PW3198

Instruction Manual

POWER QUALITY ANALYZER

EN

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Introduction

Thank you for purchasing the HIOKI PW3198 Power Quality Analyzer. To obtain maximum performance from the product, please read this manual first, and keep it handy for future reference.

Clamp-on sensors (optional; see p.3) are required in order to input current to the instrument. (Clamp-on sensors are called "clamp sensors" throughout this manual.) For more information, see the instruction manual for the clamp sensors being used.

Registered trademarks

- Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.
- Sun, Sun Microsystems, Java, and any logos containing Sun or Java are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries.
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Symbols

Symbols in this manual

⃠	Indicates the prohibited action.
(p.)	Indicates the location of reference information.
?	Indicates quick references for operation and remedies for troubleshooting.
*	Indicates that descriptive information is provided below.
[ ]	
CURSOR (Bold character)	Bold characters within the text indicate operating key labels.
Windows	Unless otherwise specified, "Windows" represents Windows 2000, Windows XP, Windows Vista, or Windows 7, Windows 8, Windows 10.
Dialogue	Dialogue represents a Windows dialog box.

Mouse action terminology

Click:	Press and quickly release the left button of the mouse.

Accuracy

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

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

Confirming Package Contents

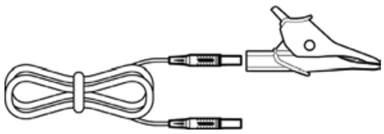
When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.

Confirm that these contents are provided.

☐ PW3198 Power Quality Analyzer....... 1

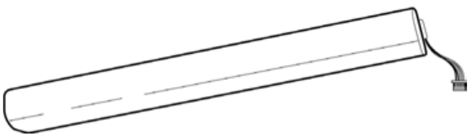
☐ Z1002 AC Adapter (includes power cord)1

☐ L1000 Voltage Cord........................... 1
(Cords: One each red, yellow, blue, and gray as well as 4 black; alligator clips: 1 each red, yellow, blue, and gray as well as 4 black)



☐ USB Cable.. 1

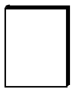
☐ Z1003 Battery Pack........................... 1
(Ni-MH, 7.2 V/4500 mAh)



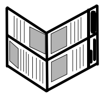
☐ Z4001 SD Memory Card 2GB............ 1

Accessories

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



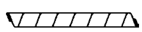
☐ Measurement Guide...........................1



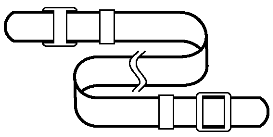
Please attach to the instrument before use. (p.28)

☐ Input Cable Labels............................ 1
(to identify voltage cable leads and input channels)

☐ Spiral Tubes....................................... 20
(to identify voltage cable leads and input channels)



☐ Strap 1
(attach to instrument)



Options

Contact your dealer or Hioki representative for details.

Clamp sensors (current measurement)

☐ 9660 Clamp-On Sensor
(100 A rms rated)
☐ 9661 Clamp-On Sensor
(500 A rms rated)
☐ 9667 Flexible Clamp-On Sensor
(5000 A rms/500 A rms rated)
☐ 9669 Clamp-On Sensor
(1000 A rms rated)
☐ 9694 Clamp-On Sensor
(5 A rms rated)
☐ 9695-02 Clamp-On Sensor
(50 A rms rated)
☐ 9695-03 Clamp-On Sensor
(100 A rms rated)
☐ 9290-10 Clamp-On Adapter
☐ 9219 Connection Cable
(For use with Model 9695-02/9695-03)
☐ 9657-10 Clamp-On Leak Sensor
(10 A rms rated)
☐ 9675 Clamp-On Leak Sensor
(10 A rms rated)
☐ CT9691 Clamp on AC/DC Sensor
(100 A/10 A rated)+CT6590 Sensor Unit
☐ CT9692 Clamp on AC/DC Sensor
(200 A/20 A rated)+CT6590 Sensor Unit
☐ CT9693 Clamp on AC/DC Sensor
(2000 A/200 A rated)+CT6590 Sensor Unit
☐ CT9667 Flexible Clamp on Sensor
(5000 A rms/500 A rms rated)
☐ CT9667-01 AC Flexible Current Sensor
(5000 A rms/500 A rms rated)
☐ CT9667-02 AC Flexible Current Sensor
(5000 A rms/500 A rms rated)
☐ CT9667-03 AC Flexible Current Sensor
(5000 A rms/500 A rms rated)
☐ CT7731 AC/DC Auto-Zero Current Sensor
(100 A rms rated)
☐ CT7736 AC/DC Auto-Zero Current Sensor
(600 A rms rated)
☐ CT7742 AC/DC Auto-Zero Current Sensor
(2000 A rms rated)
☐ CM7290 Display Unit
(For use with Model CT77××)
☐ L9095 Output Cord
(For use with Model CT77××)

Voltage measurement

☐ 9804-01 Magnetic Adapter
☐ 9804-02 Magnetic Adapter
☐ 9243 Grabber Clip
☐ L1000 Voltage Cord

Carrying cases

☐ C1001 Carrying Case (Soft type)
☐ C1002 Carrygin Case (Hard type)
☐ C1009 Carrygin Case (Bag type)

Recording media

☐ Z4001 SD Memory Card 2GB
☐ Z4003 SD Memory Card 8GB

Communications

☐ 9642 LAN Cable
☐ 9624-50 PQA-HiView Pro
(Computer application software)

Other

☐ Z1002 AC Adapter
☐ Z1003 Battery Pack
☐ PW9000 Wiring Adapter
(For use with 3-phase
3-wire (3P3W3M) voltages)
☐ PW9001 Wiring Adapter
(For use with 3-phase 4-wire
voltages)
☐ PW9005 GPS Box
(Build-to-order)

Safety Notes

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

⚠WARNING

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

Safety Symbols

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

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

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

Symbols for Various Standards

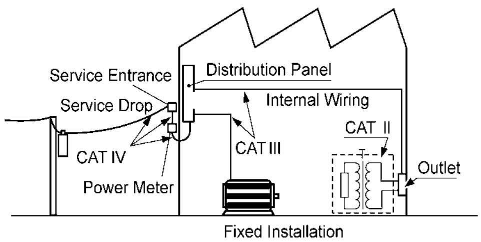
WEEE symbol	WEEE marking: This symbol indicates that the electrical and electronic appliance is put on the EU market after August 13, 2005, and producers of the Member States are required to display it on the appliance under Article 11.2 of Directive 2002/96/EC (WEEE).
Ni-MH	This is a recycle mark established under the Resource Recycling Promotion Law (only for Japan).
CE	This symbol indicates that the product conforms to safety regulations set out by the EC Directive.

Measurement categories

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

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

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



Usage Notes

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

Before Use

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

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

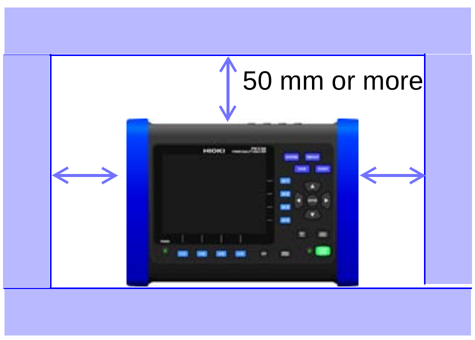
Instrument Installation

Operating temperature and humidity: 0 to 50°C, 80%RH or less, Indoors only (non-condensating)
Storing temperature and humidity: -20 to 50°C, 80%RH or less, Indoors only (non-condensating)

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 water, oil, other chemicals, or solvents Exposed to high humidity or condensation Exposed to high humidity or condensation		Exposed to strong electromagnetic fields Near electromagnetic radiators
	Exposed to high levels of particulate dust		Near induction heating systems (e.g., high-frequency induction heating systems and IH cooking utensils)
	Subject to vibration		

Installing

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



Shipping precautions

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

Handling the Instrument

DANGER

To avoid electric shock, do not open the instrument's case. The internal components of the instrument carry high voltages and may become very hot during operation.

CAUTION

- If the instrument exhibits abnormal operation or display during use, review the information in "14.2 Trouble Shooting" (p.216) and "14.3 Error Indication" (p.218) before contacting your dealer or Hioki representative.
- To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.
- The protection rating for the enclosure of this device (based on EN60529) is *IP30.

*IP30:
This indicates the degree of protection provided by the enclosure of the device against use in hazardous locations, entry of solid foreign objects, and the ingress of water.
3: Protected against access to hazardous parts with tools more than 2.5 mm in diameter. The equipment inside the enclosure is protected against entry by solid foreign objects larger than 2.5 mm in diameter.
0: Not protected against use in hazardous locations. The enclosure does not protected against entry by solid foreign objects.

NOTE

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

Handling the cords and clamp sensors

CAUTION

- To prevent damage to the instrument and clamp sensors, never connect or disconnect a sensor while the clamp sensor is clamped around a conductor.
- To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.
- To avoid breaking the cables, do not bend or pull them.
- For safety reasons, when taking measurements, only use the L1000 Voltage Cord.
- Avoid stepping on or pinching cables, which could damage the cable insulation.
- Keep the cables well away from heat sources, as bare conductors could be exposed if the insulation melts.
- When disconnecting the BNC connector, be sure to release the lock before pulling off the connector. Forcibly pulling the connector without releasing the lock, or pulling on the cable, can damage the connector.
- To avoid damaging the output cable, grasp the connector, not the cable, when unplugging the cable.
- When disconnecting the clamp sensor from the instrument, be sure to grip the part of the connector with the arrows and pull it straight out. Gripping the connector elsewhere or pulling with excessive force may damage the connector.

⚠CAUTION

- Use the 9217 Connection Cord (resin) when connecting to insulated BNC connector (resin), and the 9165 Connection Cord (metal) when connecting to metallic BNC connector (metal). If you connect metal BNC cable to insulated BNC connector, the insulated BNC connector can be damaged and the connection equipment may be damaged.
- Be careful to avoid dropping the clamp sensors or otherwise subjecting them to mechanical shock, which could damage the mating surfaces of the core and adversely affect measurement.
- Keep the clamp jaws and core slits free from foreign objects, which could interfere with clamping action.
- Keep the clamp closed when not in use, to avoid accumulating dust or dirt on the mating core surfaces, which could interfere with clamp performance.

NOTE

Use only the specified voltage cords and input cables. Using a non-specified cable may result in incorrect measurements due to poor connection or other reasons.

Before Connecting Measurement Cables

⚠WARNING

- **To avoid electric shock, turn off the power to all devices before plugging or unplugging any cables or peripherals.**
- **Be sure to connect the voltage input and current input terminals correctly. An incorrect connection could damage or short circuit this instrument.**
- **In order to prevent electric shock or device damage, observe the following precautions when making connections to the external control terminals and other interface connectors.**
- **Turn off the instrument and any equipment being connected before connecting the measurement cables.**
- **Exercise care not to exceed the ratings of external control terminal and interface connector signals.**
- **Make connections securely to avoid the risk of connections coming loose during instrument operation and bringing wires into contact with other electrically conductive parts.**
- **Ensure that devices and systems to be connected to the external control terminals are properly isolated.**

⚠CAUTION

- To avoid electric shock and short-circuit accidents, use only the supplied voltage cords to connect the instrument input terminals to the circuit to be tested.

NOTE

Always turn both devices OFF when connecting and disconnecting an interface connector.

About the AC adapter

⚠WARNING

- **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.**
- **Turn the instrument off before connecting the AC adapter to the instrument and to AC power.**
- **Use only the supplied Model Z1002 AC Adapter. 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.**

About the battery pack

WARNING

For battery operation, use only the HIOKI Model Z1003 Battery Pack. We do not take any responsibility for accidents or damage related to the use of any other batteries.

NOTE

- 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.
- To avoid problems with battery operation, remove the batteries from the instrument if it is to be stored several week or more.

Others

CAUTION

Avoid using an uninterruptible power supply (UPS) or DC/AC inverter with rectangular wave or pseudo-sine-wave output to power the instrument. Doing so may damage the instrument.

Before Connecting to the Lines to be Measured

DANGER

- **To avoid short circuits and potentially life-threatening hazards, never attach the clamp sensor to a circuit that operates at more than the maximum rated voltage to earth**
  (See your clamp sensor's instruction manual for its maximum ratings.)
- **The maximum input voltage is 1000 VAC, ±600 VDC. Attempting to measure voltage in excess of the maximum input could destroy the instrument and result in personal injury or death.**
- **To avoid electrical hazards and damage to the instrument, do not apply voltage exceeding the rated maximum to the input terminals.**
- **The maximum rated voltage between input terminals and ground is 600 VDC/AC. Attempting to measure voltages exceeding 600 V with respect to ground could damage the instrument and result in personal injury.**
- **Connect the clamp sensors or voltage cords to the instrument first, and then to the active lines to be measured. Observe the following to avoid electric shock and short circuits.**
- **Do not allow the voltage cord clips to touch two wires at the same time.**
- **Never touch the edge of the metal clips.**
- **When the 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.**
- **When connecting a clip-type input cord, you will need to clip the line to the terminal while it is hot. Bringing two wires into contact with each other while connecting the clips will cause a short-circuit.**
- **To prevent electrical shock and personnel injury, do not touch any input terminals on the VT (PT), CT or the instrument when they are in operation.**

WARNING

- **To avoid electrical accidents, confirm that all connections are secure. The increased resistance of loose connections can lead to overheating and fire.**
- **Ensure that the input does not exceed the maximum input voltage or current to avoid instrument damage, short-circuiting and electric shock resulting from heat building.**
- **To avoid electric shock when measuring live lines, wear appropriate protective gear, such as insulated rubber gloves, boots and a safety helmet.**

CAUTION

When the instrument's power is turned off, do not apply voltage to the instrument. Doing so may damage the instrument.

While Measuring

WARNING

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

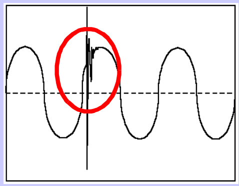
Overview Chapter 1

1.1 Product Overview

The PW3198 Power Quality Analyzer is an analytical instrument for monitoring and recording power supply anomalies, allowing their causes to be quickly investigated. The instrument can also be used to assess power supply problems (voltage drops, flicker, harmonics, etc.).

- Record abnormal waveforms
- Record voltage fluctuations
- Observe power supply waveforms
- Measure harmonics
- Measure flicker
- Measure power

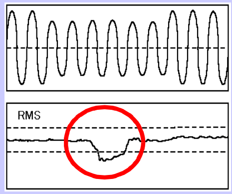
One instrument does it all!



Transient voltages

How does the PW3198 record abnormal waveforms?

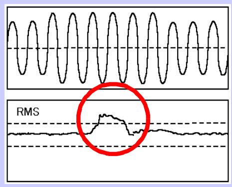
The instrument automatically judges and records a range of problems:



Voltage dips

Transient voltages

Transient voltages are caused by lightning strikes, circuit-breaker and relay contact obstructions and tripping, and other phenomena. They are often characterized by precipitous voltage variations and a high peak voltage.



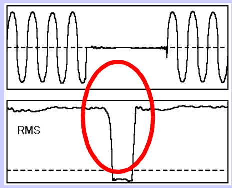
Voltage swells

Voltage dips (falling voltage)

Short-lived voltage drops are caused by the occurrence of a inrush current with a large load, such as when a motor starts.

Voltage swells (rising voltage)

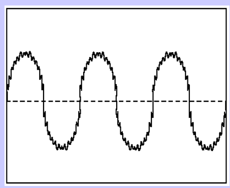
In a voltage swell, the voltage rises momentarily due to a lightning strike or the switching of a high-load power line.



Interruptions

Interruptions

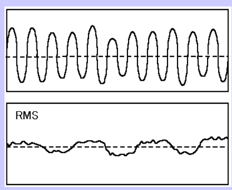
In an interruption, the supply of power stops momentarily or for a short or long period of time due to factors such as a circuit breaker tripping as a result of a power company accident or power supply short-circuit.



Harmonic

Harmonic and high-order harmonic elements

Harmonics are caused by distortions in the voltage and current caused by the semiconductor control devices that are frequently used in equipment power supplies.



Flicker

Flicker (ΔV10, IEC)

Flicker is caused by blast furnace, arc welding, and thyristor control loads. The resulting voltage fluctuations cause flicker in light bulbs and similar phenomena.

1.2 Features

Safety
Cat IV 600 V compliant. Capable of measuring lead-in wires on their primary side.

High precision Voltage measurement accuracy of ±0.1%rdg.
Complies with the new IEC61000-4-30 Class A international power quality standard.

Reliable
Quick setup functionality ensures you won't miss the occurrence of any abnormal phenomena.

Extensive selection of clamp sensors
(Available rated for use with signals ranging from leak currents to a maximum of 5,000 A.)

Ability to measure all parameters necessary for power quality measurement

Support for 400 Hz lines

Measurement of high-order harmonic components from 2 kHz to 80 kHz

Measurement of transient voltages of up to 6,000 V from 5 kHz to 700 kHz

Simultaneous 3-channel measurement of ΔV10 flicker

Easy downloading of data to a computer via USB or LAN
Separately available software simplifies analysis.

SD memory card data storage
By allowing the PW3198 to record data continuously for up to one year, the ability to use high-capacity 2 GB memory cards inspires peace of mind.

- Capable of accommodating 1-phase 2-wire, 1-phase 3-wire, 3-phase 3-wire, and 3-phase 4-wire power supplies.
- Features isolated channels for equipment analysis, neutral line ground fault measurement, and measurement of power supply lines from separate systems.
- Lets you select line voltage or phase voltage. Includes Δ-Y conversion and Y-Δ conversion functionality.
- Features a TFT color LCD that is easily visible in both bright and dark settings.
- Capable of true simultaneous measurement with gap-less continuous operation, assuring your ability to reliably capture target phenomena.
- Capable of accurately assessing the time at which phenomena occur. A GPS option allows time correction.
- Can be operated with peace of mind during an extended power outage thanks to a generous battery drive time of 180 minutes.

1.3 Measurement Flowchart

Be sure to read "Usage Notes" (p.6) before measuring.

Measurement is performed using the following process:

Note: (shaded) shaded areas indicate settings configured on the instrument's screen.

Step	See:	PW3198 operating state
Perform the pre-measurement inspection.	3.3 (p.31)	
↓		
Connect the AC adapter, voltage cords, and current clamps.	3.4 (p.32) to 3.7 (p.34)	
↓		
Turn on the instrument.	3.8 (p.36)	[SETTING]
↓		[SETTING]
Perform zero adjustment after allowing the instrument to warm up for 30 minutes. (shaded)	4.1 (p.37)	[SETTING]
↓		[SETTING]
Configure initial settings. Configure connection and clamp sensor settings. See: 4.3 (p.39) — OR — **Load a settings file (settings data).** Load a settings file from the SD memory card. See: 9.7 (p.146) (shaded)		[SETTING]
↓		[SETTING]
Connect to the measurement line.	4.5 (p.46)	[SETTING]
↓		[SETTING]
Verify connections. Note: If waveforms, measured values, or vector diagrams appear incorrect, reconnect the lines. (shaded)	4.6 (p.48)	[SETTING]
↓		[SETTING]
Configure settings using quick setup. Select quick setup and configure the connection, clamp sensor, VT and CT, and TIMEPLOT interval settings. See: 4.7 (p.50) — OR — **Configure the settings as desired.** Set thresholds and other values as desired. Settings can be configured as desired even after using quick setup functionality. See: Chapter 5 (p.55) (shaded)	**If you have loaded a settings file (settings data)** 9.7 (p.146) → skip to next step	[SETTING]
↓		[SETTING]
Verify settings, event count, and memory capacity. Note: If waveforms or settings appear incorrect, or if the event count is unusually high, change the settings. (shaded)	4.8 (p.53)	[SETTING]
↓		
Start recording.	"Starting and Stopping Recording" (p.14)	[RECORDING]
↓		[RECORDING]
Stop recording.	"Starting and Stopping Recording" (p.14)	[RECORDING]
↓		[ANALYZING]
Check and analyze measurement data. (Data can also be checked while recording is in progress.) (shaded)	Chapter 6 (p.75) to Chapter 8 (p.119)	[ANALYZING]
↓		
Disconnect the voltage cords and clamp sensors from the measurement line and turn off the instrument. (The display data will be erased. It cannot be redisplayed.)	3.8 (p.36)	
↓		
Analyze the data on a computer using the computer application.	Chapter 12 (p.155)	

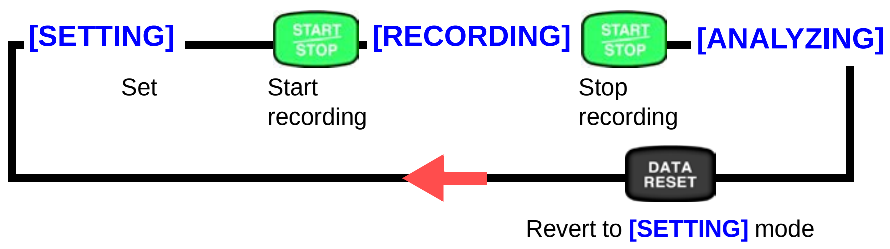
Starting and Stopping Recording

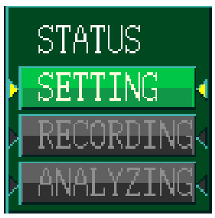
You can start and stop recording either manually or using real-time control. In either case, repeat recording can be used.

	Manual	Real-time control
Start	Press START/STOP.	Press START/STOP to start recording at the set time and date.
	↓	↓
Stop	Press START/STOP to stop recording.	Stops automatically at the specified stop time. Press the START/STOP to force stop.
Notes		**See:** "Time Start" (p.58)
Repeated recording	Recording is performed at the specified interval (once a week or once a day), and files containing measurement data are created at the specified interval. Repeated recording can be used to record for up to 55 weeks (approx. 1 year). **See:** "Repeat Record" (p.59)	

To start a new recording session after recording has ended, press the **DATA RESET** key, set the instrument to **[SETTING]** mode, and then press the **START/STOP** key. (Note that pressing the **DATA RESET** key will erase the displayed measurement data.)

Relationship between the operation status and key operations





⚠CAUTION

Do not remove the SD memory card while recording or analyzing data. Doing so may cause data on the card to be corrupted.

Names and Functions of Parts Basic Operations & Screens

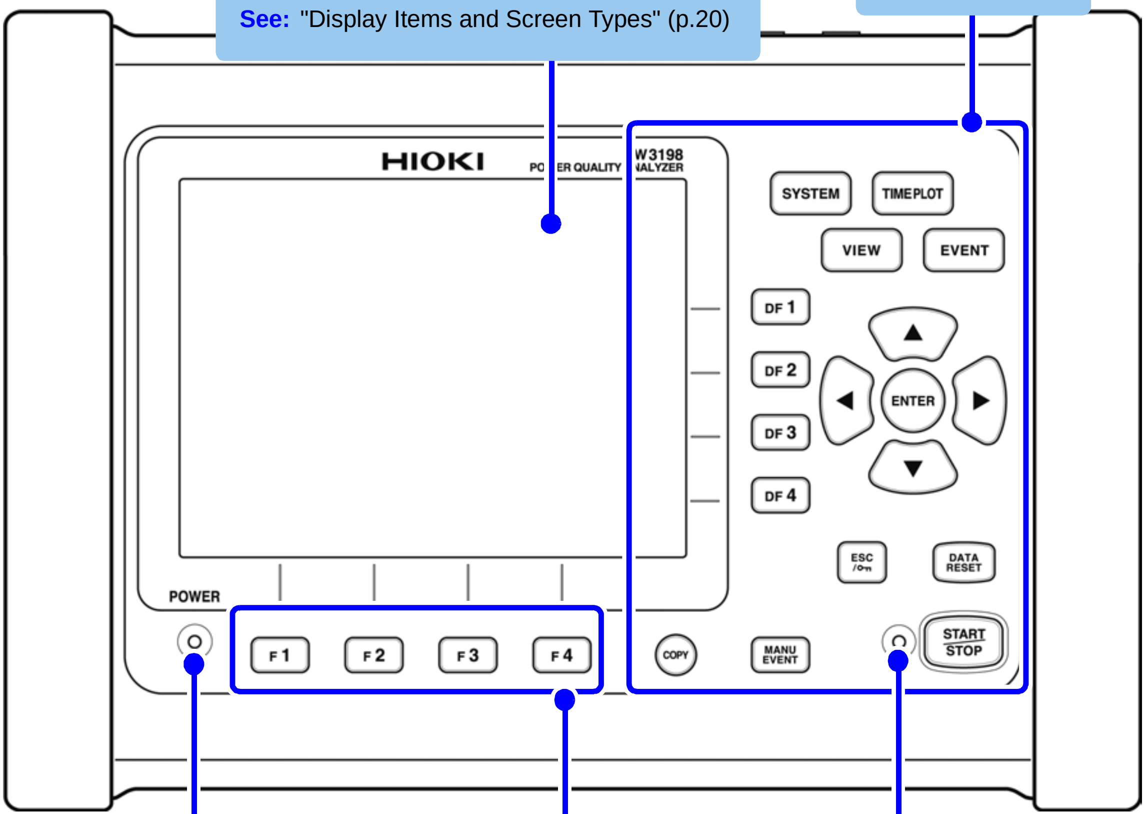
Chapter 2

2.1 Names and Functions of Parts

Front

Display
6.5" TFT color LCD display
See: "Display Items and Screen Types" (p.20)

Operation keys
See:(p.16)



POWER LED
Lights up when the **POWER** switch is turned on and power is supplied to the instrument.
Normal operation: Solid green
When using battery pack: Solid red
See: "3.8 Turning the Power On and Off (Setting the Default Language)" (p.36)

F key (Function key)
Select and change display contents and settings.
See:"2.2 Basic Operations" (p.19)

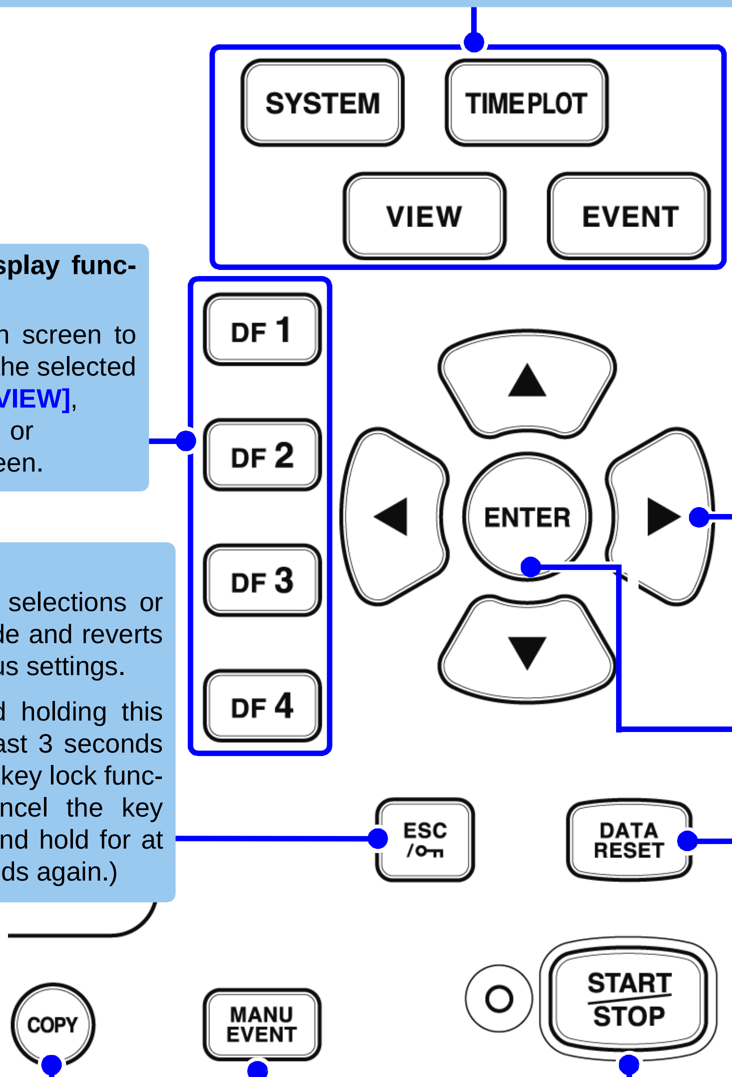
START/STOP LED
When in the recording standby state:
Flashing green
When recording:
Solid green

Operation keys

Menu keys (Screen selection)

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

SYSTEM	Displays the **[SYSTEM]** screen (which provides a list of system settings, event settings, recording condition settings, and memory [file] options [settings data, screen copy, measurement data]). (p.23)
VIEW	Displays the **[VIEW]** screen (which displays waveform and measured values). (p.24)
TIMEPLOT	Displays the **[TIMEPLOT]** screen (which displays time series graphs). (p.25)
EVENT	Displays the **[EVENT]** screen (which displays an event list). (p.26)



DF keys (display function keys)

Selects which screen to display from the selected **[SYSTEM]**, **[VIEW]**, **[TIMEPLOT]**, or **[EVENT]** screen.

Cursor keys

Move the cursor on the screen. The cursor keys are also used to scroll through graphs or waveforms.

ENTER key

Finalizes the selected or changed item.

ESC key

Cancels any selections or changes made and reverts to the previous settings.

Pressing and holding this key for at least 3 seconds activates the key lock function. (To cancel the key lock, press and hold for at least 3 seconds again.)

DATA RESET key

Erases all currently displayed measurement data. (Data that has been recorded to the SD memory card is not erased.) To start a new recording session, press this key to reset the data.

COPY key

Outputs data from the currently displayed screen to the SD memory card or printer.

MANU EVENT key

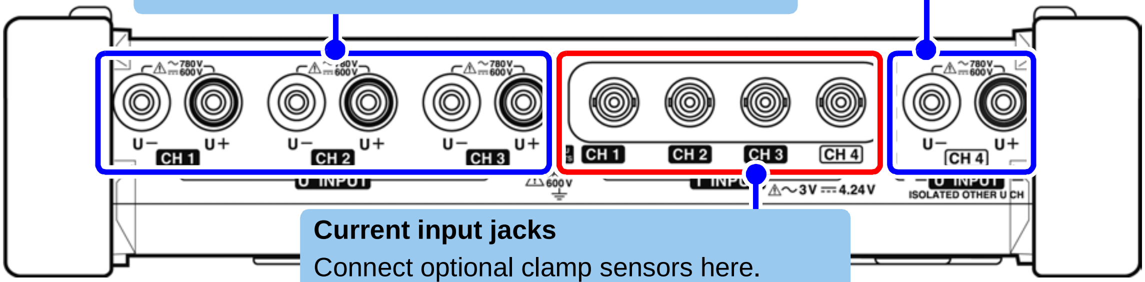
Generates an event, initiating recording of measured values and event waveforms.

START/STOP key

Starts and stops recording. To resume recording, press the **DATA RESET** key to reset the data followed by the **START/STOP** key.

Upper side

Voltage input jacks
Connect the included L1000 Voltage Cord here.
See: (p.34)



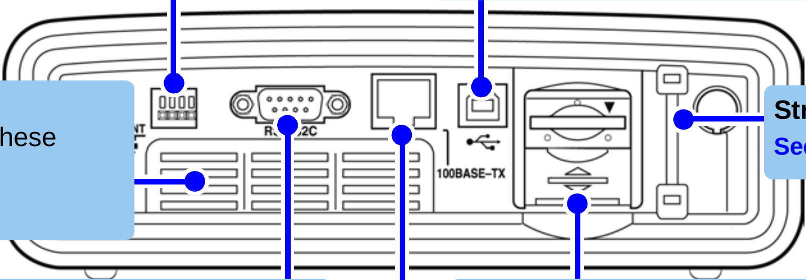
Current input jacks
Connect optional clamp sensors here.
See: (p.34)

Right side

External control terminal
IN : Allows use of external input as an event trigger.
OUT : Outputs a signal when an internal event occurs.
GND : Serves as the ground terminal for the external event input and output terminals.
See: (p.149)

USB interface
Connect a computer here using the included USB cable.
See: (p.156)

Air vents
Do not block these vents.
See: (p.6)



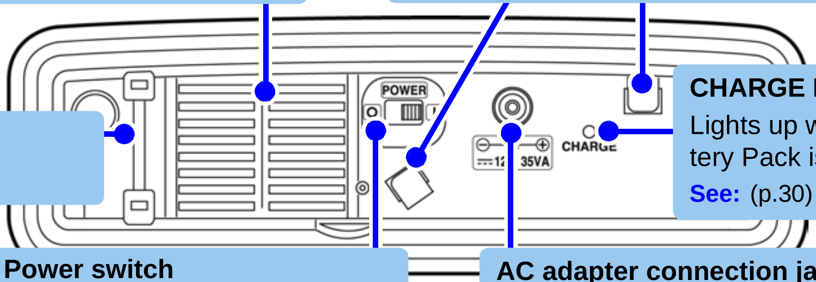
Strap eyelet
See: (p.28)

RS-232C interface
Connect a GPS box or printer using an RS-232C cable.

SD memory card slot
Insert an SD memory card here. Be sure to close the cover when recording.
See: (p.32)

LAN interface
Connect a computer here using the optional 9642 LAN Cable.
See: (p.160)

Left side



Air vents
Do not block these vents.
See: (p.6)

AC adapter hook
Loop the AC adapter cord through this hook.
See: (p.32)

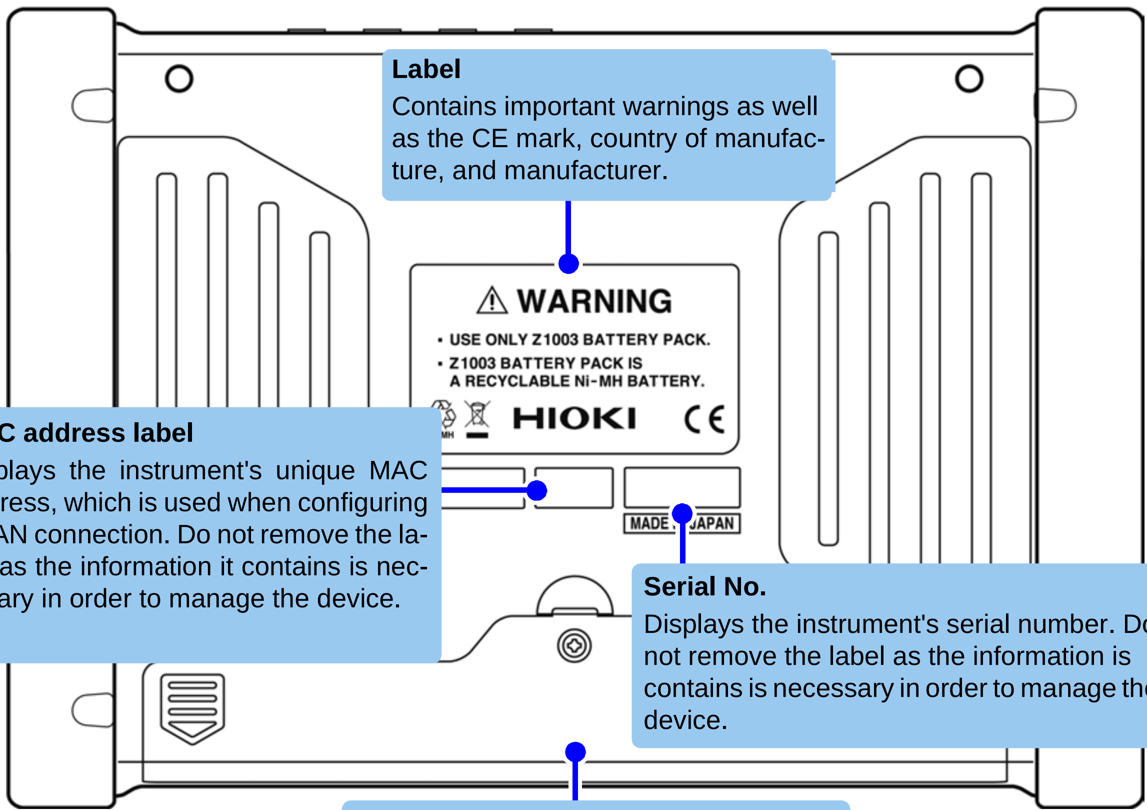
Strap eyelet
See: (p.28)

CHARGE LED
Lights up while the Z1003 Battery Pack is charging.
See: (p.30)

Power switch
Turns the instrument on and off.
| Power ON
○ Power OFF
See: (p.36)

AC adapter connection jack
Connect the included Z1002 AC Adapter here.
See: (p.32)

Back



Label
Contains important warnings as well as the CE mark, country of manufacture, and manufacturer.

MAC address label
Displays the instrument's unique MAC address, which is used when configuring a LAN connection. Do not remove the label as the information it contains is necessary in order to manage the device.

Serial No.
Displays the instrument's serial number. Do not remove the label as the information is contains is necessary in order to manage the device.

Battery compartment
Install the included Z1003 Battery Pack here.
See: (p.30)

2.2 Basic Operations

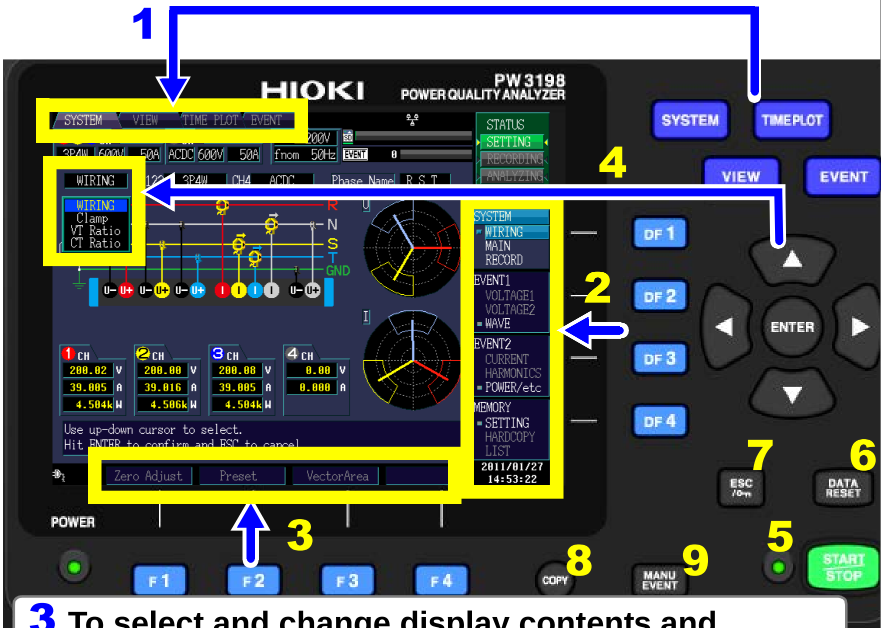
1 To select a display screen

Press **SYSTEM**, **VIEW**,**TIME PLOT**, or **EVENT** to display the corresponding screen.

See: "2.3 Display Items and Screen Types" (p.20)

2 Select the screen to display.

Press one of the **DF** keys to select and change display contents and settings. The displayed function labels depend on the currently displayed screen.



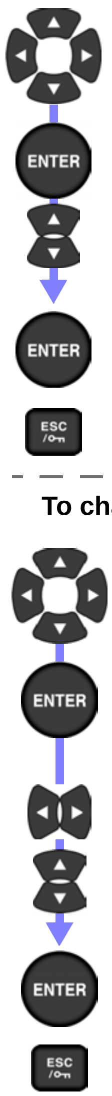
3 To select and change display contents and settings

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

Freeze the waveform or value display.

On the **[VIEW]** screen, you can freeze the waveform or value display by pressing the **F4 [HOLD]** key.

4 Select and finalize the desired settings.



Move the cursor to the desired setting

Display a pull-down menu

Select the desired setting

Accept setting

Cancel the setting

To change a value

Move the cursor to the desired setting

Select the value so that it can be changed

Select a digit

Select a value

Accept setting

Cancel

5 Start/stop recording.

Press the **START/STOP** key to start/stop recording.

See: "Starting and Stopping Recording" (p.14)

6 Revert to [SETTING] mode after stopping recording.

Press the **DATA RESET** key to reset the measurement data. The instrument will return to **[SETTING]** mode from **[ANALYZING]** mode.

7 Engage the key lock.

Press and hold the **ESC** key for at least 3 seconds. To cancel the key lock, press and hold the key for at least 3 seconds.

8 Save screen data (output it to a printer).

Press the **COPY** key. Data will be saved to the SD card (or output to the printer).

See: "9.5 Saving, Displaying, and Deleting Screen Copies" (p.144)

9 Generate an event manually.

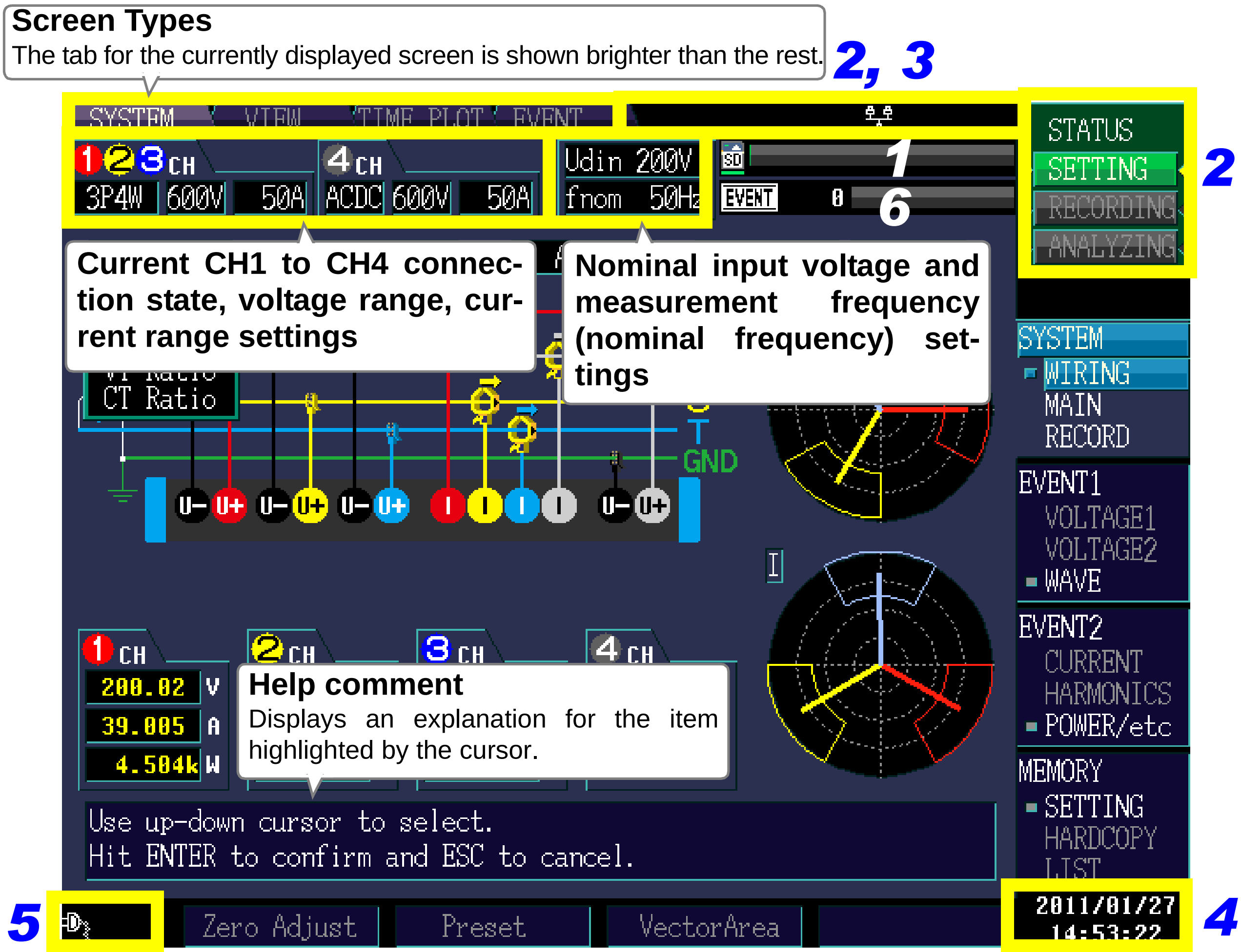
Press the **MANU EVENT** key. Measured values and event waveforms at that time will be recorded.

See: "Manual Events" (p.13)

2.3 Display Items and Screen Types

Common Display Items

These items are displayed on every screen.



1 SD memory card operation and usage status display

(no SD icon)	Lights up when no SD card is inserted.
SD (White)	Lights up when an SD memory card is inserted.
SD (Red)	Lights up when the SD memory card is being accessed.

TIMEPLOT data capacity

Once the memory is full, no additional data can be recorded.

2 Operating State Indicators

HOLD	Indicates Data Hold is active.
LOCK	Lights to indicate Key Lock is active (keys are locked), after holding the **ESC** key for three seconds.
SETTING	Lights up when settings can be configured.
WAITING	The **[SETTING]** indicator shows **[WAITING]** from the time that the **START/STOP** key is pressed until recording actually starts. During repeated recording, **[WAITING]** is also displayed when recording is stopped.
RECORDING	Lights up when data is being recorded.
ANALYZING	Lights up when the instrument is in **[ANALYZING]** mode after recording stops.

3 Interface status display

	Lights up during normal operation.
	Lights up when the instrument is both connected to an HTTP server and downloading data.
	Lights up when the instrument is downloading data.
	Lights up when the instrument is connected to an HTTP server.
	Lights up when a printer is connected to the RS-232C terminal.
(Blue)	Lights up when GPS positioning is active while connected to the PW9005 GPS Box.
(Red)	Lights up when the RS connected device is set to GPS but the PW9005 GPS Box is not yet connected.
(Yellow)	Lights up when the PW9005 GPS Box is connected but GPS positioning is not yet active.

4 Real-time clock display

Displays the current year, month, day, hour, minute, and second.

See: Setting the Clock: (p.65)

5 Power supply status display

(White)	Lights up when the instrument is being powered by the AC adapter. The POWER LED will turn green.
(Orange)	Lights up when the instrument is being powered by the AC adapter and the battery is charging. The POWER LED will turn green.
(White)	Lights up when the instrument is being powered by the battery. The POWER LED will turn red.
(Red)	Lights up when the instrument is being powered by the battery and the remaining battery life is limited. The POWER LED will turn red.
No display	No display indicates that the instrument is off or charging. The CHARGE LED will light up.

6 Event generation status display

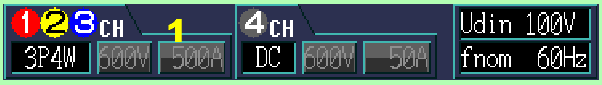
EVENT (Orange)	An event has been detected.
EVENT (White)	No event has been detected.

No. of events recorded
(Max. 1,000)

Event indicator
Full bar indicates 1,000 events.

Warning Indicators

The instrument may display the following warnings:

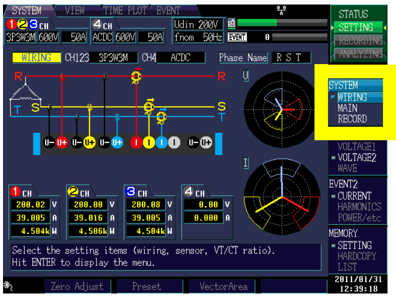
Display	Cause	Solution and page number for more information
	Normal screen display	-
(Current range indicator turns red.) 	Range or crest factor exceeded (current).	Switch to an appropriate clamp sensor. **See:** "Options" (p.3) Change the settings to an appropriate range. **See:** "5.1 Changing Measurement Conditions" (p.55)
(Voltage indicator turns red.) (**[Udin]** indicator turns red.) 	1. Range or crest factor exceeded (voltage). 2. The measured value and nominal input voltage (**[Udin]**)* differ.	For (1), the measured value has exceeded the voltage value that the instrument is capable of measuring. Use VT (PT) to make the measurement. If only (2) applies, change the nominal input voltage to an appropriate value. **See:** "5.1 Changing Measurement Conditions" (p.55)
(**[fnorm]** indicator turns red.) 	The measurement frequency (nominal frequency **[fnom]**) and measured value differ.	Change the measurement frequency to an appropriate value. **See:** "5.1 Changing Measurement Conditions" (p.55)
(The voltage range indicator and current range indicator are grayed out.) 	VT (PT) and CT have been set.	-

*: The nominal input voltage (Udin), which is calculated from the nominal supply voltage using the transformer ratio, indicates the voltage that is actually input to the instrument.

Screen Types

SYSTEM Configure settings (SYSTEM screen)

The **[SYSTEM]** screen is used to configure various instrument settings.
Press the **SYSTEM** key to display the **[SYSTEM]** screen. The screen can be changed with the **DF** keys.



DF 1

SYSTEM

- **WIRING**
  Configures the connection, clamp sensor, VT ratio, and CT ratio settings. (This screen is always displayed after the instrument is turned on.)
  See: Chapter 4 (p.37)
  - **F 1** Zero Adjust
    See: 4.1 (p.37)
  - **F 2** Preset
    See: 4.7 (p.50)
  - **F 3** VectorArea
- **MAIN**
  - **F 1** MEASURE
    Configures the connection, clamp sensor, VT ratio, CT ratio, current range, event, and TIME-PLOT settings.
    See: 5.1 (p.55)
  - **F 2** HARDWARE
    Configures the display language, screen color, clock, external output, RS-connected device, beep, LCD backlight, and LAN settings. Resets the system.
    See: 5.4 (p.64)
- **RECORD**
  Configures the recording, TIMEPLOT interval, real-time control, and repeated recording settings.
  See: 5.2 (p.58) to 5.3 (p.61)

DF 2

EVENT1
See: 5.5 (p.66)

- **VOLTAGE1**
  Configures the frequency, swell, dip, interruption, transient threshold, and hysteresis settings.
- **VOLTAGE2**
  Configures the RMS voltage, waveform peak, DC fluctuation, harmonic distortion factor, high-order harmonic component, and unbalance factor threshold settings.
- **WAVE**
  Configures the threshold settings for generating events with the voltage waveform.

DF 3

EVENT2
See: 5.5 (p.66)

- **CURRENT**
  Configures the inrush current, RMS current, waveform peak, DC fluctuation, harmonic distortion factor, high-order harmonic component, unbalance factor, and K factor threshold settings.
- **HARMONICS**
  Configures the threshold settings for 0- to 50-order harmonics (voltage, current, power, phase).
- **POWER/etc**
  Configures the active power, reactive power, apparent power, power factor threshold, timer event, external event, and continuous event settings.

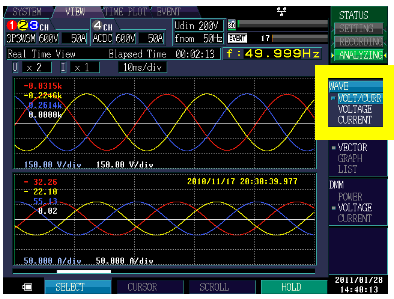
DF 4

- MEMORY
  See: Chapter 9 (p.135)
- SETTING — F1 LOAD, F2 SAVE, F3 DELETE
  Displays a list of settings data.
- HARDCOPY — F1 VIEW, F3 DELETE
  Displays a list of screenshot data.
- LIST — F1 LOAD*, F3 DELETE, F4 FORMAT
  Displays a list of the files stored on the SD memory card.

*The List's F1 (LOAD) will appear when the cursor is in the stored data folder. (B*******).

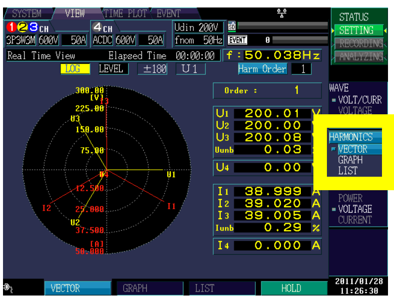
VIEW Monitor instantaneous values (VIEW screen)

The **[VIEW]** screen is used to view voltage and current instantaneous waveforms, phase relationships, values, and harmonics.
Press the **VIEW** key to display the **[VIEW]** screen. The screen can be changed with the **DF** keys.



DF 1

- WAVE
  See: 6.2 (p.76)
- VOLT/CURR
  Displays voltage waveforms for channels 1 to 4 on one screen and current waveforms for channels 1 to 4 on another screen (for a total of two screens).
- VOLTAGE
  Displays separate voltage waveforms for channels 1 to 4.
- CURRENT
  Displays separate current waveforms for channels 1 to 4.



DF 2

- HARMONICS
- VECTOR
  Displays the phase relationship between voltage and current for channels 1 to 3 as a vector diagram. The RMS value and phase instantaneous value is also shown for each order.
  See: 6.3 (p.80)
- GRAPH
  Displays the sum voltage, current, and 0- to 50-order power measured values for channels 1 to 4 as a graph.
  See: 6.4 (p.83)
- LIST
  Displays the sum voltage, current, power measured values (orders 0 to 50) for channels 1 to 4 as a graph.
  See: 6.4 (p.83)

DF 3

DMM

See: 6.5 (p.89)

POWER

Displays the RMS voltage, RMS current, active power, apparent power, reactive power, power factor, integral power, and K factor instantaneous values.

VOLTAGE

Displays the RMS voltage, voltage distortion factor, ± current peak value, current unbalance factor, harmonic voltage component, and 10-sec frequency instantaneous values.

CURRENT

Displays the RMS current, current distortion factor, ± current peak value, current unbalance factor, and high-order harmonic current component instantaneous values.

DF 4

EVENT

Shown only in **[ANALYZING]** mode.

TRANSIENT

Displays the transient waveform obtained by high-speed sampling when an event occurred.

See: 8.4 (p.126)

HHarmonic

Displays the high-order harmonic voltage and current waveforms at the time of event occurrence.

See: 8.5 (p.129)

TrendData

Displays a 30-second time series graph depicting fluctuations in the swell, dip, interruption, or inrush current when an event occurred (0.5 s before and 29.5 s after EVENT IN) (for 400 Hz measurement, approx. 0.125 s before and approx. 7.375 s after EVENT IN).

See: 8.6 (p.132)

TIME PLOT

Monitor changes in measured values (TIME PLOT screen)

The **[TIMEPLOT]** screen is used to view RMS, voltage, and harmonic fluctuations as time series graphs. Flicker values can also be shown as a graph or list.

Press the **TIMEPLOT** key to display the **[TIMEPLOT]** screen. The screen can be changed with the **DF** keys.

DF 1

TREND

See: 7.2 (p.94)

1-SCREEN

Displays the RMS value measured using data collected over approximately 200 ms, the average value of peak or other values during the TIMEPLOT interval, or the maximum, minimum, and average values as a time series, showing one per screen.

2-SCREEN

Displays the RMS value measured using data collected over approximately 200 ms, the average value of peak or other values during the TIMEPLOT interval, or the maximum, minimum, and average values as a time series, showing two per screen.

ENERGY

Displays the active energy (WP+/WP-) or reactive energy (WQLAG/WQLEAD) as selected.

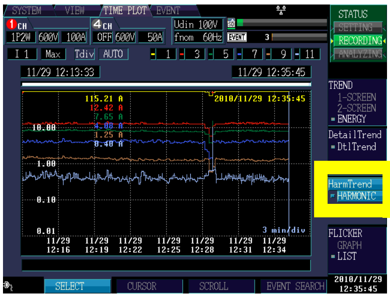
DF 2

DetailTrend

See: 7.3 (p.101)

DtlTrend

Displays the maximum and minimum values during the TIME-PLOT interval for RMS voltage refreshed each half-cycle, inrush current, S (t), frequency cycle, or other characteristics measured in half-cycle or one-cycle units.



DF 3

HarmTrend

See: 7.4 (p.107)

HARMONIC

Can display 6 orders of harmonics. Displays the average value or maximum, minimum, and average value during the TIMEPLOT interval as a time series. (You can select voltage, current, power, or phase to be displayed.)

INTERHARM

Can display 6 orders of inter-harmonics. Displays the average value or the maximum, minimum, and average values during the TIMEPLOT interval as a time series. (You can select voltage or current to be displayed.)

DF 4

FLICKER

See: 7.5 (p.111)

GRAPH

Displays Δ10V (instantaneous values) or Pst and Plt values as a time series. You can select either Δ10V flicker or IEC flicker to be displayed.

LIST

Displays Δ10V (instantaneous values) or Pst and Plt values as a list. You can select either Δ10V flicker or IEC flicker to be displayed.

EVENT

Monitor event occurrence (EVENT screen)

The **[EVENT]** screen is used to view a list of events that have occurred. In addition to checking whether a given event has occurred and the number of times it has occurred, if any, you can view high-order harmonic measured values.

Press the **EVENT** key to display the **[EVENT]** screen.

DF 1

EVENT

See: Chapter 8 (p.119)

LIST

Displays a list of events in the order of their occurrence. Detailed information and the waveform at the time of the event occurrence are also shown for the event selected on the list. You can also analyze instantaneous values, waveforms, and other information at the time of the event's occurrence on the **[VIEW]** screen.

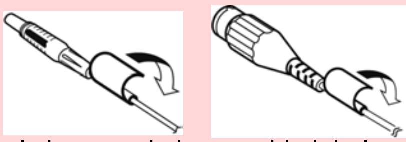
Measurement Preparations Chapter 3

3.1 Preparation Flowchart

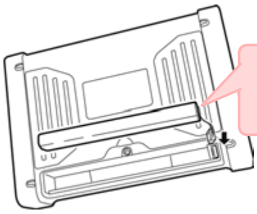
Follow the procedure described below to prepare for measurement. "After-purchase" items need only be performed once.

1 Perform the pre-measurement inspection. (p.31)

After-purchase item (1) (voluntary)



Apply input code input cable labels to the voltage cords and clamp sensors. (p.28)



After-purchase item (4)

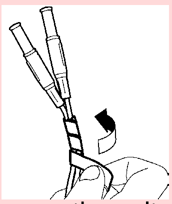
Install the battery pack. (p.30)

Back side

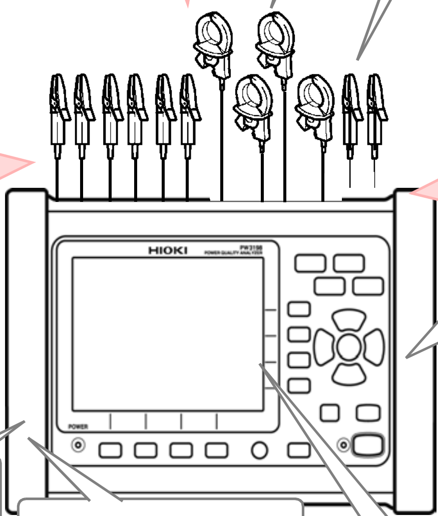
4 Connect the voltage cords (p.34) and clamp sensors (p.34).

8 Connect to the measurement line (p.46)

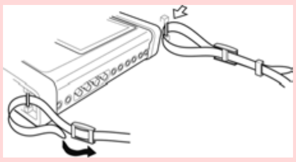
After-purchase item (3)



Secure the voltage cords together with a spiral wrapper. (p.29)

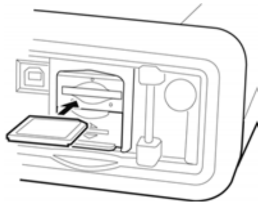


After-purchase item (2)



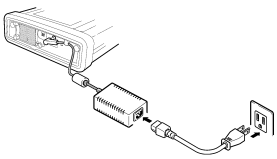
Attach the strap. (p.28)

3 Insert an SD memory card. (p.32)

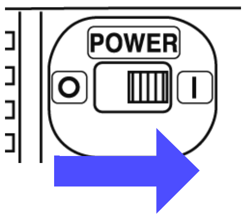


Be sure to close the cover after inserting the card.

2 Connect the AC adapter. (p.32)



5 Turn on the instrument. (p.36)



6 Perform zero adjustment. (p.37)
To ensure you are able to obtain precise measurements, it is recommended to allow the instrument to warm up for at least 30 minutes before performing zero adjustment or making measurements.

7 Set the clock. (p.65)

9 Set the connection mode. (p.39)

10 Verify that the connections have been made properly.(p.48)

11 Perform quick setup. (p.50)

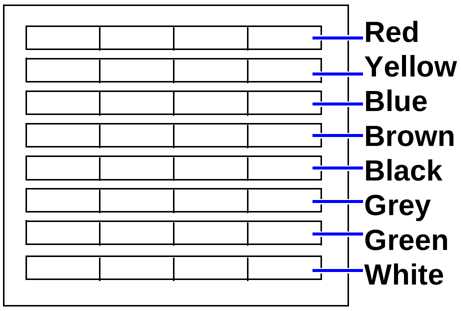
3.2 Initial Instrument Preparations

Perform the following before starting measurement the first time.

Attaching input cable labels to the voltage cords and clamp sensors

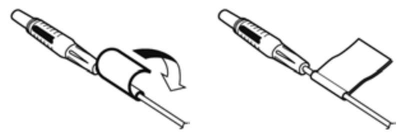
Attach input cable labels to the voltage cords and clamp sensors as needed to allow identification of individual channels.

> **■ Before applying the input cable labels**
> Wipe any dust from the surface of the voltage cords and clamp sensors, and ensure that it is dry.

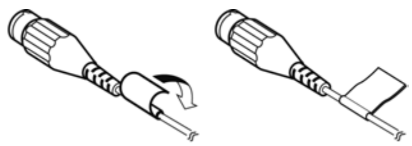


Input Cable Labels

Apply labels to both ends of the voltage cords



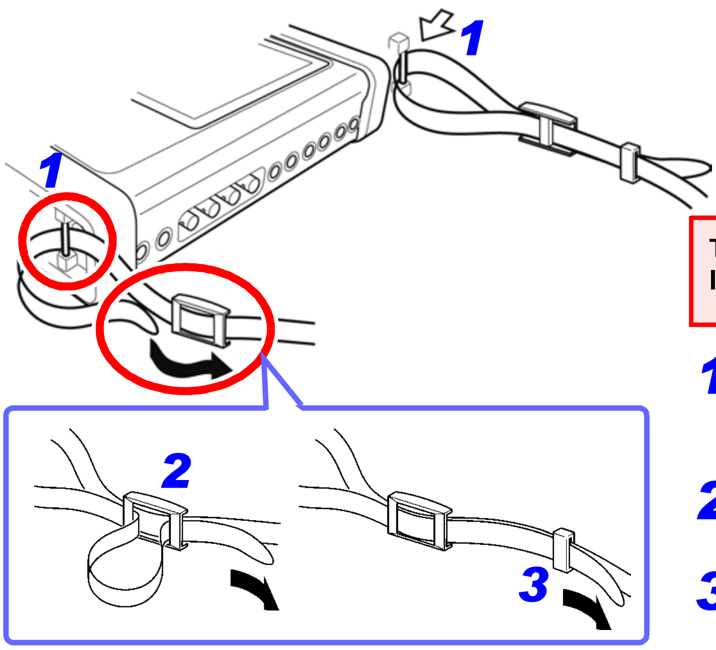
Apply labels to both ends of the clamp sensor leads.



Attaching the strap

Use the strap when carrying the instrument or suspending it from a hook during use.

⚠CAUTION Attach both ends of the strap securely to the instrument. If insecurely attached, the instrument may fall and be damaged when carrying.



Tighten securely to keep straps from loosening or twisting.

1. **Feed each end of the strap through the corresponding eyelet on the instrument.**
2. **Feed each end of the strap through its buckle.**
3. **Feed each end of the strap through its loop.**

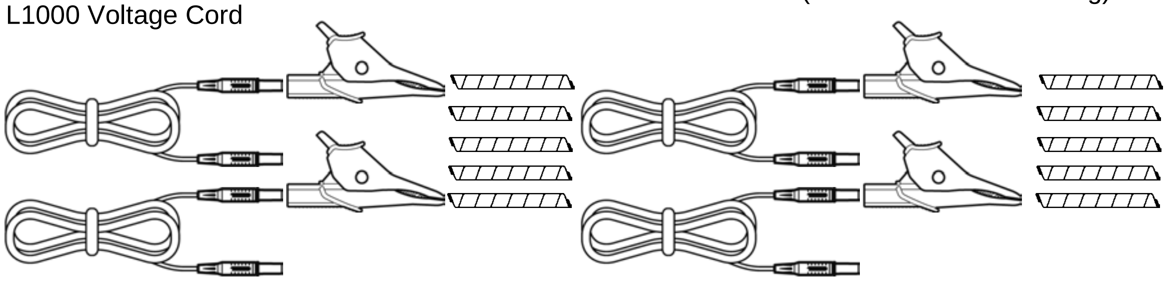
Bundle the voltage cord leads with the spiral tubes

The instrument ships with 20 spiral wrappers. Use the wrappers to bundle pairs of cords (colored and black) together as needed.

Preparation items

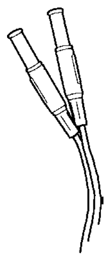
L1000 Voltage Cord

(Two sets of the following)



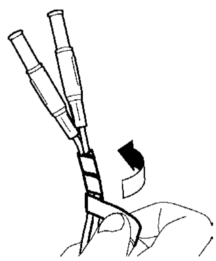
Alligator Clips (eight, one each red, yellow, blue, gray, and four black)
Banana Plug Leads (eight, one each red, yellow, blue, gray, and four black)
Spiral Tubes (twenty, for cable bundling)

Procedure



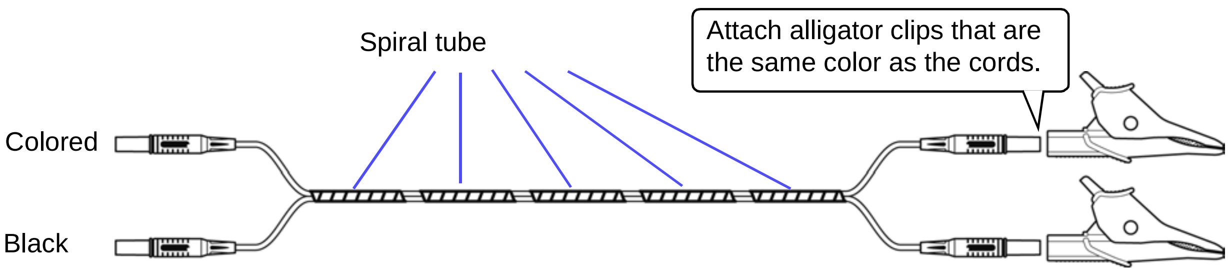
1. Line up two cords (colored and black).

Start bundling from one end of the leads.



2. Wind the spiral tube around the leads.

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



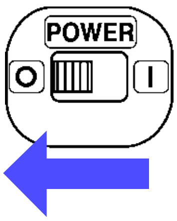
Installing the battery pack

Be sure to read the "About the battery pack" (p.9) before connecting power.

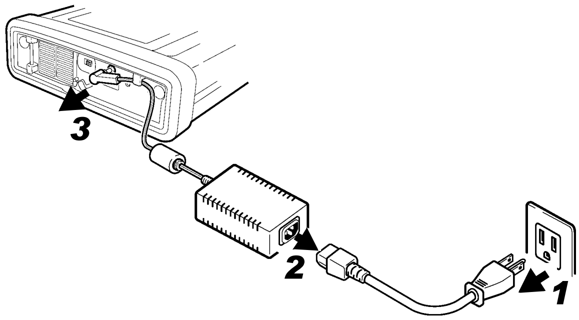
The battery pack is used to power the instrument during power outages and as a backup power supply. When fully charged, it can provide backup power for approximately 180 minutes in the event of a power outage. The battery pack is designed to charge during normal use of the instrument. The CHARGE LED will turn red while the battery pack is charging.
Note that if a power outage occurs while the battery pack is not being used, displayed measurement data will be erased. (Data that has been recorded on the SD memory card is retained.)

Tools needed to install the battery pack: 1 Phillips head screwdriver

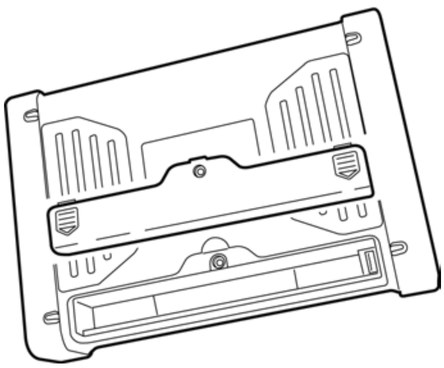
1. **Turn off the instrument.**



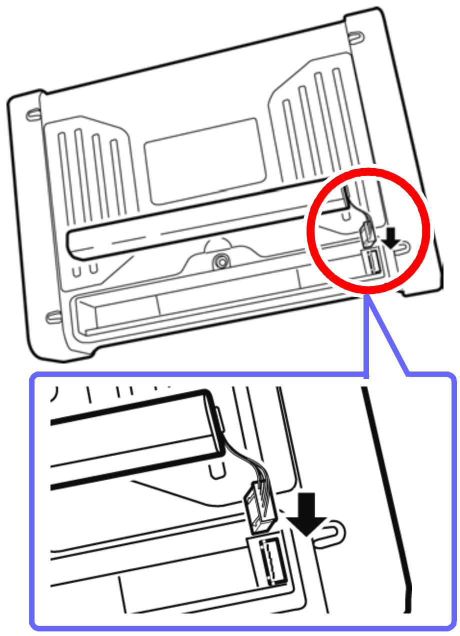
2. **Disconnect the AC ADAPTER Z1002.**



3. **Turn the instrument upside down and remove the screws that hold the battery pack cover in place. Remove the cover.**



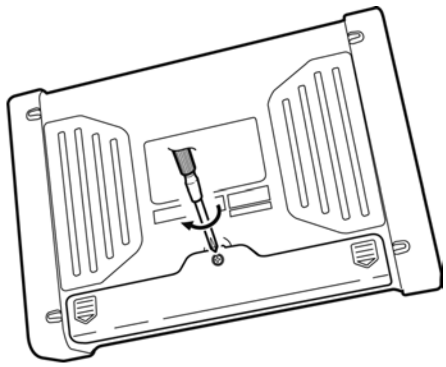
4. Connect the battery pack's plug to the connector (orient the connector so that the two protruding pieces are on the left).



5. **Insert the battery pack as indicated by the labeling on the battery pack.**

> **Exercise care not to pinch the battery pack wires between the batter pack and the instrument.**

6. **Reattach the battery pack cover to the instrument and tighten the screws securely.**



3.3 Pre-Operation Inspection

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

1 Inspect the voltage cords

Is the insulation of the voltage cord to be used damaged, or is bare metal exposed?

- Metal Exposed → Do not use if damage is present, as you could receive an electric shock. Contact your dealer or Hioki representative if you find any damage.
- No Metal Exposed ↓

2 Inspect the clamp sensors

Is a clamp cracked or damaged?

- Yes → Do not use if damage is present, as you could receive an electric shock. Contact your dealer or Hioki representative if you find any damage.
- No ↓

3 Inspect the instrument

Is damage to the instrument evident?

- Yes → Contact your dealer or Hioki representative if you find any damage.
- No ↓

4 Inspection after turning on instrument

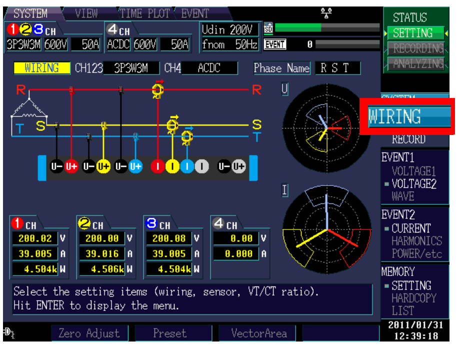
1. Does the self-test (model and version) display appear?
(The version number may be changed to the latest version number.)

