

Install & Connect

See: "Instrument Installation"(⇒ p.7)
3.2 (⇒ p.41)
3.3 (⇒ p.42)
3.4 (⇒ p.44)
3.5 (⇒ p.46)

Install the instrument → Connect the instrument cables → Turn power on

Make Instrument Settings

See: Chapter 4 (⇒ p.53)

Basic Setup

Execute Basic Setup to configure minimal settings such as the wiring configuration for recording measurements.

Advanced Setup (to change settings)

Make settings as needed to change threshold levels or to specify recording times.

Confirm Measurement Connections

See: 5.2 (⇒ p.81), 5.3 (⇒ p.86)

On the screen, verify that the instrument is properly connected to the lines to be measured SYSTEM (Wiring Confirmation screen).

→ **Measure instaneous data without recording**

VIEW

When finished ⇒Turn power off

Measure

See: 5.4 (⇒ p.88)

START/STOP

- Manual recording
- Time controlled recording

Measure automatically at preset start time

Finish

See: 5.4 (⇒ p.88)

Stop automatically at preset stop time

START/STOP To immediately stop measuring

Go to the next page.

Analyze Recording Data

See: Chapter 6 (⇒ p.95)

View data on the instrument

View instaneous data **VIEW**

View recorded time series data **TIME PLOT**

View recorded anomaly waveforms **EVENT**

View data on a computer

Connect the instrument to a computer using the supplied USB cable. Then using the supplied PC application program for Model 3197, transfer recorded data for analysis.

Finish

Turn the power off

1 Initial instrument preparations

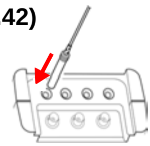
- ☐ Apply the appropriate label to the input terminals (⇒ p.37)
- ☐ Apply the appropriate labels to the voltage measurement and clamp sensor leads. (⇒ p.38)
- ☐ Attach the strap. (⇒ p.38)
- ☐ Install the 9459 Battery Pack (⇒ p.39), and charte it (⇒ p.40).

2 Install and connect the instrument, and turn the power on

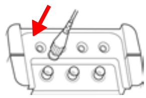
1 Install this instrument (⇒ p.7)

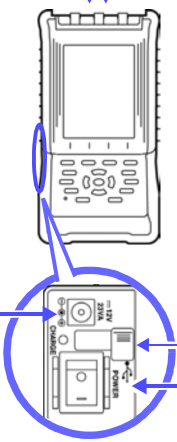
Refer to "5.1 Pre-Operation Inspection" (⇒ p.79) before using the instrument.

2 Connect the required measurement leads to the voltage input terminals. (⇒ p.42)



3 Connect the required clamp sensors to the current input terminals. (⇒ p.44)



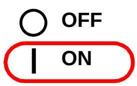


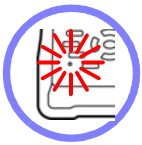
To use a computer
Connect the USB cable to the USB port on the instrument. (⇒ p.134)

4 Connect the power cord. (⇒ p.41)

1. Connect power cord to the AC adapter.
2. Plug the AC adapter into the instrument.
3. Connect the power cord to a power outlet.

5 Turn the power on (⇒ p.46).



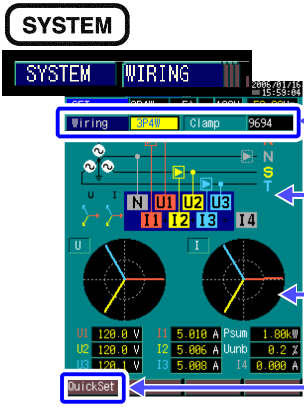


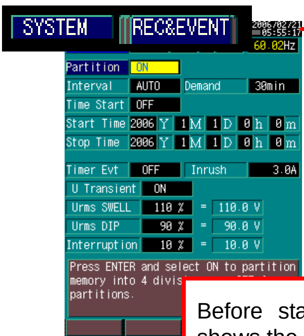
The POWER LED flashes.

3 Other preparations

- ☐ Select another display language (⇒ p.47)
- ☐ Select the screen color scheme to match the input terminal labels (⇒ p.48)
- ☐ Select the naming convention to be applied to each phase line measurement on the display. (⇒ p.49)

4 Confirming Instrument Settings and Connecting to the Lines to be Measured

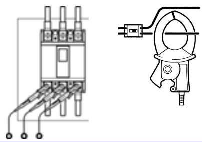




1 **Make the required settings before connecting.(⇒ p.57)**

Select the appropriate wiring configuration and clamp sensor model settings.

2 **Select the appropriate wiring configuration and clamp sensor model settings. (⇒ p.81)**



3 **Confirm the correct connection status. (⇒ p.86)**

Confirm measurement values and vector display.

4

Basic Setup measurement values and vector display

Press F1 to select Basic Setup, and press ENTER to execute. (⇒ p.54)

Advanced Setup

Make the appropriate settings for measurement as occasion demands. (⇒ p.53)

Set measurement and recording conditions such as the recording method (memory partitioning and interval) and event settings.

Before starting recording, confirm that the instrument's clock shows the correct time. If not, set the clock. (⇒ p.76)
Note that correct clock setting is especially important when recording start and end times are specified.

1

5 Start recording and analyze recorded measurement data.

Starting and stopping measurement by key presses

Start recording measurements — START/STOP → [RECORDING] → START/STOP — Stop recording measurements

Recording measurements at a specified time

Set the timers beforehand (⇒ p.66)

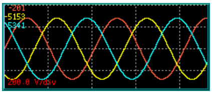
START/STOP — [WAITING] — Start Time — [RECORDING] — Stop Time

- Settings cannot be changed while recording. To change a setting, first press the **START/STOP** key to stop measuring.
- When you press the **START/STOP** key while recording, a confirmation message asks whether you want to temporarily stop recording. Press the **ENTER** key to stop the measurement.
- Enable the KEY LOCK function to avoid inadvertent key operations while recording.(⇒ p.51)
- To restart, press the **DATA RESET** key.

Analyze instaneous measurement data

Analysis can be performed during or after recording

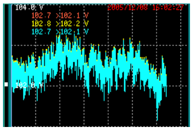
Viewing instaneous data (⇒ p.29) — VIEW



Analyze recorded measurement data

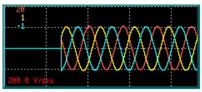
Analysis can be performed in the same way during or after recording

Viewing changes over time (time series data) (⇒ p.30) — TIME PLOT



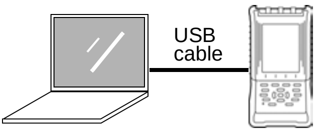
Select views of trends, demand and energy consumption.

Viewing data anomalies (when an event occurs) (⇒ p.31) — EVENT



Verify detailed event waveforms, graphs and the number of occurrences.

View on a computer



Using remote control

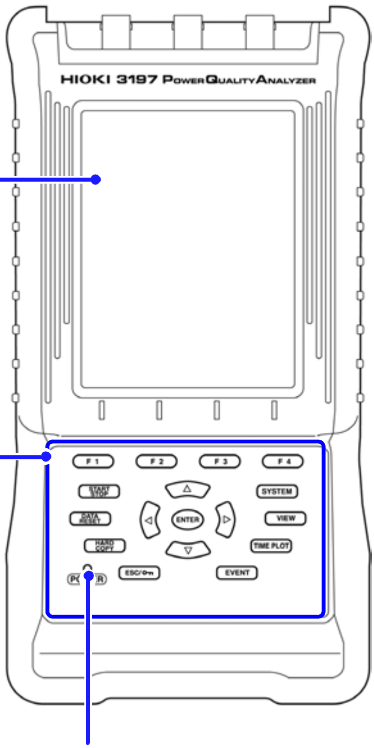
Transfer data
Analyze data
(⇒ p.127)

See the references for details

Names and Functions of Parts and Basic Setup Chapter 2

2.1 Panel and Operating Keys

Front Panel



Display Screen
4.7-inch STN color LCD

Operating Keys
(⇒ p.25)

POWER LED (green)
This LED flashes when the power switch is on, operating from the AC adapter or battery. The flashing state depends on the operating conditions. (⇒ p.46)

Left Side

Strap Hole
(⇒ p.38)

AC Adapter socket
Connect the supplied Model 9418-15 AC Adapter. (⇒ p.41)

CHARGE LED (red)
This LED lights when the battery is charging. (⇒ p.40)

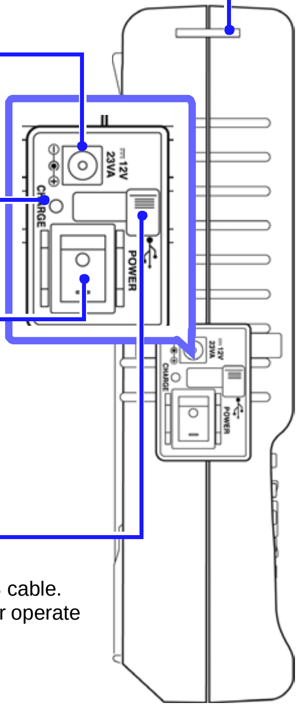
POWER Switch
Turns the instrument on and off.

○ Power Off

| Power On

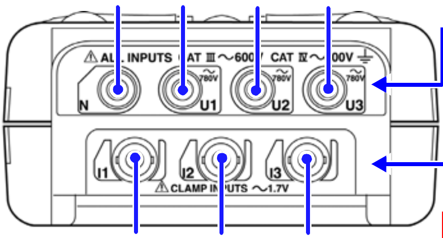
(⇒ p.46)

USB Port
(USB 2.0 mini-B receptacle)
Open the dust cap and connect the USB cable.
Connect to a computer to transfer data or operate remotely. (⇒ p.127)



Top Panel

N **U1** **U2** **U3**

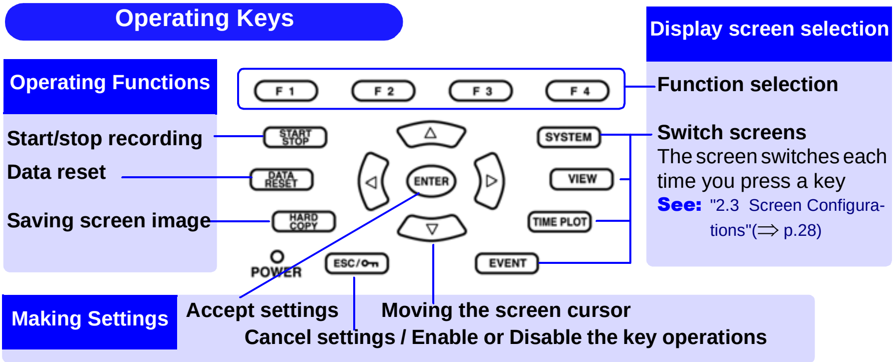


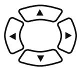
I1 **I2** **I3**

Voltage Input Terminals (⇒ p.42)
Connect the supplied Model 9438-05 Voltage Cord (voltage cords).

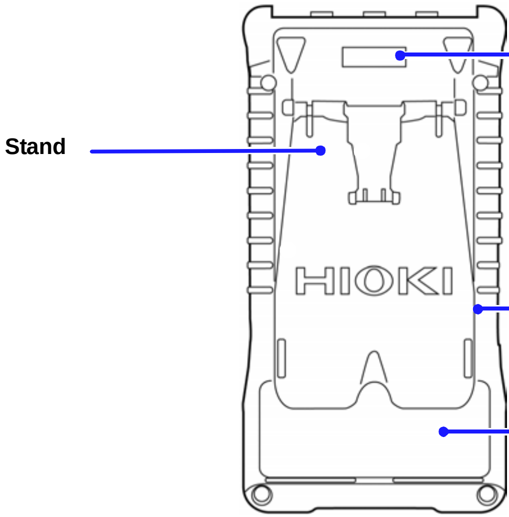
Current Input Terminals (⇒ p.44)
Connect optional clamp sensors.

Apply one of the supplied input terminal labels. (⇒ p.37)
Attach the corresponding labels to the clamp sensor and voltage cords. (⇒ p.38)



F 1 F 2 F 3 F 4	**Function keys**	Selects from the functions displayed along the bottom of the screen. Displayed functions depend on the selected screen.
SYSTEM	**SYSTEM key**	Displays the SYSTEM screen for setting instrument measurement status and checking connections. (⇒ p.28)
VIEW	**VIEW key**	Displays the VIEW screen to show measured data in waveform, vector, harmonics or DMM views. (⇒ p.29)
TIME PLOT	**TIME PLOT key**	Displays the TIME PLOT screen for analyzing measurement data fluctuations as a time series plot. (⇒ p.30)
EVENT	**EVENT key**	Displays the EVENT screen for analyzing data when an event occurs. (⇒ p.31)
	**Cursor keys**	These keys move the cursor on the screen, and scroll time series graphs.
ENTER	**ENTER key**	Accepts and applies selections and changed settings.
ESC/	**ESC / KEY LOCK key**	Cancels selections and changed settings and reverts to the original settings. KEY LOCK (disables the operating keys): hold for three seconds to lock or unlock the keys.(⇒ p.51)
START STOP	**START / STOP key**	Starts and stops recording (⇒ p.33) To restart recording: Press the **DATA RESET** key to clear the data, then press this key.
DATA RESET	**DATA RESET key**	Press this key to return to the [SET] state from the [ANALYZE] state. (⇒ p.34)
HARD COPY	**HARD COPY (Screen shot) key**	Saves the screen image as a bitmap (BMP format) file in internal memory. (⇒ p.52)

Rear Panel

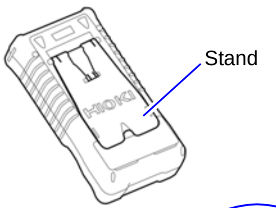


Manufacturer's serial number
Shows the manufacturer's serial number.
Do not remove this label, as it is required for product support.

Battery information
This is accessible by opening the stand.

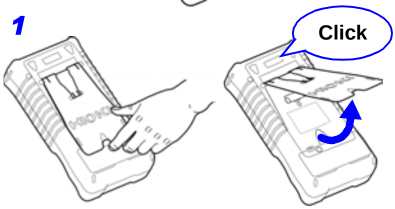
Battery Compartment
The supplied Model 9459 Battery Pack installs here. (⇒ p.39)

Opening and closing the stand



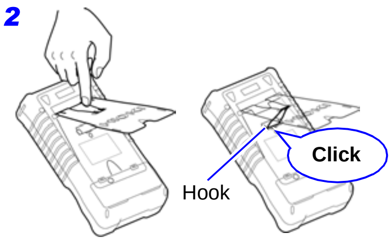
⚠CAUTION

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



Opening the stand

1. Pull the stand out until it clicks.



2. Push the stand holder in until it clicks in the hook on the rear cover.

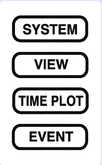
Closing the stand
Return the stand holder to its original position, and close the stand until it clicks.

2

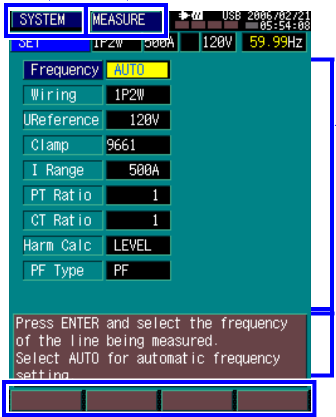
2.2 Basic Operations

Switching Screens

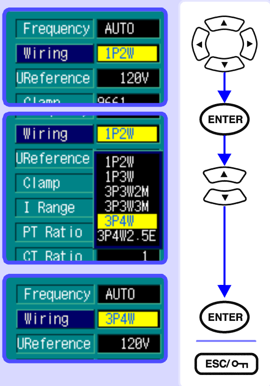
The screen switches every time you press the **SYSTEM**, **VIEW**, **TIMEPLOT**, or **EVENT** key.



Screen Type	Display Contents			
System	WIRING	MEASURE	REC&EVENT	SYSTEM
View	WAVEFORM	VECTOR	HARMONICS	DMM
Time Plot	RMS	DIP/SWELL	DEMAND	ENERGY
Event	WAVEFORM	DETAIL	RMS WAVE	INRUSH



Settings



Move between items to change settings

Opens pull-down menus

Selects from the menu

Accepts the setting

Cancels the setting

Function key usage

Display differs depending on the screen type.

Help Comment

Shows a description of the item at the cursor position on the SYSTEM screen.

NOTE Voltage fluctuation and inrush current screens can be displayed when data is present.

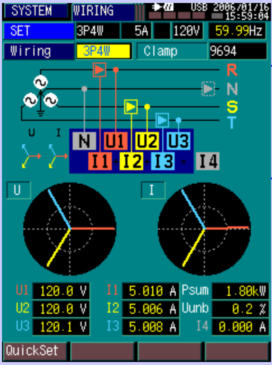
2.3 Screen Configurations

SYSTEM (Setting Conditions and System Settings)

Make the necessary settings before measuring.

The displayed screen changes each time you press **SYSTEM**

[WIRING]

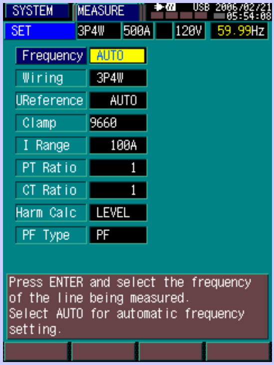


Correct Wiring Diagram

Connection Check

View the selected system wiring diagram while connecting the voltage cords and clamp sensors. Three-phase vectors and voltage, current and power values can be verified. (⇒ p.86)

[MEASURE]

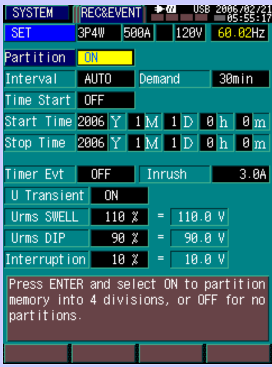


Make basic settings for measurement. You can set the measurement frequency, wiring configuration, clamp sensor model, current range, PT and CT ratios.

[SYSTEM]

Make instrument-related system settings such as display language, beep sounds, screen colors, LCD backlight, LCD contrast, real-time clock, phase names and phase colors.
The instrument's version and serial number are also displayed.

[REC&EVENT]



Recording Settings

Event Settings

Make recording-related settings here. You can set memory partitioning, recording interval, demand period, and enable/disable status and threshold values for each type of event.

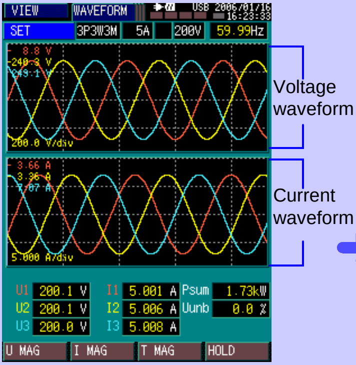
2

VIEW (View Measurement Results)

Shows instaneous measurement results.

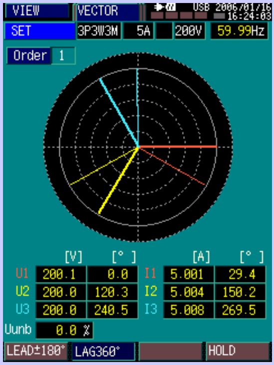
The displayed screen changes each time you press **VIEW**

[WAVEFORM]



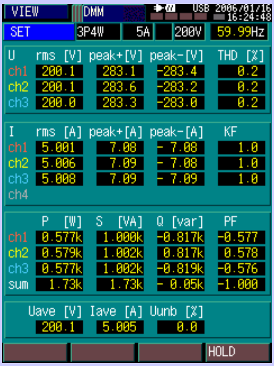
This screen displays voltage and current waveforms, and numerical voltage amplitudes, current amplitudes and the time axis setting. Cursor values can be displayed, and screen refreshing can be paused by the HOLD function.

[VECTOR]



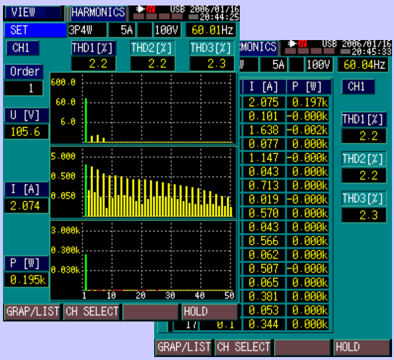
This screen displays a voltage and current vector diagram. Voltage amplitudes, current amplitudes and phase angles are displayed numerically. Phase angle display can be switched ±180° leading or 360° lagging. Screen refreshing can be paused by the HOLD function.

[DMM]



This screen displays the following numerical measurement results for each measurement channel: voltage and voltage waveform peak values, THD value, current and current waveform peak values, K factor, active power, apparent power, reactive power and power factor.

[HARMONICS]



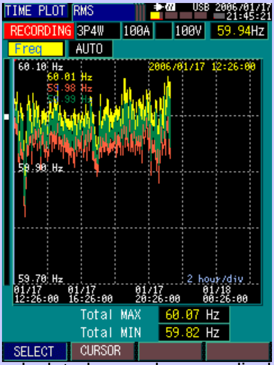
This screen displays the results of harmonic waveform measurements of voltage, current and active power to the 50th order. The function keys switch between bar graph and numerical value list displays.

TIME PLOT (Viewing Time Series Graphs)

Displays recording state and recorded results as a fluctuation graph.

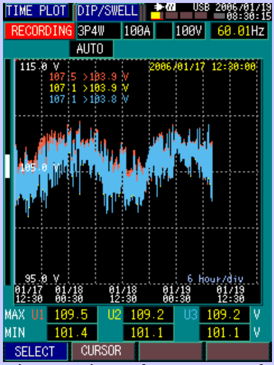
The displayed screen changes each time you press **TIME PLOT**

[RMS]



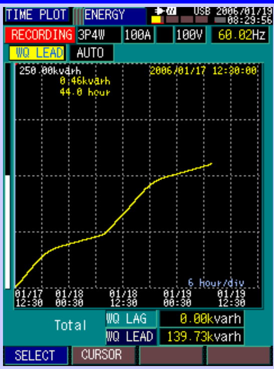
Various calculated rms values are displayed in a time series graph with maximum, minimum and average values during every interval. Displayed parameters can be selected from voltage; current; voltage and current waveform peak values; frequency; active, reactive and apparent power; power factor; THD and voltage unbalance factor.

[DIP/SWELL]



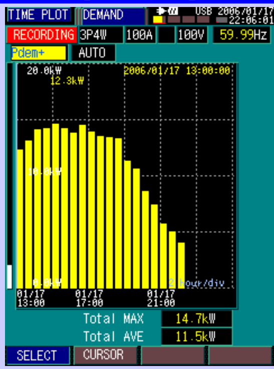
Calculated rms voltage for one waveform shifted by one-half cycle is displayed as a time series graph. Minimum and maximum values within each period and over the whole measurement period are displayed.

[ENERGY]



Energy consumption values of active power [kWh] or reactive power [kvarh] are displayed as a time series graph. Energy consumption values for consumption/regeneration and lag/lead can be displayed.

[DEMAND]



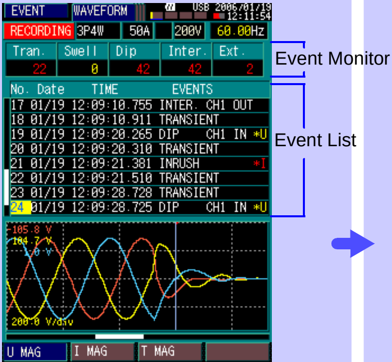
Graphically displays demand values (the average power [kW] consumed during the "demand period" used in power company transactions) for each specified demand period. The maximum value within each period (maximum demand power) and average value within each period and over the whole measurement period are also displayed.

EVENT (Viewing Anomalous Events)

Displays power anomaly detection results.

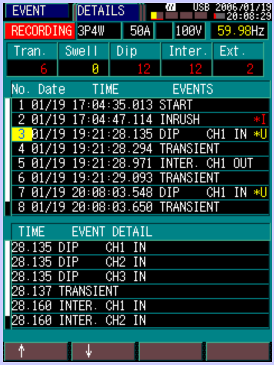
The displayed screen changes each time you press **EVENT**

[WAVEFORM]



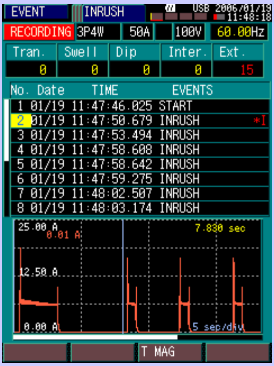
Event occurrences are monitored and contents displayed in a list. The Event Monitor shows the number of occurrences of each type of event. Use the cursor keys to select event waveforms from the list for display. Use the function keys to switch between voltage and current waveforms.

[DETAIL]



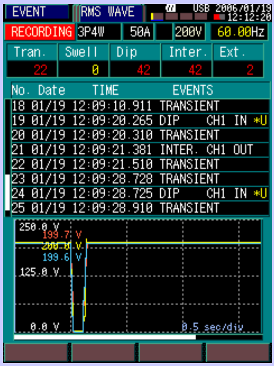
Each row of the Event List may include multiple events, in which case the details of the event contents are display in order of occurrence in the Event Detail display.

[INRUSH]



When an inrush current event has occurred, a graph showing details of rms current fluctuations appears.

[RMS WAVE]

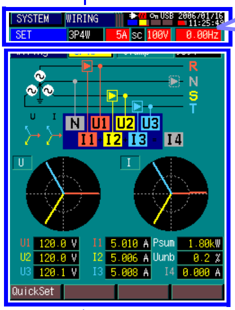


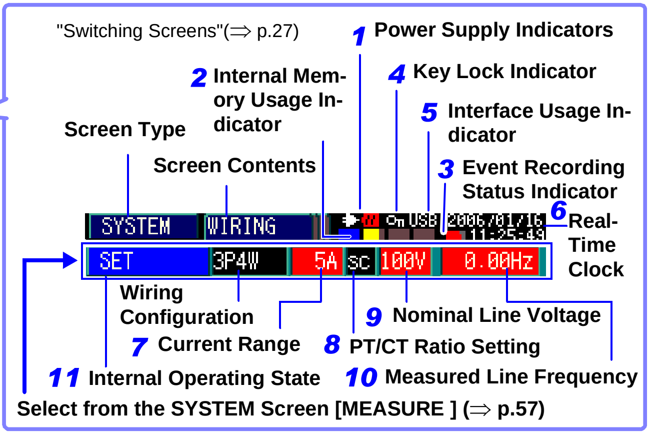
When a swell, dip or interruption event has occurred, a graph showing details of rms voltage fluctuations appears.

NOTE Voltage fluctuation and inrush current screens can be displayed when data is present.

2.4 Common Screen Elements

Common Display Area
This area appears on all screens.





Selectable Screen Display Area
Display contents depend on the selected screen
See: "2.3 Screen Configurations"(⇒ p.28)

1 Power Supply Indicators

Indicates the type and status of the instru8951J_06.zipment's power source.

	Powered by AC adapter No battery pack
(Red)	Powered by AC adapter Battery pack charging
	Powered by AC adapter Battery pack installed, charging complete
	Powered by battery pack
	Powered by battery pack, low charge state

3 Event Recording Status Indicator

Indicates the status of event occurrence. Up to 50 events can be recorded.

	Six events have been recorded
	Forty-six events have been recorded

5 Interface Usage Indicator

USB	Lights when the instrument is connected to a computer via USB cable (and the computer is on).

2 Internal Memory Usage Indicator

Indicates the memory partitioning method and memory usage state. The amount of memory occupied by TIMEPLOT data is indicated by a level meter.

	No memory partitioning, when starting recording
	No memory partitioning, when about two-thirds of memory recorded
	Four partitions, second measurement, when starting recording
	Four partitions, second measurement, when about two-thirds of memory recorded
No. 1 2 3 4	Four partitions, recording in the fourth partition (Memory No. 4)

"2.5 Internal Operating Status and Memory Usage"(⇒ p.34)

4 KEY LOCK Indicator

Lights after holding the ESC/ key for three seconds, indicating that the KEY LOCK state is active (and operating keys are disabled).

6 Real-Time Clock

Shows the current time.
Setting the clock: (⇒ p.76)

7 Current Range

A red field indicates that the crest factor is out of range.
Select a higher range

9 Normal Line Voltage

The currently selected nominal line voltage is displayed.
This field is red when the measured voltage (on channel 1) is far from the selected nominal line voltage.

8 PT/CT Ratio

SC Appears when a PT or CT ratio has been set.

Nothing appears here when the PT and CT ratio settings are 1 (1:1).

10 Measured Line Frequency

Red field indicates indicate that the measured frequency does not match the nominal line frequency setting.
When no voltage is applied, 0.00 Hz is displayed.

11 Internal Operating States (⇒ p.34)

The internal operating state changes when you press the **START/STOP** key to start and stop recording data to internal memory.

Internal Operation Indication		Internal State Description	Data Recording	Settings Available
SET	[SET]	Appears after turning power on, until recording starts.	Before Recording	All Available
WAITING	[WAITING]	When a preset start time has been set, appears while waiting for the recording start time after pressing Start.	Before Recording	Some Not Available
RECORDING	[RECORDING]	Appears when recording starts, and until measurement data has finished being saved to internal memory.	Recording	Some Not Available
ANALYZE	[ANALYZE]	Appears after recording is finished, indicating that the data stored in the internal memory is ready for analysis	Recording Stops	Some Not Available
REVIEW	[REVIEW]	Indicates that the data recorded to internal memory is ready for analysis.	Recorded (Other data)	Some Not Available

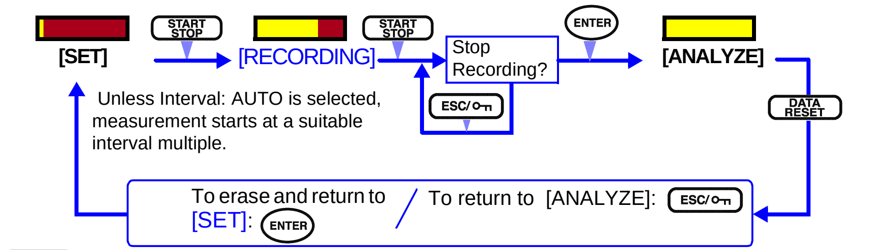
In order to measure again, [SET] must be displayed.
To return to the [SET] state, press the **DATA RESET** key, and select whether to save or erase recorded data.

2.5 Internal Operating Status and Memory Usage

How data is recorded to internal memory (internal operating status) depends on whether memory partitioning is enabled.

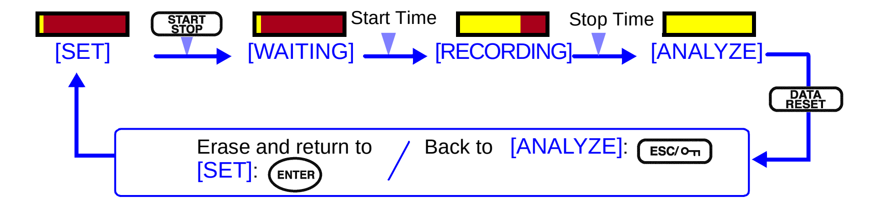
2.5.1 When Memory Partitioning is Disabled (Partition: [No])

Start and Stop Recording Manually



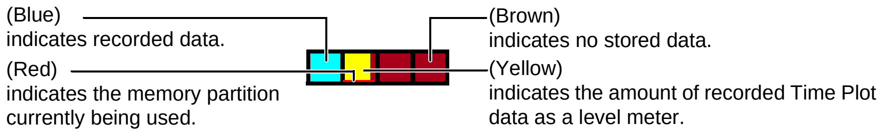
START/STOP :starts and stops recording.

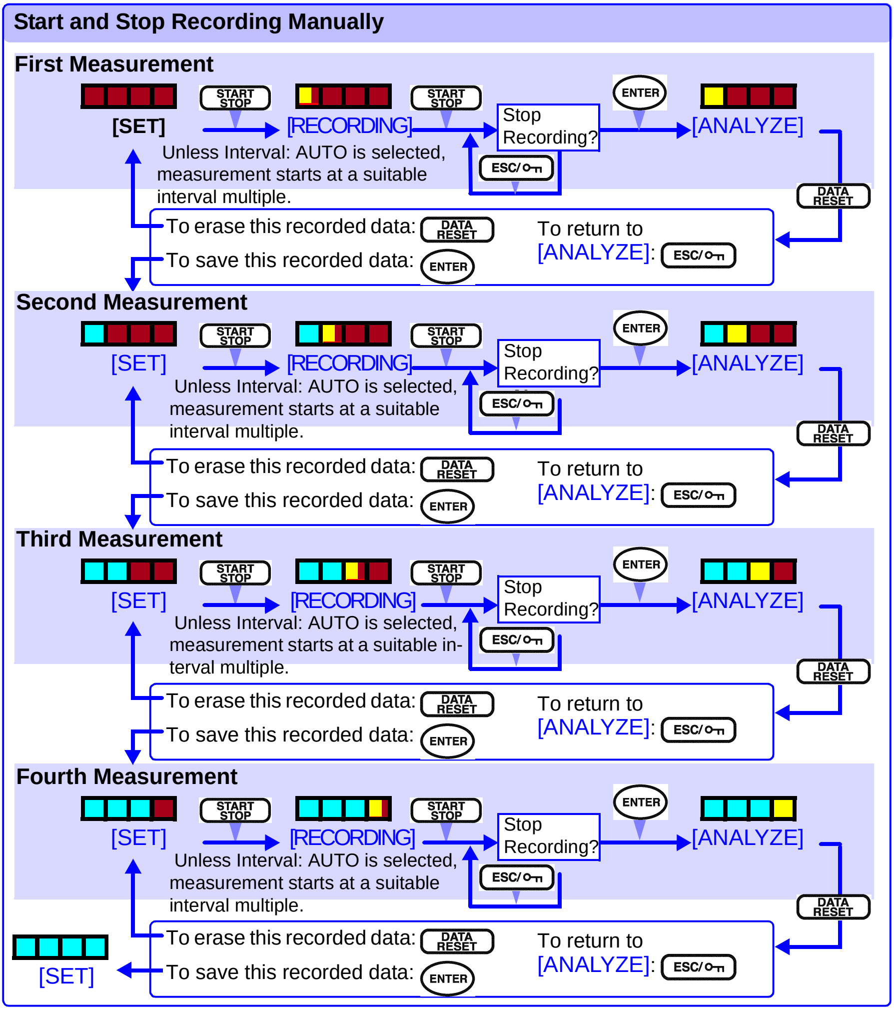
Measurement at Specified Start and Stop Times



- If you press the START/STOP key after a preset start time, "Operation Error!" is displayed.
- If you press the START/STOP key while [WAITING] and before a preset start time, recording is aborted.