HIOKI

HIOKI PW3198
POWER QUALITY ANALYZER
Ver 1.00

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

2. Is the **[WIRING]** page of the settings screen being displayed?



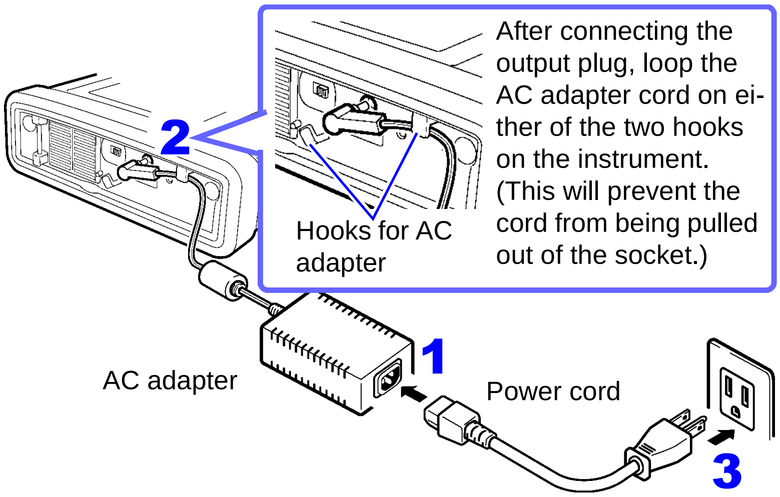
- An error is displayed → The instrument may be damaged internally. Please contact your dealer or Hioki representative.
- Yes → **Inspection complete**

3.4 Connecting the AC Adapter

Be sure to read the "Handling the cords and clamp sensors" (p.7) and "About the AC adapter" (p.8) before connecting power.

Connect the AC adapter to the power inlet on the instrument, and plug it into an outlet.

Connection Procedure



1. **Check that the instrument's power switch is turned off. Connect the power cord to the inlet on the AC adapter.**
2. **Connect the AC adapter's output plug to the instrument.**
3. **Plug the power cord's input plug into an outlet.**

Turn off the instrument before unplugging the AC adapter.

3.5 Inserting (Removing) an SD Memory Card

Important

- Use only HIOKI-approved SD memory cards (model Z4001, etc). Proper operation is not guaranteed if other cards are used.
- Format new SD memory cards before use.
- Format SD memory cards with the instrument. Using a computer to format the card may reduce the card's performance.

See:"9.2 Formatting SD Memory Cards" (p.138)

CAUTION

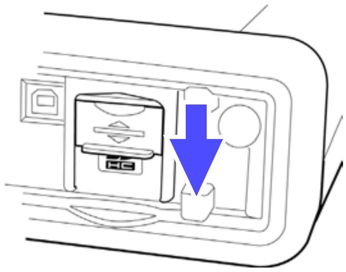
- Inserting a SD card upside down, backwards or in the wrong direction may damage the instrument.
- Do not turn off the instrument while the SD memory card is being accessed. Never remove the SD memory card from the instrument. Doing so may cause data on the card to be corrupted.
- Do not remove the SD memory card while recording or analyzing data. Doing so may cause data on the card to be corrupted.

NOTE

- The operating lifetime of the SD memory card is limited by its flash memory. After long-term or frequent usage, data reading and writing capabilities will be degraded. In that case, replace the card with a new one.
- No compensation is available for loss of data stored on the SD memory card, regardless of the content or cause of damage or loss. Be sure to back up any important data stored on an SD memory card.
- The SD memory card operation indicator (p.20) will turn red while the card is being accessed.

Insert and remove SD memory cards as follows:

1 Open the SD memory card slot cover.

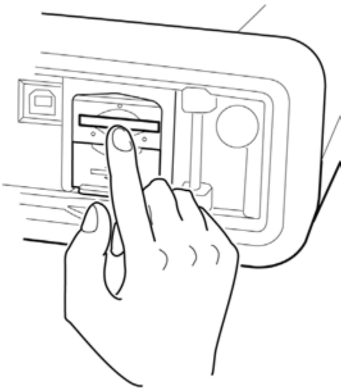


2 **To insert a card:**

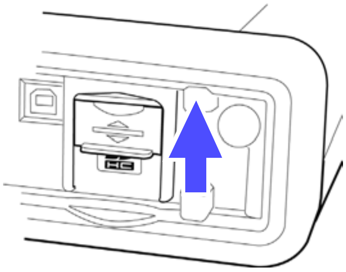
Orienting the card right side up (with the [▲] mark on the top), insert the card all the way in the direction indicated by the arrow.

2 **To remove a card:**

Push the card in and then pull it out of the slot.



3 Close the SD memory card slot cover.



Be sure to close the SD memory card slot cover.

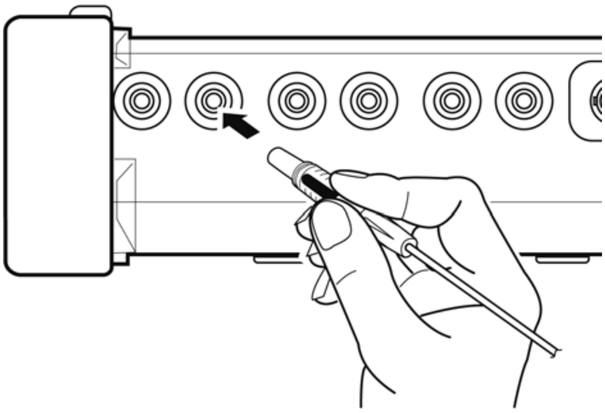
3.6 Connecting the Voltage Cords

Be sure to read the "Usage Notes" (p.6) before connecting voltage cords.

⚠CAUTION To prevent an electric shock accident, confirm that the white or red portion (insulation layer) inside the cable is not exposed. If a color inside the cable is exposed, do not use the cable.

Plug the voltage cord leads into the voltage input jacks on the instrument (the number of connections depends on the lines to be measured and selected wiring mode).

Connection Procedure



Plug the voltage cables into the appropriate channels' voltage measurement jacks.

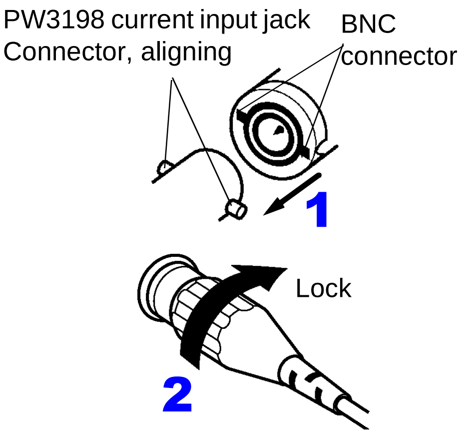
Insert the plugs into the jacks as far as they will go.

3.7 Connecting the Clamp Sensors

Be sure to read the "Usage Notes" (p.6) before connecting clamp sensors.

Plug the Clamp sensor cables into the current measurement jacks on the instrument (the number of connections depends on the lines to be measured and selected wiring mode). See the instruction manual supplied with the Clamp sensor for specification details and usage procedures.

Connection Procedure



1. **Insert the clamp sensor's BNC connector, aligning its groove with the connector guide on the instrument's current input jack.**

2. **Turn the connector clockwise to lock it in place.**
(To disconnect the connector, turn it counterclockwise to unlock it and then pull.)

To measure voltage and current beyond the range of the instrument or clamp sensor
Use an external VT (PT) or CT. By specifying the VT or CT winding ratio on the instrument, the input level at the primary side can be read directly.
See: "4.7 Quick setup" (p.50)

DANGER

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

WARNING

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

NOTE

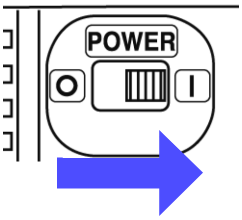
- Phase difference in an external VT (PT) or CT can cause power measurement errors. For optimum power measurement accuracy, use a VT (PT) or CT that exhibits minimal phase difference at the operating frequency.
- To ensure safety when using a VT (PT) or CT, one side of the secondary should be grounded.

3.8 Turning the Power On and Off (Setting the Default Language)

Be sure to read the "Usage Notes" (p.6) before turning the instrument on.

Turn on the instrument after connecting the AC adapter, voltage cords, and clamp sensors.

Turning the power on



Turn the POWER switch on (|).

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

See: 3.3 (p.31)

After the self-test is complete, the **[SYSTEM]-[WIRING]** screen will be displayed.

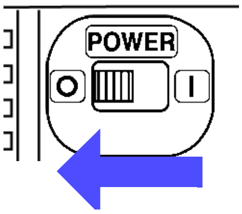
NOTE

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

1. Cancel measurement and disconnect the voltage cords and clamp sensors from the measurement line before turning off the instrument's **POWER** switch.
2. Disconnect the power cord, voltage cords, and clamp sensors from the instrument.
3. 3. Contact your dealer or Hioki representative.

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

Turning the power off



Turn the POWER switch off (○).
After use, always turn OFF the power.

⚠CAUTION

Do not turn the instrument off with the voltage cords and clamp sensors connected to the measurement line. Doing so may damage the instrument.

Setting the Default Language

When power on the instrument under factory default condition or immediately after a boot key reset (p.73), the following will be displayed in the startup screen.

Please select default language.
English: F1 Japanese: F2 Chinese: F3

Select the desired language with the **F** key. (**F1**: English, **F2**: Japanese, **F3**: Chinese)
This default language setting is retained even if the system is reset (p.73). The language is not retained when the instrument is reset to its factory settings with a boot key reset (p.73).

Configuring the Instrument before Measurement (SYSTEM - SYSTEM screen) and Wiring

Chapter 4

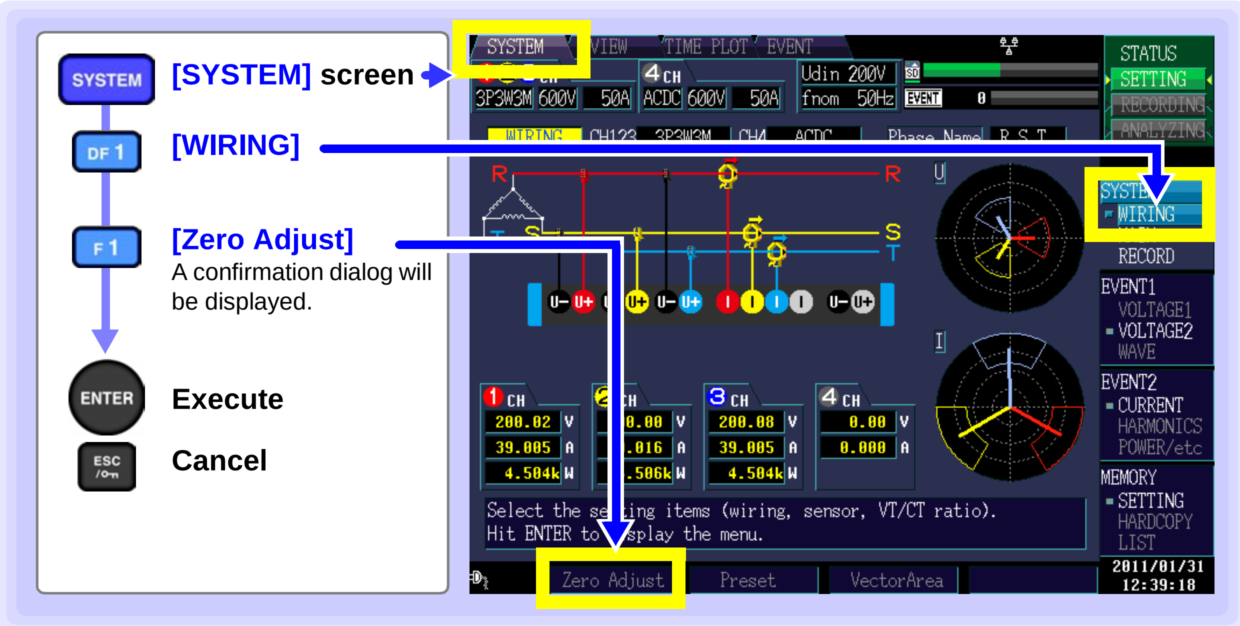
4.1 Warm-up and Zero-adjust Operation

Warm-up

It is necessary to allow the PW3198 to warm up to ensure its ability to make precise measurements. Allow the instrument to warm up for at least 30 minutes after turning it on. (p.36)

Zero Adjustment

Zero-adjust functionality creates a state in which the input signals are equal to zero in the instrument's internal circuitry and uses that level as zero. In order to ensure the device's ability to make precise measurements, it is recommended to perform zero adjustment after allowing the instrument to warm up for at least 30 minutes. Perform zero-adjustment on both voltage and current measurement channels.

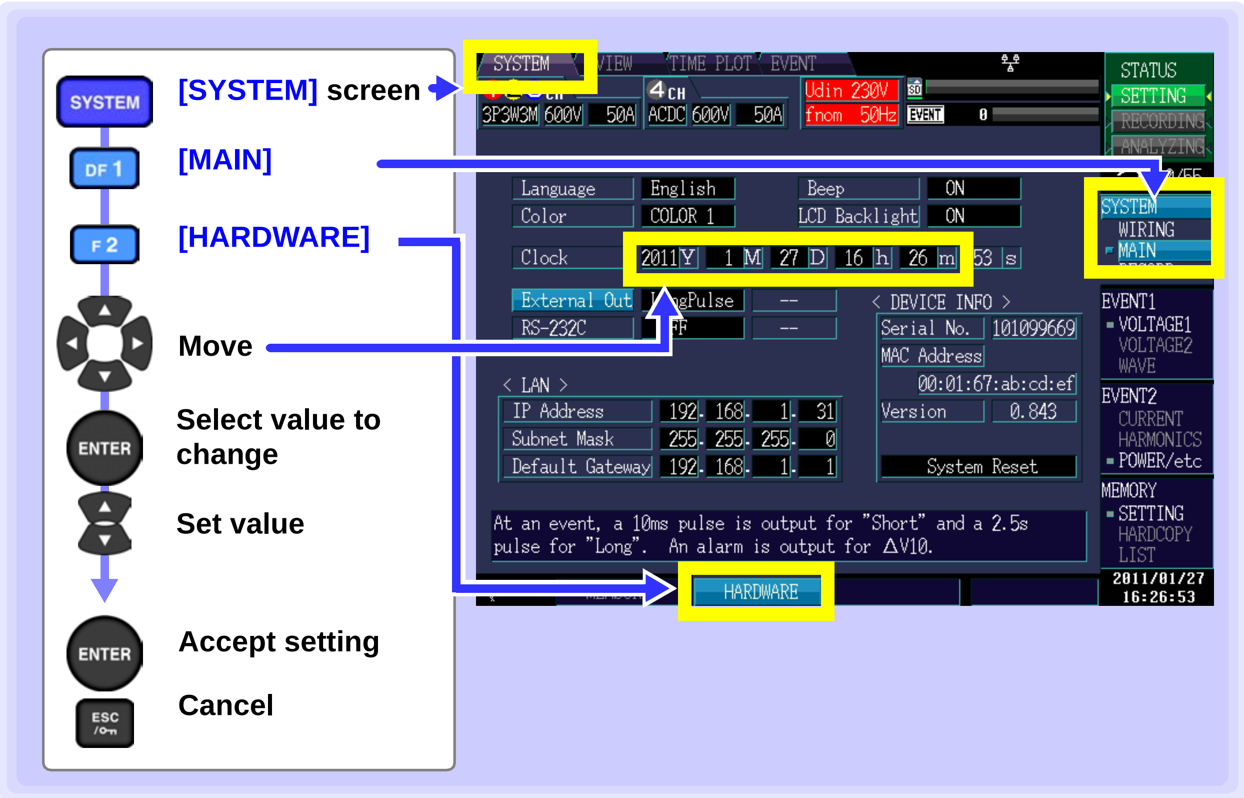


NOTE

- Perform zero adjustment only after plugging the clamp sensor into the instrument.
- Perform zero adjustment before attaching to the lines to be measured (proper adjustment requires the absence of any input voltage or current).
- In order to ensure the instrument's ability to make precise measurements, zero adjustment should be performed at an ambient temperature level that falls within the range defined by the device specifications.
- The operating keys are disabled during zero adjustment.
- When the clamp sensor has a zero adjustment function, perform zero adjustment on the HIOKI PW3198 first before performing it on the clamp sensor.

4.2 Setting the Clock

This section describes how to set the PW3198's clock.
It is recommended to check the clock before starting recording.

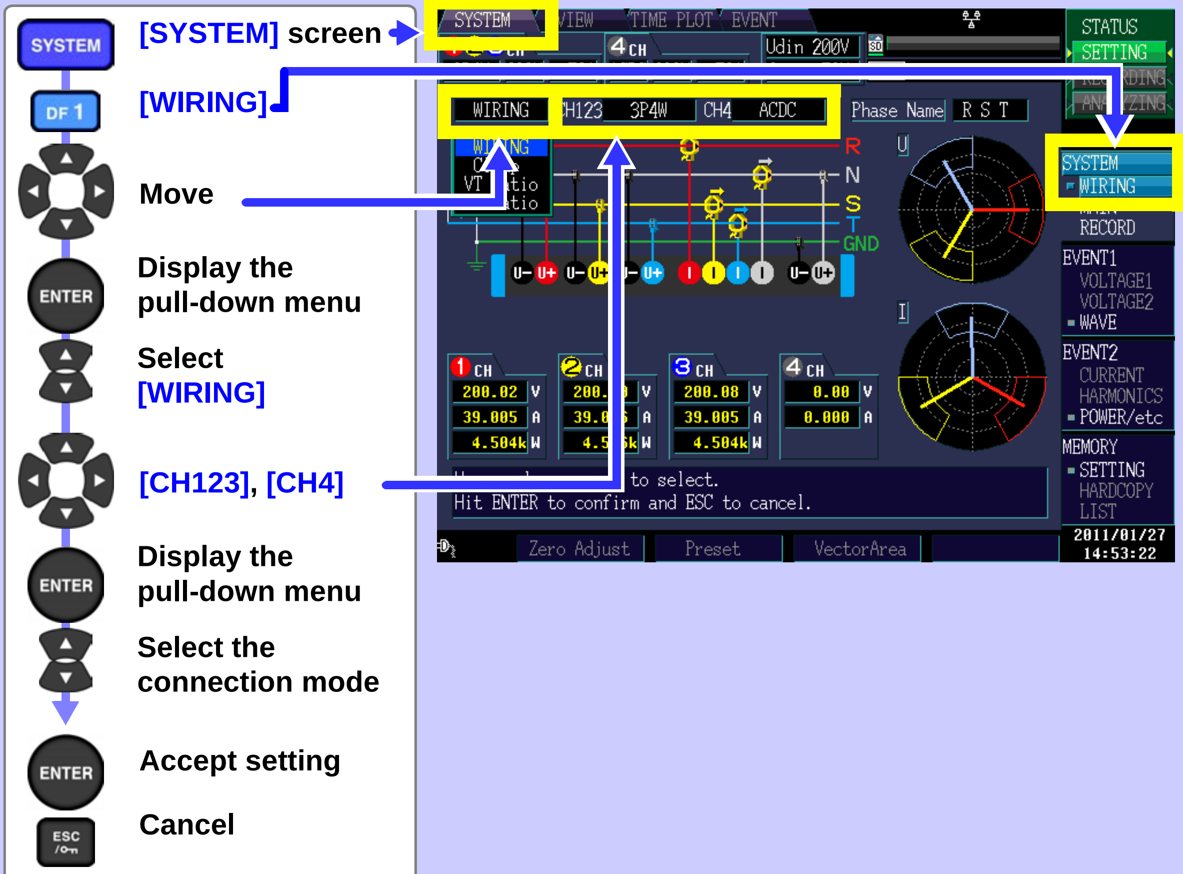


4.3 Configuring the Connection Mode and Clamp Sensors

This section describes how to configure the connection mode and clamp sensors appropriately for the measurement line being analyzed.

Eight wiring modes are available.

To select the wiring mode



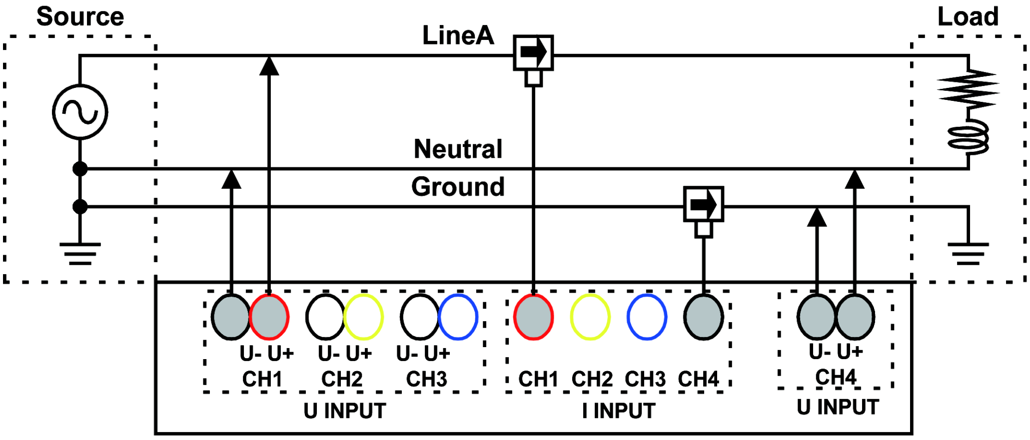
Accepting the settings will cause a connection diagram for the selected connection mode to be displayed. Accepting the selection displays the wiring diagram of the selected wiring mode. (p.40)

NOTE

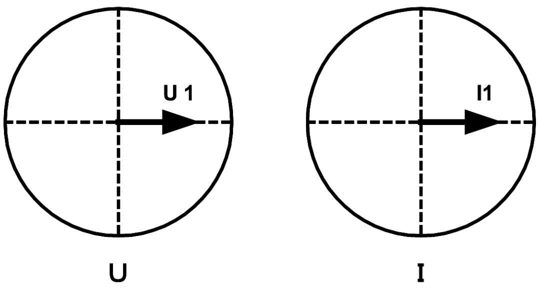
- To measure multiphase power, use the same type of clamp sensor on each phase line. For example, to measure 3-phase 4-wire power, use the same model clamp sensors on channels 1 to 3.
- When using clamp sensors with switchable ratings (ranges), for example the 9667 Flexible Clamp-On Sensor, use the same rating (range) setting for the sensors and the instrument.

Connection diagram

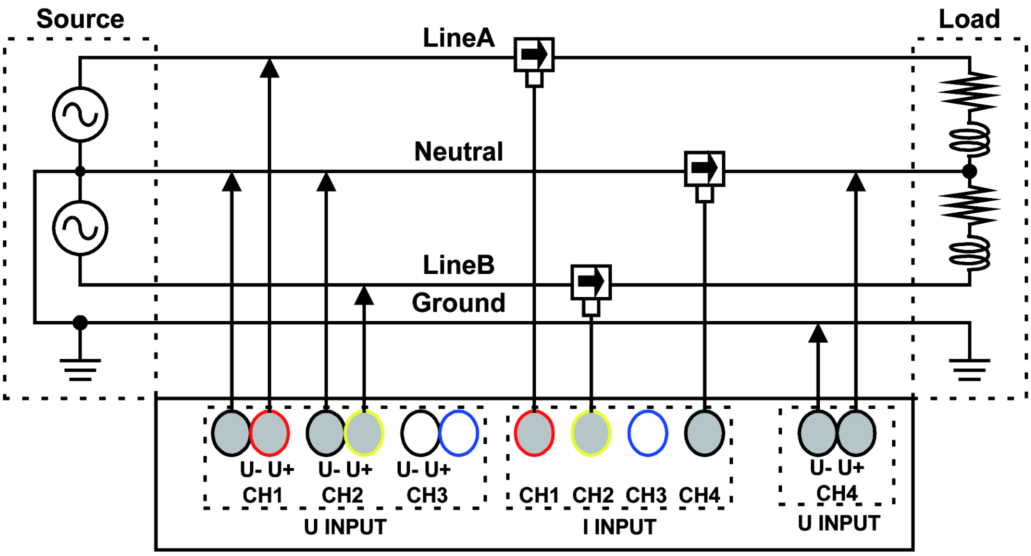
1P2W



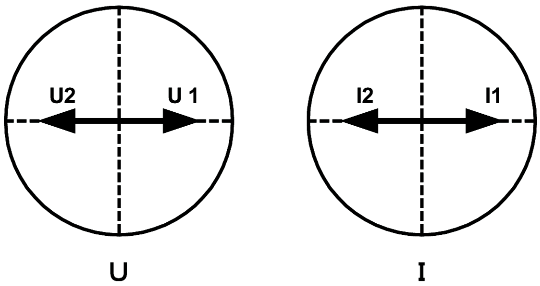
The vector diagram shows the measurement line in its ideal state.



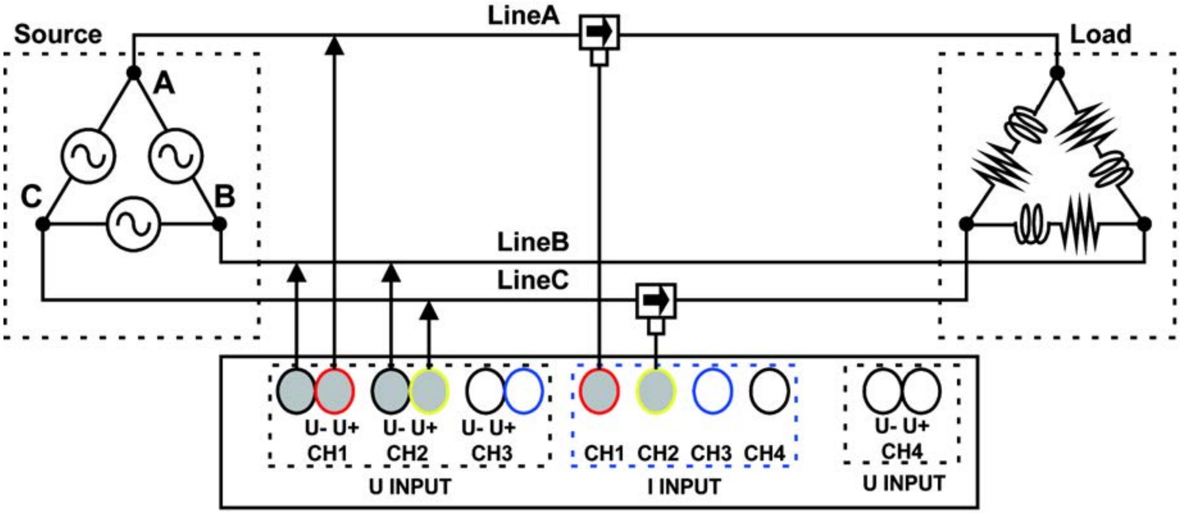
1P3W



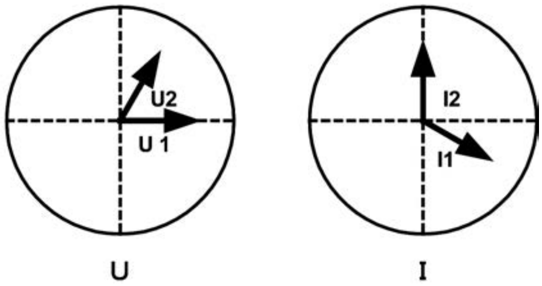
The vector diagram shows the measurement line in its ideal (balanced) state.



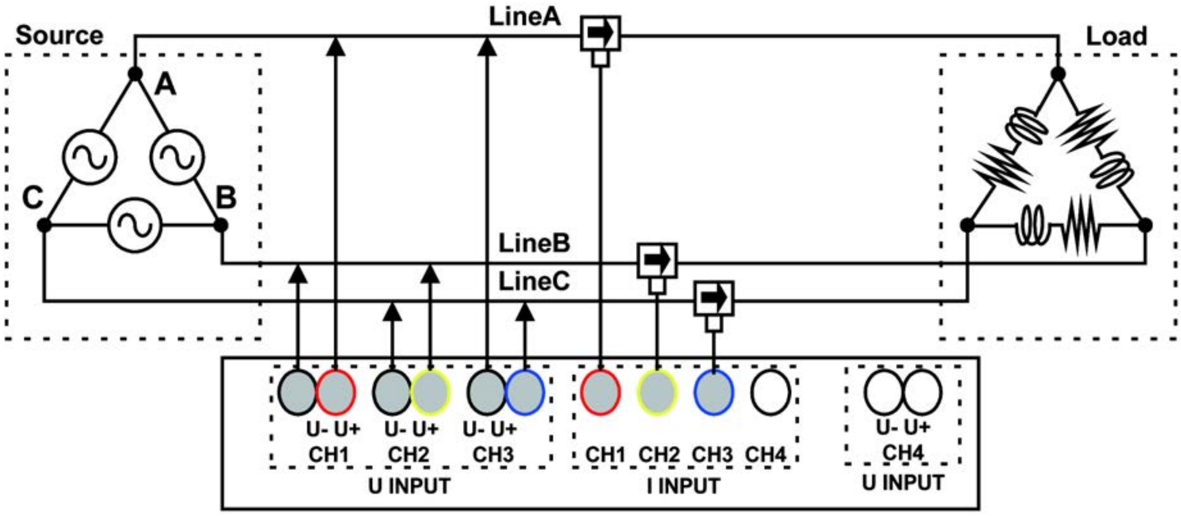
3P3W2M



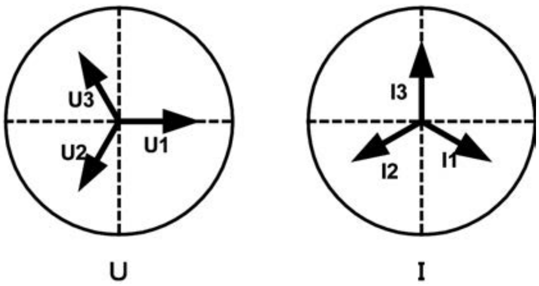
The vector diagram shows the measurement line in its ideal (balanced) state.



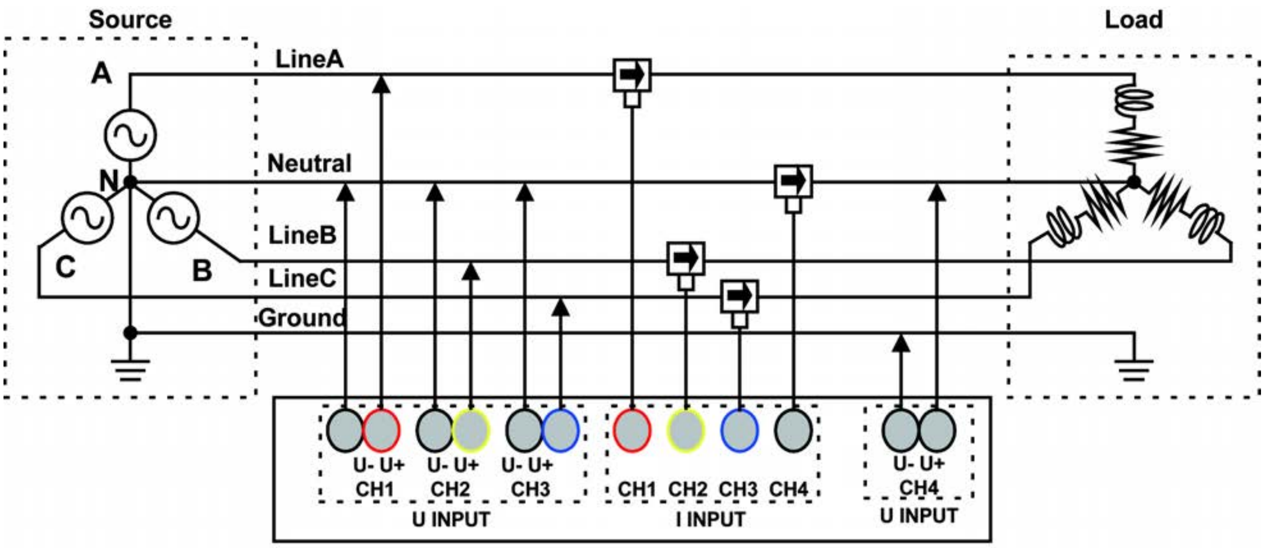
3P3W3M



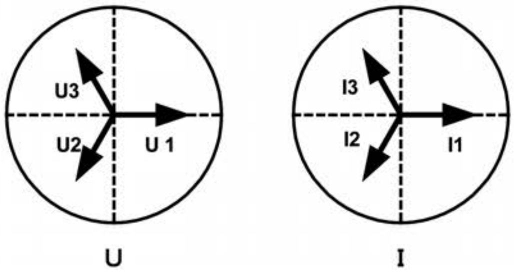
The vector diagram shows the measurement line in its ideal (balanced) state.



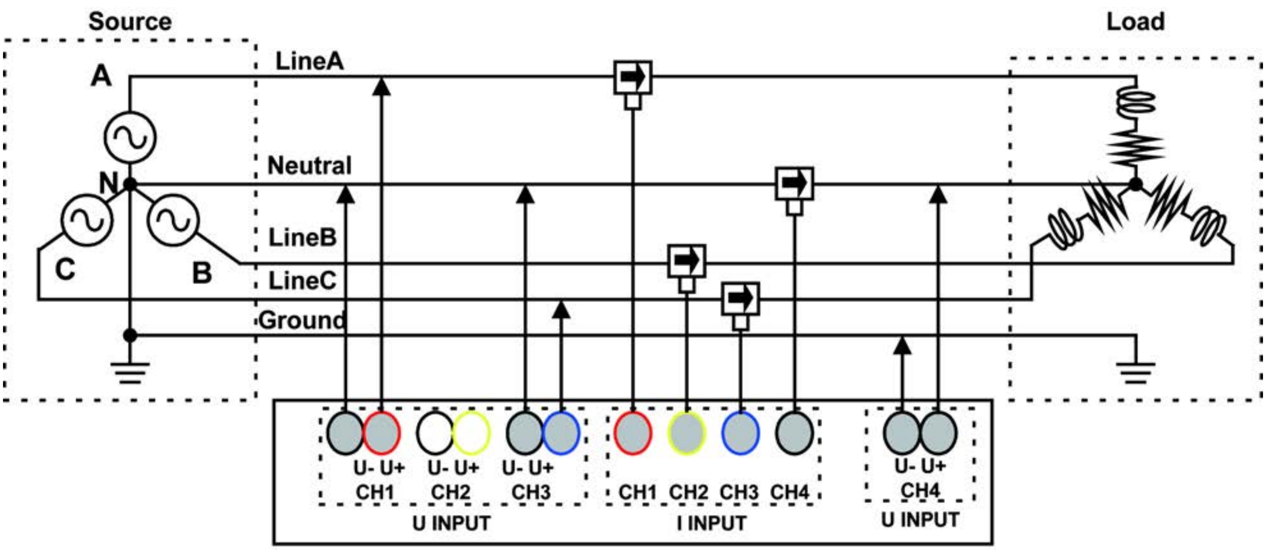
3P4W (CH4:ACDC)



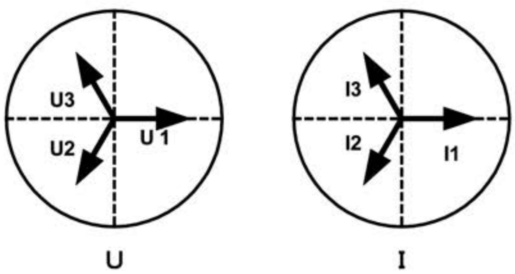
The vector diagram shows the measurement line in its ideal (balanced) state.



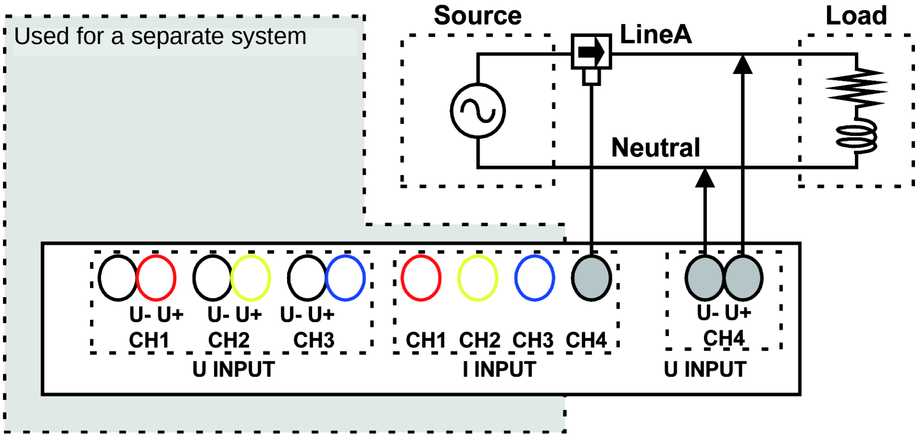
3P4W2.5E (CH4:ACDC)



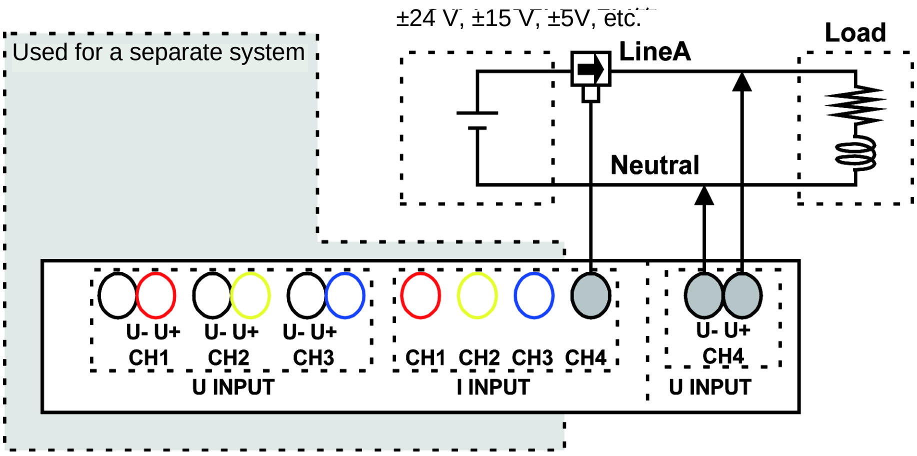
The vector diagram shows the measurement line in its ideal (balanced) state.



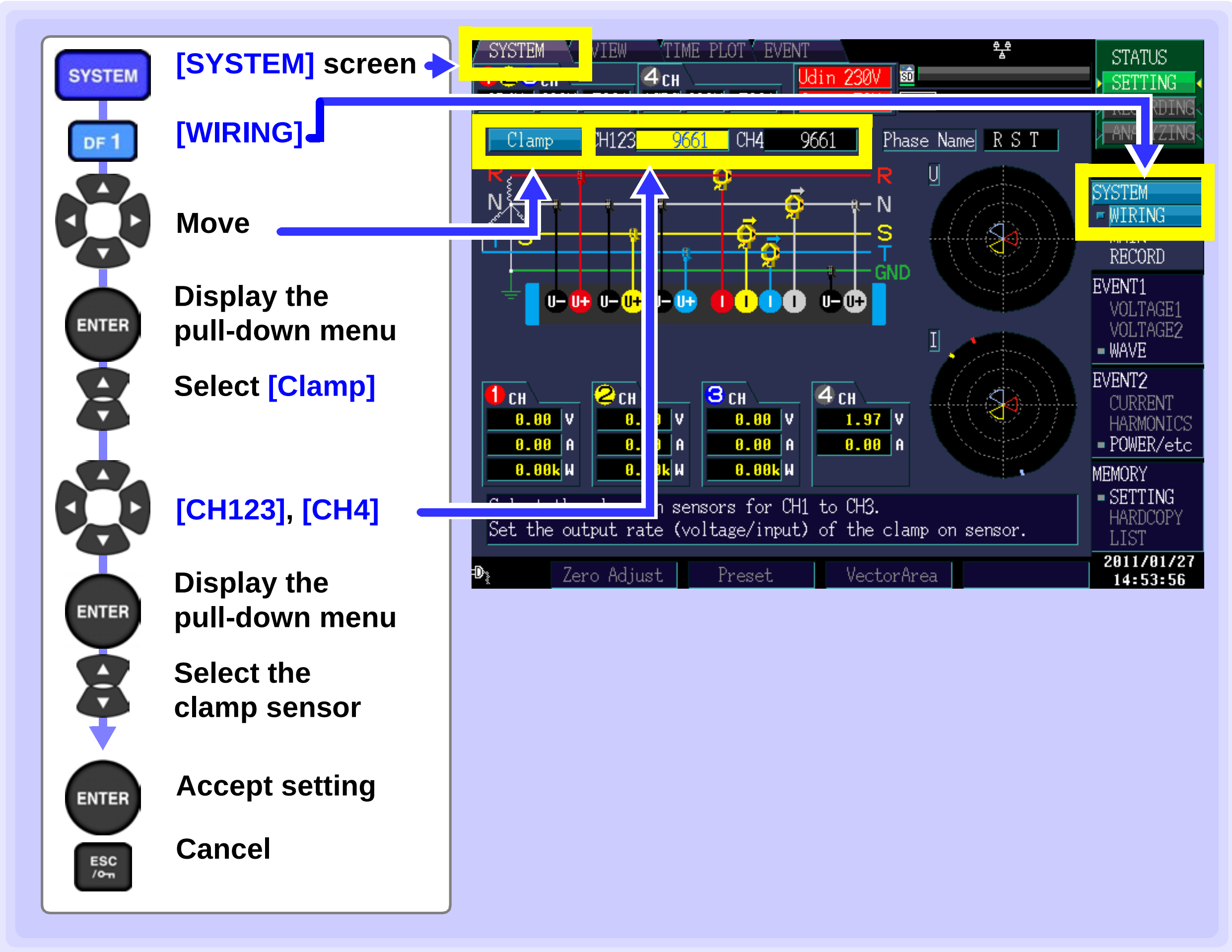
Measuring multiple systems



Measuring a system and a DC power supply



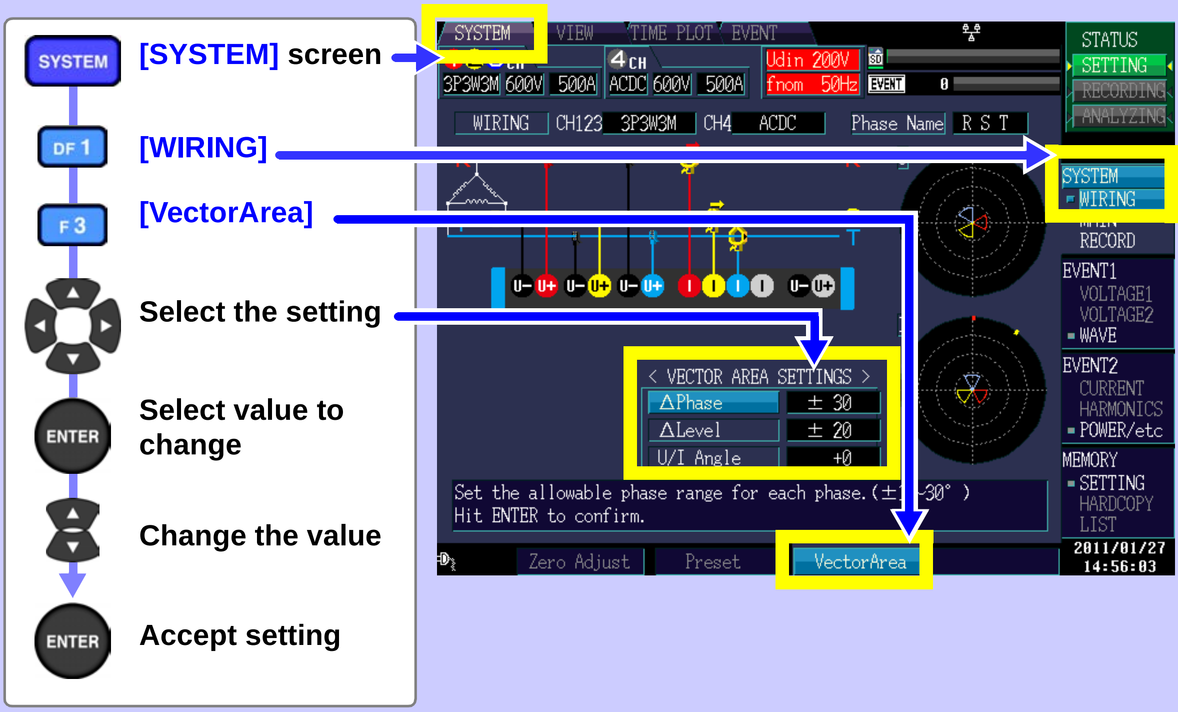
Configuring the clamp sensors



4.4 Setting the Vector Area (Tolerance Level)

This section describes how to determine rough guidelines for verifying that the connection, range, and nominal input voltage (Udin)* are correct. Changing settings causes corresponding changes in the area and position of the fan-shaped areas on the vector diagram. The instrument can normally by used with the default settings, but those settings can be changed if you wish to change the vector display area (tolerance level).

Key sequence for configuring settings



ΔPhase

Sets the tolerance level for the phase value of each phase.

Setting Contents:(∗ : Default setting)

±1 to ±30* (°)

ΔLevel

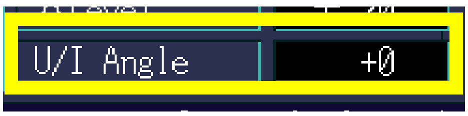
Sets the tolerance level for the RMS value of each phase. The setting takes the form of (±1% to ±30%) of the nominal voltage for voltage and CH1 for current.

Setting Contents:(∗ : Default setting)

±1 to ±30 (%) (±20*)

U/I Angle

Sets the tolerance level for the current phase difference relative to the voltage.



Setting Contents:(∗ : Default setting)

-60 to +60 (°) (0*)

*: The nominal input voltage (Udin), which is calculated from the nominal supply voltage using the transformer ratio, indicates the voltage that is actually input to the instrument.

4.5 Connecting to the Lines to be Measured (Preparing for Current Measurement)

Be sure to read the "Usage Notes" (p.6) before attaching to the lines.

Connect the voltage cords and clamp sensors to the measurement line as shown in the connection diagram on the screen. (To ensure accurate measurement, consult the connection diagram* while making the connections.)

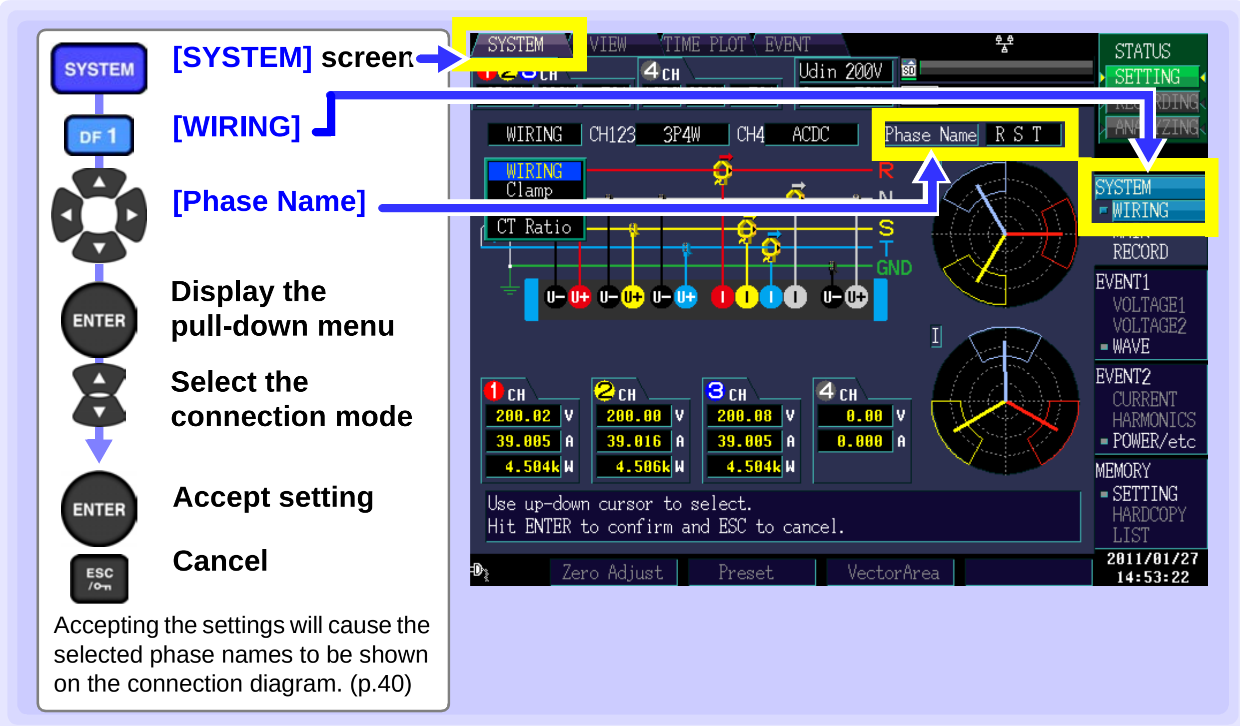
*: The diagram appears when the wiring mode is selected. (p.39)

DANGER **To avoid electric shock and short-circuit accidents, do not attach any unnecessary cables.**

WARNING **To avoid risk of electric shock, turn off the supply of electricity to the measurement circuit before making connections.**

NOTE The phases are named R, S, and T on the wiring diagram display. Substitute with equivalent names such as L1,L2, and L3 or U,V, and W, as appropriate.

Changing the phase names

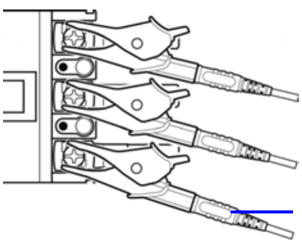


Accepting the settings will cause the selected phase names to be shown on the connection diagram. (p.40)

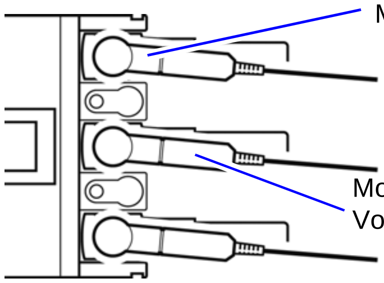
Attach voltage cords to measurement lines

Example: Secondary side of breaker

Securely clip the leads to <u>metal parts</u> such as terminal screw terminals or bus bars.

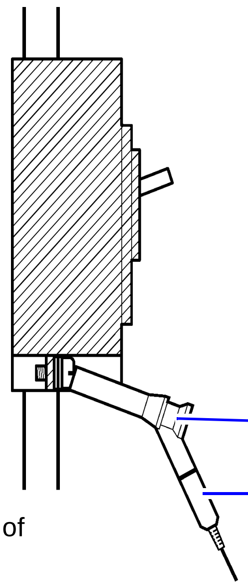


Example: When using Model 9804-01 or 9804-02 Magnetic Adapter (standard screw: M6 pan head screw)



Attach the Model 9804-01 or 9804-02 Magnetic Adapter (option) to the Model L1000 Voltage Cord.

Connect the magnetic part of the 9804-01 or 9804-02 tip to the screws on the secondary side of the breaker.



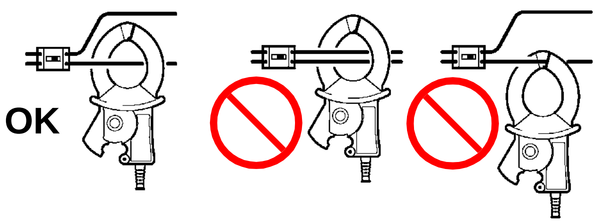
The weight of the voltage cords may prevent you from making a perpendicular connection to the Model 9804-01 or 9804-02 Magnetic Adapter. In this case, connect each cords so that it is hanging off the adapter in a manner that balances its weight.

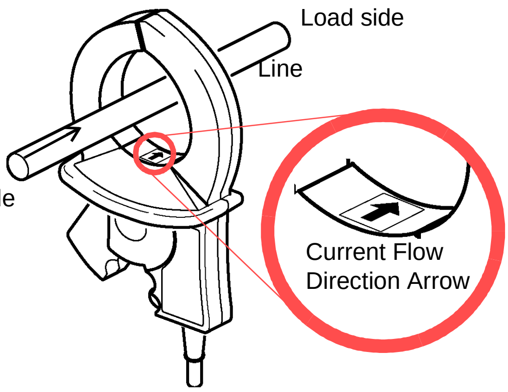
Check the voltage values to verify that the connections have been made securely.

Connecting clamp sensors to lines to be measured

(Example: 9661)

Be sure to attach each clamp around only one conductor.
Correct measurement cannot be obtained if a clamp is attached around more than one conductor.





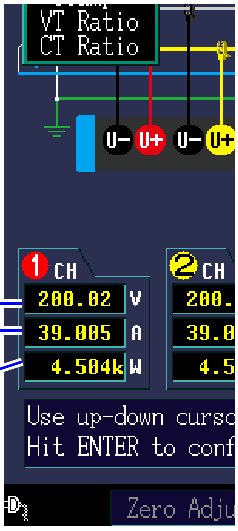
Make certain that the current flow direction arrow points toward the load.

4.6 Verifying Correct Wiring (Connection Check)

Correct attachment to the lines is necessary for accurate measurements.
Check the measured values and vectors on the [SYSTEM]-[WIRING] screen to verify that the connections have been made properly. Refer to the measured values and vector displays to verify that the measurement cables are correctly attached.

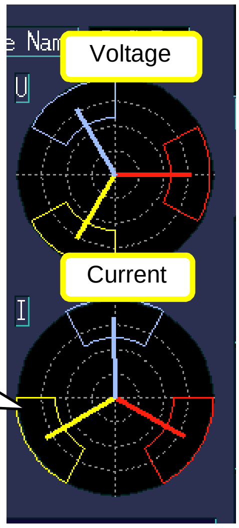
For 1P2W systems

Verify that an appropriate measurement value is displayed.



For systems other than 1P2W

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



In this case	Check
A measured value is too high or too low compared to the set **[Udin]**.	• Are the cables securely plugged into the voltage measurement jacks on the instrument? (p.34) • Are the voltage measurement cable clips properly attached to the lines? (p.46) • Has the appropriate Urms type (phase voltage/line voltage) been selected? (p.56)
If the measured current value is not correct	• Are the clamp sensors securely plugged into the current measurement jacks on the instrument? (p.34) • Are the clamp sensors properly attached to the lines? (p.47) • Are the clamp sensors appropriate for the line current to be measured? • Have the sensor's range settings been configured appropriately?
If the measured active power value is negative	• Are the clamp sensors properly attached to the lines? (p.46) • Is the arrow marker on the clamp sensors pointing toward the load? (p.47)
If vectors are too short, or unequal	**Voltage vectors:** • Are the cables securely plugged into voltage measurement jacks on the instrument? (p.34) • Are the voltage measurement cable clips properly attached to the lines? (p.46) **Current vectors:** • Are the clamp sensors securely plugged into the current measurement jacks on the instrument? (p.34) • Are the clamp sensors properly attached to the lines? (p.47) • Are the clamp sensors appropriate for the line current to be measured? • Is the sensor range set correctly?

In this case	Check
If vector direction (phase) or color is incorrect	**Voltage vectors:** • Check that the voltage measurement clips are attached to the lines according to the wiring diagram. **Current vectors:** • Check that the clamp sensors are attached to the lines according to the wiring diagram.

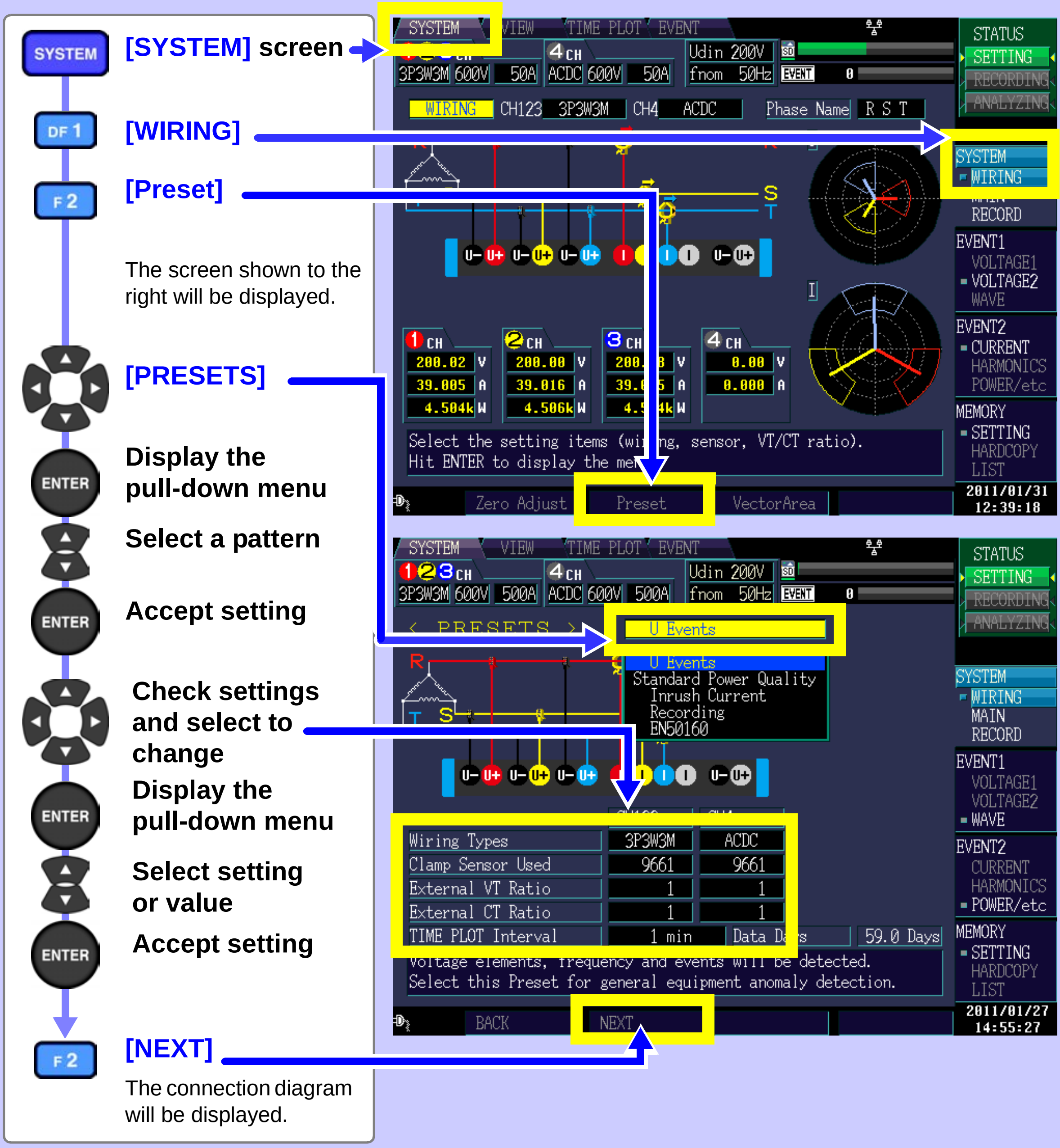
NOTE When measuring 3P3W2M systems, the active power (P) measured on each channel may be negative.

4.7 Quick setup

What settings are affected by quick setup?
For accurate measurements, settings such as range must be properly configured.
When you use quick setup, the following settings are automatically configured using HIOKI-recommended values according to the selected connection settings: current range, nominal input voltage, measurement frequency, event thresholds, etc. (p.195)

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

Key operation during configuration

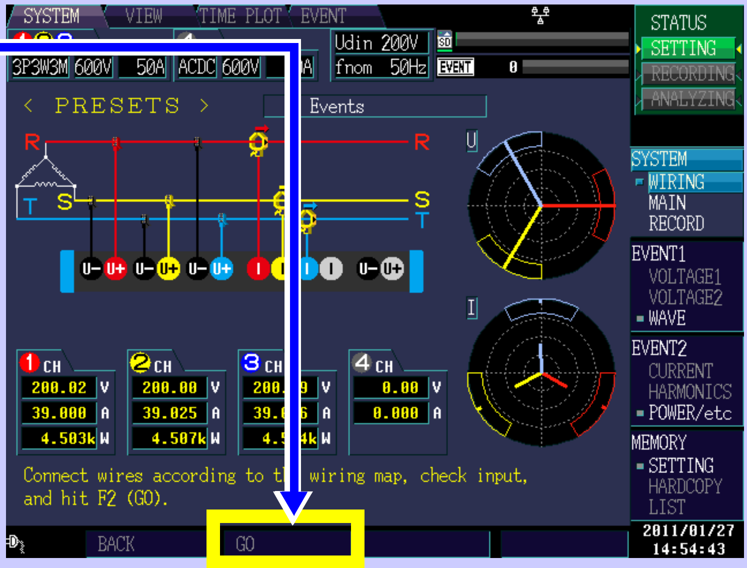


NOTE Check settings and change as necessary before you start recording. Execute quick setup when using the instrument the first time, and when changing to a different line configuration.

Key operation during configuration (continued)

F2 **[GO]**

The settings selected in the quick setup process will be accepted.



Presets

Five measurement patterns are provided. Select the pattern that best suits your application. Quick setup automatically sets appropriate values for the connections and clamp types used in measurement, settings other than VT/CT ratios, TIMEPLOT interval times, and thresholds used for event detection. Each of these settings can be changed later as desired.

Setting Contents:(∗ : Default setting)

U Events∗	Monitors voltage factors (dips, swells, interruptions, etc.) and frequency to detect events. It is recommended to select this pattern when you are troubleshooting power supply problems such as hardware malfunctions.
Standard Power Quality	Monitors voltage factors (dips, swells, interruptions, etc.), frequency, current, voltage and current harmonics, and other characteristics to detect events. This pattern is primarily used to monitor systems, so it is recommended to select this pattern when you wish to evaluate power supply quality (power quality). The TIMEPLOT interval will be set to 10 minutes.
Inrush Current	Measures inrush current. The TIMEPLOT interval will be set to 1 minute, and the inrush current threshold will be set to 200% of the RMS current (reference value) set during quick setup.
Recording	Records measured values over an extended period of time using a TIMEPLOT interval of 10 minutes. All event detection functionality other than manual events is turned off.
EN50160	Performs EN50160-compliant measurement. Standard-compliant evaluation and analysis can be performed by analyzing data using Model 9624-50 PQA-HiView Pro software. The EN50160 analysis function is only available using Model 9624-50 PQA-HiView Pro software when the interval time is set to 10 minutes.

Wiring Types

Set before performing quick setup.

Setting Contents:

CH1,2,3: 1P2W/1P3W/3P3W2M/3P3W3M/3P4W/3P4W2.5E
CH4: ACDC/DC/OFF

Clamp Sensor Used

Set before performing quick setup.

Setting Contents:

Sensor used	: Current range
0.1mV/A(5 kA)	: 5000A/500A
1mV/A(500 A)	: 500A/50A
10mV/A(50 A)	: 50A/5A
100mV/A(5 A)	: 5A/500mA
9657-10	: 5A/500mA
9660	: 100A/50A
9661	: 500A/50A
9667(500 A)	: 500A/50A
CT9667(500 A)	: 500A/50A
CT9667(5 kA)	: 5000A/500A
9667(5 kA)	: 5000A/500A
9669	: 1000A/100A
9675	: 5A/500mA
9694	: 50A/5A
9695-02	: 50A/5A
9695-03	: 100A/50A
CT9691(10 A)	: 10A/5A
CT9691(100 A)	: 100A/50A
CT9692(20 A)	: 50A/5A
CT9692(200 A)	: 500A/50A
CT9693(200 A)	: 500A/50A
CT9693(2 kA)	: 5000A/500A

NOTE

- To use CT9667-01, -02, or -03, set the **Clamp Sensor Used** to **9667**.
- To use any one of Models CT7731, CT7736, and CT7742 in combination with Model CM7290, set the **Clamp Sensor Used** to **0.1 mV/A (5 kA)**, **1 mV/A (500 A)**, or **10 mV/A (50 A)** in accordance with the output rate of the sensor (Model CM7290).
- To use a combination of Model CT7731 and Model CM7290 with the 100 A range selected, set the **Clamp Sensor Used** to **9660**.

External VT Ratio, External CT Ratio

Set when attaching an external VT or CT. Set to 1 if not attaching an external VT or CT.

Setting Contents:

0.01 to 9999.99

TIME PLOT Interval

Sets the TIMEPLOT interval.

Setting Contents:(* : Default setting)

1/ 3/ 15/ 30 sec, 1*/ 5 /10/ 15/ 30 min, 1/2 hour, 150/180cycle

If the event icon (EVENT) is orange after performing quick setup (indicating that the event is being detected continuously), it is recommended to check and reconfigure the event's threshold.

See:"5.5 Changing Event Settings" (p.66)

NOTE

The 150 (50 Hz) and 180 (60 Hz) cycle settings provide the TIMEPLOT intervals required for IEC61000-4-30-compliant measurement. When using a measurement frequency of 400 Hz, selecting 150/180 cycle will result in a 1,200 cycle interval.

Quick setup pattern details (settings)

For more information about the quick setup patterns, see "Quick setup pattern details" (p.195).

4.8 Verifying Settings and Starting Recording

Once you have determined that the settings are appropriate, start recording by pressing the **START/STOP** key. Verify that the event icon (EVENT) is not orange (indicating that the event is occurring frequently) and that measured values and waveforms on the **[VIEW]** screen are normal.

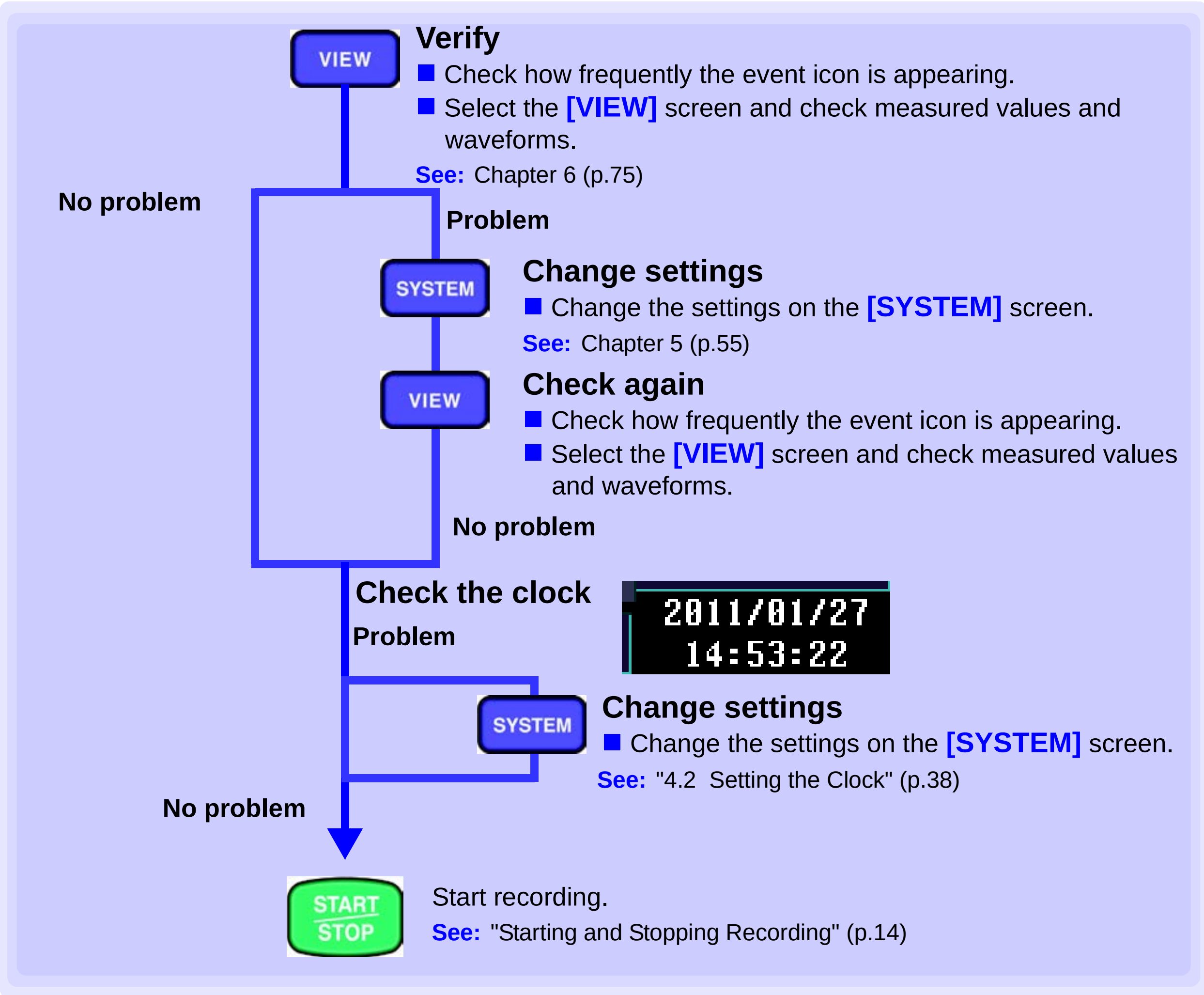
■ If the event icon is appearing frequently

Verify which event is occurring with the event list on the **[EVENT]** screen and change the problematic event threshold on the **[SYSTEM]** screen.

■ If measured values or waveforms are abnormal

Change the measurement condition settings on the **[SYSTEM]** screen and verify measured values again.

Repeat these steps until there are no other problems.



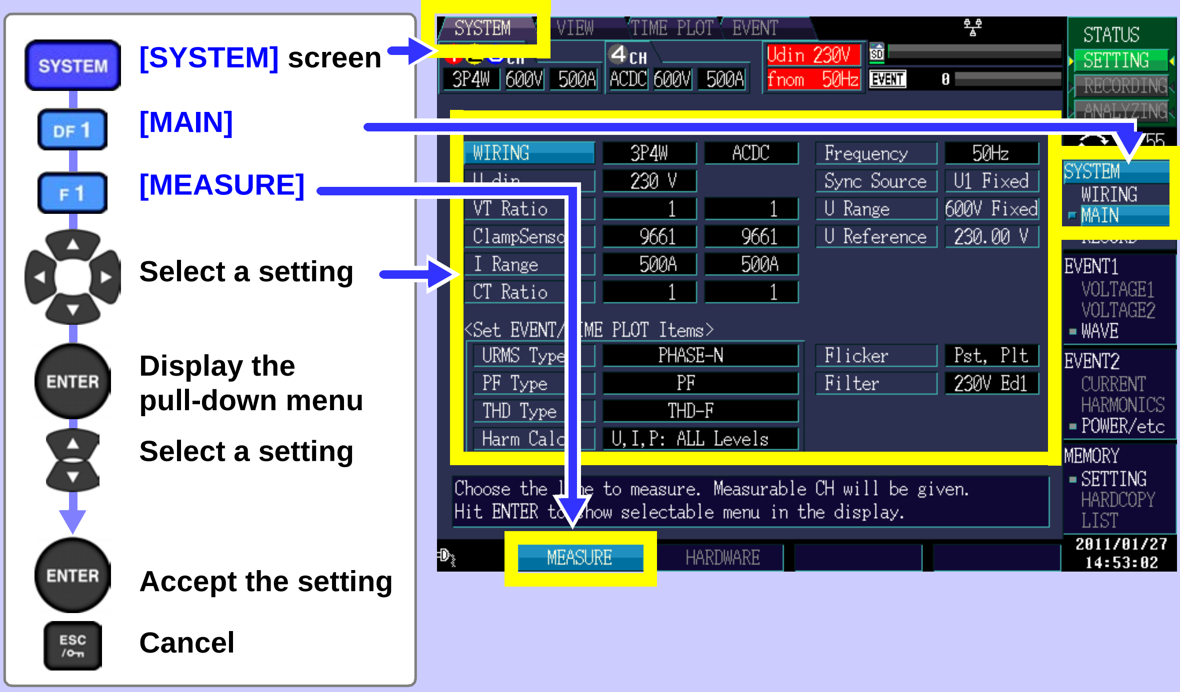
4.9 Using the Instrument during a Power Outage

If the supply of power to the instrument is interrupted (for example, during a power outage), it will operate using battery power (a fully charged battery provides enough power to operate for about 180 minutes). However, the instrument will turn off about 180 minutes after the outage occurs. Once the power is back on, the instrument will turn back on and resume recording. Integral values and other data will be reset, and the integration process will resume.