2.5.2 Using Memory Partitioning (Partition: [ON])





Pressing the **DATA RESET** key in the [SET] state erases all data from internal memory.

Select the [REVIEW] state to review recorded data. (⇒ p.123)

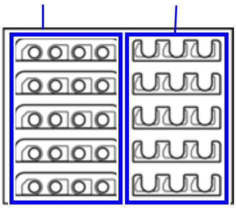
In the Real-Time Control operating state, settings are applied at the time of each measurement.

Measurement Preparations — Chapter 3

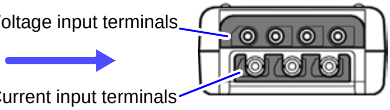
3.1 Initial Instrument Preparations

Perform the following before starting measurement the first time.

1 Apply the appropriate label to the input terminals



Input terminal labels



Before applying the labels
Wipe any dust from the surface around the terminals, and ensure that it is dry.

1. Peel the labels appropriate for your region from the supplied sheet.

   Two types of labels are provided: one type for the voltage input terminals, and another type for the current input terminals.

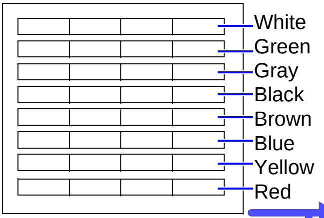
2. Confirm that the labels are properly oriented, and apply them around the input terminals.

   The display colors that identify the phases on screen should be set to match the terminal colors on the input terminal labels.(⇒ p.48)
   TYPE 1 phase colors are the factory default.

Phase Colors (Input Terminal Colors)

Selection	N	U1 I1	U2 I2	U3 I3	Region
TYPE1	Black	Red	Yellow	Blue	HIOKI & UK
TYPE2	Blue	Orange	Black	Gray	New EU & UK
TYPE3	Black	Yellow	Green	Red	China
TYPE4	Blue	Black	Red	White	EU
TYPE5	White	Black	Red	Blue	US

2 Apply the appropriate labels to the voltage measurement and clamp sensor leads.

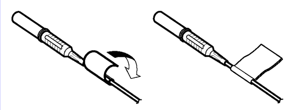


Measurement lead labels

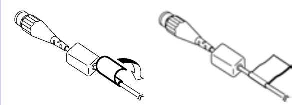
Apply the same color labels as the input terminals to the corresponding voltage and clamp sensor leads.

Before applying the labels
Wipe any dust from the surface around the terminals, and ensure that it is dry.

Apply labels to both ends of the voltage cords



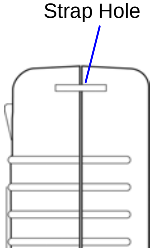
Apply labels to both ends of the clamp sensor leads.



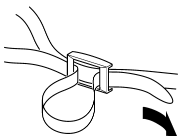
NOTE There are four measurement lead labels of each color.

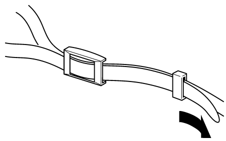
3 Attach the strap.

Use the strap to avoid dropping the instrument while carrying, or when you need to hang it on a hook.



Feed the strap through the buckle so that it is tight and not twisted.





1. Push the strap through one of the strap holes on the instrument.
2. Feed the strap through the buckle
3. Put the end of the strap under the retaining loop.
4. Repeat the same procedure with the other end of the strap and the other strap hole.

⚠CAUTION

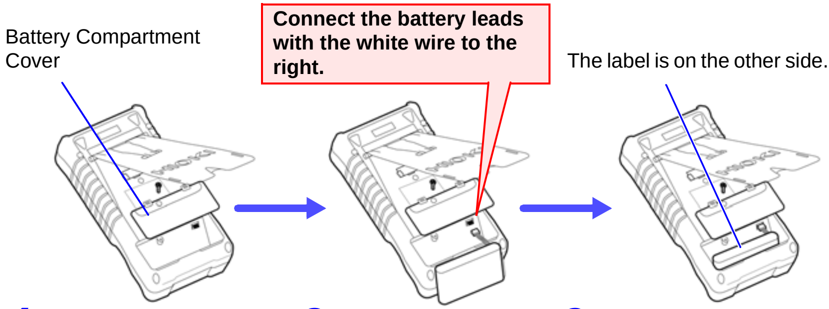
Attach the strap carefully.
If it is not attached correctly, the instrument may be damaged by accidental dropping.

4 Install the 9459 Battery Pack

When it is not possible to supply AC mains power to the instrument through the AC adapter, it can be powered by the Model 9459 Battery Pack instead.
Also, when operating the instrument from the AC mains, the battery serves as a backup power source in case a power interruption occurs.

Required tool:
One Philips screwdriver

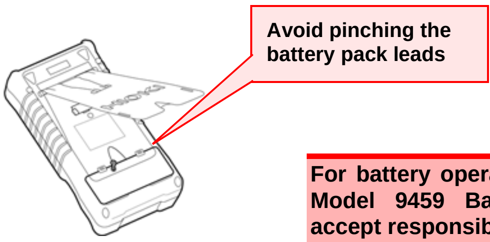
> **Important**
> **Disconnect the AC adapter when installing the battery pack.**



1 Turn the instrument over to remove the retaining screw from the battery compartment cover, and remove the cover.

2 Connect the plug from the battery pack to the connector.

3 Insert the battery pack in the direction of the battery pack label.
Insert while holding the wiring toward the right side.



4 Replace the battery pack compartment cover, and its retaining screw.

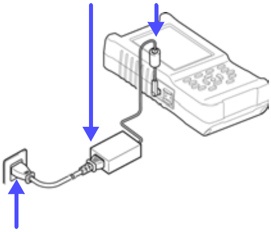
> **For battery operation, use only the HIOKI Model 9459 Battery Pack. We cannot accept responsibility for accidents or damage related to the use of any other batteries.**

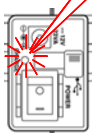
5 Charge the 9459 Battery Pack

Charge the battery pack before using it the first time.
By connecting the Model 9418-15 AC Adapter to the instrument and to an AC power outlet, the battery pack can be charged without turning the instrument on.

When to charge:
When powering the instrument from the battery pack without the AC adapter, the low battery indicator( ) is displayed when the battery charge is depleted, indicating that the battery pack requires charging.

1 Connect the AC adapter to its power cord and to the instrument.





The CHARGE LED lights red when charging begins. The " " indicator appears red on the display.

Charging is finished when the CHARGE LED turns off. If the" " indicator appears white when the AC adapter is unplugged, charging was successful.

2 Plug the power cord into an outlet.

Refer to "3.2 Connecting the AC Adapter" (⇒ p.41) for details about the AC adapter.

Nominal continuous operating time (when powered only by the battery pack)

(operating at 23°C)
After a full charge, with the LCD backlight off (five minutes after last keypress): approximately six hours
After a full charge, with the LCD backlight always on: approximately four hours

- The battery pack is subject to self-discharge. Be sure to charge the battery before initial use. If the battery capacity remains very low after correct recharging, the useful battery life is at an end.
- To avoid problems with battery operation, remove the batteries from the instrument if it is to be stored for a long time.
- The instrument is designed to be able to charge the Model 9459 Battery Pack during operation.
  Although the CHARGE LED may light red when using the Model 9418-15 AC Adapter, this does not affect measurement.

3.2 Connecting the AC Adapter

Connect the power cord and the instrument to the supplied Model 9418-15 AC Adapter, then plug the power cord into an outlet. When used with the battery pack installed, the battery serves as an operating backup supply in case of power failure, and the AC adapter otherwise has priority.

Before Connecting

DANGER

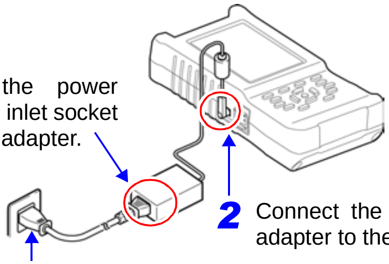
- **Use only the supplied Model 9418-15 AC Adapter(SINO-AMERICAN) input voltage range is 100 to 240 VAC (with ±10% stability) at 50/60 Hz. To avoid electrical hazards and damage to the instrument, do not apply voltage outside of this range.**
- **Turn the instrument off before connecting the AC adapter to the instrument and to AC power.**
- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord only to a 3-contact (two-conductor + ground) outlet.**

NOTE If the AC adapter is used without the battery pack installed, be aware that a power interruption lasting more than two cycles causes measurement to be interrupted and the instrument to turn off.

AC Adapter Connection Procedure

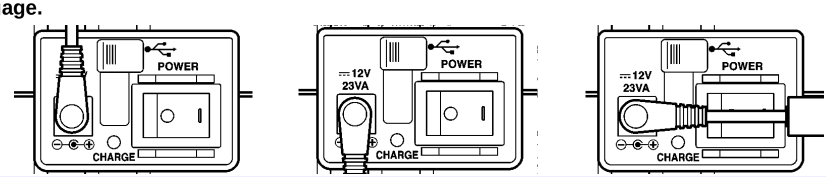
Rated supply voltage is 100 to 240 VAC, and rated supply frequency is 50 or 60 Hz.

1. Connect the power cord to the inlet socket on the AC adapter.



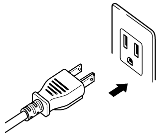
2. Connect the output plug of the AC adapter to the instrument.
3. Plug the power cord into the mains outlet.

The output plug of the AC adapter should be oriented in one of the three directions shown below while connected to the instrument. Otherwise, the plug may inadvertently disengage.



Grounded and Ungrounded Outlets

Using a Grounded Outlet



Plug the power cord into the outlet

3.3 Connecting the Voltage Cords

The color and number of voltage cords to use depends on the wiring configuration of the system being measured.Connect the supplied Model 9438-05 Voltage Cord Set to the voltage input terminals on the instrument.

Before Connecting

DANGER

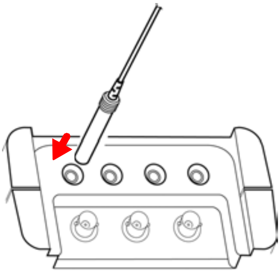
Connect the voltage cords to the instrument first, and then to the active lines to be measured.
Observe the following to avoid electric shock and short circuits.

- **Voltage cord 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.**
- **Do not allow the voltage cord clips to touch two wires at the same time. Never touch the edge of the metal clips.**

CAUTION

For safety reasons, when taking measurements, only use the 9438-05 Voltage Cord set provided with the instrument. The supplied voltage cords are colored black. Do not connect any leads that are not required for a particular measurement.

Voltage Cord Connections



Insert the plugs into the terminals as far as they will go.

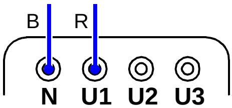
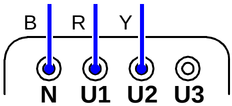
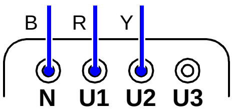
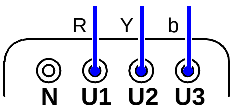
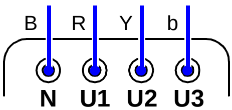
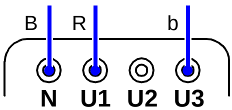
Insert each voltage cord plug into the terminal labeled with the corresponding color.

Refer to "5.2 Connecting to the Lines to be Measured" (⇒ p.81) regarding measurement line wiring configuration diagrams.

Voltage Input Terminals Wiring Diagrams

Example: TYPE 1

B: Black, R: Red, Y: Yellow, b: blue

Wiring Configuration	Voltage Input Terminals	Wiring Configuration	Voltage Input Terminals
Single-Phase 2-Wire (1P2W)		Single-Phase 3-Wire (1P3W)	
Three-Phase 3-Wire (3P3W2M)		Three-phase, 3-wire (3P3W3M)	
Three-Phase 4-Wire (3P4W)		Three-Phase 4-Wire 2.5 Element (3P4W2.5E)	

3.4 Connecting Clamp Sensors

Connect the optional clamp sensors to the current input terminals on the instrument. The clamp sensors that are compatible with this instrument are voltage output types.
Compatible clamp sensors provide about 0.5 Vrms output corresponding to full scale current. Refer to the instruction manual provided with the clamp sensors.

Before Connecting

⚠DANGER

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

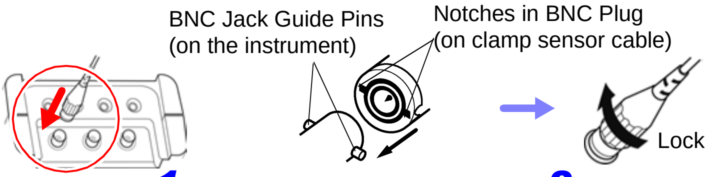
- **Clamp sensors should only be connected to the secondary side of a breaker, so the breaker can prevent an accident if a short circuit occurs. Connections should never be made to the primary side of a breaker, because unrestricted current flow could cause a serious accident if a short circuit occurs.**
- **When the clamp 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.**

⚠CAUTION

- To prevent damage to the instrument and sensor, never connect or disconnect a connector while the power is on, or while the sensor is clamped around a conductor.
- When disconnecting the BNC connector, be sure to release the lock before pulling off the connector. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.

Clamp Sensor Connection Procedure

Connect each clamp sensor plug to the terminal labeled with the corresponding color.



1 Align the notches in the BNC plug with the guide pins on the instrument's terminal, and insert the plug.

2 Turn the plug clockwise to lock.

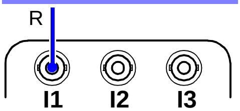
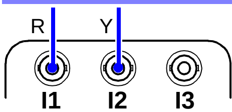
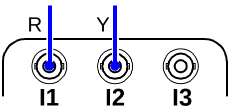
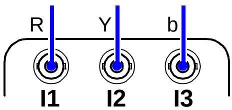
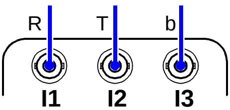
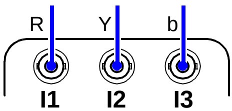
To disconnect:
Push the plug in, turn it counterclockwise to unlock, and pull it out.

Refer to "5.2 Connecting to the Lines to be Measured" (⇒ p.81) regarding measurement line wiring configuration diagrams.

Current Input Terminals Wiring Diagrams

Example: TYPE 1

R: Red, Y: Yellow, b: Blue

Wiring Configuration	Current Input Terminals	Wiring Configuration	Current Input Terminals
Single-Phase 2-Wire (1P2W)		Single-Phase 3-Wire (1P3W)	
Three-Phase 3-Wire (3P3W2M)		Three-phase, 3-wire (3P3W3M)	
Three-Phase 4-Wire (3P4W)		Three-Phase 4-Wire 2.5 Element (3P4W2.5E)	

Before taking measurements, confirm that the clamp sensor model setting is correct. (⇒ p.60)

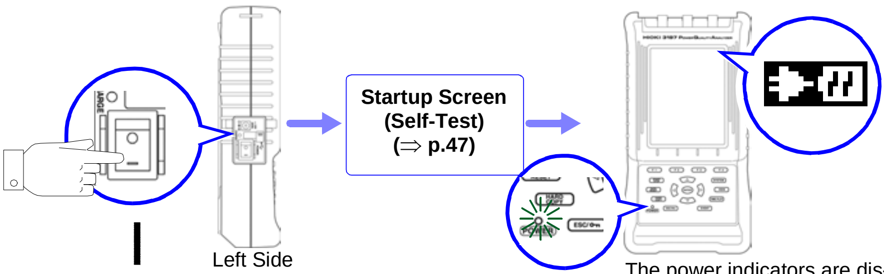
3.5 Turning the Power On and Off

⚠WARNING

Before turning power on
Confirm that the instrument and related accessories are installed and connected properly.

When using the AC adapter
Before turning the instrument on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.
AC adapter rated supply voltage: 100 to 240 VAC
(Voltage fluctuations of ±10% from the rated supply voltage are taken into account.)
Rated supply frequency: 50 or 60 Hz

Turning Power On



Turn the power switch on (|).

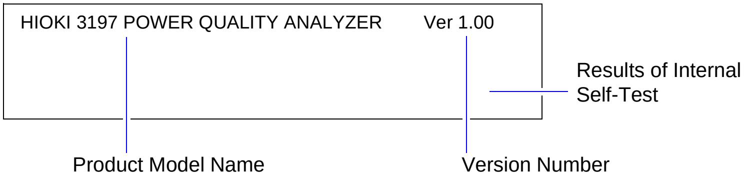
The POWER LED flashes green.

The power indicators are displayed at the top right.
About the display indicators: "2.4 Common Screen Elements" (⇒ p.32)

- If the" " indicator is not displayed, the instrument is not being powered from the AC line. In this state, the battery charge will be depleted if measuring for a long time, and measurement may be interrupted. Verify that the AC adapter is securely connected to an AC power source and to the instrument.
- About battery pack operating time:(⇒ p.40)

Startup Screen

When the instrument is turned on, the startup screen appears as the self-test starts.



When no internal test results are displayed

Self-Test Complete

↓

Normal

The [SYSTEM] [WIRING] screen appears.

When the internal test result is [System Error]

Self-Test Failed

↓

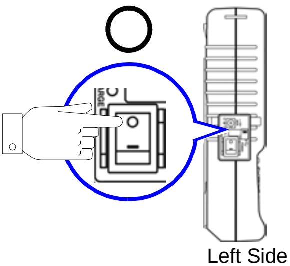
Damage

The instrument is damaged. Contact your supplier or nearest Hioki representative.

If the self-test fails, an Error or Warning message shows more information about the fault.

NOTE When first powered on after purchase, you may want to select another display language. Select from Japanese, English or Chinese.
The display language can be changed again later.

Turning Power Off



Turn the power switch off (O).

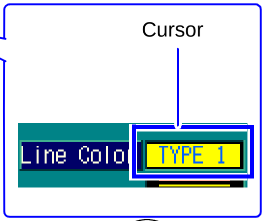
The POWER LED and display turn off.

When power is turned on again, the display appears with the settings that existed when power was last turned off.
As long as the AC adapter is plugged in, battery charging continues even when the instrument is turned off.

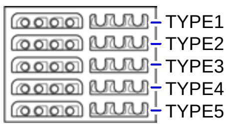
3.6 Other Preparations

1 Select the screen color scheme to match the input terminal labels

Phase wiring is easier to keep track of when the color of each phase line indication on the display matches the label color of the corresponding input terminal.
As an example, this procedure shows how to change the color scheme from TYPE 1 to TYPE 5.



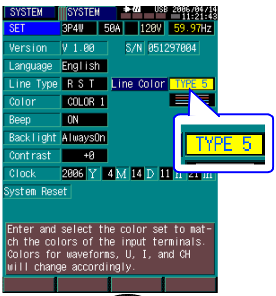
Input terminal label

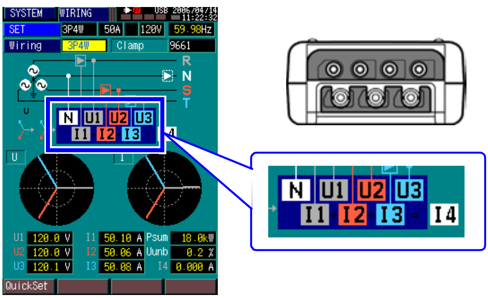


1 Turn the instrument on, and press the **SYSTEM** key to display the [SYSTEM] screen.

2 Press the (cursor) keys to move the cursor to the [TYPE 1] setting.

3 Press the **ENTER** key and then the (up/down) cursor keys to select the TYPE number with the colors that match the input terminal label colors for your power system.





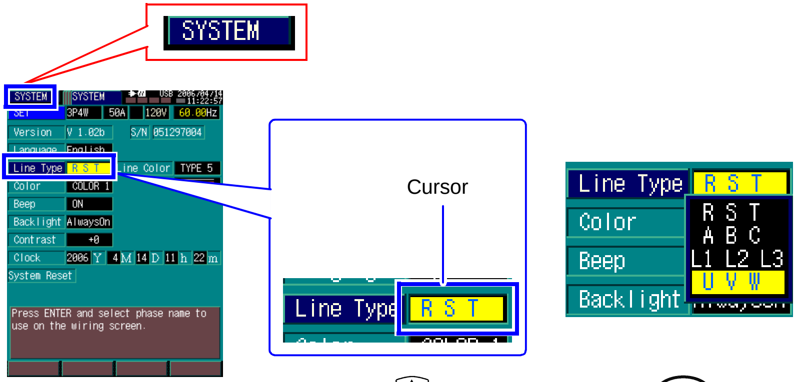
4 Press the **ENTER** key to accept the new setting.

5 Press the **SYSTEM** key to display the [WIRING] Configuration screen.

6 Confirm that each displayed phase line color matches the corresponding input terminal label color.

2 Select the naming convention to be applied to each phase line measurement on the display.

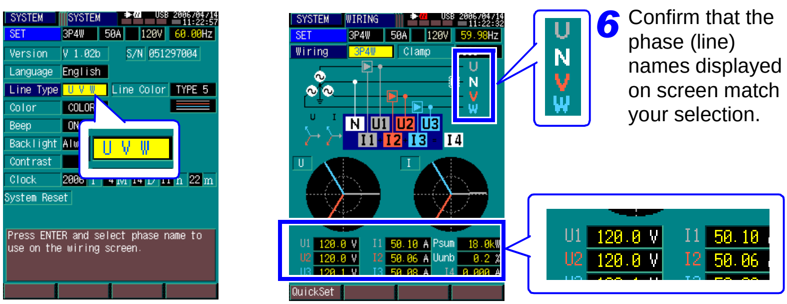
Phase line measurements can be identified on the display by the following conventions: R S T, A B C, L1 L2 L3 or U V W.
The factory default setting is R S T, but should be changed to suit your local convention.
As an example, this procedure shows how to change the phase line naming convention to U V W.



1 Press the SYSTEM key to display the [SYSTEM] screen.

2 Press the keys to move the cursor to the [RST] (factory default) setting.

3 Press the ENTER key and then the keys to select the desired naming convention.



4 Press the ENTER key to accept the new setting.

5 Press the SYSTEM key to display the [WIRING] Configuration screen.

6 Confirm that the phase (line) names displayed on screen match your selection.

Measurement data for each phase line is now identified as U1, U2 and U3 for voltage measurements, and as I1, I2 and I3 for current measurements.

Phase Naming Lists

With 1P2W selected

Select	U1 I1	N
R S T	L	N
A B C	A	N
L1 L2 L3	L1	N
U V W	H	N

With 1P3W selected

Select	U1 I1	U2 I2	N
R S T	R	T	N
A B C	A	B	N
L1 L2 L3	L1	L2	N
U V W	H	C	N

With 3P3W3M selected

Select	U1 I1	U2 I2	U3 I3
R S T	R	S	T
A B C	A	B	C
L1 L2 L3	L1	L2	L3
U V W	U	V	W

With 3P4W or 3P4W2.5E selected

Select	U1 I1	U2 I2	U3 I3	N
R S T	R	S	T	N
A B C	A	B	C	N
L1 L2 L3	L1	L2	L3	N
U V W	U	V	W	N

With 3P3W2M selected

Select	U1 I1	N	U2 I2
R S T	R	S	T
A B C	A	B	C
L1 L2 L3	L1	L2	L3
U V W	U	V	W

3.7 Auxiliary Function (KEY LOCK)

Use the KEY LOCK function to avoid inadvertent operations while recording.

Locking and Unlockin

Press and hold the ESC/KEY LOCK key for three seconds (the same operation locks and unlocks.)

The KEY LOCK indicator is displayed at the top right (and disappears when unlocked).

About the display indicator:
"2.4 Common Screen Elements" (⇒ p.32)

NOTE

- When the KEY LOCK function is enabled, all other key operations are disabled.
- The KEY LOCK state is retained when the instrument is turned off and back on.

3.8 Auxiliary Function (Save screen image)

An image of the screen is stored as a bitmap (BMP format) file in internal memory.
Saved screen images can be viewed by transferring to a computer.
(⇒ p.127)

Save screen image

Sample Massage

Check!
BMP data saved.
Data number : 40
Remaining volume [kB] : 8

Press ESC to close window.

NOTE: Approximately 30 to 40 screen images can be stored in internal memory.

Press the Hard Copy key to store the displayed screen.

To erase saved screen image files

All copy Blocks are full.
Clear all hard copy data?

Yes: ENTER No: ESC

When the screen image storage space in internal memory becomes full, a message is displayed asking whether to erase all image data.

Press the ENTER key.

NOTE: When the screen image storage space in internal memory becomes full, we recommend transferring the image files to a computer using the supplied USB cable.
To transfer the image files, use the application programs supplied with the instrument. (⇒ p.127)

Pre-Measurement and System Settings

Chapter 4

After connecting the instrument to the lines to be measured and before starting recording, verify the instrument settings.
Settings can be made in the following three ways.

Basic Setup

Make only the minimum required settings in preparation for recording measurements.

"4.1 Basic Setup (Typical Settings)"(⇒ p.54)

Advanced Settings

Make settings from the SYSTEM screens. Press the **SYSTEM** key to select among the setting screens.

"4.2 Selecting the Measurement Method (SYSTEM Screen) [MEASURE]"(⇒ p.57)
~
"4.5 Changing Instrument System Settings [SYSTEM]"(⇒ p.72)

Begin measuring when finished making settings and connections.

"5.2 Connecting to the Lines to be Measured"(⇒ p.81)
~
"5.4 Starting and Stopping Recording"(⇒ p.88)

Setting Screen Contents

(Pressing the SYSTEM key selects among setting screens)

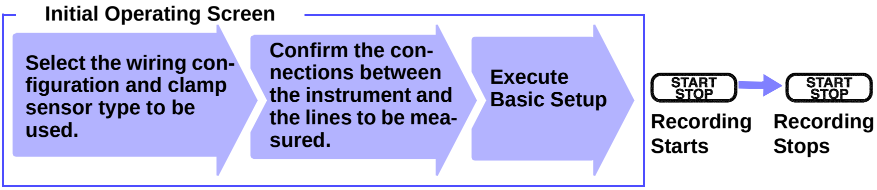
Setting Contents	Settings Screen	Refer To
Basic measurement settings	**[MEASURE]**	"4.2 Selecting the Measurement Method (SYSTEM Screen) [MEASURE]"(⇒ p.57)
Recording method settings	**[REC&EVENT]**	"4.3 Setting the Recording Method [REC&EVENT]"(⇒ p.63)
Event detection settings	**[REC&EVENT]**	"4.4 Setting Event Detection [REC&EVENT]"(⇒ p.67)
Instrument system settings	**[SYSTEM]**	"4.5 Changing Instrument System Settings [SYSTEM]"(⇒ p.72)

NOTE Refer to "Appendix 5 List of Settings (Default Settings)"(⇒ p.A7).

4.1 Basic Setup (Typical Settings)

The Basic Setup Function

After turning the instrument on, preparations for recording can be easily performed by making only the minimum required settings (wiring configuration and clamp sensor settings) on the initial operating screen, confirming wiring configuration connections and executing Basic Setup.
Complex settings are made automatically, or set to default recommended values.
Measurement recording can the be started just by pressing the **START/STOP** key.



We recommend switching to the SYSTEM screen to confirm settings as occasion demands.

Basic Setup Settings (set automatically)

Setting Item	Setting Contents	
Frequency	AUTO	The input frequency is automatically detected as 50 or 60 Hz immediately upon starting measurement.
Nominal Line Voltage	AUTO	The nominal line voltage that serves as a reference value for voltage dips, swells and interruptions is detected immediately upon starting measurement. Nominal line voltage is detected from 14 standard levels, including 100, 120 and 230 V.
Interval	AUTO	Recording starts at one-second intervals, which are automatically lengthened as memory fills up(⇒ p.64). This is to ensure that suitable measurement data is recorded.
Voltage Swells	110%	The event detection threshold for voltage swells is set to 110% of the nominal line voltage.
Voltage Dips	90%	The event detection threshold for voltage dips is set to 90% of the nominal line voltage.
Interruptions	10%	The event detection threshold for voltage interruptions is set to 10% of the nominal line voltage.
Transients	ON	Transient event detection is enabled.

Other settings are unaffected

1. Select the wiring configuration and clamp sensor model.

1 SYSTEM — Select the SYSTEM [WIRING] screen (Initial Operating Screen).

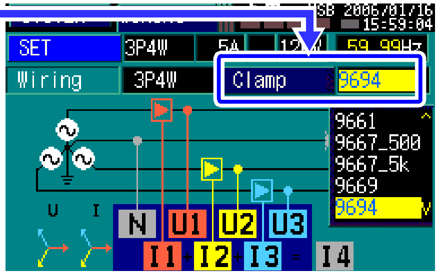
2 Move to the [Wiring] setting.

3 ENTER — Select from the pull-down menu.
ENTER — Accept

Setting details:
See: "Setting the Wiring Method (Wiring)" (⇒ p.58)

4 Move to the [Clamp] setting.

5 ENTER — Select from the pull-down menu.
ENTER — Accept



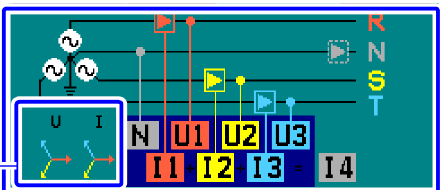
Setting details:
See: "Selecting the Clamp Sensor Model and Current Range" (⇒ p.60)

2. Setting details

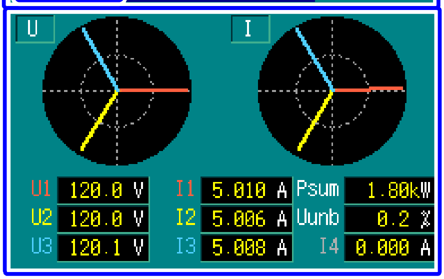
1 Connect to the lines to be measured while viewing the wiring diagram.

Wiring procedure:
See: "5.2 Connecting to the Lines to be Measured"(⇒ p.81)

Correct vector diagram



2 Verify that the vector diagram and measurement values are displayed correctly.

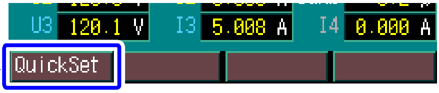


Connection checking procedure:
See: "5.3 Verifying Correct Wiring (Connection Check)"(⇒ p.86)

3. Execute Basic Setup.

1 F 1

Select [QuickSet].



A confirmation message appears.

AUTO set: Freq., Uref., Interval
Event threshold: Defalt levels
Continue?

Yes: ENTER No: ESC

2 ENTER

Execute basic setup.

Pressing **ESC** key reverts to the original screen without executing Basic Setup.

QuickSet
Setting completed!
Close window, then press START to begin recording.

Press ESC to close window.

3 START STOP

Start recording.

4.2 Selecting the Measurement Method (SYSTEM Screen) [MEASURE]

Before connecting to the lines to be measured, change these settings as occasion demands.
Make settings on the SYSTEM-[MEASURE] screen.

To open the screen:

Press the SYSTEM key to display the [MEASURE] screen. Set the following items.

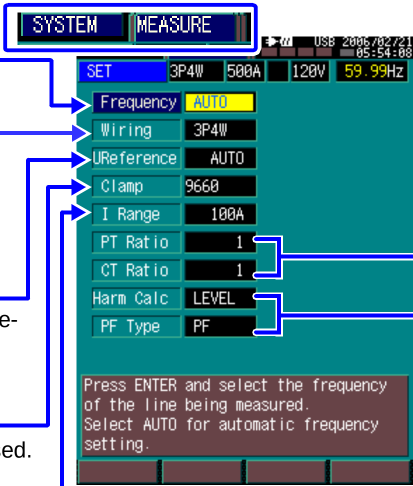
Selects the nominal frequency of the measurement lines. (⇒ p.58)

Selects the wiring configuration

Selects the nominal voltage of the measurement lines. (⇒ p.59)

Selects the clamp sensor model to be used. (⇒ p.60)

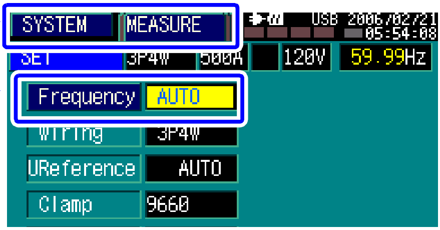
Selects the current range. (⇒ p.60)



When using PTor CT, select the ratio.

Select the calculation formula for harmonics or power factor. (⇒ p.62)

Selecting the Line Frequency (Frequency)



1. SYSTEM — Select the screen.
2. Move to the setting item.
3. ENTER — Select from the pull-down menu.

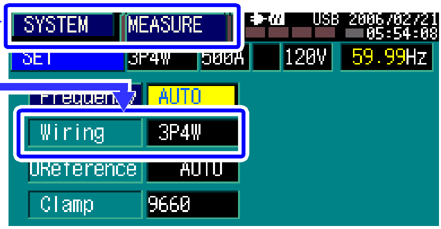
ENTER Accept / ESC Cancel

Setting Contents

AUTO/ 50Hz/ 60Hz

The AUTO setting automatically selects 50 or 60 Hz internally when measurement starts.

Setting the Wiring Method (Wiring)



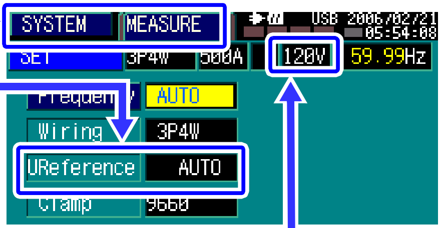
1. SYSTEM — Select the screen.
2. Move to the setting item.
3. ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

1P2W	Measure single-phase, 2-wire lines
1P3W	Measure single-phase, 3-wire lines
3P3W2M	Measure three-phase, 3-wire lines (Delta configuration, using the two-meter method) (Use to measure three-phase power by measuring current at just two points.)
3P3W3M	Measure three-phase, 3-wire lines (Delta configuration, using the three-meter method)
3P4W	Measure three-phase, 4-wire, 2.5-element lines (star configuration)
3P4W2.5E	Measure three-phase, 4-wire, 2.5-element lines (star configuration) (Use to measure three-phase power by measuring voltage at just two points.)

Setting the Line Voltage (Nominal Line Voltage) of the Lines to be Measured



1 SYSTEM — Select the screen (initial operating screen).

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel

The AUTO setting automatically selects the nominal voltage when measurement starts, and the internally set value is displayed here.