Changing Settings (as necessary) Chapter 5

5.1 Changing Measurement Conditions

Key operation during configuration



WIRING

Selects the measurement line.

Setting Contents:(∗ : Default setting)

CH1,2,3: 1P2W/1P3W/3P3W2M/3P3W3M/3P4W∗/3P4W2.5E
CH4: ACDC∗/DC/OFF

Udin

Selects the nominal input voltage (Udin) for the measurement line.

Setting Contents:(∗ : Default setting)

100/101/110/120/127/200/202/208/220/230∗/240/277/347/380/400/415/480/600/VARIABLE (set from 50 to 780 V in 1 V increments)

VT Ratio
Sets the external VT (PT) being used.

Setting Contents:(∗ : Default setting)

**1∗/60/100/200/300/600/700/1000/2000/2500/5000/
VARIABLE (0.01 to 9999.99)**

ClampSensor, I Range
Selects the type of clamp sensor being used and current range. You can also set an output rate and use a sensor that has not been registered.

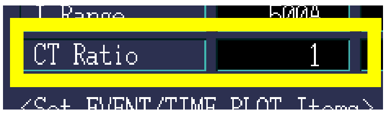
Setting Contents:(∗ : Default setting)

0.1mV/A(5 kA)	**: 5000 A/500 A**
1mV/A(500 A)	**: 500 A/50 A**
10mV/A(50 A)	**: 50 A/5 A**
100mV/A(5 A)	**: 5 A/500 mA**
9657-10	**: 5 A/500 mA**
9660	**: 100 A/50 A**
9661∗	**: 500 A∗/50 A**
9667(500 A)	**: 500 A/50 A**
9667(5 kA)	**: 5000 A/500 A**
CT9667(500 A)	**: 500 A/50 A**
CT9667(5 kA)	**: 5000 A/500 A**
9669	**: 1000 A/100 A**
9675	**: 5 A/500 mA**
9694	**: 50 A/5 A**
9695-02	**: 50 A/5 A**
9695-03	**: 100 A/50 A**
CT9691(10 A)	**: 10 A/5 A**
CT9691(100 A)	**: 100 A/50 A**
CT9692(20 A)	**: 50 A/5 A**
CT9692(200 A)	**: 500 A/50 A**
CT9693(200 A)	**: 500 A/50 A**
CT9693(2 kA)	**: 5000 A/500 A**

NOTE

- To use CT9667-01, -02, or -03, set the **Clamp Sensor Used** to **9667**.
- To use any one of Models CT7731, CT7736, and CT7742 in combination with Model CM7290, set the **Clamp Sensor Used** to **0.1 mV/A (5 kA)**, **1 mV/A (500 A)**, or **10 mV/A (50 A)** in accordance with the output rate of the sensor (Model CM7290).
- To use a combination of Model CT7731 and Model CM7290 with the 100 A range selected, set the **Clamp Sensor Used** to **9660**.

CT Ratio
Set if using an external CT.



Setting Contents:(∗ : Default setting)

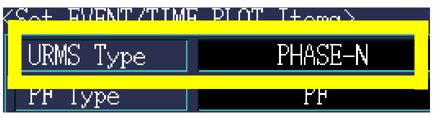
**1∗/40/60/80/120/160/200/240/300/400/600/800/1200/
VARIABLE (0.01 to 9999.99)**

Frequency
Selects the nominal frequency (fnom) for the measurement line.

Setting Contents:(∗ : Default setting)

50 Hz∗/60 Hz/400 Hz

URMS Type
Selects the voltage calculation method to use during 3-phase measurement.



Setting Contents:(∗ : Default setting)

PHASE-N∗/LINE-LINE

PF Type

Selects the power factor calculation method. You can select either PF (calculate using RMS values) or DPF (calculate using fundamental wave only). The displacement power factor (DPF) is generally used for power systems, while power factor (PF) is used when evaluating device efficiency.

Setting Contents:(∗ : Default setting)

PF∗/DPF

THD Type

Selects the total harmonic distortion (THD) calculation method. You can select either THD-F (distortion component/fundamental wave) or THD-R (distortion component/RMS value).

Setting Contents:(∗ : Default setting)

THD-F∗ / THD-R

Harm Calc

Selects the harmonic calculation method.

Setting Contents:(∗ : Default setting)

U,I,P: All Levels∗/U,I,P: All % of FND/U,P: %, I: Level

Flicker

Selects the flicker measurement type.

Setting Contents:(Default setting: ΔV10 when the language is set to Japanese; otherwise, Pst, Plt)

Pst,Plt /DV10

Filter

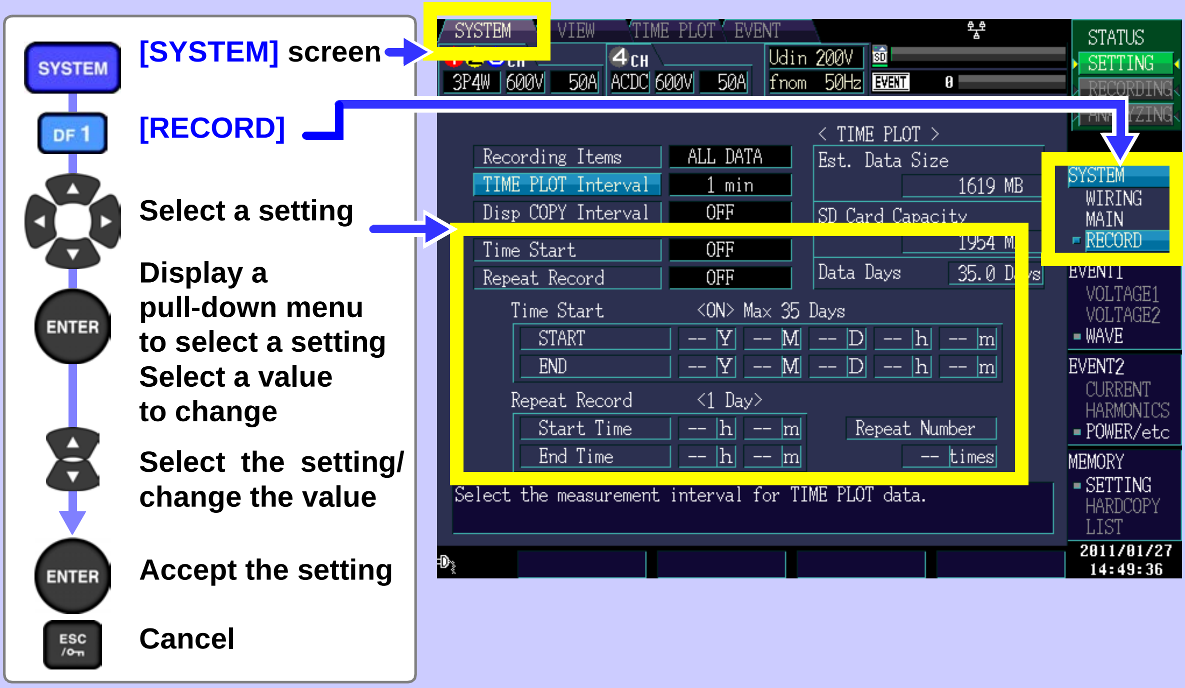
Sets the lamp system when Pst and Plt are selected for flicker measurement.

Setting Contents:(∗ : Default setting)

230V Ed1∗/120V Ed1/230V Ed2/120V Ed2

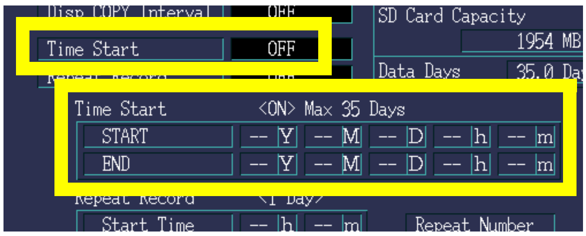
5.2 Changing the Measurement Period

Key operation during configuration



Time Start

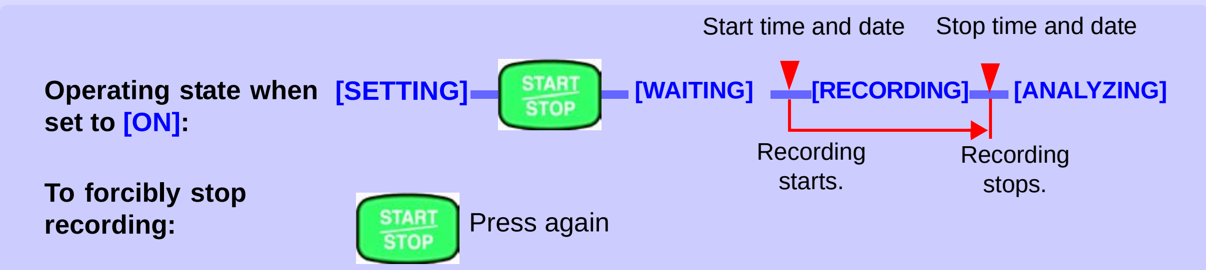
Set to **[ON]** if you wish to set the recording start and stop times. Set the desired start time and date and stop time and date.



Setting Contents:(∗ : Default setting)

OFF∗	Starts and stops recording when the **START/ STOP** key is pressed.
ON	Starts and stops recording at the set times and dates.

NOTE If a date in the past is set as the start time and date set when the **START/STOP** key is pressed, an error message will be displayed.



Repeat Record

Repeated recording operations can be conducted up to 55 days at one-day measuring intervals, and up to 55 weeks at one-week measuring intervals.
The measured data file of repeated recording is saved as a separate binary file for each one-day or one-week period on the SD memory card.

Setting Contents:(∗ : Default setting)

OFF∗	No repeated recording
1 Day	Repeated recording at one-day intervals
1 Week	Repeated recording at one-week intervals

If **[Repeat Record]** is set to **[1 Day]**, set the **[Start Time]**, **[End Time]**, and **[Repeat Number]**.

If **[Repeat Record]** is set to **[1 Week]**, set the **[Repeat Number]**.

Repeat Number

Can be set to a value from 1 to 55.

During repeated recording, the current iteration and total number of set iterations is displayed, and the green arrow flashes.

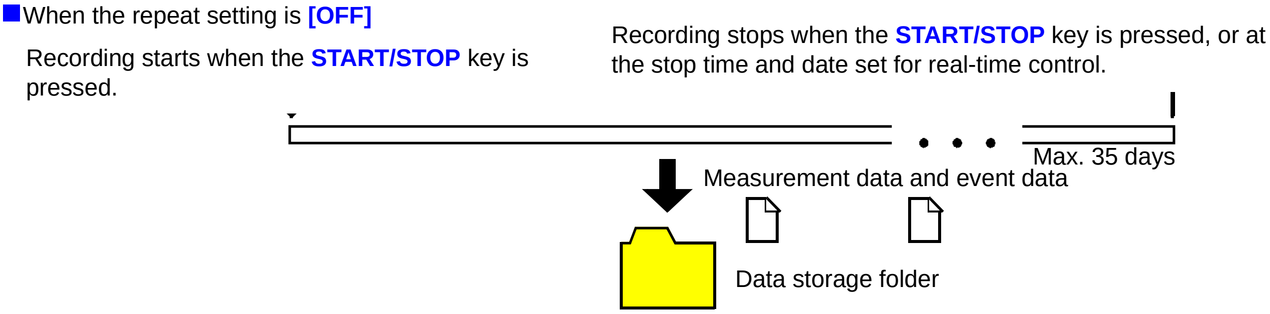
NOTE When repeated recording is set to **[1 Week]**, the stop time is set automatically.

Relationship between real-time control and repeated recording (count) settings

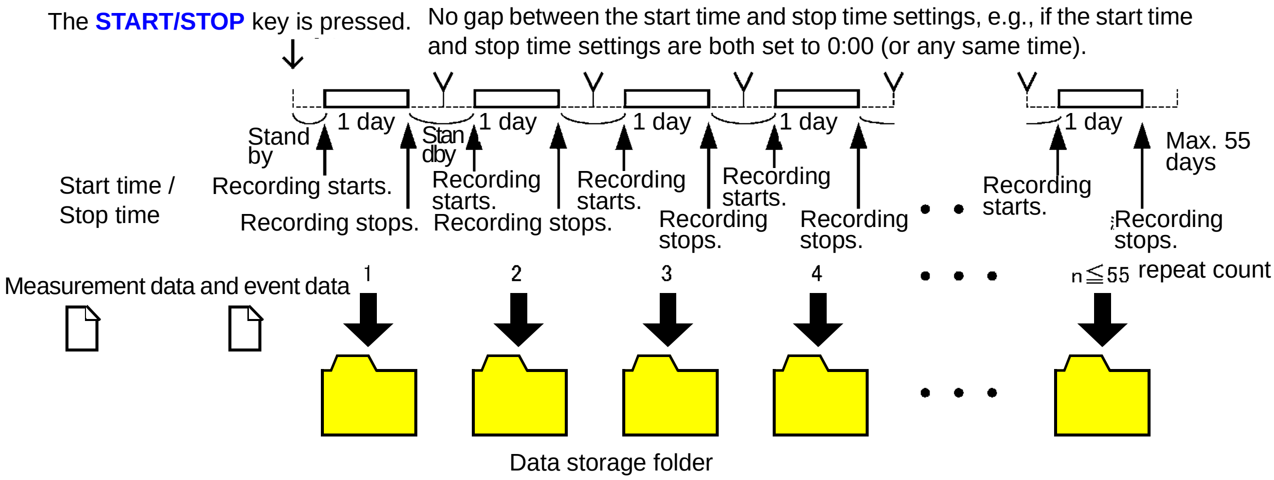
	Real-time control	Repeated measurement	Real-time control time and date setting	Repeated measurement time setting	Repeat number
Setting	ON	OFF	Start time and date and stop time and date	-	-
	ON	1 Week	Start time and date	-	Any value from 1 to 55
	ON	1 Day	Start date and stop date	Start time and stop time	-
	OFF	OFF	-	-	-
	OFF	1 Week	-	-	Any value from 1 to 55
	OFF	1 Day	-	Start time and stop time	Any value from 1 to 55

Relationship between the repeat setting and the maximum repeat count

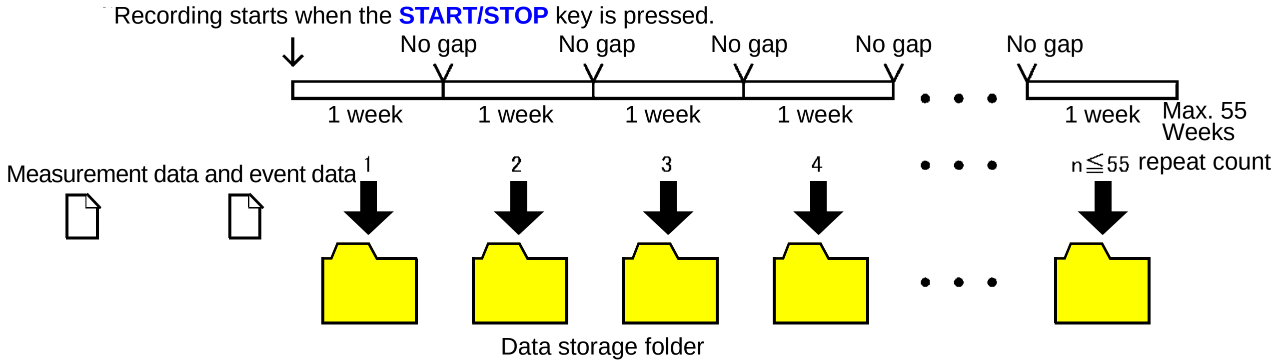
■When the repeat setting is **[OFF]**



■When the repeat setting is **[1 Day]**



■When the repeat setting is **[1 Week]**

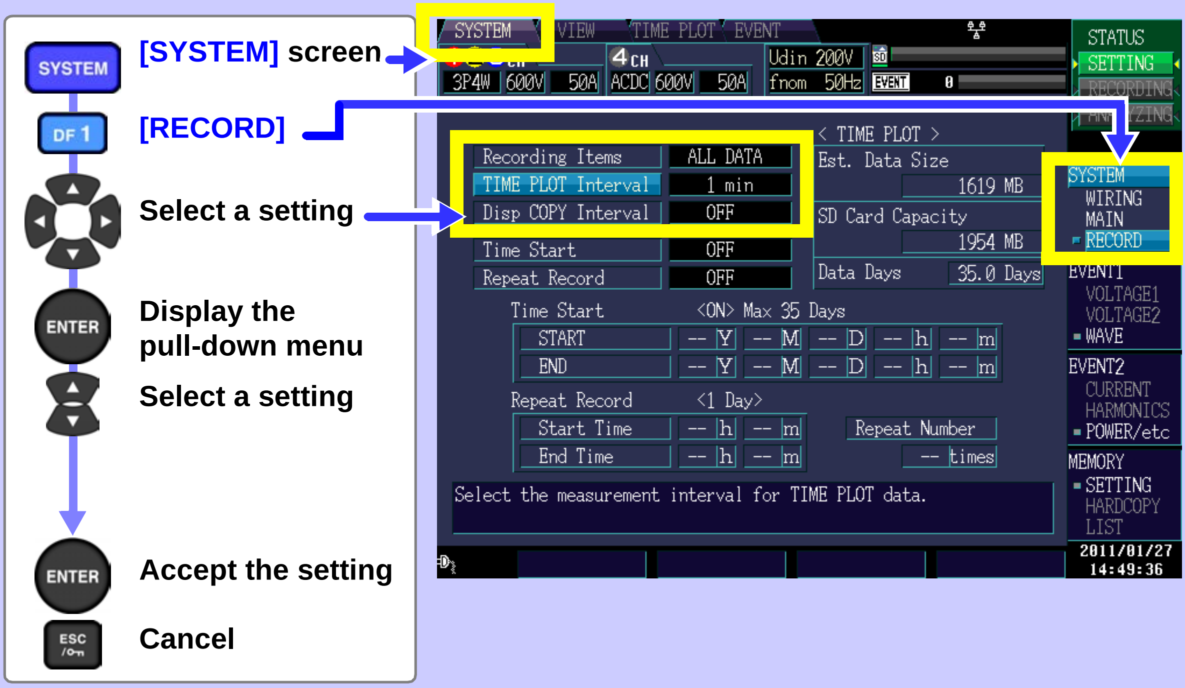


NOTE

- For more information about the data storage folder hierarchy, see "File structure (overall)" (p.140)
- In the event of a power outage (interruption of power to the instrument), the folder will be segmented.
- Once the data storage files exceed about 100 MB, data will be segmented, regardless of the repeat count.

5.3 Changing the Recording Settings

Key operation during configuration



Est. Data Size Displays an estimate of the amount of data that will be saved. The estimated data volume is calculated based on the recording item, TIMEPLOT interval, real-time control, and repeated recording settings. The estimated data volume does not include screen copy data or event data.

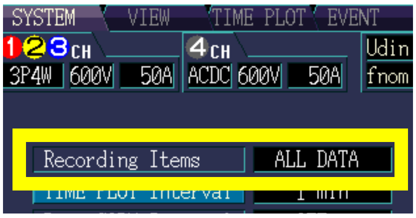
SD Card Capacity Displays the amount of space remaining on the SD memory card. If the SD memory card experiences an error, "SD Error" will be shown.

Data Days Displays an estimate of how many days of data can be saved based on the estimated data volume and the SD card remaining capacity. The actual number of days of data that can be saved may be less than the indicated amount depending on the number of screen copies made and events generated.

Recording Items

Sets the type of measurement data.

See:"Key operation during configuration" (p.61)



Setting Contents:(∗ : Default setting)

ALL DATA∗	Records all the calculation values.
P&Harm	Records all calculation values except inter-harmonics.
Power	Records all calculation values except harmonics and inter-harmonics.

Note: If 400 Hz is selected, ALL DATA can not be selected.

Recording items	Power	P&Harm	ALL DATA	Recording items	Power	P&Harm	ALL DATA
RMS voltage refreshed each half-cycle	●	●	●	Harmonic voltage	×	●	●
RMS current refreshed each half-cycle	●	●	●	Harmonic current	×	●	●
Frequency	●	●	●	Harmonic power	×	●	●
Frequency wave	●	●	●	Phase difference of harmonic voltage and harmonic current	×	●	●
10-sec frequency	●	●	●	High-order harmonic voltage phase angle	×	●	●
Voltage RMS	●	●	●	High-order harmonic current phase angle	×	●	●
Current RMS	●	●	●				
Voltage waveform peak	●	●	●	Inter-harmonic voltage	×	×	●
Current waveform peak	●	●	●	Inter-harmonic current	×	×	●
Active power	●	●	●	THD Voltage Percentage	●	●	●
Apparent Power	●	●	●	THD current percentage	●	●	●
Reactive Power	●	●	●				
Power factor/ displacement power factor	●	●	●	High-order harmonic voltage component	●	●	●
Voltage unbalance factor	●	●	●	High-order harmonic current component	●	●	●
Current unbalance factor	●	●	●	K factor	●	●	●
Instantaneous flicker value	●	●	●				
Integral power	●	●	●	Flicker (DV10/Pst,Plt)	●	●	●

NOTE Detailed trend graphs are always displayed with maximum and minimum values.

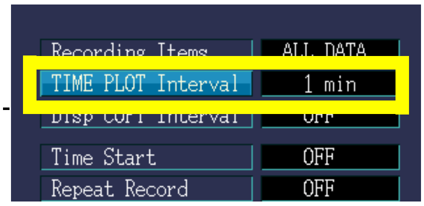
TIME PLOT Interval

Sets the TIMEPLOT interval (recording interval).

See:"Key operation during configuration" (p.61)

Setting Contents:(∗ : Default setting)

1/ 3/ 15/ 30 sec, 1∗/ 5 /10/ 15/ 30 min, 1/2 hour, 150/180/1200cycle



The time series graph recording time varies with the recorded parameters and TIMEPLOT interval setting.

See:"Recording Items" (p.62)

NOTE

The 150 cycle (50 Hz) and 180 cycle (60 Hz) settings provide the TIMEPLOT intervals required for IEC 61000-4-30-compliant measurement. You can select 150 cycles (measurement frequency of 50 Hz), 180 cycles (60 Hz), or 1,200 cycles (400 Hz).

When the memory is full

The PW3198 stops recording data to the SD memory card.

Recording times (reference value) for a Z4001 SD Memory Card 2GB (Repeat Record: 1Week, Repeat Number: 55 times)

TIME PLOT interval	Recording parameter setting		
	ALL DATA (Saves all data)	P&Harm (Saves RMS values and harmonics)	Power (Saves RMS values only)
1sec	16.9 hours	23.6 hours	11.5 days
3sec	2.1days	3.0 days	34.6 days
15sec	10.6 days	14.8 days	24 weeks
30sec	21.1days	29.5 days	49 weeks
1min	42.2 days	8.4 weeks	55 weeks
5min	30.1 weeks	42.1 weeks	55 weeks
10min	55 weeks	55 weeks	55 weeks
15min	55 weeks	55 weeks	55 weeks
30min	55 weeks	55 weeks	55 weeks
1 hour	55 weeks	55 weeks	55 weeks
2 hours	55 weeks	55 weeks	55 weeks
150/180 /1200wave (Approx. 3 sec)	2.1 days	3.0 days	34.6 days

- Recording times do not account for event data and screen copy data. Recording times may be shortened when event data and screen copy data are stored on the card.
- Recording times are not dependent on connections.
- When repeated recording is set to **[OFF]**, the maximum recording time is 35 days.
- When repeated recording is set to **[1 Day]**, the maximum recording time is 55 days.
- When repeated recording is set to **[1 Week]**, the maximum recording time is 55 weeks.
- Harmonics order data is not saved for **[Power]**, but it is saved in THD.

Measuring for an extended period of time.

If repeated recording is enabled and the recording count set, the instrument can make measurements for up to 55 weeks.

See: Long-term measurements over 1 month or longer: Enable repeated recording (see "Repeat Record" (p.59)).

Disp COPY Interval

Outputs the display image to the SD memory card or printer at the set screen copy interval.

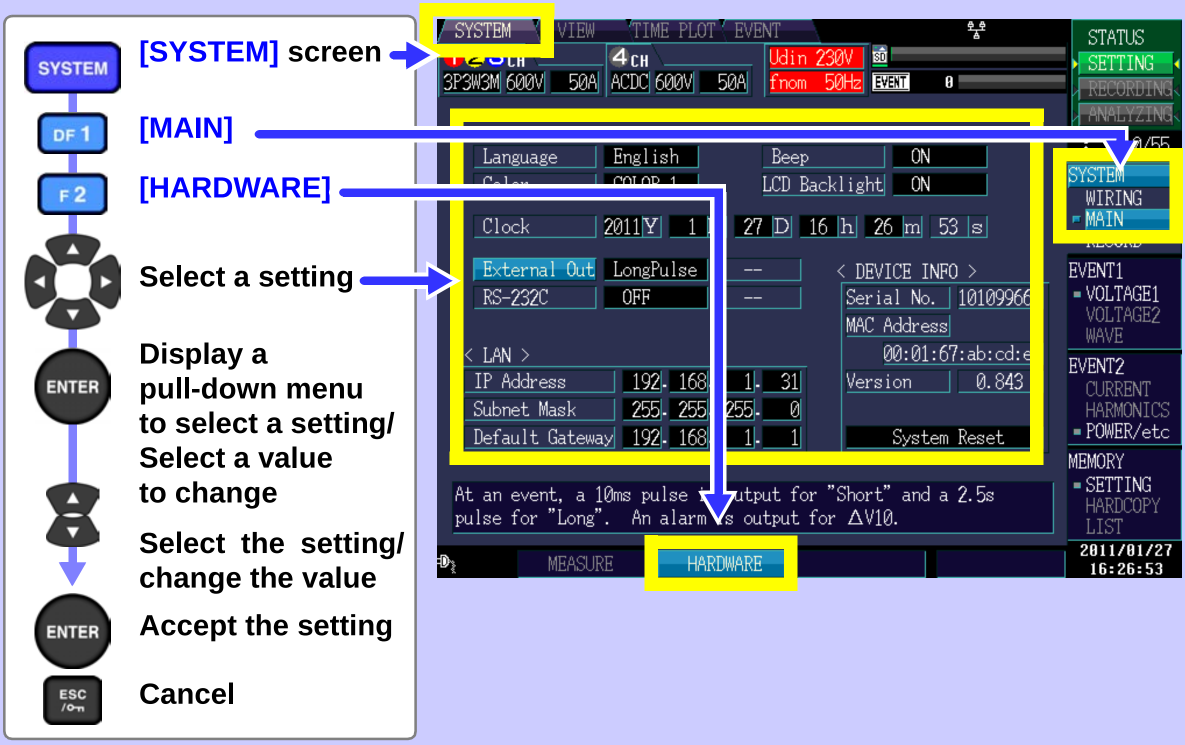
See:"Key operation during configuration" (p.61)

Setting Contents:(∗ : Default setting)

OFF∗/5min/10min/30min/1hour/2hour

5.4 Changing Hardware Settings

Key operation during configuration



Language

Sets the display language.

Setting Contents:

Japanese	Japanese
English	English
Chinese	Chinese (Simplified)

Color

Select the grid (graticule) type for the waveform screen.Sets the screen color.

Setting Contents:(∗ : Default setting)

COLOR1∗	Blue-gray
COLOR2	Blue
COLOR3	Black
COLOR4	Gray
COLOR5	White

Beep

Sets whether to beep when a key is pressed.

Setting Contents:(∗ : Default setting)

ON∗	Beeps are enabled.
OFF	Beeps are disabled.

LCD Backlight

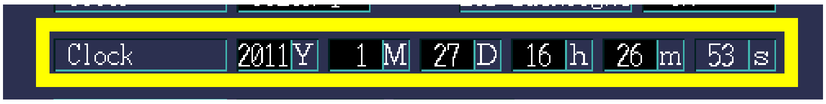
The LCD backlight can be set to turn off after a set period of time.
Pressing a key will cause the screen to be displayed again.

Setting Contents:(∗ : Default setting)

AUTO	Automatically turns the backlight off once 2 minutes have elapsed since the last key press.
ON∗	Leaves the screen backlight on at all times.

Clock

Sets the time and date, which are used to record and manage data.
Be sure to set the time and date before starting recording (seconds cannot be set).
Valid setting range: 00:00 on January 1, 2010, to 23:59 on December 31, 2079



External Out

Set when using the external control terminal to connect the PW3198 to an external device.

Setting Contents:(∗ : Default setting)

OFF	Disables external output.
ShortPulse∗	Sets output to low for at least 10 ms when an event is detected.
LongPulse	Sets output to low for 2.5 sec when an event is detected. This setting is used when connecting the PW3198 to the 2300 Remote Measurement System or other device. **See:**"Event output can be set for REMOTE MEASUREMENT SYSTEM 2300" (p.153)
DV10alarm	This setting can be selected only when the **[Flicker]** setting is **[DV10]**. Output will be set to low when the set ΔV10 threshold is exceeded. If selecting this setting, set the ΔV10 threshold. (0.00 V to 9.99 V)

RS-232C

Set when connecting the PW3198 to a printer or PW9005 GPS Box with an RS-232C cable.

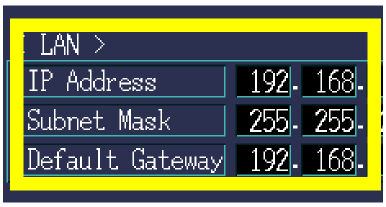
Setting Contents:(∗ : Default setting)

OFF∗	Disables the RS connection.
PRINTER	Outputs data to a printer. If selecting this setting, select the RS communication speed.
GPS	Outputs data to a Model PW9005 GPS Box. If selecting this setting, select the time zone. (-13:00 to +13:00) **See:**PW9005 Instruction manual

LAN

Set when connecting the PW3198 to a computer with a LAN cable.

See:"Configure the Instruments LAN Settings" (p.158)



Setting Contents:

IP Address	Sets the IP address. (3 characters.3 characters.3 characters.3 characters (***.***.***.***))
Subnet Mask	Sets the subnet mask. (3 characters.3 characters.3 characters.3 characters (***.***.***.***))
Default Gateway	Sets the default gateway. (3 characters.3 characters.3 characters.3 characters (***.***.***.***))

5.5 Changing Event Settings

What is an event?

See: "Appendix 2 Explanation of Power Supply Quality Parameters and Events"

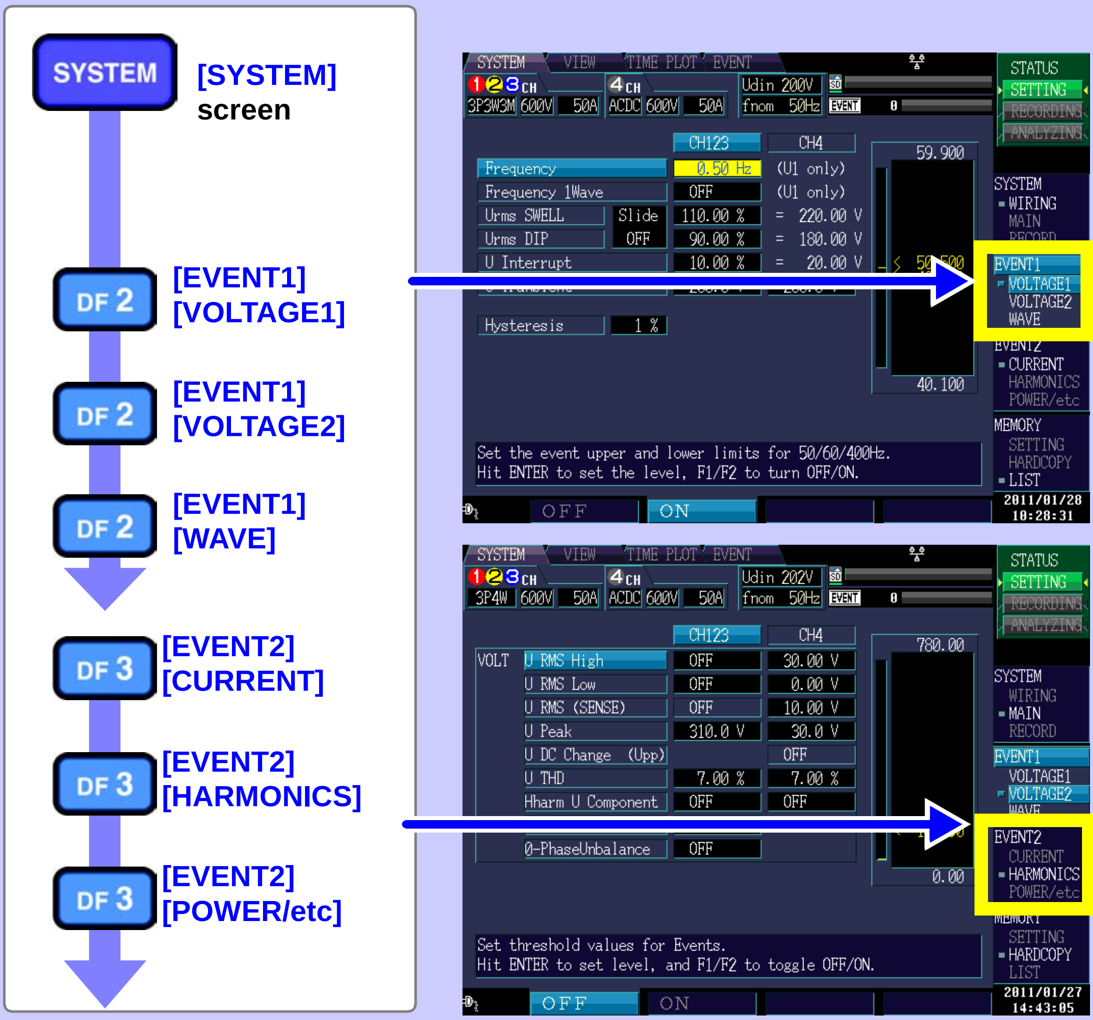
List of event settings

Event parameter	Order selection	Additional functionality	Channel selection	Threshold (Note 9)	Note
Transient overvoltage			(1,2,3) (4) (OFF)	0 to 6000 Vpk Specify as absolute value.	1,4
Swell		Slide	(1,2,3) (-) (OFF)	0 to 200%	1,5,10
Dip		Slide	(1,2,3) (-) (OFF)	0 to 100%	1,5,10
Interruption			(1,2,3) (-) (OFF)	0 to 100%	1,5,10
Inrush current			(1,2,3) (4) (OFF)	0 to (varies with range) A	1,4,5
Frequency			(U1) (-) (OFF)	0.1 to about 9.9 Hz	5
Frequency cycle			(U1) (-) (OFF)	0.1 to about 9.9 Hz	5
Voltage waveform peak			(1,2,3) (4) (OFF)	0 to 1200 Vpk	1,4,7
RMS voltage		Phase/line sense	(1,2,3) (4) (OFF)	0 to 780 V Specify upper and lower limits.	1,3,4,5
DC voltage change (CH4 only)			(-,-,-) (4) (OFF)	0 to 1200 V	1,5
Current waveform peak			(1,2,3) (4) (OFF)	0 to (varies with range) A×4	1,4,7
RMS current		Sense	(1,2,3) (4) (OFF)	0 to (varies with range) A	1,4,5
DC current change (CH4 only)			(-,-,-) (4) (OFF)	0 to (varies with range) A×4	1,5
Active power			(1,2,3)(sum) (OFF)	0 to varies with range Specify as absolute value.	1,4,5,8
Apparent power			(1,2,3)(sum) (OFF)	0 to varies with range	1,4,5,8
Reactive power			(1,2,3)(sum) (OFF)	0 to varies with range Specify as absolute value.	1,4,5,8
Power factor/displacement power factor		PF/DPF	(1,2,3)(sum) (OFF)	0 to 1	3,4,5
Negative-phase voltage unbalance factor			(-,-,-) (sum)(OFF)	0 to 100%	5
Zero-phase voltage unbalance factor			(-,-,-) (sum)(OFF)	0 to 100%	5
Negative-phase current unbalance factor			(-,-,-) (sum)(OFF)	0 to 100%	5
Zero-phase current unbalance factor			(-,-,-) (sum)(OFF)	0 to 100%	5
Harmonic voltage	Orders 0 to 50	Level (RMS)/ content percentage	(1,2,3) (4) (OFF)	0 to 780V/0 to 100% Specify 0-order as an absolute value.	1,2,3,4, 5,6
Harmonic current	Orders 0 to 50	Level (RMS)/ content percentage	(1,2,3) (4) (OFF)	1.3 × (0 to [varies with range]) A /0 to 100% Specify 0-order as an absolute value.	1,2,3,4, 5,6
Harmonic power	Orders 0 to 50	Level/content percentage	(1,2,3)(sum) (OFF)	1.3 × (0 to [varies with range]) W Specify as absolute value. /0 to 100%	1,2,3,4, 5,6,8

List of event settings

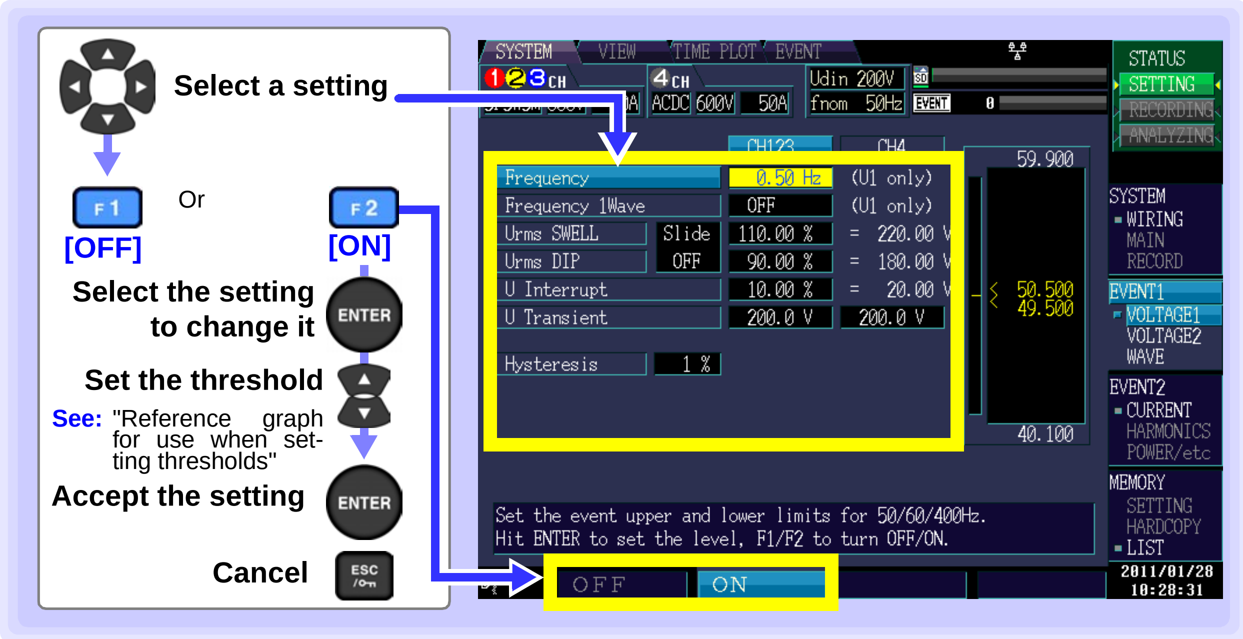
Event parameter	Order selection	Additional functionality	Channel selection	Threshold (Note 9)	Note
Harmonic voltage-current phase difference	Orders 1 to 50		(1,2,3)(sum) (OFF)	0 to 180× Specify as absolute value.	2,4,5,6
Total harmonic voltage distortion factor		-F/-R	(1,2,3) (4) (OFF)	0 to 100%	3,4,5
Total harmonic current distortion factor		-F/-R	(1,2,3) (4) (OFF)	0 to 500%	3,4,5
K factor			(1,2,3) (4) (OFF)	0 to 500	4,5
High-order harmonic voltage component RMS			(1,2,3) (4) (OFF)	0 to 600 V	1,4
High-order harmonic current component RMS			(1,2,3) (4) (OFF)	0 to (varies with ran A)	1,4
Voltage waveform comparison			(1,2,3) (-) (OFF)	0 to 100%	1
Time event			(-,-,-) (-) (OFF)	OFF,1,5,10,30 min,1,2 hour.	
Continuous event			(-,-,-) (-) (OFF)	OFF, 1, 2, 3, 4, 5 times	
External event			(External) (OFF)	None	
Manual event				None	
Start				None	
Stop				None	

Note 1: The threshold range is expanded by the VT ratio and CT ratio settings (for harmonics, level value only).
Note 2: Settings can be made for individual orders as specified in the “Order selection” column.
Note 3: Phase voltage/line voltage, level/content percentage/voltage content percentage or current power level, THD-F/THD-R, power factor/displacement power factor selections are made in the system settings.
Note 4: Thresholds can be set for separately for individual channels as grouped together (other than “OFF”) in the “Channel selection” column. (However, channels 1, 2, and 3 must share the same setting.)
Note 5: Hysteresis applies. However, the frequency is fixed at 0.1 Hz.
Note 6: During 400 Hz measurement, harmonic voltage, harmonic current, harmonic power, and harmonic voltage-current phase difference can be measured up to the 10th order.
Note 7: DC values from an approx. 200 ms aggregation are compared with the threshold only when CH4 is set to DC.
Note 8: The sum value threshold is 2 X for 1P3W, 3P3W2M, and 3P3W3M, and 3 X for all others.
Note 9: The setting precision for thresholds is ±1 dgt.
Note 10: Sets the threshold values as percentages of nominal voltage (Uref)*.



To turn voltage/current/power events on or off, or to adjust associated thresholds (p.69)
To turn harmonic events on or off, or to adjust associated thresholds (p.70)
To generate an event using an external input signal (p.71)
To generate an event manually (p.71)
To periodically generate an event (p.72)

Turning events on and off and adjusting thresholds (applies to voltage, current, and power)



Setting Contents:(∗ : Default setting)

OFF∗	Disables the event function for the selected setting.
ON	Sets the threshold at which to enable the event function for the selected setting.

NOTE

- Sets the voltage swell, voltage dip, and voltage interruption threshold values as percentages of nominal voltage (Uref)*. The converted voltage is displayed to the right of the percentage setting.
- Setting the voltage swell and voltage dip **[Slide]** settings to **[ON]** causes the threshold to be expressed as a percentage of the slide reference voltage.

*: The nominal voltage (Uref) is obtained by multiplying the nominal input voltage (Udin) by the VT ratio. When the VT ratio is 1, the nominal voltage (Uref) is equal to the nominal input voltage (Udin).

- If the threshold value falls outside the valid setting range, "-----" will be displayed. Pressing the **ENTER** key resets the value to the threshold upper limit.

Hysteresis
Set as a percentage of the event thresholds for voltage, current, power, and other measured values in order to prevent an excessively large number of events from occurring. It is generally recommended to set the hysteresis from 1% to 2%.

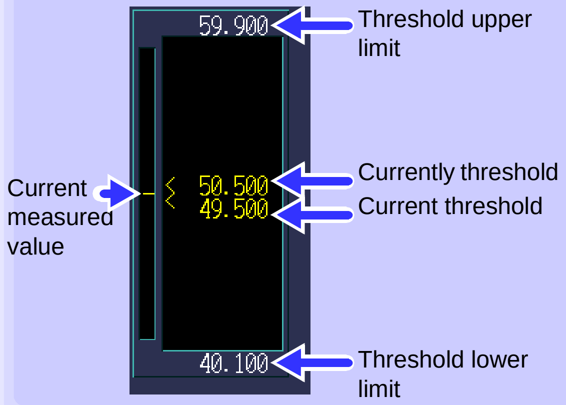
Slide (slide reference voltage)
When the voltage value fluctuates gradually, allows dip and swell to be judged using the fluctuating voltage values as a reference. (For more information. (For more information, see "Slide reference voltage" (p.A27))

SENSE (Sense)
When the RMS voltage or RMS current continues to fluctuate in excess of the threshold, generates an event when the value obtained by adding the set sense value and the measured value is exceeded. You can track events to identify the status when the RMS voltage or RMS current exceeds the threshold. (For more information, see "Sense" (p.A27))

Reference graph for use when setting thresholds

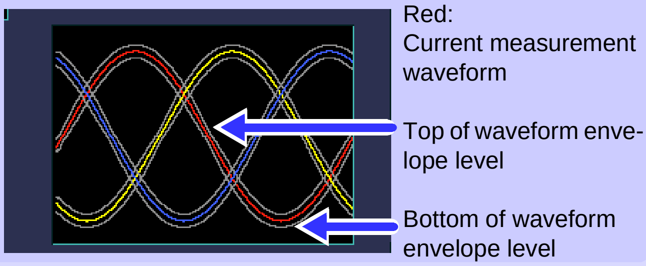
You can adjust thresholds while viewing the current measured value and measurement waveform state.

**For events other than voltage waveform comparison
(Example: Frequency)**



Voltage waveform comparison

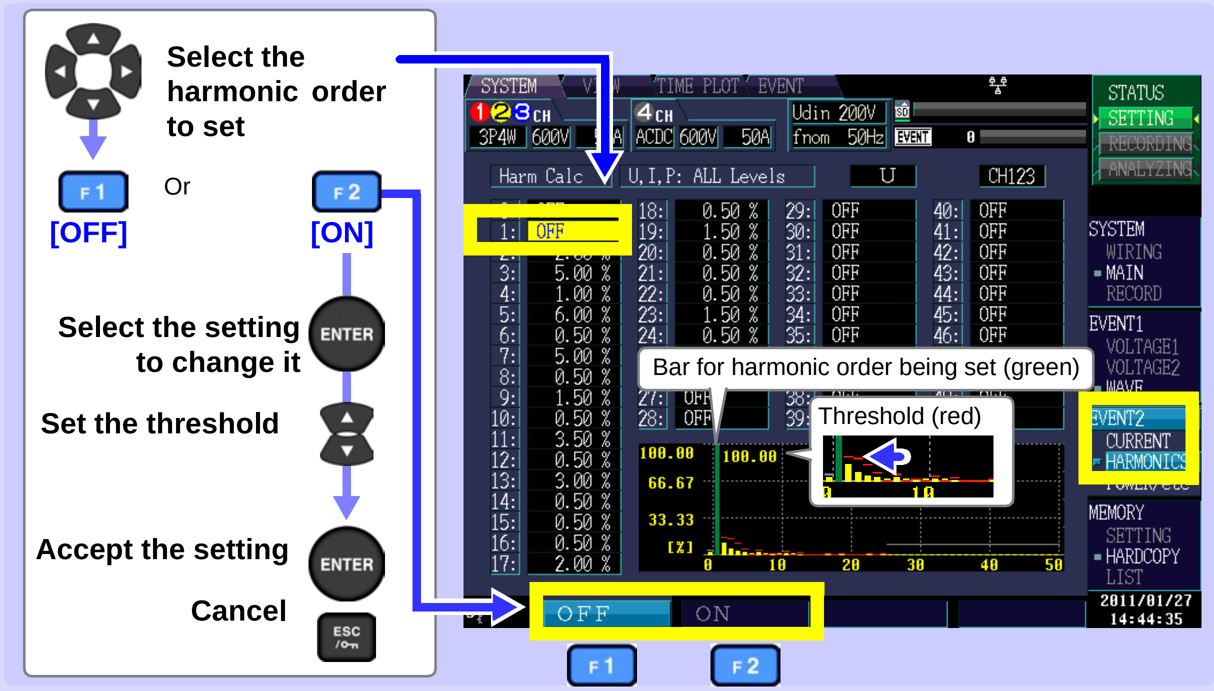
The **[U_Wave]** screen can be displayed with the **DF2** key.
A voltage waveform comparison event is generated when the measurement waveform exceeds the waveform envelope level. The waveform envelope level is set as a percentage of the nominal input voltage. When using a 3-phase connection, the waveform envelope level applies to the voltages of all 3 phases.



Set thresholds are stored internally regardless of the event's ON/OFF setting.
Even if a threshold is set, no events will be generated unless the event is set to ON.

Turning events ON and OFF and adjusting thresholds (harmonics)

Events can be configured by pressing the **DF3** key to display the **[HARMONICS]** screen. Settings can be turned ON or OFF for each harmonic order.



Setting Contents:(∗ : Default setting)

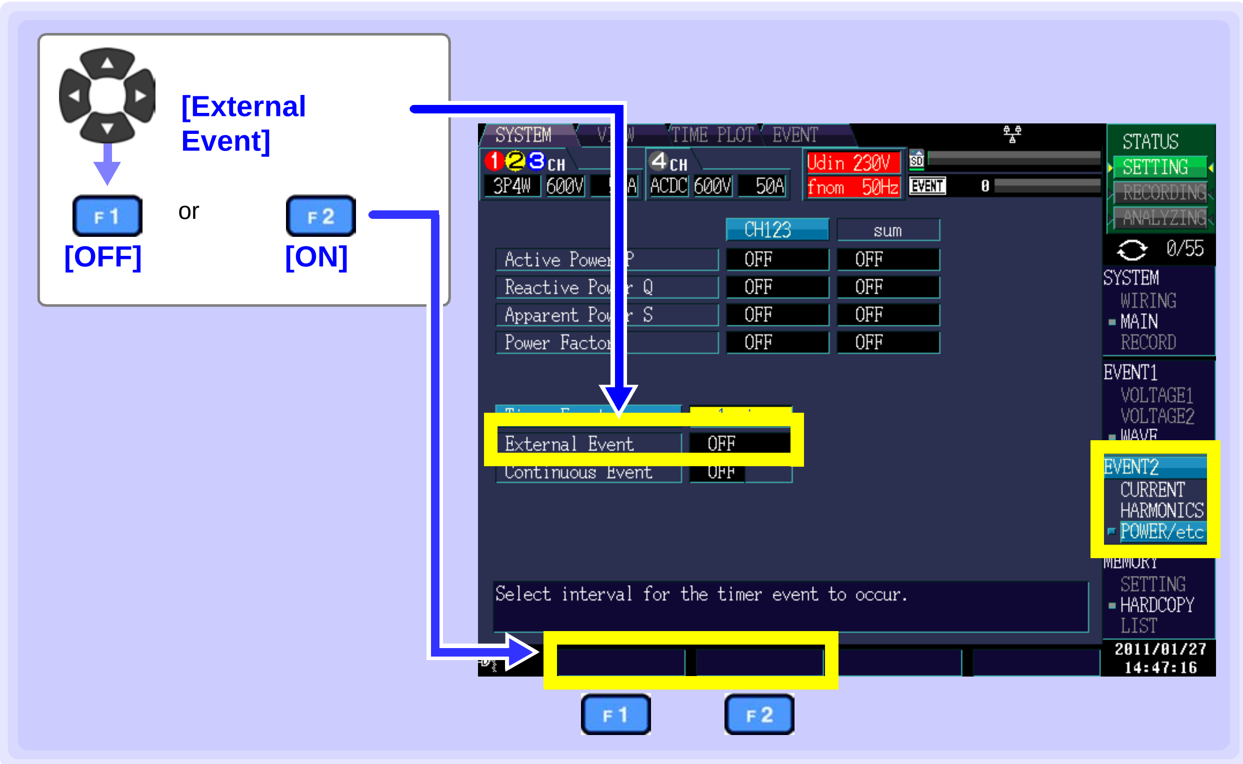
OFF∗	Disables the event function for the selected setting.
ON	Sets the threshold at which to enable the event function for the selected setting.

Set thresholds are stored internally regardless of the event's ON/OFF setting.
Even if a threshold is set, no events will be generated unless the event is set to ON.
When the measurement frequency (fnom) is 400 Hz, measurement is limited to the 10th order.

Generating events using an external input signal (external event settings)

Events can be configured by pressing the **DF3** key to display the **[POWER/etc]** screen. External events are detected using external control terminal (EVENT IN) shorts or pulse signal falling edge input. The voltage and current waveforms and measured values when the external event occurs can be recorded. This functionality is enabled by setting external events to ON.

See:"11.1 Using the External Control Terminal" (p.149)



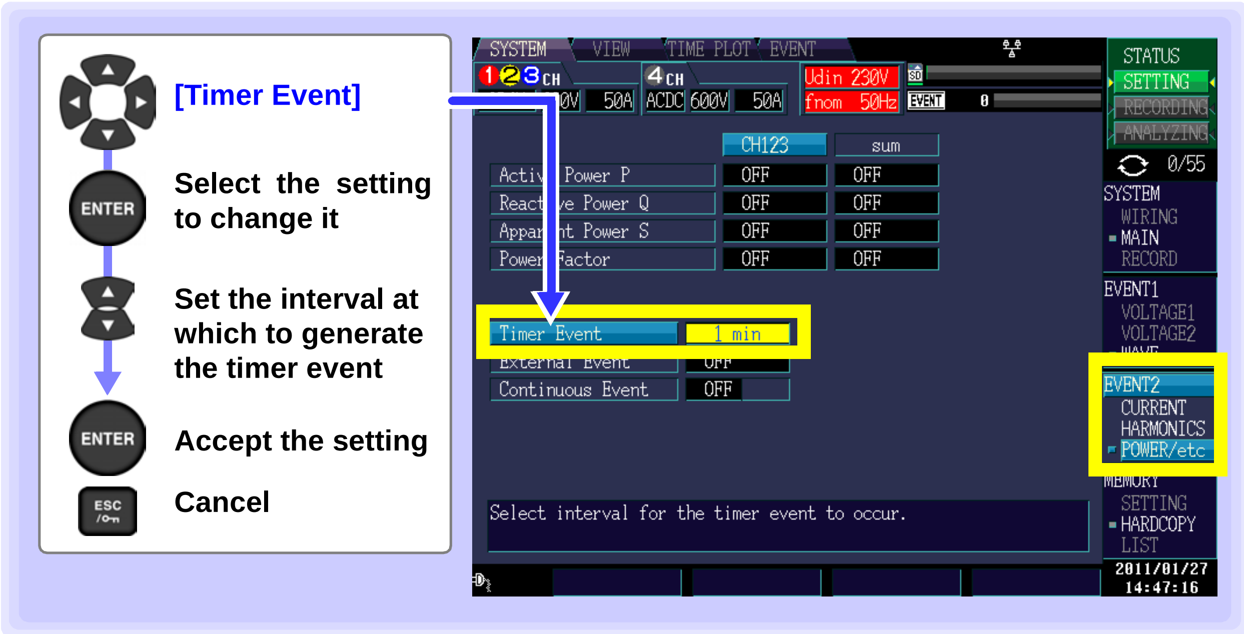
Generating events manually (manual event settings)

Events are detected when the **MANU EVENT** (manual event) key is pressed. The voltage and current waveforms and measured values when the external event occurs can be recorded. Manual events are always enabled.

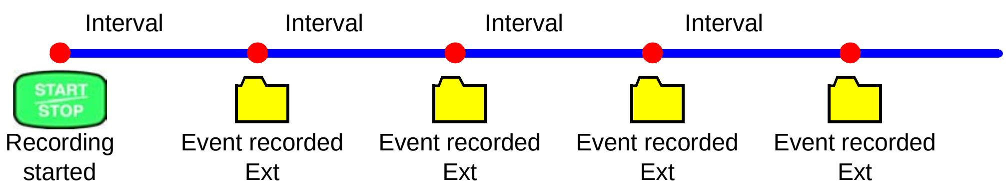
See: More about how to record event waveforms: "Appendix 4 Recording TIMEPLOT Data and Event Waveforms" (p.A14)

Generating events periodically (timer event settings)

Events can be configured by pressing the **DF3** key to display the **[POWER/etc]** screen. Events are generated at the set interval and recorded as external events.



Once recording is started, timer events will be recorded at a fixed interval (the set time) from the start time.



Generating Events Continuously (Continuous Event Function)

A function to continuously generate the number of set events (1 time to 5 times) automatically each time an event is generated.
Event apart from the first event will be recorded as "continuous event".

Due to this, instantaneous waveforms of up to one second can be recorded after an event has been generated.
However, in an event generated during a continuous event generation, continuous event will not be generated.

Continuous event generation will stop as soon as the measurement is finished.

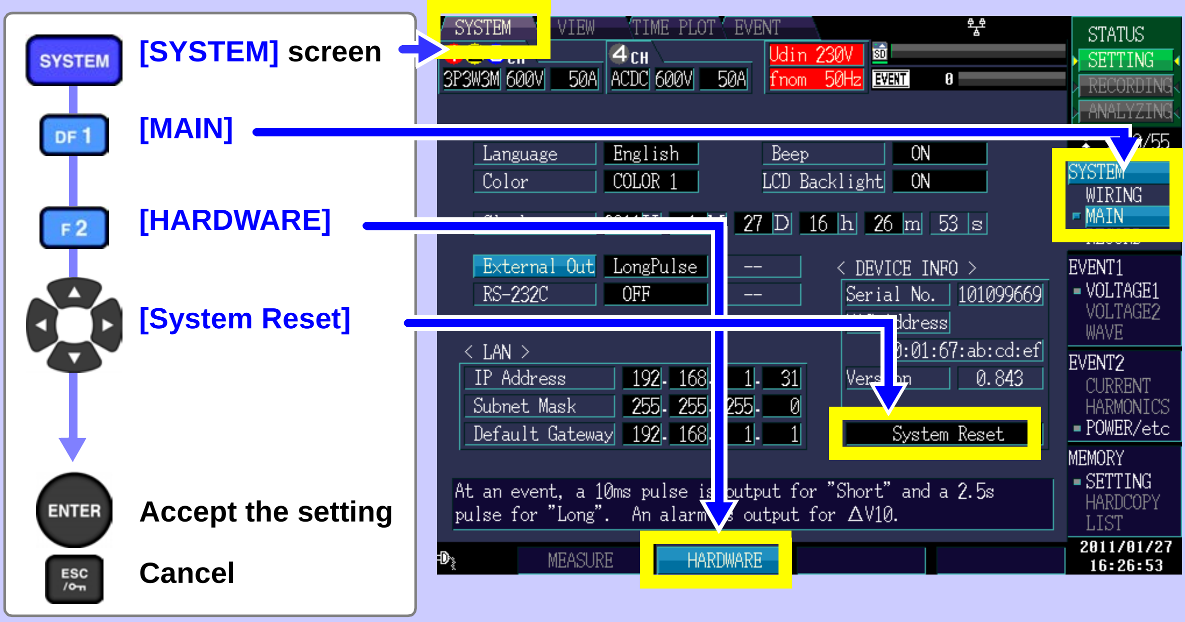
Used to observe the instance when the event is generated and the changes in the instantaneous waveforms after that. In the case of the HIOKI PW3198, waveforms of up to one second are recorded.
The waveform recorded can be displayed as continuous waveforms using the 9624-50 PQA-HiVIEW PRO HiView Pro Software.

5.6 Initializing the Instrument (System Reset)

If the instrument seems to be malfunctioning, consult "Before having the instrument repaired" (p.217).

If the cause of the problem remains unclear, try a system reset.

Key operation during configuration



NOTE

Performing a system reset causes all settings other than the display language, time, phase names, IP address, subnet mask, and RS connected device (including baud rate) to be reverted to their default values. Additionally, displayed measurement data and screen data will be deleted.

See: "5.7 Factory Settings" (p.74)

Reverting the instrument to its factory settings (boot key reset)

You can revert all settings, including language and communications settings, to their default values by turning on the instrument while holding down the **ENTER** and **ESC** keys.

5.7 Factory Settings

All settings' default values are as follows:

Measurement settings

Setting	Default value	Setting	Default value
WIRING	CH123: 3P4W CH4: ACDC	ClampSensor	CH123: 9661 CH4: 9661
Phase Name	RST	I Range	CH123: 500 A CH4: 500 A
PT Ratio	CH123: 1 CH4: 1	CT Ratio	CH123: 1 CH4: 1
Udin	230 V	THD Type	THD-F
Frequency	50 Hz	Harm Calc	U,I,P: All Levels
URMS Type	PHASE-N	Flicker	Varies with set display language.
PF Type	PF		

Measurement period and recording settings

Setting	Default value	Setting	Default value
Time Start	OFF	TIME PLOT Interval	1 min
Repeat Record	OFF	Disp COPY Interval	OFF
Recording Items	ALL DATA		

Hardware settings

Setting	Default value	Setting	Default value
Language	Set language	LCD Backlight	ON
Color	COLOR1	External Out	ShortPulse
Beep	ON	RS-232C	OFF

Vector area settings

Setting	Default value	Setting	Default value
∆Phase	±30	U/I Angle	0
∆Level	±20		

Monitoring Instantaneous Values (VIEW Screen) Chapter 6

6.1 Using the VIEW screen

The VIEW screen is composed of a number of screens corresponding to the DF1 to DF4 (DF: display function) keys. When you press a DF key, the screen corresponding to that key appears. Each time you press the same DF key, the display changes.

VIEW screen selector

About screen configuration (p.23)

Switching screen display

WAVE

See: "6.2 Displaying Instantaneous Waveforms" (p.76)

HARMONICS

See: "6.3 Displaying Phase Relationships ([VECTOR] Screen)" (p.80),
"6.4 Displaying Harmonics" (p.83)

DMM

See: "6.5 Displaying Measured Values Numerically (DMM Screen)" (p.89)

The screen shown varies with the instrument's internal operating state.

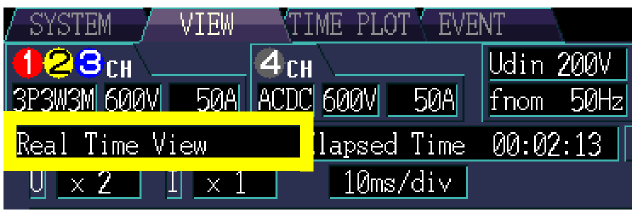
Internal operating state	Display	Display update
[SETTING]	Contents of the display update during setting.	Approximately 1 second
[WAITING]		
[RECORDING]	Contents of the latest display update during measurement.	
[ANALYZING]	Contents of the display update during analysis, or contents at the moment an event selected in [EVENT] screen occurs.	

Normal screen display:

Displays the current measurement screen.

Note: [WAITING]

From the time the START/STOP key is pressed until measurement actually starts, settings are shown as [WAITING]. Settings are also shown as [WAITING] when measurement has been stopped due to use of repeated recording.



Screen display after an event is selected:

This screen is shown when an event is selected on the [EVENT] screen in [ANALYZING] mode. As shown in the screenshot to the right, the event number, time and date, and type are displayed.

See:"8.3 Analyzing the Measurement Line Status When Events Occur" (p.124)

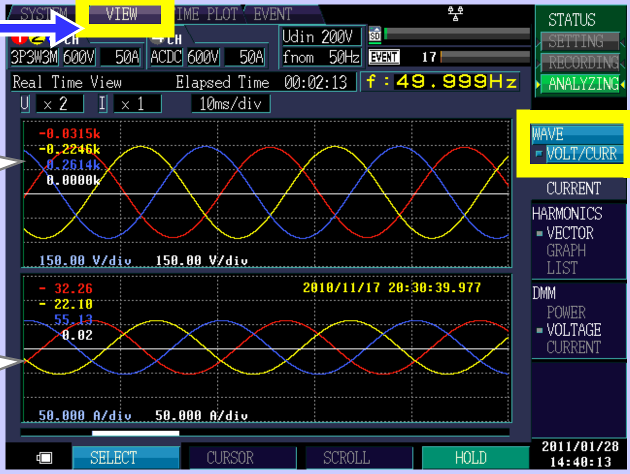
6.2 Displaying Instantaneous Waveforms

This section describes how to display the voltage and current instantaneous waveforms.

Example: Waveform showing four 3P4W (3-phase, 4-wire) channels

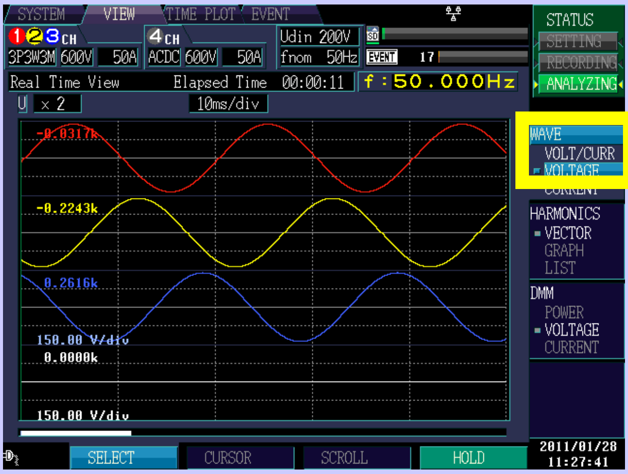
VIEW **[VIEW] screen**

Superimposes and displays 4 channels of the voltage waveform.

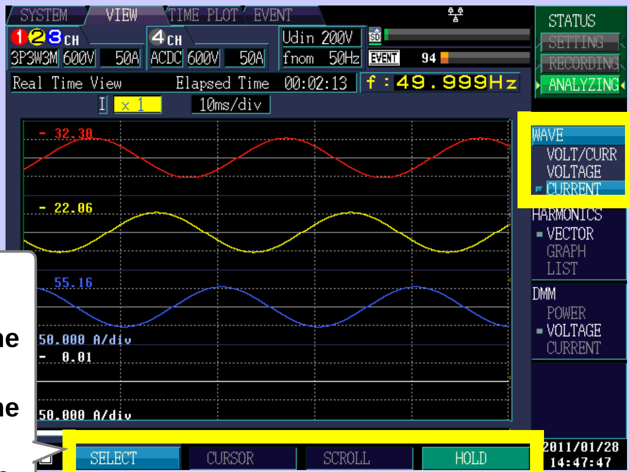


DF 1 **[WAVE] [VOLT/CURR]**

Superimposes and displays 4 channels of the current waveform.



DF 1 **[WAVE] [VOLTAGE]**



DF 1 **[WAVE] [CURRENT]**

Waveform colors
Red: CH1, Yellow: CH2
Blue: CH3, White: CH4

Select with the **F** key.

To reduce or enlarge the waveform (p.77)

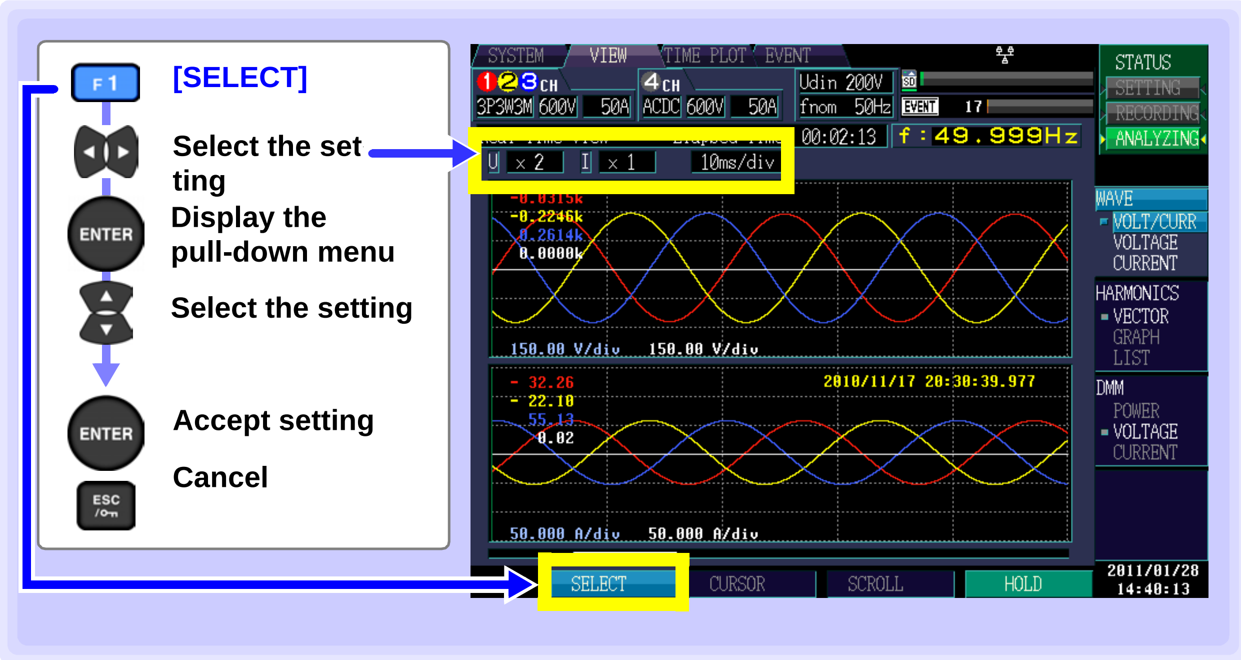
To view the value and time over the cursor (p.78)

To scroll through the waveform (p.79)

To hold the display (p.79)

NOTE The instantaneous waveform displays the waveform sampled at 20 kHz. (Measured values are calculated using waveforms sampled at a different frequency for each parameter.)

Reduce or enlarge the waveform (changing the X- and Y-axis scale)



Y-axis scale (U: Voltage, I: Current)

To reduce the graph, decrease the scale.
To enlarge the graph, increase the scale.

Settings:(∗ : Default)

x1/3, x1/2, x1∗, x2, x5, x10, x20, x50

The scale can also be changed without using the pull-down menu by pressing the up and down cursor keys.

X-axis scale

To reduce the graph, decrease the scale.
To enlarge the graph, increase the scale.

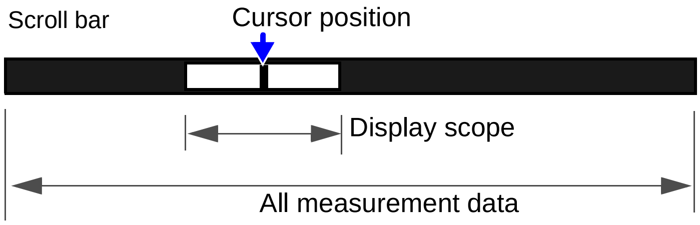
Settings:(∗ : Default)

5ms/div∗, 10ms/div, 20ms/div, 40ms/div

The scale can also be changed without using the pull-down menu by pressing the up and down cursor keys.

Viewing the value and time over the cursor (cursor measurement)

The cursor on the scroll bar shows where the cursor is located relative to all measurement data.

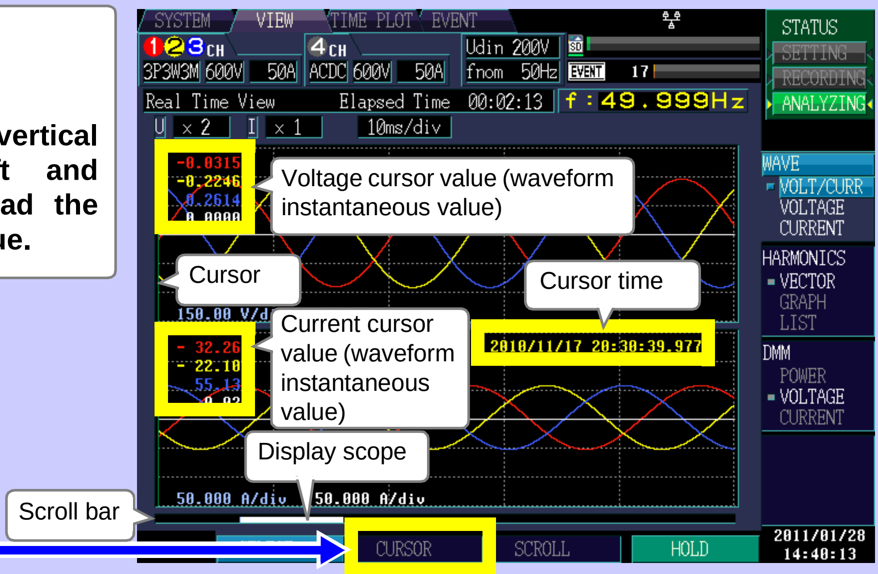


[VOLT/CURR] display

[CURSOR]

Move the vertical cursor left and right to read the display value.

Cursor color
Red: CH1
Yellow: CH2
Blue: CH3
White: CH4



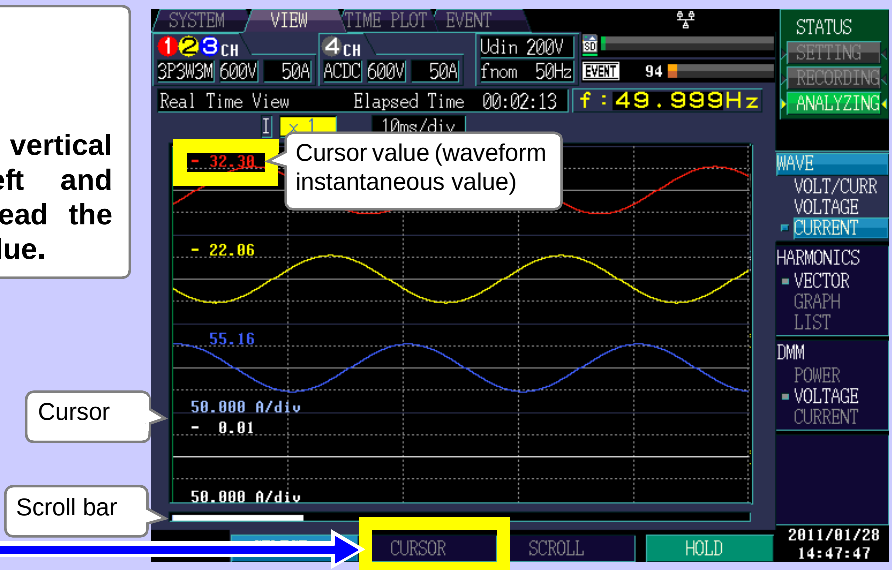
You can read waveform instantaneous values and time with the cursor. Normally, the cursor is located at the beginning of the waveform.

[VOLTAGE] or [CURRENT] display

[CURSOR]

Move the vertical cursor left and right to read the display value.

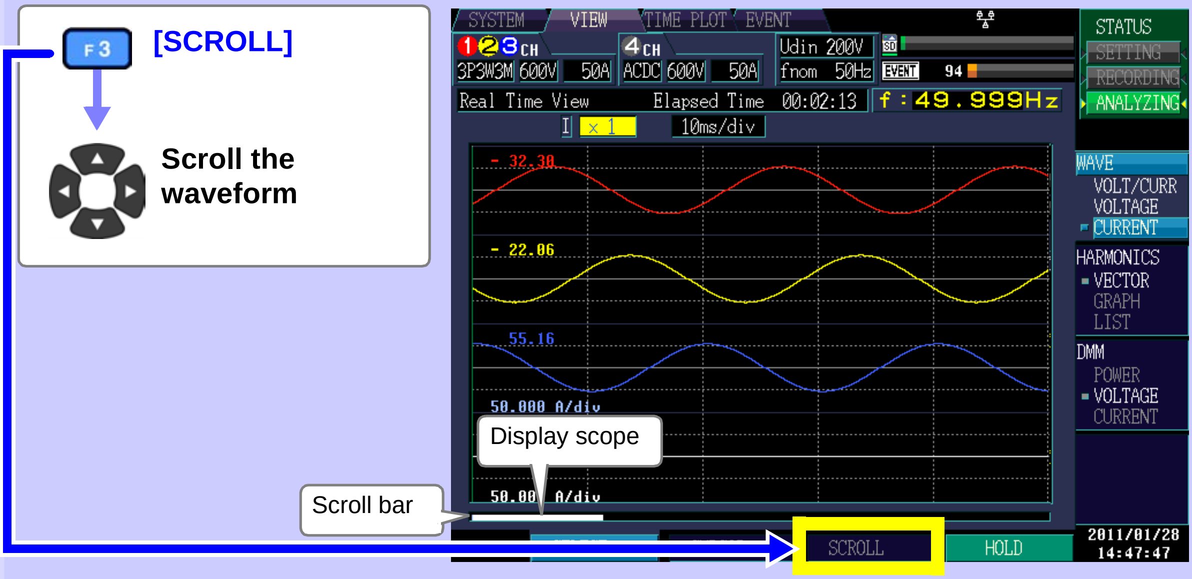
Cursor color
Red: CH1
Yellow: CH2
Blue: CH3
White: CH4



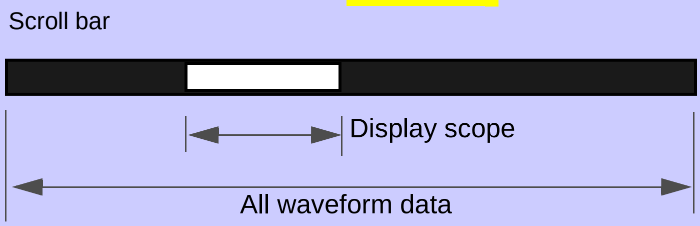
You can read waveform instantaneous values with the cursor. Normally, the cursor is located at the beginning of the waveform.

Scrolling through the waveform

You can review all measurement data by scrolling horizontally.

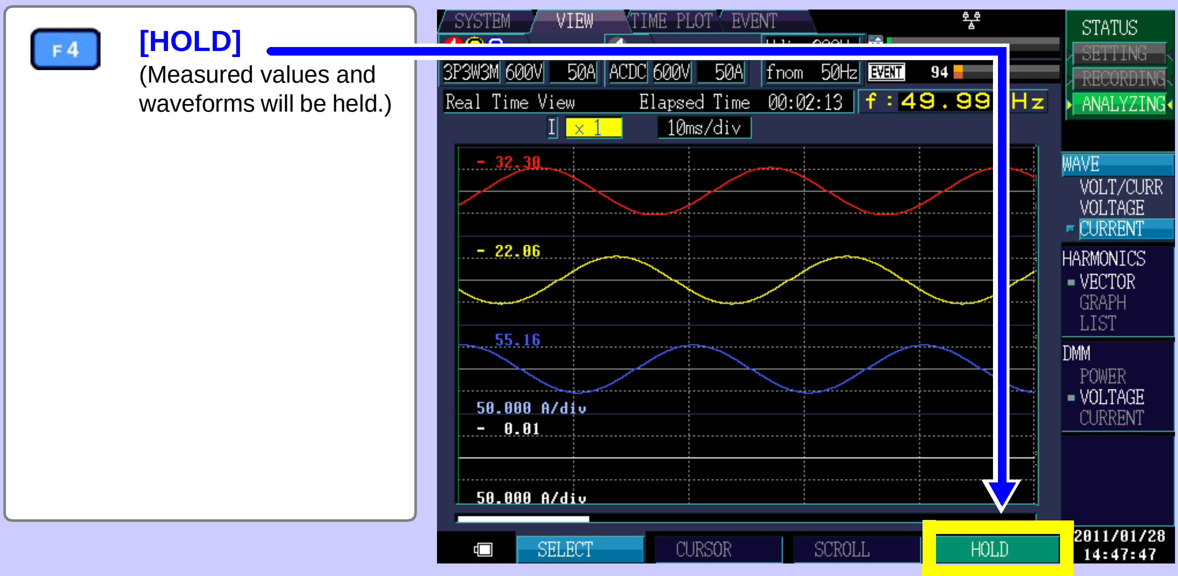


The display scope on the scroll bar (shown in white) illustrates which range of all waveform data is being shown on the screen.



NOTE If you select an event and display a waveform, you can scroll horizontally to analyze 14 waveforms at 50 Hz, 16 waveforms at 60 Hz, or 112 waveforms at 400 Hz.

Holding the display

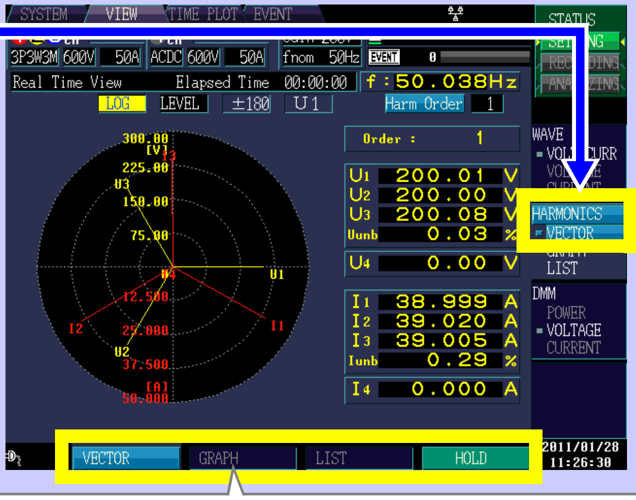


6.3 Displaying Phase Relationships ([VECTOR] Screen)

VIEW → [VIEW] screen

DF 2 → [HARMONICS] [VECTOR]

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



Select with the **F** key.

To change the axis display (p.81)

To change the RMS value/phase angle value display (p.81)

To change the phase angle display method (p.81)

RMS/phase angle/content percentage display (p.81)

To change the harmonic number of orders (p.82)

To hold the display (p.88)

Changing the axis display, RMS value/phase angle display, and phase angle value display

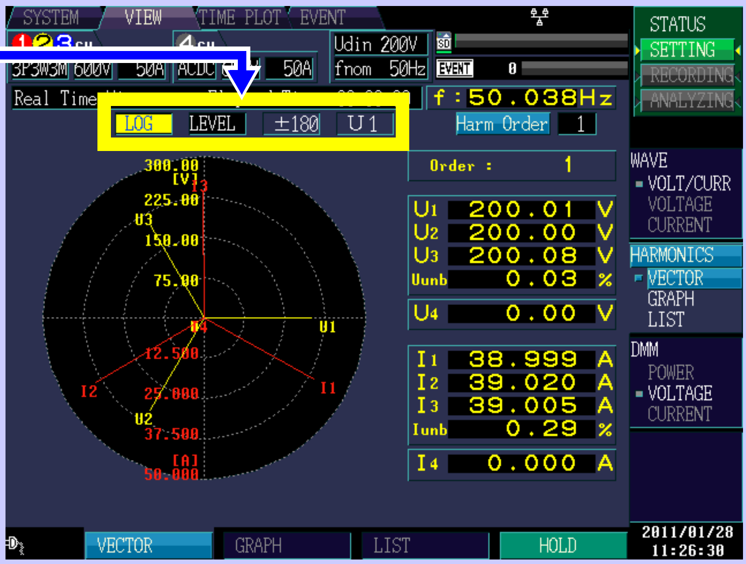
Select the setting

ENTER **Display the pull-down menu**

Select the setting

ENTER **Accept setting**

ESC **Cancel**



Axis display

You can select whether to use a linear display (LINEAR) or logarithmic display (LOG) for the vector axis. If you select the logarithmic display method, the vector is easy to see even at low levels.

Settings:(＊ : Default)

LINER＊	Linear display
LOG	Log Logarithmic display

NOTE When the 400 Hz measurement frequency is selected, harmonic analysis is performed up to the 10th order, and inter-harmonic analysis is not available.

RMS/phase angle/content percentage display

Selects which value to display (RMS value display, phase angle display, or content percentage display). If **[PHASE]** is selected, you can also set the phase angle value display method.

Settings:(＊ : Default)

LEVEL＊	RMS
Phase	Phase angle
Content	Content percentage

Phase angle value display method

You can select the type of phase angle display. (This setting can be configured only when [Phase] is selected.)
If **[lag360]** is selected, you can also set the phase angle reference source.

Settings:(＊ : Default)

±180＊	lead 0 to 180°, lag 0 to -180°
lag360	lag 0 to 360°

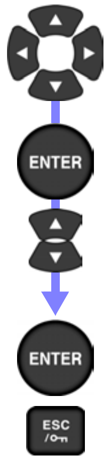
Phase angle reference source

You can select the reference source (0°) to display the phase angle value.

U1＊/ I1/ U2/ I2/ U3/ I3

Changing the harmonic number of orders

You can select what value to display.
When you change the number of orders, the values change along with the vector.
In this case, the voltage and current unbalance factors remain the same as the values calculated using the fundamental wave (1st order).



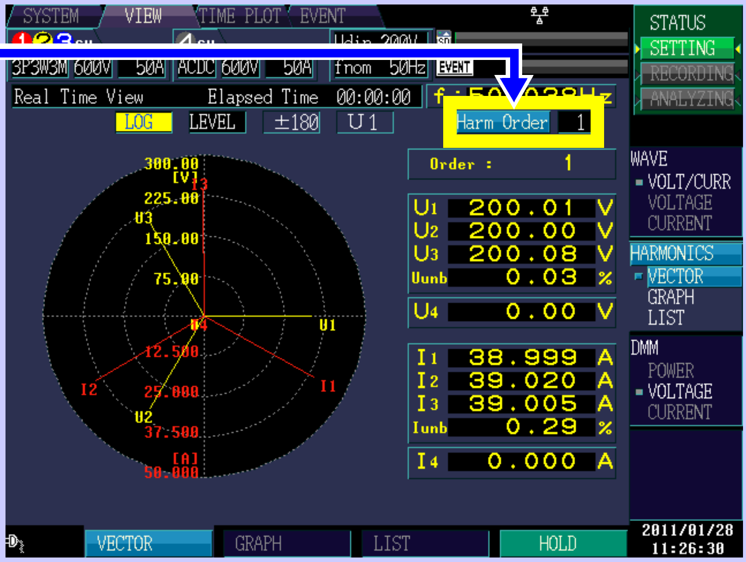
[Harm Order]

Display the pull-down menu

Change the number of order
(Up to the 50th order can be set)

Accept setting

Cancel

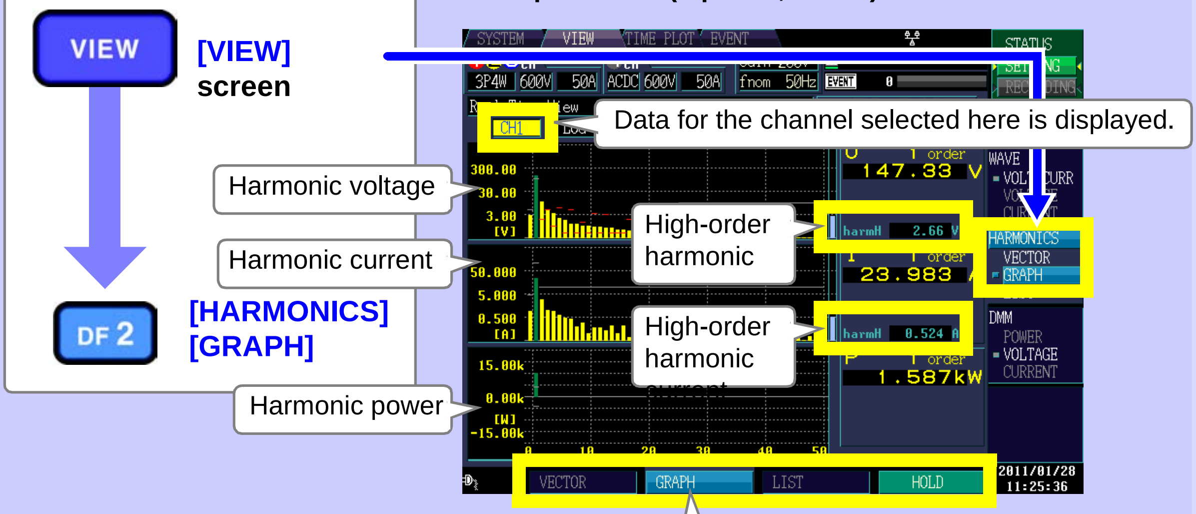


The harmonic number of orders can also be changed without using the pull-down menu by pressing the up and down cursor keys.

6.4 Displaying Harmonics

Displaying harmonics as a bar graph

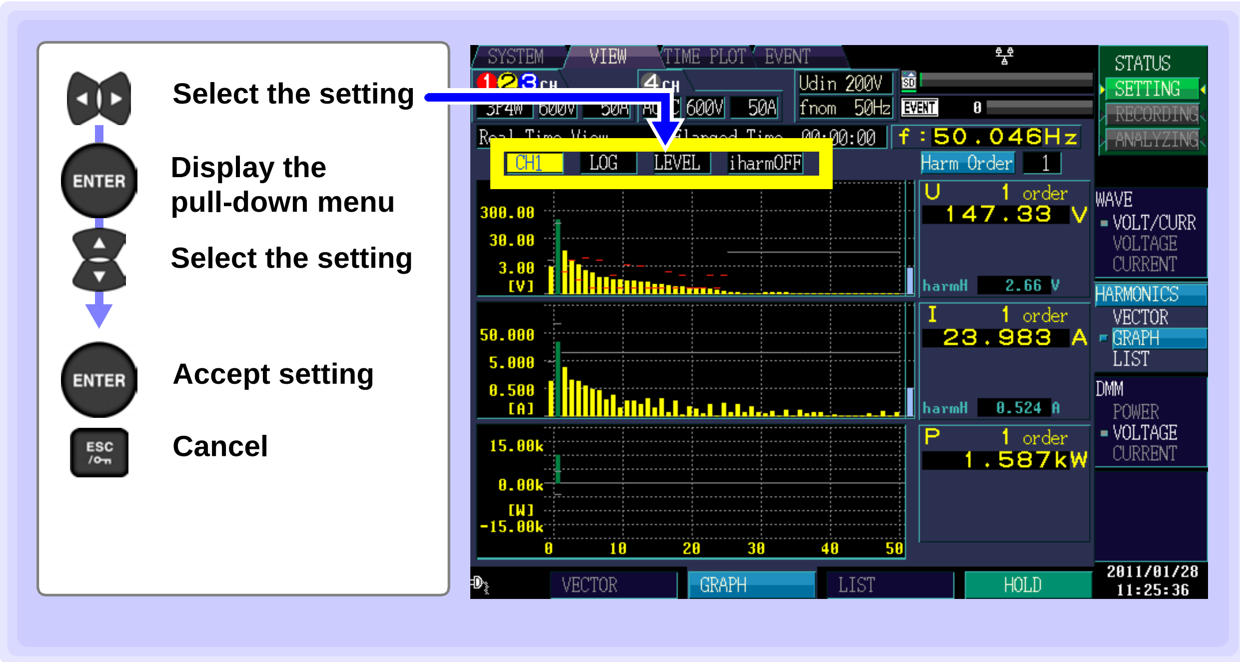
Example: 3P4W (3-phase, 4-wire)



Select with the **F** key.

To change the display channel (p.84)
To change the axis display (p.84)
To change the RMS value/phase angle display (p.84)
To display inter-harmonics (p.85)
To change the display order (p.85)
To hold the display (p.88)

Changing the display channel, axis display, RMS/phase angle display, and inter-harmonics



Displayed channel

Settings:(∗ : Default)

CH1∗/ **CH2**/ **CH3**/ **CH4/sum**

NOTE When the 400 Hz measurement frequency is selected, harmonic analysis is performed up to the 10th order, and inter-harmonic analysis is not available.

Axis display

If you select the logarithmic display method, the vector is easy to see even at low levels.

Settings:(∗ : Default)

LINER∗	Linear display
LOG	Log Logarithmic display

RMS/phase angle/content percentage display

Select the harmonic bar graph display (RMS value display, phase angle display, or content percentage). The harmonic power phase angle indicates the harmonic voltage-current phase difference.

Settings:(∗ : Default)

LEVEL∗	RMS
Phase	Phase angle
Content	Content percentage

In the level display, the high-order harmonic component bar graph and measured value (harmH) are displayed next to the U and I bar graphs.

Inter-harmonics

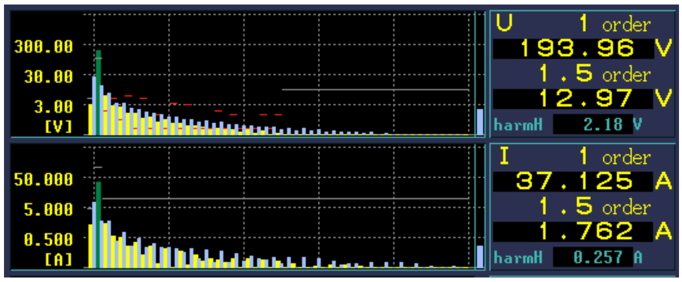
Settings:(∗ : Default)

iharmOFF∗, **iharmON**

The setting can also be changed without using the pull-down menu by pressing the up and down cursor keys.

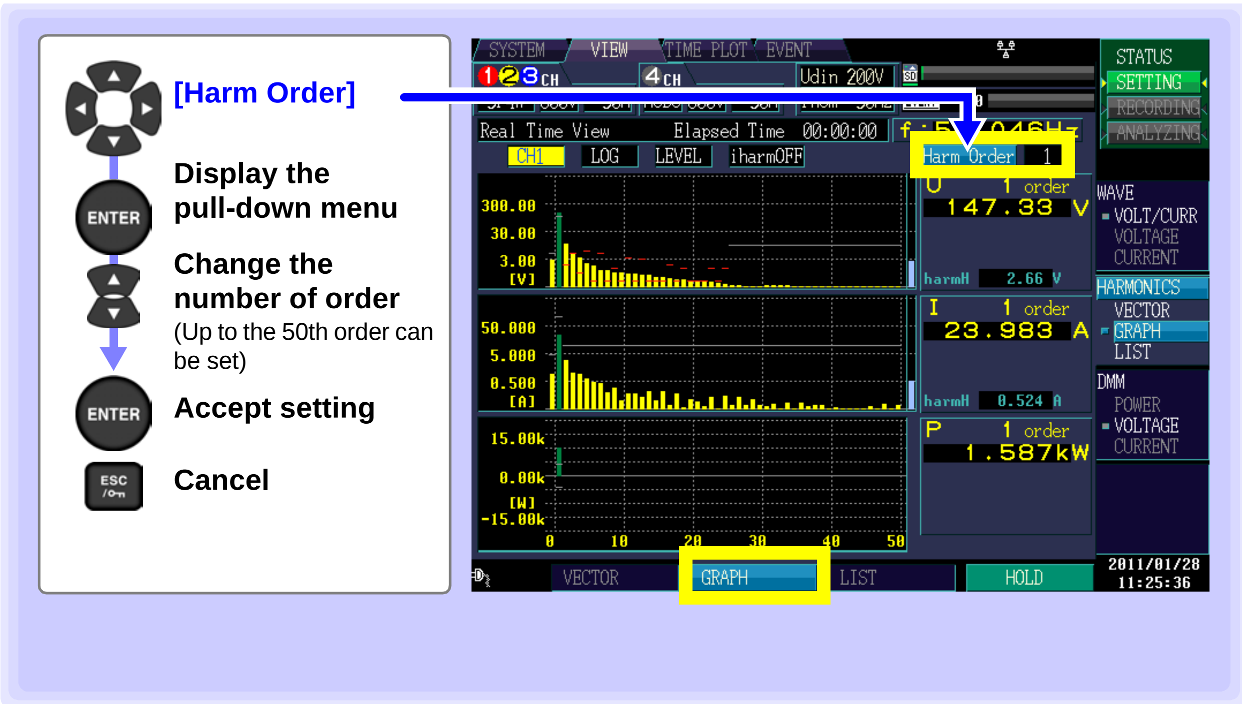
When the inter-harmonics display is enabled (iharmON), the screen changes as shown to the right.

Turquoise: inter-harmonics components



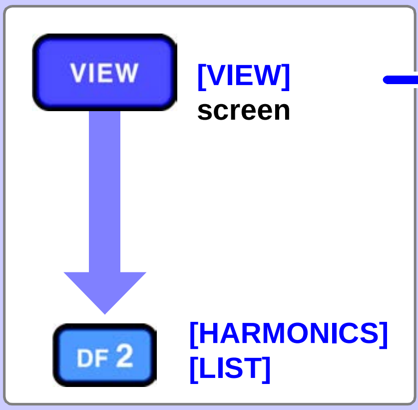
Changing the Displayed Order

The selected order number becomes green on the bar graph.
If you change the order number, the values change along with the bar graph.
You can also change the displayed order without displaying the pull-down menu by using the up and down cursor keys.

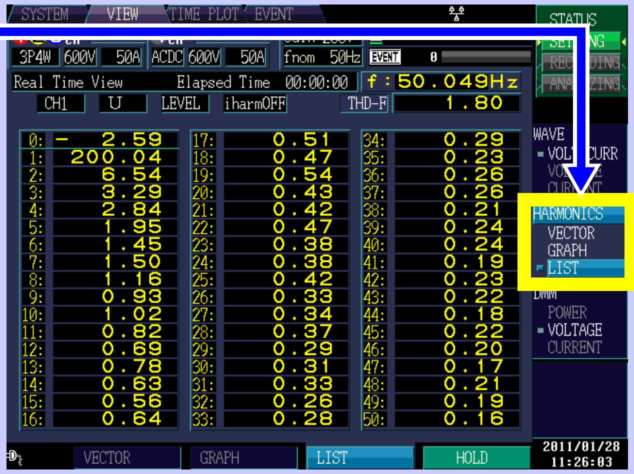


Displaying harmonics as a list

The 1st to 50th harmonic orders and 0.5 to 49.5 inter-harmonic orders are displayed in a list for the selected item.



Example: 3P3W3M Wiring

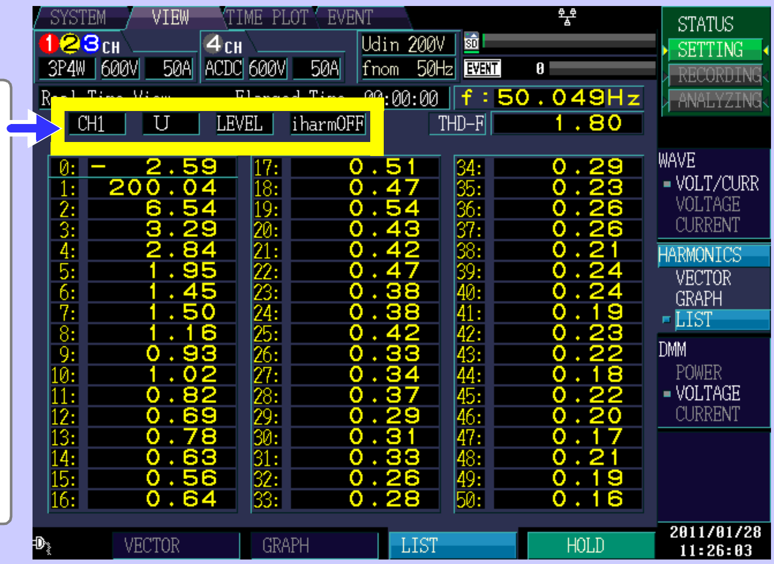


To change the displayed channels (p.84)
To change the displayed items (p.84)
To change the RMS value/phase angle display (p.84)
To display inter-harmonics (p.85)

NOTE When the 400 Hz measurement frequency is selected, harmonic analysis is performed up to the 10th order, and inter-harmonic analysis is not available.

Changing the display channels, items, RMS value, phase angle, inter-harmonics

Select the setting
ENTER — **Display the pull-down menu**
Select the setting
ENTER — **Accept setting**
ESC — **Cancel**



Displayed channel

Settings:(∗ : Default)

CH1∗/ **CH2**/ **CH3**/ **CH4/sum**

Displayed item

Settings:(∗ : Default)

U∗	Voltage
I	Current
P	Active power

RMS/phase angle/content percentage display

Select the harmonics list display (RMS value display, phase angle display, or content percentage). The harmonic power phase angle indicates the harmonic voltage-current phase difference.

Settings:(∗ : Default)

LEVEL∗	RMS
Phase	Phase angle
Content	Content percentage

Inter-harmonics

When active power (P) is selected as the display item, inter-harmonics are not displayed.

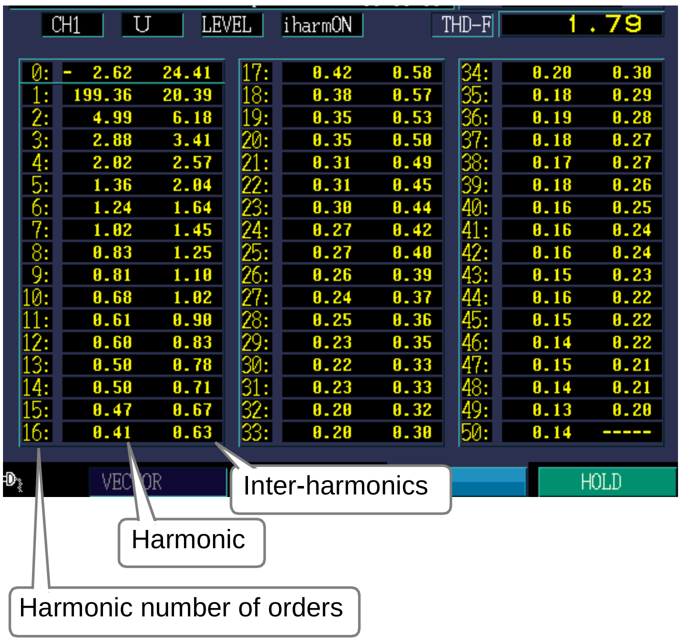
Settings:(∗ : Default)

iharmOFF∗, **iharmON**

The setting can also be changed without using the pull-down menu by pressing the up and down cursor keys.

When the inter-harmonics display is enabled (iharmON), the screen changes as shown to the right.

The left side of the example shows harmonics and the right inter-harmonics.
The inter-harmonics order is obtained by adding 0.5 to the harmonics order for the same row.
(Example)
The order of inter-harmonics on the right of the 20th harmonic is 20.5.



Chapter 6 Monitoring Instantaneous Values (VIEW Screen)

6

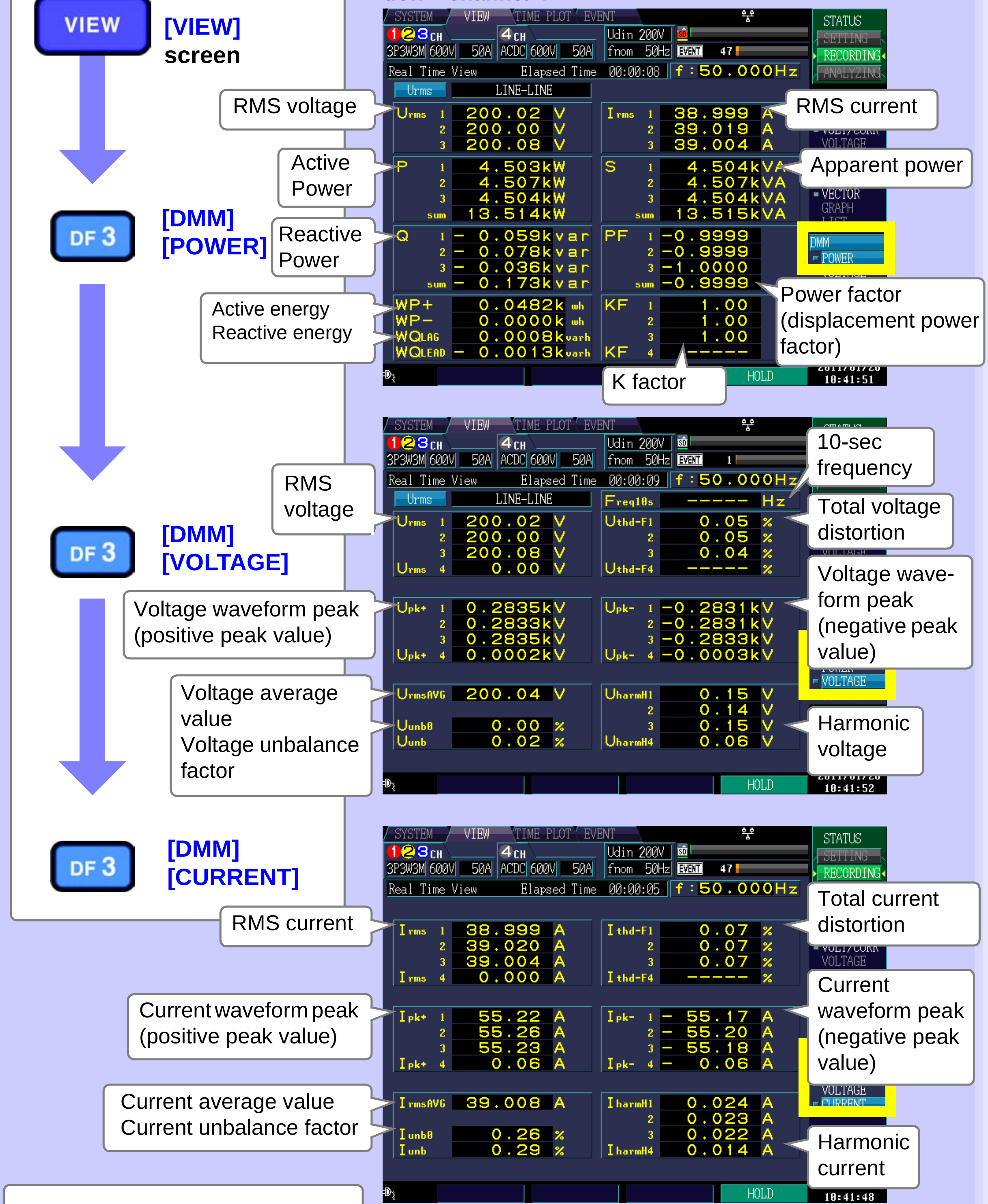
Holding the display

F4

[HOLD]
(Measured values and waveforms will be held.)

6.5 Displaying Measured Values Numerically (DMM Screen)

Example: 4-channel DMM display for 3P3W3M connection + channel 4



Select with the **F** key.

To hold the display (p.90)

See: For more information about the voltage calculation method (Urms type), power factor calculation method (PF type), and THD calculation method (THD type) settings: "5.1 Changing Measurement Conditions" (p.55)

Holding the display

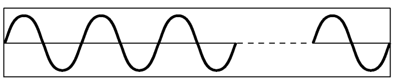
F4 **[HOLD]**
(Measured values will be held.)

Monitoring Fluctuations in Measured Values (TIME PLOT Screen)

Chapter 7

The [TIMEPLOT] screen allows you to view measured value fluctuations as a time series graph.

Trend and harmonic trend time series graphs:



50 Hz: 10 waveforms, 60 Hz: 12 waveforms, 400 Hz: 80 waveforms

↓

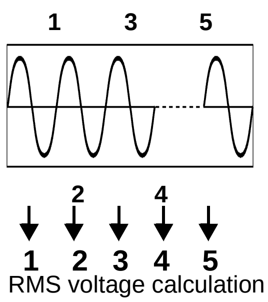
RMS value calculation
Harmonic calculation

RMS voltage, RMS current, and other measured values calculated every 200 ms are displayed as a time series graph. The maximum, minimum, and average values during the TIMEPLOT interval are recorded.

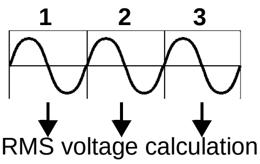
Example
If the TIMEPLOT interval is set to 1 s, five values will be calculated in 1 s. Of those, the maximum, minimum, and average values will be recorded.

Detailed trend time series graph:

During 50/60 Hz measurement



During 400 Hz measurement



The RMS voltage refreshed each half-cycle, frequency cycle, and other measured values calculated for each waveform are displayed as a time series graph. The maximum and minimum values during the TIMEPLOT interval are recorded. As shown in the figure, RMS voltage refreshed each half-cycle is shifted a half-wave and calculated every wave.

Example
If the TIMEPLOT interval is set to 1 s, there are 100 RMS values and 50 frequency values calculated every 1 s (for a 50 Hz signal). Of those, the maximum and minimum values are recorded.

See: Trend graph recording methods: "Recording TIMEPLOT Data and Event Waveforms" (pA.14)

Display of trend data, detailed trend data, and harmonic trend data on the instrument is subject to certain constraints. Updating of the displayed time series graph will stop when the times listed in the following table are exceeded. Data will continue to be recorded to the SD memory card (see recording times (p.63)) even if updating of the displayed time series graph stops.

[TIMEPLOT] screen maximum display times

TIME PLOT Interval	Recording Items setting		
	ALL DATA (Saves all data)	P&Harm (Saves RMS values and harmonics)	Power (Saves RMS values only)
1sec	7 min. 52 sec.	15 min. 44 sec.	2 hours 37 min. 20 sec.
3sec	23 min. 36 sec.	47 min. 12 sec.	7 hours 52 min.
15sec	1 hour 58 min.	3 hours 56 min.	1 day 15 hours 20 min.
30sec	3 hours 56 min.	7 hours 52 min.	3 days 6 hours 40 min.
1min	7 hours 58 min.	15 hours 44 min.	6 days 13 hours 20 min.
5min	1 day 15 hours 20 min.	3 days 6 hours 40 min.	32 days 18 hours 40 min.
10min	3 days 6 hours 40 min.	6 days 13 hours 20 min.	35 days
15min	4 days 22 hours	9 days 20 hours	35 days
30min	9 days 20 hours	19 days 16 hours	35 days
1hour	19 days 16 hours	35 days	35 days
2hours	35 days	35 days	35 days
150/180 wave (Approx. 3 sec)	23 min. 36 sec.	47 min. 12 sec.	7 hours 52 min.

7.1 Using the [TIMEPLOT] Screen

The TIME PLOT screen is composed of a number of screens that correspond to the DF1 to DF4 (DF: display function) keys.

When you press a DF key, the screen corresponding to that key appears.When there are multiple screens, the screen display will change every time the same DF key is pressed.

TIMEPLOT **TIME PLOT screen selector**

About screen configuration (p.23)

Switching screen display

DF 1 TREND

See: "7.2 Displaying Trends" (p.94)

DF 2 DetailTrend

See: "7.3 Displaying detailed trends" (p.101)

DF 3 HarmTrend

See: "7.4 Displaying Harmonic Trends" (p.107)

DF 4 FLICKER

See: "7.5 Displaying Flicker Values in Graph and List Form" (p.111)

The screen shown varies with the instrument's internal operating state.

When recording starts, the time series graph is displayed on the TIME PLOT screen. The Y-axis and X-axis are automatically scaled so that all the time series graphs are displayed on the screen.
When recording is stopped, updating of the time series graph display stops.

Internal operation status	Display	Display update
[SETTING]	No time series graph display data.	-----------
[WAITING]		
[RECORDING]	The time series graph display is updated.	Every set TIMEPOT interval
[ANALYZING]	Updating of the time series graph display stops.	-----------

Relationship between instrument status and key operation

[SETTING] — Set — START/STOP (Start recording) → [RECORDING] — START/STOP (Stop recording) → [ANALYZING] — DATA RESET: Revert to [SETTING] mode

When you want to start recording, but START/STOP does not work because the instrument is in [ANALYZING] mode

DATA RESET (Return to [SETTING] mode from [ANALYZING] mode) → START/STOP (Start recording) → [RECORDING]

When you want to change settings in [RECORDING] or [ANALYZING] mode

In [RECORDING] mode: START/STOP (Stop recording) → DATA RESET (Revert to [SETTING] mode) → [SETTING]

In [ANALYZING] mode: DATA RESET (Revert to [SETTING] mode) → [SETTING]

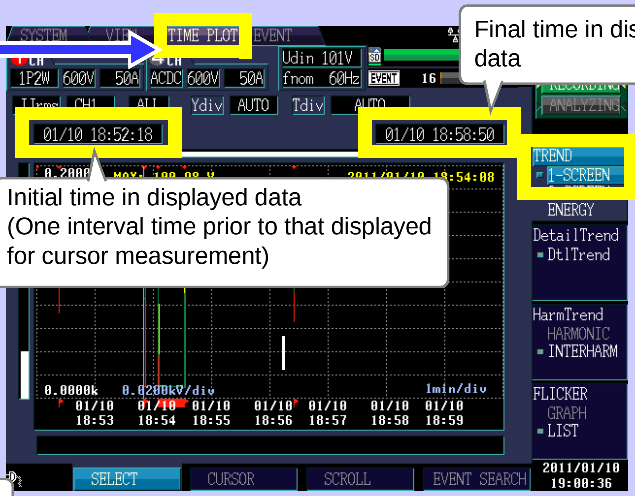
In both cases, all displayed measurement data will be deleted.

7.2 Displaying Trends

This section describes how to generate a time series display of values calculated internally every 200 ms each TIMEPLOT interval. When using one or two screens, the maximum, minimum, and average values during the TIMEPLOT interval are shown.

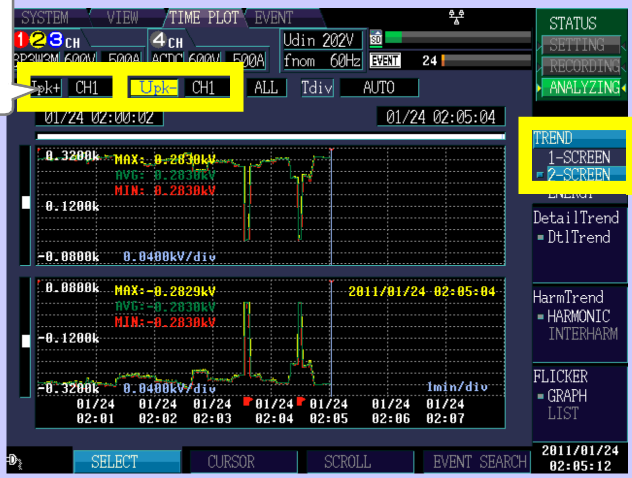
Example: 3P4W (3-phase, 4-wire)

TIME PLOT **[TIME PLOT] screen**

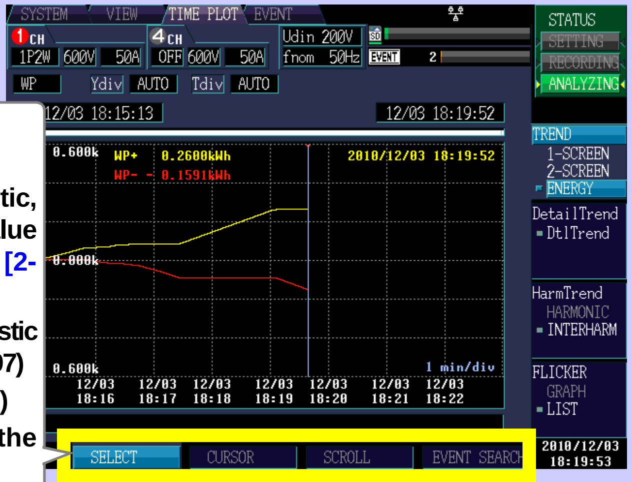


DF 1 **[TREND] [1-SCREEN]**

When displaying **[2-SCREEN]**, you can select two characteristics to display.



DF 1 **[TREND] [2-SCREEN]**



DF 1 **[TREND] [ENERGY]**

Select with the **F** key.

To change the displayed characteristic, channel, waveform, or measured value (when displaying [1-SCREEN] or [2-SCREEN] screen) (p.95)

To change the displayed characteristic (when displaying [ENERGY] screen) (p.97)

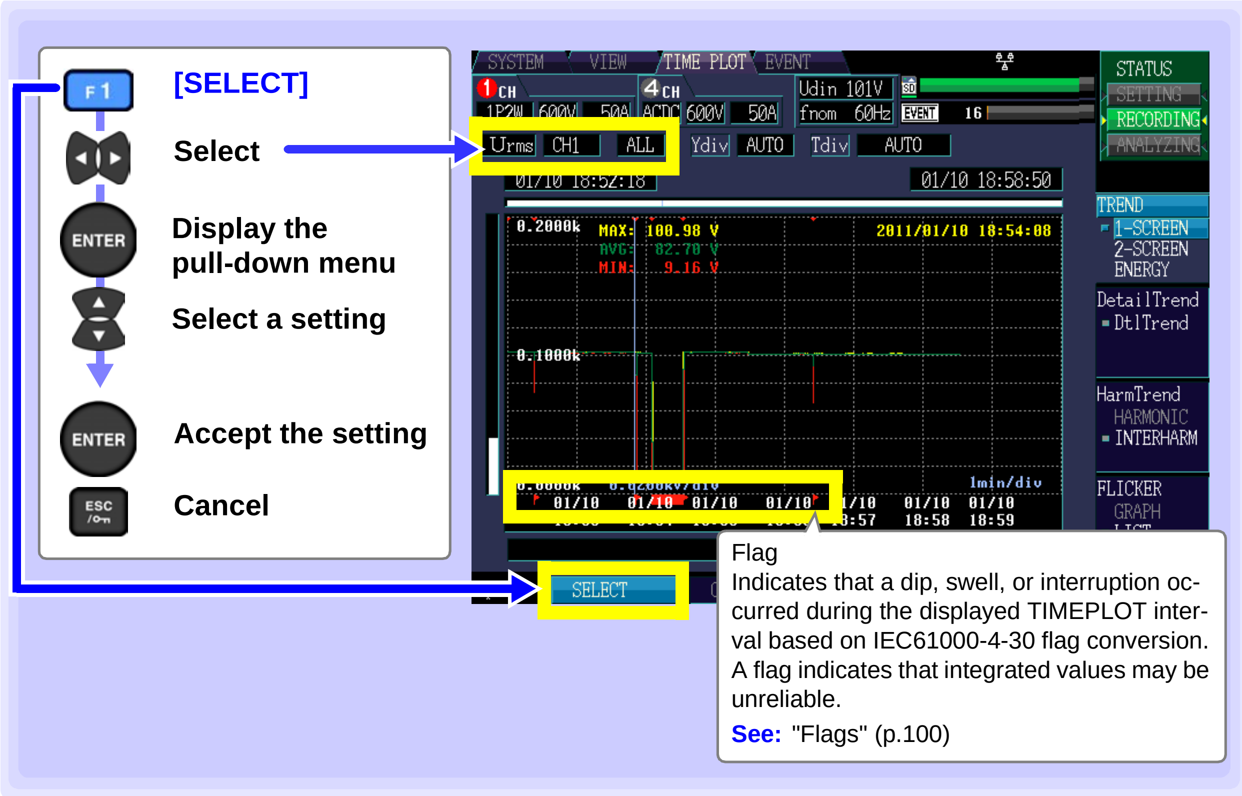
To enlarge or reduce the graph (p.98)

To view the value and time over the cursor (p.99)

To scroll through display data (p.99)

To search for an event (p.100)

Changing the displayed items, channels, waveforms, or measured value ([1-SCREEN] and [2-SCREEN] screen)



Displayed items and channels

Allows you to select the displayed item and channel. Which channels are available depends on the selected displayed item.

Settings:(∗ : Default)

Displayed item	Displayed channel					Displayed item	Displayed channel			
Freq∗	Freq∗	f10s				Ipk-	CH1∗	CH2	CH3	CH4
Urms	CH1∗	CH2	CH3	CH4	AVG	Idc	CH4∗			
Upk+	CH1∗	CH2	CH3	CH4		Iunb	unb∗	unb0		
Upk-	CH1∗	CH2	CH3	CH4		IharmH	CH1∗	CH2	CH3	CH4
Udc	CH4∗					Ithd	CH1∗	CH2	CH3	CH4
Uunb	unb∗	unb0				P	CH1∗	CH2	CH3	sum
UharmH	CH1∗	CH2	CH3	CH4		S	CH1∗	CH2	CH3	sum
Uthd	CH1∗	CH2	CH3	CH4		Q	CH1∗	CH2	CH3	sum
Irms	CH1∗	CH2	CH3	CH4	AVG	PF	CH1∗	CH2	CH3	sum
Ipk+	CH1∗	CH2	CH3	CH4		KF	CH1∗	CH2	CH3	CH4

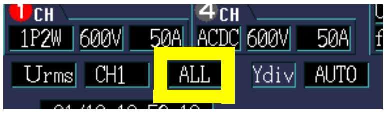
- For, Freq, Uunb, and Iunb, you can select a detailed measurement item, rather than a channel.
- AVG indicates the average value for channels 1 through 3 (varies with connection).
- Sum indicates the sum for channels 1 through 3 (varies with connection).

NOTE The channels available for selection vary with the connection mode setting.

Notation meaning

Symbol	Measurement Items	Symbol	Measurement Items	Symbol	Measurement Items
Freq＊	Frequency	**Irms**	RMS current	**Uunb0** **Uunb**	Voltage zero-phase unbalance factor current Negative-phase unbalance factor
f10s	Frequency 10 sec (Freq10s)	**IrmsAVG**	Average RMS current (when avg is selected)	**Iunb0** **Iunb**	Current zero-phase unbalance factor current Negative-phase unbalance factor
Upk+ **Upk-**	Voltage waveform peak+ Voltage waveform peak-	**Idc**	Current DC	**UharmH**	High-order harmonic voltage component
Ipk+ **Ipk-**	Current waveform peak+ Current waveform peak-	**P**	Active power	**IharmH**	High-order harmonic current component
Urms	RMS voltage (phase/line)	**S**	Apparent power	**Uthd-F** **Uthd-R**	Total harmonic voltage distortion factor
UrmsAVG	Average RMS voltage (when avg is selected)	**Q**	Reactive power	**Ithd-F** **Ithd-R**	Total harmonic current distortion factor
Udc	Voltage DC	**PF**	Power factor	**KF**	K factor

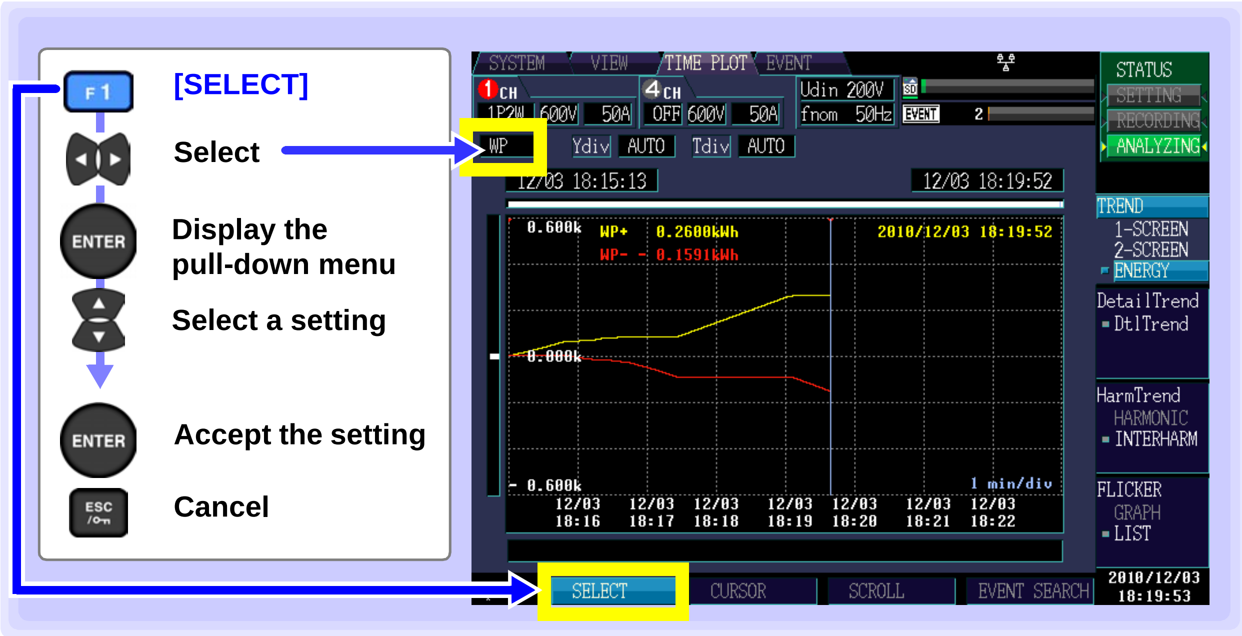
Displayed waveform and measured value



Settings:(＊ : Default)

MAX	Displays the maximum value during the TIMEPLOT interval.
MIN	Displays the minimum value during the TIMEPLOT interval.
AVG	Displays the average value during the TIMEPLOT interval.
ALL＊	Displays the maximum, minimum, and average values during the TIMEPLOT interval.

Changing the displayed items ([ENERGY] screen)

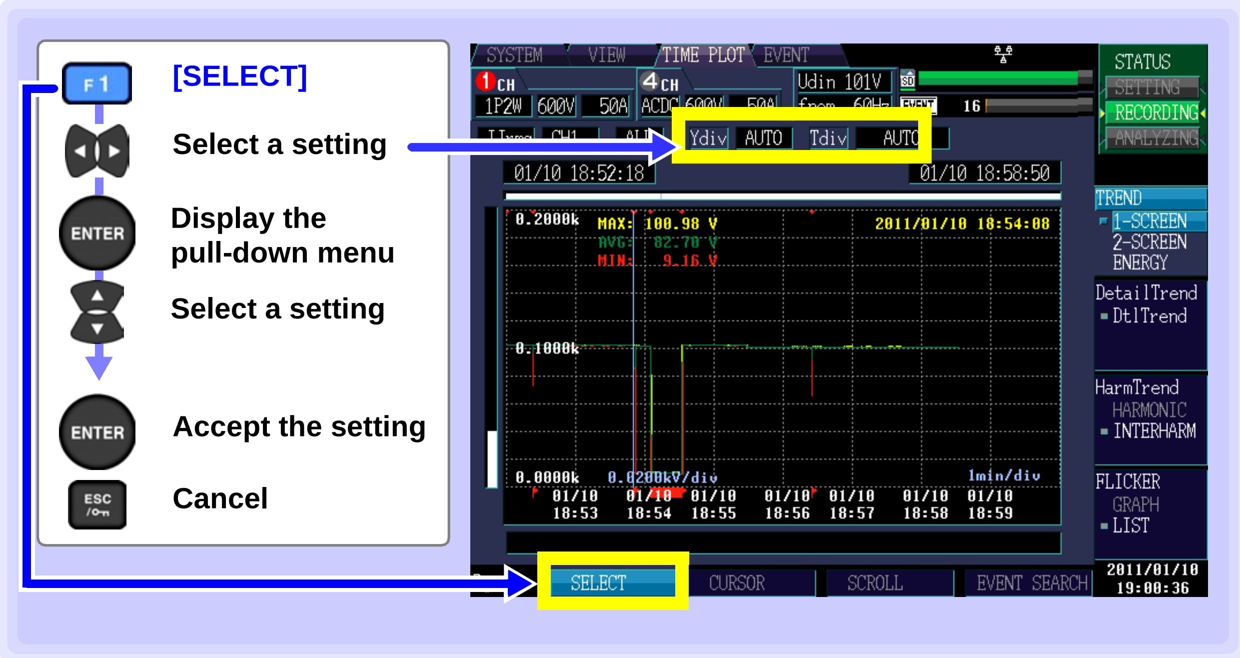


Displayed items

Settings:(∗ : Default)

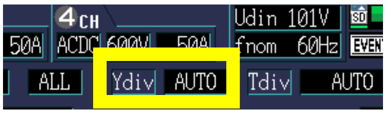
WP∗	Active integration amount for WP+ consumption, WP- regeneration
WQ	Reactive power WQLAG lag, WQLEAD lead

Enlarging or reducing the graph (changing the X- and Y-axis scale)



Y-axis scale (Ydiv)

To reduce the graph, decrease the scale.
To enlarge the graph, increase the scale.



Settings:(* : Default)

AUTO*, **x1**, **x2**, **x5**, **x10**, **x25**, **x50**

X-axis scale (Tdiv)

Selects the X-axis scale.

Settings:

AUTO*, **From 1min/div**

When recording, use AUTO.

Viewing the value and time over the cursor (Cursor measurements)

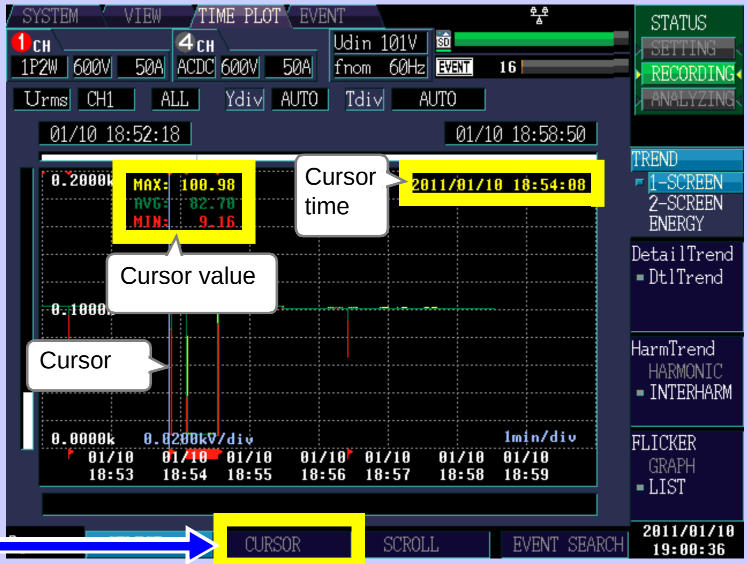
You can read the value above the cursor and the time on the time series graph

[CURSOR]

Move the vertical cursor left and right to read the display value.

When using one or two screens:
MAX (maximum value),
AVG (average value),
MIN (minimum value)

When using the **[ENERGY]** screen:
WP+ (consumption), WP- (regeneration), LAG (lag), LEAD (lead)

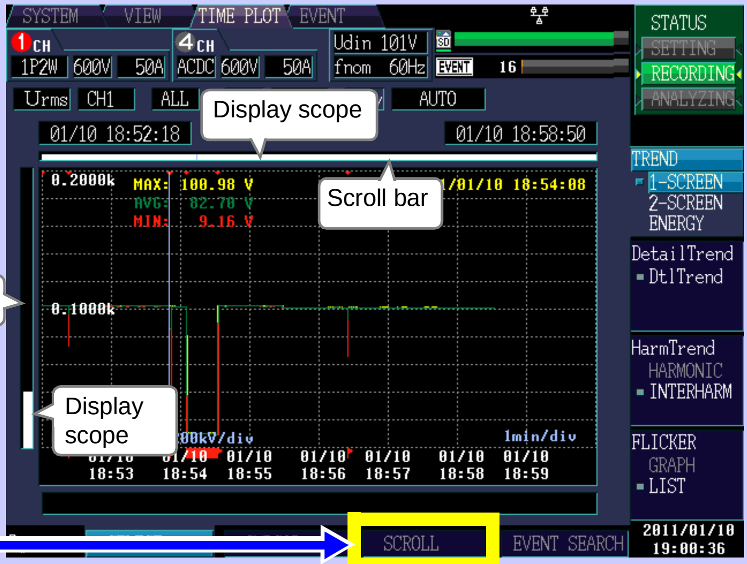


Scrolling through display data

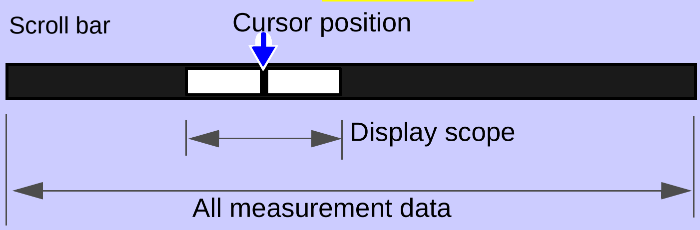
During recording, the X- and Y-axis are automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X- and Y-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left, right, up, and down.

[SCROLL]

Scroll through the graph

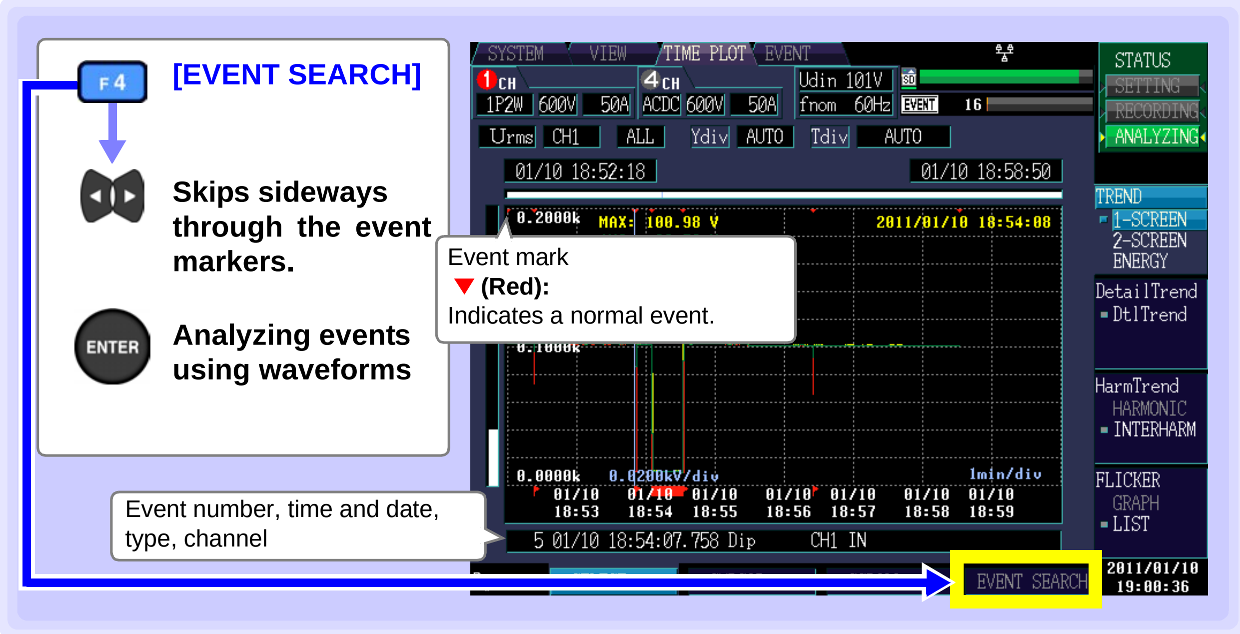


- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar shows where the cursor is located relative to all measurement data.



Searching for events

You can search for the time the event occurred (event marker).
When recording starts and stops, start and stop events are generated. This corresponds to the event selected on the event list.

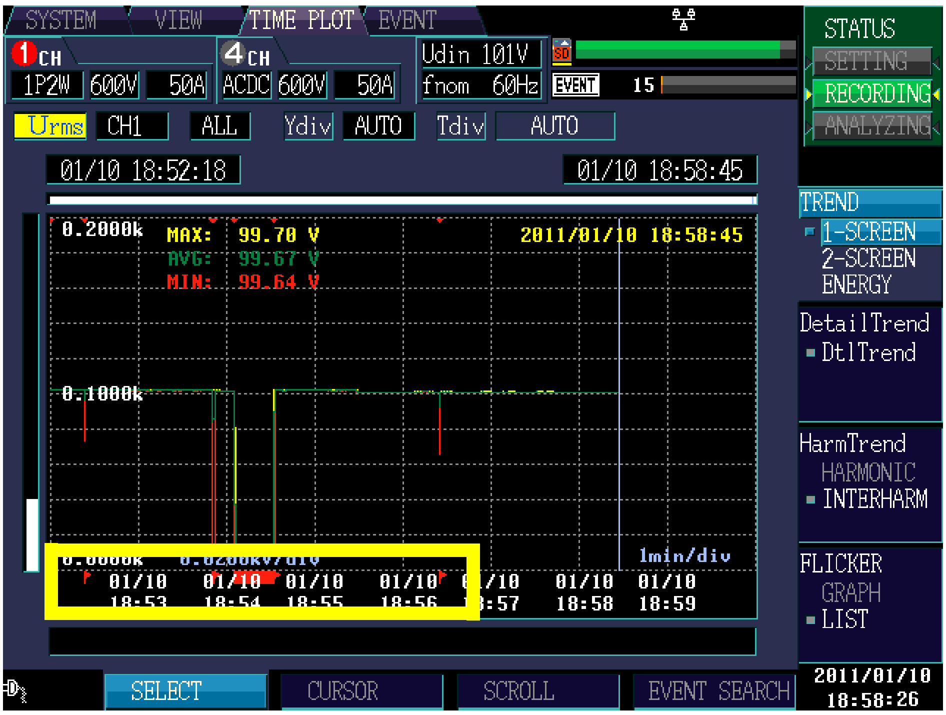


NOTE

Flags

The measurement algorithm may generate unreliable values during dips, swells, and interruptions. The possible unreliability of these measured values (set-values) is indicated by flags that are displayed with TIMEPLOT data when dips, swells, or interruptions occur. Even when dip, swell, and interruption events have been turned off, flags are shown with measurement data when a dip or interruption (when the voltage falls 10% relative to the nominal voltage) or swell (when the voltage rises 200%) is judged to have occurred.

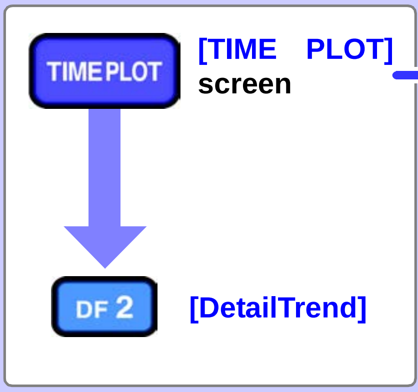
Flag icon:



7.3 Displaying detailed trends

Displaying a detailed trend graph for each TIMEPLOT interval

This section describes how to display a time series graph for each TIMEPLOT interval for Urms1/2, Irms1/2 (inrush current), S(t), or one frequency cycle.



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

Waveform/measured value colors when displaying CH1/2/3 data
Red : CH1
Yellow : CH2
Blue : CH3

Select with the **F** key.

To change displayed items and displayed channel (p.102)
To enlarge or reduce the graph (p.103)
To read the value above the cursor (p.104)
To scroll through display data (p.105)
To search for an event (p.106)

NOTE Unlike trend data, which consists of one graph each for the maximum, minimum, and average values, detailed trend data is displayed as a single graph with vertically connected bands between the maximum and minimum values.

Changing the displayed items and displayed channel

Displayed items

Settings:(∗ : Default)

Urms1/2∗	RMS voltage refreshed each half-cycle
Irms1/2	RMS current refreshed each half-cycle (inrush current)
Freq_wav	One frequency cycle
S(t)	Instantaneous flicker value

NOTE

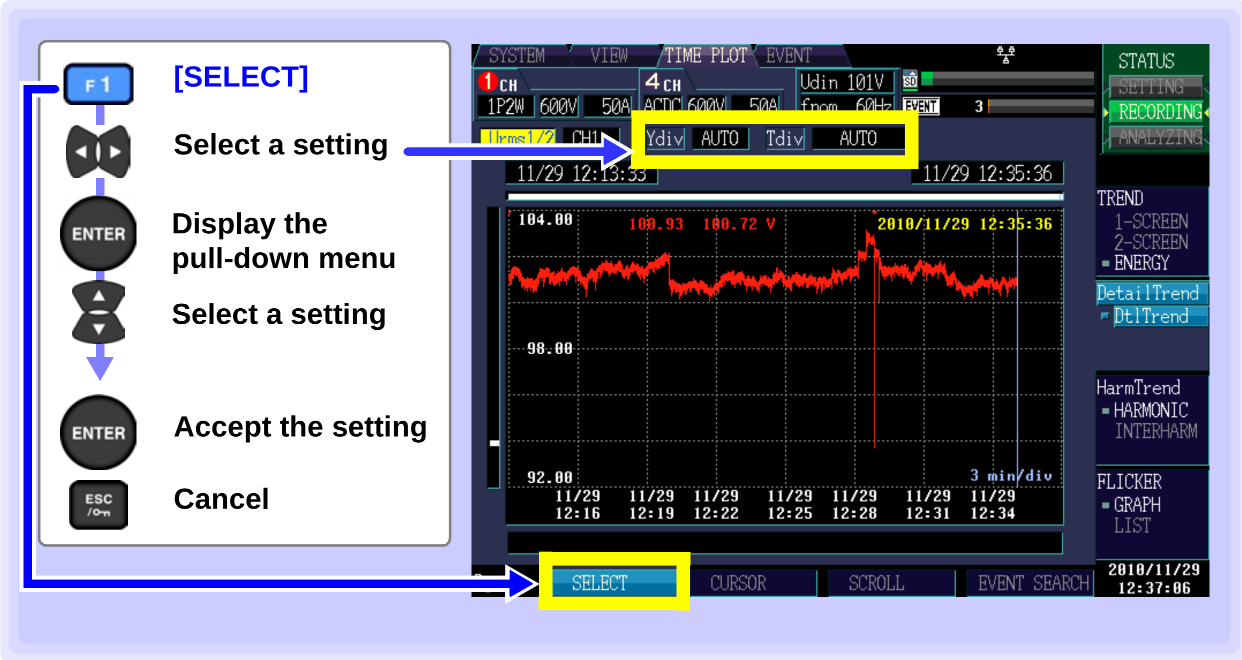
S(t) is only displayed when **[Flicker]** is set to **[Pst, Plt]**.

Displayed channel

Settings:(∗ : Default)

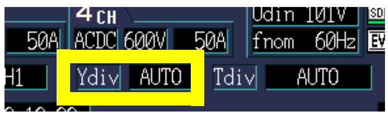
CH1∗/ **CH2**/ **CH3**/ **CH4**

Enlarging or reducing the graph (changing the X- and Y-axis scale)



Y-axis scale (Ydiv)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.

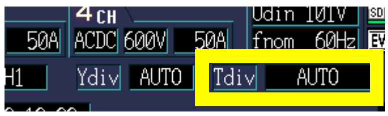


Settings:(∗ : Default)

AUTO∗, **x1**, **x2**, **x5**, **x10**, **x25**, **x50**

X-axis scale (Tdiv)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.



Settings:(∗ : Default)

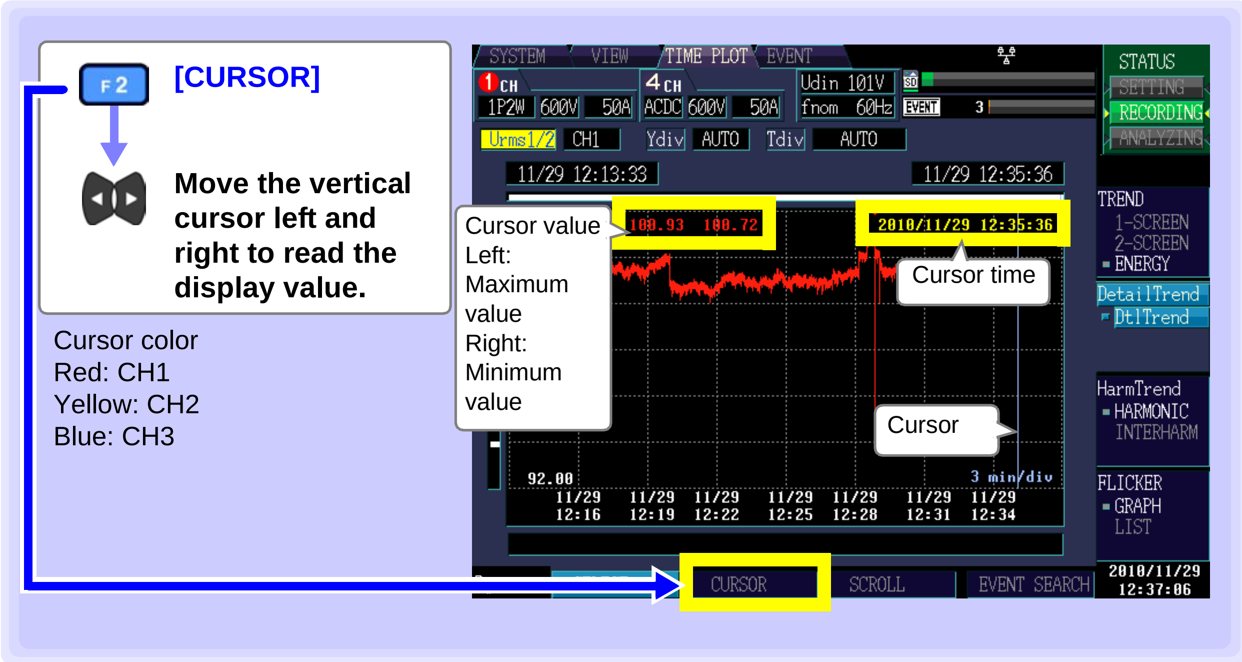
AUTO∗, **From 1min/div** (varies with TIME PLOT interval)

NOTE

AUTO scaling is used during recording. This cannot be changed.