Setting Contents

AUTO / VALIABLE (50 to 600)/ 100V/ 101V/ 110V/ 120V/ 127 V/ 200V/ 202V/ 208V/ 220V/ 230V/ 240V/ 277V/ 347V/ 380V/ 400V/ 415V/ 480V/ 600V

To set "VALIABLE"

Select a digit to change (◀ :move up, ▶ : move down)

Change the digit's value (▲ : increase the value, ▼ :decrease the value)

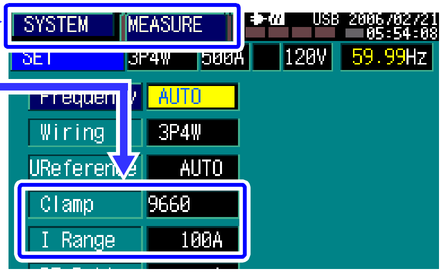
Selecting the Clamp Sensor Model and Current Range

Select the model name of the clamp sensors to be used.

This setting is ignored if no clamp sensors are used.

For the detail about the clamp sensor, refer to the instruction manual provided with the device.

1. SYSTEM — Select the screen.
2. Move to the setting item.
3. ENTER — Select from the pull-down menu.
   ENTER Accept / ESC Cancel



Clamp sensor	Current range	
9660	10A/ 100A	9660 Clamp-on Sensor
9661	50A/ 500A	9661 Clamp-on Sensor
9667_500	50A/ 500A	9667 Flexible Clamp-on Sensor (500A range)
9667_5k	500A/ 5000A	9667 Flexible Clamp-on Sensor (5000A range)
9669	100A/1000A	9669 Clamp-on Sensor
9694	5A/ 50A	9694 Clamp-on Sensor
9695-02	5A/ 50A	9695-02 Clamp-on Sensor
9695-03	10A/ 100A	9695-03 Clamp-on Sensor
9657-10	0.5A/ 5A	9657-10 Clamp-on Leak Sensor
9675	0.5A/ 5A	9675 Clamp-on Leak Sensor

The current ranges available for selection depend on the clamp sensor model.
The range setting applies to all channels (1 to 3). Different ranges cannot be set for individual channels.

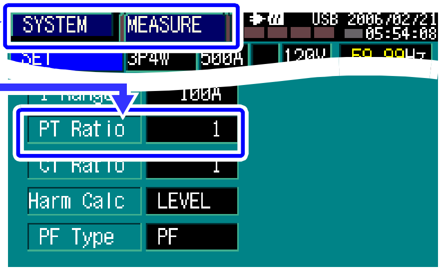
To use non-Hioki clamp sensors, bear in mind the following requirements:

- Only voltage-output type clamp sensors can be used.
- Output should not exceed 1.7 Vrms (2.4 Vpeak).
- The ratio of output voltage to input current should be the same as Hioki clamp sensors. Refer to "Appendix 3 Power Range Structure"(⇒ p.A5).

NOTE When the clamp sensor model setting is changed, the highest current range is initially selected.

Setting the PT Ratio (when measuring using a transformer)

When measuring the secondary side of a High Voltage line, measured values can be converted to display the voltage value at the primary side.



1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

VARIABLE (1.00 to 999.99)/ 1/ 60/ 100/ 200/ 300/ 600/ 700

To set "VARIABLE"

Select a digit to change (◀ :move up, ▶ : move down)

Change the digit's value (▲ : increase the value, ▼ :decrease the value)

Setting the CT Ratio (when measuring using a transformer)

When measuring the secondary side of a High Voltage line, measured values can be converted to display the current value at the primary side.

1 SYSTEM — Select the screen (initial operating screen).

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

VARIABLE (0.01 to 999.99)/ 1/ 4/ 6/ 8/ 10/ 12/ 15/ 20/ 30/ 40/ 60/ 80/ 100/ 120/ 160

To set "VARIABLE"

Select a digit to change (◀ :move up, ▶ : move down)

Change the digit's value (▲ : increase the value, ▼ :decrease the value)

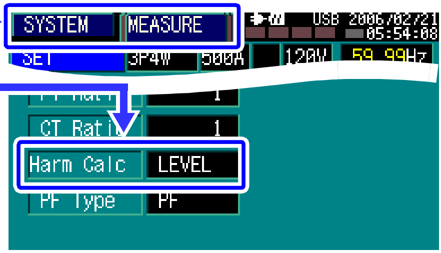
Selecting the Voltage Harmonic Calculation Method

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel



Setting Contents

Rms Value	Displays rms harmonic voltage.
Percentage Content	Displays the amplitude (harmonic voltage percentage) of an harmonic order component relative to that of the fundamental waveform.

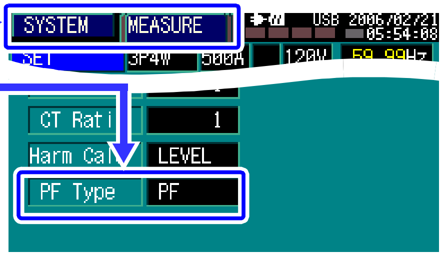
Selecting the Power Factor Calculation Method (PF Type)

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel



Setting Contents

PF	Displays power factor.
DPF	Displays displacement power factor.

What is the power factor?

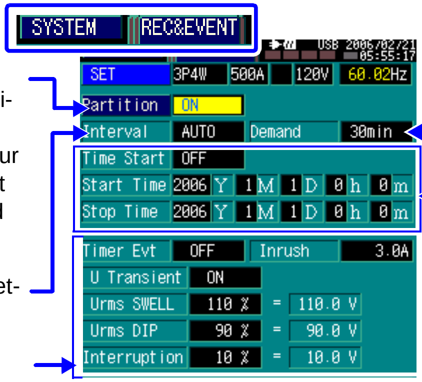
- PF (Power Factor) is the ratio of apparent power to active power. Its calculation includes all frequency components, so large harmonic components result in a small power factor.
- DPF (Displacement Power Factor) is the cosine of the phase difference between the fundamental voltage and current waveforms. Its calculation includes only fundamental waveform contents, so harmonics have no effect.

4.3 Setting the Recording Method[REC&EVENT]

Make recording method settings before measuring, as occasion demands.
Make settings on the SYSTEM-[REC&EVENT] screen.

Opening the [REC&EVENT] screen

Press the SYSTEM key to display the [REC&EVENT] screen.



Specifies whether memory is to be partitioned for recording (when partitioned, four sets of measurement results can be stored internally). (⇒ p.63)

Recording interval setting. (⇒ p.64)

Event threshold settings (for anomalous phenomena)
Event Settings (⇒ p.67)

Specified demand period (demand calculation period) (⇒ p.65)

Specified start and stop times for timed recording. (⇒ p.66)

4

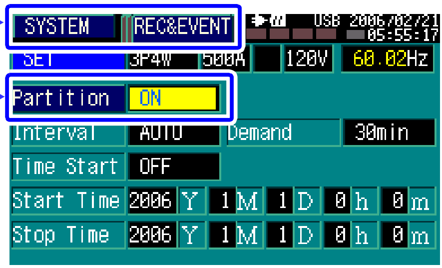
Setting the Method for Recording to Internal Memory (Partition)

Selects whether to record multiple measurement (start and stop recording) sessions to separate partitions of internal memory.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.
ENTER Accept / ESC Cancel



Setting Contents

ON	Four measurement sessions can be recorded. (maximum recordable period is one-fourth that of unpartitioned memory)
OFF	Only one measurement session can be recorded.

When data has been recorded in partitioned memory, memory partitioning cannot be canceled until the data has been erased.

Setting the Recording Interval (Interval)

Measurement data during the specified intervals is recorded as a time series graph.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

AUTO/ 1 min/ 5 min/ 15 min/ 30 min/ 60 min

Time Series Graph Recording

"RMS" records maximum, average and minimum values within each interval.
"Rms voltage" records maximum and minimum values within each interval.
The recordable length of a time series graph depends on the specified interval.
When memory partitioning is disabled ([No]), the measurements of about 3,000 times intervals can be recorded. When memory partitioning is enabled ([ON]), measurements from about 750 times intervals can be recorded during each measurement session.

See: "Appendix 1 Interval and Recording Time Settings"(⇒ p.A1)

The [AUTO] Interval Setting

The interval automatically increases sequentially from 1, 2, 10 and 30 seconds and 1, 5, 15, 30 and 60 minutes.
Recording beings at one-second intervals, and increases to the next longer interval as memory fills up, so that the most suitable measurement data is usually recorded.
The time axis of the TIME PLOT screen at each interval setting is shown in "Appendix 1 Interval and Recording Time Settings"(⇒ p.A1).

Setting Demand Period

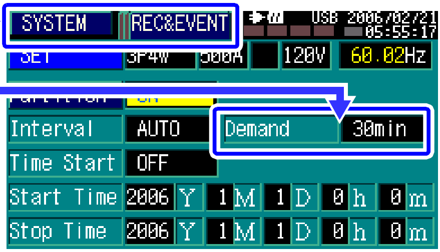
Set the demand period for recordings.

1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 ENTER, ▲/▼ — Select from the pull-down menu.

ENTER Accept / ESC Cancel



Setting Contents

15 min/ 30 min/ 60 min

What is Demand?

"Demand" here is the average power [kW] consumed during the "demand period" (typically 30 minutes), used in power company transactions.

Setting Recording Start and Stop Times

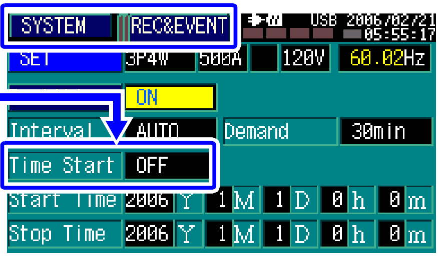
When timed recording is enabled, recording start and stop times can be set.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel



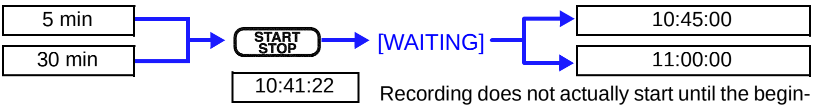
Setting Contents

OFF	Start and stop recording by pressing the **START/STOP** key. However, note that after pressing the **START/STOP** key, and depending on the specified interval, recording starts only at appropriate times.
ON	Operates as though you pressed the **START/STOP** key at the specified start and stop times.

When OFF (recording start time depends on interval setting)

Example: If the following intervals are selected and you press START/STOP at current time 10:41:22

Interval Setting



Recording does not actually start until the beginning of the next scheduled interval.

When ON

When an interval is specified, recording does not actually start until the appropriate time. Start and stop times can be set by two methods.

Manual Setting

- (Left/Right keys) Selects year, month, day, hour and minute
- (Up/Down keys) Change a numerical value ([▲]: increase the value, [▼]: decrease the value)

Automatic Setting
[Start Time]

- F 1 Sets to the current time

[Stop Time]

- F 1 Sets to one hour from the start time.
- F 2 Sets one day from the start time.
- F 3 Sets one week from the start time.

NOTE If the start time has already passed when you press the **START/STOP** key, "Operation Error!" is displayed. During the [WAITING] mode, pressing the **START/STOP** key before the start time aborts the recording.

4.4 Setting Event Detection [REC&EVENT]

With this instrument, an "event" is the detection of an anomaly (abnormal phenomena) that may occur on power lines.
The detection criteria (Event Settings) are specified before recording measurements.
When the specified criteria are satisfied while recording, the data is recorded as an event, and can be analyzed on the EVENT screen.
Event settings are made on the SYSTEM-[REC&EVENT] screen.

Parameter that can be analyzed on the EVENT screen:
- View event occurrences on the Event Monitor.
- View sequence, date, time and event parameter.
- View the voltage or current event waveform.
- On the detailed fluctuation graph, view rms fluctuations when an event occurs.

See: "Viewing Anomalous Phenomena (EVENT screen)" (⇒ p.108)

This instrument supports eight types of events

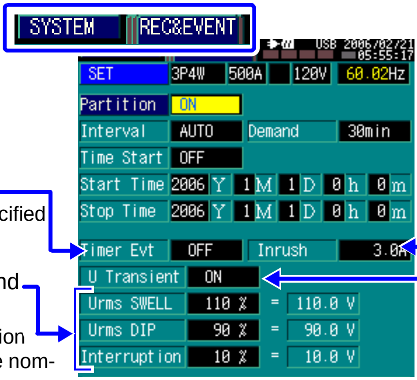
Manual	Inrush Current
Timer	Transients
Voltage Swell	Voltage Dip
Interruption	Start, Stop

See: Refer to: Event Details, "Detection Methods and Recording Contents of Events" (⇒ p.110)

Event Recording
- Event criteria can be ORed together (logical sum).
- Events are recorded when recording starts and stops, regardless of criteria settings.
- The instrument can record data from up to 50 events (in the Event List and Event Waveforms).
- Depending on the type of event, two recordings may occur: once when a threshold is exceeded [IN] and again upon return [OUT].

Opening the [REC&EVENT] Screen

Press the SYSTEM key to display the [REC&EVENT] screen.



Start Event • Stop Event

By enabling Start/Stop Events, measurements are recorded as an event each time recording is started and stopped.

Manual Events

Manual event recording records the measurement state at the current time as an event.

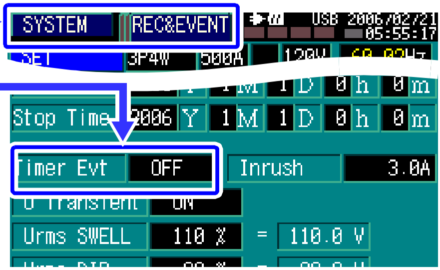
Manual event recording is always enabled.

See: "Manual" (⇒ p.113)

ESC/O-π + EVENT The time of a manual event is the moment at which these keys are pressed simultaneously.

Setting Timed Events

Timed events are recordings made automatically at a predefined interval.



1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 F 1 OFF / F 2 ON

4 ENTER — Select from the pull-down menu.

▲ ▼

ENTER Accept / ESC/⊶ Cancel

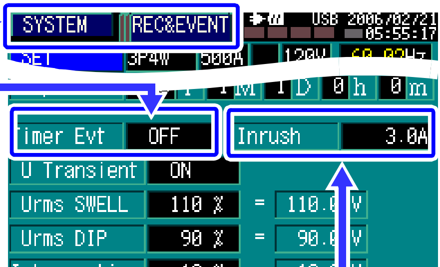
Setting Contents

OFF/1 min/5 min/15 min/30 min/1 hour/2 hour/ 12 hour/ 1 day

See: "Timer" (⇒ p.113)

Setting Inrush Events

Inrush events indicate that inrush current (inrush, starting or surge current) has exceeded the specified threshold.



1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 F 1 OFF / F 2 ON

4 ENTER — Change a numerical value ([▲]: increase the value, [▼]: decrease the value)

▲ ▼

ENTER Accept / ESC/⊶ Cancel

Setting Contents

0.0mA to 5.000kA

The inrush current threshold setting is an rms current value.

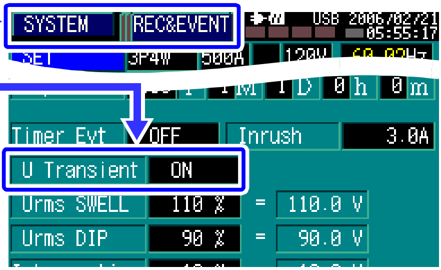
See: "Inrush Current" (⇒ p.113)

When an event occurs, a graph of the inrush current is recorded in addition to the event waveform.

4

Setting Transient Events

An event is recorded when high frequency impulse noise is imposed on the mains voltage waveform.



1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 F1 OFF / F2 ON

4 ENTER — Select from the pull-down menu.
(up/down keys)
ENTER Accept / ESC Cancel

Setting Contents

OFF/ ON (disable/enable transient event recording)

An event is detected as the presence, during any single cycle of the mains voltage waveform, of a frequency component at 10 to 100 kHz with 50 Vrms (±70.7 Vpeak equivalent) or greater amplitude in either the positive or negative direction on any of the three channels.

See: "Transient Overvoltage" (⇒ p.112)

What is a transient?

On this instrument, a "transient overvoltage" is also called a "transient".
Transient overvoltage is sometimes also called an "excessive voltage spike" or "Impulsive voltage".

NOTE Only the existence or non-existence of transient overvoltage is detected. Although voltage and current waveforms can be displayed when an event is detected, the transient overvoltage waveform cannot be displayed.

Setting Voltage Swell, Dip and Interruption Events

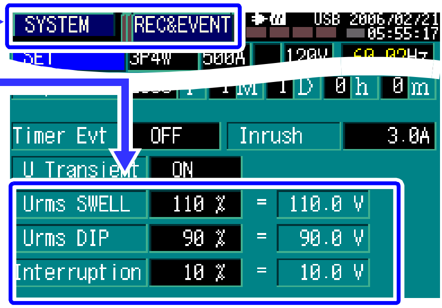
A voltage swell, voltage dip or interruption of the nominal voltage is recorded as an event.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Change a numerical value ([▲]: increase the value, [▼]: decrease the value)

ENTER Accept / ESC Cancel



Setting Contents

Voltage Swell	Set a percentage larger than the nominal line voltage (default 110%).
Voltage Dip	Set a percentage smaller than the nominal line voltage (default 90%).
Interruption	Set a percentage smaller than the nominal line voltage (default 10%).

In all cases, an event is recorded when the threshold is breached in either direction (once upon onset, and once again upon recovery).
Upon event recovery ("event out "), the continuous period and worst-case voltage swell values are displayed.
Upon event onset ("event in "), an event voltage fluctuation graph is recorded.

What is Voltage Swell?

Voltage swell is a rise of rms voltage, where a threshold is set above the nominal voltage.
When the rms voltage rises above the threshold, it is detected as an "event in (onset)" voltage swell event. Subsequently, when the voltage falls back below the threshold (minus appropriate hysteresis), it is detected as an "event out (recovery)" voltage swell event.

What is Voltage Dip?

Voltage dip is the opposite of voltage swell, that is a fall of rms voltage where a threshold is set below the nominal voltage.
When the rms voltage falls below the threshold, it is detected as an "event in (onset)" voltage dip event. Subsequently, when the voltage rises back above the threshold (plus appropriate hysteresis), it is detected as an "event out (recovery)" voltage dip event.

What is Interruption?

This is the power suspension state when voltage drops to a threshold below the nominal voltage and further below the voltage dip threshold.
When the rms voltage falls below the threshold, it is detected as an "event in (onset)" voltage interruption event. Subsequently, when the voltage rises back above the threshold (plus appropriate hysteresis), it is detected as an "event out (recovery)" voltage interruption event.

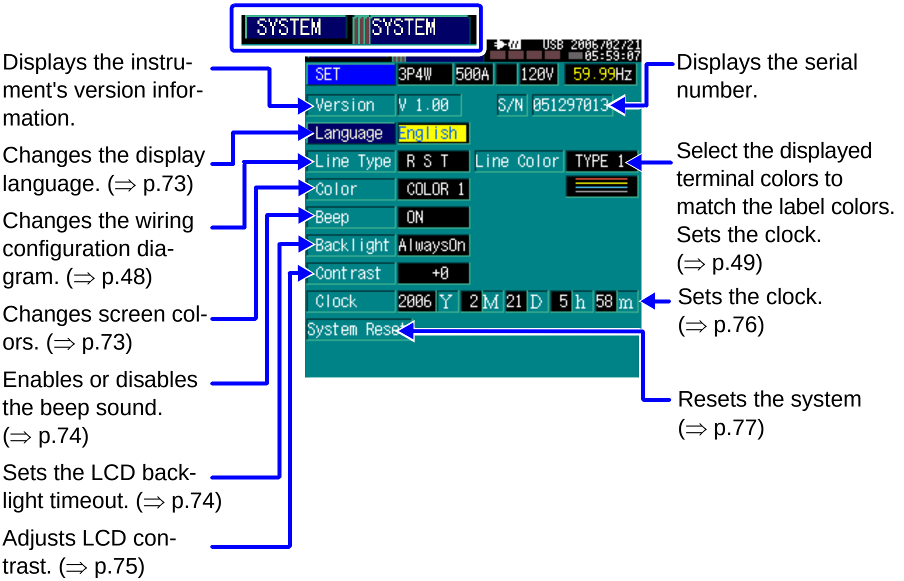
See: "Voltage Swell" (⇒ p.110), "Voltage Dip" (⇒ p.111), "Interruption" (⇒ p.111)

4.5 Changing Instrument System Settings [SYSTEM]

The instrument's version information can be viewed, and the display language, beep sounds and screen colors can be changed from the SYSTEM screen.
Confirm that the clock is set correctly before starting recording. If the clock is not set correctly, recording results may not be analyzed correctly. (⇒ p.76)

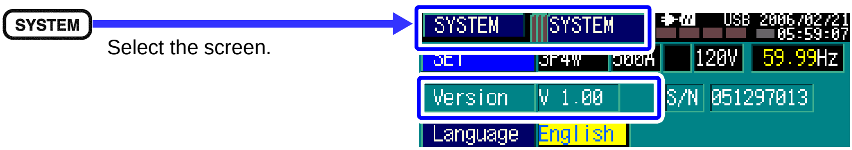
Opening the [SYSTEM] Screen

Press the SYSTEM key to display the [SYSTEM] screen.



Displaying the Instrument's Version Number (Version)

Shows the instrument's version number.



Changing the Display Language (Language)

The display language can be selected from Japanese, English or Chinese.

1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 ENTER, ▲/▼ — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

Japanese/ English/ Chinese

Changing Screen Colors (Color)

1 SYSTEM — Select the screen.

2 (cursor keys) — Move to the setting item.

3 ENTER, ▲/▼ — Select from the pull-down menu.

ENTER Accept / ESC Cancel

Setting Contents

COLOR1	Dark green
COLOR2	Dark blue
COLOR3	Monochrome (white characters)
COLOR4	Light blue
MONO	Monochrome (black characters)

For printing black and white reports and such, select [MONO] and perform a saving screen images (press the Hard Copy key).

Enable or Disable Beep Sounds (Beep)

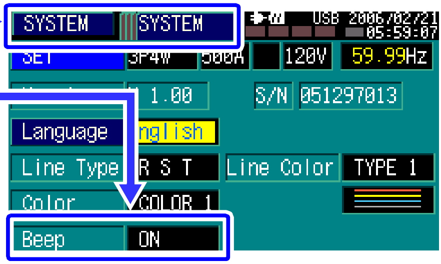
Keypress beep sounds can be enabled or disabled.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel



Setting Contents

ON	Keypress beeps are enabled
OFF	Keypress beeps are disabled.

Setting the LCD Backlight Timeout (Backlight)

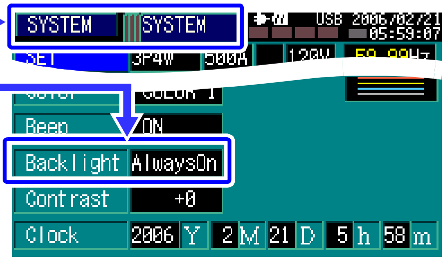
When operating from the battery pack only, operating time can be maximized by setting the LCD backlight to turn off automatically after a specified period of key inactivity.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Select from the pull-down menu.

ENTER Accept / ESC Cancel



Setting Contents

AlwaysOn	Keeps the backlight always on.
1min/ 5min/ 10min/ 30min/ 1hour	The backlight turns off automatically after the selected period of inactivity.

To turn the backlight back on

Press any key to turn the backlight back on after it has turned off automatically. The backlight comes back on even if Key Lock is active.

> **NOTE** The LCD backlight automatically switches from high to low brightness when there is no key press for ten seconds. No setting is available to retain high brightness at all times.

Adjusting Screen Contrast (Contrast)

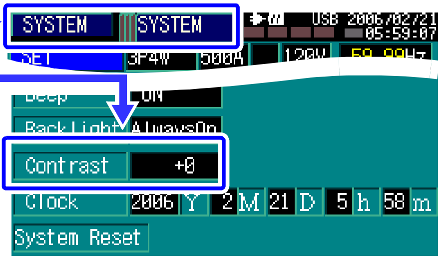
Because screen contrast is temperature dependent, you may need to adjust LCD contrast to retain visibility.

1 SYSTEM — Select the screen.

2 Move to the setting item.

3 ENTER — Change a numerical value ([▲]: increase the value, [▼]: decrease the value)

ENTER — Accept



Setting Contents

+0	
-30 to -2	Lower setting values make the screen lighter.
+2 to +20	Higher setting values make the screen darker.

Setting the Clock (Clock)

Set the instrument's real-time clock to the current date and time. Data recording and management depends on the clock being set correctly.

1 SYSTEM Select the screen.

2 Move to the setting item.

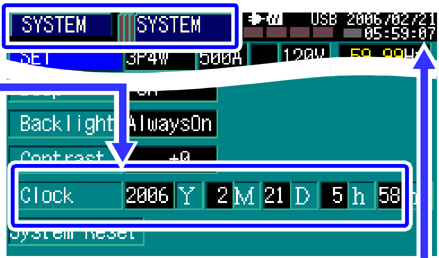
Move between the year, month, day, hour and minute to set.

3 ENTER

Change a numerical value ([▲]: increase the value, [▼]: decrease the value)

ENTER Accept / ESC Cancel

4 Verify the correct time display

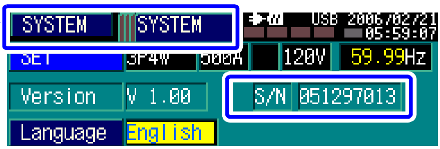


NOTE Especially when recording with specified start and stop times, confirm that the instrument's clock is set correctly before recording.
If not set to the correct time, time-dependent analyses will give incorrect results.
Before starting recording, we recommend setting the clock using a standard time source such as a telephone or internet time service (NTP).

Viewing the Serial Number

The serial number of the instrument is displayed. The displayed number should match the number on the label pasted on the back of the instrument. The serial number is used to identify the instrument for purposes such as user registration.

SYSTEM Select the screen.



NOTE If the displayed serial number is not the same as that on the label, please contact your dealer or Hioki representative

4.6 Initializing the Instrument (System Reset)

If the instrument begins to exhibit unusual behavior, refer to the "Before returning for repair" (⇒ p.166).
If the cause of the unusual behavior remains undetermined, perform a system reset.

1 SYSTEM
Select the screen.

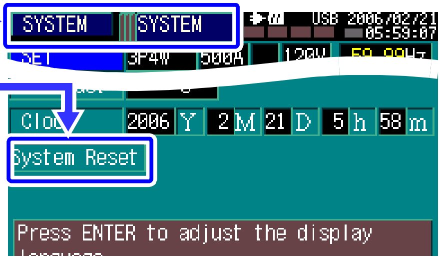
2 (cursor keys)
Move to the setting item.

3 ENTER

Resetting system
Are you sure?

Yes: ENTER No: ESC

ENTER Accept / ESC Cancel



4

NOTE System reset initializes all settings to their factory defaults except for the display language, phase names and phase color settings.
System reset also erases all measurement data in internal memory, and all data displayed on screen.
See: "Appendix 5 List of Settings (Default Settings)"(⇒ p.A7)

Making Connections and Starting & Stopping Measurement

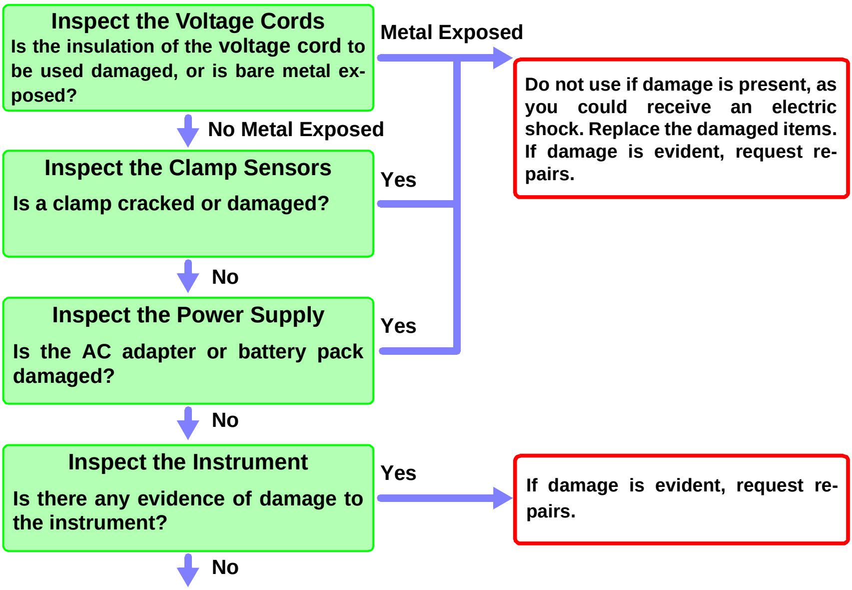
Chapter 5

Before recording, be sure to read "Operating Precautions"(⇒ p.7) and "Chapter 3 Measurement Preparations"(⇒ p.37)

5.1 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 Inspection before conection



2 Confirmation during Connection

Is the battery pack installed in the instrument?

No → If the battery pack is not used, measurement is not possible during power outages.

Yes ↓

Is the Model 9418-15 AC Adapter being used with the instrument?

No → Using the AC adapter is recommended when measuring at one site for a long time.

Yes ↓

3 Power-On Confirmation

Does the POWER lamp flash green and does the screen display ap-

No →

When using the AC Adapter

The AC adapter output plug might be damaged, or the instrument might have internal damaged.

When not using the AC Adapter

The battery pack may not be sufficiently charged. Allow it to charge fully.
If the battery has been fully charged and the power lamp does not flash or the screen stays blank, the battery pack may have deteriorated or be damaged. Obtain a new battery pack, or request repair.

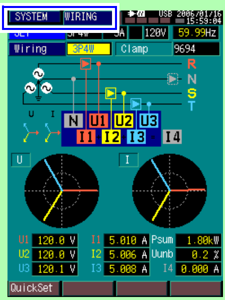
Yes ↓

Startup Screen (⇒ p.47)

HIOKI 3197 POWER QUALITY ANALYZER Ver 1.00

↓

After the self-test on the Startup screen has finished, does the SYSTEM-[WIRING] screen appear?



An error is displayed → **The instrument may be damaged internally. Have the instrument repaired.**

Yes ↓

Inspection complete

5.2 Connecting to the Lines to be Measured

Connect the voltage cords and clamp sensors to the lines to be measured. To ensure proper connections for correct measurements, look at the wiring configuration diagram (⇒ p.83) while making connections.

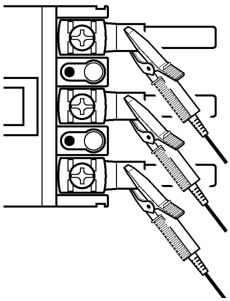
NOTE

- When measuring three-phase lines, make connections to the lines to be measured in the same sequence as the measurement channesl (channels 1, 2 and 3).
- Although this one instrument can measure various wiring configurations from single-phase 2-wire to three-phase 4-wire, it cannot measure single-phase power in three different systems.

Connecting voltage cords to lines to be measured

Example:

Secondary side of breaker



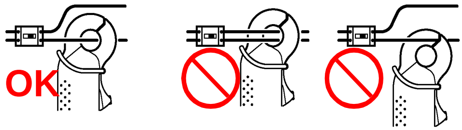
Securely clip the leads to metal parts such as load-side screw terminals or bus bars.

9438-05 Voltage Cord

Connecting clamp sensors to lines to be measured

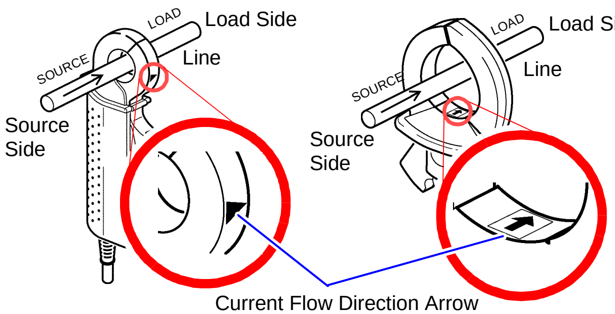
To measure load current

(Example: Model 9660)



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.

(Example: Model 9660) **(Example: Model 9661)**

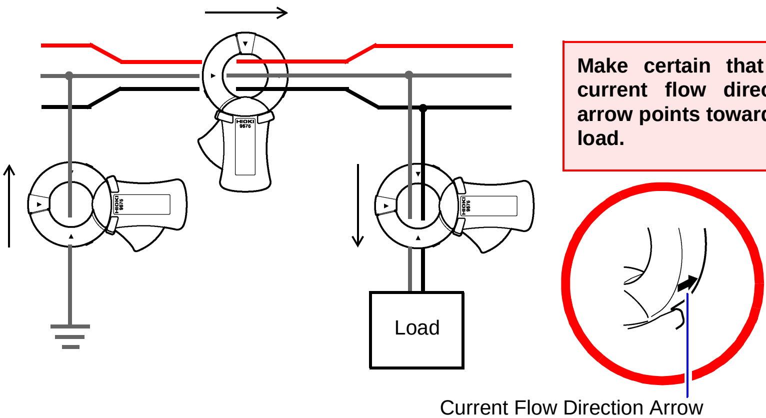


Make certain that the current flow direction arrow points toward the load.

To measure leakage current

(Example: Model 9675)

Single-phase, 2-wire line: clamp around both wires
Single-phase, 3-wire line: clamp around all three wires
Three-phase, 3-wire line: clamp around all three wires
Earth ground: clamp around just the one line

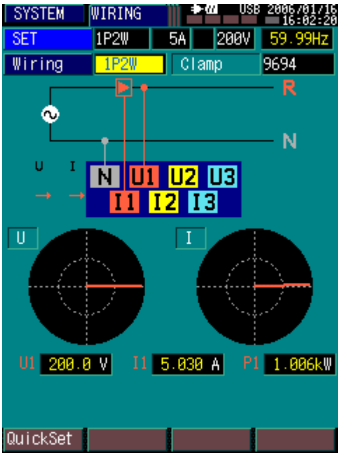


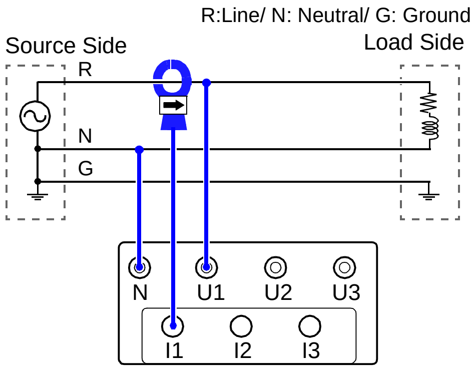
Make certain that the current flow direction arrow points toward the load.

System Wiring Diagrams

Press the SYSTEM key to display the [WIRING] screen.
While looking at the diagram, pay attention to the colors of the input terminals and leads.
These examples use the R S T phase names and TYPE 1 (HIOKI) phase colors.