Reading the value above the cursor (Cursor measurements)

You can read the value above the cursor and the time on the time series graph.

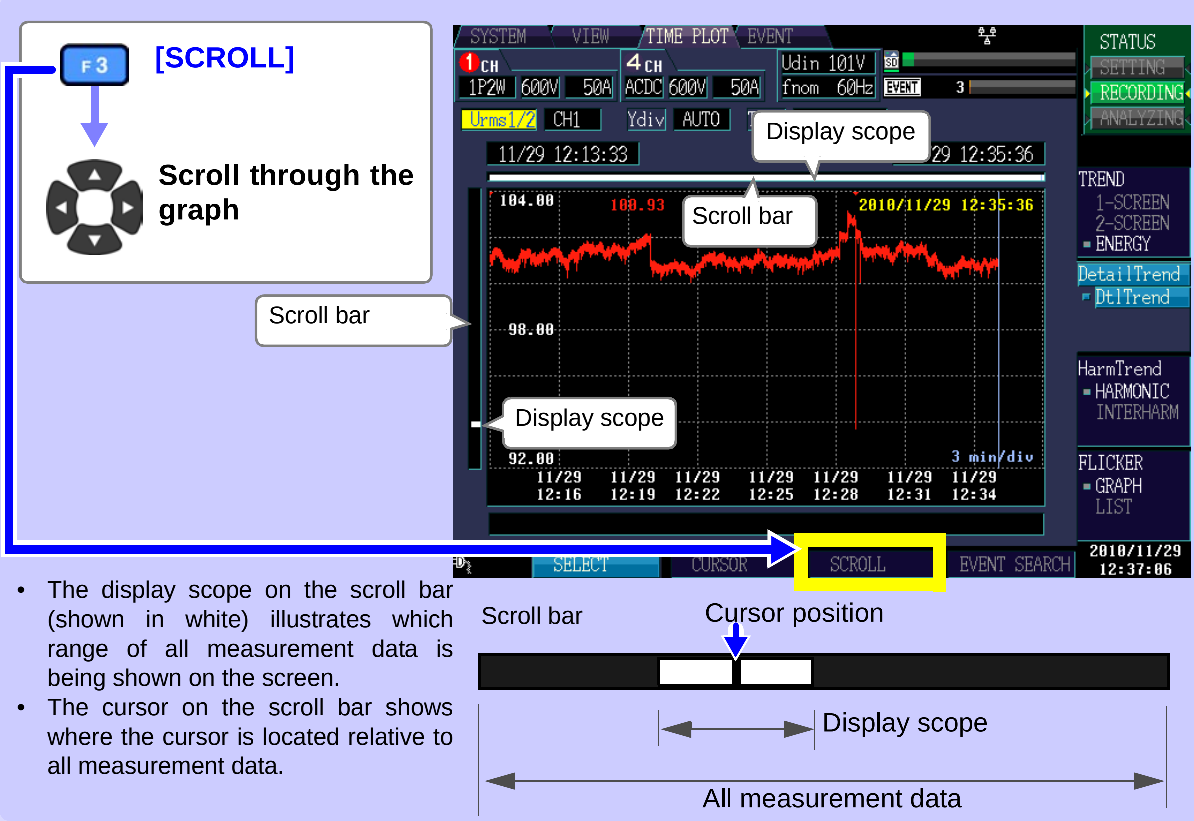


NOTE

- When the TIMEPLOT interval is set to 150 or 180 cycles, the time is shown in ms units.
- The time displayed during cursor measurement is based on the CH1 voltage (U1). The event time shown on the event list and the time displayed during cursor measurement may not agree.

Scrolling through display data

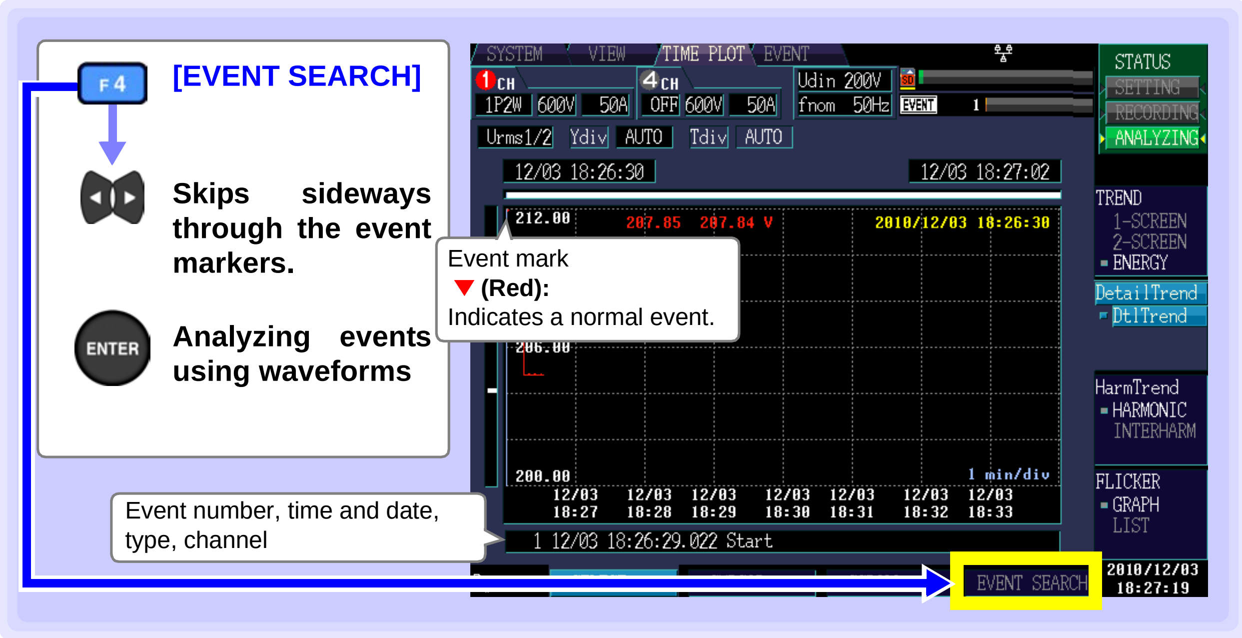
During recording, the X- and Y-axis are automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X- and Y-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left, right, up, and down.



- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar shows where the cursor is located relative to all measurement data.

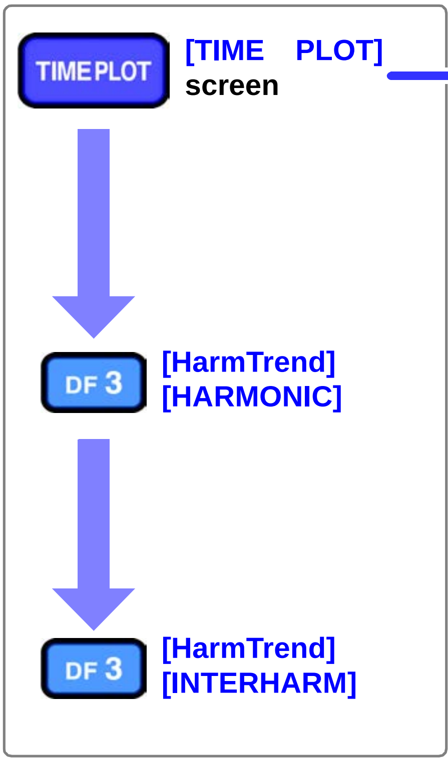
Searching for events

You can search for the time (event mark) at which an event occurred. When recording starts and stops, start and stop events are generated. This corresponds to the event selected on the event list.

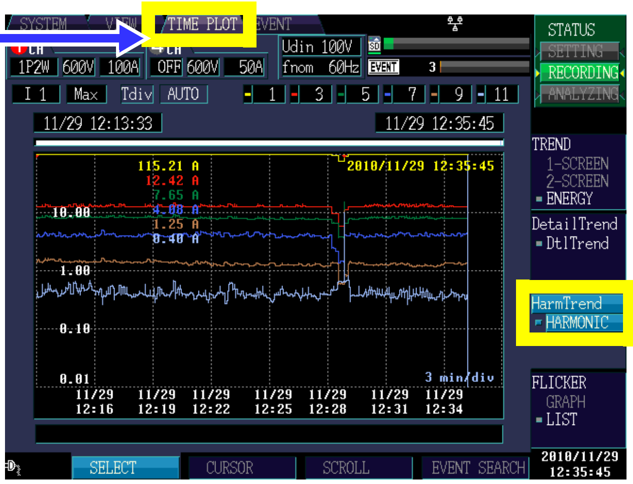


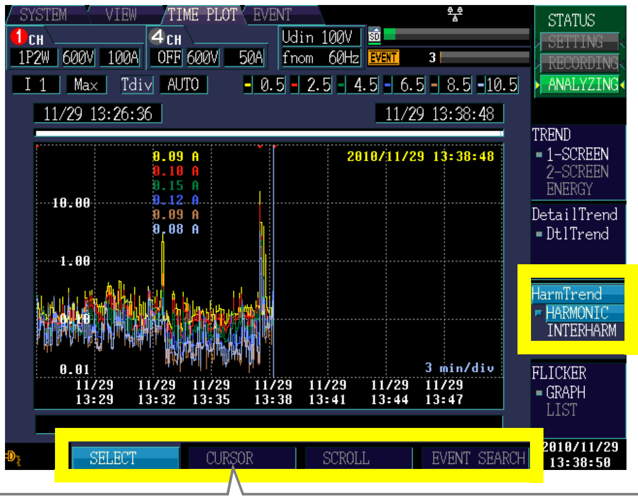
7.4 Displaying Harmonic Trends

This section descries how to select six orders and display their harmonic time series graphs. The maximum, minimum, or average value during the TIMEPLOT interval can be displayed.



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





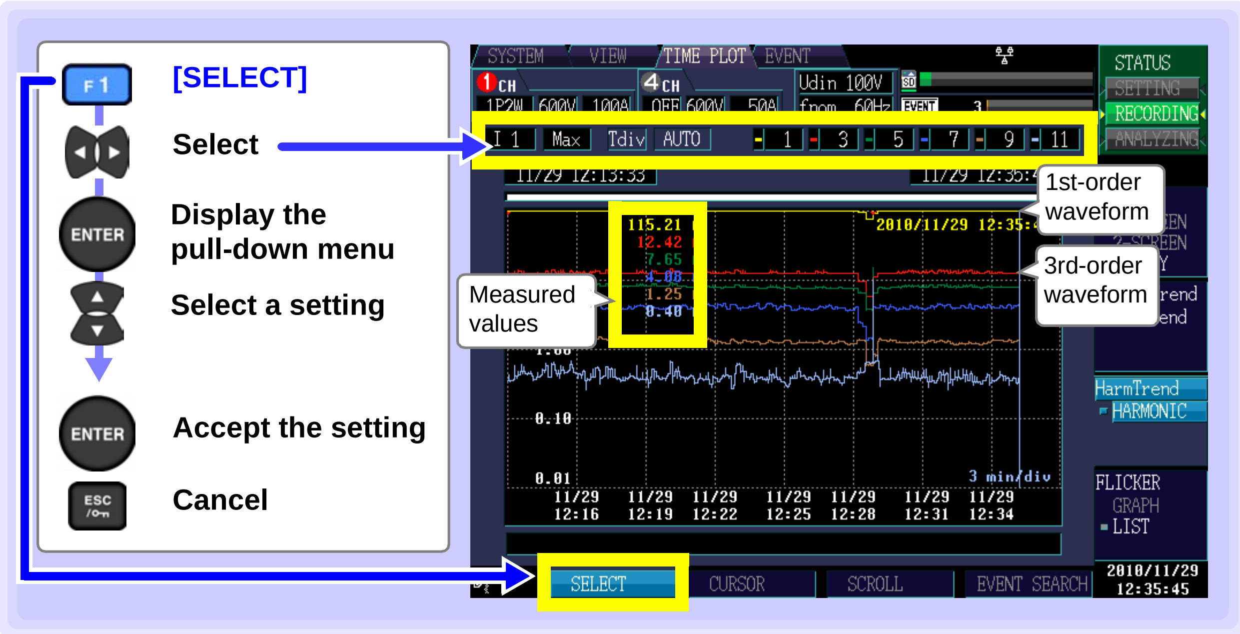
Select with the **F** key.

To change displayed items/waveform/measurement value (p.108)
To enlarge or reduce the graph (p.108)
To change display number of order (p.108)
To read the value above the cursor (p.109)
To scroll waveform data (p.110)
To search for an event (p.110)

NOTE

- When **[Power]** is selected under the **[Recording Items]** settings (see **SYSTEM-DF1 [RECORD]** (p.62)), harmonic trends (the harmonic trend graph and inter-harmonic trend graphs) will not be displayed. Additionally, inter-harmonic trend data will not be displayed if **[P&Harm]** is selected.
- During 400 Hz measurement, harmonic analysis is performed up to the 10th order, and inter-harmonic analysis is not available.

Changing displayed items, displayed waveforms, and displayed measured values; enlarging and reducing graphs (changing the X-axis scale); and changing the displayed order



Displayed items

Settings:(∗ : Default)

U1∗/**U2**/**U3**/**U4**	Voltage (CH1/2/3/4)
I1/**I2**/**I3**/**I4**	Current (CH1/2/3/4)
P1/**P2**/**P3**	Active power (CH1/2/3)
Psum	Total active power
θ1/**θ2**/**θ3**	Phase difference (P phase) (CH1/2/3)
θsum	Total phase difference (P phase)

The available displayed characteristics options vary with the connection method.

NOTE Only U1/U2/U3/U4/I1/I2/I3/I4 can be selected for the inter-harmonic time series graph.

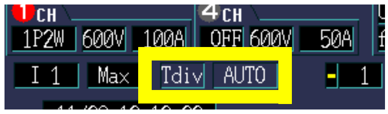
Displayed waveforms, displayed measured values

Settings:(∗ : Default)

MAX∗	Displays the maximum value during the TIME-PLOT interval.
MIN	Displays the minimum value during the TIME-PLOT interval.
AVG	Displays the average value during the TIME-PLOT interval.

X-axis scale (Tdiv)

Selects the X-axis scale.



Settings:

From 1min/div

AUTO scaling is used during recording. This cannot be

NOTE The Y-axis scale cannot be changed. The Y-axis maximum value will be the same as the range's full-scale value.

Displayed Order

Six orders can be selected and displayed at the same time. The measured value and waveform are displayed using the color of the order at the left.

Settings:(∗ : Default)

(1,3,5,7,9,11)∗, 0 to 50 ([HARMONIC] screen)
(1.5,3.5,5.5,7.5,9.5,11.5)∗, 0.5 to 49.5 ([INTERHARM] screen)

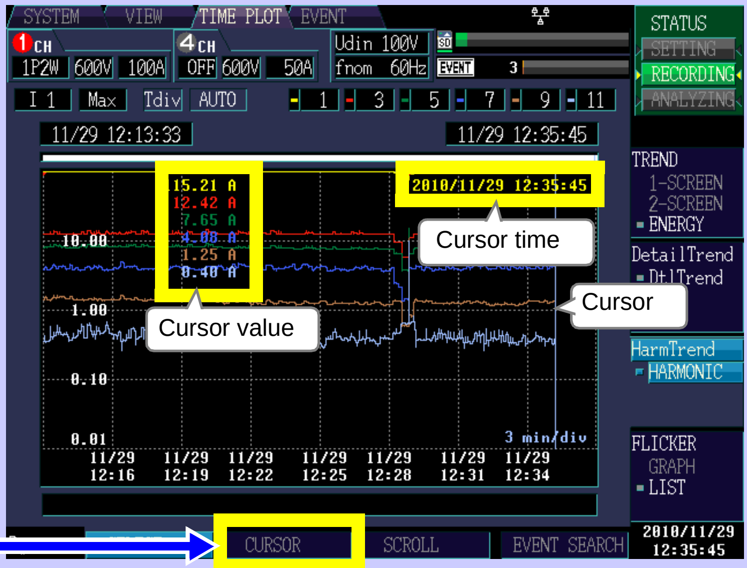
Reading the value above the cursor (Cursor measurements)

This section describes how to read the value and time above the time series graph cursor.

F2 **[CURSOR]**

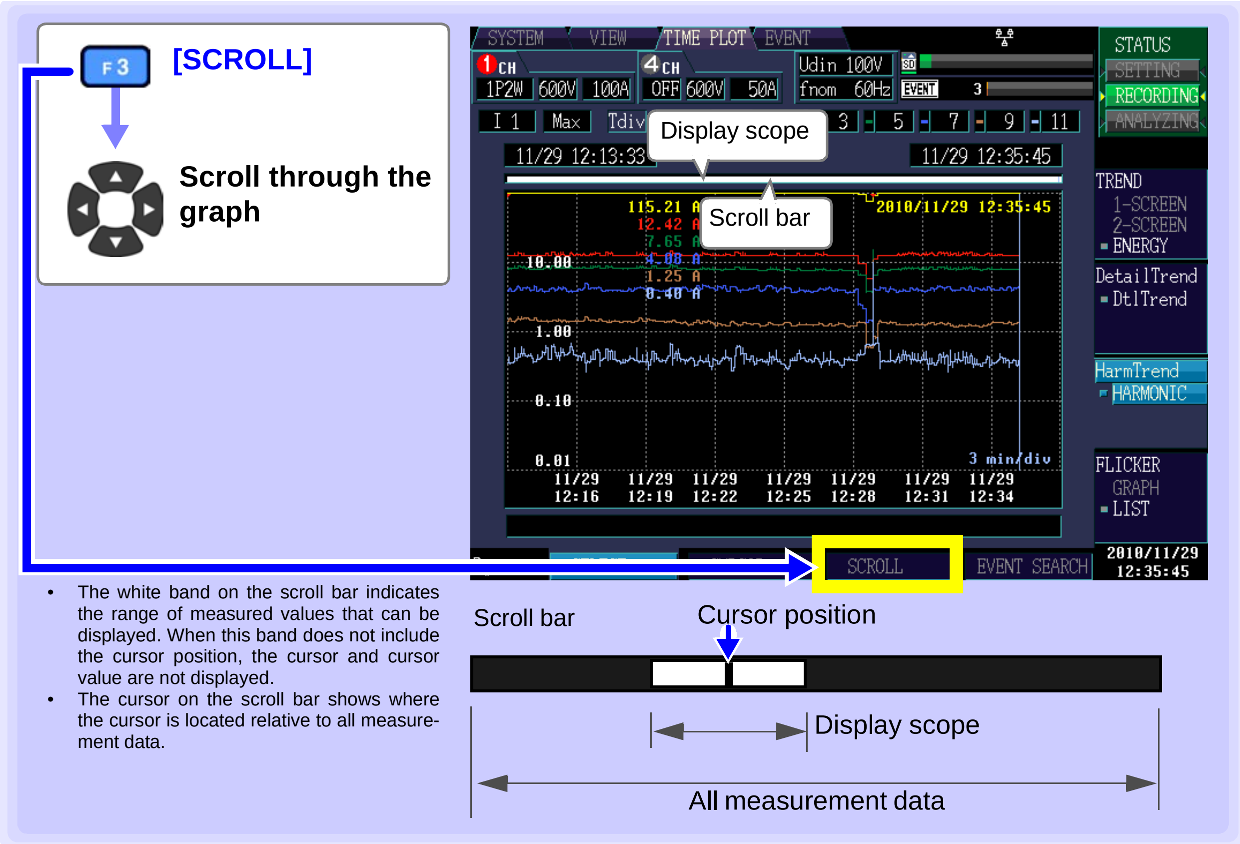
Move the vertical cursor left and right to read the display value.

The cursor value is shown in the same color as the selected order.



Scrolling through waveforms

During recording, the X-axis is automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left and right.



Searching for events

You can search for the time the event occurred (event marker).
The start time and stop time event markers are always displayed.
Synchronization is achieved with an event selected from the event list.

7.5 Displaying Flicker Values in Graph and List Form

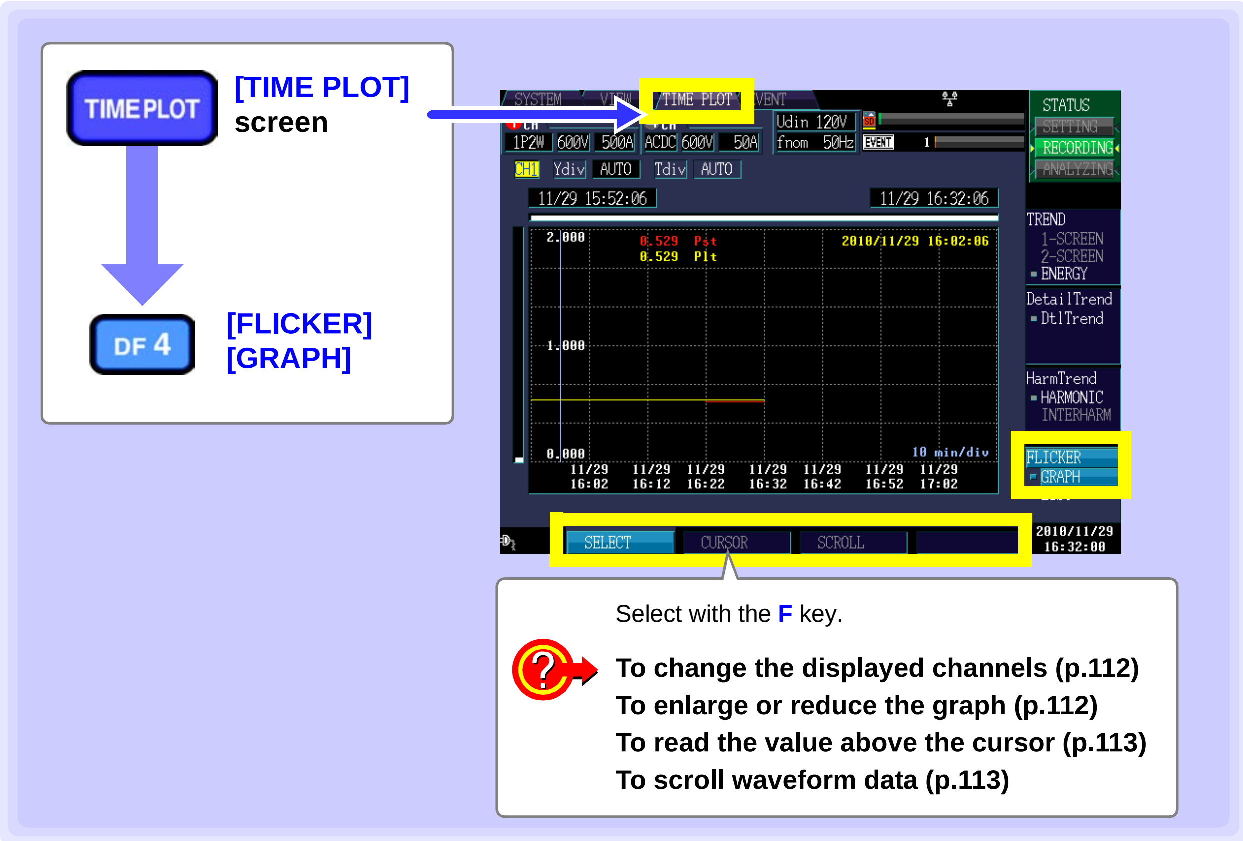
NOTE Flicker measurement cannot be performed during 400 Hz measurement.

IEC flicker meters and ΔV10 flicker meters

Flicker meters are used to measure the sensation of visual instability that occurs due to changes in light source brightness and wavelength. There are two types of flicker meters: IEC flicker meters (UIE flicker meters), which comply with IEC standards, and ΔV10 flicker meters, which are used domestically in Japan. Both types of flicker meter observe fluctuations in voltage and display values used to objectively judge flicker.

Displaying an IEC flicker fluctuation graph

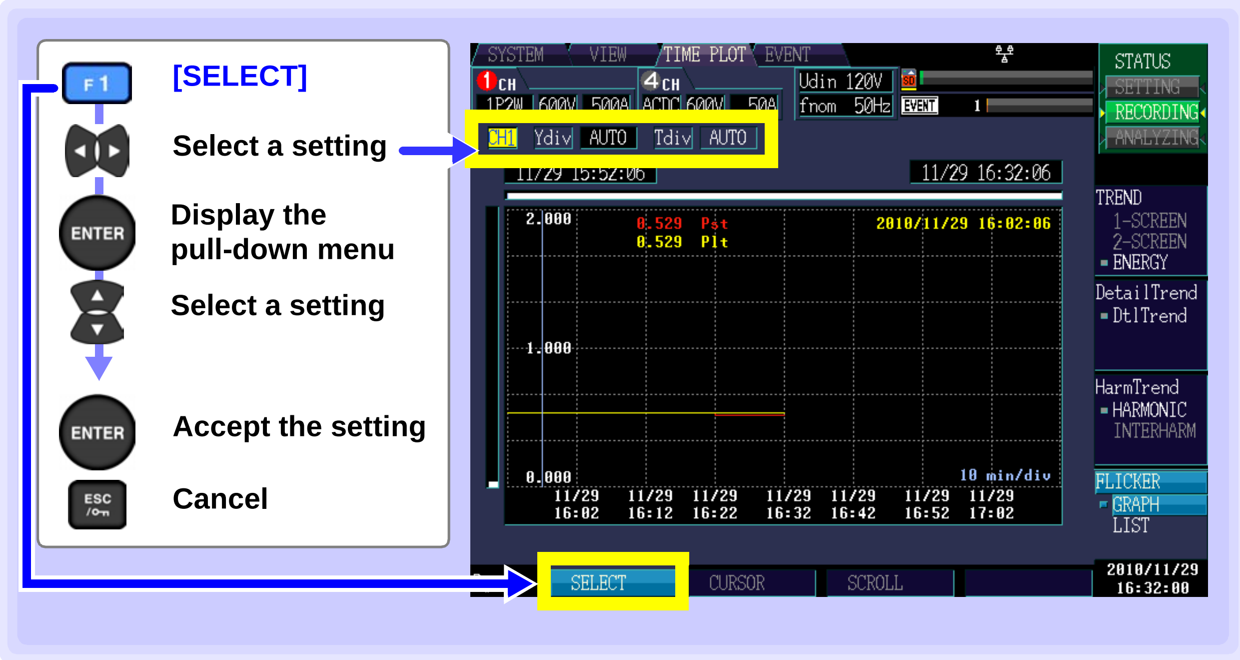
This section describes how to display an IEC flicker fluctuation graph.



NOTE

- The graph is updated every 10 minutes, regardless of the **[TIMEPLOT Interval]** set in **SYSTEM-DF1 [RECORD]** (p.63).
- The graph is not displayed unless **[Flicker]** is set to **[Pst, Plt]** in **[SYSTEM]-DF1 [MAIN]-F1 [MEASURE]**.
- Urms1/2, Irms1/2, Freq_wav, and S(t) are recorded continuously.
- Due to the influence of the high pass filter used, measured values are unstable when starting Pst, Plt measurement immediately after settings have been configured, and the initial measured value may be excessively high. It is recommended to wait about 2 minutes after making settings on the **[SYSTEM]** screen before starting measurement.

Changing the displayed channel and enlarging and reducing graphs (changing the X- and Y-axis scale)



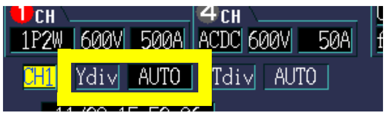
Displayed channel

Settings:(∗ : Default)

CH1∗**, CH2, CH3**

Y-axis scale (Ydiv)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.

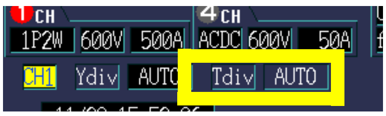


Settings:(∗ : Default)

AUTO∗**, x1, x2, x5, x10, x25, x50**

X-axis scale (Tdiv)

Selects the X-axis scale.



Settings:

From 10min/div

AUTO scaling is used during recording. This cannot be changed.

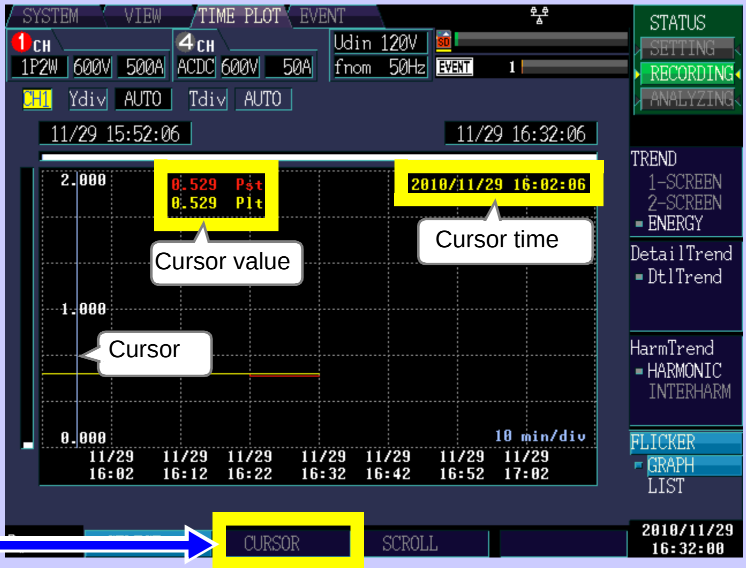
Reading the value above the cursor (Cursor measurements)

This section describes how to read the Pst and Plt measured values every 10 minutes.

F2 **[CURSOR]**

Move the vertical cursor left and right to read the display value.

Cursor value
Top: Pst measured value
Bottom: Plt measured value



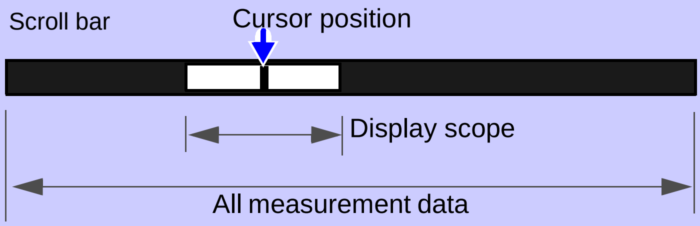
Scrolling through waveforms

During recording, the X- and Y-axis are automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X- and Y-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left, right, up, and down.

F3 **[SCROLL]**

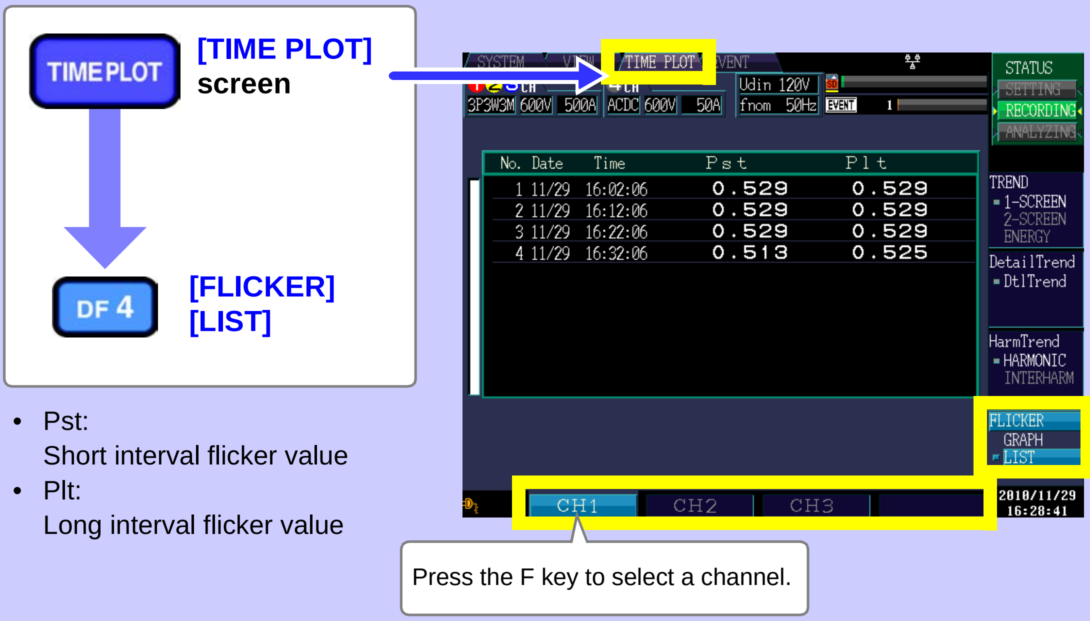
Scroll through the graph

- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar shows where the cursor is located relative to all measurement data.



Displaying an IEC flicker list

This section describes how to display Pst and Plt statistics along with the time and date every 10 minutes.



- Pst:
  Short interval flicker value
- Plt:
  Long interval flicker value

NOTE

- Statistics consist of a list of the following IEC flicker statistics (Pst and Plt) along with the time and date, which is updated every 10 minutes.
- This information will not be displayed unless **[Flicker]** has been set to **[Pst, Plt]** in **[SYSTEM]-DF1 [MAIN]-F1 [MEASURE]**.
- EN50160,"Voltage Characteristics in Public Distribution Systems," gives "Plt ≤ 1 for 95% of week" as a limit value.
- For IEC 61000-4-30 Plt values, use only the values shown with even numbered 2-hour intervals, and discard the other Plt values. The other Plt values are provided for information only, and are not IEC 61000-4-30 Plt values.

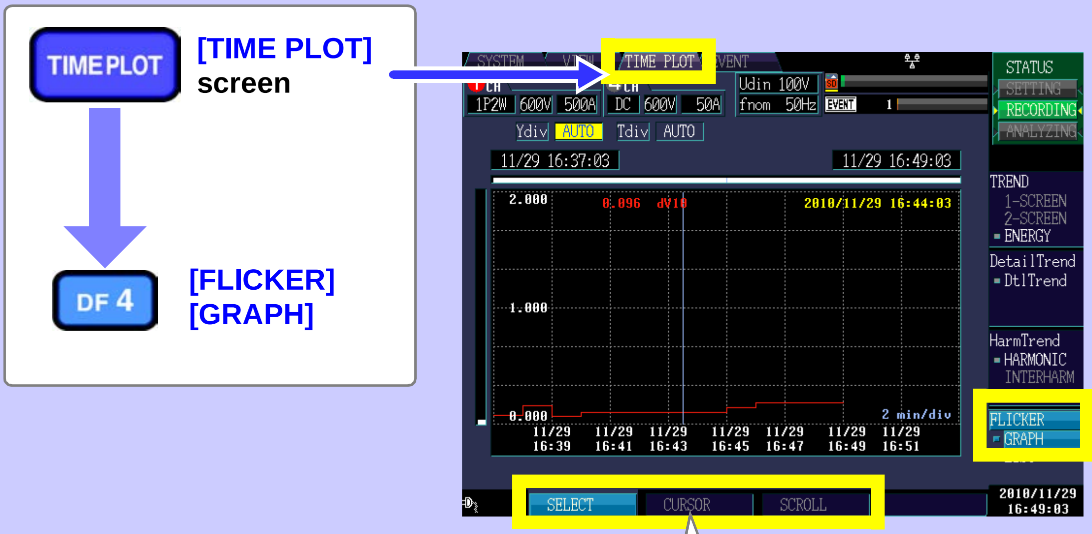
Flags

The measurement algorithm may generate unreliable values during dips, swells, and interruptions. The possible unreliability of these measured values (set-values) is indicated by flags that are displayed with TIMEPLOT data when dips, swells, or interruptions occur. Even when dip, swell, and interruption events have been turned off, flags are shown with measurement data when a dip or interruption (when the voltage falls 10% relative to the nominal voltage) or swell (when the voltage rises 200%) is judged to have occurred.

Flag icon: 

Displaying a ΔV10 flicker fluctuation graph

This section describes how to display a ΔV10 flicker fluctuation graph.



Select with the **F** key.

To enlarge or reduce the graph (p.116)
To read the value above the cursor (p.117)
To scroll waveform data (p.117)

NOTE

- The graph is updated once a minute, regardless of the TIMEPLOT interval set in **[SYSTEM]-DF1 [RECORD]**.
- The graph is not displayed unless **[Flicker]** is set to **[DV10]** in **[SYSTEM]-DF1 [MAIN]-F1 [MEASURE]**.
- ΔV10 flicker can be measured simultaneously for the voltage channels U1, U2, and U3 (depends on connection).

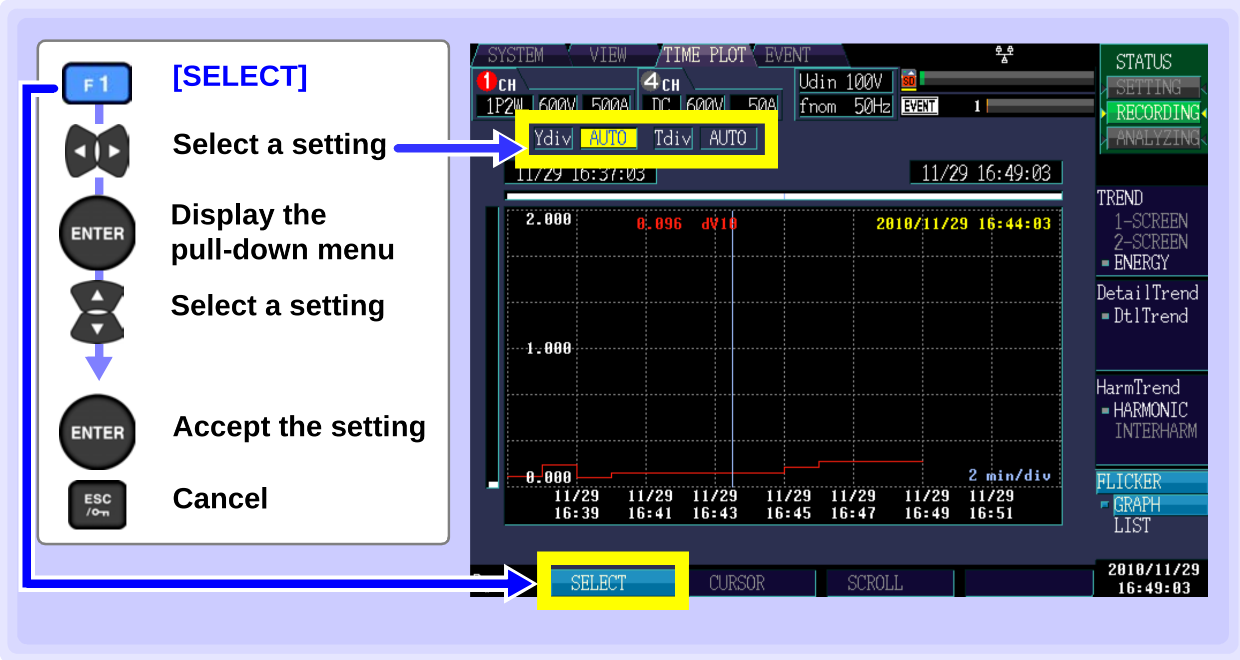
ΔV10 flicker reference voltage

In ΔV10 flicker measurement, the reference voltage is automatically set internally using AGC (automatic gain control).

Once the fluctuating voltage value has stabilized, the reference voltage is automatically changed to that value. Consequently, there is no need to switch supply voltage settings as with conventional ΔV10 flicker meters.
(Example)
Fluctuating voltage: Stabilizes at 96 Vrms The reference voltage is automatically changed to 96 V rms.
Fluctuating voltage: Stabilizes at 102 Vrms The reference voltage is automatically changed to 102 V rms.

Due to the influence of the high pass filter used in ΔV10 flicker measurement, measured values are unstable when starting ΔV10 measurement immediately after settings have been configured, and the first and second ΔV10 measured values may be excessively high. It is recommended to wait about 5 minutes after making settings on the **[SYSTEM]** screen before starting measurement.

Enlarging or reducing the graph (changing the X- and Y-axis scale)



Y-axis scale (Ydiv)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.

Settings:(∗ : Default)

AUTO∗, x1, x2, x5, x10, x25, x50

X-axis scale (Tdiv)

Selects the X-axis scale.

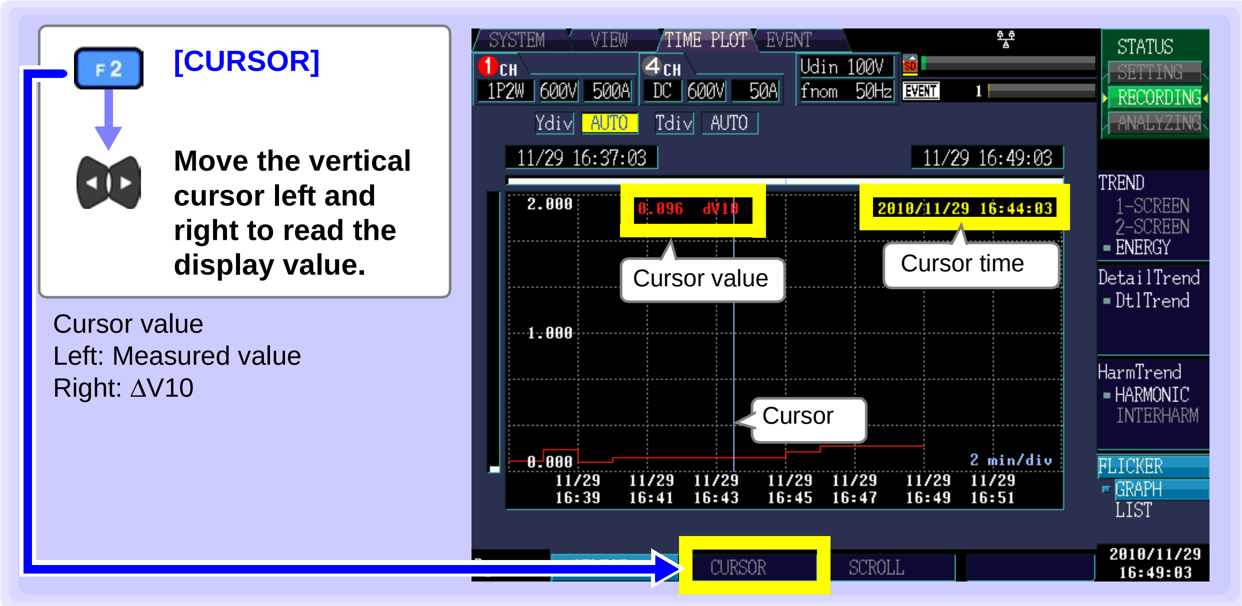
Settings:

From 1min/div

AUTO scaling is used during recording. This cannot be changed.

Reading the value above the cursor (Cursor measurements)

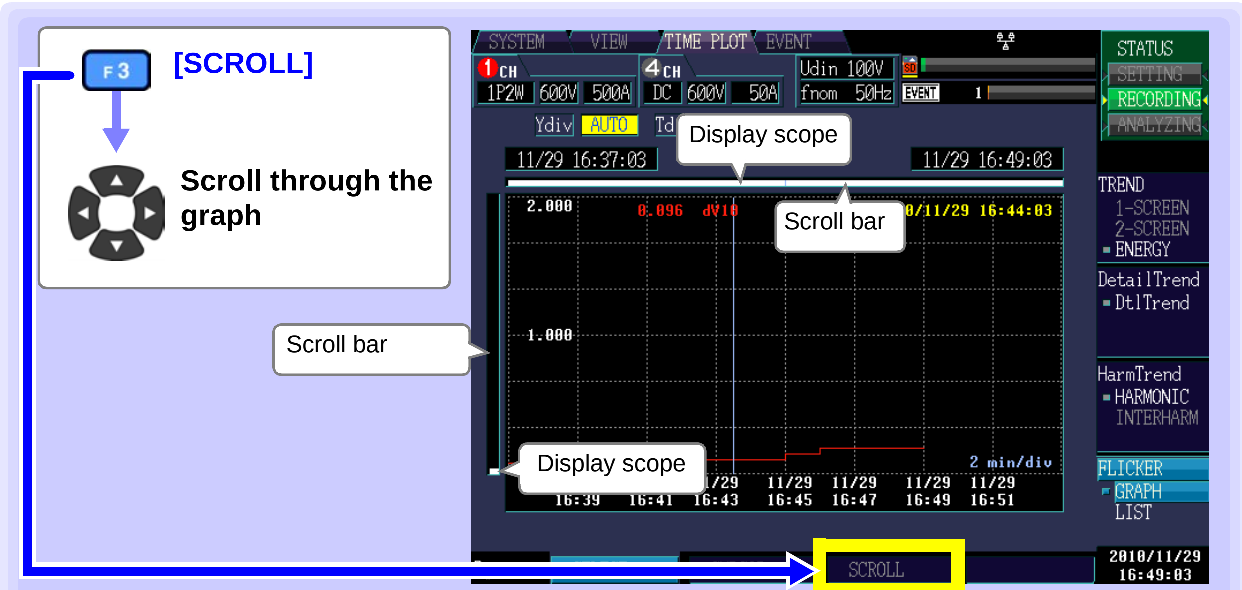
This section describes how to read the ΔV10 flicker measured value once a minute.



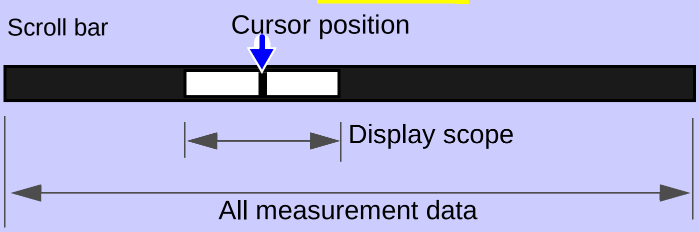
NOTE The time displayed during cursor measurement is based on the CH1 voltage (U1). The event time shown on the event list and the time displayed during cursor measurement may not agree.

Scrolling through waveforms

During recording, the X- and Y-axis are automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X- and Y-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left, right, up, and down.



- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar shows where the cursor is located relative to all measurement data.



Displaying a ΔV10 flicker list

This section describes how to display the following ΔV10 flicker statistics along with the time and date once an hour:

- ΔV10 flicker 1-hour maximum value
- ΔV10 flicker 1-hour fourth-largest value
- ΔV10 flicker 1-hour average value

ΔV10 flicker statistics for the measurement period are displayed. Each ΔV10 value is updated once a minute.

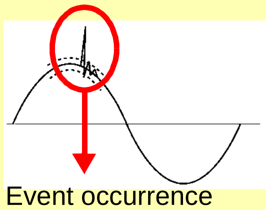
- ΔV10 flicker overall maximum value

NOTE

- Statistics are updated once an hour, and the ΔV10 flicker overall maximum value is updated once a minute.
- The list is not displayed unless **[Flicker]** is set to **[DV10]** in **[SYSTEM]**-DF1 **[MAIN]**-F1 **[MEASURE]**.
- In Japan, the average (ΔV10 flicker 1-hour average value) and maximum (ΔV10 flicker 1-hour maximum value, 1-hour fourth-largest value, or overall maximum value) limit values for ΔV10 flicker are 0.32 V and 0.45 V, respectively.

Checking Events (EVENT screen) Chapter 8

Data is analyzed on the **[EVENT]** screen. For more information about events, see "Appendix 2 Explanation of Power Supply Quality Parameters and Events" (p.A4).



Each time an event occurs, an event is added to the **[EVENT LIST]** screen.

■ Display the event list. (p.121)

You can check events that have occurred on the **[EVENT LIST]** screen.

■Analyze events. (p.124 to p.132)

You can display the screen at the time the selected event occurred.

Events displayed by the PW3198

- Start recording events
- Stop recording events
- Calculation events (events for which one or more thresholds can be set)
- Event waveforms (transient waveforms, high-order harmonic data, fluctuation data)

NOTE

- When making measurements using events, be sure to set the event setting on the **[SYSTEM]** screen to ON.

SYSTEM → DF 2 **[EVENT1]** DF 3 **[EVENT2]**

See: "5.5 Changing Event Settings" (p.66)

- The maximum number of events that can be displayed is 1,000. Depending on the repeated recording and repeat count settings, up to 55,000 events can be recorded. (Event data should be analyzed using the 9624-50 PQA Hi-View Pro software.)

8.1 Using the EVENT screen

Pressing the **DF1** key on the **[EVENT]** screen displays the **[EVENT LIST]** screen.

EVENT **EVENT screen**

About screen configuration (p.20)

DF 1 EVENT LIST

The screen shown varies with the instrument's internal operating state.

Screen operation is limited depending on the instrument's internal operating state.

Internal operating state	Display update
[SETTING]	None
[RECORDING]	After each event
[ANALYZING]	Stop

Relationship between instrument status and key operation

[SETTING] ENTER Set → START STOP Start recording → **[RECORDING]** → START STOP Stop recording → **[ANALYZING]**

DATA RESET Revert to **[SETTING]** mode

When you want to start recording, but START STOP does not work because the instrument is in [ANALYZING] mode

DATA RESET Return to **[SETTING]** mode from **[ANALYZING]** mode → START STOP Start recording → **[RECORDING]**

When you want to change settings in [RECORDING] or [ANALYZING] mode

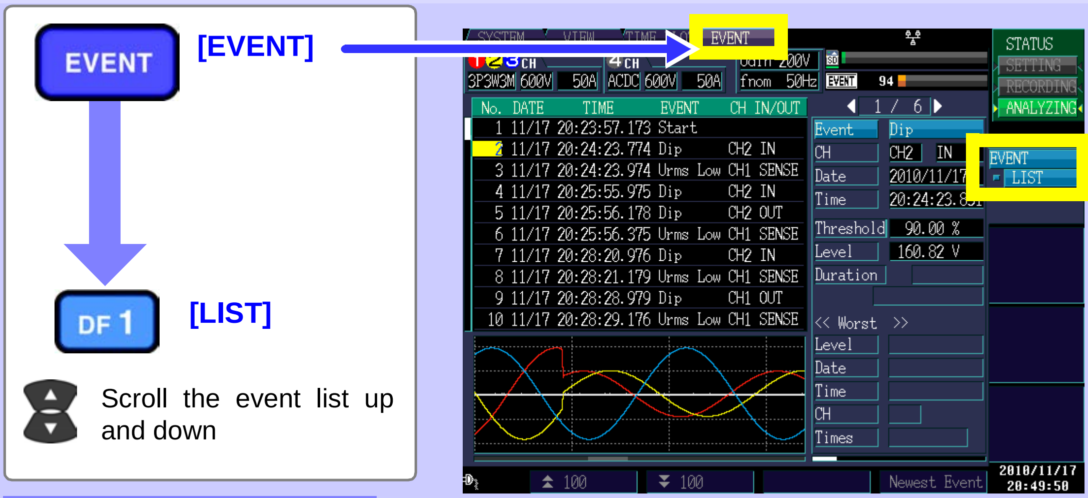
In **[RECORDING]** mode: START STOP Stop recording → DATA RESET Revert to **[SETTING]** mode → **[SETTING]**

In **[ANALYZING]** mode: DATA RESET Revert to **[SETTING]** mode → **[SETTING]**

In both cases, all displayed measurement data will be deleted.

8.2 Displaying the Event List

Displays events in a list.



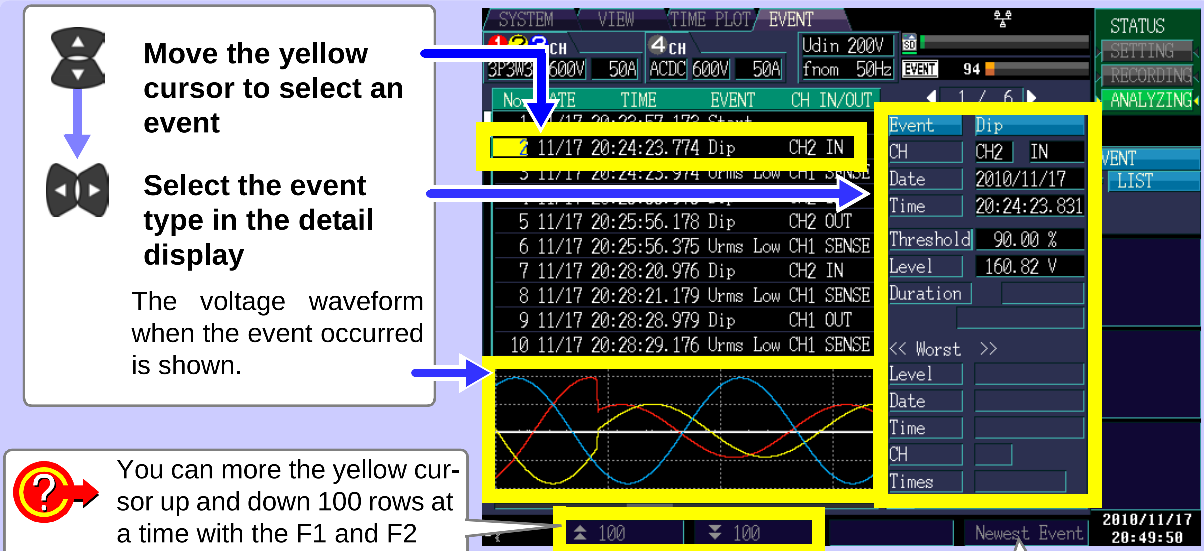
See: "Event items, list notation, and saved items" (p.122)

To analyze the state when the event occurred (p.124)
(Available only in **[ANALYING]** mode.)
To analyze the transient waveform (p.126)
To view high-order harmonic measured values (p.129)
To check fluctuation data (p.132)

- Information that is recorded as the event includes the start, stop, the PW3198 message, and event parameters set in the **[SYSTEM]** screen.
- Up to 1,000 events can be displayed, numbered from 1 to 1,000.
- When events with multiple differing parameters occur during the same approximately 200 ms period, they are displayed together as a single event. A list of the multiple parameters is shown to the right.

Displaying event details

Select an event to display detailed event information and multiple event parameters.



You can more the yellow cursor up and down 100 rows at a time with the F1 and F2 keys.

You can move the cursor to the most recent event with the **F4** key.

Event items, list notation, and saved items

Event items	Event list notation	IN/OUT/ SENSE	Saved items			
			Measurement items	Event waveform	High-speed waveform	Fluctuation data
Transient overvoltage	Tran	IN/OUT	All instantaneous values (Frequency, voltage, current, power, power factor, unbalance factor, harmonic voltage, harmonic current, harmonic power, harmonic voltage distortion factor, harmonic current distortion factor, K factor, high-order harmonic voltage component and current component, etc.)	Yes	Transient overvoltage waveform	
Swell	Swell	IN/OUT		Yes		Yes
Dip	Dip	IN/OUT		Yes		Yes
Interruption	Intrpt	IN/OUT		Yes		Yes
Inrush current	Inrush (Irms1/2)	IN/OUT		Yes		Yes
Frequency	Freq	IN/OUT		Yes		
Frequency cycle	Freq_wav	IN/OUT		Yes		
Voltage waveform peak	Upk	IN/OUT		Yes		
RMS voltage	Urms	IN/OUT/SENSE		Yes		
Voltage DC change (CH4 only)	Upp	IN/OUT		Yes		
Current waveform peak	Ipk	IN/OUT		Yes		
RMS current	Irms	IN/OUT/SENSE		Yes		
Current DC change (CH4 only)	Ipp	IN/OUT		Yes		
Active power	P	IN/OUT		Yes		
Apparent power	S	IN/OUT		Yes		
Reactive power	Q	IN/OUT		Yes		
Power factor/ displacement factor	PF	IN/OUT		Yes		
Voltage negative-phase unbalance factor	Uunb	IN/OUT		Yes		
Voltage zero-phase unbalance factor	Uunb0	IN/OUT		Yes		
Current negative-phase unbalance factor	Iunb	IN/OUT		Yes		
Current zero-phase unbalance factor	Iunb0	IN/OUT		Yes		
Harmonic voltage	Uharm	IN/OUT		Yes		
Harmonic current	Iharm	IN/OUT		Yes		
Harmonic power	Pharm	IN/OUT		Yes		
Phase difference of harmonic voltage and harmonic current	Pphase	IN/OUT		Yes		
Total harmonic voltage distortion factor	Uthd	IN/OUT		Yes		
Total harmonic current distortion factor	Ithd	IN/OUT		Yes		
K factor	KF	IN/OUT		Yes		
High-order harmonic voltage component	UharmH	IN/OUT		Yes	High-order harmonic waveform	
High-order harmonic current component	IharmH	IN/OUT		Yes	High-order harmonic waveform	
Voltage waveform comparison	Wave			Yes		
Timer event	Timer			Yes		
Continuous event	Cont			Yes		
External event	Ext			Yes		
Manual event	Manu			Yes		
Start	Start			Yes		
Stop	Stop			Yes		
GPS Note 1	GPS_IN			Yes		
	GPS_OUT			Yes		
	GPS_Err			Yes		

Note1
- GPS error (GPS error): GPS IN
- GPS error cleared (GPS positioning): GPS OUT
- GPS time correction failure (GPS time error): GPS Err
  IN/OUT rules are irrelevant.

NOTE Fluctuation data is only displayed for IN events. If a series of swell, dip, interrupt, or inrush current IN events occur, fluctuation data may be unavailable.

Event list order

The first event to occur (the start event) is assigned No. 1, and subsequent events are assigned numbers in order as they occur.

Event list display

Event list

The event list is displayed in the order events occur.

Displayed item	Contents	Example
No.	Order of event occurrence	1
Date	Event occurrence (date)	2001/6/7
Time	Event occurrence (time)	10:05:32.016
EVENT	Event item	Uharm
CH	Event channel (CH1, CH2, CH3, CH4, sum)	CH2
IN/OUT	IN : Event occurrence OUT : Event end SENSE : Sense event occurrence	IN

When two event IN items occur simultaneously, voltage factor events are given precedence in the display. Similarly, when two event OUT items occur simultaneously, voltage factor events are given precedence in the display.

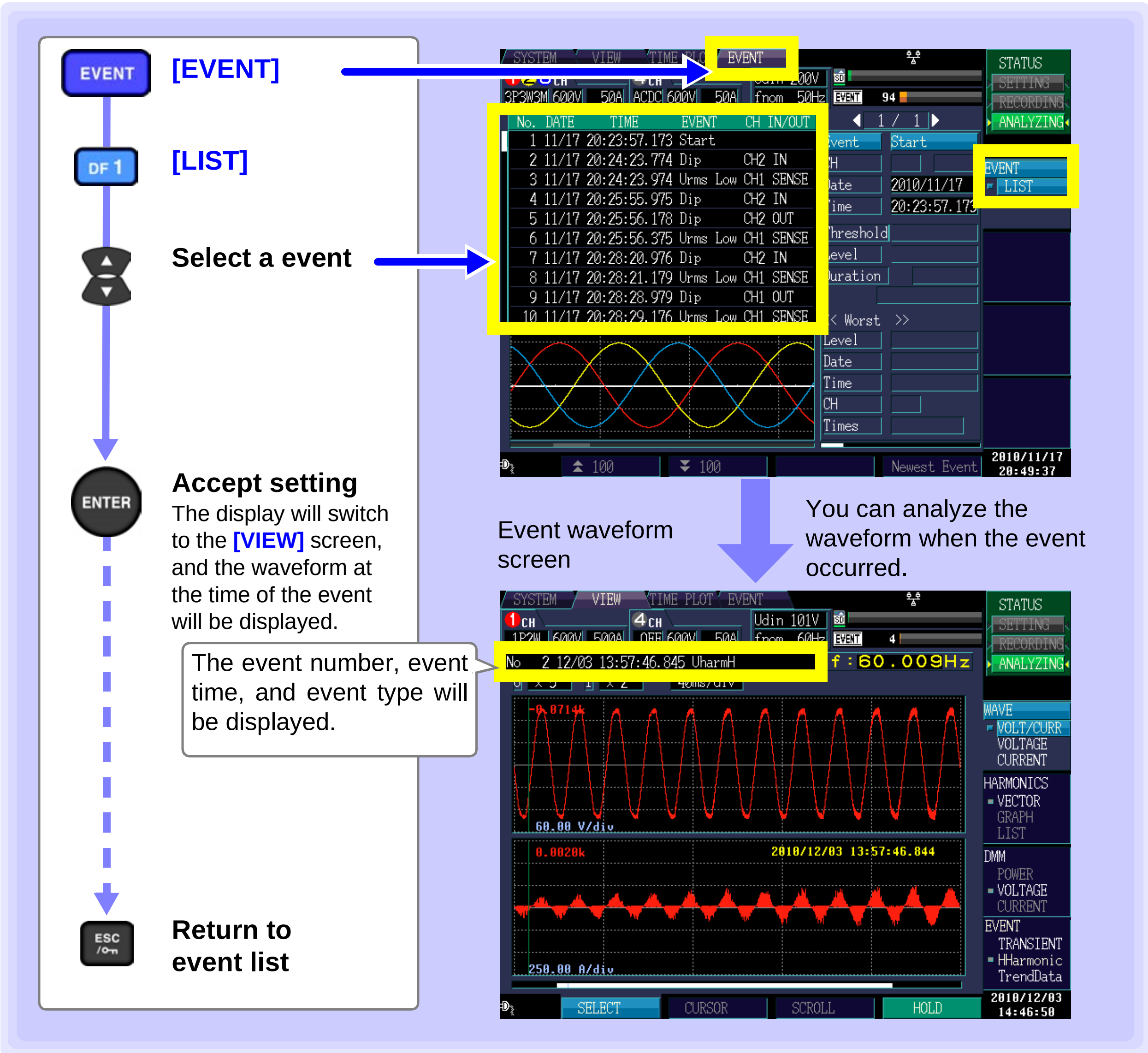
Event details list

Some detailed information cannot be displayed in the event list alone, and multiple events may occur simultaneously. In that case, representative events are shown in the event list, and other events are shown with the event description on the details list.

Displayed item		Contents	Example
EVENT		Event item (variable) Harmonic and inter-harmonic orders are also shown for harmonic events.	Uharm (2)
CH		Event channel (CH1, CH2, CH3, CH4, sum) and IN (event occurrence), OUT (event end), and SENSE (sense event occurrence) For frequency events, the list indicates either up (when the reading was greater than the threshold) or down (when the reading was less than the threshold).	CH4 OUT
Date		Indicates the date on which the event was detected.	2001/6/7
Time		Indicates the time at which the event was detected.	10:05:32.016
Threshold		Set event threshold (sense value, measured value)	62.053 V
Level		Measured value when event was detected For transient overvoltage values, the transient width is also shown in 500 ns units.	1012.0 V
Duration		Indicates the period after which the reading returned after the threshold was exceeded, or the period from IN to OUT.	0:57:12.032 10.5µs
Worst	Level	Worst measured value during event period For transient overvoltage values, the maximum transient overvoltage value width during the event period is also shown.	120.01 V 10.5 µs
	Date	Indicates the date on which the worst value was detected.	2001/6/7
	Time	Indicates the time at which the worst value was detected.	10:05:32.016
	CH	Channel on which the worst value was detected	CH1
Times		Number of transient overvoltages detected from the transient overvoltage event IN to the transient overvoltage event OUT (up to 99,999)	5Times

8.3 Analyzing the Measurement Line Status When Events Occur

You can display the waveform and measured values that obtained when an event occurred on the [VIEW] screen by selecting the event you wish to analyze on the [EVENT LIST] screen.



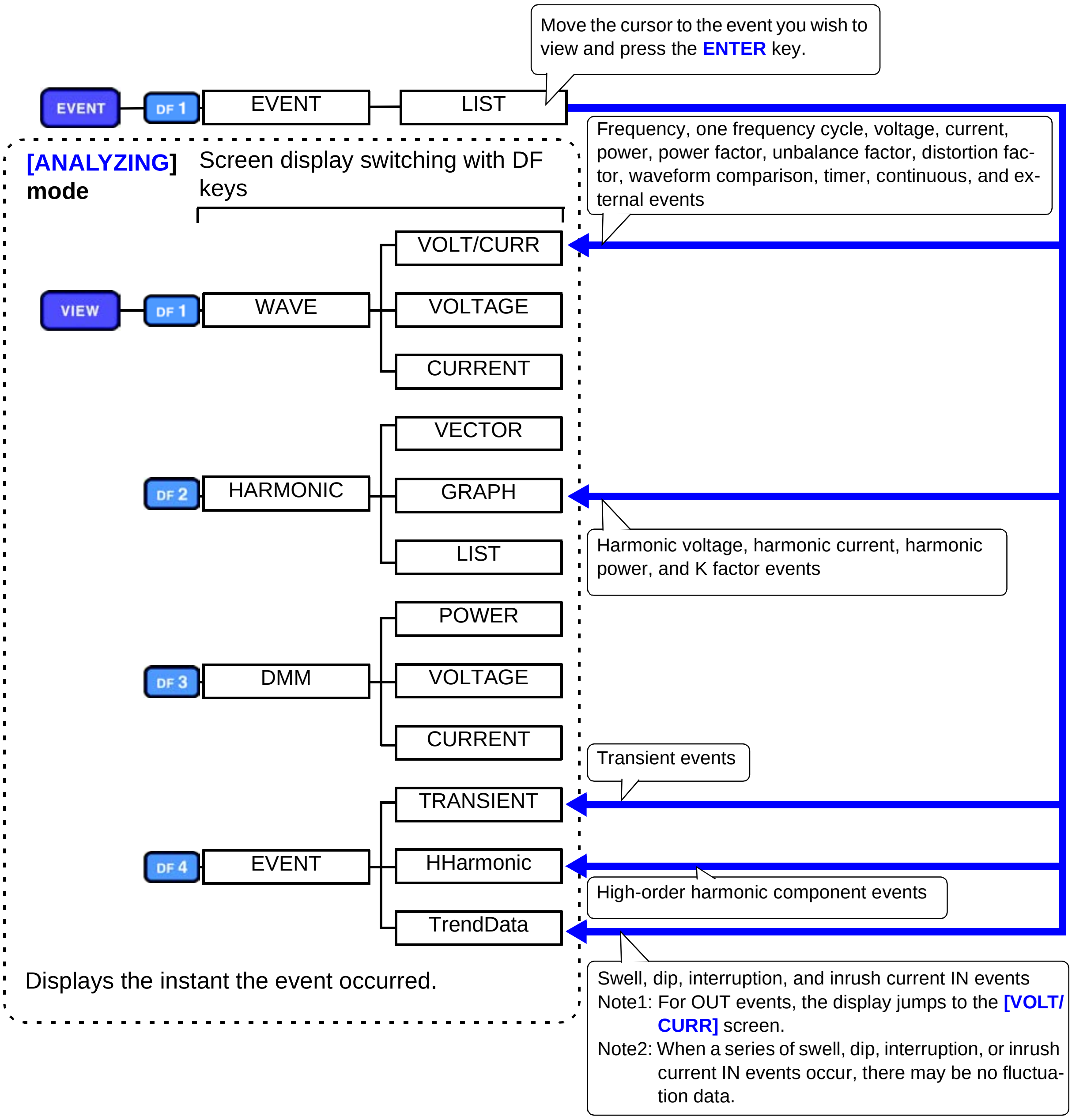
NOTE

You can change to the event generation screens (**DF1 [WAVE]**, **DF2 [HARMONICS]**, **DF3 [DMM]**, and **DF4 [EVENT]**) by pressing a DF key from the event waveform screen.

Screen transitions and measurement data when events occur

Event jump function

Moving the cursor to the event you wish to view on the event list and pressing the **ENTER** key displays the measurement data for that time. The screen displayed initially varies with the event that occurred. Subsequently, you can press a DF key to display the desired screen and check measurement data.



How can event waveforms be recorded?

See: "Appendix 4 Recording TIMEPLOT Data and Event Waveforms" (p.A14)

8.4 Analyzing Transient Waveforms

Displaying transients

EVENT **[EVENT]**

DF 1 **[LIST]**

Select an event for which “Tran” is shown on the event list or event details list

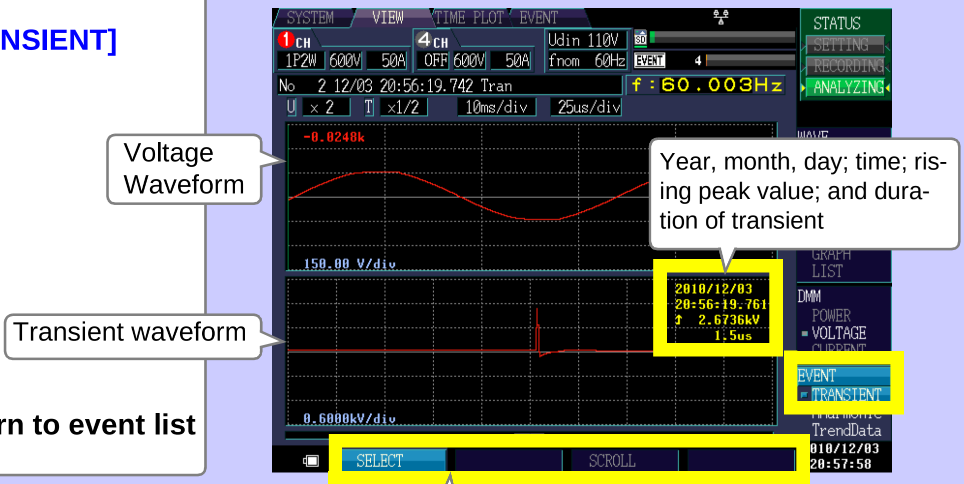
ENTER **Accept setting**

The display will switch to the **[VIEW]** screen, and the waveform at the time of the event will be displayed.

DF 4 **[TRANSIENT]**

ESC **Return to event list**

Voltage/Transient waveforms display



Select with the **F** key.

To enlarge or reduce the transient waveform (p.127)
To scroll transient waveform data (p.128)

Enlarging and reducing the transient waveform

Y-axis range

To reduce the waveform, increase the voltage value per division.
To enlarge the waveform, reduce the voltage value per division.

Setting Contents:(∗ : Default setting)

Voltage waveform range (U)
x1/3, x1/2, x1∗, x2, x5, x10, x20, x50
Transient waveform range (T)
x1/2∗, x1, x2, x5, x10, x20

X-axis range (Tdiv)
(left: voltage waveform range; right: transient waveform range)

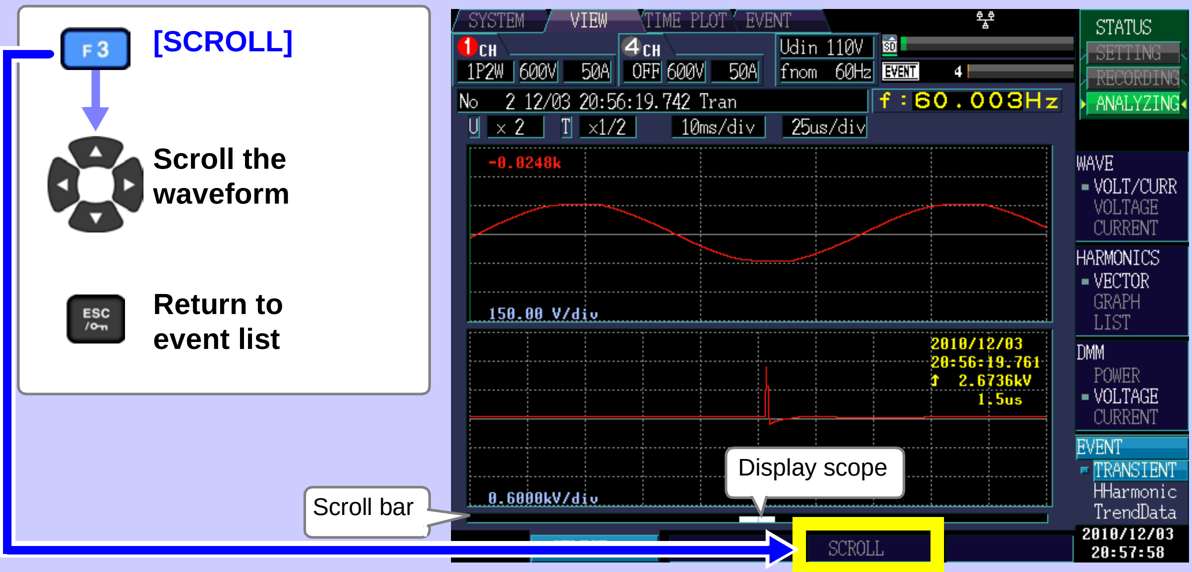
Selects the X-axis scale.