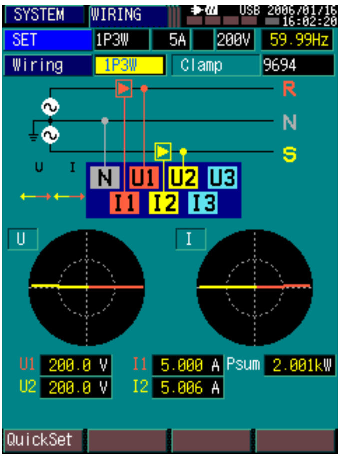
Single-Phase 2-Wire (1P2W)

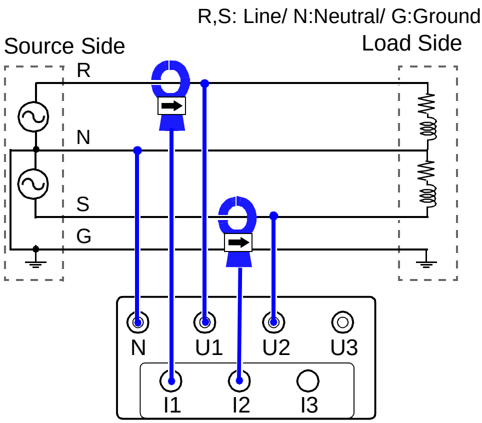




The arrows point toward the load.

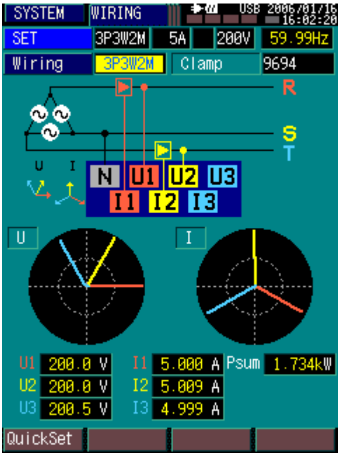
Single-Phase 3-Wire (1P3W)

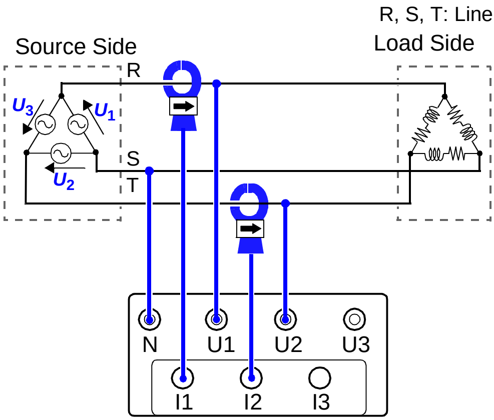




The arrows point toward the load.

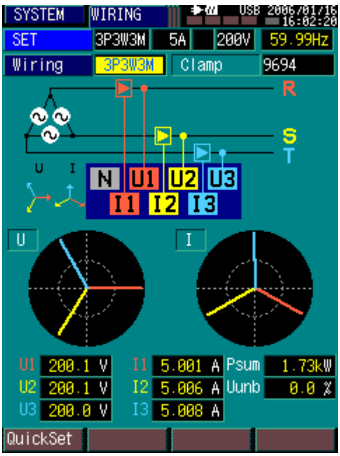
Three-Phase 3-Wire (3P3W2M)

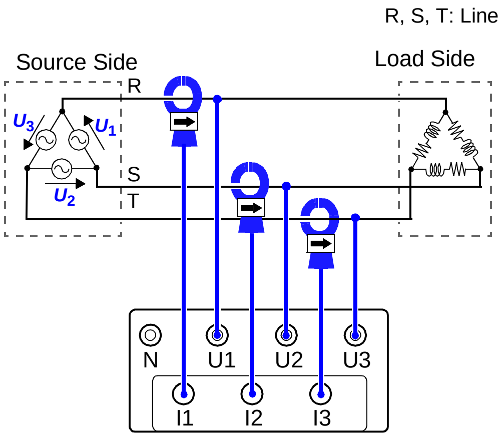




The arrows point toward the load.

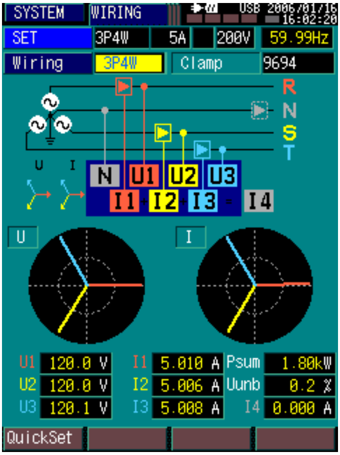
Three-Phase 3-Wire (3P3W3M)

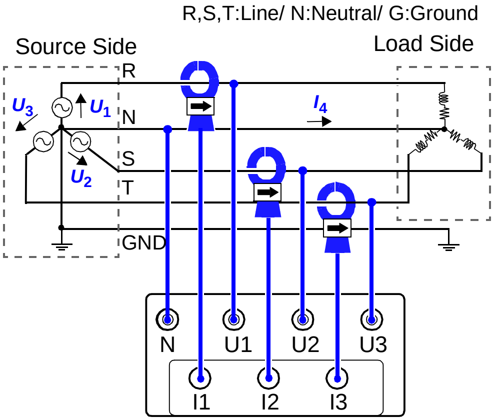




The arrows point toward the load.

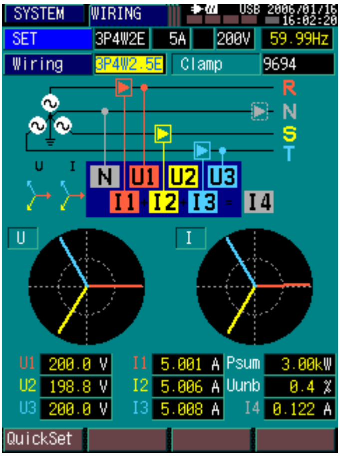
Three-Phase 4-Wire (3P4W)

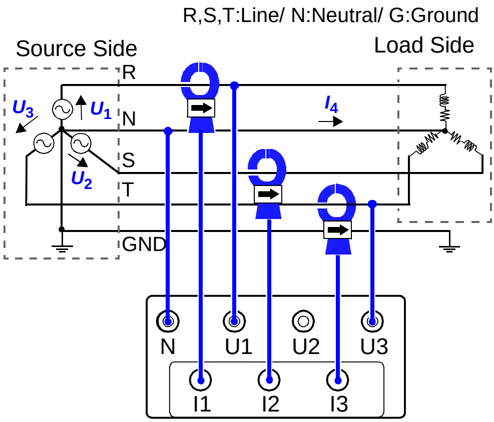




The arrows point toward the load.

Three-Phase 4-Wire (3P4W2.5E)

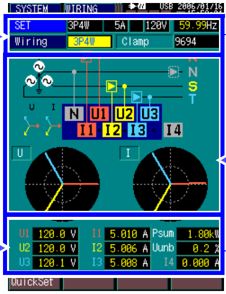




The arrows point toward the load.

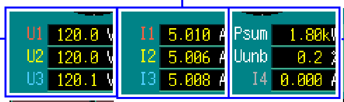
5.3 Verifying Correct Wiring (Connection Check)

Press the SYSTEM key to display the [WIRING] screen. Verify that the connections are correct from the measured values and vector display.



(Example: three-phase 4-wire (3P4W))

Confirming Measured Values



Psum ... total 3-phase active power
Uunb .... voltage unbalance
I4 .... calculated neutral line current

In this case	Check
If the voltage is above or below the selected [Nominal Voltage]	• Are the voltage cords securely clipped to the conductors to be measured? • Are the voltage cords firmly inserted into the voltage input terminals? • Is the nominal voltage setting correct?
If the current is not suitably within the [Current Range]*	• Are the clamp sensor cables securely connected to the current input terminals? • Are the clamp sensors properly clamped around the conductors to be measured? • Is the current range setting correct? Measurement is not possible if the range is set too high for the input level, or if its set so low that the input level reads overrange.
If the displayed active power value is negative	• Are the voltage cords misconnected to the input terminals so that measurements display as negative numerical values? • Is a clamp sensor indicating a negative value because the current flow direction arrow incorrectly points toward the source?

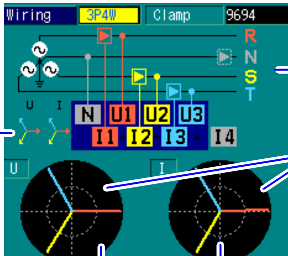
* Value set on the SYSTEM [MEASURE] screen.

Verify Settings

Current Range
Values displayed in red indicate over-range. Select a higher range, or use a clamp sensor with a higher rating.

Frequency
Values are displayed in red when different from the line frequency setting. Change the line frequency setting if necessary.

Verify the Vector Display



Wiring Configuration Diagram

Correct Vector Diagram

Real-Time Wiring Vector Diagrams

Voltage Vectors

Current Vectors

In this case	Check
If the length of the vectors is too short, or of differing lengths	• Voltage vector Verify that the voltage cords are securely connected to the voltage input terminals and lines to be measured. • Current vector Verify that the clamp sensor leads are securely connected to the current input terminals and lines to be measured.
If a vector's direction (phase) or color is wrong	• Voltage vector Verify that the voltage cord connections correspond to the wiring diagram. • Current vector Verify that the clamp sensor leads are securely connected to the current input terminals and lines to be measured

5.4 Starting and Stopping Recording

To start and stop recording	Recording can be started and stopped either manually or at preset times. • Manual recording Press the **START/STOP** key to start and stop recording. • Timed recording After setting start and stop times, recording starts and stops at the preset times. With either method, always press the **START/STOP** key to start recording. You can start and stop recording by pressing **START/STOP** with any screen displayed. When recording starts, data is recorded to internal memory.
When recording with partitioned memory **To erase recorded data**	Press the **DATA RESET** key. • After pressing the **DATA RESET** key, execute "Store Recording Data". • After pressing the **DATA RESET** key, execute "Erase the Data Just Recorded".
When you want to measure once (such as for long-term recording) **When measuring multiple times (up to four**	These are selected by setting memory partitioning. **See:** "Setting the Method for Recording to Internal Memory (Partition)"(⇒ p.63) Recording start and stop operations differ according to whether memory partitioning is enabled. • When memory partitioning is disabled Only one-time measurement is available, but available recording time is longer than when memory partitioning is enabled. • When memory partitioning is enabled Four measurement sessions can be recorded, but only one quarter of the amount of data can be recorded (compared to when memory partitioning is disabled). **See:** "2.5 Internal Operating Status and Memory Usage"(⇒ p.34) "Appendix 1 Interval and Recording Time Settings"(⇒ p.A1)

NOTE Up to 50 events can be recorded, whether or not memory is partitioned. Verify the number of recordable events before starting recording.

Starting and Stopping Recording Without Memory Partitioning (Partition: OFF)

Starting and Stopping Recording Without Memory Partitioning

Confirm that the [Partition] setting on the SYSTEM-[REC&EVENT] screen is set to [OFF]. (⇒ p.63)

To manually start and stop recording

[SET]	The POWER LED blinks (four and half-seconds on, half-second off).
START STOP ↓	**Starts recording.** **(Press the START/STOP key during [SET])**
[WAITING] ↓	The POWER LED blinks quickly (half-second on, half-second off).
Recording Starts ↓	Recording starts at an appropriate time for the selected interval (see NOTE).
[RECORDING]	The POWER LED blinks slowly (half-second on, one and half-second off). During [RECORDING], data is written to internal memory. Time series data is written at each measurement interval. Event data is written when an event occurs.
START STOP ↓	Measurement stops. A confirmation message is displayed.
Stop recording. Are you sure? Yes: ENTER No: ESC	
ENTER ↓	
[ANALYZE]	The POWER LED blinks (two seconds on, two seconds off).

NOTE

The Effect of the Interval Setting on the Start Time

The actual start time depends on the interval setting and current time, as follows.
If you press the **START/STOP** key when the current time is 10:41:22

Example 1. If the interval setting is 5 minutes

START STOP → [WAITING] → **Recording starts at 10:45:00**

Example 2. If the interval setting is 30 minutes

START STOP → [WAITING] → **Recording starts at 11:00:00**

[Partition]: with either setting to [ON] or [OFF], recording starts at the appropriate time.

Starting and Stopping Recording at Preset Times (Time Start)

Before starting recording, confirm that the [Time Start] setting on the SYSTEM-[REC&EVENT] is [ON], and that the start and stop times are set as required.

[SET]	The POWER LED blinks quickly (four and half-seconds on, half-second off).
↓ START STOP ↓	Starts recording **(Press the START/STOP key during [SET])**
[WAITING]	The POWER LED blinks quickly (half-second on, half-second off).
↓	
At the specified Start Time: Recording Starts	Recording starts at the specified start time.
↓	
[RECORDING]	The POWER LED blinks slowly (half-second on, one and half-second off). During [RECORDING], data is written to internal memory. Time series data is written at each measurement interval. Event data is written when an event occurs.
↓	
At the set Stop Time: Recording Stops	Recording stops at the specified stop time. You can abort recording by pressing the START/STOP key.
↓	
[ANALYZE]	The POWER LED blinks (two seconds on, two seconds off).

NOTE If the specified start time has already passed when you press the **START/STOP** key, "Operation Error!" is displayed.
In the [WAITING] states, if you press the **START/STOP** key before the specified start time, recording is aborted.

Recording Again, or Erasing Recording Data (Reset)

When recording stops, the [ANALYZE] **message indicates that data has been stored in internal memory.**
To restart measurement, erase the data stored in the instrument (perform data reset).

[ANALYZE]

DATA RESET — Press the **DATA RESET** key when [ANALYZE] appears)

DATA RESET has been pressed.
ALL DATA from internal memory will be deleted.
Continue?
Yes: ENTER No: ESC

A confirmation message is displayed.

ENTER — Executes data reset

[SET]

NOTE Recorded data is not erased even when the instrument is turned off. However, it is erased by executing Data Reset.
To perserve measurement data, copy it to a computer via USB cable

Starting and Stopping Recording with Partitioned Memory (Partition: ON)

When memory partitioning is enabled, the internal memory is partitioned into four parts, and data is recorded into each partition. However, no more than 50 events can be recorded, regardless of whether partitioning is enabled.

Recording Multiple Times

[SET]
The POWER LED blinks (four and half-seconds on, half-second off

START STOP
Starts recording
(Press the START/STOP key during [SET])

[WAITING]
The POWER LED blinks quickly (half-second on, half-second off

Recording Starts
Recording starts at an appropriate time for the selected interval.
See: "The Effect of the Interval Setting on the Start Time"(⇒ p.89)

[RECORDING]
The POWER LED blinks slowly (half-second on, one and half-seconds off).
During [RECORDING], measurement data is written to internal memory.
The red underline indicates the memory partition that is being used for recording.
Time series data is written at each measurement interval.
Event data is written when an event occurs.

START STOP

Stop Recording.
Are you sure?
Yes: ENTER No: ESC

Done Recording
A confirmation message is displayed.

ENTER

[ANALYZE]
The POWER LED blinks (two seconds on, two seconds off).

Recording is stopped.
Analyze Data: press ESC
Store Data / Return to SETTING status: press DATA RESET
Press ESC to close window.

A confirmation message is displayed.

To record again

DATA RESET

Store recorded data — **ENTER**

Erase recorded data — **DATA RESET**

When restarting recording while continuing to store previous data, new data is stored in the next memory partition.

Data is stored sequentially in memory partitions 1, 2, 3 and 4. To store data from more than four measurements, copy the existing data to a computer via USB cable.
See: (⇒ p.127)

5.5 Erasing Data

The method to use for erasing data depends on the internal operating state.

Internal Operating State	Partition: OFF	Partition: ON
[SET]	No data exists.	DATA RESET → "DATA RESET has been pressed. ALL DATA from internal memory will be deleted. Continue? Yes: ENTER No: ESC" → ENTER: Erases all data
[ANALYZE]	DATA RESET → "DATA RESET has been pressed. ALL DATA from internal memory will be deleted. Continue? Yes: ENTER No: ESC" → ENTER: Erase	DATA RESET → "Save the recorded data: ENTER / Cansel / Analyze: ESC / Delete the recorded data: DATA RESET" → DATA RESET: Erases the current data

5.6 Recovering From a Long-Term Power Outage

If the power supplied to the instrument is interrupted, operation continues on the (charged) battery pack. However, if the power is not restored for a long time (four to six hours or more), the instrument shuts off.

However, if memory partitioning is set [ON], and power fails while recording, recording resumes in the next partition when power is restored (for example, if power fails while recording in Memory Partition 2, recording resumes in Partition 3).

The following message appears initially when power is restored, and recording resumes immediately.

```
HIOKI 3197 POWER QUALITY ANALYZER V 1.00


Recording Re-started.
```

NOTE However, if recording in Memory Partition 4 or with memory partitioning set [OFF] when power is interrupted, recording does not resume when power is restored (even though "Recording Re-started" still appears)

Internal Operating State	Partition	Memory No.	Operation when power is restored
[RECORDING]	[ON]	No. 1, 2, or 3	Recording resumes in the next memory partition.
		No. 4	Recording does not resume.
	[OFF]	-	

Nominal continuous operating time (battery only)

After full charge, with LCD backlight auto-off (after 5 min.) enabled: Approx. 6 hours	
After full charge, with LCD backlight always on : Approx. 4 hours	

(operating at 23°C)

Viewing Data Chapter 6

The three data display screen types are called [VIEW], [TIME PLOT] and [EVENT].

Viewing Instantaneous Data
(displays the measurement status about once per second)

Screen Display		Setting Contents	Ref.
VIEW	**[WAVEFORM]** **[VECTOR]** **[HARMONICS]** **[DMM]**	Displays instantaneous measurement values. Measurement data can be viewed at any time regardless of recording start or stop state.	"6.1 Viewing Instantaneous Data (VIEW Screen)" (⇒ p.96)

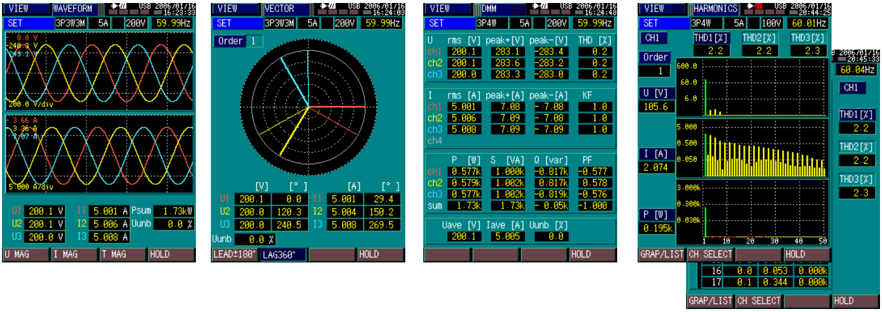
View Recording Data
(displays the current recording conditions or recorded results)

TIME PLOT	**[RMS]** **[DIP/SWELL]** **[DEMAND]** **[ENERGY]**	Displays data at each measurement interval as a time series graph. Shows fluctuations that occur between recording start and stop.	"6.2 Displaying a Time Series Plot (TIME PLOT screen)" (⇒ p.102)
EVENT	**[WAVEFORM]** **[DETAILS]** **[RMS WAVE]** **[INRUSH]**	Displays the results of event detection. Shows the contents of events detected between recording start and stop.	"6.3 Viewing Anomalous Phenomena (EVENT screen)" (⇒ p.108)

6.1 Viewing Instantaneous Data (VIEW Screen)

There are four types of VIEW screens: [WAVEFORM], [VECTOR], [HARMONICS] and [DMM]. Press the VIEW key to switch between them.
The VIEW screens display instantaneous data by refreshing about once per second, regardless of the internal operating state ([SET], [RECORDING] or [ANALYZE]).

[WAVEFORM] [VECTOR] [DMM] [HARMONICS]



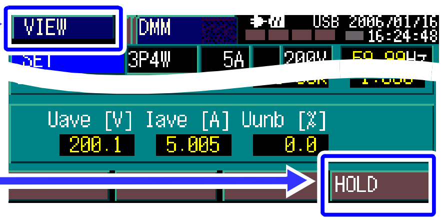
Holding the Screen Display (Common to all VIEW screens)

The screen display can be held (screen refresh stopped). Although the VIEW screen is refreshed in real-time, values and graphs can be easier to read by holding the display.

Display hold is also useful prior to executing screen shot (HARD COPY).

VIEW → **Select the VIEW screen.**

F 4 → **Press to activate the hold state**



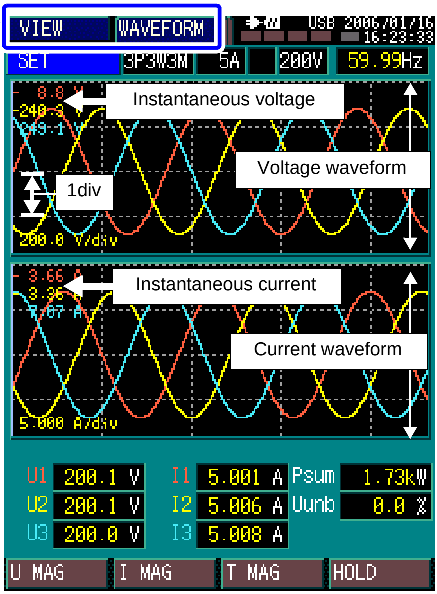
When you press the F4 key, its display label changes to HOLD as the display is held.
To cancel, press the F4 (Cancel Hold) key once.

NOTE While the F4 key label is HOLD, the display is not refreshed.
To refresh the display, press the **F4** (Cancel Hold) key to cancel the hold state.

Viewing Waveforms [WAVEFORM]

Voltage and current waveforms and rms values (voltage, current and active power) are displayed together.
The number of displayed channel waveforms depends on the selected wiring configuration.

VIEW
Select the screen.

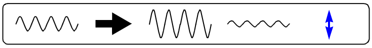


F 1 F 2 F 3 F 4
(⇒ p.96)

Magnification changes each time you press a key.

Magnifying and Compressing Waveforms on the Vertical Axis

Changing magnification of the vertical axis (voltage/current)



Vertical magnification can be selected from factors of 1/2, 1, 2.5, 5, 10, 25, 50 and 100.

To change voltage magnification F 1

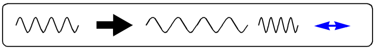
Scale per division:
1 kV/div, or 500, 200, 100, 50, 20, 10 or 5 V/div

To change current magnification F 2

Scale per division:
Available settings are multiples of the current range.
Available magnification factors are 0.5, 1, 2.5, 5, 10, 25, 50 or 100 times the current range.

Magnifying and Compressing Waveforms on the Horizontal Axis

Changing magnification of the horizontal (time) axis



Available magnification factors are 1, 2, 4 or 8 times horizontally.

To change time axis magnification F 3

Viewing Instantaneous Waveform Values

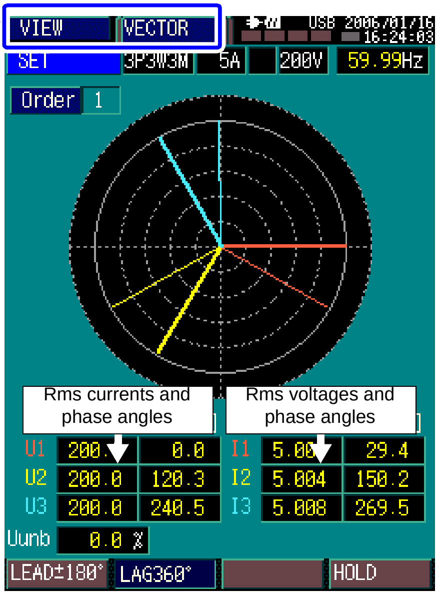
Move the cursor along a waveform and read the instantaneous values at the cursor.
Press the right or left cursor key to move the cursor in the respective direction.

Vector Display [VECTOR]

Voltage and current vectors are displayed. The rms voltages and phase angles, and the rms currents and phase angles of the fundamental waveform are also displayed. The number of channels for which vectors are displayed depends on the selected wiring configuration.

VIEW

Select the screen.



F 1 F 2 F 4

(⇒ p.96)

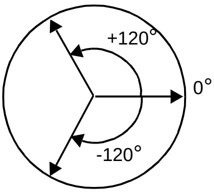
The selected item is indicated by its "key-pressed" appearance on the display. Press another key to change the selection.

Thick lines indicate voltage vectors, and thin lines indicate current vectors.

Changing the phase angle display method

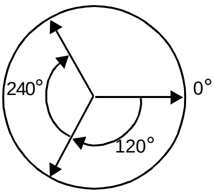
To display ±180° lead F 1

Displays -180° to -0° or 0° to 180° as positive lead.



To display 360° lag F 2

Displays 0° to 360° as positive lag.



Displaying Harmonics [HARMONICS]

Harmonics can be displayed in a bar graph or in a list. The display method is selected by the F1 key.

Displaying the harmonics bar graph

The harmonics bar graph displays voltage, current and power from the fundamental waveform to the 50th order.

In the bar graph, yellow indicates positive values and red indicates negative values.

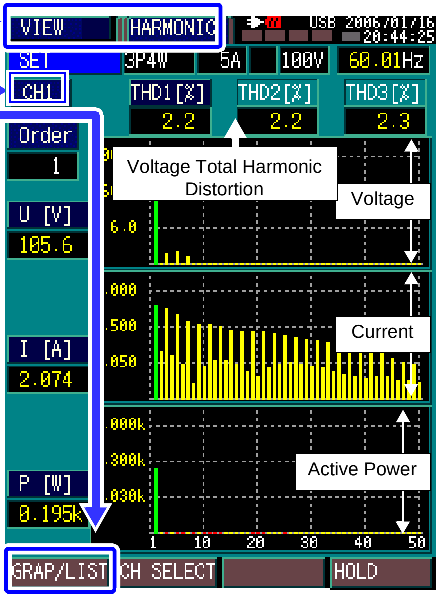
Voltage total harmonic distortion (THD) is also displayed.

1 VIEW

Select the screen.

2 F 1

Select the bar graph [GRAP/LIST] display



F 1 F 2 F 4

(⇒ p.96)

The channel changes each time you press the key.

The bar graph and list selection changes each time you press the key.

To change the displayed channel

Changes in the sequence: Channels that can be switched are determined by the wiring configuration.

F 2 CH1 → CH2 → CH3 →

To view the values of each harmonic order

Green indicates the cursor position.

Move the cursor to read the value of each harmonic order.

Press the right or left cursor key to move the cursor in the respective direction.

NOTE The voltage harmonic calculation method (RMS [V] ↔ Content Percentage [%]) can be changed on the SYSTEM-[MEASURE] screen (⇒ p.62).

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Displaying the Harmonic List

The harmonic list shows values of voltage, current and power.
The voltage total harmonic distortion (THD) is also displayed.

1 VIEW — **Select the screen.**

2 F 1 — **Select the [GRAP/LIST] display**

To change the displayed channel

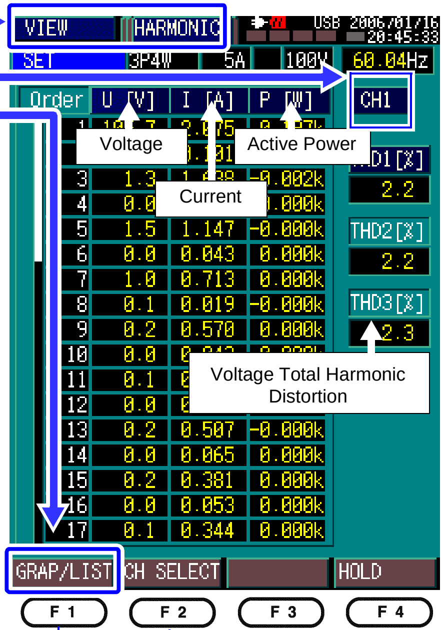
Changes in the sequence: Channels that can be switched are determined by the wiring configuration.

F 2 → CH1 → CH2 → CH3

Changes the displayed order

Changes the displayed order ▲ ▼

The list scrolls from the fundamental waveform up to the 50th order.



(⇒ p.96)

The channel changes with each key press.

The bar graph and list selection changes with each key press.

NOTE The voltage harmonic calculation method (RMS [V] ↔ Content Percentage [%]) can be changed on the SYSTEM-[MEASURE] screen (⇒ p.62).

Displaying the DMM Screen (voltage, current and instantaeous power values) [DMM]

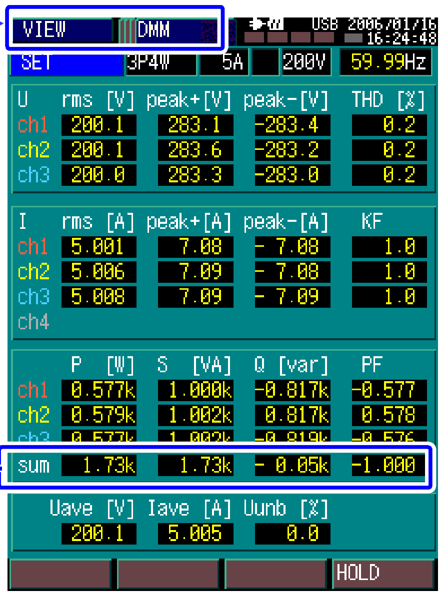
The following measurement values are displayed numerically (DMM screen).

U rms	U peak+	U peak-	U THD
rms voltage	Voltage Waveform Peak Value		Voltage Total Harmonic Distortion
I rms	**I peak+**	**I peak-**	**KF**
Rms Current	Current Waveform Peak Value		K Factor
P	**S**	**Q**	**PF**
Active Power	Apparent Power	Reactive Power	Power Factor (or DPF - Displacement Power Factor)
Uave	**Iave**	**Uunb**	
Rms Voltage Channel average	Rms Current Channel average	Voltage Unbalance	

The number of channels for which paramters are displayed depends on the selected wiring configuration.

VIEW

Select the screen.



3 phase summation

F 4

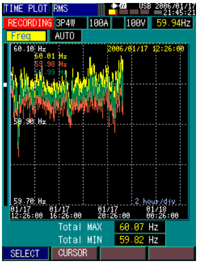
(⇒ p.96)

6.2 Displaying a Time Series Plot (TIME PLOT screen)

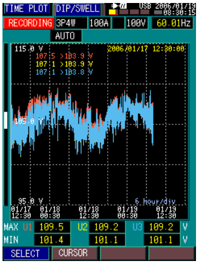
There are four TIME PLOT screens, called [RMS], [DIP/SWELL], [DEMAND] and [ENERGY]. The displayed screen changes each time you press the TIME PLOT key.

During the [RECORDING] internal operating state, the graphs on the TIME PLOT screen are refreshed at each measurement interval.

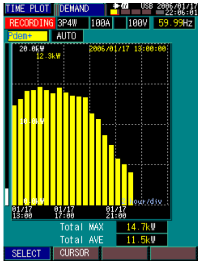
[RMS]



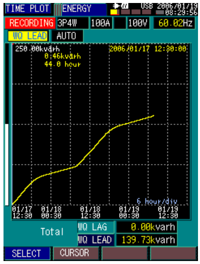
[DIP/SWELL]



[DEMAND]



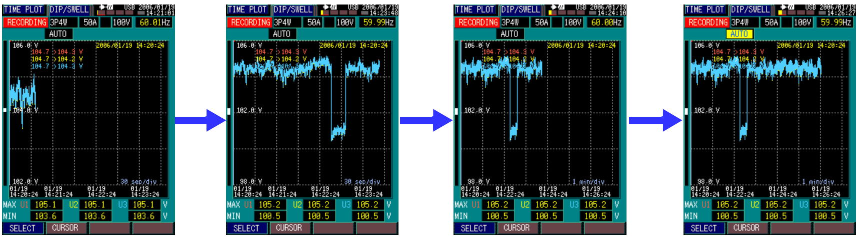
[ENERGY]



Common Operations and Screen Items (Common to TIME PLOT screens)

Screen Refresh

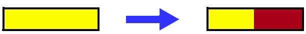
All graph plots begin from the left side, and extend to the right each time the display refreshes. When a plot reaches the right side, it is horizontally compressed by about half as it is continued.



Drawing Starts → Graph Fills Screen → Graph is Compressed → Plotting Continues

Internal memory compression

When internal memory becomes filled with recorded memory data for graphs, the internal memory is compressed and recording continues at a longer interval.



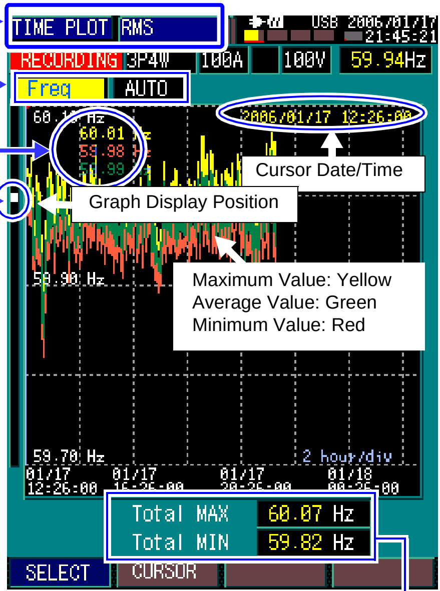
NOTE For additional details about screen refresh, internal memory compression and maximum recording times, refer to "Recordable TIME PLOT data period" (⇒ p.156), "Appendix 1 Interval and Recording Time Settings" (⇒ p.A1).

Displaying the Rms Fluctuation Graph [RMS]

View a fluctuation graph of parameters selected from voltage; current; voltage and current waveform peak values (±); frequency; active, reactive and apparent power; power factor; displacement power factor; THD and voltage unbalance factor.

TIME PLOT

Select the screen.



F 1 — **Changes displayed parameters.**

F 2 — **Selects cursor operation.**

Shows the global maximum (Total MAX), and minimum (Total MIN) values over the whole measurement period.

Selecting, Magnifying and Reducing Display Parameters on the Vertical Axis

F 1 → ENTER → ENTER

Moving to a setting item
Left: Display contents (⇒ p.104)
Right: Time axis (display magnification)
AUTO, ×1, ×2, ×5, ×10, ×25, ×50

Select from a pull-down menu

Viewing Values with the Cursor

F 2

Scrolls the fluctuation graph vertically

F 2

Scrolling is useful for analyzing the display after magnifying the vertical axis.