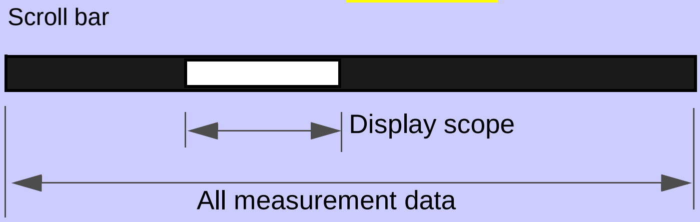
Setting Contents:(∗ : Default setting)

Voltage waveform range:
5ms/div∗, 10ms/div, 20ms/div, 40ms/div
Transient waveform range:
25µs/div∗, 50µs/div, 100µs/div, 200µs/div, 400µs/div

Scrolling the transient waveform

You can check all waveform data by scrolling the waveform horizontally.





The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.

8.5 Viewing High-order Harmonic Waveforms

RMS values for noise components at 2 kHz and higher are known as the high-order harmonic component. When a high-order harmonic component event is detected, the high-order harmonic waveform is recorded. The high-order harmonic waveform is a 40 ms instantaneous waveform sampled at 200 kHz.

EVENT **[EVENT]**

DF 1 **[LIST]**

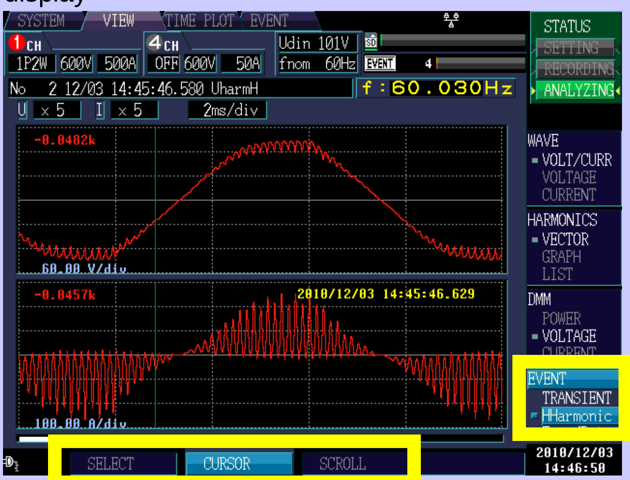
Select a event

ENTER **Accept setting**
The display will switch to the **[VIEW]** screen, and the waveform at the time of the event will be displayed.

DF 4 **[HHarmonic]**

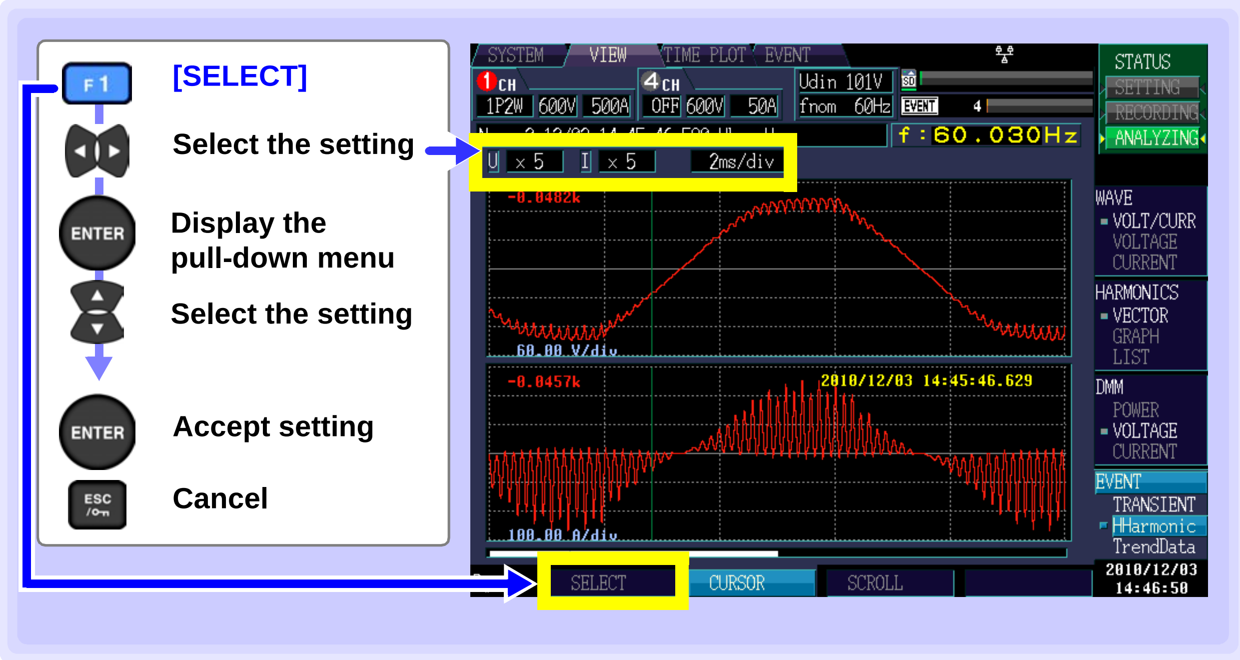
ESC **Return to event list**

High-order harmonic waveforms display



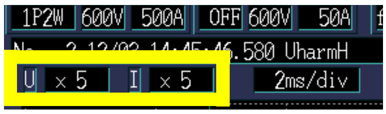
Select with the **F** key.
To enlarge or reduce the graph (p.130)
To read the value above the cursor (p.131)
To scroll waveform data (p.131)

Enlarging or reducing the graph (changing the X- and Y-axis scale)



Y-axis scale (U: Voltage, I: Current)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.

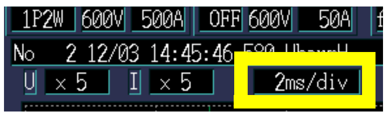


Setting Contents:(⁎ : Default setting)

x1/3, x1/2, x1*, x2, x5, x10, x20, x50

X-axis scale

Selects the X-axis scale.



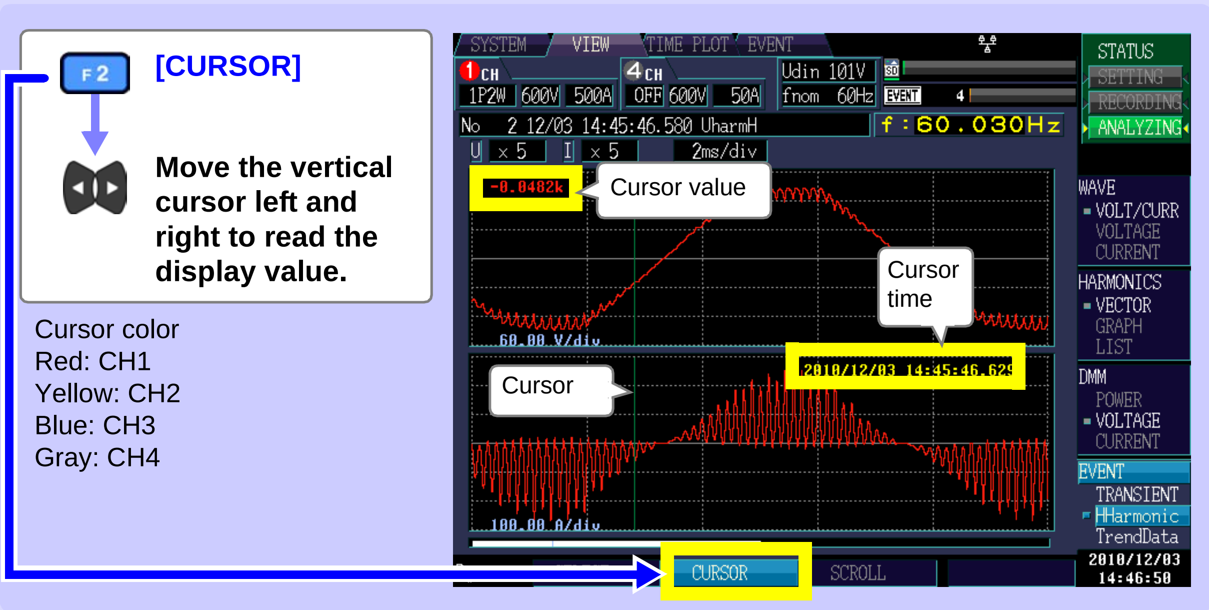
Setting Contents:(⁎ : Default setting)

0.5ms/div*, 1ms/div, 2ms/div,5ms/div,10ms/div

The scale can also be changed without using the pull-down menu by pressing the up and down cursor keys.

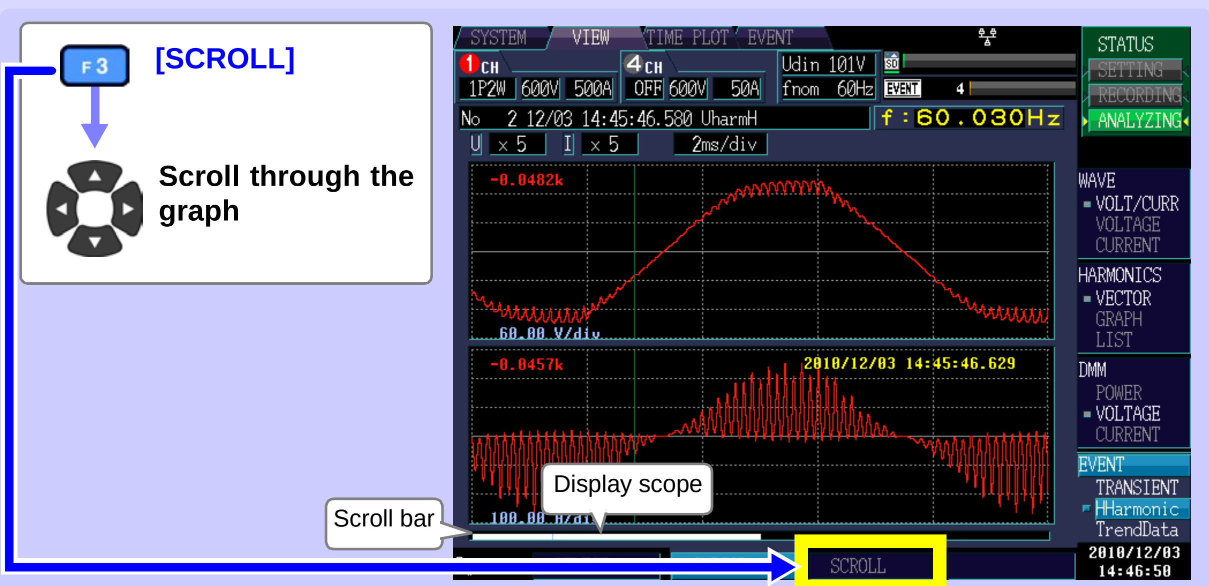
Viewing the value and time at the cursor position (Cursor measurements)

You can read the value and time at the cursor position on waveform graphs.

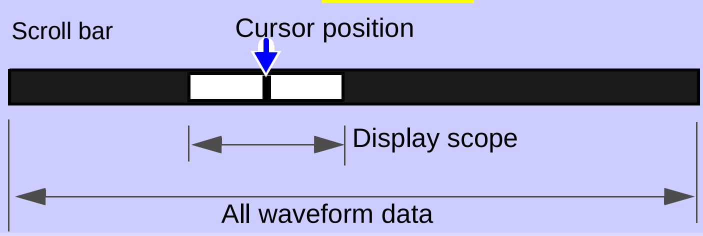


Scrolling the waveform

During recording, the X-axis is automatically scaled so that the full waveform graph fits on the screen. Once recording has stopped and the X-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the waveform graph by moving left, right, up, and down.



- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar indicates where the cursor is located relative to all waveform data.



8.6 Checking Fluctuation Data

Fluctuation data for swell, dip, interruption, and inrush current events when an event occurs is displayed for 30 s (from 0.5 s before to 29.5 s after the event IN) as a time series graph (during 400 Hz measurement, from 0.125 s before to 7.375 s after the event IN).

EVENT **[EVENT]**

DF 1 **[LIST]**

Select a event

ENTER **Accept setting**
The display will switch to the **[VIEW]** screen, and an event will occur.

DF 4 **[TrendData]**

ESC **Return to event list**

Fluctuation data display

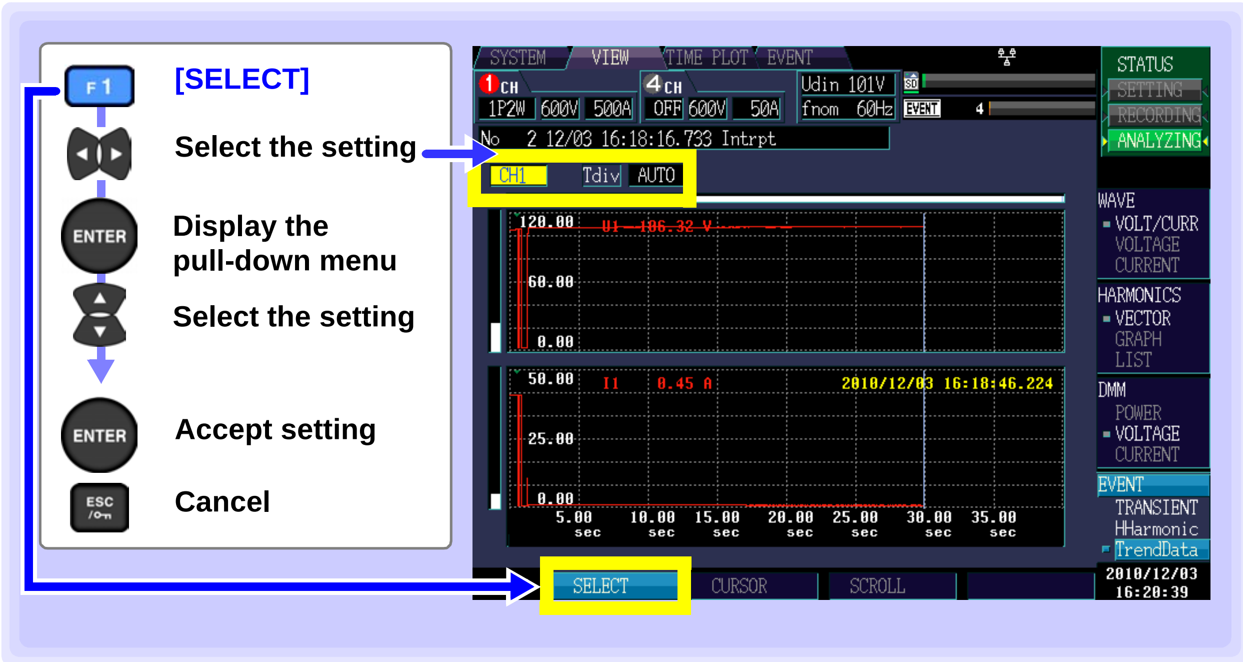
The U1, U2, and U3 time series graphs are displayed. The pre-trigger and total recording periods are fixed at 0.5 and 30 s, respectively.
Red: CH1
Yellow: CH2
Blue: CH3
Gray: CH4
The maximum and minimum values during the TIMEPLOT interval are shown as the MAX and MIN values.

Select with the **F** key.
To change the displayed channels (p.133)
To enlarge or reduce the graph (p.133)
To read the value above the cursor (p.134)
To scroll waveform data (p.134)

NOTE

- Data can be recorded regardless of the recording item settings (p.62) and the TIME-PLOT interval settings (p.63) (**SYSTEM-DF1 [RECORDING]**).
- When an event occurs while 30 s of fluctuation data is being recorded, fluctuation data is only recorded for the first event.
- Ultimately, data can be analyzed in detail and reports generated using the 9624-50 PQA Hi-View Pro software.

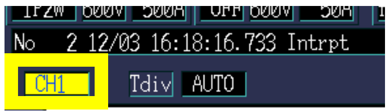
Changing the displayed channel and enlarging or reducing the graph (changing the X-axis scale)



Displayed channel

Setting Contents:(∗ : Default setting)

CH1∗/ **CH2**/ **CH3**/ **CH4** (varies with connection)

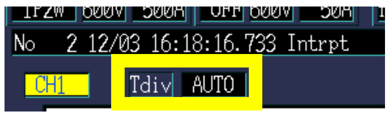


X-axis scale (Tdiv)

When you want to reduce the graph, make the scale smaller.
When you want to enlarge the graph, make the scale larger.

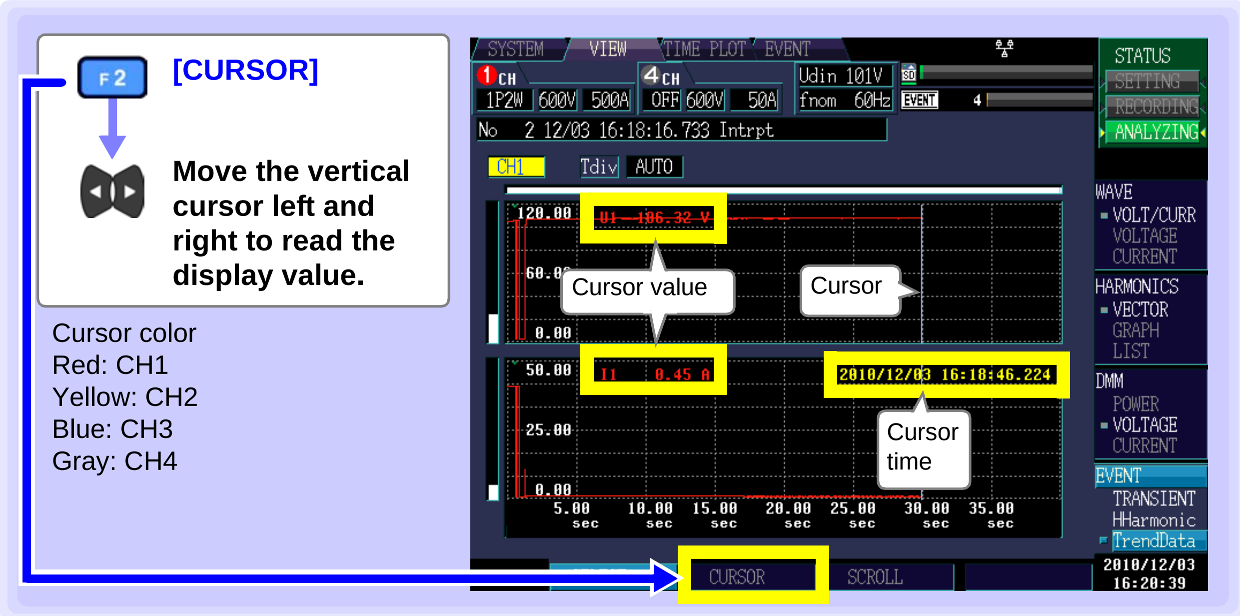
Setting Contents:(∗ : Default setting)

AUTO∗, **x5, x2, x1, x1/2, x1/5, x1/10**



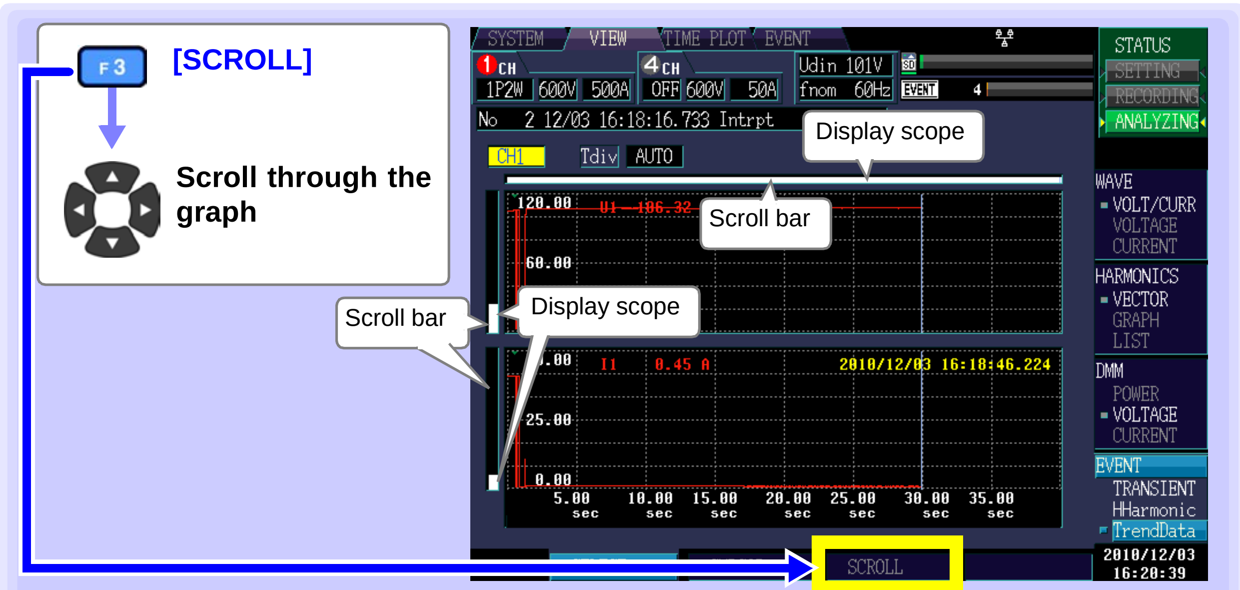
Viewing the value and time at the cursor position (Cursor measurements)

You can read the value and time at the cursor position on time series graphs.

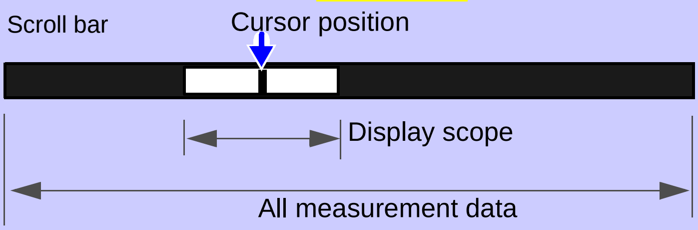


Scrolling the waveform

During recording, the X-axis and Y-axis are automatically scaled so that the full time series graph fits on the screen. Once recording has stopped and the X-axis or Y-axis scale has been changed so that the waveforms do not fit on the screen, you can scroll through the time series graph by moving left, right, up, and down.



- The display scope on the scroll bar (shown in white) illustrates which range of all measurement data is being shown on the screen.
- The cursor on the scroll bar shows where the cursor is located relative to all measurement data.



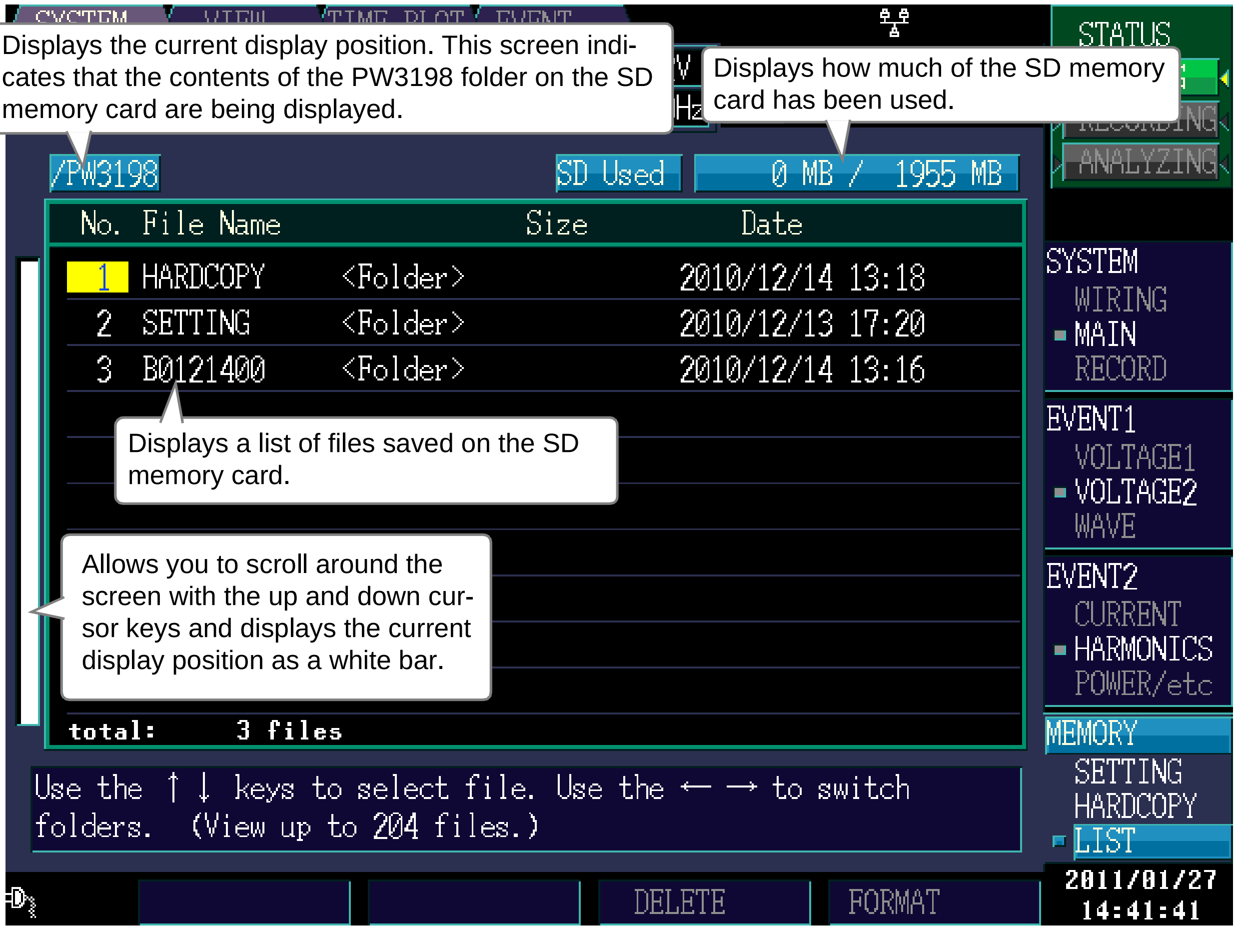
Data Saving and File Operations (SYSTEM-MEMORY screen) Chapter 9

The PW3198 saves settings data, measurement data, waveform data, event data, and screen copy data to an optional SD memory card. (Of this data, only setting conditions can be loaded by the instrument.)

See:"3.5 Inserting (Removing) an SD Memory Card" (p.32)

9.1 [MEMORY] Screen

This section describes the **[MEMORY]** screen.



NOTE An error message will be displayed if the SD memory card experiences an error. SD utilization is not shown.

About File Types

The following file data types may be stored.

Name	Type	Description
00000001.SET	SET	Settings file
00000001.BMP	BMP	Screen copy data file
EV000001.EVT	EVT	Event data file
TR000001.TRN	TRN	Transient waveform file
HH000001.HHC	HHC	High-order harmonic waveform file
000001.WDU	WDU	Fluctuation data file
AT000000.BMP	BMP	Screen data file saved once each screen copy interval
PW3198.SET	SET	Settings data file at start of time series measurement
TP0000.ITV	ITV	Time series measurement normal binary file
FL0000.FLC	FLC	Time series measurement flicker data
HARDCOPY	<Folder>	Folder for saving screen copy data files
SETTING	<Folder>	Folder for saving settings
BYMMDDNN	<Folder>	Folder for saving data (name varies with folder type, date, and number of folder)(p.140))
EVENT	<Folder>	Folder for saving events
AUTOCOPY	<Folder>	Folder for automatically saving screen data (folder for saving AT*******.BMP files)

- Files are numbered consecutively inside each folder.
- The first letter of the folder for saving data indicates the data type, while Y represents the last digit of the year, MM the month, DD the day, and NN the consecutive number for that day.

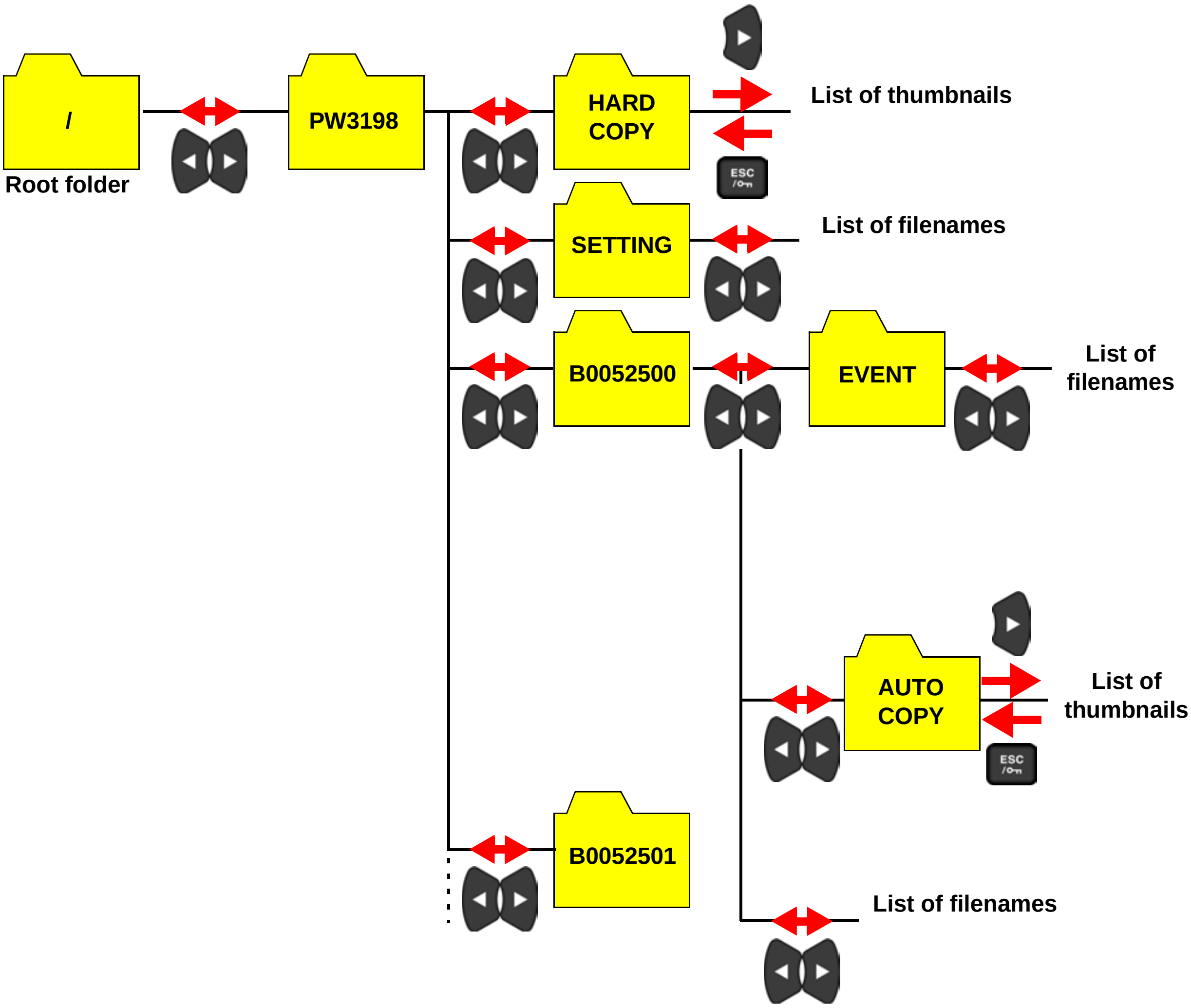
Moving inside folders, moving to the root folder, and list displays

Moving inside a folder

- You can display the contents of a folder by moving the cursor to the folder with the up and down cursor keys and then pressing the right cursor key.
- While the root folder **[/]** is being displayed, you can move to the **[PW3198]** folder with the right cursor key, regardless of the cursor position.
- To go back one folder when the **[HARDCOPY]** or **[AUTOCOPY]** folder is being displayed, press the **ESC** key. For other folders, press the left cursor key.
- You cannot move to folders unrelated to the instrument.

List displays

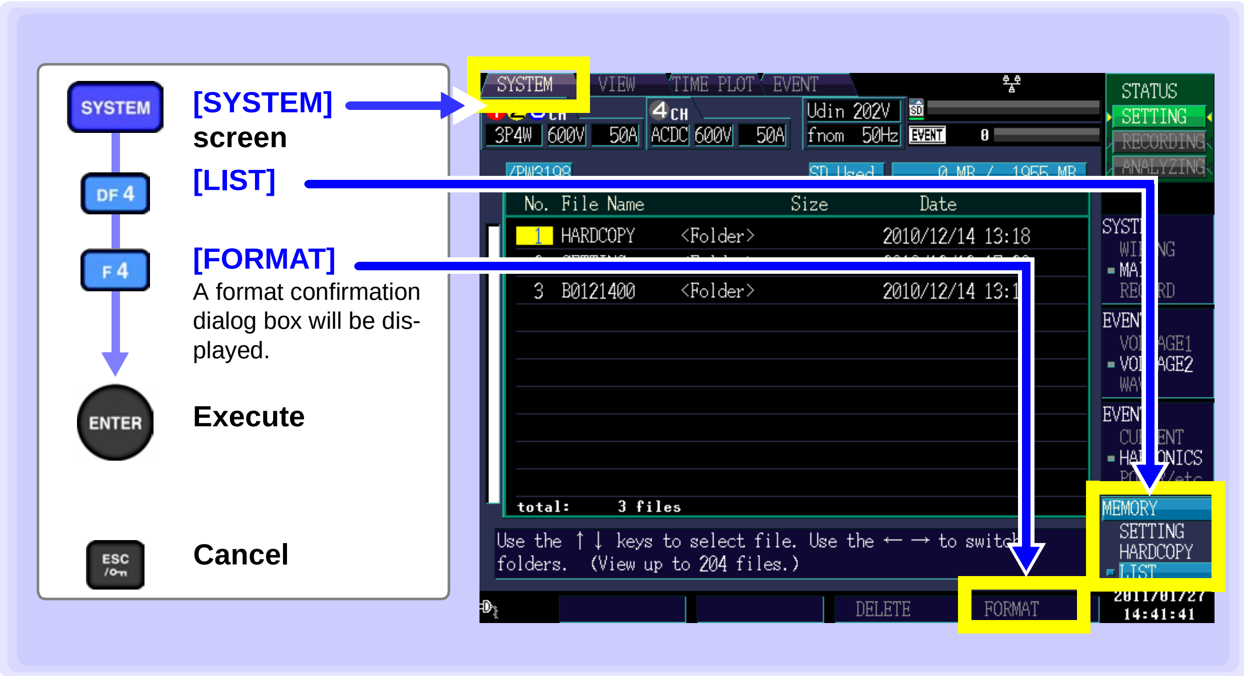
The contents of **[HARDCOPY]** and **[AUTOCOPY]** folders are displayed as a list of BMP file thumbnails, and their contents are displayed in list form. Other folder contents are displayed as a list of filenames.



9.2 Formatting SD Memory Cards

You will need to use this functionality if the SD memory card being used has not been formatted (initialized). Start the formatting process after inserting the SD memory card you wish to format into the instrument (p.32).

Once formatting is complete, the **[PW3198]** folder will be automatically created in the root directory (the uppermost level in the directory structure on the SD memory card).



NOTE

- Formatting erases any data stored on the SD memory card so that it cannot be recovered. Execute only after confirming that no important files will be lost.
  We recommend keeping a backup of any precious data stored on a SD memory card.
- Use the instrument to format cards. Cards formatted on a computer may not use the proper SD format, resulting in decreased memory card performance.
- The instrument can only store data on memory cards that use the SD format.
- Use only HIOKI-approved SD memory cards (model Z4001, etc). Proper operation is not guaranteed if other cards are used.

9.3 Save Operation and File Structure

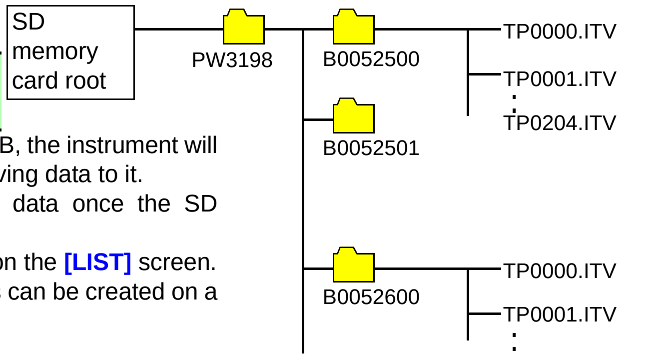
Save operation

Saving measurement data (p.141)

(p.141)

Saving method	Data is automatically saved according to the time control settings.

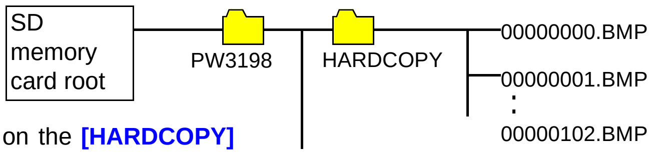
Figure: Time series measurement normal data files



- When the file size exceeds 100 MB, the instrument will create a new file and continue saving data to it.
- The instrument will stop saving data once the SD memory card is full.
- Up to 204 files can be displayed on the **[LIST]** screen.
- Up to 100 measurement data files can be created on a single date.

Saving screen copies (p.144)

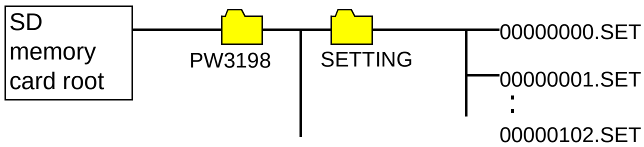
Saving method	Press the **COPY** key while the screen you wish to save is being displayed.



- Up to 102 files can be displayed on the **[HARDCOPY]** screen.

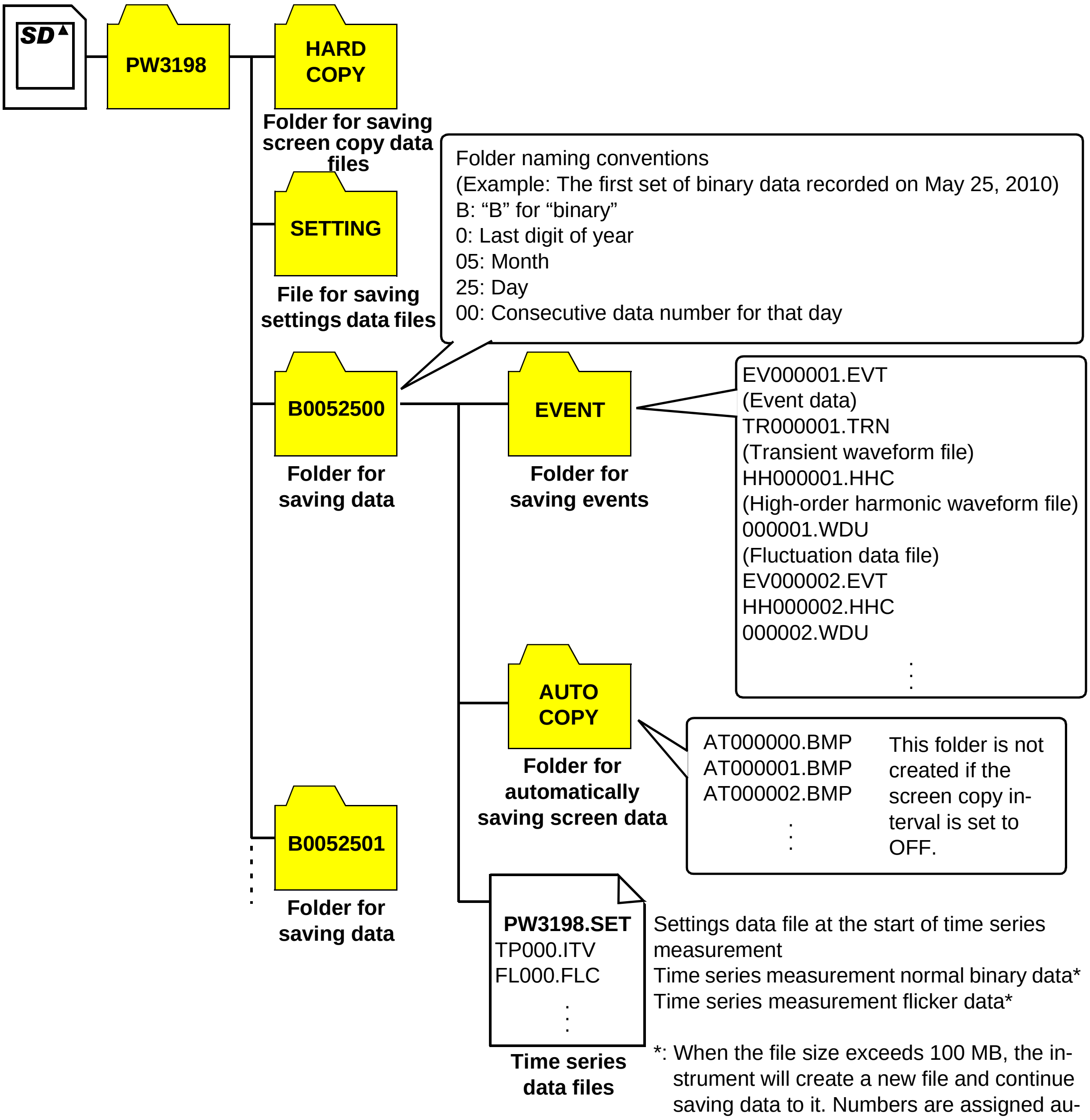
Saving settings data (p.145)

Saving method	Move to the folder in which you wish to save the data on the SD memory card screen and press the **F2** key.



- Up to 102 files can be displayed on the **[SETTING]** screen.

File structure (overall)



*: When the file size exceeds 100 MB, the instrument will create a new file and continue saving data to it. Numbers are assigned automatically, as for TP0001.ITV.

9.4 Saving, Display and Deleting Measurement Data

Saving data

Characteristics selected with the **[Recording Items]** setting are all automatically saved to the SD memory card in the binary format. Up to 100 measurement data files can be created on a single date.

NOTE If an SD memory card is not inserted into the instrument, measurement data will not be saved.

Save procedure

1. Set the recorded items and TIMEPLOT interval.
   (See "Recording Items" (p.62), "TIME PLOT Interval" (p.63))
2. Set the recording start time and end time (as necessary).
   (See "Time Start" (p.58))
3. Press the START STOP key to start recording.

   (To cancel recording, press the START STOP key again.)

   (A folder will be automatically created, and the data will be stored there. See 9.3 (p.139).)

Save destination:	SD memory card
File names:	Filenames are automatically created based on the start time and date and given an extension of "ITV" (time series measurement normal binary data) or "FLC" (time series measurement flicker data). Numbering starts at 0000 and goes to 9999. Example: TP0000.ITV (the first set of time series measurement normal binary data saved in the folder)

Remaining storage time
The remaining storage time on the SD memory card being used is displayed when setting the recorded items and TIMEPLOT interval. The time is calculated and displayed based on the SD memory card's storage capacity, the number of items being recorded, and the TIMEPOT interval time. This calculation does not take event data into account, so the recording time may vary significantly with the number of events.

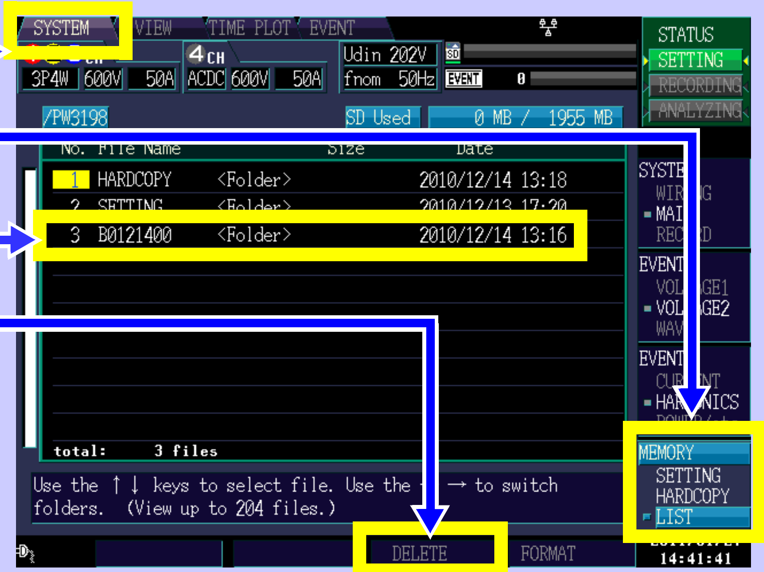
Recording times for (reference value) a Z4001 SD Memory Card 2GB (Repeat Record: 1 Week, Repeat Number: 55 times)

TIME PLOT interval	Recording parameter setting		
	ALL DATA (Saves all data)	P&Harm (Saves RMS values and harmonics)	Power (Saves RMS values only)
1sec	16.9 hours	23.6 hours	11.5 days
3sec	2.1days	3.0 days	34.6 days
15sec	10.6 days	14.8 days	24 weeks
30sec	21.1days	29.5 days	49 weeks
1min	42.2 days	8.4 weeks	55 weeks
5min	30.1 weeks	42.1 weeks	55 weeks
10min	55 weeks	55 weeks	55 weeks
15min	55 weeks	55 weeks	55 weeks
30min	55 weeks	55 weeks	55 weeks
1 hour	55 weeks	55 weeks	55 weeks
2 hours	55 weeks	55 weeks	55 weeks
150/180 /1200wave (Approx. 3 sec)	2.1 days	3.0 days	34.6 days

- Recording times do not account for event data and screen copy data. Recording times may be shortened when event data and screen copy data are stored on the card.
- Recording times are not dependent on connections.
- When repeated recording is set to **[OFF]**, the maximum recording time is 35 days.
- When repeated recording is set to **[1 Day]**, the maximum recording time is 55 days.
- When repeated recording is set to **[1 Week]**, the maximum recording time is 55 weeks.
- Harmonics order data is not saved for **[Power]**, but it is saved in THD.

Delete

- SYSTEM **[SYSTEM] screen**
- DF 4 **[LIST]**
- ▲▼ **Select the number (No.) you wish to delete**
- F 3 **[DELETE]**
  A deletion confirmation dialog box will be displayed.
- ENTER **Execute**
- ESC **Cancel**



Display Measurement Data (Load)

In the **[SYSTEM]-[MEMORY]-[LIST]** screen, when the cursor is moved to the stored data folder to be displayed and the F1 **[Load]** key is pressed, **[Analyze]** will be activated and the event list, trend data, detailed trend data in the specified folder will be displayed.
Event, trend data and detailed trend data can be checked.
Refer to "Chapter 8 Checking Events (EVENT screen)" (p.119) for the Event Confirmation Method.
Return to [Settings] with the DATARESET key.

⚠CAUTION

- The maximum displayed times of the trend data, detailed trend data, and harmonic trend data in the **[TIME PLOT]** screen of the HIOKI PW3198 is subject to certain constraints. To confirm all measured trend data, use the 9624-50 PQA-HiView Pro Software.
- Measurement data can only be loaded on the instrument which measures. Data measured in different versions will not load even if the instrument is the same.
- The F1 **[Load]** key will appear when the cursor is in the stored data folder. (B*******).

[TIMEPLOT] screen maximum display times

TIME PLOT Interval	Recording Items setting		
	ALL DATA (Saves all data)	P&Harm (Saves RMS values and harmonics)	Power (Saves RMS values only)
1sec	7 min. 52 sec.	15 min. 44 sec.	2 hours 37 min. 20 sec.
3sec	23 min. 36 sec.	47 min. 12 sec.	7 hours 52 min.
15sec	1 hour 58 min.	3 hours 56 min.	1 day 15 hours 20 min.
30sec	3 hours 56 min.	7 hours 52 min.	3 days 6 hours 40 min.
1min	7 hours 58 min.	15 hours 44 min.	6 days 13 hours 20 min.
5min	1 day 15 hours 20 min.	3 days 6 hours 40 min.	32 days 18 hours 40 min.
10min	3 days 6 hours 40 min.	6 days 13 hours 20 min.	35 days
15min	4 days 22 hours	9 days 20 hours	35 days
30min	9 days 20 hours	19 days 16 hours	35 days
1hour	19 days 16 hours	35 days	35 days
2hours	35 days	35 days	35 days
150/180 wave (Approx. 3 sec)	23 min. 36 sec.	47 min. 12 sec.	7 hours 52 min.

9.5 Saving, Displaying, and Deleting Screen Copies

You can save the currently displayed screen as a BMP (256-color) file. The file extension is ".bmp." If the instrument is connected to a printer, you can also print screens (in monochrome).

Save

You can save (output) the screen at a given instant to the set SD memory card by pressing the COPY key while the screen you wish to save is displayed.

RS Connection:	SD memory card or printer
File names:	Auto generated, extension of ".bmp" 00000000.BMP (consecutive numbering in the folder ranges from 00000000 to 99999999) Example: 00000001.BMP

NOTE

- When saving screen copies to the SD memory card, verify that the **[RS-232C]** setting on the **[SYSTEM]**-**DF1** **[MAIN]**-**F2** **[HARDWARE]** screen is set to **[OFF]**. (If this parameter is set to **[PRINTER]**, data will be output to the printer instead of the SD memory card.)
- Up to 102 files can be displayed on the **[HARDCOPY]** screen.

Displaying and deleting files

SYSTEM **[SYSTEM] screen**

DF 4 **[HARDCOPY]**

Select the file you wish to display

F 1 **[VIEW]**
The file will be displayed.

ESC **Return to the list.**
(You can also return with any other key.)

To delete a file:

Select the file you wish to delete

F 3 **[DELETE]**
A deletion confirmation dialog box will be displayed.

ENTER **Execute**

ESC **Cancel**

To view hard copies of screens for which a screen copy interval was set

Use the cursor keys on the **[LIST]** screen to move the cursor to an **[AUTO COPY]** file to display a thumbnail. Select the thumbnail whose screen you wish to view with the cursor keys and press the **[VIEW]** key to view hard copies of screens for which a screen copy interval was set.

9.6 Saving and Deleting Settings Files (Settings Data)

This section describes how to save the instrument's current settings.

SYSTEM **[SYSTEM] screen**

DF 4 **[SETTING]**

F 2 **[SAVE]**
The file will be saved.

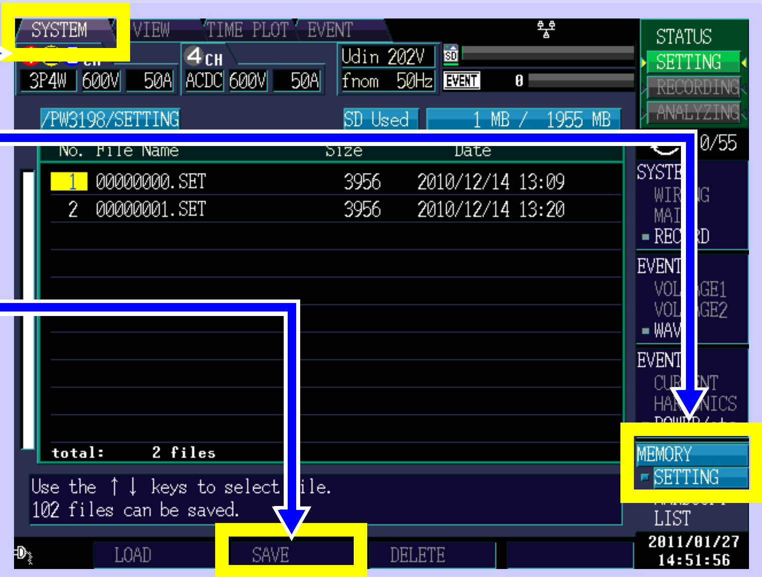
To delete a file

Select the number (No.) you wish to delete

F 3 **[DELETE]**
A deletion confirmation dialog box will be displayed.

ENTER **Execute**

ESC **Cancel**



NOTE

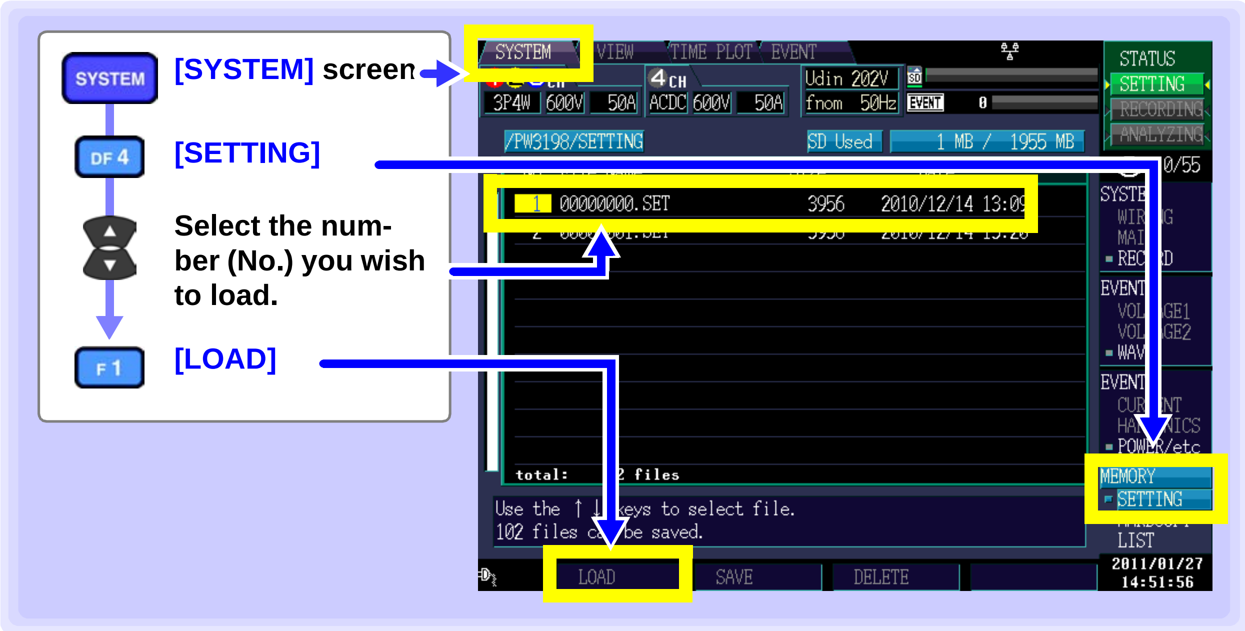
- All filenames are assigned automatically and cannot be changed by the user (for example, 00000000.SET).

See:"9.3 Save Operation and File Structure" (p.139)

- Up to 102 files can be displayed on the **[SETTING]** screen.

9.7 Loading Settings Files (Settings Data)

This section describes how to select and load saved settings.



9.8 File and Folder Names

NOTE The instrument does not allow users to create folders. All folders are created automatically. Additionally, file and folder names cannot be changed.

Changing file and folder names

The names of files and folders downloaded to your computer can be changed. Names can be up to 8 characters long. Settings files should be placed in the **[SETTING]** folder, and screen copy files should be placed in the **[HARDCOPY]** folder. Filenames containing characters other than letters and numbers may not be properly displayed by the instrument.

Analyzing Data Using the Computer Application (9624-50)

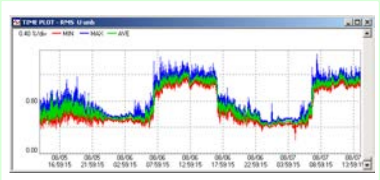
Chapter 10

10.1 Computer Application (9624-50) Capabilities

The Hioki 9624-50 PQA-HiView Pro is a software application for analyzing binary-format measurement data from the PW3198 on a computer. The 9624-50 can load and read only binary data recorded with the Hioki PW3198. It cannot read text or CSV data.

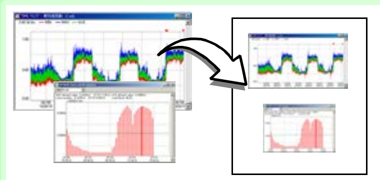
Display and Analyze Measurement Data

Analyze measurement data in greater detail using the same display as the PW3198. You can also display and compare multiple graphs.



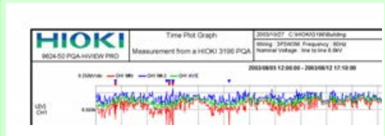
Print Displayed Windows and Copying

Print and copy displayed windows for use in other applications.



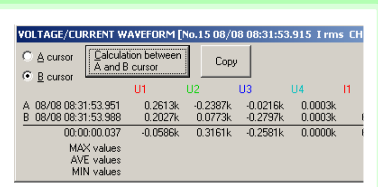
Generate Measurement Data Reports

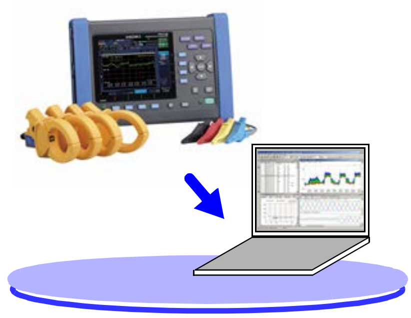
Print any measurement as a report.
You can also save it as a rich text format file, and use it in other applications.



Display Measurement and Calculation Values (Maximum, Minimum and Average)

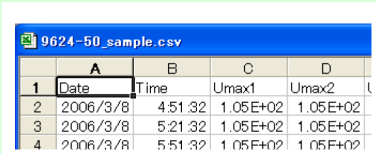
Use the A/B cursors to view maximum, minimum and average values within any time span.





Convert Measurement Data to CSV Format

Convert any span of measurement data to CSV format. Load converted files into computer spreadsheet programs.



Calculate Demand and Integral Power Hioki PW3198

From the measurement data, calculate maximum and average demand values, and integral power.

Download measurement data from the PW3198

Connect the Hioki PW3198 to a computer via LAN to download data from its internal memory and data files from the PW3198's SD memory card.

Display measurement data in EN50160 mode Judge anomalies according to the ITIC (CBEMA) Curve*

* Commonly used in the USA, the ITIC Curve is a standard for evaluating voltage anomalies by specifying a range of acceptable tolerance. A "User-Defined Curve" can be optionally defined for voltage anomaly evaluation.

NOTE You must use version 2.00 or higher of the 9624-50 application. An upgrade is available (for a fee) to users of versions prior to 2.00.

10.2 Downloading Data from the SD Memory Card

Measurement data saved on the SD memory card can be downloaded to a computer using an SD memory card reader or via the instrument's LAN and USB functions.

See: Connection method: "12.1 Downloading Measurement Data Using the USB Interface" (p.156),
"Connecting the Instrument to a Computer with an Ethernet ("LAN") Cable" (p.161)

See: More detailed information: See the 9624-50 PQA-HiView Pro Instruction Manual.

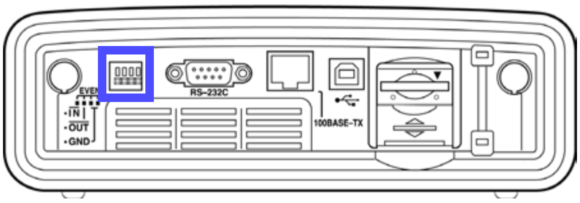
NOTE Data cannot be written from a connected computer to the SD memory card via a USB connection.

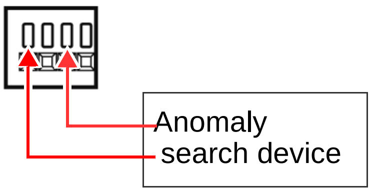
Connecting External Devices

Chapter 11

11.1 Using the External Control Terminal

You can enter events and output event occurrence times with the external control terminals.



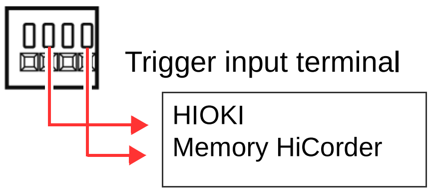


Event input terminal (EVENT IN)

Synchronized with an external device, analyzes anomalies.

When you connect the search signal of an anomaly search device such as an over-current relay to the event input terminal, you can analyze anomalies using this device according to anomaly operations.

See: "Using the event input terminal (EVENT IN)" (p.151)



Event output terminal (EVENT OUT)

This informs an external device when anomalies occur within the PW3198. When you connect the event output terminal to a trigger input terminal on a waveform recording device such as the HIOKI Memory HiCorder, you can record waveforms on the Memory HiCorder when events occur.

See: "Using the event input terminal (EVENT OUT)" (p.152)

⚠CAUTION

To avoid damaging this device, do not input voltages outside the ranges -0.5 V to +6.0 V (EVENT IN) or -0.5 to +6.0 V (EVENT OUT) to the external control terminals.

NOTE

When using the external control terminals, to use the external event function, set the external event to ON. (**SYSTEM-DF3 [POWER/etc]-[External Event: ON]**)

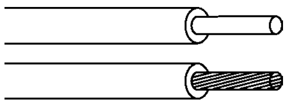
See: "Generating events using an external input signal (external event settings)" (p.71)

Connecting to the External Control Terminal

Be sure to read "Before Connecting Measurement Cables" (p.8) before attempting to connect the instrument to a computer.

⚠CAUTION To avoid electric shocks, use the specified material only.

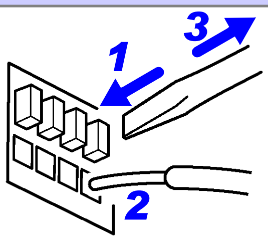
Items to connect (required items):



Electric wires that conform with:
single line: ϕ0.65 mm (AWG22)
twisted wire: 0.32 mm^2 (AWG22)
diameter of search wire: ϕ0.12 mm or more

Supported electric wires
single line: ϕ0.32 mm to ϕ0.65 mm (AWG28 to AWG22)
twisted wire: 0.08 mm^2 to 0.32 mm^2 (AWG28 to AWG22)
diameter of search wire: ϕ0.12 mm or more

Standard direction wire length : 9 to 10 mm
Tools that conform to button operations : flat head screwdriver (diameter: 3 mm, width of blade-tip: 2.6 mm)



1. **Press down on the terminal button using a tool, such as a flat head screwdriver.**
2. **While the button is depressed, insert the wire into the electric wire connection hole.**
3. **Release the button.**

   The electric wire is locked in place.

Using the event input terminal (EVENT IN)

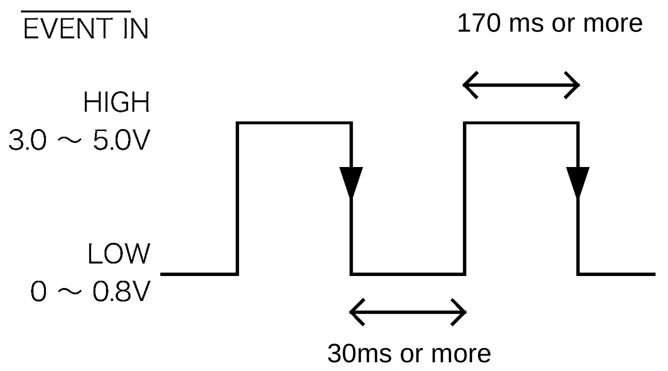
By inputting a signal to the event input terminal externally, you can make the PW3198 determine that an external event has occurred when that event was input. Similar to other events, you can record the voltage and current waveforms, and the measurement values of external events.
Using this device, you can analyze power anomalies that occur in other electrical equipment.

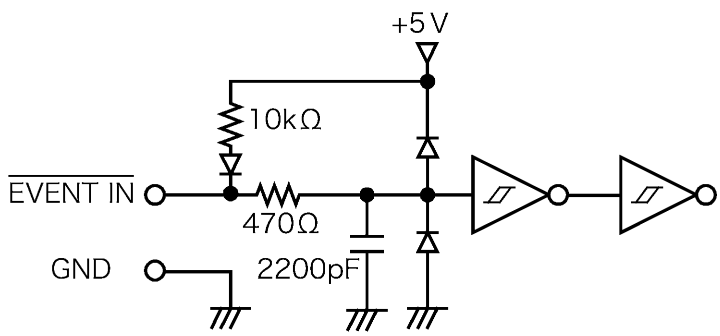
⚠CAUTION To avoid damaging this device, do not input voltages outside the range -0.5 V to +6.0 V to the external control terminals.

Signal input methods

Short-circuit the terminal or input a pulse signal.
Use the event input terminal (EVENT IN) and the ground terminal (GND).
You can control the event input terminal by short-circuiting the terminal (active LOW) or dropping the pulse signal (1.0 V).

Input voltage range	HIGH level : 3.0 to 5.0 V LOW level : 0 to 0.8 V
Maximum input voltage	-0.5 to +6.0 V





Using the event input terminal (EVENT OUT)

This indicates events occurring externally that were synchronized with events occurring internally for this device.

Usage method 1. Connect a warning device.

This is a good way to output warnings when events such an interruptions occur.

Usage method 2. Connect to the trigger input terminal of a Memory HiCorder.

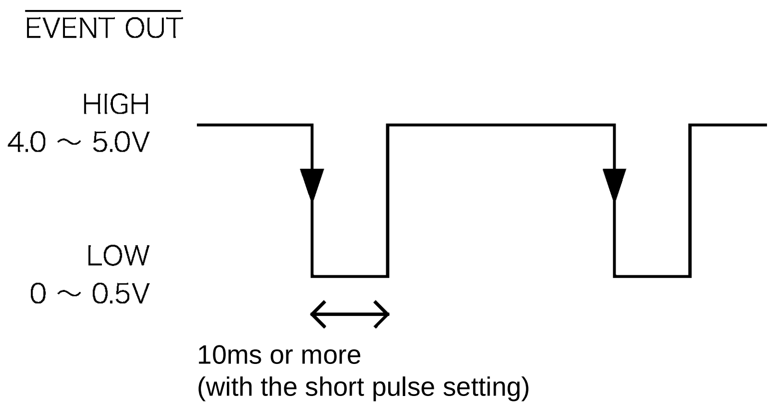
This allows you to record waveforms on the Memory HiCorder when events occur on the PW3198.
You can record between 14 and 16 waveforms on the PW3198 when events occur. When you want to record waveforms for a longer period of time, use the PW3198 in parallel with a Memory HiCorder.

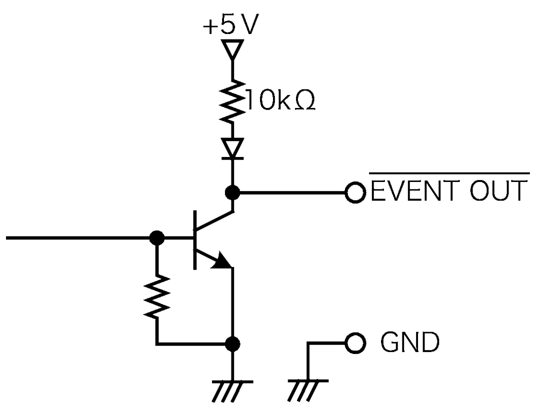
⚠CAUTION To avoid damaging this device, do not input voltages outside the -0.5 V to +6.0 V range to the external control terminal.

Signal output method

If an event occurs in the PW3198, a pulse signal is output.
Use the event output terminal (EVENT OUT) and the ground terminal (GND).

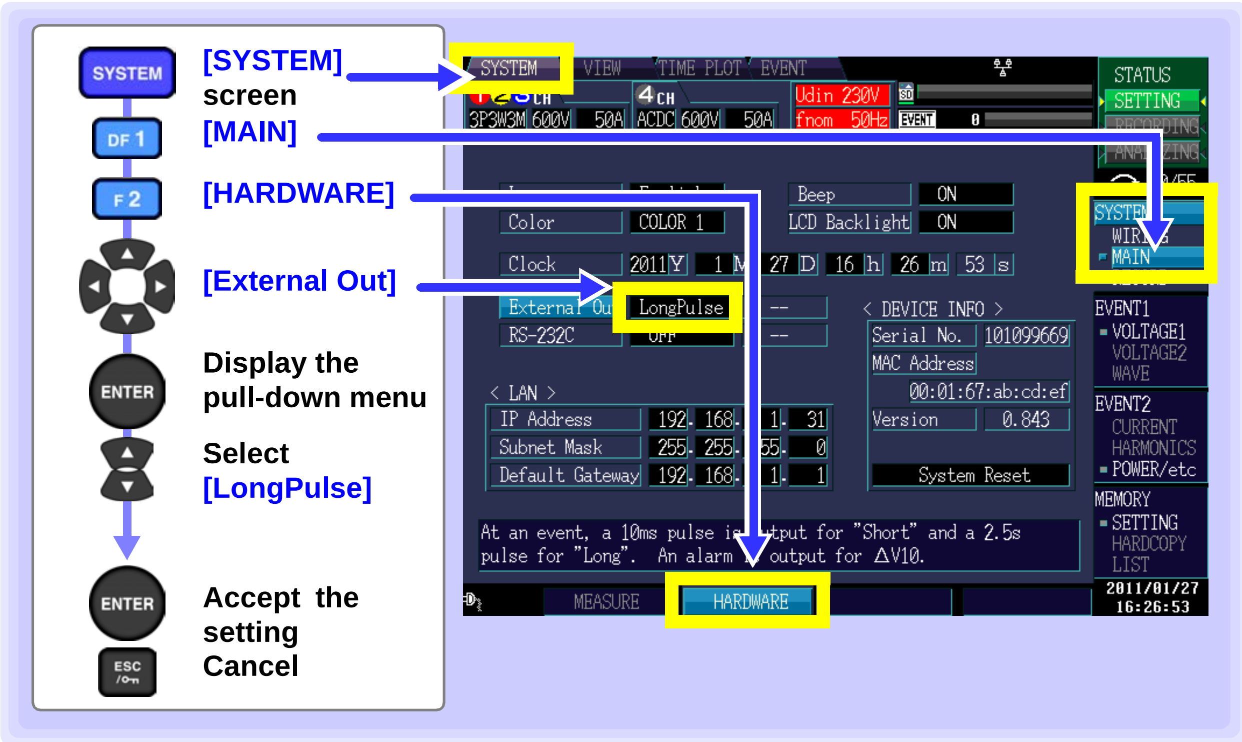
Output signal	Open collector output (includes voltage output) Active LOW
Output voltage range	HIGH level: 4.5 to 5.0 V LOW level: 0 to 0.5 V
Pulse width	LOW level: longer than 10 ms
Maximum input voltage	-0.5 V to +6.0 V





Event output can be set for REMOTE MEASUREMENT SYSTEM 2300

By setting the **[External Out]** setting to **[Long Pulse]**, the instrument can be configured to generate event output for the REMOTE MEASUREMENT SYSTEM 2300 and similar hardware.



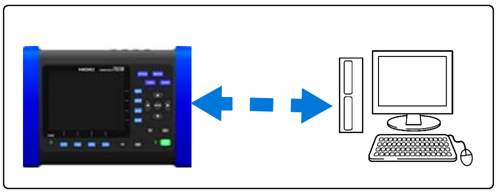
NOTE

- When the START event occurs, no pulse signal (Low pulse) is output from the event output terminal.
- The pulse signal from the event output terminal is held Low for about 2.5 seconds. When events occur continuously (but for not more than 2.5 seconds each), the signal goes Low at the first event, and remains Low until about 1.5 seconds after the last event occurs.

Operation with a Computer — Chapter 12

The instrument includes standard USB and Ethernet interfaces to connect a computer for remote control.

The instrument can be controlled by communication commands, and measurement data can be transferred to the computer using the dedicated application program.