6

Selectable Display Parameters

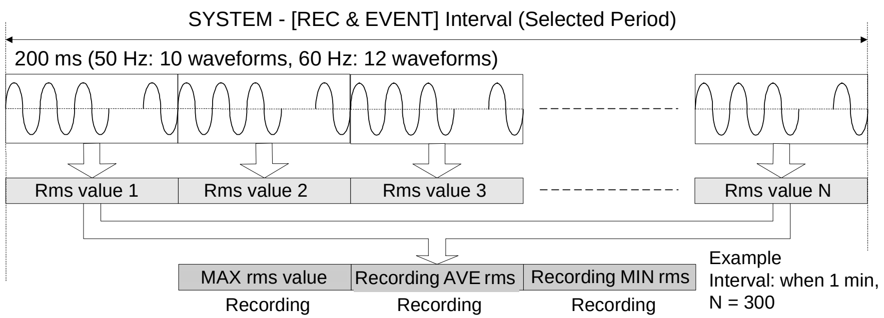
Display Parameter	Display Contents
Freq	Frequency
U1	CH1 voltage
I1	CH1 current
U2	CH2 voltage
I2	CH2 current
U3	CH3 voltage
I3	CH3 current
I4	Neutral current (calculated)
U1peak+	CH1 (+) voltage waveform peaks
U1peak-	CH1 (-) voltage waveform peaks
I1peak+	CH1 (+) current waveform peaks
I1peak-	CH1 (-) current waveform peaks
U2peak+	CH2 (+) voltage waveform peaks
U2peak-	CH2 (-) voltage waveform peaks
I2peak+	CH2 (+) current waveform peaks
I2peak-	CH2 (-) current waveform peaks

Display Parameter	Display Contents
U3peak+	CH3 (+) voltage waveform peaks
U3peak-	CH3 (-) voltage waveform peaks
I3peak+	CH3 (+) current waveform peaks
I3peak-	CH3 (-) current waveform peaks
Uave	CH average voltage
Iave	CH average current
Psum	3-phase total active power
Qsum	3-phase total reactive power
Ssum	3-phase total apparent power
PFsum	3-phase total power factor / Displacement power factor
THD1	CH1 voltage total harmonic distortion
THD2	CH2 voltage total harmonic distortion
THD3	CH3 voltage total harmonic distortion
Uunb	Voltage unbalance factor

Some parameters are not selectable depending on the selected wiring configuration.

For each displayed parameter, the maximum, average and minimum values within the interval are calculated and recorded.

TIME PLOT - [RMS]

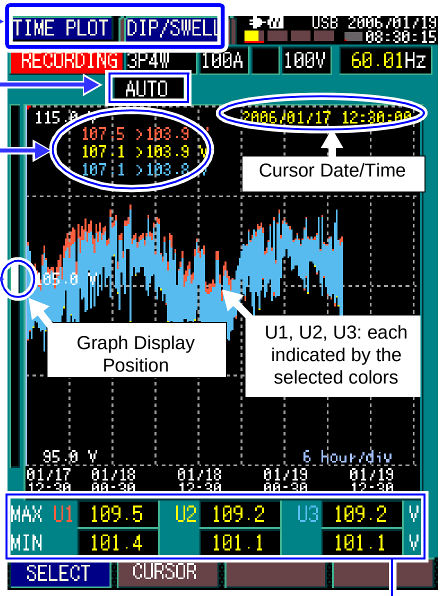


Displaying a Voltage Fluctuation Graph [DIP/SWELL]

An rms voltage fluctuation graph is displayed.
You can view this graph to confirm rms voltage fluctuations when evaluating voltage dip (DIP), voltage swell (SWEL) and interruptions.

TIME PLOT

Select the screen.



Selects cursor operation.

Changes displayed parameters.

Shows the global maximum (Total MAX), and minimum (Total MIN) values over the whole measurement period for each channel.

Magnifying and Compressing on Vertical Axis

- **F 1** — Moving to a setting item
- Vertical axis (display magnification): AUTO, ×1, ×2, ×5, ×10, ×25, ×50
- **ENTER** — Left: Display contents (see table below); Right: Time axis
- **ENTER** — Select from a pull-down menu

Viewing Values with the Cursor

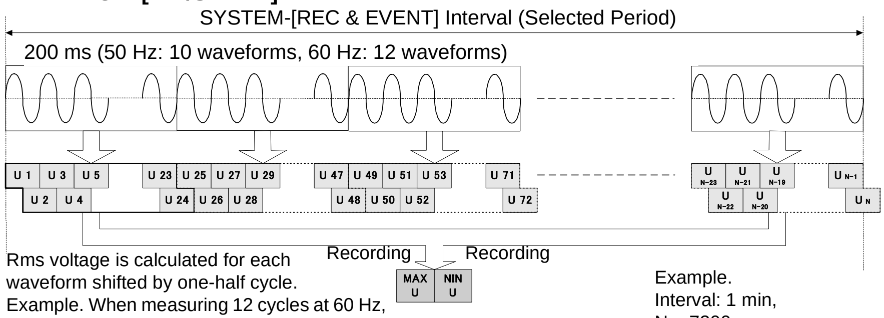
F 2

	Maximum value	Minimum value
U1	102.7 V >	102.1V
U2	102.8 V >	102.2V
U3	102.7 V >	102.1V

Scrolls the fluctuation graph vertically

F 2 — Scrolling is useful for analyzing the display after magnifying the vertical axis.

TIME PLOT -[DIP/SWELL]



Rms voltage is calculated for each waveform shifted by one-half cycle.
Example. When measuring 12 cycles at 60 Hz, 24 values of U are calculated within 200 ms.

Example.
Interval: 1 min,
N = 7200

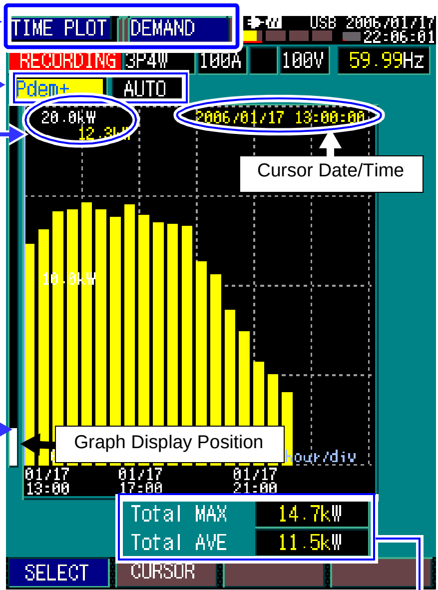
6

Displaying a Demand Graph [DEMAND]

The demand value is the average power [kW] consumed during the demand period (typically 30 minutes), and is used in power company transactions. The demand graph is refreshed after each demand period. A bar graph is displayed at the start of recording, but for long-term recording, the display changes to a fluctuation graph.

TIME PLOT

Select the screen.



F 1 F 2

Selects cursor operation.

Changes displayed parameters.

Shows the global maximum demand value (Total MAX) and average demand value (Total AVE) for the whole measurement period.

Selecting, Magnifying and Reducing Display Parameters

F 1 — Moving to a setting item
Left: Display contents (see table below)
Right: Vertical axis
AUTO, ×1, ×2, ×5, ×10, ×25, ×50

ENTER

Select from a pull-down menu

ENTER

Viewing Values with the Cursor

F 2 — 3-Phase Total Demand Value

Scrolls the fluctuation graph vertically

F 2 — Scrolling is useful for analyzing the display after magnifying the vertical axis.

Display Parameter	Display Contents
Pdem+	Active Power Demand (consumption only)
Pdem-	Active Power Demand (regenerated only)
QdemLAG	Reactive Power Demand (lagging only)
QdemLEAD	Reactive Power Demand (leading only)

NOTE The interval and demand period for a time series graph can be set independently. So there are some cases where the recordable period for the time series graph and the demand period are different. (⇒ p.156)

Displaying an Energy Consumption Graph [ENERGY]

Energy values are calculated as power times time.
Active power value [Wh] = Active power [W] x Time [h]
Reactive power value [Varh] = Reactive power [Var] x Time [h]
Example. When a 100 W light bulb is lit continuously for two hours, 200 Wh of active power is consumed.
Power values used for power company transactions are usually active power values [kWh]. This instrument displays the cumulative power value from the beginning to the end of a recording as a graph.

TIME PLOT

Select the screen.

Selecting, Magnifying and Reducing Display Parameters

F 1

Moving to a setting item
Left: Display contents (see table below)
Right: Vertical axis AUTO, ×1, ×2, ×5, ×10, ×25, ×50

ENTER

Select from a pull-down menu

ENTER

Viewing Values with the Cursor

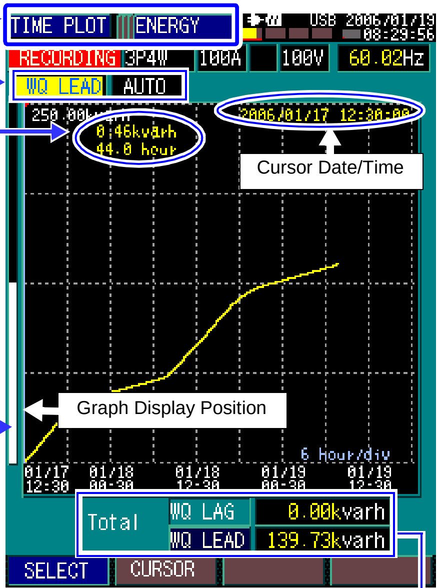
F 2

The energy value is the 3-phase total
Elapsed time is also displayed (HH:MM:SS)

Scrolls the fluctuation graph vertically

F 2

Scrolling is useful for analyzing the display after magnifying the vertical axis.



F 1 F 2

Selects cursor operation.

Changes displayed parameters.

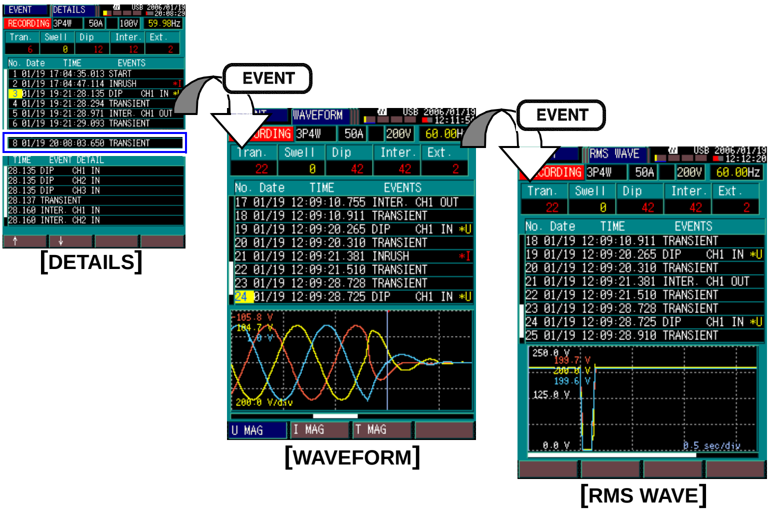
Shows the global maximum energy value over the whole measurement period.

Display Parameter	Display Contents
WP+	Active Power (consumption only)
WP-	Active Power (regenerated only)
WQLAG	Reactive Power (lagging only)
WQLEAD	Reactive Power (leading only)

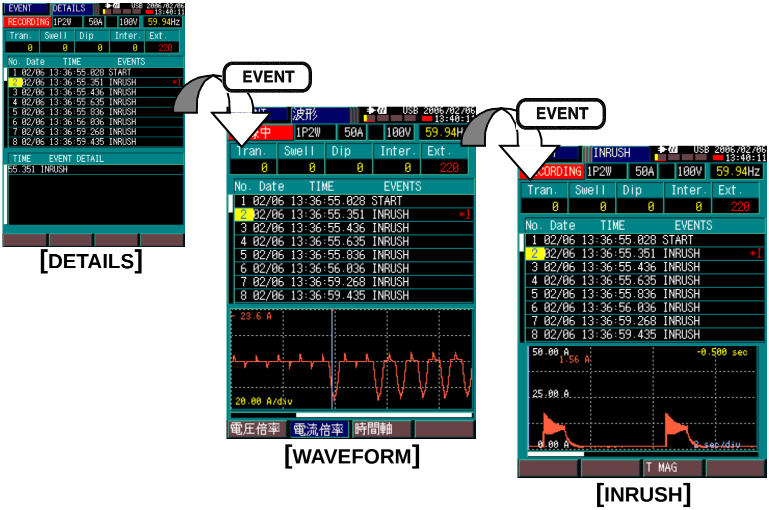
6.3 Viewing Anomalous Phenomena (EVENT screen)

There are four EVENT screens, called [LIST], [WAVEFORM], [VOLTAGE] and [INRUSH]. The displayed screen changes each time you press the EVENT key.
The Event List appears on all screens.
During the [RECORDING] internal operating state, the EVENT screens are refreshed every time an event occurs. During the [ANALYZE] internal operating state, event occurrence results are preserved.
Each screen is related to the others by the event occurrence. For example, if you select the No. 24 voltage dip event on the event [DETAILS] screen and then switch to the [DETAILS] screen, the voltage waveform of the No. 24 voltage dip is displayed, and switching to the [RMS WAVE] screen displays the event voltage fluctuation graph of the No. 3 voltage dip.

Viewing the [RMS WAVE] Screen

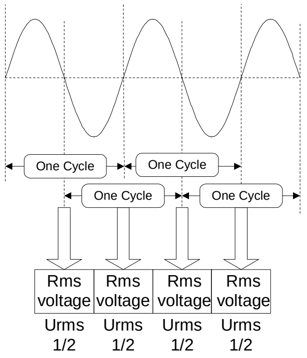


Viewing the [INRUSH] Screen



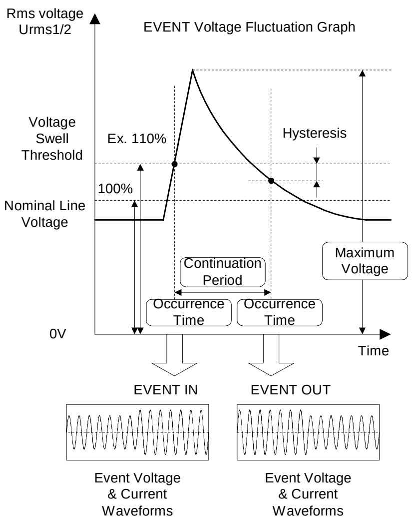
Detection Methods and Recording Contents of Events

Rms voltage (Urms1/2) (use to detect voltage swells, voltage dips and interruptions)



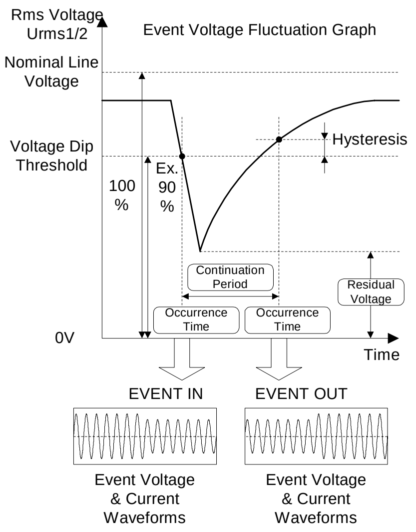
- Calculation Method
  Rms voltage (Urms 1/2) is calculated separately for three channels at every half cycle.

Voltage Swell



- Detection Method
  Detect Using Urms 1/2.
  Set the threshold as a percentage of nominal voltage.
  When the rms voltage rises above the positive threshold, it is detected as an “EVENT IN (on set)" event. Subsequently, when the voltage falls back below the threshold (minus appropriate hysteresis), it is detected as an “EVENT OUT (recovery)" event.
- Recording Contents
  Event list data, voltage/corrent waveforms, event voltage fluctuation graph
- Event Data Format
  EVENT IN (On set): Event no., occurrence date, occurrence time, event type, channel and IN
  EVENT OUT (Recovery): Event no., occurrence date, occurrence time, event type, channel, OUT, maximum voltage and continuation period
- Event Voltage Fluctuation Graph
  Fluctuation graph of Urms from about 0.5 seconds before detection to about 2.5 seconds after detection

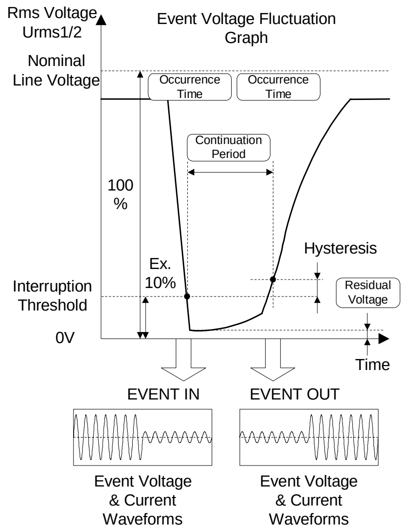
Voltage Dip



- Detection Method
  Detect Using Urms 1/2.
  Set the threshold as a percentage of nominal voltage. When the rms voltage falls below the negative threshold, it is detected as an "EVENT IN (onset)" event. Subsequently, when the voltage rises back above the threshold (plus appropriate hysteresis), it is detected as an "EVENT OUT (recovery)" event.
- Recording Contents
  Event list data, voltage/corrent waveforms, event voltage fluctuation graph
- Event Data Format
  EVENT IN (Onset): Event no., occurrence date, occurrence time, event type, channel, IN
  EVENT OUT (Recovery): Event no., occurrence date, occurrence time, event type, channel, OUT, residual voltage, continuation period
- Event Voltage Fluctuation Graph
  Fluctuation graph of Urms from about 0.5 seconds before detection to about 2.5 seconds after detection

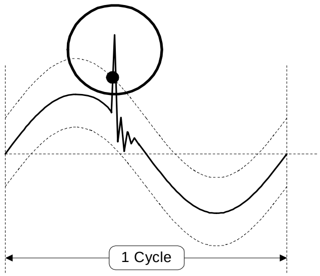
6

Interruption



- Detection Method
  Detect using Urms 1/2. Set the threshold as a percentage of nominal voltage.
  When the rms voltage falls below the threshold, it is detected as an "EVENT IN (onset)" event. Subsequently, when the voltage rises back above the threshold (plus appropriate hysteresis), it is detected as an "EVENT OUT (recovery)" event.
- Recording Contents
  Event list data, voltage/corrent waveforms, event voltage fluctuation graph
- Event Data Format
  EVENT IN (Onset): Event no., occurrence date, occurrence time, event type, channel, IN
  Event EVENT OUT (Recovery): Event no., occurrence date, occurrence time, event type, channel, OUT, residual voltage, continuation period
- Event Voltage Fluctuation Graph
  Fluctuation graph of Urms from about 0.5 seconds before detection to about 2.5 seconds after detection

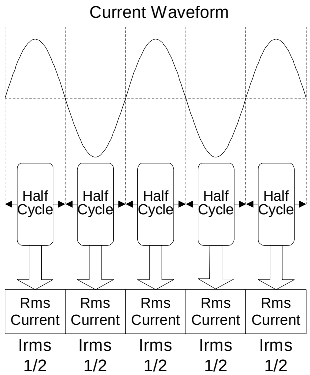
Transient Overvoltage



- Detection Method
  During each cycle, signals between 10 and 100 kHz are detected by comparator on any of three voltage channels if their amplitude exceeds ±70.7 Vpeak.
  Presence Detection
- Recording Contents
  Event List data, voltage/current waveforms
- Event Data Format
- EVENT IN (On set):Event number, occurrence date, occurrence time, Event type, IN
- EVENT OUT (Recovery):Event number, occurrence date, occurrence time, Event type, OUT, duration

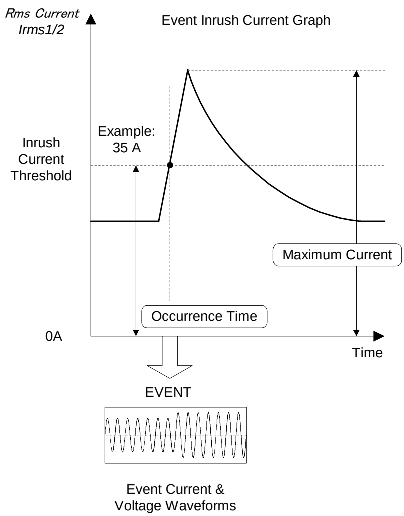
Note 1:
Only the presence or non-presence of transient overvoltage is detected.
Voltage and current waveforms at the time of event detection can be displayed. However, the transient overvoltage waveform itself (circled in the diagram) cannot be displayed.
Note 2:
Transient overvoltage that occurs repeatedly will be detected as IN/OUT events. A transient overvoltage occurring even once during a 200 ms period will be identified as an IN event. Subsequent occurrence will be monitored every 200 ms and when it is no longer detected, an OUT event will be identified.

Rms Current (used to detect inrush current)



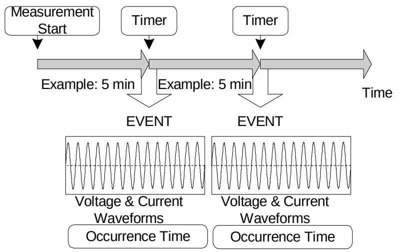
- Calculation Method
  Rms current is calculated separately at each half-cycle on three current channels (Irms 1/2).

Inrush Current



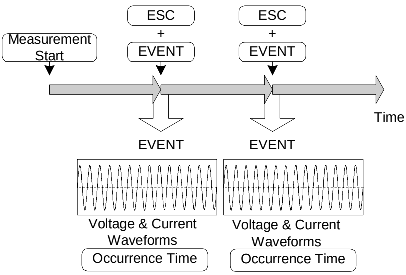
- Detection Method
  Detects using Irms 1/2.
  Set the current threshold value.
  An event is detected when the current exceeds the threshold in the positive direction.
- Recording Contents
  Event list data, voltage/current waveforms, inrush current fluctuation graph
- Event Data Format
  Event number, occurrence date, occurrence time, event type, channel and maximum current
- Inrush Current Fluctuation Graph
  Fluctuation graph of Irms from about 0.5 seconds before detection to about 29.5 seconds after detection

Timer



- Detection Method
  A detected event occurs after every set timer interval.
- Recording Contents
  Event list data, voltage/current waveforms
- Event Data Format
  Event number, occurrence date, occurrence time, event type

Manual



- Detection Method
  A detected event occurs whenever the **ESC** and **EVENT** keys are pressed simultaneously.
- Recording Contents
  Event list data, voltage/current waveforms
- Event Data Format
  Event number, occurrence date, occurrence time, event type

Operations Common to the EVENT Screens

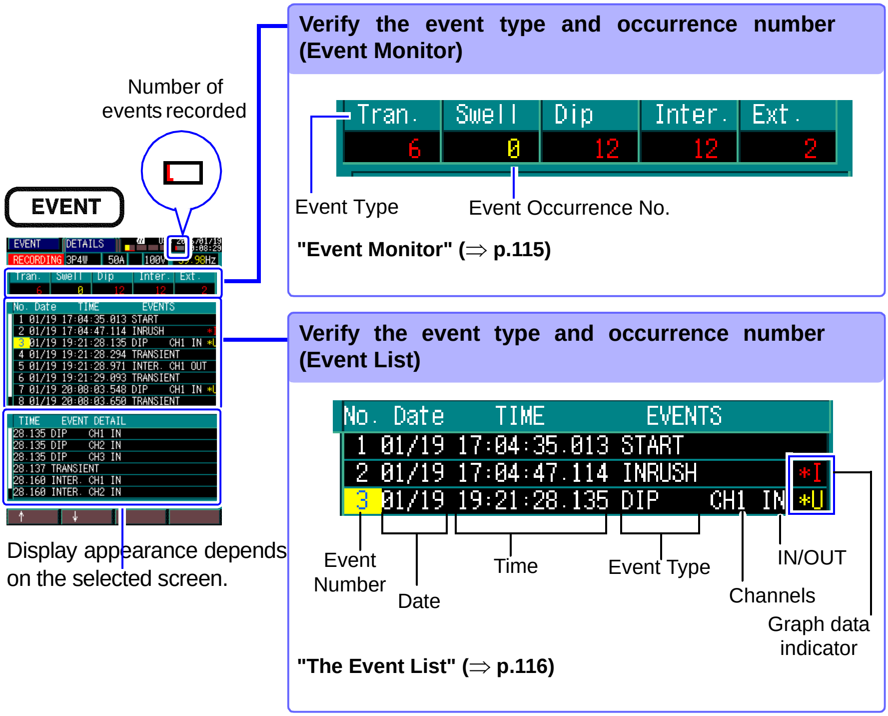
All EVENT screens display the same info in the top half, and the Event List. The first event to occur is displayed as No. 1, with subsequent events displayed as No. 2, No. 3, up to No. 50. Each time an event occurs, the display is refreshed to the latest event list.

Because the [DETAILS] screen can display only eight events, scroll the Event List up and down to display other events as needed. Similarly, on the [WAVEFORM], [RMS WAVE] and [INRUSH] screens, you can scroll the Event List when more than eight events have occurred.

For Users of the Model 3196 Power Quality Analyzer

Note that the event number assignment method of the Model 3197 Power Quality Analyzer is the opposite of Model 3196.

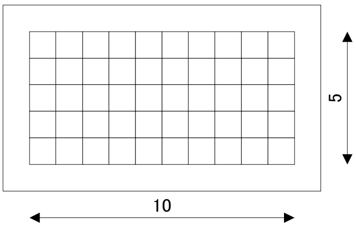
NOTE Multiple events occurring within the same 200-ms period are displayed together as a single event.



Recordable Number of Events

The number of events that can be recorded is as follows regardless of whether internal memory is partitioned.

Event	Recordable Qty.	Description
Event data	Total 50	Overall Event List, details, voltage/current waveforms
Event voltage fluctuation graph data	Total 20	Event voltage fluctuation graph for 3 seconds (*U)
Inrush current fluctuation graph data	1	Inrush current fluctuation graph for 30 seconds (*I)



The number of recorded events is indicated on the upper part of the screen.
Events recorded in internal memory are represented by colored blocks.
A total of 50 blocks can be colored, beginning at the bottom left and ending at the top right.

 Indicates that six events have been recorded

 Indicates that 46 events have been recorded

NOTE Although up to 50 inrush events can be detected, inrush current fluctuation data can be recorded (and a graph displayed) for only one INRUSH event (indicated by *I in the Event List).

Event Monitor

The number of occurrences of each event type is displayed. Event types that have not occurred are indicated by "0". When an event occurs, the number of occurrences is displayed in red.

Item		Description
Event Type	Tran.	Transient Overvoltage
	Swell	Voltage Swell*
	Dip	Voltage Dip*
	Inter.	Interruption*
	Ext.	External (Start, Stop, Timer, Manual or Inrush current)

* Voltage swell, voltage dip and interruption events have EVENT IN (onset) and EVENT OUT (recovery) occurrences. Therefore, most such events occur in pairs (onset and recovery), and the monitored values are usually multiples of two.

The Event List

Item	Example	Description	Details
Event Number	3	Event Number	Displays from 1 to 50.
Date	10/03	Month/Day	
Time	13:49:11.320	Hour:Min:Sec	1 ms resolution
Event Type	START	Start	
	STOP	Stop	
	MANUAL	Manual	
	TIMMER	Timer	
	SWELL	Voltage Swell	
	DIP	Voltage Dip	
	INTER.	Interruption	
	TRANSIENT	Transient Overvoltage	
	INRUSH	Inrush Current	
Channels	CH1	Channel 1	Displayed for voltage swell, dip and interruption
	CH2	Channel 2	
	CH3	Channel 3	
IN/OUT	IN	EVENT IN (Onset)	Displayed for voltage swell, voltage dip, interruption and transient overvoltage
	OUT	EVENT OUT (recovery)	
Graph indicators	*U	Voltage Fluctuation Graph	Indicates analysis is available on the voltage fluctuation screen
	*I	Inrush Current Graph	Indicates analysis is available on the inrush current screen

Refer to the “Event Detail List” for details about contents for multiple events. (⇒ p.118)

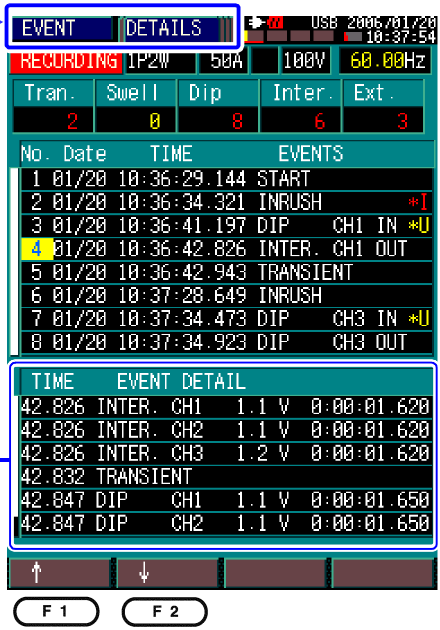
Viewing Event Detection Details [DETAILS]

Details of an event selected in the Event List can be viewed in the Event Detail List. When multiple events have occurred, the details of the events can be viewed in the Event Detail List. Multiple events occurring within the same 200-ms period are displayed together as a single event.

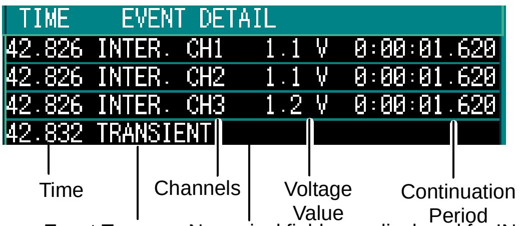
EVENT

Select the screen.

Select an event



The Event Detail List can be scrolled when it contains more than six items.



Numerical fields are displayed for IN (Onset) events (Fields are blank for OUT (Recovery) events.)

"Event Detail List" (⇒ p.118)

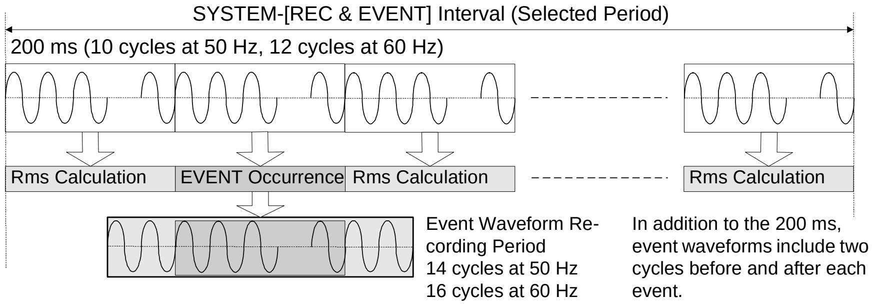
6

Event Detail List

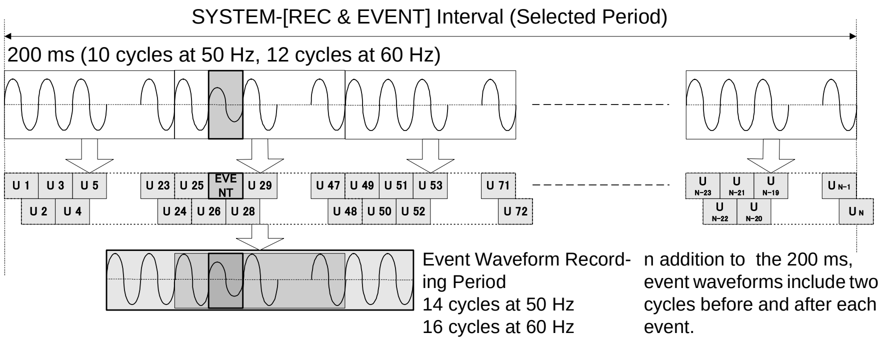
<table>
<tr><th>Item</th><th>Example</th><th>Description</th><th>Description</th></tr>
<tr><td>Time</td><td>11.320</td><td>Seconds</td><td>1 ms resolution</td></tr>
<tr><td rowspan="9">Event Type</td><td>START</td><td colspan="2">Start</td></tr>
<tr><td>STOP</td><td colspan="2">Stop</td></tr>
<tr><td>MANUAL</td><td colspan="2">Manual</td></tr>
<tr><td>TIMMER</td><td colspan="2">Timer</td></tr>
<tr><td>SWELL</td><td colspan="2">Voltage Swell</td></tr>
<tr><td>DIP</td><td colspan="2">Voltage Dip</td></tr>
<tr><td>INTER.</td><td colspan="2">Interruption</td></tr>
<tr><td>TRANSIENT</td><td colspan="2">Transient Overvoltage</td></tr>
<tr><td>INRUSH</td><td colspan="2">Inrush Current</td></tr>
<tr><td rowspan="3">Channels</td><td>CH1</td><td>Channel 1</td><td rowspan="5">Displayed for voltage swell, dip and interruption</td></tr>
<tr><td>CH2</td><td>Channel 2</td></tr>
<tr><td>CH3</td><td>Channel 3</td></tr>
<tr><td rowspan="2">IN/OUT</td><td>IN</td><td>EVENT IN (Onset)</td></tr>
<tr><td>(blank)</td><td>EVENT OUT (Recovery)</td></tr>
<tr><td rowspan="3">Voltage Value</td><td rowspan="3">0.7V</td><td>Max. voltage before voltage swell detection</td><td rowspan="4">Displayed for "Event Out (Recovery)” occurrences of voltage swell, dip and interruption</td></tr>
<tr><td>Min. voltage before voltage dip detection</td></tr>
<tr><td>Min. voltage before interruption detection</td></tr>
<tr><td>Continuation Period</td><td>0:00:00.564</td><td>Hour:Min:Sec
(1 ms resolution)</td></tr>
</table>

Waveform Anomaly Recording Methods (Data Displayed on EVENT Screen)

Event Types other than Voltage Swell, Voltage Dip and Interruption



Voltage Swell, Voltage Dip and Interruption Event Types

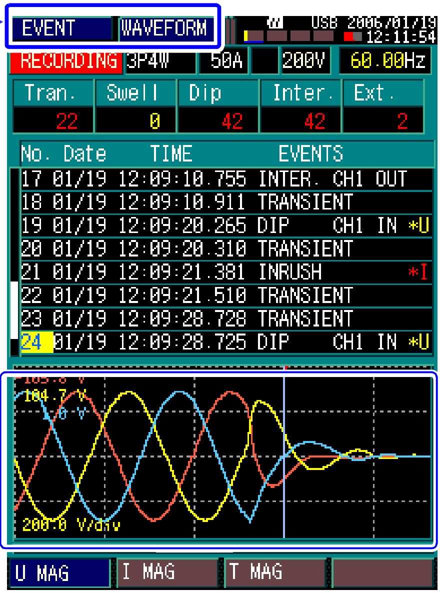


Displaying Detected Event Waveforms [WAVEFORM]

The event waveform is displayed for the event selected in the Event List. Pressing the up and down cursor keys sequentially changes the selected event waveform.

EVENT

Select the screen.



F 1 — Selects voltage waveforms and changes vertical axis magnification

F 2 — Selects voltage waveforms and changes vertical axis magnification

F 3 — Changes time axis magnification

The Event Detail List can be scrolled up and down when it contains more than four items. The number of channels of displayed waveforms depends on the selected wiring configuration.