USB Connection Capabilities

- Measurement data can be transferred to a computer using the dedicated application (optional 9624-50 PQA-HiView Pro). (When the instrument is connected to a host controller, typically a computer, with a USB cable, the SD memory card in the instrument will be recognized as a removable disk.)

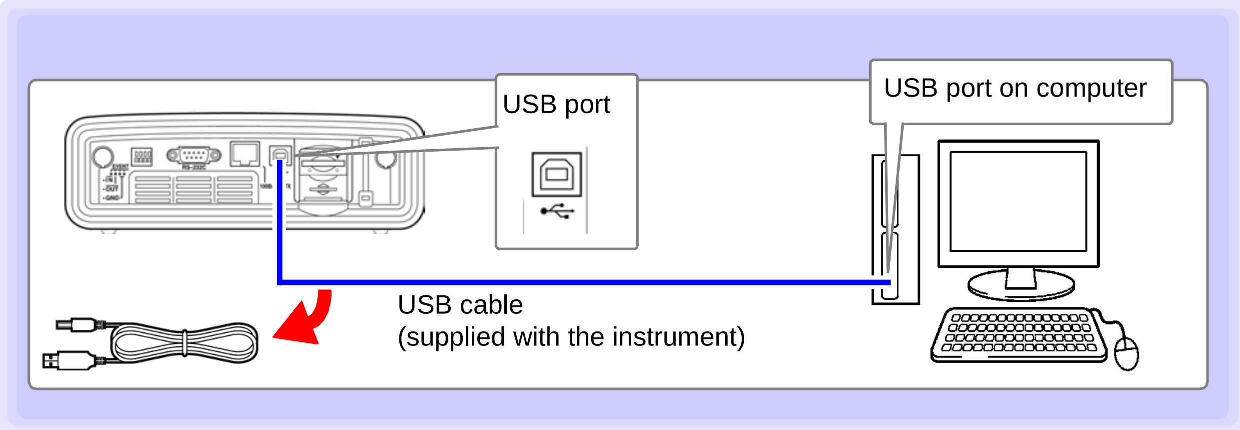
Ethernet ("LAN") Connection Capabilities

- Control the instrument remotely by internet browser.(p.162)
- Control the instrument remotely using the dedicated application program (optional 9624-50 PQA-HiView Pro) to transfer measurement data to the computer.

12.1 Downloading Measurement Data Using the USB Interface

Since the instrument includes a standard USB interface, measurement data can be transferred to a USB-connected computer (using the instrument's mass storage function).

Connect the instrument to the computer with a USB cable. No instrument settings are necessary to establish the USB connection.



A message such as the following is displayed on the instrument when it is connected to a computer:

```
Accessing USB storage.
To stop, hit ESC.

STOP: ESC
```

⚠CAUTION

- To avoid faults, do not disconnect or reconnect the USB cable during instrument operation.
- Connect the instrument and the computer to a common earth ground. Using different grounds could result in potential difference between the instrument and the computer. Potential difference on the USB cable can result in malfunctions and faults.

NOTE

If both the instrument and computer are turned off the power while connected by the USB cable, turn on the power of the computer first. It is not able to communicate if the instrument is turned on the power first.

After Connecting

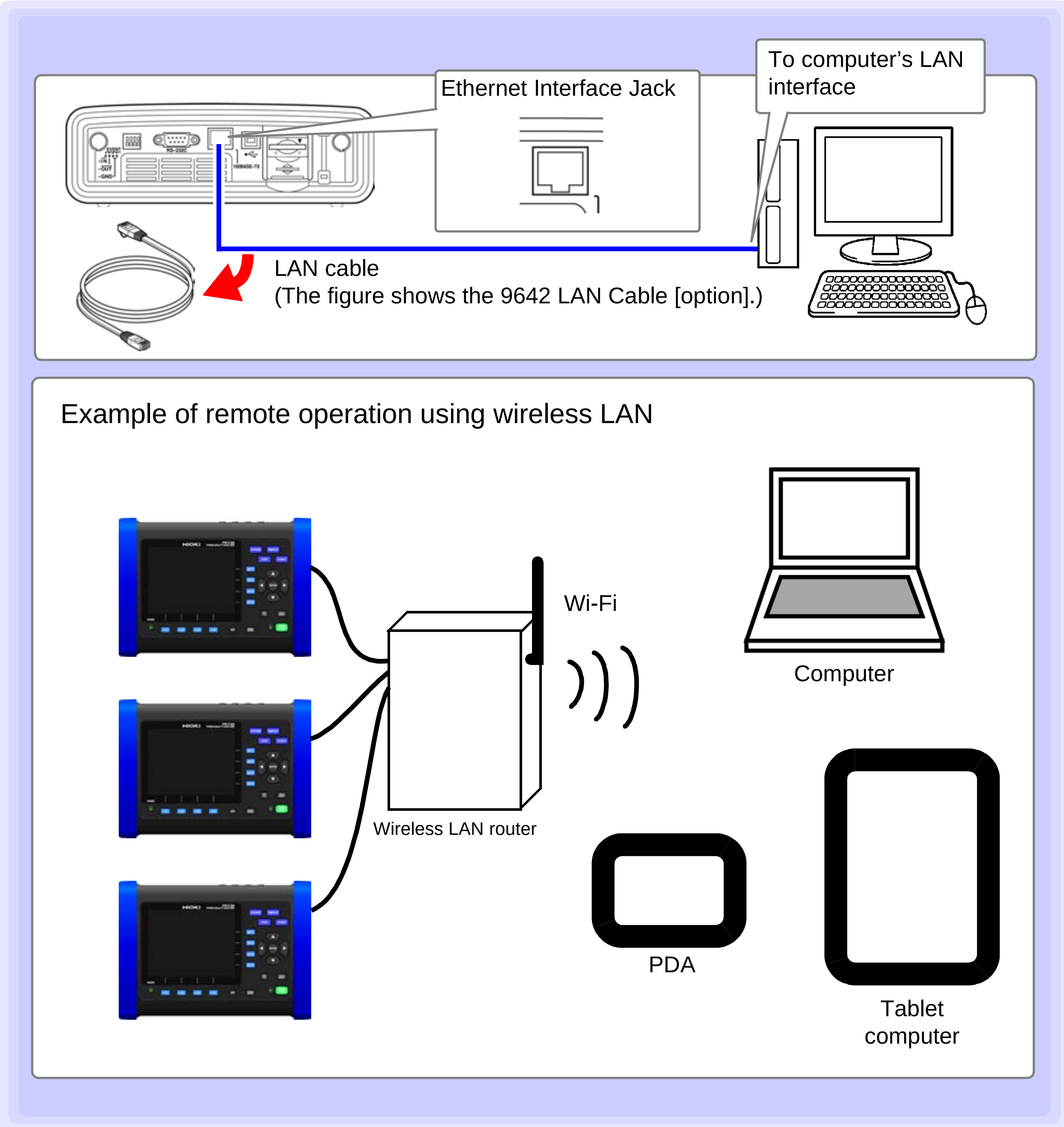
Use the following procedure when disconnecting a USB cable connected to the instrument from the computer:

1. Press the **ESC** key to terminate the USB connection. Alternately, you can use the computer's "Safely Remove Hardware" icon to end the connection.
2. Disconnect the USB cable from the computer.

The transferred data can be analyzed using the 9624-50 PQA-HiView Pro application. Files other than screen copies cannot be opened directly.

12.2 Control and Measurement via Ethernet ("LAN") Interface

Measured data can be transferred to a computer remotely using an Internet browser or with a dedicated application (optional 9624-50 PQA-HiView Pro).



Configure the instruments LAN settings for the network environment, and connect the instrument to a computer with the Ethernet cable.

When using a wireless LAN router

The instrument does not support network environments where an IP address is automatically acquired using DHCP. Configure the router to assign a fixed IP address to the PW3198. For more information about router settings, see the instruction manual for your wireless LAN router.

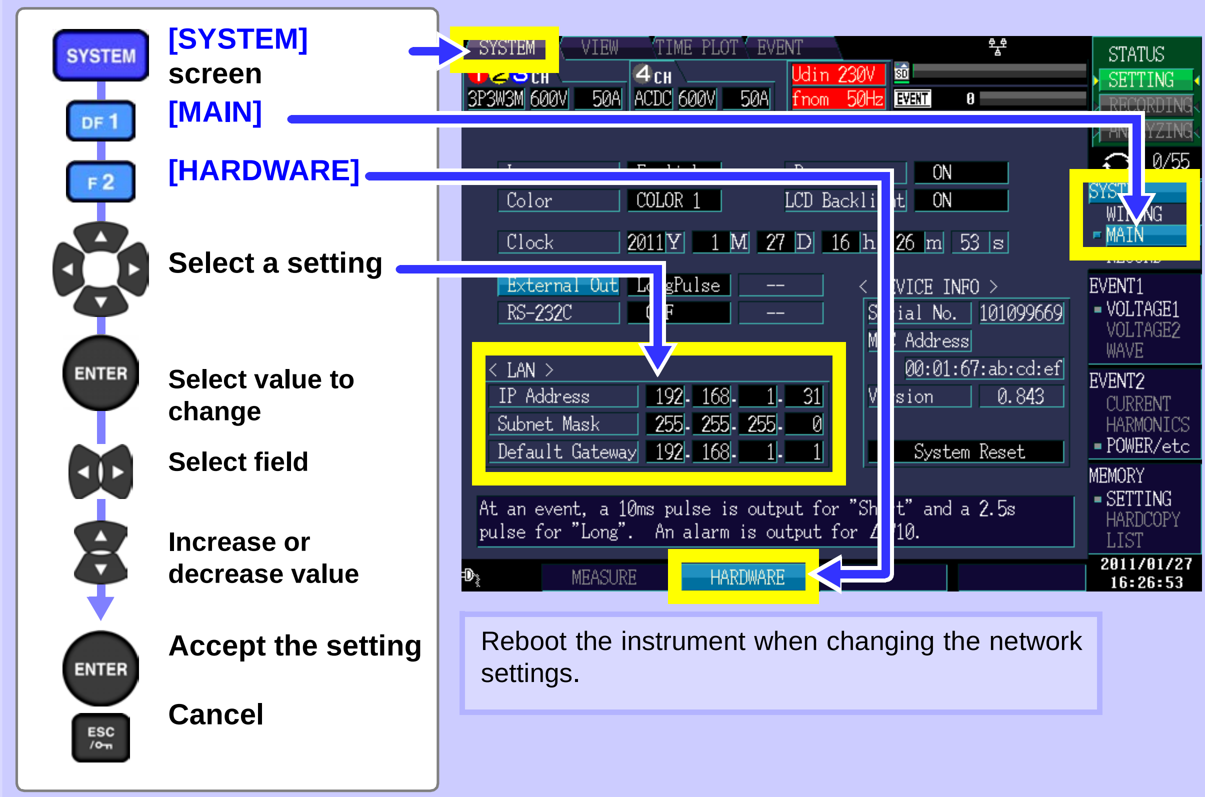
NOTE For more information about how to use the dedicated application (optional 9624-50 PQA-HiView Pro), please see the included Instruction Manual.

LAN Settings and Network Environment Configuration

Configure the Instruments LAN Settings

NOTE

- Make these settings before connecting to a network. Changing settings while connected can duplicate IP addresses of other network devices, and incorrect address information may otherwise be presented to the network.
- The instrument does not support DHCP (automatic IP address assignment) on a network.



Reboot the instrument when changing the network settings.

Setting Items

IP Address
Identifies each device connected on a network.
Each network device must be set to a unique address.
The instrument supports IP version 4, with IP addresses indicated as four decimal octets, e.g., "192.168.0.1".

Subnet Mask
This setting is used to distinguish the address of the network from the addresses of individual network devices.
The normal value for this setting is the four decimal octets "255.255.255.0".

Default Gateway
When the computer and instrument are on different but overlapping networks (subnets), this IP address specifies the device to serve as the gateway between the networks.
If the computer and instrument are connected one-to-one, no gateway is used, and the instrument's default setting "0.0.0.0" can be kept as is.

Network Environment Configuration

Example 1. Connecting the instrument to an existing network

To connect to an existing network, the network system administrator (IT department) has to assign settings beforehand.
Some network device settings must not be duplicated.
Obtain the administrator's assignments for the following items, and write them down.

IP Address___.___.___.___
Subnet Mask___.___.___.___
Default Gateway___.___.___.___

Example 2. Connecting multiple instruments to a single computer using a hub

When building a local network with no outside connection, the following private IP addresses are recommended.

Configure the network using addresses 192.168.1.0 to 192.168.1.24

IP Address	: Computer	: 192.168.1.1
	: PW3198	: assign to each instrument in order 192.168.1.2, 192.168.1.3, 192.168.1.4, ...
Subnet Mask	: 255.255.255.0	
Default Gateway	: Computer	: ___.___.___.___
	: PW3198	: 0.0.0.0

Example 3. Connecting one instrument to a single computer using the 9642 LAN Cable

The 9642 LAN Cable can be used with its supplied connection adapter to connect one instrument to one computer, in which case the IP address is freely settable. Use the recommended private IP addresses.

IP Address	: Computer	: 192.168.1.1
	: PW3198	: 192.168.1.2 (Set to a different IP address than the computer.)
Subnet Mask	: 255.255.255.0	
Default Gateway	: Computer	: ___.___.___.___
	: PW3198	: 0.0.0.0

Instrument Connection

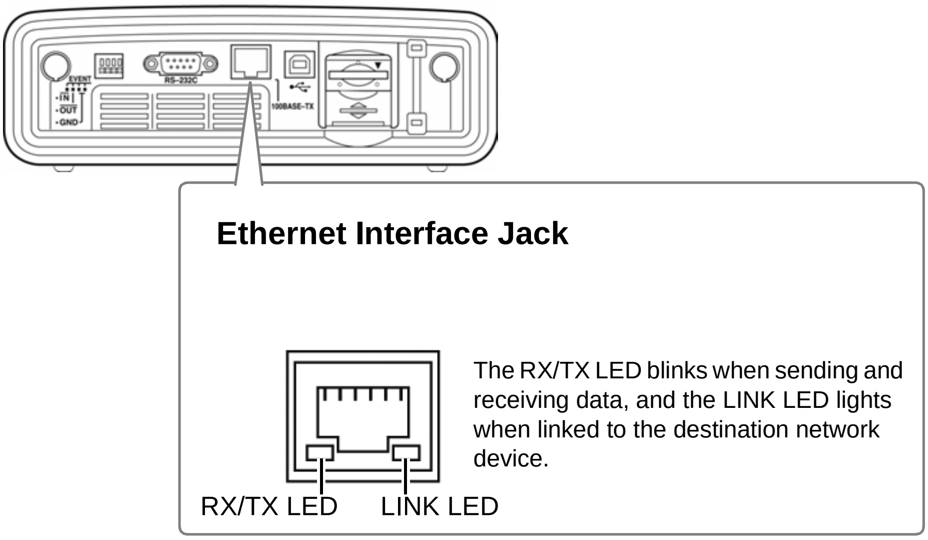
Connect the instrument to the computer using an Ethernet LAN cable.

Required items:
When connecting the instrument to an existing network
(prepare any of the following):
- Straight-through Cat 5, 100BASE-TX-compliant Ethernet cable (up to 100 m, commercially available). For 10BASE communication, a 10BASE-T-compliant cable may also be used.
- Hioki 9642 LAN Cable (option)

When connecting one instrument to a single computer
(prepare any of the following):
- 100BASE-TX-compliant cross-over cable (up to 100 m)
- 100BASE-TX-compliant straight-through cable with cross-over adapter (up to 100 m)
- Hioki 9642 LAN Cable (option)

Instrument Ethernet ("LAN") interface

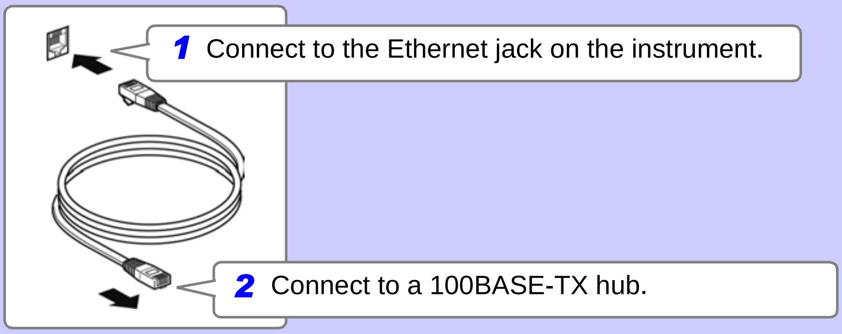
The Ethernet interface jack is on the right side.



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

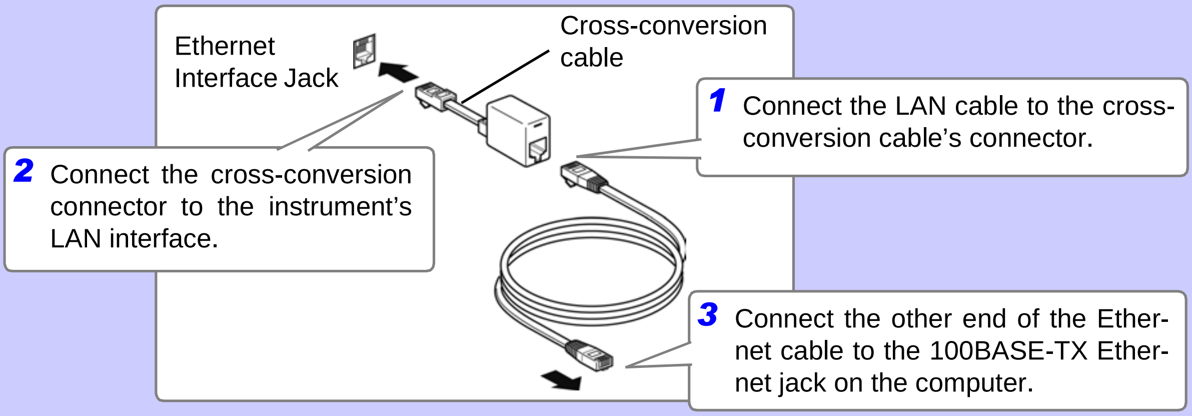
Connect by the following procedure.

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



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

Use the Hioki 9642 LAN Cable and cross-over adapter (9642 accessory)



The icon display varies with the state of the LAN connection as follows:

	HTTP server and data download connection
	Data download connection
	HTTP server connection

12.3 Remote Control of the Instrument by Internet Browser

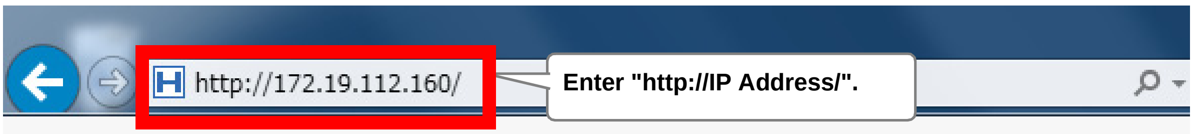
The instrument includes a standard HTTP server function that supports remote control by an internet browser on a computer.
The instrument's display screen and control panel keys are emulated in the browser. Operating procedures are the same as on the instrument.

NOTE

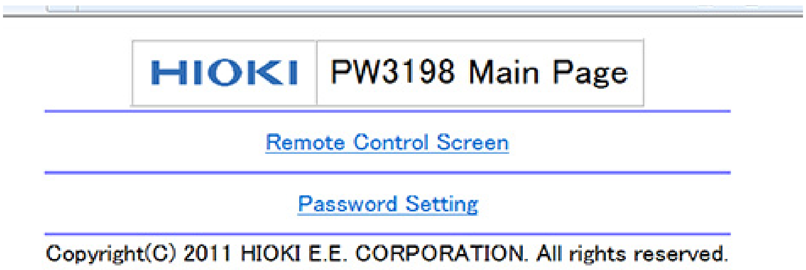
- It is recommended to use either Microsoft Internet Explorer version 8 or later or Apple Safari version 5.0 or later.
- Only one computer can be connected at a time.
- Set the browser security level to “Medium” or “Medium-high,” or enable Active Scripting settings.
- Unintended operations may occur if remote control is attempted from multiple computers simultaneously. Use one computer at a time for remote control.
- Remote control can be performed even if the instrument's key lock is active.

Connecting to the Instrument

Launch Internet Explorer (afterwards called IE), and enter "http://" followed by the IP address assigned to the instrument in the browser's address bar.
For example, if the instrument's IP address is 172.19.112.160, enter as follows.



A main page such as the following will be displayed when the browser has successfully connected to the instrument:



If no HTTP screen is displayed

1. Perform this procedure.

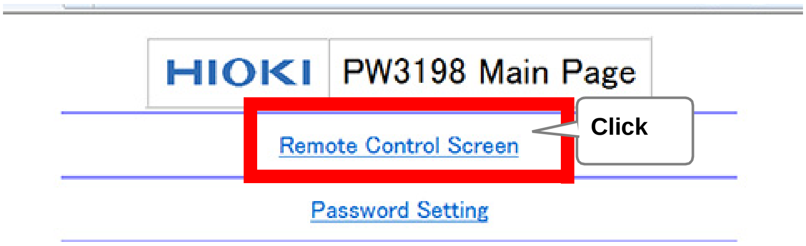
(1) Click **[Tools]-[Internet Options]** to display IE settings.
(2) On the **[Advanced]** tab, under HTTP 1.1 settings, enable **[Use HTTP1.1]** and disable **[Use HTTP1.1 through proxy connections]**.
(3) On the **[Connections]** tab, click **[LAN Settings]**, and disable **[Use a proxy server]**.

2. LAN communications may not be possible.

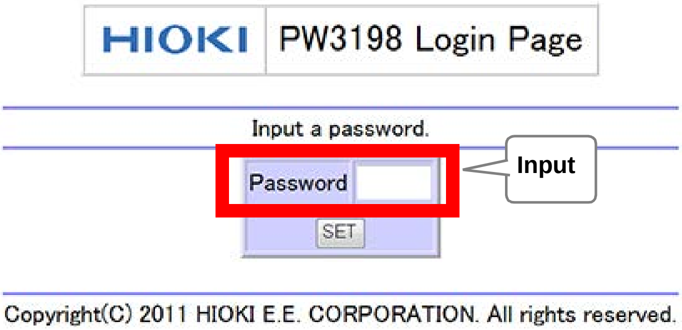
(1) Check the network settings on the instrument and the IP address of the computer.
See: "LAN Settings and Network Environment Configuration" (p.158)
(2) Check that the LINK LED in the Ethernet internet jack is lit, and that (the LAN indicator) is displayed on the instrument's screen.
See: "Instrument Connection" (p.160)

Operating Procedure

Click the **[Remote Control Screen]** link to jump to the Remote Control page.



If a password has been set, the following page will be displayed:



Enter the password and click the **[SET]** button to display the control panel in the browser window. (If no password has been set or the password has been set to “0000” [four zeroes], this screen will not be displayed. The default password setting is “0000.”)

Setting a password

You can restrict remote operation by setting a password.

1. Click **[Password Setting]** on the main page. (The following page will be displayed.)

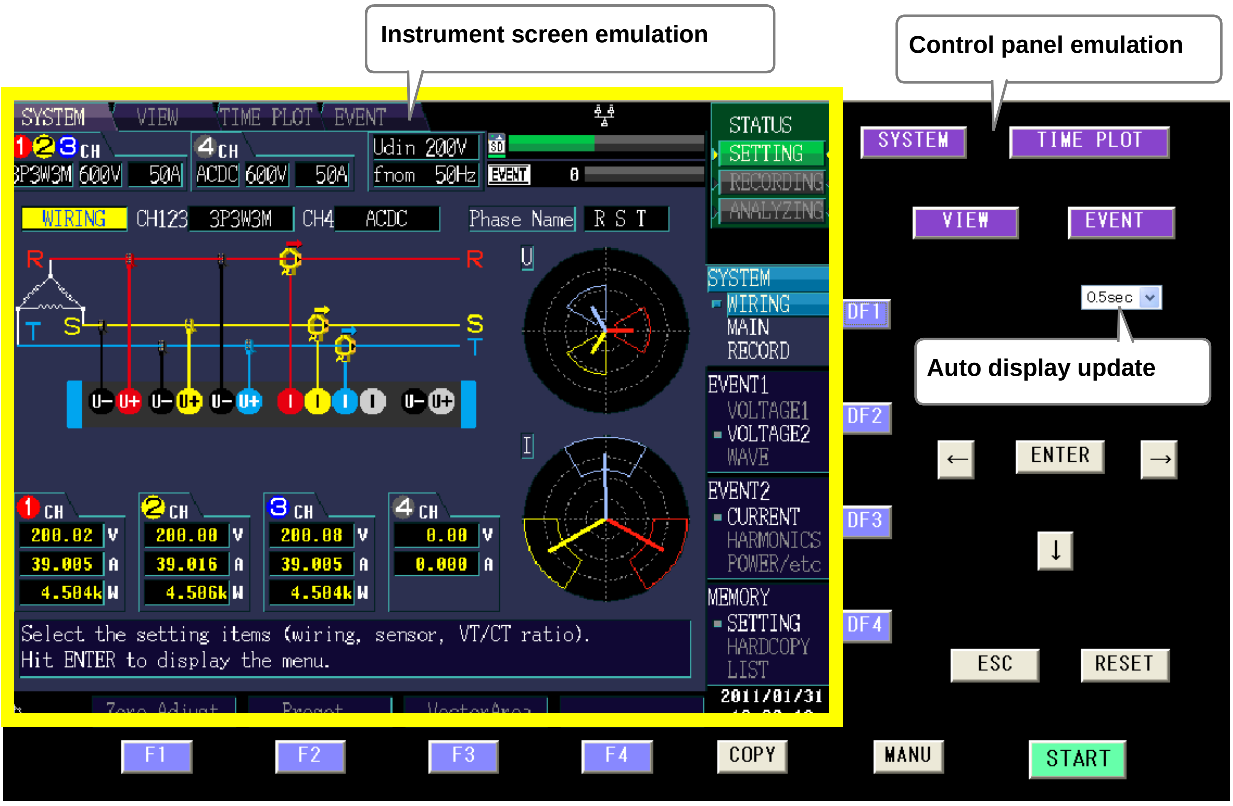
2. Enter the **[Old Password]**, **[New Password]**, and **[Confirm New Password]** fields and click the **[SET]** button. (Enter up to four English letters. If setting a password for the first time, enter “0000” (four zeroes) as the **[Old Password]**. If changing a previously set password, enter the previously set password.)

The new password will become effective immediately.

If you forget your password

Triggering a boot key reset* on the instrument will cause the password to be reset to its default value of “0000.” The password cannot be initialized by means of remote operation.

*: The boot key reset will cause the instrument’s settings to be reverted to their default values. You can revert all settings, including language and communications settings, to their default values by turning on the instrument while holding down the **ENTER** or **ESC** key.



Click on the control panel keys to perform the same operations as the instrument keys.
To enable automatic browser screen updating, set the Update Time in the Auto Update menu

Auto display update	The instrument screen emulation updates at the specified interval.

Setting Contents:(∗ : Default setting)

OFF∗, **0.5**/ **1**/ **2**/ **5**/ **10 sec**

If the instrument does not accept key input
Is the browser's security level set to “High”, or has JavaScript been disabled?
Change the browser's security setting to Medium or Medium-high.

NOTE

The displayed information may vary with the browser being used.

12.4 Converting Binary Data to Text Data

The optional 9624-50 PQA-HiView Pro application can be used to convert binary data to text data. For more information, see the 9624-50 instruction manual.

Specifications Chapter 13

13.1 Environmental Safety Specifications

Operating environment	Indoors, altitude up to 3,000 m (measurement category is lowered to 600 V Cat III when above 2,000 m), Pollution degree 2
Storage temperature and humidity	-20 to 50°C (-4 to 122°F) 80% RH or less (non-condensating) (If the instrument will not be used for an extended period of time, remove the battery pack and store in a cool location [from -20 to 30°C (-4 to 86°F)].)
Operating temperature and humidity	0 to 50°C (32 to 122°F) 80% RH or less (non-condensating)
Dust and water resistance	IP30 (EN60529)
Applicable standards	Safety EN61010 EMC EN61326 Class A
Maximum input voltage	Voltage input section 1000 VAC, DC±600 V, max. peak voltage ±6000 Vpk Current input section 3 VAC, DC±4.24 V
Maximum rated voltage to earth	Voltage input terminal 600 V (Measurement Categories IV, anticipated transient overvoltage 8000 V)

13.2 General Specifications

Input Specifications

Measurement line type	One single-phase 2-wire (1P2W), single-phase 3-wire (1P3W), three-phase 3-wire (3P3W2M,3P3W3M) or three-phase 4-wire (3P4W,3P4W2.5E) plus one extra input channel (must be synchronized to reference channel during AC/DC measurement)
Number of input channels	Voltage: 4 channels U1 to U4 Current: 4 channels I1 to I4
Input methods	Voltage: Isolated and differential inputs (Between U1,U2 and U3: channels not isolated, Between U1 to U3 and U4: channels isolated) Current: Insulated clamp sensors (voltage output)
Input resistance	Voltage: 4 MΩ ±80 kΩ (differential inputs) Current: 100 kΩ ±10 kΩ
Measurement ranges	Voltage measurement: 600.00 V; transient measurement: 6000 Vpk Current measurement: Using clamp sensors (×10, ×5, ×1 range, max. 2 ranges) Note: Only CH4 can be configured separately.
Crest factor	Voltage measurement: 2 (in 600 V range); transient overvoltage measurement: 1 (in 6,000 Vpk range); current measurement: 4 (with f.s. input)
Measurement method	Simultaneous digital sampling of voltage and current,
Sampling frequency	RMS voltage and current, active power, etc.: 200 kHz Transient overvoltage measurement : 2 MHz Harmonic/inter-harmonic analysis : 4,096 points, 10/12 cycles (50/60 Hz) or 4096 points, 80 cycles (400 Hz)
A/D converter resolution	RMS voltage and current: 16bit; transient overvoltage measurement: 12bit
Compatible clamp sensors	Units with f.s. = 0.5 V output at rated current input (f.s.=0.5 V recommended) Units with rate of 0.1 mV/A, 1 mV/A, 10 mV/A, or 100 mV/A

Basic Specifications

Product warranty period	3 years
Backup lithium battery life	Clock and settings (Lithium battery), Approx. 10 years @23°C (@73.4°F)
Real-Time Clock function	Auto-calendar, leap-year correcting 24-hour clock
Real-time clock accuracy	±0.3 s per day (instrument on, 23°C±5°C (73°F±9°F) ±1 s per day (instrument on, within operating temperature and humidity range) ±3 s per day (instrument off, @23°C (@73.4°F))
Memory data capacity	SD memory card/ SDHC memory card 2G to 32GB
Maximum recording period	55 weeks (with repeated recording settings of **[1 Week]**, 55 iterations) 55 days (with repeated recording settings of **[1 Day]**, 55 iterations) 35 days (with repeated recording settings of **[OFF]**)
Maximum recordable events	55000 events (with repeated recording on) 1000 events (with repeated recording off)
Power supply	Z1002 AC Adapter (12 VDC) Rated supply voltage : 100 VAC to 240 VAC (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) Rated power supply frequency : 50/60 Hz, maximum rated current:1.7 A, anticipated transient overvoltage 2500 V Anticipated transient overvoltage: 2500 V Z1003 Battery Pack (Ni-MH 7.2VDC 4500 mAh)
Recharge function	The battery pack charges regardless of whether the instrument is on or off. Charge time: Max. 5 hr. 30 min. @23°C (@73.4°F) Charging temperature range: 10°C to 35°C (50°F to 95°F)
Maximum rated power	35 VA (when charging) 15 VA (when not charging)
Continuous battery operation time	Approx. 180 min. (@23°C (@73.4°F), when using Z1003 Battery Pack)
Dimensions	Approx. 300 W× 211 H × 68 D mm (11.81" W × 8.31" H × 2.68" D) (excluding protrusions)
Mass	Approx. 2.2 kg (77.6 oz.) (excluding battery pack) Mass of battery pack: Approx. 365 g (12.9 oz.)
Power supply quality measurement method	IEEE1159, IEC61000-4-30Ed2:2008

Display specifications

Display	6.5-inch TFT color LCD (640×480 dots) Display defects: 5 or fewer dead pixels, 1 or fewer bright pixels

External Interface Specifications

(1) SD card Interface

Slot	SD standard compliant × 1
Compatible card	SD memory card/ SDHC memory card (Use only HIOKI-approved SD memory cards)
Supported memory capacity	SD memory card: Up to 2GB, SDHC memory card: Up to 32GB
Functions	Saving of binary data (settings data) (up to 9,999 files) Up to 100 files of measurement data can be saved on the same date. Saving of settings files (up to 102 files) Loading of settings files (up to 102 files) Saving of screen copies (up to 99,999,999 files) Loading of screen copies Formatting of SD memory cards Deleting of files
Media full processing	Saving of data to SD memory card is stopped (time series data is stored on a first-in, first-out basis.)

(2) RS-232C Interface

Connector	D-sub9 pin ×1
Method	RS-232C “EIA RS-232D”, “CCITT V.24”, “JIS XS101” compliant
Connection destination	Printer, GPS box (cannot be connected to computer)
Functions	Printer : Printing of screen copies GPS : Measurement and control using GPS-synchronized time

(3) LAN Interface

Connector	RJ-45 × 1
Electrical specifications	IEEE 802.3-compliant Ethernet
Transmission method	10BASE-T/ 100BASE-TX
Protocol	TCP/IP

(3) LAN Interface

Functions	1. HTTP server function (compatible software: Internet Explorer Ver.6 or later Remote operation application function, measurement start and stop control functions, system configuration function, event list function (capable of displaying event waveforms, event vectors, and event harmonic bar graphs) 2. Downloading of data from the SD memory card using the 9624-50 PQA-HiView Pro

(4) USB-F Interface

Connector	Series B receptacle × 1
Method	USB 2.0 (full-speed, high-speed), mass storage class
Connection destination	Computer (Windows2000/WindowsXP/WindowsVista(32bit)/Windows7 (32/64bit)/Windows8 (32/64bit)/Windows10(32/64bit))
Functions	1. Recognition of the SD memory card as a removable disk when connected to a computer The instrument cannot be connected during recording (including standby operation) or analysis. 2. Downloading of data from the SD memory card using the 9624-50 PQA-HiView Pro The instrument cannot be connected during recording (including standby operation) or analysis.

(5) External control interface

Connector	4-pin screwless terminal block × 1 External event input: EVENT IN terminal × 1 External event output and V10 alarm: EVENT OUT terminal × 1, GND terminal × 2
External event input	External event input at TTL low level (at falling edge of 1.0 V or less and when shorted) between GND terminal and EVENT IN terminal Min. pulse width: 30 ms; rated voltage: -0.5 V to +6.0 V
External event output	(see table below) Rated voltage -0.5 V to +6.0 V

External event output item setting	Operation	Pulse width
Short pulse output	TTL low output at event generation between [GND] terminal and [EVENT OUT] terminal	Low level for 10 ms or more
Long pulse output	TTL low output at event generation between [GND] terminal and [EVNET OUT] terminal No external event output at START event	Low level for approx. 2.5 s
ΔV10 alarm	TTL low output at ΔV10 alarm between [GND] terminal and [EVENT OUT] terminal	Low level while alarm occurring; reverts to high at data reset

Accessories and Options Specifications

Accessories

- Instruction manual 1
- Measurement guide 1
- L1000 Voltage Cord 1
  (8 cords, approx. 3 m each: 1 each red, yellow, blue, and gray as well as 4 black;
  8 alligator clips: 1 each red, yellow, blue, and gray as well as 4 black)
- Spiral Tube 20
- Input Cable Labels 1
  (For identifying channel of voltage cords and clamp sensors)
- Z1002 AC Adapter 1
- Strap 1
- USB cable 1
  (CSK00027*K0080 Approx. 1 m in length)
- Z1003 Battery Pack 1
  (Ni-MH, 7.2 V/4500 mAh)
- Z4001 SD Memory Card 2GB 1

Accessories and Options Specifications

Current measurement options	9660 Clamp-On Sensor (100 Arms rated) 9661 Clamp-On Sensor (500 Arms rated) 9667 Flexible Clamp-On Sensor (5000 Arms/500 Arms rated) 9669 Clamp-On Sensor (1000 Arms rated) 9694 Clamp-On Sensor (5 Arms rated) 9695-02 Clamp-On Sensor (50 Arms rated) 9695-03 Clamp-On Sensor (100 Arms rated) 9290-10 Clamp-On Adapter 9219 Connection Cable (for Model 9695-02/9695-03) 9657-10 Clamp-On Leak Sensor (10 Arms rated) 9675 Clamp-On Leak Sensor (10 Arms rated) CT9691 Clamp on AC/DC Sensor (100 A/10 A rated) + CT6590 Sensor Unit CT9692 Clamp on AC/DC Sensor (200 A/20 A rated) + CT6590 Sensor Unit CT9693 Clamp on AC/DC Sensor (2000 A/200 A rated) + CT6590 Sensor Unit CT9667 Flexible Clamp on Sensor (5000 A rms/500 A rms rated) CT9667-01 AC Flexible Current Sensor (5000 A rms/500 A rms rated) CT9667-02 AC Flexible Current Sensor (5000 A rms/500 A rms rated) CT9667-03 AC Flexible Current Sensor (5000 A rms/500 A rms rated) CT7731 AC/DC Auto-Zero Current Sensor (100 A rms rated) CT7736 AC/DC Auto-Zero Current Sensor (600 A rms rated) CT7742 AC/DC Auto-Zero Current Sensor (2000 A rms rated) CM7290 Display Unit (For Model CT77××) L9095 Output Cord (For Model CT77××)
Voltage measurement options	Voltage Cord Leads (banana male-to-male with dolphin clip, one each red and black, about 3m long) 9804-01 Magnetic Adapter (1 red) 9804-02 Magnetic Adapter (1 Black) 9243 Grabber Clip (1 each red and black)
Printer options	(Not applicable to CE Marking) 9670 Printer (BL-100W made by SANEI ELECTRIC INC.) 9671 AC Adapter (for Model 9670) 9672 Battery Pack (for Model 9670) 9673 Battery Charger (for Model 9672) 9638 RS-232C Cable (for Printer) 9237 Recording Paper (80 mm - 25 m, 4 rolls)
Computer connection options	9642 LAN Cable 9624-50 PQA-HiView Pro (PC application software ver. 2.00 or later)
Other options	Z1002 AC Adapter Z1003 Battery Pack Z4001 SD Memory Card 2GB Z4003 SD Memory Card 8GB C1001 Carrying Case (soft type) C1002 Carrying Case (hard type) C1009 Carrying Case (Bag type) PW9000 Wiring Adapter (for three-phase 3-wire (3P3W3M) voltage) PW9001 Wiring Adapter (for three-phase 4-wire voltage) PW9005 GPS Box (assembled after receiving the order)

13.3 Measurement Specifications

Measurement items

(1) Items detected at 2 MHz sampling without a gap

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN/AVG
Transient overvoltage	Tran	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,3,4	

(2) Items measured without gaps for each waveform

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN/AVG
Frequency cycle	Freq_wav	U1	U1	U1	U1	U1	U1	**

(3) Items measured without gaps with 1 overlapping waveform every half-cycle
(When measuring at 400 Hz, items measured in a wave without gaps)

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN/AVG
RMS voltage refreshed each half-cycle	Urms1/2	1,4	1,2,4	1,2,3,4 Note1	1,2,3,4	1,2,3,4	1,2,3,4	**
Swell	Swell	1	1,2	1,2	1,2,3	1,2,3	1,2,3	
Dip	Dip	1	1,2	1,2	1,2,3	1,2,3	1,2,3	
Interruption	Intrpt	1	1,2	1,2	1,2,3	1,2,3	1,2,3	
Instantaneous flicker	S(t)	1	1,2	1,2	1,2,3	1,2,3	1,2,3	**

(4) Items measured without gaps every half-cycle

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN/AVG
RMS current refreshed each half-cycle (inrush current)	Irms1/2 (Irms1/2)	1,4	1,2,4	1,2,3,4 Note1	1,2,3,4	1,2,3,4	1,2,3,4	**

(5) Items measured without gaps and aggregated every approx. 200 ms
(about once every 10 cycles at 50 Hz, every 12 cycles at 60 Hz, or every 80 cycles at 400 Hz)

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN /AVG
Frequency	Freq	U1	U1	U1	U1	U1	U1	*
10-sec frequency	Freq10s	U1	U1	U1	U1	U1	U1	*
Voltage Waveform Peak	Upk+, Upk-	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Current Waveform Peak	Ipk+,Ipk-	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
rms voltage (phase/line)	Urms	1,4	1,2,4,AVG	1,2,3,4, AVG Note1	1,2,3,4, AVG	1,2,3,4, AVG	1,2,3,4, AVG	*
Voltage DC	Udc	4	4	4	4	4	4	*
rms current	Irms	1,4	1,2,4,AVG	1,2,3,4, AVG Note1	1,2,3,4, AVG	1,2,3,4, AVG	1,2,3,4, AVG	*
Current DC	Idc	4	4	4	4	4	4	*
Active power	P	1	1,2,sum	1,2,sum	1,2,3,sum	1,2,3,sum	1,2,3,sum	*
Active energy	WP+, WP-	1	sum	sum	sum	sum	sum	
Apparent power	S	1	1,2,sum	1,2,sum	1,2,3,sum	1,2,3,sum	1,2,3,sum	*
Reactive power	Q	1	1,2,sum	1,2,sum	1,2,3,sum	1,2,3,sum	1,2,3,sum	*
Reactive energy (lag) (lead)	WQLAG, WQLEAD	1	sum	sum	sum	sum	sum	
Power factor/displacement power factor*2	PF/DPF	1	1,2,sum	1,2,sum	1,2,3,sum	1,2,3,sum	1,2,3,sum	*

(5) Items measured without gaps and aggregated every approx. 200 ms
(about once every 10 cycles at 50 Hz, every 12 cycles at 60 Hz, or every 80 cycles at 400 Hz)

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W2.5E	MAX/MIN /AVG
Zero-phase voltage unbalance factor Voltage negative-phase unbalance factor	Uunb0, Uunb	-	-	sum	sum	sum	sum	*
Zero-phase current unbalance factor Current negative-phase unbalance factor	Iunb0, Iunb	-	-	sum	sum	sum	sum	*
High-order harmonic voltage component	UharmH	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
High-order harmonic current component	IharmH	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Harmonic voltage (orders 0 to 50)	Uharm	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Harmonic current (0 to 50th)	Iharm	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Harmonic power (0 to 50th)	Pharm	1	1,2,sum	sum	sum	1,2,3,sum	1,2,3,sum	*
Inter-harmonic voltage (0.5to 49.5th)	Uiharm	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Inter-harmonic current (0.5 to 49.5th)	Iiharm	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Harmonic voltage phase angle (1 to 50th)	Uphase	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	
Harmonic current phase angle (1 to 50th)	Iphase	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	
Harmonic voltage-current phase difference (1to 50th)	Pphase	1	1,2,sum	sum	sum	1,2,3,sum	1,2,3,sum	*
Total harmonic voltage distortion factor Note2	Uthd-F/Uthd-R	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Total harmonic current distortion factor Note2	Ithd-F/Ithd-R	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
K factor	KF	1,4	1,2,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	*
Voltage waveform comparison	Wave	1	1,2	1,2	1,2,3	1,2,3	1,2,3	

Note 1: All CH4 displays turn ON when CH4 is set to AC+DC or DC.
Note 2: When CH4 is turned OFF, all CH4 display values and waveforms are also turned OFF.
Note 3: Meaning of "*" in the "MAX/MIN/AVG" column
Indicates that maximum, minimum, and average values (all) can be displayed during the MAX/MIN/AVG TIMEPLOT interval.
Note 4: Meaning of "**" in the "MAX/MIN/AVG" column
Indicates that maximum and minimum values (all) can be displayed, regardless of the MAX/MIN/AVG TIMEPLOT interval.
*1: CH3 is calculated but not displayed. It can be output only as binary data.
*2: Select either.

(6) Flicker measurement items:

Measurement items	Notation	1P2W	1P3W	3P3W2M	3P3W3M	3P4W	3P4W 3P4W2.5E	MAX/MIN /AVG
ΔV10 (every minute, 1-hour average value, 1-hour maximum value, 1-hour fourth-largest value, overall maximum value [during measurement period])	dV10, dV10 AVG, dV10max,dV10max4, dV10 total max	1	1,2	1,2	1,2,3	1,2,3	1,2,3	
Short interval voltage flicker Pst Long interval voltage flicker Plt	Pst, Plt	1	1,2	1,2	1,2,3	1,2,3	1,2,3	

Conditions of Guaranteed Accuracy

Conditions of guaranteed accuracy	Warm-up time of at least 30 minutes, power factor = 1, common-mode voltage of 0 V, input of at least 1.666% f.s. to reference channel after zero adjustment
Temperature and humidity for guaranteed accuracy	23±5°C (73±9°F), 80%RH or less (applies to all specifications unless otherwise noted))
Period of guaranteed accuracy	1 year
Fundamental waveform range for guaranteed accuracy	When measurement frequency is set to 50 Hz : 40 to 58 Hz When measurement frequency is set to 60 Hz : 51 to 70 Hz When measurement frequency is set to 400 Hz: 360 Hz to 440 Hz

Display

Total display area	Voltage : 0.08% to 130% of selected range (Displaying values that are less than 0.08% f.s. as the value zero.) Current : 0.5% to 130% of the range (Displaying values that are less than 0.5% f.s. as the value zero.) Power : 0.1% to 130% of the range (Displaying values that are less than 0.1% f.s. as the value zero.) Measurement items other than above: 0% to 130% of the range
Effective measuring range	Voltage : 1.666% to 130% of selected AC range (actual input of 10 to 780 V), 0.1666% to 100% of selected DC range (actual input of 1 to 600 V)) Current : 1% to 110% of the range Power : 0.15% to 130% of the range (with both voltage and current within valid measurement range) Note: See separate specifications for harmonic measurement.

Measurement items

There are no accuracy specifications where measurement accuracy is not noted or for 3P3W2M CH3 measured values.

Transient overvoltage (Tran)

Measurement method	Detected from waveform obtained by eliminating the fundamental component (50/60/400 Hz) from the sampled waveform. Detection occurs once for each fundamental voltage waveform.
Sampling frequency	2 MHz
Displayed item	Transient voltage value : Waveform peak value during 4 ms period after elimination of fundamental component Transient width : Period during which threshold is exceeded (2 ms max.) Max. transient voltage value : Max. peak value of waveform obtained by eliminating the fundamental component during the period from transient IN to transient OUT (leaving channel information) Transient period : Period from transient IN to transient OUT Transient count during period : Number of transients occurring during period from transient IN to transient OUT (transients occurring across all channels or simultaneously on multiple channels count as 1) RMS transient : For testing purposes
Measurement range, resolution	±6.0000k Vpk
Measurement band	5 kHz (-3dB) to 700 kHz (-3dB), specified at 20 Vrms
Min. detection width	0.5 μs
Measurement accuracy	±5.0% rdg.±1.0%f.s. (specified at 1,000 Vrms/30 Hz and 700 Vrms/100 kHz)
Event threshold	Set as an absolute value relative to the peak value (crest value) of the waveform obtained by eliminating the 6,000.0 V resolution fundamental component
Event IN	First transient overvoltage detected in an approx. 200 ms aggregation interval.The event occurrence time indicates the peak voltage value and transient width when the threshold was exceeded.
Event OUT	Start of approx. 200ms aggregation in which no transient overvoltage was detected for any channel within the first approx. 200 ms aggregation period following the transient event IN state. The transient period (difference between the IN and OUT times) is indicated.
Multiple-phase system treatment	Begins when a transient is detected for any one of the U1 to U4 channels and ends when no transient is detected for any of the channels.
Saved waveforms	Event waveforms, Transient waveforms Waveforms are saved for 2 ms before and after the position at which the transient overvoltage waveform was detected for the first transient IN and 2 ms before and after the point at which the transient maximum voltage waveform was detected between the IN and OUT points.

Frequency cycle (Freq_wav)

Measurement method	Calculated as the reciprocal of the accumulated whole-cycle time during one U1 (reference channel) cycle. Frequency is given per waveform. When set to a measurement frequency of 400 Hz, calculated as the reciprocal of the accumulated whole-cycle time during 8 cycles. Average frequency is given for 8 waveforms.
Sampling frequency	200 kHz
Displayed item	Worst frequency cycle value between EVENT IN and EVENT OUT (max. deviation).
Measurement range, resolution	When the measurement frequency is set to 50/60 Hz:: 70.000 Hz When the measurement frequency is set to 400 Hz : 440.00 Hz
Measurement band	When the measurement frequency is set to 50/60 Hz : 40.000 to 70.000 Hz When the measurement frequency is set to 400 Hz : 360.00 to 440.00 Hz
Measurement accuracy	When the measurement frequency is set to 50/60 Hz: ±0.200 Hz or less (for input from 10% f.s. to 110% f.s.) When the measurement frequency is set to 400 Hz: ±2.00 Hz or less (for input from 10% f.s. to 110% f.s.)
Event threshold	Specified as deviation of 0.1 to 9.9 Hz in 0.1 Hz increments.
Event IN	±Start time of waveform exceeding threshold
Event OUT	±Start time of waveform returning to (threshold - 0.1 Hz) Note: Equivalent to 0.1 Hz frequency hysteresis.
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

RMS voltage refreshed each half-cycle (Urms1/2)

Measurement method	True RMS type IEC6100-4-30 compliant When the measurement frequency is set to 50/60 Hz, RMS voltage values are calculated using sample data for 1 waveform derived by overlapping the voltage waveform every half-cycle. When the measurement frequency is set to 400 Hz, the RMS voltage value is calculated for each voltage waveform. The line voltage is used for 3-phase 3-wire (3P3W3M) connections, while the phase voltage is used for 3-phase 4-wire connections.
Sampling frequency	200 kHz
Displayed item	RMS voltage refreshed each half-cycle
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	When the measurement frequency is set to 50/60 Hz: With 1.666% f.s. to 110% f.s. input: Specified as 0.2% of nominal voltage with a nominal input voltage (Udin) of at least 100 V. With input outside the range of 1.666% f.s. to 110% f.s. or a nominal input voltage (Udin) of less than 100 V: 0.2% rdg. 0.08% f.s. When the measurement frequency is set to 400 Hz: ±0.4% rdg.±0.50%f.s.
Event threshold	See dips/swells/interruptions.
Event IN	See Dip/ Swell/Interruption
Event OUT	See Dip/ Swell/Interruption
Multiple-phase system treatment	None
Saved waveforms	None
Constraints	With a 400 Hz measurement frequency, measured values recorded on the event voltage fluctuation graph consist of RMS voltage values for each waveform.

RMS current refreshed each half-cycle (Irms1/2)

Measurement method	IEC61000-4-30 compliant When the measurement frequency is set to 50/60 Hz, the RMS current is calculated using current waveform data sampled every half-cycle (synchronized to the voltage of the channel in question). When the measurement frequency is set to 400 Hz, the RMS current is calculated for the current waveform once each cycle.
Sampling frequency	200 kHz
Displayed item	RMS current refreshed each half-cycle
Measurement range, resolution	Varies with sensor used (see input specifications).
Measurement band	See RMS frequency characteristics.
Measurement accuracy	When the measurement frequency is set to 50/60 Hz: ±0.3% rdg.±0.5%f.s. + clamp sensor accuracy When the measurement frequency is set to 400 Hz: ±0.4% rdg.±1.0%f.s. +clamp sensor accuracy
Event threshold	See inrush current.
Event IN	See inrush current.
Event OUT	See inrush current.
Multiple-phase system treatment	See inrush current.
Saved waveforms	See inrush current.
Other	Generates events as inrush current.

Swell (Swell)

Measurement method	IEC61000-4-30 compliant During 50/60 Hz measurement, a swell is detected when the RMS voltage refreshed each half-cycle exceeds the threshold in the positive direction. During 400 Hz measurement, a swell is detected when the maximum of 4 RMS voltage values occurring within 10 ms (values calculated for one 400 Hz waveform) exceeds the threshold in the positive direction.
Sampling frequency	200 kHz
Displayed item	Swell height: Worst value for RMS voltage refreshed each half-cycle [V] Swell duration: Period from the time a U1 to U3 swell is detected until the reading exceeds the value obtained by subtracting the hysteresis from the threshold in the negative direction
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	Same as for RMS voltage refreshed each half-cycle Within half a cycle of the start accuracy time, within half a cycle of the end accuracy time (not specified for 400 Hz measurement)
Event threshold	Percentage of the nominal voltage or percentage of the slide reference voltage (user-selectable)
Event IN	Start of the waveform for which the RMS voltage refreshed each half-cycle exceeded the threshold in the positive direction
Event OUT	Start of the waveform for which the RMS voltage refreshed each half-cycle exceeded the value obtained by subtracting the hysteresis from the threshold in the negative direction
Multiple-phase system treatment	Starts when any of the U1 to U3 channels experiences a swell and ends when the swell has ended for all channels.
Saved waveforms	Event waveforms
Fluctuation data	RMS data refreshed each cycle is saved from 0.5 s before to 29.5 s after the EVENT IN. When set to 400 Hz, RMS data refreshed each cycle is saved from 0.125 s before to 7.375 s after.

Dip (Dip)

Measurement method	IEC61000-4-30 compliant During 50/60 Hz measurement, a dip is detected when the RMS voltage refreshed each half-cycle exceeds the threshold in the negative direction. During 400 Hz measurement, a dip is detected when the minimum of 4 RMS voltage values occurring within 10 ms (values calculated for one 400 Hz waveform) exceeds the threshold in the negative direction.
Sampling frequency	200 kHz
Displayed item	Dip depth : Worst value for RMS voltage refreshed each half-cycle [V] Dip duration: Period from the time a U1 to U3 dip is detected until the reading exceeds the value obtained by subtracting the hysteresis from the threshold in the positive direction
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	Same as for RMS voltage refreshed each half-cycle Within half a cycle of the start accuracy time, within half a cycle of the end accuracy time (not specified for 400 Hz measurement)
Event threshold	Percentage of the nominal voltage or percentage of the slide reference voltage (user-selectable)
Event IN	Start of the waveform for which the RMS voltage refreshed each half-cycle exceeded the threshold in the negative direction
Event OUT	Start of the waveform for which the RMS voltage refreshed each half-cycle exceeded the value obtained by adding the hysteresis to the threshold in the negative direction
Multiple-phase system treatment	Starts when any of the U1 to U3 channels experiences a dip and ends when the dip has ended for all channels.
Saved waveforms	Event waveforms
Fluctuation data	RMS data refreshed each cycle is saved from 0.5 s before to 29.5 s after the EVENT IN. When set to 400 Hz, RMS data refreshed each cycle is saved from 0.125 s before to 7.375 s after.

Interruption (Intrpt)

Measurement method	IEC61000-4-30 compliant During 50/60 Hz measurement, an interruption is detected when the RMS voltage refreshed each half-cycle exceeds the threshold in the negative direction. During 400 Hz measurement, an interruption is detected when the minimum of 4 RMS voltage values occurring within 10 ms (values calculated for one 400 Hz waveform) exceeds the threshold in the negative direction.
Sampling frequency	200 kHz
Displayed item	Interruption depth : Worst value for RMS voltage refreshed each half-cycle [V] Interruption duration : Period from the time a U1 to U3 interruption is detected until the reading exceeds the value obtained by adding the hysteresis to the threshold in the positive direction
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	Same as for RMS voltage refreshed each half-cycle Within half a cycle of the start accuracy time, within half a cycle of the end accuracy time (not specified for 400 Hz measurement)
Event threshold	Percentage of the nominal voltage
Event IN	Start of the waveform for which the RMS voltage refreshed every cycle exceeded the threshold in the negative direction
Event OUT	Start of the waveform for which the RMS voltage refreshed each half-cycle exceeded the value obtained by adding the hysteresis to the threshold in the positive direction
Multiple-phase system treatment	Starts when all of the U1 to U3 channels experience an interruption and ends when the interruption ends for any of the channels.
Saved waveforms	Event waveforms
Fluctuation data	RMS data refreshed each cycle is saved from 0.5 s before to 29.5 s after the EVENT IN. When set to 400 Hz, RMS data refreshed each cycle is saved from 0.125 s before to 7.375 s after.

Instantaneous flicker value (S(t))

Measurement method	As per IEC61000-4-15 User-selectable from 230 Vlamp/120 Vlamp (when Pst and Plt are selected for flicker measurement)/4 types of Ed2 filter (230 Vlamp 50/60 Hz, 120 Vlamp 60/50 Hz)
Displayed item	Instantaneous flicker value
Measurement range, resolution	99.999, 0.001
Measurement band	See RMS frequency characteristics.
Measurement accuracy	-
Event threshold	None

Frequency (Freq or f)

Measurement method	Calculated as the reciprocal of the accumulated whole-cycle time during approx. 200 ms period of 10, 12, or 80 U1 (reference channel) cycles.
Sampling frequency	200 kHz
Displayed item	Frequency
Measurement range, resolution	When the measurement frequency is set to 50/60 Hz : 70.000 Hz When the measurement frequency is set to 400 Hz : 440.00 Hz
Measurement band	When the measurement frequency is set to 50/60 Hz : 40.000 to 70.000 Hz When the measurement frequency is set to 400 Hz : 360.00 to 440.00 Hz
Measurement accuracy	When the measurement frequency is set to 50/60 Hz : ±0.020 Hz or less When the measurement frequency is set to 400 Hz : ±0.20 Hz or less (with input voltage of 4% f.s. to 110% f.s.)
Event threshold	Specified as deviation from 0.1 Hz to 9.9 Hz in 0.1 Hz increments
Event IN	Start of approx. 200 ms aggregation in which ±threshold was exceeded
Event OUT	Start of approx. 200 ms aggregation in which reading returned to ±(threshold - 0.1 Hz) Note: Equivalent to 0.1 Hz frequency hysteresis.
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

10-sec frequency (Freq10s or f10s)

Measurement method	Calculated as the reciprocal of the accumulated whole-cycle time during the specified 10 s period for U1 (reference channel) as per IEC61000-4-30. (To ensure measurement precision, it is necessary to wait a maximum of 20 s after inputting the signal.)
Sampling frequency	200 kHz
Displayed item	10-sec frequency
Measurement range, resolution	When the measurement frequency is set to 50/60 Hz : 70.000 Hz When the measurement frequency is set to 400 Hz : 440.00 Hz
Measurement band	When the measurement frequency is set to 50/60 Hz : 40.000 to 70.000 Hz When the measurement frequency is set to 400 Hz : 360.00 to 440.00 Hz
Measurement accuracy	When the measurement frequency is set to 50/60 Hz : ±0.010 Hz or less When the measurement frequency is set to 400 Hz : ±0.10 Hz or less (with input voltage of 1.666% f.s. to 110% f.s.)
Event threshold	N/A

Voltage waveform peak (Upk)

Measurement method	Measured every 10 cycles (50 Hz) or 12 cycles (60 Hz); maximum and minimum points sampled during approx. 200 ms aggregation. During 400 Hz measurement, measured every 80 cycles; maximum and minimum points sampled during approx. 200 ms aggregation.
Sampling frequency	200 kHz
Displayed item	Positive peak value and negative peak value
Measurement range, resolution	Area of the RMS voltage range to which the crest factor was added. ±1200.0 Vpk
Measurement band	See RMS frequency characteristics.
Measurement accuracy	-
Event threshold	0 to 1200 V (value before setting VT ratio) 1 V increments, absolute value comparison
Event IN	Start of approx. 200 ms aggregation in which ±threshold was exceeded
Event OUT	Start of first approx. 200 ms aggregation after IN state in which ±threshold was not exceeded
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Current waveform peak (Ipk)

Measurement method	Measured every 10 cycles (50 Hz) or 12 cycles (60 Hz); maximum and minimum points sampled during approx. 200 ms aggregation. During 400 Hz measurement, measured every 80 cycles; maximum and minimum points sampled during approx. 200 ms aggregation.
Sampling frequency	200 kHz
Displayed item	Positive peak value and negative peak value
Measurement range, resolution	Area of the current range to which the crest factor was added.
Measurement band	See RMS frequency characteristics.
Measurement accuracy	-
Event threshold	0 to (rated current of clamp sensor being used × 4) A (value before setting CT), absolute value comparison
Event IN	Start of approx. 200 ms aggregation in which ±threshold was exceeded
Event OUT	Start of first approx. 200 ms aggregation after IN state in which ±threshold was not exceeded
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

RMS voltage (Urms)

Measurement method	AC+DC True RMS type IEC61000-4-30 compliant: 10 cycles (50 Hz) or 12 cycles (60 Hz) (approx. 200 ms aggregation) During 400 Hz measurement, calculated from 80 cycles (approx. 200 ms aggregation) When set to 3P3W3M/3P4W/3P4W2.5E, the phase voltage/line voltage setting is applied to the RMS voltage Urms. Includes Zero-display range.
Sampling frequency	200 kHz
Displayed item	RMS voltage for each channel and AVG (average) RMS voltage for multiple channels (for more information, "13.10 Calculation Formula" (p.198))
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	When input is 10% to 150% of Udin and 1.666%f.s. to 110%f.s. (Up to 660V when Udin>440V):±0.1% of the nominal voltage. Otherwise:±0.2% rdg.±0.08%f.s. When the measurement frequency is set to 400 Hz: ±0.2% rdg.±0.16%f.s.
Event threshold	Upper and lower limits set separately from 0 to (lower limit) to (upper limit) to 780 V (value before setting VT ratio) When set to 3P3W3M/3P4W/3P4W2.5E, the phase voltage/line voltage setting is applied.
Sense	Set from 0 to 600 V.
Event IN	Start of the approx. 200 ms aggregation during which the reading was greater than the upper limit or less than the lower limit
Event OUT	Start of the approx. 200 ms aggregation during which the reading was less than (upper limit - hysteresis) after being greater than the upper limit or was greater than (lower limit + hysteresis) after being less than the lower limit
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Voltage DC value (Udc)

Measurement method	Average value during approx. 20 ms aggregation synchronized with the reference channel (CH4 only) Includes Zero-display range.
Sampling frequency	200 kHz
Displayed item	Voltage DC value
Measurement range, resolution	600.00 V
Measurement band	See RMS frequency characteristics.
Measurement accuracy	±0.3% rdg.±0.08%f.s.
Event threshold	0 V to 1,200 V The difference between the positive and negative waveform peak values in the 200 ms aggregation is compared to the threshold to generate DC fluctuation events.
Sense	Set from 0 to 600 V.
Event IN	Start of the 200 ms aggregation in which the threshold was exceeded
Event OUT	Start of the first 200 ms aggregation after the IN state in which the threshold was not exceed
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

RMS current (Irms)

Measurement method	AC+DC True RMS type IEC61000-4-30 compliant: 10 cycles (50 Hz) or 12 cycles (60 Hz) (approx. 200 ms aggregation) During 400 Hz measurement, 200 kHz sampling at 80 cycles (approx. 200 ms aggregation) Includes Zero-display range.
Sampling frequency	200 kHz
Displayed item	RMS current for each channel and AVG (average) RMS current for multiple channels (for more information, "13.10 Calculation Formula" (p.198))
Measurement range, resolution	See input specifications.
Measurement band	See RMS frequency characteristics.
Measurement accuracy	When the measurement frequency is set to 50/60 Hz: ±0.2% rdg.±0.1%f.s. + clamp sensor accuracy When the measurement frequency is set to 400 Hz: ±0.2% rdg.±0.6%f.s. +clamp sensor accuracy
Event threshold	0 to current range
Sense	0 to current range
Event IN	Start of approx. 200 ms aggregation in which threshold was exceeded
Event OUT	Start of approx. 200 ms aggregation in which reading was less than (threshold - hysteresis)
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Current DC value (Idc)

Measurement method	Average value during approx. 200 ms aggregation synchronized to reference channel (CH4 only) Includes Zero-display range.
Sampling frequency	200 kHz
Displayed item	Current DC value
Measurement range, resolution	Varies with clamp sensor used (CH4 only).
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band.
Measurement accuracy	±0.5% rdg.±0.5%f.s. + clamp sensor specifications accuracy Not specified when using AC dedicated clamp sensor.
Event threshold	0 to (rated current of clamp sensor being used × 4) A The difference between the positive and negative waveform peak values in the 200 ms aggregation is compared to the threshold to generate DC fluctuation events.
Sense	0 to current range
Event IN	Start of the 200 ms aggregation in which the threshold was exceeded
Event OUT	Start of the first 200 ms aggregation after the IN state in which the threshold was not exceed
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

Active power (P)

Measurement method	Measured every 10 cycles (50 Hz) or 12 cycles (60 Hz) (approx. 200 ms aggregation). During 400 Hz measurement, measured every 80 cycles (approx. 200 ms aggregation) Includes Zero-display range.
Sampling frequency	200 kHz
Displayed item	Active power for each channel and sum value for multiple channels (for more information, see "13.10 Calculation Formula" (p.198)) Sink (consumption) : Unsigned Source (regeneration) : Negative
Measurement range, resolution	Combination of voltage × current range (see "13.11 Clamp Sensors and Ranges" (p.211))
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band.
Measurement accuracy	When the measurement frequency is set to 50/60 Hz: ±0.2% rdg.±0.1%f.s. + clamp sensor accuracy (sum value is sum for channels being used) When the measurement frequency is set to 400 Hz: ±0.4% rdg.±0.6%f.s. +clamp sensor accuracy (The total is the sum of the channels used.)
Event threshold	Comparison of power range absolute values
Event IN	Start of approx. 200 ms aggregation in which the absolute value was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Active energy and reactive energy (WP+, WP-/WQLAG, WQLEAD)

Measurement method	Measured every 10 cycles (50 Hz) or 12 cycles (60 Hz) (approx. 200 ms). During 400 Hz measurement, measured every 80 cycles using the 8-cycle waveform (approx. 200 ms). Integrated separately by consumption and regeneration from active power. Integrated separately by lag and lead from reactive power. Recorded at the specified TIMEPLOT interval. Data is updated every 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz) (approx. 200 ms). Integration starts at the same time as recording and continues to previous TIMEPLOT update at termination of recording.
Sampling frequency	200 kHz
Displayed item	Active energy: WP+ (consumption), WP- (regeneration) Sum of multiple channels (for more information, see "13.10 Calculation Formula" (p.198)) Reactive energy: WQLAG (lag), WQLEAD (lead) Sum for multiple channels (for more information, see "13.10 Calculation Formula" (p.198)) Elapsed time
Measurement range, resolution	Combination of voltage × current range (See "13.11 Clamp Sensors and Ranges" (p.211))
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band.
Measurement accuracy	Active energy : Active power measurement accuracy ±10 dgt. Reactive energy : Reactive power measurement accuracy ±10 dgt. Cumulative time accuracy : ±10 ppm ±1 s (23°C [73°F])
Event threshold	N/A

Apparent power (S)

Measurement method	Calculated from RMS voltage U and RMS current I. No polarity
Sampling frequency	200 kHz
Displayed item	Apparent power of each channel and its sum for multiple channels. (For details, see "13.10 Calculation Formula" (p.198))
Measurement range, resolution	Depends on the voltage × current range combination. (See "13.11 Clamp Sensors and Ranges" (p.211))
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band.
Measurement accuracy	±1 dgt. for calculations derived from the various measurement values. (sum is ±3 dgt.)
Event threshold	Power range
Event IN	Start of approx. 200 ms aggregation in which the absolute value was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Reactive power (Q)

Measurement method	Calculated using apparent power S and active power P. Lag phase (LAG: current lags voltage): Unsigned Lead phase (LEAD: current leads voltage): Negative
Sampling frequency	200 kHz
Displayed item	Reactive power of each channel and its sum for multiple channels. (For details, see"13.10 Calculation Formula" (p.198).)
Measurement range, resolution	Depends on the voltage × current range combination. (See "13.11 Clamp Sensors and Ranges" (p.211))
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band.
Measurement accuracy	±1 dgt. for calculations derived from the various measurement values. (sum is ±3 dgt.)
Event threshold	Power range
Event IN	Start of approx. 200 ms aggregation in which the absolute value was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Power factor and displacement power factor (PF, DPF)

Measurement method	Power factor : Calculated from RMS voltage U, RMS current I, and active power P. Displacement power factor : Calculated from the phase difference between the fundamental voltage wave and the fundamental current wave. Lag phase (LAG: current lags voltage) : Unsigned Lead phase (LEAD: current leads voltage) : Negative DPF values for all channels (excluding sum values) during 3P3W2M and 3P3W3M connections are undefined.
Sampling frequency	200 kHz
Displayed item	Displacement power factor of each channel and its sum value for multiple channels. (For details, see "13.10 Calculation Formula" (p.198).)
Measurement range, resolution	-1.0000 (lead) to 0.0000 to 1.0000 (lag)
Measurement band	See RMS frequency characteristics and consider clamp sensor measurement band
Measurement accuracy	-
Event threshold	0.000 to 1.000
Event IN	Start of approx. 200 ms aggregation in which the absolute value was less than the threshold
Event OUT	Start of the approx. 200 ms aggregation in which the reading was greater than (absolute value + hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Voltage unbalance factor (negative-phase unbalance factor, zero-phase unbalance factor) (Uunb, Uunb0)

Measurement method	Calculated using various components of the three-phase fundamental voltage wave (line-to-line voltage) for three-phase 3-wire (3P3W2M, 3P3W3M) and three-phase 4-wire connections. (For details, see "13.10 Calculation Formula" (p.198))
Sampling frequency	200 kHz
Displayed item	Negative-phase unbalance factor (Uunb), zero-phase unbalance factor (Uunb0)
Measurement range, resolution	Component is V and unbalance factor is 0.00% to 100.00%.
Measurement band	See "13.10 Calculation Formula" (p.198).
Measurement accuracy	When the measurement frequency is set to 50/60 Hz ±0.15% (0.0% to 5.0% range specified for IEC61000-4-30 performance testing)
Event threshold	0.0% to 100.0%
Event IN	Start of approx. 200 ms aggregation in which reading was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis)
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

Current unbalance factor (negative-phase unbalance factor, zero-phase unbalance factor) (Iunb, Iunb0)

Measurement method	For 3-phase 3-wire (3P2W2M and 3P3W3M) and 3-phase 4-wire, calculated using 3-phase fundamental current component (For details, see "13.10 Calculation Formula" (p.198).)
Sampling frequency	200 kHz
Displayed item	Negative-phase unbalance factor (Iunb), zero-phase unbalance factor (Iunb0)
Measurement range, resolution	Component is A and unbalance factor is 0.00% to 100.00%.
Measurement band	Fundamental component
Measurement accuracy	-
Event threshold	0.0% to 100.0%
Event IN	Start of approx. 200 ms aggregation in which reading was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis)
Multiple-phase system treatment	None
Saved waveforms	Event waveforms

High-order harmonic voltage component and high-order harmonic current component (UharmH, IharmH)

Measurement method	The waveform obtained by eliminating the fundamental component is calculated using the true RMS method during 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz) of the fundamental wave (approx. 200 ms aggregation).
Sampling frequency	200 kHz
Displayed item	High-order harmonic voltage component value: RMS voltage for the waveform obtained by eliminating the fundamental component High-order harmonic current component value: RMS current for the waveform obtained by eliminating the fundamental component High-order harmonic voltage component maximum value: Maximum RMS value for the waveform obtained by eliminating the fundamental component for the period from EVENT IN to EVENT OUT (leaving channel information) High-order harmonic current component maximum value: Maximum RMS value for the waveform obtained by eliminating the fundamental component for the period from EVENT IN to EVENT OUT (leaving channel information) High-order harmonic voltage component period: Period from high-order harmonic voltage component EVENT IN to EVENT OUT High-order harmonic current component period: Period from high-order harmonic current component EVENT IN to EVENT OUT
Measurement range, resolution	High-order harmonic voltage component: 600.00 V High-order harmonic current component: Varies with current range; see input specifications.
Measurement band	2 kHz (-3dB) to 80 kHz (-3dB)
Measurement accuracy	High-order harmonic voltage component: ±10% rdg.±0.1%f.s. (specified for 10 V sine wave at 5 kHz, 10 kHz, and 20 kHz) High-order harmonic current component: ±10% rdg.±0.2%f.s. + clamp sensor accuracy (specified as 1% f.s. sine wave at 5 kHz, 10 kHz, and 20 kHz)
Event threshold	High-order harmonic voltage component: 0 V or greater, 600.00 V or less High-order harmonic current component: 0 A or greater, current range or less
Event IN	Start of approx. 200 ms aggregation in which reading was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which high-order harmonics were not detected during the first approx. 200 ms aggregation following the IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms High-order harmonic waveform 40 ms from the end of the first approx. 200 ms aggregation interval in which the reading was greater than the threshold (8,000 data points)

Harmonic voltage and harmonic current (including fundamental component) (Uharm/Iharm)

Measurement method	Uses IEC61000-4-7:2002. Max. order: 50th Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB. Indicated harmonic voltage and harmonic current values incorporate inter-harmonics components adjacent to the next whole-number harmonic component after harmonic analysis. (For details see "13.10 Calculation Formula" (p.198).) Measurement accuracy is specified for input that is 10% to 200% of IEC61000-2-4 Class 3.
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	From order 0 to 50 (with a fundamental wave of 40 to 70 Hz) From order 0 to 10 (with a fundamental wave of 360 to 440 Hz) Select either RMS or content percentage (When using content percentage, Zero-display range causes all orders to be given as 0% when the RMS value is 0.)
Measurement range, resolution	Harmonic voltage: 600.00 V Harmonic current: Varies with current range (see input specifications).
Measurement accuracy	See measurement accuracy with a fundamental wave of 50/60 Hz and measurement accuracy with a fundamental wave of 400 Hz.
Event threshold	Harmonic voltage: 0.00 to 780.00 V (order 0: absolute value comparison) Harmonic current: Varies with clamp sensor ×1.3 (see input specifications) (order 0: absolute value comparison).
Event IN	Start of approx. 200 ms aggregation in which readings were greater than the threshold for each order
Event OUT	Start of approx. 200 ms aggregation in which readings were less than (threshold - hysteresis) for each order
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms
Constraints	When using an AC-only clamp sensor, order 0 is not specified for current and power.