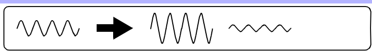
Select voltage or current waveforms.

Display voltage waveforms. F 1

Display current waveforms. F 2

Select an event.

Changing magnification of the vertical axis



Vertical magnification can be selected from factors of 1/2, 1, 2.5, 5, 10, 25, 50 and 100.

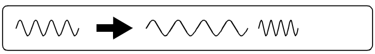
To change voltage magnification F 1

Scale per division:
1 kV/div, or 500, 200, 100, 50, 20, 10 or 5 V/div

To change current magnification F 2

Scale per division:
Available settings are multiples of the current range.

Available settings are multiples of the current range.



Available multiples are 1, 2, 4 or 8 times horizontally.

To change time axis magnification F 3

Displaying Detected Voltage Fluctuation Events [RMS WAVE]

Select a voltage dip, voltage swell or interruption EVENT IN (Onset) event having an *U indicator in the Event List to display its voltage fluctuation graph.

Pressing the up/down cursor keys switches the display sequentially between events. The rms voltage fluctuation graph is calculated from each half-cycle-shifted waveform (Urms 1/2).

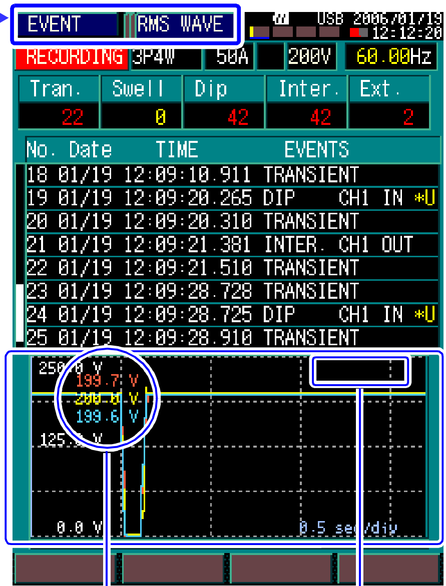
The event voltage fluctuation graph begins about 0.5 seconds before detection and continues to about 2.5 seconds after detection. The graph is drawn according to the selected channel colors.

EVENT

Select the screen.

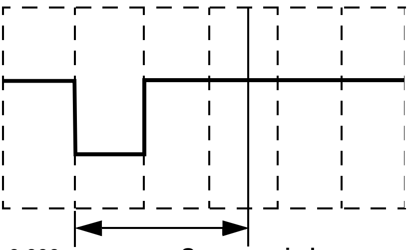
The horizontal axis is fixed at 0.5 sec/div.

To perform cursor measurement
Scrolls the graph horizontally



Cursor value
(Rms voltage on each channel)

Cursor period
(Elapsed time from event detection to cursor position)



0.000 sec **Cursor period**

NOTE Cursor period calculation is valid only for 50 or 60 Hz line frequency.

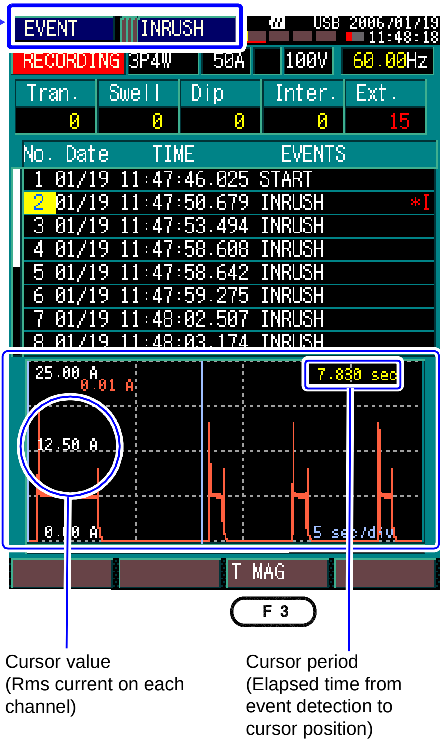
Displaying Detected Inrush Current Events [INRUSH]

Select the event with the *I indicator in the Event List to display its inrush current graph.

Pressing the up/down cursor keys switches the display sequentially between events. The rms current fluctuation graph is calculated from each half-cycle measurement (Irms 1/2). The event inrush current fluctuation graph begins about 0.5 seconds before detection and continues to about 29.5 seconds after detection. The graph is drawn according to the selected channel colors.

EVENT

Select the screen.

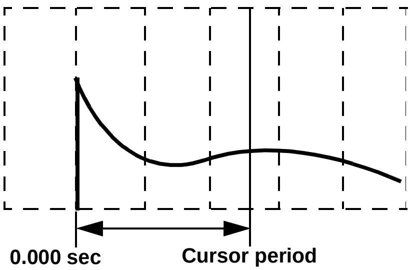


Magnifying and Compressing Waveforms

The horizontal axis can be set to 0.5, 1, 2 or 5 sec/div.

To change time axis magnification F 3

To perform cursor measurement
Scrolls the graph horizontally



NOTE
- Cursor period calculation is valid only for 50 or 60 Hz line frequency.
- The inrush current fluctuation graph displays rms current fluctuations.

6.4 Viewing Recorded Data ([REVIEW] State)

Data stored in internal memory when memory is partitioned [ON] can be viewed and re-analyzed.

After recording data in the **[SET]** state, switch to the **[REVIEW]** state to re-analyze data. To select the **[REVIEW]** state, press the F4 (Re-Analyze) key from the [TIME PLOT] or [EVENT] screen.

6.4.1 Viewing Only Data Recorded in Memory Partition No. 1

In the **[REVIEW]** state, [SYSTEM], [TIME PLOT] and [EVENT] data recorded in Memory No. 1 can be analyzed. ([VIEW] data cannot be analyzed.)

TIME PLOT | EVENT

From the TIME PLOT or EVENT screen, select the [SET] state.

Memory indicator: Blue

Reviewing

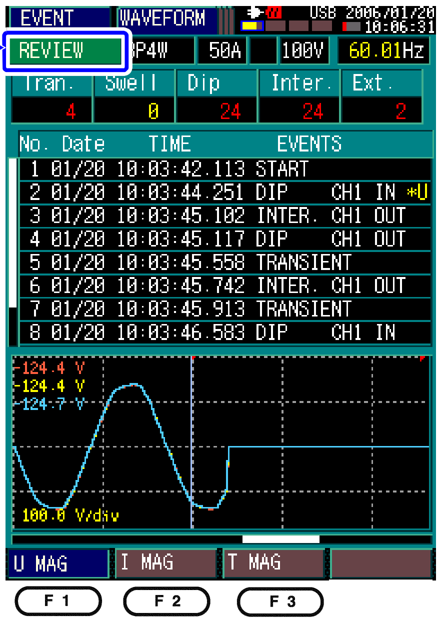
Select the [REVIEW] state F 4

The following message appears.

> The [REVIEW] state is enabled.
> Press the DATA RESET key to return to the [SET] state.

Memory indicator: Blue frame

Recorded data can be analyzed by selecting the [SYSTEM], [TIME PLOT] and [EVENT] screens.



To exit from Reviewing

Select the [SET] state DATA RESET

The following message appears.

> Exiting the [REVIEW] state and returning to the [SET] state.

Memory indicator: Blue

6

6.4.2 Viewing Data Recorded in Multiple Memory Partitions

In the **[REVIEW]** state, [SYSTEM], [TIME PLOT] and [EVENT] data recorded in multiple memory partitions (Nos. 1 to 4) can be analyzed.

TIME PLOT | EVENT

From the TIME PLOT or EVENT screen, select the [SET] state.

Memory indicator: Blue

Reviewing

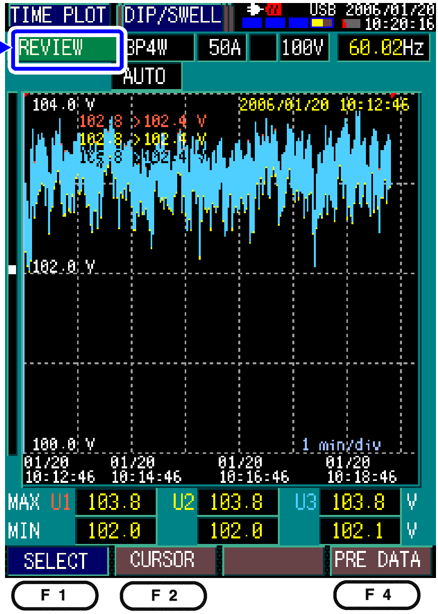
Select the [REVIEW] state F 4

The following message appears.

> The [REVIEW] state is enabled.
> Press the DATA RESET key to return to the [SET] state.

Memory indicator: Blue frame

Recorded data can be analyzed by selecting the [SYSTEM], [TIME PLOT] and [EVENT] screens.



To finish Reviewing

Select the [SET] state DATA RESET

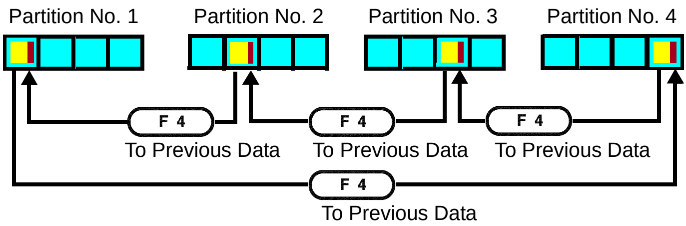
The following message appears.

> Exiting the [REVIEW] state and returning to the [SET] state.

Memory indicator: Blue

Analyzing TIME PLOT data

TIME PLOT data recorded in multiple memory partitions can be analyzed by switching the browsed memory partition using the F4 (Previous Data) key. The selected memory partion is indicated by a blue frame. At that time, the [SYSTEM] data (that was set when the selected memory was recorded) is displayed.



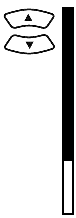
Analyzing EVENT data

You do not need to select a memory partition to analyze recorded EVENT data. Up to four events can be analyzed together.

All events recorded in memory partitions 1 to 4 are displayed in the Event List.

The up/down cursor keys select events in the list.

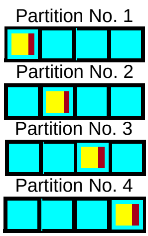
Either the "Internal Memory Usage indiicator" or "Event Monitor" appears according to the selected event.



Event List

No.	Date	TIME	EVENTS
1	12/19	07:30:00.000	START
2	12/19	14:30:00.000	STOP
3	12/20	07:30:00.000	START
4	12/20	14:30:00.000	STOP
5	12/21	07:30:00.000	START
6	12/22	14:30:00.000	STOP
7	12/21	07:30:00.000	START
8	12/22	14:30:00.000	STOP

Internal Memory Usage Indicator



Event Monitor

Tran.	Swell	Dip	Inter.	Ext.
0	0	0	0	2
Tran.	Swell	Dip	Inter.	Ext.
0	0	0	0	2
Tran.	Swell	Dip	Inter.	Ext.
0	0	0	0	2
Tran.	Swell	Dip	Inter.	Ext.
0	0	0	0	2

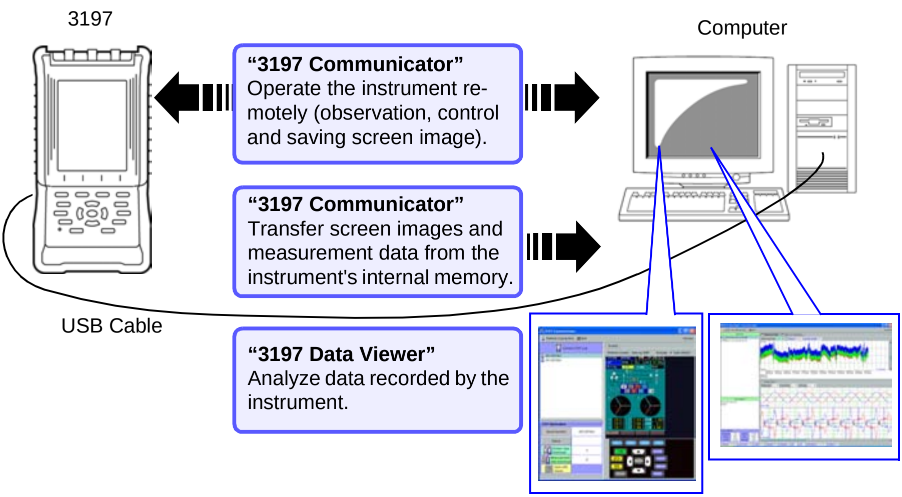
Viewing Data on a Computer — Chapter 7

This chapter describes the preparations to make before using the PC application programs designed for this instrument. Refer to the instructions on the CD for details about program operation.

7.1 Overview

Communication between the instrument and a computer is available by connecting the supplied USB cable between them.
The supplied CD contains communication programs. The two application programs for this instrument are called "3197 Communicator" and "3197 Data Viewer".

PC application program for Model 3197



Availability	Software	Description	
Supplied	JRE	Java Plug-in	The application for this instrument utilizes Java™ developed by Sun Microsystems, Inc., which requires that the JRE be installed on the PC. Check for the presence of the Java applet in the Windows Control Panel to confirm that Java is installed.
	Application for this instrument	3197 Communicator	Operates the instrument remotely (observation, control and saving screen image). Transfers screen images and measurement data from the instrument's internal memory.
		3197 Data Viewer	Analyzes data recorded by the instrument.
Optional	Applications for this instrument and Model 3196	9624-50 PQA-HiView PRO (Available soon)	Analyzes (binary) measurement data recorded on this instrument as well as on the Model 3196 Power Quality Analyzer.

7.1.1 PC System Requirements

Computer:	PC/AT-compatible (at least 1-GHz CPU)
OS:	Windows 2000/XP Japanese or English edition
Display:	1024 Å~ 768 dots, at least 16-bit color
Memory:	At least 128 MB (256 MB or more recommended)
Hard Disk Space :	At least 128 MB free space
Communications Port :	USB 1.1 or 2.0 (Full-Speed)

7.1.2 Files on the CD

Japanese	setup.exe	Japanese installer for application programs
	3197appli_manual_j_00.pdf	Japanese manual for the application programs
	AdobeRdr70_jpn_full.exe	Japanese installer for Adobe Reader
English	setup.exe	English installer for application programs
	3197appli_manual_e_00.pdf	English manual for the application programs
	AdobeRdr70_enu_full.exe	English installer for Adobe Reader
j2re-1_4_2_09-windows-i586-p.exe		JRE (Java2 runtime environment Standard Edition)

NOTE Adobe Reader must be installed on the PC in order to read the manuals. If it is not already installed, run AdbeRdr70_enu_full.exe.

7.1.3 Preparing to Run the Application Programs

1. Turn on the computer.
2. Install JRE.(⇒ p.130)
3. Install the application programs (⇒ p.132).
   (The necessary USB driver is also installed.)

7.1.4 Running the Application Programs

1. Turn on the computer.
2. Turn on the instrument.
3. Connect the instrument to the computer with the supplied USB cable.
   (⇒ p.134)
   (Connect if using "3197 Communicator".)
4. Start the application programs.

⚠CAUTION To avoid malfunctions and data loss, do not plug or unplug the USB cable while in use.

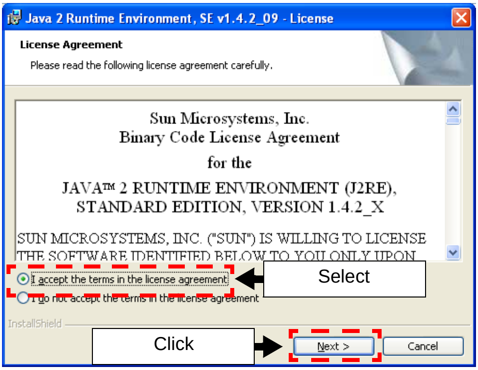
7.2 Installing JRE

Installation procedure

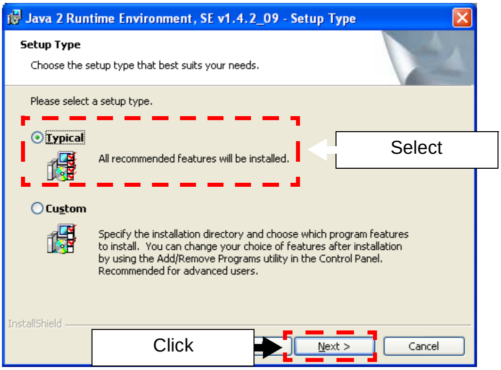
1 Load the supplied CD into the CD drive.

2 Double click the file "j2re-1_4_2_09-windows-i586-p.exee" to run it. The [Java 2 Runtime Environment, SE v1.42_09] screen appears.

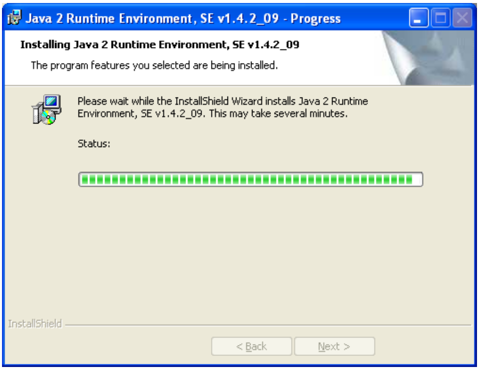
3 Select [I accept the terms in the license agreement] and click [Next] if you agree to the terms of the License Agreement.

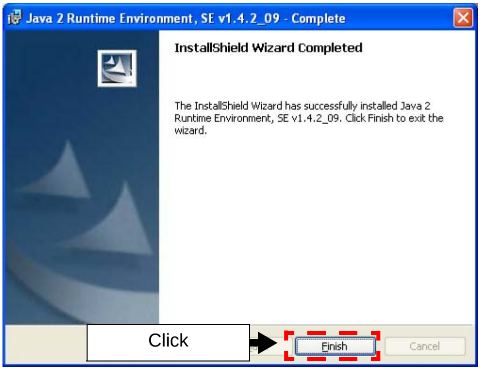


4 Select [Typical], and click [Next].



5 When the installation process has completed successfully, click [Finish].





7.3 Installing the Application Programs

In addition to the USB driver, two instrument application programs can be installed on the computer: " 3197 Communicator" and "3197 Data Viewer". The procedure for installing the instrument applications on a Windows XP computer is described here.

Installation procedure

1 If the computer's operating system is Windows 2000 or XP Professional, log on as an "administrator" user.

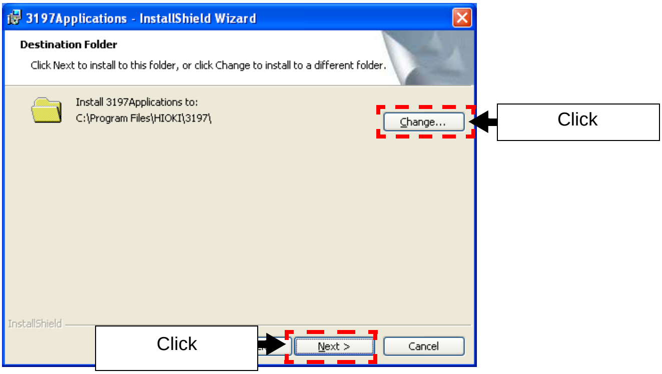
2 Before starting the installer, close all currently running applications.

3 Run the program E:\3197Application\English\setup.exe (assuming your CD-ROM is drive E:)

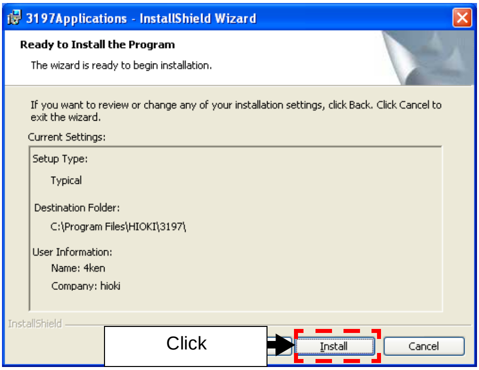
After running setup.exe, installation continues with the following on-screen instructions.

1 Click [Next].

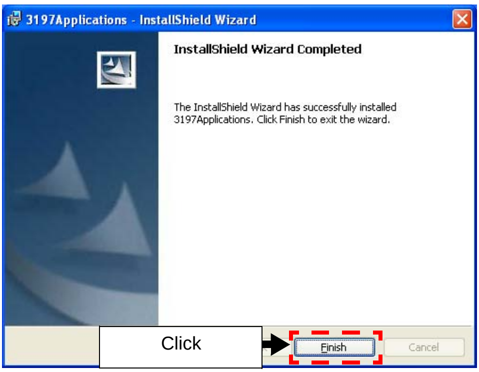
2 To change the installation destination, click [Change] and select the destination. Then click [Next].



3 Click [Install].



4 Click [Finish] to complete the installation.



Uninstall Procedure

To uninstall, open Add or Remove Programs in the Windows Control Panel, and select [3197 Applications].

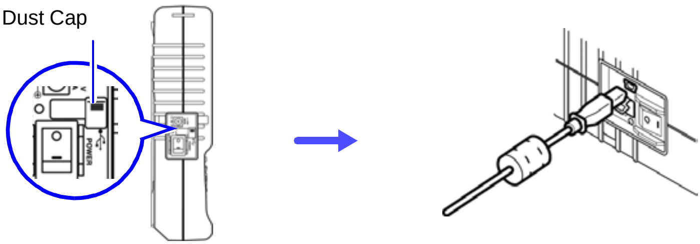
NOTE When updating the applications, first uninstall the old versions.

7.4 Connecting the Instrument and Computer with the Supplied USB Cable

Use only the supplied USB cable to connect the instrument to the computer, by the following procedure.

⚠CAUTION
- To avoid malfunctions and data loss, do not plug or unplug the USB cable while in use.
- Connect the earth grounds of this instrument and the computer to a common grounding point.
  Grounding to different points may result in a potential difference between the grounds of the instrument and the computer, which could cause malfunctions or damage when connecting the USB cable.

USB connection procedure



1 Remove the dust cap from the USB port.

2 With attention to connector orientation, insert the USB cable plug into the port.

The "Found New Hardware Wizard" launches when you connect the instrument to the computer with the USB cable.

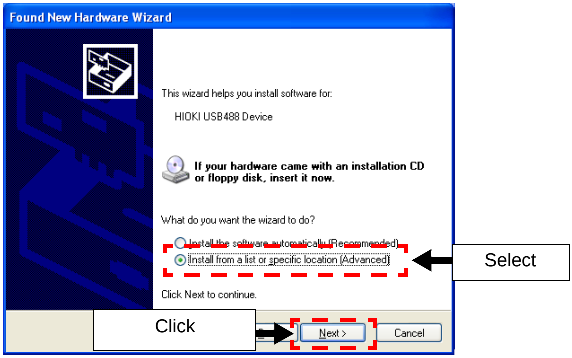
⚠CAUTION To avoid malfunctions and data loss, do not plug or unplug the USB cable while in use.

NOTE The "Found New Hardware Wizard" launches whenever an instrument with a different serial number is connected to the computer. It does not launch again when the same instrument is reconnected later.

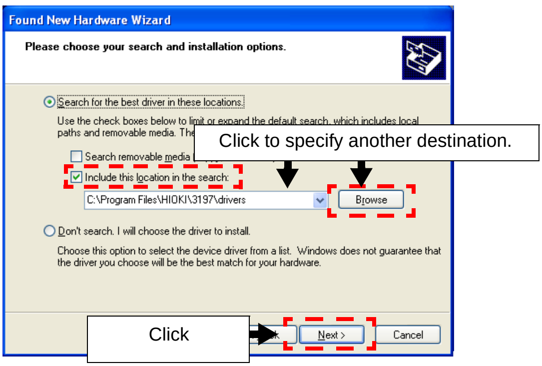
This example presumes the computer is running Windows XP.

1 Select "No, not this time", and click [Next].

2 Select "Install from a list or specific location (Advanced)", and click [Next]



3 Select “Include this location in hte search”, and cick [Browse] to specify the destination installed the USB driver.



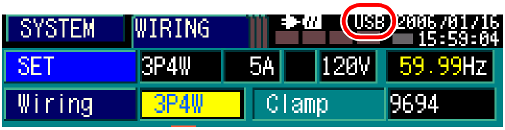
Installation starts automatically when you click [Next].

4 Click [Finish] to close the wizard.

Confirming connections

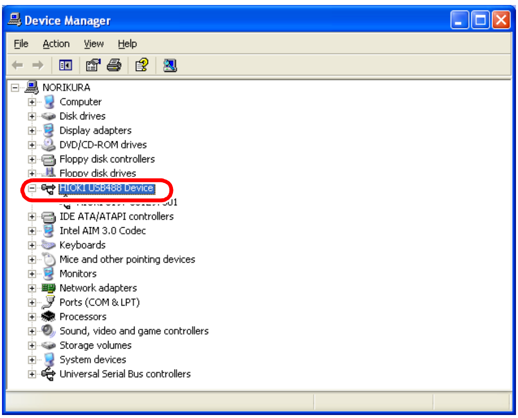
Instrument Connection

When connected, the [USB] indicator appears on the instrument's screen.



Computer Connection

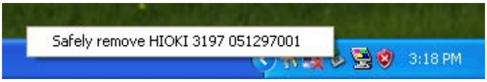
On-screen confirmation is accessible at [Control Panel] - [System] - [Hardware] - [Device Manager]. The instrument's model name and serial number are displayed in [HIOKI USB488-Device].
Multiple instruments are recognized when connected.



Disconnecting the USB cable

When disconnecting a USB cable between the instrument and a running computer, perform the following steps:

- Turn the instrument off.
- Open the "Safely Remove Hardware" icon in the computer's Notification area, and select the instrument to disconnect.



⚠CAUTION To avoid malfunctions and data loss, do not plug or unplug the USB cable while in use.

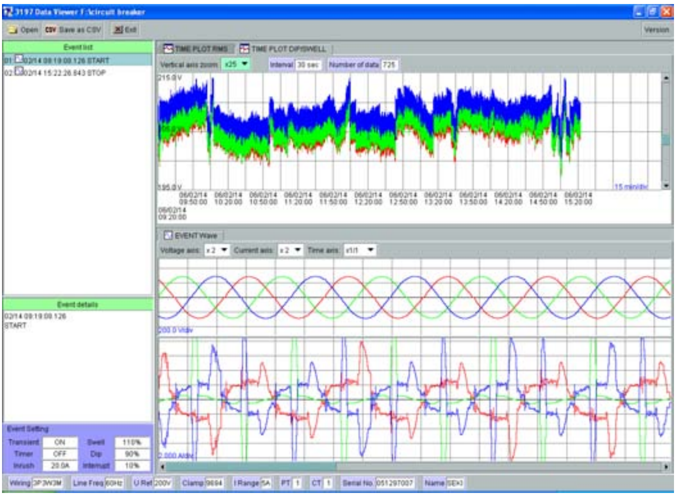
7.5 Starting the Instrument Application Programs

"3197 Communicator" application

From the Windows [start] menu, select [All Programs] - [HIOKI] - [3197 Applications] - [3197 Communicator].

To start the "3197 Data Viewer" application

From the Windows [start] menu, select [All Programs] - [HIOKI] - [3197 Applications] - [3197 Data Viewer].



For operating instructions, refer to the pdf manual on the CD.

Chapter 8 Specifications

8.1 General Specifications

Environmental and Safety-Related Specifications

Operating environment	Indoors, up to 2000 m (6562-ft.) ASL
Storage temperature and humidity	-10 to 50°C (14 to 122°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)
Withstand voltage	@50/60 Hz, for 15 s 5.312 kVrms AC (1 mA sense current) from voltage measurement terminals to chassis 3.32 kVrms AC (1 mA sense current) from voltage measurement terminals to current measurement terminals and USB port
Applicable standards	Safety EN61010-1: 2001, Pollution degree 2, Measurement Categories III (600 V) and IV (300 V) (anticipated transient overvoltage 6000 V) EMC EN61326:1997+A1:1998+A2:2001+A3:2003 Class A EN61000-3-2:2000 EN61000-3-3:1995+A1:2001
Power source	Model 9418-15 AC Adapter SINO-AMERICAN Model SA130A-1225V-S 12V 2.5A Rated supply voltage 100 to 240V AC (with up to ±10% voltage variation) Rated supply frequency 50/60 Hz Model 9459Battery Pack Sanyo Electric Model 6HR-AU NiMH Battery (7.2 V, 2700 mAh)
Maximum rated power	23 VA (with AC adapter, at maximum load)
Continuous operating time	When using Model 9459Battery Pack (@23°C, 73°F) Approx. 6 hours (after full charge, with 5 min. auto-off LCD backlight) Approx. 4 hours (after full charge, with LCD backlight always on)
Charging function	Available for the Model 9459Battery Pack, with the Model 9418-15 AC Adapter connected
Quick-Charging time	Approx. 3 hours (@23°C, 73°F) After quick charging, trickle charging continues (to prevent self discharge)
Dimensions	Approx. 128 W × 246 H × 63 D mm (5.04"W × 9.69"H × 2.48"D) (including stand)
Mass	Approx. 1.2 kg (42.3 oz.) (With battery pack installed, without AC adapter)

Measurement Input Specifications

Wiring configurations	Single-phase 2-wire (1P2W), single-phase 3-wire (1P3W), three-phase 3-wire (3P3W2M and 3P3W3M), three-phase four-wire (3P4W and 3P4W2.5E), Neutral current calculation and display
Measurement line frequency	Autoselecting (50/60 Hz)
Measurement input method	Voltage: isolated inputs and differential inputs (not isolated between U1, U2, U3 and N) Current: isolated inputs by clamp-on sensors
Input impedance (50/60 Hz)	Voltage: 3.2 MΩ ±10% (differential inputs) Current: 200 kΩ ±10%
Max. allowable input voltage	Voltage input section: 780 V AC (1103 Vpeak) Current input section: 1.7 V AC (2.4 Vpeak)
Maximum rated voltage to ground	Voltage input section: 600 V AC (50/60 Hz) (Measurement Category III) 300 V AC (50/60 Hz) (Measurement Category IV) Current input section: per clamp-on sensors used

Basic Measurement Specifications

Measurement method	Simultaneous digital sampling of voltage and current
A/D converter resolution	16 bits
Sampling frequency	10.24 kHz per channel (204.8 points per cycle at 50 Hz, 170.67 points per cycle at 60 Hz)
Calculation processing	• Voltage (1/2) Alternately calculated for every full cycle at half-cycle intervals, continuous measurement without gaps (interpolation available) • Current (1/2) Calculated every half-cycle, continuous measurement without gaps (interpolation available) • Rms (measurement values other than voltage (½), current (½) and harmonic-related) 200 ms calculation of continuous measurements with no gaps (with interpolation) • Harmonics 2048-point calculation of continuous measurements without gaps (10 cycles @50 Hz, 12 cycles @60 Hz)

Measured and Detected Parameter Specifications

Measured parameters	Voltage (½), Current (½) Voltage, peak voltage, current, peak current, frequency, active power, reactive power, apparent power, power factor, displacement power factor, active power, reactive power, active power demand, reactive power demand, voltage harmonics, current harmonics, power harmonics, fundamental waveform phase angle, voltage total harmonic distortion, K factor, voltage unbalance factor
Event types	Voltage swell, voltage dip, interruption, inrush current, transient overvoltage, timer, manual, upon start/stop

Display Specifications

Display refresh rate	Approx. once per second
Measurement display range	Voltage and current: 1 to 130% of range (zero-suppressed below 1%), power (active, reactive, apparent, power factor, displacement power factor), total power, energy consumption and demand are zero-suppressed when voltage or current is zero.
Usable measurement range	5 to 110% of range
Display	4.7-inch color STN LCD (portrait orientation)
Resolution	240 × 320 dots (RGB)
Dot pitch	0.10 × 0.30 mm
Display languages	English, Japanese or Chinese (Simplified)
LCD backlight	Always On or Auto-Off (after 1, 5, 10 or 30 s, or after 1 h)
LCD brightness adjustment	If no key is pressed for ten seconds, the backlight switches from high to low brightness.
LCD contrast adjustment	Provided

Interface Specifications

Interface	USB 2.0 (Full Speed)
Connection destination	Computer
Functions	Data transfer, remote control and data analysis Change settings, transfer measurement values

Guaranteed Accuracy Specifications

Conditions of guaranteed accuracy	After 30 minutes warm-up, sine wave input, power factor 1, frequency 50/60 Hz ±2 Hz
Temperature and humidity range for guaranteed accuracy	@23 ±5°C (73±9°F), 80% RH or less This temperature and humidity specification applies unless specified otherwise
Display range of guaranteed accuracy	Usable measurement range
Period of guaranteed accuracy	1 year

Other Accuracy-Related Specifications

Real-Time Clock accuracy	±5 ppm (within 13 s/mo., @25°C, 77°F)
Temperature coefficient	±0.03% f.s./°C or better (in the ranges 0 to 18°C, 32 to 64°F and 28 to 40°C, 82 to 104°F)
Effect of same-phase voltages	±0.2% f.s. or better (600 Vrms AC, 50/60 Hz, between shorted voltage input terminals and instrument case)
Effect of external magnetic field	±1.5% f.s. or better (in a magnetic field of 400 Arms/m AC, 50/60 Hz)
Effect of radiated RF electromagnetic field	Using Model 9667 Flexible Clamp-on Sensor, current ±5% f.s. or better at 10 V/m (f.s. is rated primary current of sensor), no effect with other clamp-on sensors
Effect of conducted RF electromagnetic field	Using Model 9667 Flexible Clamp-On Sensor, current ±5% f.s. or better at 3 V (f.s. is rated primary current of sensor), no effect with other clamp-on sensors

Other Basic Specifications

Backup battery life	To retain clock data, settings data and measurement data (lithium battery) Approx. 10 years (@23°C, 73°F)
Clock functions	Auto calendar, auto leap year, 24-hour format
Data capacity of internal memory	4 MB (backed up by lithium battery)

Accessory and Option Specifications

Accessories	• One Model 9438-05 Voltage Cord (Four black voltage cords, EN61010-2-031:2001, for Japan) • One Model 9438-05 Voltage Cord (Four black measurement leads, EN61010-22031 :2001, for international) • One Model 9418-15 AC Adapter • One power cord (region-specific) • One Model 9459Battery Pack • One input terminal label sheet (5 wiring types) • One measurement lead label set (for voltage measurement and clamp sensor leads) • One strap • One Instruction Manual • One Measurement Guide • One USB cable (USB 2.0, with ferrite core, approx. 0.9 m) • One CD (application programs for this instrument • One Carrying Case
Options	• Model 9418-15 AC Adapter • Model 9459 Battery Pack • Model 9660 Clamp-on Sensor (100 A_{rms} rating) • Model 9661 Clamp-on Sensor (500 A_{rms} rating) • Model 9667 Flexible Clamp-on Sensor (500 A_{rms} rating, 5000 A_{rms} rating) • Model 9669 Clamp-on Sensor (1000 A_{rms} rating) • Model 9694 Clamp-on Sensor (5 A_{rms} rating) • Model 9695-02 Clamp-on Sensor (50 A_{rms} rating) • Model 9695-03 Clamp-on Sensor (100 A_{rms}) • Model 9219 Connection Cable (for Models 9695-02, 03) • Model 9657-10 Clamp on Leak Sensor (10 A_{rms} rating) • Model 9675 Clamp-on Leak Sensor (10 A_{rms} rating) • Model 9722 Connection Cord (AC power cord) • Model 9489 Carrying Case • Model 9624-50 PQA HiView PRO (PC application program) *: available soon

8.2 Detailed Specifications of Measurement Parameters

Measurement Parameter

[Voltage] Urms	Measurement method	200 ms calculation
	Measurement range	600.0 V_{rms}
	Measurement accuracy	±0.3% rdg. ±0.2% f.s.
	Crest factor	2 or less (w/full-scale input)
[Voltage(1/2)] Urms1/2	Measurement method	rms method, one cycle calculation refreshed every half cycle
	Measurement range	same as U_{rms} voltage
	Measurement accuracy	±0.3% rdg. ±0.2% f.s.
[Peak Voltage] Upeak	Measurement method	200 ms calculation
	Displayed parameters	Positive and negative waveform peaks (max. and min. values)
	Measurement range	Voltage range × Crest factor
[Current] Irms	Measurement method	rms method, 200 ms calculation
	Measurement range	When using Models 9657-10, 9675 500.0 mA/5.000 A When using Models 9694, 9695-02 5.000 A/50.000 A When using Models 9660, 9695-03 10.00 A/100.0 A When using Models 9661, 9667_500A 50.00 A/500.0 A When using Model 9669 100.0 A/1.000 kA When using Model 9667_5k 500.0 A/5.000 kA
	Range selection	Manual ranging
	Measurement accuracy	±0.3% rdg. ±0.2% f.s. + specified clamp-on sensor accuracy
	Crest factor	3 or less (with full-scale input)
[Current](1/2)] Irms1/2	Measurement method	rms method, half-cycle calculation (half-cycle voltage synchronized)
	Measurement range	same as I_{rms} current
	Measurement accuracy	±0.3% rdg. ±0.2% f.s. + specified clamp-on sensor accuracy

Measurement Parameter

[Peak Current] Ipeak	Measurement method	200 ms calculation
	Displayed parameters	Positive and negative waveform peaks (max. and min. values)
	Measurement range	Current range × Crest factor
[Frequency] f	Measurement source	U1 Voltage
	Measurement method	200 ms calculation
	Measurement display range	40.00 to 70.00 Hz
	Usable measurement range	45.00 to 66.00 Hz
	Measurement range	99.99 Hz
	Measurement accuracy	±0.01 Hz ±1 dgt. or less (with a sine wave between 10 and 110% of the range applied to U1
	Display when measurement is impractical	0.00 Hz ±1 dgt.
[Active Power] P	Measurement range	Depends on conbined voltage × current range
	Measurement method	200 ms calculation
	Measurement accuracy	±0.3% rdg. ±0.2% f.s. + clamp-on sensor specification (Power Factor = 1)
	Effect of Power Factor	±1.0% rdg. (50 /60Hz, Power Factor = 0.5)
	Polarity indication	None for consumption, "–" for regeneration
[Reactive Power] Q	Measurement range	Depends on conbined voltage × current range
	Measurement method	Calculates from active and apparent power, 200 ms calculation
	Measurement accuracy	±1 dgt. of calculation from each measurement value
	Polarity indication	No sign for lagging phase (current lags voltage) Minus sign (–) for leading phase (current leads voltage)

Measurement Parameter

[Apparent Power]] S	Measurement range	Depends on conbined voltage × current range
	Measurement method	200 ms calculation
	Measurement accuracy	±1 dgt. of calculation from each measurement value
	Polarity indication	No polarity
[Power Factor] PF	Measurement method	200 ms calculation
	Measurement range	-0.000 to -1.000 (leading), +0.000 to +1.000 (lagging)
	Measurement accuracy	±1 dgt. of calculation from each measurement value
	Polarity indication	No sign for lagging phase (current lagging voltage) Minus sign (–) for leading phase (current leading voltage)
	Non-Input display	“1.000” (when voltage or current is zero)
[Displacement Power Factor] DPF	Measurement method	Calculated from phase difference between fundamental voltage and current waveforms, 200 ms calculation
	Measurement range	-0.000 to -1.000 (leading), +0.000 to +1.000 (lagging) 0.0000 to 1.0000 (leading), + 0.0000 to + 1.0000 (lagging)
	Measurement accuracy	±1 dgt. of calculation from each measurement value
	Polarity indication	No sign for lagging phase (current lags voltage) Minus sign (–) for leading phase (current leads voltage)
	Non-Input display	“1.000”(when voltage or current is zero)
[Energy Consumption]	Measurement parameter	Active power value: WP+ (consumption), WP- (regeneration) Reactive power value: WQLAG (lagging), WQLEAD (leading) Active or reactive power value (selectable)
	Measurement method	Cumulative consumption and regeneration are calculated separately using active power Cumulative lagging and leading values are calculated separately using reactive power
	Measurement accuracy	±1 dgt. applied to active and reactive power measurement accuracy
	Time accuracy	±10 ppm ±1s (@23ºC, 73ºF)

Measurement Parameter

[DEMAND]	Measurement Parameter	Active or reactive power demand (selectable) Active power demand (3-phase total value) Pdem+ (consumption only), Pdem (regeneration only) Reactive power demand (3-phase total value) QdemLAG (Lagging only), QdemLEAD (Lagging only)
	Measurement method	Calculated using active or reactive power within the demand calculation period
	Measurement accuracy	±1 dgt. applied to active and reactive power measurement accuracy
[HARMONICS]	Measurement method	2048-point DFT (frequency is calculated as correct 50/60 Hz)
	Harmonic analysis window width	200 ms (10 cycles @50 Hz, 12 cycles @60 Hz)
	Points per window	2048
	Harmonic analysis window	Rectangular
	Harmonic analysis orders	Up to 50th order
	Measurement Parameter	Harmonic voltage: rms voltage or percentage content of each harmonic order (Fundamental = 100%) Harmonic current: rms current of each harmonic order Harmonic power: rms active power of each harmonic order Total voltage harmonic distortion : Voltage THD-F (LAG360°,LEAD180° display) Fundamental phase difference: phase difference relative to the fundamental voltage on channel 1
	Measurement accuracy	Harmonic voltage, current and power 1st to 15th order ±0.5% rdg. ±0.2% f.s. 16th to 25th order ±1.0% rdg. ±0.3% f.s. 26th to 35th order ±2.0% rdg. ±0.3% f.s. 36th to 45th order ±3.0% rdg. ±0.3% f.s. 46th to 50th order ±4.0% rdg. ±0.3% f.s. Accuracy is not specified for harmonic power
	Guaranteed accuracy range	Fundamental waveform voltage is specified for 50/60 Hz Add clamp-on sensor accuracy to harmonic rms current specifications
[K Factor] KF	Measurement method	Calculated from rms harmonic waveform of the fundamental to 50th order (magnification ratio)
	Display range	0.00 to 500.00
	Measurement accuracy	unspecified

Measurement Parameter

[Voltage Unbalance Factor] Uunb	Measurement method	For three-phase 3 wire (3P3W3M) and three-phase 4-wire, the value for each phase is calculated from the fundamental waveform voltage (inter-line)
	Display range	0.0 to 100.0
	Measurement accuracy	unspecified

Wiring Configuration Measurement Parameters

Measurement Parameter		1P2W	1P3W	3P3W2M,3P3W3M	3P4W,3P4W2.5E
Voltage (1/2)	Urms1/2	1	1, 2	1, 2, 3	1, 2, 3
Voltage	Urms	1	1, 2, ave	1, 2, 3, ave	1, 2, 3, ave
Peak voltage (±)	Upeak	1	1, 2	1, 2, 3	1, 2, 3
Current(1/2)	Irms1/2	1	1, 2	1, 2, 3	1, 2, 3
Current	Irms	1	1, 2, ave	1, 2, 3, ave	1, 2, 3, 4, ave
Peak current (±)	Ipeak	1	1, 2	1, 2, 3	1, 2, 3, 4
Frequency	f	1	1	1	1
Active power	P	1	sum,(1,2)*	sum,(1,2,3)*	sum,(1,2,3)*
Reactive power	Q	1	sum,(1,2)*	sum,(1,2,3)*	sum,(1,2,3)*
Apparent power	S	1	sum,(1,2)*	sum,(1,2,3)*	sum,(1,2,3)*
Power factor/Displacement power factor	PF/DPF	1	sum	sum	sum
Active power value	WP+/WP-	sum	sum	sum	sum
Reactive power value	WQLAG/ WQLEAD	sum	sum	sum	sum
Active power demand	Pdem+/Pdem-	sum	sum	sum	sum
Reactive power demand	QdemLAG/ QdemLEAD	sum	sum	sum	sum
Harmonic voltage	U1 to U50	1	1, 2	1, 2, 3	1, 2, 3
Harmonic current	I1 to I50	1	1, 2	1, 2, 3	1, 2, 3
Harmonic power	P1 to P50	1	1, 2, sum	1, 2, 3, sum	1, 2, 3, sum
Fundamental waveform voltage phase difference	ϕU	1	1, 2	1, 2, 3	1, 2, 3
Fundamental waveform current phase difference	ϕI	1	1, 2	1, 2, 3	1, 2, 3
Voltage total harmonic distortion	THD-F	1	1, 2	1, 2, 3	1, 2, 3
K factor	KF	1	1, 2	1, 2, 3	1, 2, 3
Voltage unbalance factor	Uunb	–	–	sum**	sum

Note 1. “ave” indicates the average value between channels.
Note 2. “sum” indicates the sum of the values between channels.

* : Only displayed on DMM screen
** : Not measurable in 3P3W2M systems

Time Series Calculations

Time series calculation values	MAX, MIN and AVE values More negative peak voltage (-) and peak current (-) values are handled as minima, and less negative values are handled as maxima
Time series calculation method	MAX, MIN and AVE values are calculated within the specified interval (but no AVE voltage (½) value is calculated)

Time Series Recording Measurement Parameters and Averaging

Measurement Parameter		Time Series Recording	AVE Value Calculation Method	
			CHs 1, 2, 3	sum/ave
Voltage(1/2)	Urms1/2	O	–	–
Voltage	Urms	O	Calculated average	Calculated average of the average result for each channel
Peak voltage(±)	Upeak	O	Signed calculated average	–
Current	Irms	O	Calculated average	Calculated average of the average result for each channel
Peak current(±)	Ipeak	O	Signed calculated average	–
Frequency	f	O	Calculated average	–
Active power	P	O	–	Calculated average of sum values
Reactive power	Q	O	–	Calculated average of sum values
Apparent power	S	O	–	Calculated average of sum values
Power factor/displacement power factor	PF/DPF	O	–	Calculated average of sum values (per Note)
Voltage total harmonic distortion	THD-F	O	Calculated average	–
Voltage unbalance factor	Uunb	O	–	Calculated average
Note. For power factor, the AVE value is the average centered around ±1, MAX value is the worst-case value when +0 is the maximum, and MIN value is the worst-case value centered around -0.				

Measurement Parameter		Time Series Recording
Active power value	WP+/WP-	O
Reactive power value	WQLAG/WQLEAD	O
Active power demand	Pdem+/Pdem-	O
Reactive power demand	QdemLAG/QdemLEAD	O

8.3 Event Specifications

Event Type

[Voltage Swell, Voltage Dip, Interruption] Dip, Swell, Interruption	Measurement method	Detection using voltage (½) measured every half cycle
	Detected event types	Voltage Swell: Maximum voltage (worst value), occurrence time, recovery time, period Voltage Dip: Residual voltage (worst value), occurrence time, recovery time, period) Interruption: Residual voltage voltage, detection date/time, recovery date/time, period
	Threshold	Swell: 100 to 150% of nominal voltage Dip, Interruption: 0 to 100% of nominal voltage
	Hysteresis	2% of nominal voltage
	Recording contents	Event data, event waveform, event voltage fluctuation graph
	Event data format	Event number, date, time, event type, channel, status (EVENT IN (Onset) / EVENT OUT (Recovery), period, worst value
[Inrush Current] Inrush Current	Measurement method	Detection using current (1/2) every half cycle
	Detected event types	Maximum current (worst value), detection time
	Threshold	0.0 mA to 5.000 kA (independent of current range and CT ratio)
	Recording contents	Event data, event waveform, inrush current graph
	Event data format	Event number, date, time, event type
[Transient Overvoltage] Transient	Measurement method	Comparator
	Detection criteria	Displays whether a positive or negative transient exists during every voltage cycle on any of three channels
	Transient detection range	50 Vrms (±70.7 Vpeak equiv.) or more, 10 to 100 kHz
	Recording contents	Event Data, Event waveform
	Event data format	Event number, date, time, event type, status (EVENT IN (Onset) / EVENT OUT (Recovery), continuation period

Event Type

[Timer] **Timer**	Measurement method	Detect events at preset intervals
	Timer event interval	OFF, 1, 5, 15 or 30 minutes; 1, 2 or 12 hours; or 1 day
	Detection criteria	Occurrence time
	Recording contents	Event data, event waveform
	Event data format	Event number, date, time, event type
[Manual] **Manual**	Measurement method	Detect events when keys are pressed (pressing the [ESC] and [EVENT] keys at the same time)
	Recording contents	Event data, event waveform
	Event data format	Event number, date, time, event type
[Start, Stop] **Start, Stop**	Measurement method	Recording start and stop operations are detected as events
	Recording contents	Event data, event waveform,
	Event data format	Event number, date, time, event type

Event Detection

Event detection method	Detection by ORing each event type
Event setting	Events other than manual events, and start/stop can be enabled/disabled (set on/off)
Event waveform recording length	Waveform from 20 ms before detection + 200 ms upon detection + 20 ms after detection
Event voltage fluctuation graph length	0.5 s before + 2.5 s after detection
Inrush current graph length	0.5 s before + 29.5 s after detection
Maximum event count	1000
Maximum recording event number	50 event waveforms 20 event voltage fluctuation graphs 1 inrush current graph

8.4 Function Specifications

Display

SYSTEM	Settings
VIEW	Waveforms, DMM, vectors, harmonics (bar graph/list)
TIME PLOT	Voltage (½), voltage, current, frequency, active power, power factor, voltage total harmonic distortion, voltage unbalance factor, energy consumption, demand
EVENT	Event list, event monitor, event waveform, event voltage fluctuation graph, inrush current graph

Setting Contents (factory defaults in bold)

<table>
<tr><td>Measurement frequency</td><td>AUTO, 50 Hz, 60 Hz</td></tr>
<tr><td>Phase colors (input terminal colors)</td><td>TYPE1, TYPE2, TYPE3, TYPE4, TYPE5</td></tr>
<tr><td>Phase names</td><td>R S T, A B C, L1 L2 L3, U V W</td></tr>
<tr><td>Wiring Configuration</td><td>1P2W, 1P3W, 3P3W2M, 3P3W3M, 3P4W, 3P4W2.5E</td></tr>
<tr><td>Nominal Line Voltage</td><td>AUTO, 100, 101, 110, 120, 127, 200, 202, 208, 220, 230, 240, 277, 347, 380, 400, 415, 480, 600 or VALIABLE (VALIABLE = any integer from 50 to 600 V)</td></tr>
<tr><td>Clamp sensors</td><td>Models 9660, 9661, 9667_500, 9667_5k, 9669, 9694, 9695-02, 9695-03, 9657-10 or 9675</td></tr>
<tr><td>Current range</td><td><table>
<tr><th>Clamp Model</th><th>Measurement range</th></tr>
<tr><td>9657-10, 9675</td><td>500.0 mA, 5.000 A</td></tr>
<tr><td>9694, 9695-02</td><td>5.000 A, 50.00 A</td></tr>
<tr><td>9660, 9695-03</td><td>10.00 A, 100.0 A</td></tr>
<tr><td>9661, 9667 (using 500 A range)</td><td>50.00 A, 500.0 A</td></tr>
<tr><td>9669</td><td>100.0 A, 1.000 kA</td></tr>
<tr><td>9667 (using 5 kA range)</td><td>500.0 A, 5.000 kA</td></tr>
</table></td></tr>
<tr><td>PT ratio</td><td>1, 60, 100, 200, 300, 600, 700 or VALIABLE (1.00 to 999.99)</td></tr>
<tr><td>CT ratio</td><td>1, 4, 6, 8, 10, 12, 15, 20, 30, 40, 60, 80, 100, 120, 160 or VALIABLE (0.01 to 999.99)</td></tr>
<tr><td>Harmonic voltage calculation</td><td>Rms value, percentage content</td></tr>
<tr><td>Power factor calculation</td><td>Power factor/displacement power factor (PF/DPF)</td></tr>
<tr><td>Memory partitioning</td><td>ON / OFF</td></tr>
<tr><td>Interval</td><td>AUTO, 1, 5, 15 and 30 min., and 1 hour (AUTO sequentially selects 1, 2, 10, 30 seconds, 1, 5, 15 and 30 min., and 1 hour automatically)</td></tr>
<tr><td>Demand period</td><td>15 min., 30 min. and 1 hour</td></tr>
</table>

Setting Contents (factory defaults in bold)

Real-time control	ON / OFF (both starting from zero seconds)
Settable start time	Year, month, day, hour and minute (24-hour system, valid for the specified time)
Settable stop time	Year, month, day, hour and minute (24-hour system, valid for the specified time)
Version information	Firmware version display
Display language	Japanese, English or Chinese
Beep sound	**ON**, OFF
Screen colors	**COLOR1**, COLOR2, COLOR3, COLOR4, MONO
LCD backlight	**Always ON**/Auto, OFF (1, 5, 15 and 30 min., and 1 hour)
LCD contrast	-30 to **+0** to +20
Clock setting	Year, month, day, hour and minute (24-hour system)
System reset	System reset returns the instrument to factory default setting condition (time and display language are not reset)
Product number information	Product number information
Version information	Version information

Event settings

Event	ON/OFF and Setting Value	
Voltage Swell	OFF	ON (100 to 150%)
Voltage Dip	OFF	ON (0 to 100%)
Interruption	OFF	ON (0 to 100%)
Inrush current	OFF	0.0 A to 5.000 kA (set in 1 A steps)
Transient Overvoltage	OFF	ON
Timer	OFF	1, 5, 15 and 30 min., 1, 2 and 12 hours, and 1 day

Manual events and Start and Stop events cannot be changed (always on)

Basic setup

Basic Setup Contents

Setting Item	Setting
Frequency	AUTO
Nominal Line Voltage	AUTO
Interval	AUTO
Voltage Swell	110%
Voltage Dip	90%
Interruption	10%
Transient Overvoltage	ON

Other Functions

Wiring configuration diagram display	Wiring configuration diagram display
Phase (input terminal) color selection	Displays wiring configurations, numerical values, waveforms and vectors with selected phase colors
Battery check	Remaining battery charge
Display hold	Display Hold on/off (VIEW screen only)
Warning indicators	Crest factor out-of-range, frequency selection error, internal memory overwrite error
Numerical over-range display	"- - - - -" (Numerical display when 130% of voltage or current range is exceeded)
Key-lock	Enable/disable by holding [ESC] key for 3 seconds Disables all key operations except the power switch
Help messages	Displays a description of the selected item on the SYSTEM screen

Memory Backup Operation

Savable data	Measurement data and image data
Data management function	Amount of recorded data, remaining recording capacity displays Data deletion
Recording format	Settings data: Binary format Image data: BMP format Measurement data: Binary format

Memory Backup Operation

Maximum recordable data

Image data: 10 images
Measurement data
Event Data: 50 events
Event voltage fluctuation graph data: 20 graphs
Inrush current data: 1 measurement
TIME PLOT data: see following table

Interval	Recordable TIME PLOT data period	
	No Memory Partitioning	4 Memory Partitions
1 min.	50 hours (approx. 2 days)	12.5 hours (approx. 0.5 days)
5 min.	250 hours (approx. 10 days)	62.5 hours (approx. 2 days)
15 min.	750 hours (approx. 31 day)	187.5 hours (approx. 7 days)
30 min.	1500 hours (approx. 62 days)	375 hours (approx. 15 days)
1 hour	3000 hours (approx. 125 days)	750 hours (approx. 31 day)

(The recordable period for demand data is the demand period applied to the interval period.)

8.5 Calculation Formulas

Basic Calculation Formulas

Wiring Configuration Parameter	Single-Phase 2-Wire *1	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire	
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E
Voltage (1/2) U(1/2) [Vrms]	U_1	U_1 U_2	Inter-line voltage U_1 U_2 $U_3 (U_{3s}=-U_{1s}+U_{2s})$ $(U_{1s}+(-U_{2s})+U_{3s} = 0$ are assumed)	Inter-line voltage $U_1\ (U_{1s}=u_{1s}-u_{2s})$ $U_2\ (U_{2s}=u_{2s}-u_{3s})$ $U_3\ (U_{3s}=u_{3s}-u_{1s})$	Phase voltage U_1 U_2 U_3	
	$Uc = \sqrt{\frac{1}{M}\sum_{S=0}^{M-1}(Ucs)^2}$					
Voltage *U* [Vrms]	U_1	U_1 U_2	Inter-line voltage U_1 U_2 $U_3 (U_{3s}=-U_{1s}+U_{2s})$ $(U_{1s}+(-U_{2s})+U_{3s} =$ 0 are assumed)	Inter-line voltage $U_1\ (U_{1s}=u_{1s}-u_{2s})$ $U_2\ (U_{2s}=u_{2s}-u_{3s})$ $U_3\ (U_{3s}=u_{3s}-u_{1s})$	Phase voltage U_1 U_2 U_3	 $U_2 (U_{2s}=-U_{1s}-U_{3s})$ $(U_{1s}+U_{2s}+U_{3s} = 0$ are assumed)
		$Uave = \frac{U_1+U_2}{2}$	$Uave = \frac{U_1+U_2+U_3}{3}$			
	$Uc = \sqrt{\frac{1}{M}\sum_{S=0}^{M-1}(Ucs)^2}$					

- Subscript definitions
  c: Measurement channel (1 to 3); 1, 2, 3: Measurement channel; M: Sample count; s: Sample point number; ave: average of multiple channels; *sum*: sum of multiple channels
- Variable definitions
  U: Inter-line voltage (three-phase 4-wire phase voltage), u: phase voltage from virtual neutral

*1.Formulas that apply to inputs 1 to 3 for single-phase wiring also apply to c in other wiring configurations.

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Wiring Configuration / Parameter	Single-Phase 2-Wire *1	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire	
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E
Current (1/2) I(1/2) [Arms]	I_1	I_1 I_2	I_1 I_2 $I_3(I_{3s}=-I_{1s}-I_{2s})$ ($I1s+I2s+I3s = 0$ are assumed)	I_1 I_2 I_3		
	$Ic = \sqrt{\frac{1}{M}\sum_{S=0}^{M-1}(Ics)^2}$					
Current *I* [Arms]	I_1	I_1 I_2	I_1 I_2 $I_3(I_{3s}=-I_{1s}-I_{2s})$ (Assuming $I_{1s}+I_{2s}+I_{3s} = 0$)	I_1 I_2 I_3	I_1 I_2 I_3 $I_4(I_{4s}=I_{1s}+I_{2s}+I_{3s})$	
		$Iave = \frac{I1 + I2}{2}$	$Iave = \frac{I1 + I2 + I3}{3}$			
	$Ic = \sqrt{\frac{1}{M}\sum_{S=0}^{M-1}(Ics)^2}$					

- Subscript definitions
  c: Measurement Channel (1 to 3), 1, 2, 3: Measurement Channel, *M*: Sample count, *s*: Sample point number, ave: average of multiple channels; *sum*: sum of multiple channels
- Variable definitions
  I: line current, *u*: phase voltage from virtual neutral

*1.Formulas that apply to inputs 1 to 3 for single-phase wiring also apply to *c* in other wiring configurations.

Wiring Configuration / Parameter	Single-Phase 2-Wire *1 (1P2W)	Single-Phase 3-Wire (1P3W)	Three-phase, 3-wire (3P3W2M)	Three-phase, 3-wire (3P3W3M)	Three-Phase 4-Wire (3P4W)	Three-Phase 4-Wire (3P4W2.5E)
Active Power *2 *P* [W]	P_1	$Psum = P_1+P_2$		$Psum = P_1+P_2+P_3$ (Using Ucs as phase voltage)		
	$Pc = \frac{1}{M}\sum_{S=0}^{M-1}(Ucs \times Ics)$					
Apparent Power *S* [VA]	S_1	$Ssum = S_1+S_2$	$Ssum = \frac{\sqrt{3}}{3}(S_1+S_2+S_3)$ (Using Uc as inter-line voltage)		$Ssum = S_1+S_2+S_3$ (Using Uc as phase voltage)	
Reactive Power *Q* [var]	Q_1	$Qsum = si\sqrt{S_{sum}^2 - P_{sum}^2}$				
	$Qc = si\sqrt{S_1^2 - P_1^2}$					
Power Factor PF [ ]	PF_1	$PFsum = si\left\lvert\frac{Psum}{Ssum}\right\rvert$				
	$PF_1 = si\left\lvert\frac{P_1}{S_1}\right\rvert$					
Displacement Power Factor DPF [ ]	DPF_1	$DPFsum = si\left\lvert\frac{P_{sum(1)}}{\sqrt{P_{sum(1)}^2 + Q_{sum(1)}^2}}\right\rvert$				

- Subscript definitions
  c: Measurement Channel (1 to 3), 1, 2, 3: Measurement Channel, *M*: Sample count, *s*: Sample point number, ave: average of multiple channels; *sum*: sum of multiple channels
- Variable definitions
  U: Inter-line voltage (three-phase 4-wire phase voltage), *I*: line current, *u*: phase voltage from virtual neutral
  si : Polarity sign of lead and lag (using sign of fundamental waveform reactive power)
  The polarity sign of the leading phase (LEAD) is "–" when the polarity of fundamental waveform reactive power is positive.
  The polarity of the lagging phase (LAG) is unsigned when the polarity of fundamental waveform reactive power is negative.

*1. Formulas that apply to inputs 1 to 3 for single-phase wiring also apply to *c* in other wiring configurations.

*2. The polarity of Active Power P is (+) for consumption and (–) for regeneration, indicating the power flow direction.

*3. When S<|P| due to a measurement error or unbalance effect, processing is performed with S=|P|, Q=0 and PF=1

*4. When S=0, processing is performed with PF=over "1.000"

Energy Consumption and Demand Formulas

Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
Parameter	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
Active Power value (amount of consumption) WP+ [kWh]	WP_{1+}	$WP_{sum+} = WP_{1+} + WP_{2+}$		$WP_{sum+} = WP_{1+} + WP_{2+} + WP_{3+}$	
	$WP_{c+} = k\sum_{1}^{h}(\lvert P_{C(+)}\rvert$				
Active Power value (amount of regeneration) WP- [kWh]	WP_{1-}	$WP_{sum-} = WP_{1-} + WP_{2-}$		$WP_{sum-} = WP_{1-} + WP_{2-} + WP_{3-}$	
	$WP_{c-} = k\sum_{1}^{h}(\lvert P_{C(-)}\rvert)$				
Reactive Power value (amount of lag) WQLEAD [kVarh]	WQ_{1LEAD}	$WQ_{sumLEAD} = k\sum_{1}^{h}(\lvert Q_{sum(+)}\rvert)$			
	$WQ_{cLEAD} = k\sum_{1}^{h}(\lvert Q_{c(+)}\rvert)$				
Reactive Power value (amount of lead) Active Power demand WQLAG [kVarh]	WQ_{1LAG}	$WQ_{sumLAG} = k\sum_{1}^{h}(\lvert Q_{sum(-)}\rvert)$			
	$WQ_{cLAG} = k\sum_{1}^{h}(\lvert Q_{c(-)}\rvert)$				
Active Power demand Pdem+ [kW]	P_{dem1+}	$P_{demsum} = P_{dem1+} + P_{dem2+}$		$P_{demsum} = P_{dem1+} + P_{dem2+} + P_{dem3+}$	
	$P_{demc+} = \frac{1}{h}\sum_{1}^{h}(\lvert P_{C(+)}\rvert)$				
Active Power demand Pdem- [kW]	P_{dem1-}	$P_{demsum} = P_{dem1-} + P_{dem2-}$		$P_{demsum} = P_{dem1-} + P_{dem2-} + P_{dem3-}$	
	$P_{demc-} = \frac{1}{h}\sum_{1}^{h}(\lvert P_{C(-)}\rvert)$				

Note. h: Measurement period, k: 1-hour conversion coefficient
(+): Use this value (amount of consumption for Active Power or amount of lag for Reactive Power) only when the numerical value is positive.
(–): Use this value (amount of regeneration for Active Power or amount of lead for Reactive Power) only when the numerical value is negative.

Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
Reactive Power demand QdemLEAD [kVar]	$Q_{dem\ 1LEAD}$	$Q_{dem\ sumLEAD} = \frac{1}{h}\sum_{1}^{h}(\lvert Q_{sum(+)}\rvert)$			
	$Q_{dem\ cLEAD} = \frac{1}{h}\sum_{1}^{h}(\lvert Q_{c(+)}\rvert)$				
Reactive Power demand QdemLAG [kVar]	$Q_{dem\ 1LAG}$	$Q_{dem\ sumLAG} = \frac{1}{h}\sum_{1}^{h}(\lvert Q_{sum(-)}\rvert)$			
	$Q_{dem\ cLAG} = \frac{1}{h}\sum_{1}^{h}(\lvert Q_{c(-)}\rvert)$				

Note. h: Measurement period, k: 1-hour conversion coefficient
(+): Use this value (amount of consumption for Active Power or amount of lag for Reactive Power) only when the numerical value is positive.
(–): Use this value (amount of regeneration for Active Power or amount of lead for Reactive Power) only when the numerical value is negative.

Harmonic Formulas

Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
Harmonic Voltage U_k [Vrms] *1	U_{1k}	U_{1k} U_{2k}	Inter-Line Voltage U_{1k} U_{2k} U_{3k} ($U_{1s}+(-U_{2s})+U_{3s}=0$ are assumed)	Phase Voltage U_{1k} U_{2k} U_{3k}	Phase Voltage U_{1k} U_{2k} U_{3k}
	$Uck = \sqrt{U_{kr}^{2} + U_{ki}^{2}}$				
Harmonic Current I_k [Arms]	I_{1k}	I_{1k} I_{2k}	I_{1k} I_{2k} I_{3k} (Assuming $I_{1s}+I_{2s}+I_{3s}=0$)	I_{1k} I_{2k} I_{3k}	
	$Ick = \sqrt{I_{kr}^{2} + I_{ki}^{2}}$				
Harmonic Power *2 P_k [W]	P_{1k}	$P_{sumk}=P1k + P2k$		$P_{sumk}=P_{1k} + P_{2k} + P_{3k}$ (U is phase voltage for FFT)	
	$Pck = U_{kr} \times I_{kr} + U_{ki} \times I_{ki}$				

c: Measurement channel, *k*: Analysis order, *r*: Amount of resistance after FFT, *i*: Amount of reactance after FFT

*1. Harmonic content percentage (harmonic voltage) divide each value by the fundamental waveform amplitude to make 100%.

*2. The phase value from the virtual neutral point is used to calculate Pk and Qk for 3P3W3M.

Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
For internal calculations*1 Harmonics Reactive Power Q_k [var]	Q_{1k}	$Q_{sumk}=Q_{1k} + Q_{2k}$		$Q_{sumk}=Q_{1k} + Q_{2k} + Q_{3k}$ (U is phase voltage for FFT)	
	$Qck = U_{kr} \times I_{ki} - U_{ki} \times I_{kr}$				

*1. The phase value from the virtual neutral point is used to calculate Pk and Qk for 3P3W3M.

*2. Phase angles of the fundamental voltage and current waveforms are calculated using only the first-order calculated harmonic, and are displayed by normalizing fundamental waveform U1 to 0°.

Wiring Configuration / Parameter	Single-Phase 2-Wire 1P2W	Single-Phase 3-Wire 1P3W	Three-phase, 3-wire 3P3W2M	Three-phase, 3-wire 3P3W3M	Three-Phase 4-Wire 3P4W, 3P4W2.5E
Fundamental waveform Voltage phase angle *2 ϕU [deg]	$\phi U_{1(1)}$	$\phi U_{1(1)}$ $\phi U_{2(1)}$	$\phi U_{1(1)}$ $\phi U_{2(1)}$ $\phi U_{3(1)}$		
	$\phi U_{c(1)} = \tan^{-1}\left(\frac{U_r}{-U_i}\right)$				
Fundamental waveform Current phase angle *2 ϕI [deg]	$\phi I_{1(1)}$	$\phi I_{1(1)}$ $\phi I_{2(1)}$	$\phi I_{1(1)}$ $\phi I_{2(1)}$ $\phi I_{3(1)}$		
	$\phi I_{c(1)} = \tan^{-1}\left(\frac{I_r}{-I_i}\right)$				

*1. The phase value from the virtual neutral point is used to calculate Pk and Qk for 3P3W3M.
*2. Phase angles of the fundamental voltage and current waveforms are calculated using only the first-order calculated harmonic, and are displayed by normalizing fundamental waveform U1 to 0°.

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Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
Voltage Total Harmonic Distortion THD [%]	THD_{UF1}	THD_{UF1} THD_{UF2}	THD_{UF1} THD_{UF2} THD_{UF3}		
	$THD_{UFc} = \frac{\sqrt{\sum_{k=2}^{50} (U_{ck})^2}}{U_{c1}} \times 100$				
K factor *KF* [ ]	KF_1	KF_1 KF_2	KF_1 KF_2 KF_3		
	$KFc = \frac{\sum_{k=1}^{50} (k^2 \times I_{ck}^2)}{\sum_{k=1}^{50} I_{ck}^2}$				

c: Measurement channel, k: Analysis order, r: Amount of resistance after FFT, i: Amount of reactance after FFT

Wiring Configuration / Parameter	Single-Phase 2-Wire	Single-Phase 3-Wire	Three-phase, 3-wire		Three-Phase 4-Wire
	1P2W	1P3W	3P3W2M	3P3W3M	3P4W, 3P4W2.5E
Voltage Unbalance Factor *Uunb* [%]	/	/	/	$Uunb = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ $\beta = \frac{U_{12}^4 + U_{23}^4 + U_{31}^4}{(U_{12}^2 + U_{23}^2 + U_{31}^2)^2}$	

Maintenace and Service

Chapter 9

9.1 Troubleshooting

Inspection and Repair

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

NOTE If damage is suspected, check the "Before returning for repair" (⇒ p.166)" section before contacting your dealer or Hioki representative.

Transporting

- Use the original packing materials when transporting the instrument, if possible.
- Pack the instrument so that it will not sustain damage during shipping, and include a description of existing damage. We cannot accept responsibility for damage incurred during shipping.

Replaceable Parts

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

Part	Life
Lithium Battery	Approx. 10 years
Backlight (to half brightness)	Approx. 36,000 hours
Battery pack	Approx. 1 year
Electrolytic Capacitors	Deterioration occurs after about 10 years when used in severe environments (temperatures around 40°C).

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

- The instrument contains many electrolytic capacitors. The useful life of electrolytic capacitors varies greatly according to the operating environment, so they may need to be replaced periodically.
- Hioki intends to maintain a supply of spare parts for maintenance and service for a period of five years after the end of production.

Before returning for repair

If abnormal operation occurs, check the following items.

Symptom	Check Items
The POWER LED flashes, but nothing appears on the screen.	• Is the power switch turned on? • Are the AC adapter and power cable securely connected? • Is the battery pack installed correctly? • Is the LCD backlight auto-off function enabled (ON)?
The keys do not operate.	• Are any of the keys stuck down? • Is the KEY LOCK function enabled (ON)?
Measurement values are unstable.	• Is the frequency of the lines to be measured 50/60 Hz? This instrument does not support 400-Hz lines.
The expected measurement data cannot be obtained.	• Are the voltage measurement and clamp sensor leads properly connected for the system wiring configuration? • Does the wiring configuration setting match the actual system wiring configuration?
Operation is abnormal when connected to a computer.	• Is the instrument power turned on? • Is the interface cable securely connected? • Is the PC application software installed?
Power does not turn on.	• A power protection component may be damaged. As these are not intended to be replaced or repaired by customers, please contact your supplier or nearest Hioki representative.

If the cause is unknown

Try performing a system reset. All settings are returned to their factory defaults.

See: "4.6 Initializing the Instrument (System Reset)" (⇒ p.77)

9.2 Cleaning

NOTE

Cleaning the Instrument

- To clean the instrument and input modules, wipe it gently with a soft cloth moistened with water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners or gasoline, as they can deform and discolor the case.
- Wipe the LCD gently with a soft, dry cloth.

Cleaning Clamp Sensors

- Measurements are degraded by dirt on the mating surfaces of the clamp-on sensor, so keep the surfaces clean by gently wiping with a soft cloth.

9.3 Battery Pack Replacement and Disposal

WARNING

- **To avoid electric shock when replacing the battery, turn the power switch off and disconnect all leads and cables from the instrument.**
- **To avoid the possibility of explosion, do not short circuit, disassemble or incinerate battery pack. Handle and dispose of batteries in accordance with local regulations.**

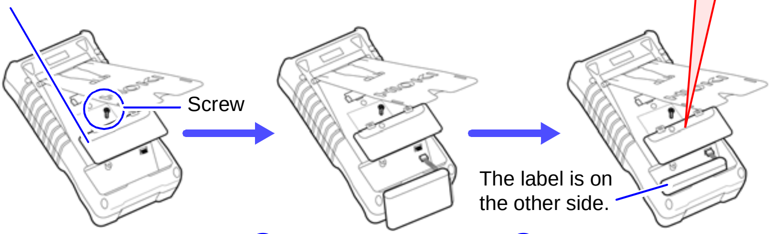
NOTE

- Expected battery pack life is about one year (or about 500 recharges). Replace only with another Hioki Model 9459 Battery Pack.
- The battery pack is subject to self-discharge. Be sure to charge the battery pack before initial use. If the battery capacity remains very low after correct recharging, the useful battery life is at an end.

Replacement Procedure

Required tool: One Philips screwdriver

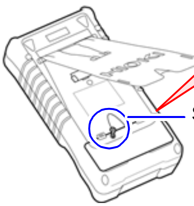
> **Important!**
> **Disconnect the AC adapter when installing the battery pack.**



1 Turn the instrument over to remove the retaining screw from the battery pack compartment cover, and remove the cover.

2 Remove the battery pack and pull the plug out of the connector. It should be easy to remove when the instrument is laid upside down.

3 Connect a new battery pack to the connector, and insert it together with its wires.



4 Replace the compartment cover and its retaining screw.

9.4 Disposing of the Instrument

Before Disposing of the Instrument

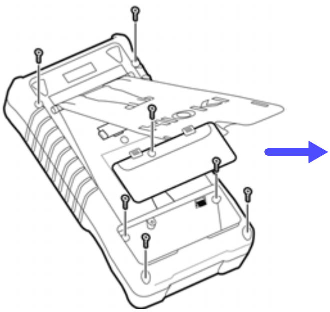
The instrument contains a lithium battery for memory backup. Remove this battery before disposing of the instrument.

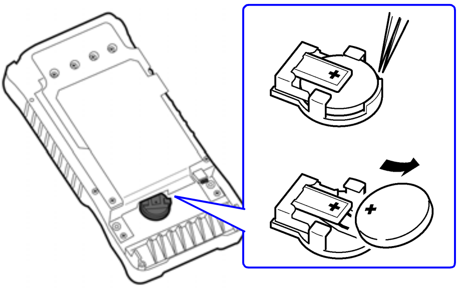
WARNING

- **To avoid electrocution, turn off the power switch and disconnect the power cord and cables before removing the lithium battery.**
- **Handle and dispose of batteries in accordance with local regulations.**

Removing the Lithium Battery

Required tools:
- **One Philips screwdriver (to remove screws)**
- **One tweezers (to remove the lithium battery)**





1 Turn the instrument over to remove the retaining screw from the battery pack compartment cover, and remove the cover.

2 Remove the six screws affixing the two halves of the case.

3 To remove the battery, insert the tweezers between the lithium battery holder and the battery to grasp the battery.

Appendix

Appendix 1 Interval and Recording Time Settings

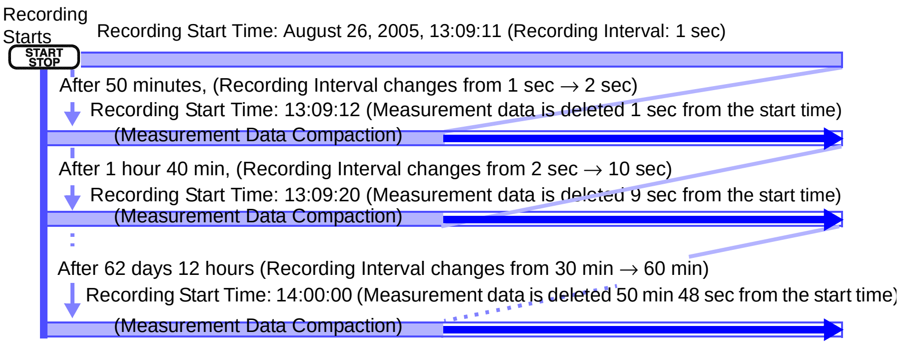
Interval: [Auto] (when memory partitioning is set [OFF])
When memory partitioning is set [ON], the recording interval for a one-time measurement can be from one second to 15 minutes.

Interval Setting	Recording Interval	Longest Recording Time	TimePlot div	0div	1div	2div	3div	4div	5div	6div	7div (7+1/3 div)
Auto	1sec	50min	30sec/div	0min	0.5min	1min	1.5min	2min	2.5min	3min	3.5min
			1min/div	0min	1min	2min	3min	4min	5min	6min	7min
			2min/div	0min	2min	4min	6min	8min	10min	12min	14min
			5min/div	0min	5min	10min	15min	20min	25min	30min	35min
			10min/div	0min	10min	20min	30min	40min	50min	1hour	1hour10min
	2sec	1hour40min	15min/div	0min	15min	30min	45min	1hour	1hour15min	1hour30min	1hour45min
	10sec	8hours20min	30min/div	0min	30min	1hour	1hour30min	2hours	2hours30min	3hours	3hours30min
			1hour/div	0hours	1hour	2hours	3hours	4hours	5hours	6hours	7hours
			2hour/div	0hours	2hours	4hours	6hours	8hours	10hours	12hours	14hours
	30sec	1day1hour	3hour/div	0hours	3hours	6hours	9hours	12hours	15hours	18hours	21hour
			6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days
	1min	2days2hours	12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours

Interval Setting	Recording Interval	Longest Recording Time	TimePlot div	0div	1div	2div	3div	4div	5div	6div	7div	8div	9div (9+1/6 div)
Auto	5min	10days 10hours	1day/div	0days	1day	2days	3days	4days	5days	6days	7days	8days	9days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	16days	18days
	15min	31days 6hours	3day/div	0days	3days	6days	9days	12days	15days	18days	21day	24days	27days
			to	to	to	to	to	to	to	to	to	to	to
			5day/div	0days	5days	10days	15days	20days	25days	30days	35days	40days	45days
	30min	62days 12hours	6day/div	0days	6days	12days	18days	24days	30days	36days	42days	48days	54days
			to	to	to	to	to	to	to	to	to	to	to
			9day/div	0days	9days	18days	27days	36days	45days	54days	63days	72days	81day
	60min	125days	10day/div	0days	10days	20days	30days	40days	50days	60days	70days	80days	90days
			to	to	to	to	to	to	to	to	to	to	to
			15day/div	0days	15days	30days	45days	60days	75days	90days	105days	120days	135days

The recording interval automatically changes to the next longer interval when the longest recordng time for the currently selected interval is exceeded. The data at the start of measurement depends on the last interval selected when the previous measurement finished. Data from earlier measurements that does not match the last interval is deleted.

Appendix 1 Interval and Recording Time Settings



Interval: 1, 5, 15, 30 and 60 min case (when memory partitioning is set [OFF])

Interval Setting	Recording Interval	Longest Recording Time											
1min	1min	2days2hours	30min/div	0min	30min	1hour	1hour30min	2hours	2hours30min	3hours	3hours30min		
			1hour/div	0hours	1hour	2hours	3hours	4hours	5hours	6hours	7hours		
			2hour/div	0hours	2hours	4hours	6hours	8hours	10hours	12hours	14hours		
			3hour/div	0hours	3hours	6hours	9hours	12hours	15hours	18hours	21hour		
			6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days		

Interval Setting	Recording Interval	Longest Recording Time											
5min	5min	10days 10hours	2hour/div	0hours	2hours	4hours	6hours	8hours	10hours	12hours	14hours		
			3hour/div	0hours	3hours	6hours	9hours	12hours	15hours	18hours	21hour		
			6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days		
			12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours		
			1day/div	0days	1day	2days	3days	4days	5days	6days	7days	8days	9days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	16days	18days

Interval Setting	Recording Interval	Longest Recording Time											
15min	15min	31day 6hours	6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days		
			12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours		
			1day/div	0days	1day	2days	3days	4days	5days	6days	7days	6days	7days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	12days	14days
			3day/div	0days	3days	6days	9days	12days	15days	18days	21day	24days	27days
			4day/div	0days	4days	8days	12days	16days	20days	24days	28days	32days	36days

Interval Setting	Recording Interval	Longest Recording Time											
30min	30min	62days 12hours	12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours		
			1day/div	0days	1day	2days	3days	4days	5days	6days	7days	6days	7days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	12days	14days
			3day/div	0days	3days	6days	9days	12days	15days	18days	21day	24days	27days
			to	to	to	to	to	to	to	to	to	to	to
			7day/div	0days	7days	14days	21day	28days	35days	42days	49days	56days	63days

Interval Setting	Recording Interval	Longest Recording Time											
60min	60min	125days	1day/div	0days	1day	2days	3days	4days	5days	6days	7days	6days	7days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	12days	14days
			3day/div	0days	3days	6days	9days	12days	15days	18days	21day	24days	27days
			4day/div	0days	4days	8days	12days	16days	20days	24days	28days	32days	36days
			to	to	to	to	to	to	to	to	to	to	to
			15day/div	0days	15days	30days	45days	60days	75days	90days	105days	120days	135days

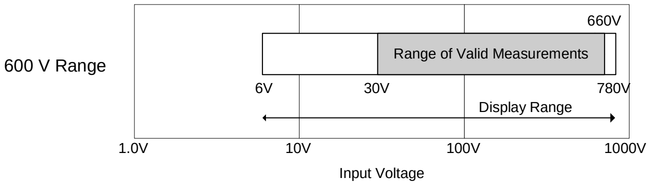
Interval: 1, 5, 15, 30 and 60 min case (when memory partitioning is set [ON])

Interval Setting	Recording Interval	Longest Recording Time											
1min	1min	12hours30min	30min/div	0min	30min	1hour	1hour30min	2hours	2hours30min	3hours	3hours30min	
			1hour/div	0hours	1hour	2hours	3hours	4hours	5hours	6hours	7hours	
			2hour/div	0hours	2hours	4hours	6hours	8hours	10hours	12hours	14hours	
5min	5min	2days14hours 30min	2hour/div	0hours	2hours	4hours	6hours	8hours	10hours	12hours	14hours	
			3hour/div	0hours	3hours	6hours	9hours	12hours	15hours	18hours	21hour	
			6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days	
			12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours	
15min	15min	7days19hours 30min	6hour/div	0hours	6hours	12hours	18hours	1day	1day6hours	1day12hours	2days	
			12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours	
			1day/div	0days	1day	2days	3days	4days	5days	6days	7days	8days	9days
30min	30min	15days 15hours	12hour/div	0hours	12hours	1day	1day12hours	2days	2days12hours	3days	3days12hours	
			1day/div	0days	1day	2days	3days	4days	5days	6days	7days	8days	9days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	16days	18days
60min	60min	31day6hours	1day/div	0days	1day	2days	3days	4days	5days	6days	7days	8days	9days
			2day/div	0days	2days	4days	6days	8days	10days	12days	14days	12days	14days
			3day/div	0days	3days	6days	9days	12days	15days	18days	21day	24days	27days
			4day/div	0days	4days	8days	12days	16days	20days	24days	28days	32days	36days

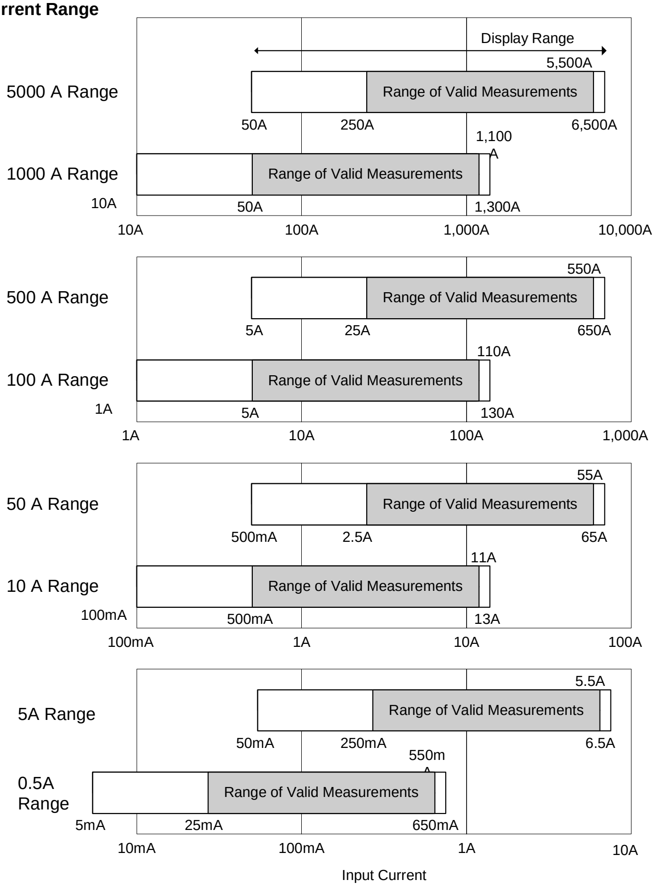
Appendix 2 Displayed and Measurement Ranges

The displayed ranges and ranges of usable measurements (guaranteed accuracy) are as follows:

Voltage Range



Current Range



Appendix 3 Power Range Structure

Power Range Structure Table 1

Current Range		Using Model 9657-10 or 9675 (100 mV/A)		Using Model 9694 or 9695-02 (10 mV/A)		Using Model 9660 or 9695-03 (5 mV/A)	
Voltage Range	Wiring Configuration	500.0mA	5.000A	5.000A	50.00A	10.000A	100.00A
600.0V	1P2W	300.0W	3.000kW	3.000kW	30.00kW	6.000kW	60.00kW
	1P3W 3P3W2M	600.0W	6.000kW	6.000kW	60.00kW	12.00kW	120.0kW
	3P3W3M, 3P4W, 3P4W2.5E	900.0W	9.000kW	9.000kW	90.00kW	18.00kW	180.0kW

Power Range Structure Table 2

Current Range		Using Model 9661 or 9667 in 500A range (1 mV/A)		Using Model 9669 (0.5 mV/A)		Using Model 9667 in 5 kA range (0.1 mV/A)	
Voltage Range	Wiring Configuration	50.00A	500.0A	100.00A	1.000kA	500.0A	5.000kA
600.0V	1P2W	30.00kW	300.0kW	60.00kW	600.0kW	300.0kW	3.000MW
	1P3W 3P3W2M	60.00kW	600.0kW	120.0kW	1.200MW	600.0kW	6.000MW
	3P3W3M, 3P4W, 3P4W2.5E	90.00kW	900.0kW	180.0kW	1.800MW	900.0kW	9.000MW

The range structure tables indicate the full-scale display value of each measurement range. The power range indicates summed values, with the 1P2W power range applicable to each channel regardless of the actual wiring configuration.
The range structure of Apparent Power (S) and Reactive Power (Q) are the same, but in units of VA and var, respectively.

Appendix 4 Clamp Sensor Combined Accuracy

Current and Power Accuracy of Clamp Sensor Combinations

Clamp Sensor	3197 Range	Combined Accuracy
9657-10	0.5A	±1.3%rdg.±1.2%f.s.
	5A	±1.3%rdg.±0.3%f.s.
9675	0.5A	±1.3%rdg.±0.3%f.s.
	5A	±1.3%rdg.±0.21%f.s.
9694	5A	±0.6%rdg.±0.22%f.s.
	50A	No specified accuracy
9695-02	5A	±0.6%rdg.±0.4%f.s.
	50A	±0.6%rdg.±0.22%f.s.
9660	10A	±0.6%rdg.±0.4%f.s.
	100A	±0.6%rdg.±0.22%f.s.
9695-03	10A	±0.6%rdg.±0.4%f.s.
	100A	±0.6%rdg.±0.22%f.s.
9661	50A	±0.6%rdg.±0.3%f.s.
	500A	±0.6%rdg.±0.21%f.s.
9667 500A	50A	±2.3%rdg.±3.2%f.s.
	500A	±2.3%rdg.±0.5%f.s.
9669	100A	±1.3%rdg.±0.3%f.s.
	1kA	±1.3%rdg.±0.21%f.s.
9667 5kA	500A	±2.3%rdg.±3.2%f.s.
	5kA	±2.3%rdg.±0.5%f.s.

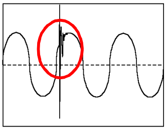
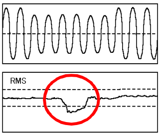
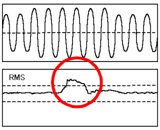
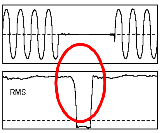
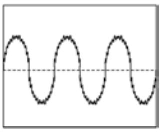
Appendix 5 List of Settings (Default Settings)

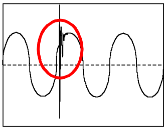
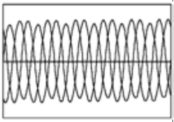
The settings of this instrument are as follows.

Item	Initial State (Factory Default Setting)			O : Initialized x: Not Initialized	
				Power Resume	System Reset
Setting	Measurement frequency	AUTO		x	O
	Wiring Configuration	3P4W		x	O
	Nominal Line Voltage	AUTO		x	O
	Clamp Sensors	9661		x	O
	Current Range	500A		x	O
	PT Ratio	1 VARIABLE is also 1.00		x	O
	CT Ratio	1 VARIABLE is also 1.00		x	O
	Harmonic Calculation	rms value		x	O
	Power Factor Type	PF		x	O
	Memory Partitioning	ON		x	O
	Interval	AUTO		x	O
	Demand Period	30min		x	O
	Timed Control	OFF		x	O
	Timer Event	OFF		x	O
	Voltage Transients	ON		x	O
	Inrush Current	OFF (Threshold 0.0 A)		x	O
	Voltage Swell	110%		x	O
	Voltage Dip	90%		x	O
	Interruption	10%		x	O
	Display Language	Japanese	English	x	x
	Phase Colors	TYPE1	TYPE5	x	x
	Phase Names	R S T	A B C	x	x
	Beep Sounds	ON		x	O
	Screen Colors	COLOR 1		x	O
	LCD Backlight	Always ON		x	O
	LCD Contrast	+0		x	O
State	HOLD State	HOLD OFF		O	O
	Internal Operating Status	Setting (Start key backup function)		O	O
	Memory Recording Data	Erase		x	O
	Browse Mode	Browse Mode OFF		O	O
	Key Lock	Key Lock Disabled		x	O

Appendix 6 Definitions

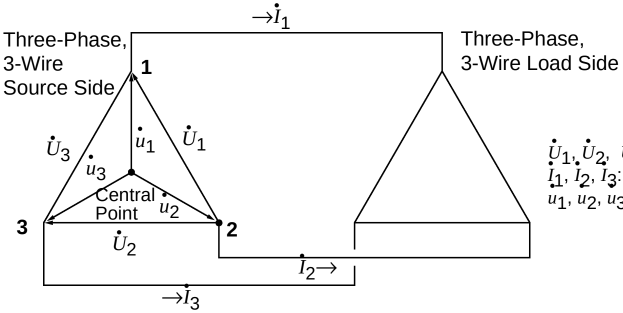
Detecting Anomalies and Phenomena Due to Drops in Power Quality

Power Quality Parameter	Waveform Display	Phenomenon	Related Malfunctions
Transient Overvoltage (Impulse)		Occurs typically as a result of lightning, circuit breaker tripping, fouled relay contacts or load shutdown. Many cases exhibit abrupt voltage changes and high peak voltage.	Near the source of the phenomena, power devices may sustain damage or operations reset abruptly because of the especially high voltage.
Voltage Dip (Sag)		As a result of large inrush current to a load such as a motor starting up, a brief voltage dip occurs.	Equipment may unexpectedly stop or reset due to low supply voltage.
Voltage Swell (Surge)		Instantaneous voltage increases that may occur as a result of lightning strikes, switching of heavily loaded power lines and other loads.	Damage to the power or reset operations of equipment may result from rising supply voltage.
Interruption		The power source may shut off momentarily or for a short or long term such as from tripping of a circuit breaker, often as a result of power company accident (electric supply interrupted by a lightning strike, etc.) or from power system short circuit.	The recent popularity of UPS (uninterruptible power supplies) has increased protection for computers and other equipment, although interruptions can still cause devices to shut down or reset.
Harmonics		Cases commonly occur when a semiconductor control system is employed to power equipment, where harmonics occur as a reuslt of distortion of voltage and current waveforms.	When harmonic contents become large, major accidents such as resulting from abnormal heating of motors and transformers or burn out of reactances connected to leading-phase capacitors may occur.

Power Quality Parameter	Waveform Display	Phenomenon	Related Malfunctions
Transient Overvoltage (Impulse)		Occurs typically as a result of lightning, circuit breaker tripping, fouled relay contacts or load shutdown. Many cases exhibit abrupt voltage changes and high peak voltage.	Near the source of the phenomena, power devices may sustain damage or operations reset abruptly because of the especially high voltage.
Unbalance Factor		Because of the fluctuation of loads on each phase, such as when used for motive power or operation of machinery that load the phases unevenly, some phases may be more heavily loaded, causing more voltage or current waveform distortion on some phases than on others as a result of voltage drop or reactive voltage.	Voltage unbalance, reverse-phase voltage and harmonics can cause accidents resulting from occurrence such as unstable motor rotation, tripping of 3E breakers and transformer thermal overload.

Power Measurement by the Two-Meter Method, and U3, I3 Measurement Theory

(3P3W2M Wiring Configuration Mode)



$\dot{U}_1, \dot{U}_2, \dot{U}_3$: Inter-line voltage vectors
$\dot{I}_1, \dot{I}_2, \dot{I}_3$: Line (phase) current vectors
$\dot{u}_1, \dot{u}_2, \dot{u}_3$: Phase voltage vectors

Circuit Concept of Three-Phase, 3-Wire Lines

Three-phase power P is usually calculated as the sum of the power of each phase.

$P = \dot{u}_1\dot{I}_1 + \dot{u}_2\dot{I}_2 + \dot{u}_3\dot{I}_3$ .... (1)

However, because there is no central point in three-phase, 3-wire lines, there is no way to measure the power of each phase independently, and even if there was, three wattmeters would be required to measure simultaneously. The two-wattmeter method is therefore commonly used (measuring two voltages and two currents).
Power can then be theoretically calculated by the following formulas:

When measuring $\dot{U}_1$, $\dot{U}_2$, $\dot{I}_1$ and $\dot{I}_2$ using wattmeters,

$P = \dot{U}_1\dot{I}_1 + \dot{U}_2\dot{I}_3$ (where $\dot{U}_1 = \dot{u}_1\ \ \dot{u}_2$ and $\dot{U}_2 = \dot{u}_3\ \ \dot{u}_2$) .... (1)
$= (\dot{u}_1 - \dot{u}_2)\dot{I}_1 + (\dot{u}_3 - \dot{u}_2)\dot{I}_3$
$= \dot{u}_1\dot{I}_1 + \dot{u}_2(-\dot{I}_3 - \dot{I}_1) + \dot{u}_3\dot{I}_3$ (where the closed-circuit condition is $\dot{I}_1+\dot{I}_2+\dot{I}_3=0$)
$= \dot{u}_1\dot{I}_1 + \dot{u}_2\dot{I}_2 + \dot{u}_3\dot{I}_3$ .... (2)

Here, formulas (1) and (2) match, proving the 2-wattmeter method of measuring three-phase, 3-wire power.
Also, there are no special requirements other than the closed circuit and no leakage circuit, so 3-phase power can be measured regardless of whether the phases are balanced.
The 3P3W2M wiring configuration mode of this instrument employs this method.

Also, under these conditions, the sums of the voltage and current vectors is always zero, so,
$|\dot{U}_3| = |\dot{U}_1 - \dot{U}_2|$
$|\dot{I}_2| = |-\dot{I}_1 - \dot{I}_3|$
are calculated internally to obtain measurements of the voltage and current of the third phase.

For $\dot{U}_3$ and $\dot{I}_2$, measurement is performed regardless of distortion. These values affect the values of 3-phase apparent power and power factor (when set so as to not use a reactive power measurement method).

NOTE With the 3P3W2M wiring configuration mode of this instrument, the T phase current of the three-phase lines is applied to I2 in each circuit, so the T phase current of the three-phase lines is displayed as current I2, and the S phase calculated value of the three-phase lines is displayed as I3.

Terminology

K Factor

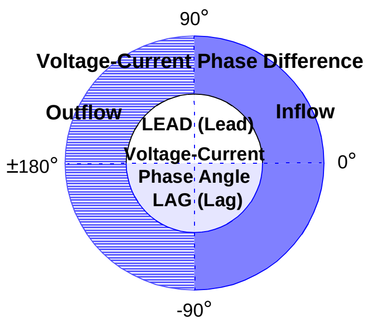
Also called the multiplication factor, the K factor expresses the power loss caused by harmonic currents in a transformer.
The formula for calculating K factor (KF) is:

$$KF = \frac{\sum_{k=2}^{50} \left(k^2 \times I_k{}^2\right)}{\sum_{k=2}^{50} I_k{}^2}$$

k: Order of harmonic
Ik: Percentage of harmonic current relative to the fundamental current [%]
Higher-order harmonic currents have a greater influence on the K factor than do lower-order harmonic currents.
The K factor is measured while the transformer is subjected to the maximum circuit load.
If the measured K factor is larger than the multiplication ratio of the transformer being used, the transformer should be replaced with one having a higher K factor, or the load on the transformer must be reduced.
When replacing a transformer, the replacement should have a K factor one rank higher than the K factor measured with the transformer being replaced.

Harmonic Phase Angle and Harmonic Phase Difference

The harmonic voltage phase angle and harmonic current phase angle are based upon the phase of the fundamental component of the PLL source (referenced to the PLL input, which is selected from U1, U2 or U3 in this instrument).
The phase difference between each harmonic component and the fundamental component is expressed as a signed angle (º), with negative ("–" sign) signifying lagging phase and positive (+) signifying leading (+) phase.
The harmonic voltage-current phase difference expresses the difference between the phase of each harmonic order voltage component and the phase of each harmonic order current component for each channel, as an angle (º).
The sum is the total power factor of each harmonic order (calculated from the total harmonic power and total harmonic reactive power) expressed as an angle (°). When the harmonic voltage-current phase difference is between -90° and +90°, the power of that harmonic order is flowing toward the load (inflow). When it is between +90° and +180° or between -90° and -180°, the power of that harmonic order is flowing away from the load (outflow).



Harmonic Phase Angle

Unbalance Factor

- Balanced (Symmetrical) Three-Phase Voltage (Current)
  This term denotes three-phase alternating voltage or current when each phase has the same voltage (or current) and a phase difference of 120 degrees between phases.
- Unbalanced (Asymmetrical) Three-Phase Voltage (Current)
  Denotes three-phase alternating voltage or current when the voltages (or currents) of the phases are not the same, or when the phase difference between the phases is not 120 degrees.

Although the following descriptions refer to voltage, they apply to current as well.
Degree of Unbalance in Three-Phase Alternating Voltage
Usually called the voltage unbalance factor, this is the ratio of negative-phase voltage to positive-phase voltage

$$\text{Voltage Unbalance Factor} = \frac{\text{Positive-Phase Voltage}}{\text{Negative-Phase Voltage}} \times 100\ [\%]$$

Zero-Phase, Positive-Phase and Negative-Phase Voltage
The concept of zero-, positive- and negative-phase components in a three-phase alternating circuit applies the method of symmetrical coordinates (in which a circuit is thought of as divided into symmetrical components of zero phase, positive phase, and negative phase).

- Zero-phase component: Voltage [V_0] that is equal in each phase (the *"0"* subscript denotes a zero-phase-sequence component).
- Positive-phase component: Symmetrical three-phase voltage [V_1] in which the value for each phase is equal, and each of the phases is delayed (lags) by 120 degrees in the phase sequence a→b→c (the "1" subscript denotes a positive-phase-sequence component).
- Negative-phase component: Symmetrical three-phase voltage [V_2] in which the value for each phase is equal, and each of the phases is delayed (lags) by 120 degrees in the phase sequence a→c→b (the "2" subscript denotes a negative-phase-sequence component).

If Va, Vb, and Vc are the three-phase alternating voltages, the zero-, positive- and negative-phase voltages are formulated as follows:

$$\text{Zero-phase voltage } V_0 = \frac{Va+Vb+Vc}{3}$$

$$\text{Positive-phase voltage } V_1 = \frac{Va+aVb+a^2Vc}{3}$$

$$\text{Negative-phase voltage } V_2 = \frac{Va+a^2Vb+aVc}{3}$$

Here, "a" denotes the "vector operator", which is a vector with magnitude 1 and phase angle of 120 degrees. Any given phase angle is advanced by 120 degrees when multiplied by a, and by 240 degrees when multiplied by a^2.
When the three-phase alternating voltage is balanced, the zero- and negative-phase voltages are 0, so only the positive-phase voltage (which in this case is equal to the rms value of the three-phase alternating voltage) is displayed remains.

Displacement Power Factor (DPF)	The power factor (PF) is the ratio of active power to apparent power. An inductive load delays the current behind the voltage, and a capacitive load advances the current ahead of the voltage.
PF (Power Factor)	0 < PF < 1 Indicates reactive power is supplied but not consumed. PF = 1 All supplied power is consumed, and no reactive power is present. PF = -1 In-phase power, voltage and current are generated. -1 < PF < 0 Leading or lagging phase power and current are generated. In general, power factor is calculated using all rms values, so harmonic contents are included. In addition to this power factor (PF), the displacement power factor (DPF) is the ratio of active power to apparent power. However, the displacement power factor (DPF) is defined as the cosine of the phase difference between the current and voltage of the fundamental waveform, and so does not include the harmonic voltage or current components.
DPF (Displacement Power Factor)	0 < DPF < 1 The current phase leads or lags the voltage phase, and the load circuit consumes power. DPF = 1 Current and voltage are in phase, and the load circuit consumes power. DPF = -1 The current and voltage have opposite phases, and the load circuit generates power. -1 < DPF < 0 The current phase leads or lags the voltage phase, and the load circuit generates power. The displacement power factor is the same as the power factor employed in ordinary residential watt-hour meters, and is also the same as that calculated using the true reactive-power-measurement method employed by the Model 3197. If the displacement power factor is low (current lags voltage), a phase-advancing capacitor can be added to the power source side for correction. In general, displacement power factor is used when measuring the power source side, and power factor is used when measuring the equipment load side. In a typical neighborhood, the power factor shows a larger value than the displacement power factor.
Demand	Denotes the average power [kW] consumed during the demand period (typically 30 minutes), and is used for power company transactions.

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HIOKI

DECLARATION OF CONFORMITY

Manufacturer's Name:	HIOKI E.E. CORPORATION
Manufacturer's Address:	81 Koizumi, Ueda, Nagano 386-1192, Japan
Product Name:	POWER QUALITY ANALYZER
Model Number:	3197
Accessories:	9418-15 AC ADAPTER（SINO-AMERICAN, SA130A-1225V-S） 9459 BATTERY PACK 9438-05 VOLTAGE CORD

The above mentioned products conform to the following product specifications:

Safety:	EN61010-1:2001 EN61010-031:2002
EMC:	EN61326:1997+A1:1998+A2:2001+A3:2003 Class A equipment Equipment intended for use in industrial location Portable test, measuring and monitoring equipment used in low-voltage distribution systems EN61000-3-2:2000 EN61000-3-3:1995+A1:2001

Supplementary Information:

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

HIOKI E.E. CORPORATION

15 September 2006

T. Yoshiike

Tatsuyoshi Yoshiike

President

3197A999-02

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Instruction Manual

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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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