Harmonic power (including fundamental component) (Pharm)

Measurement method	Uses IEC61000-4-7:2002. Max. order: 50th Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB. Indicates harmonic power values consisting of harmonic power for each channel and the sum of multiple channels. (For details see "13.10 Calculation Formula" (p.198).)
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	From order 0 to 50 (with a fundamental wave of 40 to 70 Hz) From order 0 to 10 (with a fundamental wave of 360 to 440 Hz) Select either RMS or content percentage (When using content percentage, Zero-display range causes all orders to be given as 0% when the RMS value is 0.)
Measurement range, resolution	See power ranges.
Measurement accuracy	See measurement accuracy with a fundamental wave of 50/60 Hz and measurement accuracy with a fundamental wave of 400 Hz.
Event threshold	0 to (varies with range) (specified as absolute value)
Event IN	Start of approx. 200 ms aggregation in which the reading is greater than the threshold (when the threshold is positive) or less than the threshold (when the threshold is negative)
Event OUT	Start of the approx. 200 ms aggregation in which the reading is less than (threshold - hysteresis) (when the threshold is positive) or greater than (threshold + hysteresis) (when the threshold is negative) in the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms
Constraints	When using an AC-only clamp sensor, order 0 is not specified for current and power.

Measurement accuracy with a fundamental wave of 50/60 Hz

	Harmonic input	Measurement accuracy	Notes
Voltage	At least 1% of nominal voltage	Order 0 : ±0.3% rdg.±0.08%f.s. Order 1+ : ±5.00% rdg.	Specified with a nominal voltage of at least 100 V.
	<1% of nominal voltage	Order 0 : ±0.3% rdg.±0.08%f.s. Order 1+ : ±0.05% of nominal voltage	Specified with a nominal voltage of at least 100 V.
Current		Order 0 : ±0.5% rdg.±0.5%f.s. Orders 1 to 20th : ±0.5% rdg.±0.2%f.s. Orders 21 to 50th : ±1.0% rdg.±0.3%f.s.	Add clamp sensor accuracy.
Power		Order 0 : ±0.5% rdg.±0.5%f.s. 1 to 20th : ±0.5% rdg.±0.2%f.s. 21 to 30th : ±1.0% rdg.±0.3%f.s. Orders 31 to 40th : ±2.0% rdg.±0.3%f.s. Orders 41 to 50th : ±3.0% rdg.±0.3%f.s.	Add clamp sensor accuracy.

Measurement accuracy with a fundamental wave of 400 Hz

	Harmonic input	Measurement accuracy	Notes
Voltage		Order 0 : ±0.5% rdg.±0.08%f.s. Orders 1 to 2th : ±0.5% rdg.±0.20%f.s. Orders 3 to 6th : ±1.0% rdg.±0.30%f.s. Orders 7 to 10th : ±5.0% rdg.±0.30%f.s.	
Current		Order 0 : ±0.5% rdg.±0.5%f.s. 1 to 2th : ±0.5% rdg.±0.2%f.s. 3 to 6th : ±1.0% rdg.±0.3%f.s. 7 to 10th : ±5.0% rdg.±0.3%f.s.	Add clamp sensor accuracy.
Power		Order 0 : ±0.5% rdg.±0.5%f.s 1 to 2th : ±0.5% rdg.±0.2%f.s. 3 to 6th : ±1.0% rdg.±0.3%f.s. 7 to 10th : ±7.0% rdg.±0.3%f.s.	Add clamp sensor accuracy.

Inter-harmonic voltage and inter-harmonic current (Uiharm, Iiharm)

Measurement method	Uses IEC61000-4-7:2002. Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB. After harmonic analysis, harmonic voltage and current are summed and displayed as inter-harmonic contents with the harmonic contents according to harmonic order Measurement accuracy is specified for input that is 10% to 200% of IEC61000-2-4 Class 3.
Analysis window width	10 cycles (50 Hz) or 12 cycles (60 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	0.5 to 49.5 orders (of 42.5- to 70-Hz fundamental waveform) Select either RMS or content percentage (When using content percentage, Zero-display range causes all orders to be given as 0% when the RMS value is 0.)
Measurement range, resolution	Inter-harmonic voltage: U1 to U4, 600.00 V Inter-harmonic current: I1 to I4, Varies with current range (see input specifications).
Measurement accuracy	Inter-harmonic voltage (Specified with a nominal voltage of at least 100 V.) At least 1% of harmonic input nominal voltage:: ±5.00% rdg. <1% of harmonic input nominal voltage: ±0.05% of nominal voltage Inter-harmonic current: Unspecified
Event threshold	N/A
Constraints	Not displayed for 400 Hz measurement.

Harmonic voltage phase angle and Harmonic current phase angle (including fundamental component) (Uphase/Iphase)

Measurement method	Uses IEC61000-4-7:2002. Max. order: 50th Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB.
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	After harmonic analysis, the harmonic phase angle components for whole orders are displayed. (Reference channel's fundamental wave phase angle must be 0°.)
Measurement range, resolution	0.00 to ±180.00°
Measurement accuracy	-
Event threshold	N/A

Harmonic voltage-current phase angle (including fundamental component) (Pphase/ θ)

Measurement method	Uses IEC61000-4-7:2002. Max. order: 50th Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB.
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	Indicates the difference between the harmonic voltage phase angle and the harmonic current phase angle. Harmonic voltage-current phase difference for each channel and sum (total) value for multiple channels (For details, see "13.10 Calculation Formula" (p.198).)
Measurement range, resolution	0.00to ±180.00°
Measurement accuracy	At 50/60 Hz: 1st to 3rd orders : ± 2° 4th to 50th orders: ±(0.05°×k+2°) (k: harmonic orders) At 400 Hz: 1st to 10th orders: ±(0.16°×k+2°) (k: harmonic orders) Note1: However, clamp sensor accuracy is added. Note2: Specified with a harmonic voltage of 1 V for each order and a current level of at 1% f.s. or greater.
Event threshold	Specified from 0° to 180° in 1° intervals.
Event IN	Start of approx. 200 ms aggregation in which the absolute value is greater than the threshold.
Event OUT	Start of the approx. 200 ms aggregation in which the absolute value is less than (threshold - hysteresis) in the EVENT IN state.
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Total harmonic voltage and Total harmonic current distortion factor (Uthd, Ithd)

Measurement method	Uses IEC61000-4-7:2002. Max. order: 50th Anti-aliasing low-pass filter causes attenuation of frequencies other than measurement target of at least 50 dB.
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	THD-F (total harmonic distortion factor for the fundamental wave) THD-R (total harmonic distortion factor for the total harmonic including the fundamental wave)
Measurement range, resolution	0.00 to 100.00%(Voltage), 0.00 to 500.00%(Current)
Measurement accuracy	-
Event threshold	0.00 to 100.00%
Event IN	Start of approx. 200 ms aggregation in which the absolute value was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

K Factor (multiplication factor) (KF)

Measurement method	Calculated using the harmonic RMS current of the 2nd to 50th orders. (For details, see "13.10 Calculation Formula" (p.198).)
Analysis window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	Rectangular, 4,096 points
Displayed item	K factor
Measurement range, resolution	0.00 to 500.00
Measurement accuracy	-
Event threshold	0 to 500.0
Event IN	Start of approx. 200 ms aggregation in which the absolute value was greater than the threshold
Event OUT	Start of approx. 200 ms aggregation in which the reading was less than (threshold - hysteresis) following the EVENT IN state
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Voltage waveform comparison (Wave)

Measurement method	A judgment area is automatically generated from the previous 200 ms aggregation waveform, and events are generated based on a comparison with the judgment waveform. Waveform judgments are performed once for each 200 ms aggregation.
Comparison window width	10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz)
No. of window points	4,096 points synchronized with harmonic calculations
Displayed item	Event detection only
Event threshold	0.0% to 100.0% of nominal voltage RMS value
Event IN	First time at which waveform diverges from judgment area
Event OUT	None
Multiple-phase system treatment	Separate by channel
Saved waveforms	Event waveforms

Inrush current (Irms1/2 , Inrush)

Measurement method	Detected using the current RMS Irms 1/2. For 400 Hz measurement, inrush current is detected when the maximum of 4 RMS current values existing within the same 10 ms period (calculated values for one 400 Hz waveform) is greater than the threshold in the positive direction.
Displayed item	Maximum RMS current Irms 1/2 current
Measurement range, resolution	Varies with clamp sensor used (see input specifications).
Measurement accuracy	Same as RMS current refreshed each half-cycle Irms 1/2
Event threshold	Varies with set range.
Event IN	Time at the start of each channel's voltage half-cycle waveform for which the RMS current refreshed each half-cycle exceeded the threshold
Event OUT	Time at the start of the voltage half-cycle waveform in which the RMS current refreshed each half-cycle exceeded (threshold - hysteresis) in the negative direction
Multiple-phase system treatment	None
Saved waveforms	Event waveforms
Fluctuation data	With a measurement frequency of 50/60 Hz: RMS current Irms 1/2 values are saved from 0.5 s before to 29.5 s after the event. With a measurement frequency of 400 Hz: RMS current Irms 1/2 values are saved from 0.125 s before to 7.375 s after the event.

ΔV10 Flicker (dV10)

Measurement method	"13.10 Calculation Formula" (p.198) Calculated values are subject to 100 V conversion following gap-less measurement once each minute.
Standard voltage	Automatic (with AGC)
Displayed item	Δ V10 measured at one minute intervals, average value for one hour, maximum value for one hour, fourth largest value for one hour, total (within the measurement interval) maximum value
Measurement range, resolution	0.000 to 99.999 V
Measurement accuracy	±2% rdg.±0.01 V (with a fundamental wave of 100 Vrms [50/60 Hz], a fluctuation voltage of 1 Vrms, and a fluctuation frequency of 10 Hz)
Threshold	0.00 to 9.99V Alarm output is generated when the reading for each minute is compared to the threshold and found to be greater
Event IN	N/A
Event OUT	N/A
Multiple-phase system treatment	None

IEC Flicker (Pst, Plt)

Measurement method	Uses IEC61000-4-15:1997 +A1:2003 Ed1/Ed2, Calculated as described in "13.10 Calculation Formula" (p.198). Pst is calculated after 10 minutes of continuous measurement and Plt after 2 hours of continuous measurement.
Displayed item	Short interval flicker Pst, long interval flicker Plt
Measurement range, resolution	0.0001 to 10000 PU broken into 1,024 segments with a logarithm
Flicker filter	Select 230 V lamp Ed1, 120 V lamp Ed1, 230 V lamp Ed2, or 120 V lamp Ed2.
Measurement accuracy	Pst ±5% rdg. (Specified within range 0.1000 to 20.000 using IEC61000-4-15 Ed1.1 and IEC61000-4-15 Ed2 Class F1 performance test.)

Other Characteristics

RMS frequency characteristics

Frequency	Voltage	Current	Power
40 Hz to 70 Hz	Specified as RMS value	Specified as RMS value	Specified as RMS value
70 Hz to 360 Hz	±1% rdg.±0.2%f.s.	±1% rdg.±0.5%f.s.	±1% rdg.±0.5%f.s.
360 Hz to 440 Hz	Specified as RMS value	Specified as RMS value	Specified as RMS value
440 Hz to 5kHz	±5% rdg.±0.2%f.s.	±5% rdg.±0.5%f.s.	±5% rdg.±1%f.s.
5kHz to 20 kHz	±5% rdg.±0.2%f.s.	±5% rdg.±0.5%f.s.	
20 kHz to 50 kHz	±20% rdg.±0.4%f.s.	±20% rdg.±0.5%f.s.	
80 kHz	-3dB	-3dB	

Specified for RMS voltage Urms and RMS current Irms. Current and power values incorporate clamp sensor accuracy.

Temperature characteristic: Specified within operating temperature and humidity range.

Voltage, Current, Power	±0.03%f.s./°C Add ±0.05% f.s./×C for DC measured values.

Effect of common mode voltage

±0.2%f.s. or less	600 Vrms, 50/60 Hz, Between voltage measurement jacks and instrument chassis
±2%f.s. or less	600 Vrms, 400 Hz, Between voltage measurement jacks and instrument chassis

Magnetic field interference

Voltage	±0.5f.s. or less (in a magnetic field of 400 A/m rms, 50/60 Hz)
Current, Power	±1.5%f.s. or less (in a magnetic field of 400 A/m rms, 50/60 Hz)

Flag concept

IEC61000-4-30 flag concept

When a dip, swell, or interruption compromises the reliability of a value, a flag is attached to the measurement data. Flags are referenced when determining the slide reference voltage and interruption frequency and recorded along with TIMEPLOT data status information. Even when dip, swell, and interruption events have been turned off, flags are attached to measurement data when a dip or interruption (when the voltage falls 10% relative to the nominal voltage) or swell (when the voltage rises 200%) is judged to have occurred. Flags can be reviewed on the TIMEPLOT trend, detailed trend, and flicker (Pst, Plt) graphs. They are shown on trend graphs and can also be reviewed with the measurement data using the 9624-50 PQA-HiView Pro software.

13.4 Event Specifications

Event detection

Event detection method	• The detection method relative to measured values for each event target is listed in the measurement specifications. • External events are detected by detecting signal input to the external event (EVENT IN) terminal. • Manual events are detected when the MANU EVENT key is pressed. • Enabled measurement item events are detected using OR logic. • Events cannot be detected using maximum, minimum, or average values. • The threshold setting error is ±1 dgt. relative to the setting.

Event-synchronized save functionality

Event waveform	Approx. 200 ms aggregation (10 cycle/12 cycle) + instantaneous waveforms for 2 cycles before and after (20 kS/s) (for 400 Hz measurement, 80 cycles + 16 cycles before and after)
Transient waveform	Instantaneous waveform for 2 ms before and after the transient overvoltage waveform detection position (2 MS/s)
High-order harmonic waveform	Instantaneous waveform for 40 ms following the first approx. 200 ms aggregation period in which the reading is greater than the threshold (200 kS/s) 8,000 data points
Fluctuation data	Display of RMS fluctuation data every half cycle equivalent to from 0.5 s before the event to 29.5 s after event (for 400 Hz, measurement, from 0.125 s before to 7.375 s after) as a detailed trend graph

Sense function

A SENSE START event occurs and sense starts when the upper or lower value is exceeded while sense is on. While the sense function is operating, measured values are continuously compared to the range defined by (the measured value when the event last occurred + the sense threshold) and (the measured value when the event last occurred - the sense threshold). If the value falls outside this range, a sense event is generated, and the sense range is updated. When the upper limit or lower limit exceeded event ends, a SENSE END event is generated, and sense function operation terminates.

13.5 Operating Specifications

Operating modes

Three modes: **[SETTING]**, **[RECORDING]** (including **[WAITING]**), and **[ANALYZING]**
A group of screens including **[SYSTEM]**, **[VIEW]**, **[TIMEPLOT]**, and **[EVENT]** displays groups exists for each mode.

Recording start timing

Recording starts at a round TIMEPLOT interval time. For TIMEPLOT intervals of 150/180 cycles, recording starts in 1-minute increments.

Power outage processing

In the event of a power outage during recording, the instrument resumes recording once the power is back on (integral power starts from 0).

[SETTING] (SETTING)

Instrument has been turned on, and there is no data stored internally.

[SYSTEM]	Settings can be changed, and measured values are updated approximately once every 0.5 s.
[VIEW]	Screen updated approximately once every 0.5 s
[TIME PLOT]	None
[EVENT]	None
START LED	Off

[WAITING] (WAITING)

Effective from the time the **START/STOP** button is pressed until the recording start time

[SYSTEM]	Settings cannot be changed, and measured values are updated approximately once every 0.5 s.
[VIEW]	Screen updated approximately once every 0.5 s
[TIME PLOT]	Standby display with time series graph
[EVENT]	Standby display
START LED	Flashing

[RECORDING] (RECORDING)

Recording has started, and measurement data is being saved on the SD memory card.

[SYSTEM]	Settings cannot be changed, and measured values are updated approximately once every 0.5 s.
[VIEW]	Screen updated approximately once every 0.5 s
[TIME PLOT]	Screen updated every TIMEPLOT interval
[EVENT]	Screen updated every time an event occurs
START LED	On

[ANALYZING] (ANALYZING)

Recording has stopped, and the instrument's internal measurement data can be analyzed.

[SYSTEM]	Settings cannot be changed, and measured values are updated approximately once every 0.5 s.
[VIEW]	Analysis of event specified on the **[TIMEPLOT]** or **[EVENT]** screen
[TIME PLOT]	Time series graph display
[EVENT]	Event display
START LED	Off

Chapter 13 Specifications

13.6 Measurement and Analysis Function Specifications

[VIEW] screen

Mode	Display	Display updates	Displayed screens
[SETTING] [RECORDING]	Real-time data	Approx. 0.5 s	Waveform display, vector display, DMM display, harmonic bar graph display, harmonic list display
[ANALYZING]	Event data selected on [TIMEPLOT] or [EVENT] screen		Waveform display, transient overvoltage waveform display, DC waveform display, vector display, DMM display, harmonic bar graph display, harmonic list display, high-order harmonics

Note: Maximum, minimum, and average data is not shown on the [VIEW] screen.

Waveform display

Displayed screens	1. Voltage/ Current : 2-segment split display (voltage waveform (U1 to U4) Current waveform (I1 to I4)) 2. Voltage 4 channels: 4-segment split display (voltage waveform (U1 to U4)) 3. Current 4 channels: 4-segment split display (current waveform (I1 to I4))

Harmonic display

Displayed screens	Vector/harmonic graph/harmonic list The screen displays 10-/12-cycle RMS values based on the IEC61000-4-30 standard for the RMS voltage, RMS current, and power for each order on the vector, graph, and list screens.

DMM display

Displayed screens	1. Power, 2. Voltage, 3. Current The screen shows 10-/12-cycle RMS values based on the IEC61000-4-30 standard for RMS voltage and RMS current on the DMM screen.

Transient overvoltage waveform display

Display conditions	When an event is selected (event is selected on the waveform display screen)
Display selection	All voltage channels
Display period	2 ms before and 2 ms after trigger point

High-order harmonics display

Display conditions	When an event is selected (event is selected on the waveform display screen)
Display format	High-order harmonic voltage component and current component waveforms
Display selection	Channel: Select from CH1, CH2, CH3, and CH4
Display period	40 ms starting after the first approx. 200 ms aggregation interval in which event occurred (8,000 data points)

[TIME PLOT] screen

Trend graph display

Displayed screens	1-screen/2-screen/Energy
Displayed content	Time series graph of maximum, minimum, and average values for 1 item on 1-screen display or 2 items on 2-screen display Select from Freq, Freq10s, Upk+, Upk-, Ipk+, Ipk-, Urms, UrmsAVG, Udc, Irms, IrmsAVG, Idc, P, S, Q, PF, DPF, Uunb0, Uunb, Iunb0, Iunb, UharmH, IharmH, Uthd-F, Uthd-R, Ithd-F, Ithd-R, and KF. "Integration" refers to a time series graph of 1 integrated item.
Display update rate during measurement	Every TIMEPLOT interval

Detailed trend graph display (interval)

Displayed screens	Time series graph of maximum and minimum values for fluctuation data
Displayed content	Select any 1 of Urms1/2, Irms1/2, S(t), and frequency cycle. (S(t) cannot be selected during 400 Hz measurement.)
Display update rate during measurement	Every TIMEPLOT interval

Fluctuation data display (detailed trend graph at event occurrence)

Displayed screens	Time series graph of fluctuation data at event occurrence (from 0.5 s before to 29.5 s after event occurrence for 50/60 Hz measurement; from 0.125 s before to 7.375 s after event occurrence for 400 Hz measurement)
Displayed content	Either Urms1/2 or Irms1/2 (inrush current)
Display update rate during measurement	Each time a displayed event occurs (display is overwritten)

Harmonic trend graph display

Displayed screens	1-screen display
Displayed content	Time series graph of maximum, minimum, and average values for up to 6 items
Display update rate during measurement	Every TIMEPLOT interval

Inter-harmonics trend graph display

Displayed screens	1-screen display
Displayed content	Time series graph of maximum, minimum, and average values for up to 6 items
Display update rate during measurement	Every TIMEPLOT interval

ΔV10 flicker graph display (when flicker is set to ΔV10)

Displayed content	Time series graph of ΔV10 (instantaneous value) (simultaneous display for all measurement channels)
Constraints	No display for 400 Hz measurement

ΔV10 flicker list display (when flicker is set to ΔV10)

Displayed content	ΔV10 1-hour average value, ΔV10 1-hour maximum value, ΔV10 1-hour fourth-largest value, ΔV10 overall maximum value

ΔV10 flicker list display (when flicker is set to ΔV10)

Display refresh rate	Every 1 min (ΔV10 overall maximum value), every 1 hr (others)
Display selection	CH1 to CH3 (varies with connection)
Constraints	No display for 400 Hz measurement

IEC flicker graph display (when flicker is set to IEC **[Pst, Plt]**)

Displayed content	Time series graph of Pst and Plt values
Constraints	No display for 400 Hz measurement

IEC flicker list display (when flicker is set to IEC **[Pst, Plt]**)

Displayed content	Pst and Plt values
Display refresh rate	Each time Pst is updated
Constraints	No display for 400 Hz measurement

[EVENT] screen

Event list display

Display format	• Event list display • Event details display (detailed information for event selected on event list) • Waveform display (waveform for event selected on event list; either voltage or current screen as set with **[VIEW]** screen's **[VOLT/CURR]** display setting)
Event list display order	Order of occurrence
Event jump function	Allows details for specified event to be analyzed on **[VIEW]** screen.

13.7 Configuration Function Specifications

Detailed description of Urms type, PF type, THD type, and harmonics

Selection / Details	Urms type	PF type	THD type	Harmonics
Measured value (DMM screen)	Selection is applied to RMS voltage (Urms) only and does not affect RMS voltage refreshed each half-cycle or transient measured values.	Selection is applied.	Selection is applied.	Selection is applied.
Measured value display switching (DMM screen display only)	Phase voltage/line voltage switched on DMM screen.	-	-	Level/content percentage switched on DMM screen.
TIMEPOT and events	Selection on main settings screen is applied to RMS voltage (Urms) but does not affect RMS voltage refreshed each half-cycle or transient events.	Selection on main settings screen is applied.	Selection on main settings screen is applied.	Selection on main settings screen is applied.
Binary data storage (displayed on computer application)	Phase voltage and line voltage	Power factor and displacement power factor	THD-F and THD-R	Level and content percentage
Other	Valid with 3P3W3M, 3P4W, and 3P4W2.5E connections. Does not apply to waveform.	DPF values for channels (excluding sum values) for 3P3W2M and 3P3W3M connections are undefined.		

Power (small) / P&Harm (normal) / all data (full) details

Recorded item	Power	P&Harm	All Data
RMS voltage refreshed each half-cycle	Yes	Yes	Yes
RMS current refreshed each half-cycle	Yes	Yes	Yes
Frequency	Yes	Yes	Yes
Frequency cycle	Yes	Yes	Yes
10-sec frequency	Yes	Yes	Yes
RMS voltage	Yes	Yes	Yes
RMS current	Yes	Yes	Yes
Voltage waveform peak	Yes	Yes	Yes
Current waveform peak	Yes	Yes	Yes
Active power	Yes	Yes	Yes
Apparent power	Yes	Yes	Yes
Reactive power	Yes	Yes	Yes
Power factor/displacement power factor	Yes	Yes	Yes
Voltage unbalance factor	Yes	Yes	Yes
Current unbalance factor	Yes	Yes	Yes
Instantaneous flicker value	Yes	Yes	Yes
Integral power	Yes	Yes	Yes

Recorded item	Power	P&Harm	All Data
Harmonic voltage		Yes	Yes
Harmonic current		Yes	Yes
Harmonic power		Yes	Yes
Harmonic voltage and current phase difference		Yes	Yes
Harmonic voltage phase angle		Yes	Yes
Harmonic current phase angle		Yes	Yes
Inter-harmonic voltage			Yes
Inter-harmonic current			Yes
Total harmonic voltage distortion factor	Yes	Yes	Yes
Total harmonic current distortion factor	Yes	Yes	Yes
High-order harmonic voltage component	Yes	Yes	Yes
High-order harmonic current component	Yes	Yes	Yes
K factor	Yes	Yes	Yes
Flicker (ΔV10/Pst, Plt)	Yes	Yes	Yes

Quick setup pattern details

Setting \ Pattern	Abnormal voltage detection	Basic power supply quality measurement	Inrush current measurement	Measured value recording	EN50160
Connection	Set in advance				
Clamp sensor	Set in advance				
CT, PT ratios	Set in advance				
Measurement frequency	Automatic detection of 50/60/400 Hz; if unable to detect, user (manual) setting				
Nominal input voltage	Automatic detection; if unable to detect, user (manual) setting				
Flicker/ΔV10 (depends on selected language)	Pst, Plt (when Japanese is selected, ΔV10)	Pst, Plt (when Japanese is selected, ΔV10)	Pst, Plt (when Japanese is selected, ΔV10)	Pst, Plt (when Japanese is selected, ΔV10)	Pst,Plt
Measurement RMS voltage selection	Default	Default	Default	Default	Default
Measurement harmonics selection	RMS value	RMS value	RMS value	RMS value	Content percentage
Total harmonic distortion factor selection	THD_F	THD_F	THD_F	THD_F	THD_F
Power factor selection	PF	PF	PF	PF	PF
Repeat setting and iterations	OFF (max. 35 days)	OFF (max. 35 days)	OFF (max. 35 days)	OFF (max. 35 days)	OFF (max. 35 days)
Recorded items setting	P&Harm (Normal)	All Data (Full)	P&Harm (Normal)	All Data (Full)	All Data (Full)
TIMEPLOT interval	1 minute	10 minutes	1 minute	10 minutes	10 minutes
Current range	Automatic detection	Automatic detection	Max. range	Automatic detection	Automatic detection
Event hysteresis	1%	1%	1%	1%	2%
Transient overvoltage	70% of nominal voltage	70% of nominal voltage	OFF	OFF	100% of nominal voltage
Voltage swell	110% of nominal voltage	110% of nominal voltage	OFF	OFF	110% of nominal voltage
Voltage dip	90% of nominal voltage	90% of nominal voltage	OFF	OFF	90% of nominal voltage
Interruption	10% of nominal voltage	10% of nominal voltage	OFF	OFF	1% of nominal voltage
Frequency	±5 Hz of nominal frequency	±0.5 Hz of nominal frequency	OFF	OFF	±0.5 Hz of nominal frequency
Frequency cycle	OFF	OFF	OFF	OFF	OFF
Voltage waveform peak (±)	150% of reference value	150% of reference value	OFF	OFF	170% of nominal voltage
Voltage DC fluctuation (±) (when DC is selected)	±10% based on DC measured value	±10% based on DC measured value	OFF	OFF	OFF
Current waveform peak (±)	OFF	200% of reference value	300% of reference value	OFF	OFF
Current DC fluctuation (±) (when DC is selected)	±10% based on DC measured value	±10% based on DC measured value	OFF	OFF	OFF
RMS voltage	10% of reference value SENSE width: ±10 V	10% of reference value SENSE width: ±10 V	OFF	OFF	OFF
RMS current	OFF SENSE width: OFF	50% of reference value SENSE width: OFF	OFF SENSE width: OFF	OFF SENSE width: OFF	OFF SENSE width: OFF
Inrush current (Irms 1/2)	OFF	OFF	200% of reference value	OFF	OFF
Active power	OFF	OFF	OFF	OFF	OFF
Apparent power	OFF	OFF	OFF	OFF	OFF
Reactive power	OFF	OFF	OFF	OFF	OFF
Power factor/displacement power factor	OFF	OFF	OFF	OFF	OFF

Quick setup pattern details

Setting \ Pattern	Abnormal voltage detection	Basic power supply quality measurement	Inrush current measurement	Measured value recording	EN50160
Voltage unbalance factor (zero-phase, negative-phase)	OFF, 3%	OFF, 3%	OFF, OFF	OFF, OFF	OFF, 2%
Current unbalance factor (zero-phase, negative-phase)	OFF, OFF	OFF, OFF	OFF, OFF	OFF, OFF	OFF, OFF
Harmonic voltage fundamental wave order 0 Harmonic orders 3, 5, 7, 9 11	OFF OFF OFF	OFF 5% of nominal voltage 10% of nominal voltage	OFF OFF OFF	OFF OFF OFF	As per EN50160 harmonic voltage limit value; see table below.
Harmonic current fundamental wave order 0 Harmonic orders 3, 5, 7, 9, 11	OFF OFF OFF	OFF 5% of range OFF	OFF OFF OFF	OFF OFF OFF	OFF OFF OFF
Harmonic power fundamental wave order 0 Harmonic orders 3, 5, 7, 9 11	OFF OFF OFF	OFF OFF OFF	OFF OFF OFF	OFF OFF OFF	OFF OFF OFF
Harmonic voltage and current phase difference	OFF	OFF	OFF	OFF	OFF
Total harmonic voltage distortion factor	5%	7%	OFF	OFF	OFF
Total harmonic current distortion factor	OFF	OFF	OFF	OFF	OFF
K factor	OFF	OFF	OFF	OFF	OFF
High-order harmonic voltage component	OFF	OFF	OFF	OFF	OFF
High-order harmonic current component	OFF	OFF	OFF	OFF	OFF
Voltage waveform comparison	±15%	±10%	OFF	OFF	OFF

- When the RMS voltage is less than 3% f.s. of the range, 5% of the range is used as the upper limit, and 0% of the range is used as the lower limit.
- When the voltage peak value is less than 3% f.s. of the range, 5% of the range is used as the threshold.
- Harmonic voltage and current distortion factor calculation are turned off when the harmonic voltage is less than 3% f.s. of the range.
- A value of 10% of the range is used as the threshold when the current and power reference value (measured values) are 10% or less of the range.
- Changing VT or CT after quick setup causes the threshold and sense to change (this also applies when not using quick setup).
- As a rule, settings not included in the table are set to OFF (other than manual events).
- When EN50160 is selected, the EN50160 analysis function using Model 9624-50 PQA-HiView Pro software is only available when the interval time is set to 10 minutes.

EN50160 harmonic voltage limits

Odd harmonics				Even harmonics	
Not multiples of 3		Multiples of 3			
Order h	Relative voltage (Un)	Order h	Relative voltage (Un)	Order h	Relative voltage (Un)
5	6.0%	3	5.0%	2	2.0%
7	5.0%	9	1.5%	4	1.0%
11	3.5%	15	0.5%	6...24	0.5%
13	3.0%	21	0.5%		
17	2.0%				
19	1.5%				
23	1.5%				
25	1.5%				

Un = nominal voltage (Uref)

13.8 GPS Time Synchronization Function

The GPS BOX PW9005 can be connected to the instrument to synchronize the instrument's time with the GPS satellite time (coordinated universal time).

GPS settings and status display function

GPS box connection setting	RS connected device: GPS
GPS reception status display	Positioning status : Err (no positioning data), 2D (2D independent positioning), 3D (3D independent positioning), D2D (differential 2D positioning), D3D (differential 3D positioning) No. of positioning satellites : 0 to 12 (no. of satellites that can be used in position calculation) DOP value : 0 to 9,999 (GPS positioning status reliability) (smaller values other than 0 indicate higher reliability)
GPS mark	A GPS mark is displayed among other icons along the top of the screen to indicate the GPS positioning status.
	Blue GPS mark : Time correction has been performed. Yellow GPS mark : The device is unable to acquire GPS satellites or unable to calculate its position. The yellow mark is also shown when time correction is canceled during recording. Red GPS mark : The PW3198 has not detected the GPS box.

Time correction function

Corrected time and correction accuracy	Set to amount of variation from universal coordinated time (UTC). The instrument's clock is corrected within ±2 ms of the GPS time accuracy.
Initial position	1. The GPS mark is yellow after connecting the GPS BOX PW9005 to the instrument. 2. The GPS mark turns blue after the unit has acquired GPS satellites and positioning status and finished correcting the instrument time.
Time correction processing	• Time correction is performed once every 1 s (during recording, once every 30 s). • If the time variation is 16 ms or less during recording, time correction is performed every second with ms-order precision. If the time variation is greater than 16 ms, a GPS Err event occurs, and time correction is not performed. • When synchronizing the time among multiple PW3198 instruments, 200 ms aggregation start times may vary for up to 10 minutes from the start of recording.
GPS event function	When recording is started in the time-corrected state (while the GPS mark is blue), a GPS event is generated when any of the following occur during recording: • GPS error (GPS error): GPS IN • GPS error cleared (GPS positioning): GPS OUT • GPS time correction failure (GPS time error): GPS Err

13.9 Other Functions

Warning functions

Out of range	When the input exceeds the range by 130%, displays ---.---. Phase/line voltage setting is irrelevant.
Out of crest factor	When the waveform peak exceeds 2 the voltage range or 4 the current range, "crest factor exceeded" is displayed. The phase/line voltage setting is irrelevant.

13.10 Calculation Formula

RMS voltage refreshed each half-cycle (Urms1/2), Dip (Dip), Swell (Swell), interruption (Intrpt), RMS current refreshed each half-cycle (Irms1/2), inrush current (Irms1/2)

Items \ Connection setting	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
Urms1/2 Dip Swell Intrpt	U_1 U_4 $Uc=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(Ucs)^2}$	U_1 U_2 U_4	Line-to-line voltage $U_{12}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U1s)^2}$ $U_{32}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U2s)^2}$ U_{31} is calculated from the RMS value for $(U3s=U2s-U1s)$. U_4	Line-to-line voltage $U_{12}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U1s)^2}$ $U_{23}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U2s)^2}$ $U_{31}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U3s)^2}$ U_4	U_1 U_2 U_3 U_4 With 3P4W2.5E connections $U2(U2s=-U1s-U3s)$ (Assumes $U1s + U2s + U3s = 0$.)
	• For 50/60 Hz measurement, calculated with 1 overlapping waveform each half-cycle. • For 400 Hz measurement, calculated with 1 waveform (M = number of samples in one 400 Hz period).				
Irms1/2 (Inrush current)	I_1 I_4 $Ic=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(Ics)^2}$	I_1 I_2 I_4	Line-to-line voltage $I_1=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(I1s)^2}$ $I_2=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(I2s)^2}$ I_3 is calculated from the RMS value for $(I3s=-I1s-I2s)$. I_4	Line-to-line voltage $I_1=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(I1s)^2}$ $I_2=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(I2s)^2}$ $I_3=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(I3s)^2}$ I_4	I_1 I_2 I_3 I_4
	• For 50/60 Hz measurement, calculated each half-cycle. • For 400 Hz measurement, calculated with 1 waveform.				

Note) c: measured channel, M: number of samples per period, s: number of sampling points

Voltage Waveform Peak (Upk), Current Waveform Peak (Ipk)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Upk+ Upk-	U_{p1} U_{p4}	U_{p1} U_{p2} U_{p4}	U_{p12} U_{p23} U_{p4}	U_{p12} U_{p23} U_{p31} U_{p4}	U_{p1} U_{p2} U_{p3} U_{p4}
	• The maximum positive and negative values are calculated for all points with 10 waveforms (50 Hz measurement) or 12 waveforms (60 Hz measurement). For 400 Hz measurement, the calculation is performed with 80 waveforms. • The CH4 voltage peak value can be calculated regardless of the connection type.				
Ipk+ Ipk-	I_{p1} I_{p4}	I_{p1} I_{p2} I_{p4}	I_{p1} I_{p2} I_{p4}	I_{p1} I_{p2} I_{p3} I_{p4}	I_{p1} I_{p2} I_{p3} I_{p4}
	• The maximum positive and negative values are calculated for all points with 10 waveforms (50 Hz) or 12 waveforms (60 Hz). During 400 Hz measurement, the calculation is performed with 80 waveforms. • The voltage waveform peak for CH4 can be calculated regardless of the connection method.				

Note) c: measured channel, M: number of samples per period, s: number of sampling points

RMS Voltage (Urms), RMS Current (Irms)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Urms	U_1 U_4 $Uc=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(Ucs)^2}$	U_1 U_2 U_4	Line-to-line voltage $U_{12}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U1s)^2}$ $U_{32}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U2s)^2}$ U_{31} is calculated from the RMS value for $(U3s=U2s-U1s)$.	Line-to-line voltage $U_{12}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U1s)^2}$ $U_{23}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U2s)^2}$ $U_{31}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U3s)^2}$	Phase voltage U_1 U_2 U_3
			U_4	U_4	U_4
			Phase voltage	Phase voltage $U_1=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}\left(\frac{U1s-U3s}{3}\right)^2}$ $U_2=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}\left(\frac{U2s-U1s}{3}\right)^2}$ $U_3=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}\left(\frac{U3s-U2s}{3}\right)^2}$	Line-to-line voltage $U_{12}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U1s-U2s)^2}$ $U_{23}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U2s-U3s)^2}$ $U_{31}=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(U3s-U1s)^2}$
				U_4	U_4
		$Uave=\frac{1}{2}(U_1+U_2)$	Line-to-line voltage $Uave=\frac{1}{2}(U_{12}+U_{32})$	Line-to-line voltage $Uave=\frac{1}{3}(U_{12}+U_{23}+U_{31})$	Phase voltage $Uave=\frac{1}{3}(U_1+U_2+U_3)$
			Phase voltage	Phase voltage $Uave=\frac{1}{3}(U_1+U_2+U_3)$	Line-to-line voltage $Uave=\frac{1}{3}(U_{12}+U_{23}+U_{31})$
	• Calculated with 10 waveforms (50 Hz measurement) or 12 waveforms (60 Hz measurement). For 400 Hz measurement, the calculation is performed with 80 waveforms. • For 3-phase 3-wire connections, the phase voltage is calculated so that the neutral point is at the center. The CH4 RMS voltage can be calculated regardless of the connection type.				
Irms	I_1 I_4 $Ic=\sqrt{\frac{1}{M}\sum_{s=0}^{M-1}(Ics)^2}$	I_1 I_2 I_4	I_1 I_2 I_3 is calculated from the RMS value for $(I3s=-I1s-I2s)$. I_4	I_1 I_2 I_3 I_4	I_1 I_2 I_3 I_4
		$Iave=\frac{1}{2}(I_1+I_2)$	$Iave=\frac{1}{2}(I_1+I_2)$	$Iave=\frac{1}{3}(I_1+I_2+I_3)$	$Iave=\frac{1}{3}(I_1+I_2+I_3)$
	• Calculated with 10 waveforms (50 Hz measurement) or 12 waveforms (60 Hz measurement). For 400 Hz measurement, the calculation is performed with 80 waveforms. • The CH4 RMS current can be calculated regardless of the connection type.				

Note) c: measured channel, M: number of samples per period, s: number of sampling points

Active Power (P), Apparent Power (S), Reactive Power (Q)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
P	P_1 $Pc=\frac{1}{M}\sum_{S=0}^{M-1}(Ucs \times Ics)$	P_1 P_2	P_1 P_2	P_1 P_2 P_3	P_1 P_2 P_3
		$Psum=P_1+P_2$	$Psum=P_1+P_2$	$Psum=P_1+P_2+P_3$	$Psum=P_1+P_2+P_3$
	• Calculated with 10 waveforms (50 Hz measurement) or 12 waveforms (60 Hz measurement). For 400 Hz measurement, the calculation is performed with 80 waveforms. • For 3P3W3M and 3P4W systems, phase voltage is used for waveform voltage Ucs. (3P3W3M: $U1s=(U1s-U3s)/3$, $U2s=(U2s-U1s)/3$, $U3s=(U3s-U2s)/3$) • The polarity sign for active power indicates power flow direction: positive (+P) for forward power (consumption), and negative (-P) for reverse power (regeneration), and indicates net current flow for power.				
S	S_1 $Sc= Uc \times Ic$ (When $P>$, make $P=S$.)	S_1 S_2	S_1 S_2	S_1 S_2 S_3	S_1 S_2 S_3
		$Ssum=S_1+S_2$	$Ssum=\frac{\sqrt{3}}{2}(S_1+S_2)$	$Ssum=S_1+S_2+S_3$	$Ssum=S_1+S_2+S_3$
	For 3P3W3M and 3P4W systems, phase voltage is used for waveform voltage Uc.				
Q	Q_1 $Qc= sic\sqrt{Sc^2-Pc^2}$	Q_1 Q_2	Q_1 Q_2	Q_1 Q_2 Q_3	Q_1 Q_2 Q_3
		$Qsum=Q_1+Q_2$	$Qsum=Q_1+Q_2$	$Qsum=Q_1+Q_2+Q_3$	$Qsum=Q_1+Q_2+Q_3$
	• The polarity sign (sic) for reactive power (Q) is indicated by [none] for lag or [-] for lead. • The reverse of the fundamental wave reactive power (using k = 1 (1st order)) after calculating the harmonic reactive power for each measurement channel (c) is used as the polarity sign sic. (See the harmonic reactive power formula.)				

Note) c: measured channel, M: number of samples per period, s: number of sampling points

Power factor (PF), Displacement power factor (DPF)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
PF	PF_1 $PFc = si_c \left\lvert \frac{P_c}{S_c} \right\rvert$	PF_1 PF_2	PF_1 PF_2	PF_1 PF_2 PF_3	PF_1 PF_2 PF_3
		$PFsum = si_{sum} \left\lvert \frac{P_{sum}}{S_{sum}} \right\rvert$	$PFsum = si_{sum} \left\lvert \frac{P_{sum}}{S_{sum}} \right\rvert$	$PFsum = si_{sum} \left\lvert \frac{P_{sum}}{S_{sum}} \right\rvert$	$PFsum = si_{sum} \left\lvert \frac{P_{sum}}{S_{sum}} \right\rvert$
	• The polarity symbol si for power factors indicates a LEAD or LAG in polarity; no symbol indicates a LAG, while the "-" symbol indicates a LEAD. • Calculate the harmonic reactive power using the polarity symbol sic and attach the opposit symbol for the fundamental wave reactive power (using $k = 1$ (1st order) for each measured channel (c)). • Calculate the harmonic reactive power using the polarity symbol sisum and attach the opposite symbol of the sum of the fundamental wave reactive power (using $k = 1$ (1st order)). (See the harmonic reactive power formula.)				
DPF	DPF_1 $DPFc = si_c \cos\theta_{c1}$	DPF_1 DPF_2	DPF_1 DPF_2	DPF_1 DPF_2 DPF_3	DPF_1 DPF_2 DPF_3
		$DPFsum = si_{sum} \left\lvert \frac{P_{sum1}}{S_{sum1}} \right\rvert$	$DPFsum = si_{sum} \left\lvert \frac{P_{sum1}}{S_{sum1}} \right\rvert$	$DPFsum = si_{sum} \left\lvert \frac{P_{sum1}}{S_{sum1}} \right\rvert$	$DPFsum = si_{sum} \left\lvert \frac{P_{sum1}}{S_{sum1}} \right\rvert$
	• The polarity symbol si of power factors indicates a LEAD or LAG in polarity; no symbol indicates a LAG, • while the "-" symbol indicates a LEAD. • Calculate the harmonic reactive power using the polarity symbol sic and attach the opposit symbol for the fundamental wave reactive power (using $k = 1$ (1st order) for each measured channel (c)). • Calculate the harmonic reactive power using the polarity symbol sisum and attach the opposite symbol for the sum of the fundamental wave reactive power (using k = 1 (1st order)). (See the harmonic reactive power formula.) • θc1 indicates the voltage-current phase difference for the fundamental wave. (See the voltage-current phase difference formula.) • Psum1 indicates the total of fundamental wave power and the formula becomes $k = 1$ for the sum of harmonic power. (See the harmonic power formula.) • Ssum1 indicates the total of fundamental wave apparent power and can be calculated using the fundamental wave RMS voltage and fundamental wave RMS current. (For information on the formulae for harmonic voltage, harmonic current, and the sum of apparent power, see each of their calculation formulae.)				

Note) c: measured channel, k: order for analysis

Voltage unbalance factor, Current unbalance factor

Phase System / Items	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Voltage unbalance factor Uunb0 [%]			$Uunb0 = \frac{Uzero}{Upos} \times 100$	$Uunb0 = \frac{Uzero}{Upos} \times 100$	$Uunb0 = \frac{Uzero}{Upos} \times 100$
Voltage unbalance factor Uunb [%]			Same as 3P3W3M (U_{31} is computed by means of vector calculations.)	$Uunb = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ where $\beta = \frac{U_{12}^4 + U_{23}^4 + U_{31}^4}{(U_{12}^2 + U_{23}^2 + U_{31}^2)^2}$	$Uunb = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ where $\beta = \frac{U_{12}^4 + U_{23}^4 + U_{31}^4}{(U_{12}^2 + U_{23}^2 + U_{31}^2)^2}$
	• For U12, U23, and U31, use the fundamental wave RMS voltage from the calculated harmonics results. • For three-phase 4-wire configurations, this is detected using phase-to-neutral voltage but can be converted and calculated using line-to-line voltage.				
Current unbalance factor Iunb0 [%]			$Iunb0 = \frac{Izero}{Ipos} \times 100$	$Iunb0 = \frac{Izero}{Ipos} \times 100$	$Iunb0 = \frac{Izero}{Ipos} \times 100$
Current unbalance factor Iunb [%]			Same as 3P3W3M (I_{31} is computed by means of vector calculations.)	$Iunb = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ where $\beta = \frac{I_{12}^4 + I_{23}^4 + I_{31}^4}{(I_{12}^2 + I_{23}^2 + I_{31}^2)^2}$	$Iunb = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ where $\beta = \frac{I_{12}^4 + I_{23}^4 + I_{31}^4}{(I_{12}^2 + I_{23}^2 + I_{31}^2)^2}$
	• For I12, I23, and I31, use the fundamental wave RMS current (line-to-line current) from the calculated harmonics results. • For three-phase 3-wire and three-phase 4-wire configurations this is detected using phase current, but can be converted and calculated using line-to-line current.				

Voltage zero-phase component Uzero [V]

$$Uzero = \frac{1}{3}\sqrt{(U1 \bullet cos(\alpha) + U2 \bullet cos(\beta + seq2) + U3 \bullet cos(\Upsilon + seq3))^2 + (U1 \bullet sin(\alpha) + U2 \bullet sin(\beta + seq2) + U3 \bullet sin(\Upsilon + seq3))^2}$$

The fundamental RMS voltage (phase voltage) from harmonic calculations is used for U1, U2, and U3.
For 3-phase 3-wire connections, the value is detected as a line voltage and then converted to a phase voltage.
At the zero-phase, seq2=0°, seq3=0°
α=U1 phase angle, β=U2 phase angle, γ=U3 phase angle

Voltage positive-phase component Upos [V]

$$Upos = \frac{1}{3}\sqrt{(U1 \bullet cos(\alpha) + U2 \bullet cos(\beta + seq2) + U3 \bullet cos(\Upsilon + seq3))^2 + (U1 \bullet sin(\alpha) + U2 \bullet sin(\beta + seq2) + U3 \bullet sin(\Upsilon + seq3))^2}$$

The fundamental RMS voltage (phase voltage) from harmonic calculations is used for U1, U2, and U3.
For 3-phase 3-wire connections, the value is detected as a line voltage and then converted to a phase voltage.
At the positive-phase, seq2=120°, seq3=240°
α=U1 phase angle, β=U2 phase angle, γ=U3 phase angle

Voltage negative-phase component Uneg [V]

$$Uneg = \frac{1}{3}\sqrt{(U1 \bullet cos(\alpha) + U2 \bullet cos(\beta + seq2) + U3 \bullet cos(\Upsilon + seq3))^2 + (U1 \bullet sin(\alpha) + U2 \bullet sin(\beta + seq2) + U3 \bullet sin(\Upsilon + seq3))^2}$$

The fundamental RMS voltage (phase voltage) from harmonic calculations is used for U1, U2, and U3.
For 3-phase 3-wire connections, the value is detected as a line voltage and then converted to a phase voltage.
At the negative-phase, seq2=240°, seq3=120°
α=U1 phase angle, β=U2 phase angle, γ=U3 phase angle

Current zero-phase component Izero [A]

$$\mathrm{Izero} = \frac{1}{3}$$
$$\sqrt{(\mathrm{I}1 \bullet \cos(\alpha) + \mathrm{I}2 \bullet \cos(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \cos(\Upsilon + \mathrm{seq}3))^2 + (\mathrm{I}1 \bullet \sin(\alpha) + \mathrm{I}2 \bullet \sin(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \sin(\Upsilon + \mathrm{seq}3))^2}$$

The fundamental RMS current (phase current) from harmonic calculations is used for I1, I2, and I3.
At the zero-phase, seq2=0°, seq3=0°
α=I1 phase angle, β=I2 phase angle, γ=I3 phase angle

Current positive-phase component Ipos [A]

$$\mathrm{Ipos} = \frac{1}{3}$$
$$\sqrt{(\mathrm{I}1 \bullet \cos(\alpha) + \mathrm{I}2 \bullet \cos(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \cos(\Upsilon + \mathrm{seq}3))^2 + (\mathrm{I}1 \bullet \sin(\alpha) + \mathrm{I}2 \bullet \sin(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \sin(\Upsilon + \mathrm{seq}3))^2}$$

The fundamental RMS current (phase current) from harmonic calculations is used for I1, I2, and I3.
At the positive-phase, seq2=120°, seq3=240°
α=I1 phase angle, β=I2 phase angle, γ=I3 phase angle

Current negative-phase component Ineg [A]

$$\mathrm{Ineg} = \frac{1}{3}$$
$$\sqrt{(\mathrm{I}1 \bullet \cos(\alpha) + \mathrm{I}2 \bullet \cos(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \cos(\Upsilon + \mathrm{seq}3))^2 + (\mathrm{I}1 \bullet \sin(\alpha) + \mathrm{I}2 \bullet \sin(\beta + \mathrm{seq}2) + \mathrm{I}3 \bullet \sin(\Upsilon + \mathrm{seq}3))^2}$$

The fundamental RMS current (phase current) from harmonic calculations is used for I1, I2, and I3.
At the negative-phase, seq2=240°, seq3=120°
α=I1 phase angle, β=I2 phase angle, γ=I3 phase angle

Harmonic Voltage (Uharm), Harmonic Current (Iharm), Inter-harmonic voltage (Uiharm), Inter-harmonic current (Iiharm)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Uharm[Vrms]=Uck (including adjacent inter-harmonic components)	U_{1k} U_{4k} $U'ck=\sqrt{\{(Uckr)^2+(Ucki)^2\}}$ $Uck=\sqrt{\sum_{n=-1}^{1} U'^2c((10k+n)/10)}$	U_{1k} U_{2k} U_{4k}	U_{12k} U_{32k} U_{4k}	U_{12k} U_{23k} U_{31k} U_{4k}	U_{1k} U_{2k} U_{3k} U_{4k}
	• For 3-phase 3-wire connections, indicates the result of harmonic calculations using the line voltage. For 3-phase 4-wire connections, indicates the result of harmonic calculations using the phase voltage. • The harmonic voltage content percentage is calculated by dividing the harmonic voltage component for the specified order by the fundamental voltage component and multiplying by 100. • For 60 Hz measurement, the value 10 in the formula is replaced with 12. For 400 Hz measurement, the value 10 in the formula is replaced with 80. • When K = 0, the Uc0 component is treated as DC for order 0.				
Iharm[Arms]=Ick (including adjacent inter-harmonic components)	I_{1k} I_{4k} $I'ck=\sqrt{\{(Ickr)^2+(Icki)^2\}}$ $Ick=\sqrt{\sum_{n=-1}^{1} I'^2c((10k+n)/10)}$	I_{1k} I_{2k} I_{4k}	I_{1k} I_{2k} I_{4k}	I_{1k} I_{2k} I_{3k} I_{4k}	I_{1k} I_{2k} I_{3k} I_{4k}
	• The harmonic current content percentage is calculated by dividing the harmonic current component for the specified order by the fundamental current component and multiplying by 100. • When using 60 Hz, the number "10" in the expression above is "12." When using 400 Hz, the number "10" in the expression above is "80." • When K = 0, the Ic0 component is treated as DC for order 0.				
Uiharm[Vrms]=Uck	U_{1k} U_{4k} $U'ck=\sqrt{\{(Uckr)^2+(Ucki)^2\}}$ $Uck=\sqrt{\sum_{n=-3}^{3} U'^2c((10k+n)/10)}$	U_{1k} U_{2k} U_{4k}	U_{12k} U_{32k} U_{4k}	U_{12k} U_{23k} U_{31k} U_{4k}	U_{1k} U_{2k} U_{3k} U_{4k}
	• The values 3 and -3 in the formula apply to 50 Hz measurement and are replaced with 4 and -4 for 60 Hz measurement. In the formula, k = 0.5, 1.5, 2.5, 3.5,... • For 3-phase 3-wire connections, indicates the result of harmonic calculations using the line voltage. For 3-phase 4-wire connections, indicates the result of harmonic calculations using the phase voltage. • The inter-harmonic voltage content percentage is calculated by dividing the inter-harmonic voltage component for the specified order by the fundamental voltage component and multiplying by 100. • For 60 Hz measurement, the value 10 in the formula is replaced with 12.				

Harmonic Voltage (Uharm), Harmonic Current (Iharm), Inter-harmonic voltage (Uiharm), Inter-harmonic current (Iiharm)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measure-ment 3P3W2M	3-Phase, 3-Wire, 3-Measure-ment 3P3W3M	3-Phase, 4-Wire 3P4W
Iiharm[Arms]=Ick	I_{1k} I_{4k} $I'ck=\sqrt{\{(Ickr)^2+(Icki)^2\}}$ $Ick=\sqrt{\sum_{n=-3}^{3} I'^2c((10k+n)/10)}$	I_{1k} I_{2k} I_{4k}	I_{1k} I_{2k} I_{4k}	I_{1k} I_{2k} I_{3k} I_{4k}	I_{1k} I_{2k} I_{3k} I_{4k}
	• The values 3 and -3 in the formula apply to 50 Hz measurement and are replaced with 4 and -4 for 60 Hz measurement. In the formula, k = 0.5, 1.5, 2.5, 3.5, ... • For 60 Hz measurement, the value 10 in the formula is replaced with 12. • The inter-harmonic current content percentage is calculated by dividing the inter-harmonic current component for the specified order by the fundamental current component and multiplying by 100.				

Note) c: Measurement channel, k: Order of analysis, r: resistance after FFT, i: reactance after FFT
However, for 60 Hz measurement, the value 10 in the formula is replaced with 12.

Harmonic Power (Pharm), Harmonic Reactive Power (Qharm), K Factor (KF)

Phase System / Items	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Pharm[W]=Pck	P_{1k} $Pck=$ $U_{ckr}\times I_{ckr}+U_{cki}\times I_{cki}$	P_{1k} P_{2k}	P_{1k} P_{2k}	$P_{1k}=$ $\frac{1}{3}(U_{1kr}-U_{3kr})\times I_{1kr}+\frac{1}{3}(U_{1ki}-U_{3ki})\times I_{1ki}$ $P_{2k}=$ $\frac{1}{3}(U_{2kr}-U_{1kr})\times I_{2kr}+\frac{1}{3}(U_{2ki}-U_{1ki})\times I_{2ki}$ $P_{3k}=$ $\frac{1}{3}(U_{3kr}-U_{2kr})\times I_{3kr}+\frac{1}{3}(U_{3ki}-U_{2ki})\times I_{3ki}$	P_1 P_2 P_3
		$Psumk=$ $P_{1k}+P_{2k}$	$Psumk=$ $P_{1k}+P_{2k}$	$Psumk=$ $P_{1k}+P_{2k}+P_{3k}$	$Psumk=$ $P_{1k}+P_{2k}+P_{3k}$
	• The harmonic power content percentage is calculated by dividing the harmonic power component for the specified order by the absolute value of the fundamental power component and multiplying by 100. • For 3P3W2M and 3P3W3M connections, CH1 to CH3 values are used only for internal calculations.				
Only for use with internal calculation Qharm[var]=Qck	Q_{1k} $Qck=$ $U_{ckr}\times I_{cki}-U_{cki}\times I_{ckr}$	Q_{1k} Q_{2k}	Q_{1k} Q_{2k}	$Q_{1k}=$ $\frac{1}{3}(U_{1kr}-U_{3kr})\times I_{1ki}-\frac{1}{3}(U_{1ki}-U_{3ki})\times I_{1kr}$ $Q_{2k}=$ $\frac{1}{3}(U_{2kr}-U_{1kr})\times I_{2ki}-\frac{1}{3}(U_{2ki}-U_{1ki})\times I_{2kr}$ $Q_{3k}=$ $\frac{1}{3}(U_{3kr}-U_{2kr})\times I_{3ki}-\frac{1}{3}(U_{3ki}-U_{2ki})\times I_{3kr}$	Q_1 Q_2 Q_3
		$Qsumk=$ $Q_{1k}+Q_{2k}$	$Qsumk=$ $Q_{1k}+Q_{2k}$	$Qsumk=$ $Q_{1k}+Q_{2k}+Q_{3k}$	$Qsumk=$ $Q_{1k}+Q_{2k}+Q_{3k}$
KF[ ]	KF_1 KF_4 $KFc=$ $\frac{\sum_{k=1}^{50}(k^2\times I_{ck}^2)}{\sum_{k=1}^{50}I_{ck}^2}$	KF_1 KF_2 KF_4	KF_1 KF_2 KF_4	KF_1 KF_2 KF_3 KF_4	KF_1 KF_2 KF_3 KF_4
	• The K factor is also called the multiplication factor, and indicates the power loss using the harmonic RMS current for the electrical transformer.				

Note) c: Measurement channel, k: Order of analysis, r: resistance after FFT, i: reactance after FFT

Total Harmonic Voltage Distortion Factor (Uthd-F, Uthd-R) and Total Harmonic Current Distortion Factor (Ithd-F, Ithd-R)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Uthd-F[%]	*THDUF1* *THDUF4* *THDUFc*= $\frac{\sqrt{\sum_{k=2}^{K}(U_{ck})^2}}{U_{c1}} \times 100$	*THDUF1* *THDUF2* *THDUF4*	*THDUF12* *THDUF32* *THDUF4*	*THDUF12* *THDUF23* *THDUF31* *THDUF4*	*THDUF1* *THDUF2* *THDUF3* *THDUF4*
	• For 3-phase 3-wire connections, indicated values represent harmonic calculation results obtained using line voltage. • The value K in the equation indicates the total number of analyzed orders.				
Ithd-F[%]	*THDIF1* *THDIF4* *THDIFc*= $\frac{\sqrt{\sum_{k=2}^{K}(I_{ck})^2}}{I_{c1}} \times 100$	*THDIF1* *THDIF2* *THDIF4*	*THDIF1* *THDIF2* *THDIF4*	*THDIF1* *THDIF2* *THDIF3* *THDIF4*	*THDIF1* *THDIF2* *THDIF3* *THDIF4*
	• The value K in the equation indicates the total number of analyzed orders.				
Uthd-R[%]	*THDUR1* *THDUR4* *THDURc*= $\frac{\sqrt{\sum_{k=2}^{K}(U_{ck})^2}}{\sqrt{\sum_{k=1}^{K}(U_{ck})^2}} \times 100$	*THDUR1* *THDUR2* *THDUR4*	*THDUR12* *THDUR32* *THDUR4*	*THDUR12* *THDUR23* *THDUR31* *THDUR4*	*THDUR1* *THDUR2* *THDUR3* *THDUR4*
	• For 3-phase 3-wire connections, indicated values represent harmonic calculation results obtained using line voltage. • The value K in the equation indicates the total number of analyzed orders.				
Ithd-R[%]	*THDIR1* *THDIR4* *THDIRc*= $\frac{\sqrt{\sum_{k=2}^{K}(I_{ck})^2}}{\sqrt{\sum_{k=1}^{K}(I_{ck})^2}} \times 100$	*THDIR1* *THDIR2* *THDIR4*	*THDIR1* *THDIR2* *THDIR4*	*THDIR1* *THDIR2* *THDIR3* *THDIR4*	*THDIR1* *THDIR2* *THDIR3* *THDIR4*
	• The value K in the equation indicates the total number of analyzed orders.				

Harmonic Voltage Phase Angle (Uphase), Harmonic Current Phase Angle (Iphase), Phase Difference Of Harmonic Voltage And Harmonic Current (Pphase)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
Uphase[deg]=θUk	θ_{U1k} θ_{U4k} $\theta Uck=tan^{-1}\left\{\frac{Uckr}{-Ucki}\right\}$	θ_{U1k} θ_{U2k} θ_{U4k}	θ_{U12k} θ_{U32k} θ_{U4k}	θ_{U12k} θ_{U23k} θ_{U31k} θ_{U4k}	θ_{U1k} θ_{U2k} θ_{U3k} θ_{U4k}
	• For 3-phase 3-wire connections, indicated values represent harmonic calculation results obtained using line voltage. • The harmonic voltage phase angle is displayed after correction using the reference channel's fundamental wave to 0°. • *When Uckr=Ucki=0, θuk=0°* • The harmonic voltage used in calculations is calculated using only whole-number orders.				
Iphase[deg]=θIk	θ_{I1k} θ_{I4k} $\theta Ick=tan^{-1}\left\{\frac{Ickr}{-Icki}\right\}$	θ_{I1k} θ_{I2k} θ_{I4k}	θ_{I1k} θ_{I2k} θ_{4k}	θ_{I1k} θ_{I2k} θ_{I3k} θ_{I4k}	θ_{I1k} θ_{I2k} θ_{I3k} θ_{I4k}
	• The harmonic voltage phase angle is displayed after correction using the reference channel's fundamental wave to 0°. • *When Ickr=Icki=0, θIk=0°* • The harmonic voltage used in calculations is calculated using only whole-number orders.				
Pphase[deg]=θk	θ_{1k} $\theta_{ck}=\theta_{cIk}-\theta_{cUk}$	θ_{1k} θ_{2k}			θ_{1k} θ_{2k} θ_{3k}
		$\theta_{sum}=tan^{-1}\left\{\frac{Qsumk}{Psumk}\right\}$	$\theta_{sum}=tan^{-1}\left\{\frac{Qsumk}{Psumk}\right\}$	$\theta_{sum}=tan^{-1}\left\{\frac{Qsumk}{Psumk}\right\}$	$\theta_{sum}=tan^{-1}\left\{\frac{Qsumk}{Psumk}\right\}$
	• *When Psumk=Qsumk=0, θk=0°* • Psumk indicates the total harmonic power (see the equations for harmonic power). • Qsumk indicates total harmonic reactive power (see the equations for harmonic reactive power).				

Note: c: measurement channel; k: order of analysis; r: resistance after FFT; i: reactance after FFT

Voltage Flicker (dV10), Short Interval Voltage Flicker (Pst), and Long Interval Voltage Flicker (Plt)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measurement 3P3W2M	3-Phase, 3-Wire, 3-Measurement 3P3W3M	3-Phase, 4-Wire 3P4W
dV10=ΔV10	$\Delta V10_{(1)}$ $\Delta V10_{(c)}=\frac{100}{U_f^2}\sqrt{\sum(a_n\times\Delta U_n)^2}$	$\Delta V10_{(1)}$ $\Delta V10_{(2)}$	$\Delta V10_{(12)}$ $\Delta V10_{(32)}$	$\Delta V10_{(12)}$ $\Delta V10_{(23)}$ $\Delta V10_{(31)}$	$\Delta V10_{(1)}$ $\Delta V10_{(2)}$ $\Delta V10_{(3)}$
	• Uf represents the reference voltage for voltage flicker and indicates the 1-minute average of RMS voltage values. • an represents the flicker luminosity coefficient corresponding to the fluctuation frequency fn [Hz] calculated from the flicker luminosity curve. • ΔUn represents the voltage fluctuation in fn.				
Pst	Pst_1 $Pst_c=\sqrt{K_1P_{0.1}+K_2P_{1s}+K_3P_{3s}+K_4P_{10s}+K_5P_{50s}}$	Pst_1 Pst_2	Pst_1 Pst_2	Pst_1 Pst_2 Pst_3	Pst_1 Pst_2 Pst_3
	• Indicates values for K1=0.0314, K2=0.0525, K3=0.0657, K4=0.28, and K5=0.08. • Calculations are performed using a 1,024-class cumulative probability function (CPF). • Results are calculated from cumulative probability (Pi) values using linear interpolation, smoothed using the following methods, and used to calculate the cumulative probability (Pis): P1s=(P0.7+P1+P1.5)/3, P3S=(P2.2+P3+P4)/3, P10s=(P6+P8+P10+P13+P17)/5, P50s=(P30+P50+P80)/3				
Plt	Plt_1 $Plt_c=\sqrt[3]{\frac{\sum_{n=1}^{N}(Pstn)^3}{N}}$	Plt_1 Plt_2	Plt_1 Plt_2	Plt_1 Plt_2 Plt_3	Plt_1 Plt_2 Plt_3
	• N indicates the number of measurements (N=12). (When N<12, the number of measurements is used as N.)				

Note: c: measurement channel

Active energy (WP), reactive energy (WQ)

Items \ Phase System	Single Phase 2-wire 1P2W	Single Phase 3-wire 1P3W	3-Phase, 3-Wire, 2-Measure-ment 3P3W2M	3-Phase, 3-Wire, 3-Measure-ment 3P3W3M	3-Phase, 4-Wire 3P4W
WP+	$WP1+=k\sum_{1}^{h}(\lvert P1(+)\rvert)$	$WPsum+=k\sum_{1}^{h}(\lvert Psum(+)\rvert)$			
	• h: measurement period; k: coefficient for converting to 1 hour • (+): Value is only used when positive (consumption).				
WP-	$WP1-=k\sum_{1}^{h}(\lvert P1(-)\rvert)$	$WPsum+=k\sum_{1}^{h}(\lvert Psum(-)\rvert)$			
	• h: measurement period, k: coefficient converted to 1 hour • (-): Value is only used when negative (regeneration).				
WQLAG	$WQ_{Lag}=k\sum_{1}^{h}(\lvert Q1(+)\rvert)$	$WQ_{LAG}=k\sum_{1}^{h}(\lvert Qsum(+)\rvert)$			
	• h: measurement period, k: coefficient converted to 1 hour • (+): Value is only used when positive (lag).				
WQLEAD	$WQ_{LEAD}=k\sum_{1}^{h}(\lvert Q1(-)\rvert)$	$WQ_{LEAD}=k\sum_{1}^{h}(\lvert Qsum(-)\rvert)$			
	• h: measurement period, k: coefficient converted to 1 hour • (-): Value is only used when negative (lead).				

Average calculation

Average calculation methods

	CH1 to 4	sum/AVG	Comment
Freq	Signed average	-	Same as Freq10s.
Upk	Signed average	-	
Ipk	Signed average	-	
Urms	RMS	Average results for all channels are averaged.	
Irms	RMS	Average results for all channels are averaged.	
Udc	Signed average	-	
Idc	Signed average	-	
P	Signed average	Average results for all channels are totaled.	
S	Signed average	Average results for all channels are totaled.	
Q	Signed average	Average results for all channels are totaled.	
PF/DPF	See Note 1.	Sum value is calculated using the formula described in Note 1 below.	This calculation is used for both PF and DPF.
Uunb	RMS	-	Same applies to Uunb0.
Iunb	RMS	-	Same applies to Iunb0.
Uharm	RMS	-	For content percentage and order 0, signed average. Same applies to Uiharm.
Iharm	RMS	-	For content percentage and order 0, signed average. Same applies to Iiharm.
Pharm	Signed average	Average results for all channels are totaled.	The content percentage is calculated from the sum value calculated from the level.
Uphase	See *2 below.	See *2 below.	
Iphase	See *2 below.	See *2 below.	
Pphase	See *2 below.	See *2 below.	
Uthd	Calculated from RMS value of RMS values.	-	This calculation is used for both THD-F and THD-R.
Ithd	Calculated from RMS value of RMS values.	-	This calculation is used for both THD-F and THD-R.
KF	Signed average	-	
UharmH	RMS	-	
IharmH	RMS	-	

Signed average: Signs of values are included in average calculation.
"(AVG)" following a parameter indicates the average result.

*1 PF/DPF average calculation

Addition processing : If the power factor value is negative, it is multiplied by (-1). If the power factor value is positive, it is multiplied by (-1), and the value 2 is added. The resulting value is integrated.

Averaging processing : The result of addition processing described above is divided by the number of added data points. If the result is less than 1, it is multiplied by (-1). If it is greater than or equal to 1, it is multiplied by (-1), and the value 2 is added.

*2 Phase average calculation

Uphase average calculation

$\tan^{-1}\left\{\begin{matrix} Uckr \\ -Ucki \end{matrix}\right\}$ Uckr and Ucki represent the signed averages for each channel.

Iphase average calculation

I

$\tan^{-1}\left\{\begin{matrix} Ickr \\ -Icki \end{matrix}\right\}$ Ickr and Icki represent the signed averages for each channel.

Pphase average calculation

(Channel averaging processing) : $\tan^{-1}\left\{\begin{matrix} Qharm_k \\ Pharm_k \end{matrix}\right\}$ Qharmk and Pharmk represent the signed averages for each channel.

(Sum averaging processing) : $\tan^{-1}\left\{\begin{matrix} Q_{sumk} \\ P_{sumk} \end{matrix}\right\}$ Qsumk and Psumk represent the signed averages for each channel.

13.11 Clamp Sensors and Ranges

The instrument's current ranges are as follows:

Current sensor	Current range
0.1 mV/A (5 kA)	5.0000 kA/500.00 A
1 mV/A (500 A)	500.00 A/50.000 A
10 mV/A (50 A)	50.000 A/5.0000 A
100 mV/A (5 A)	5.0000 A/500.00 mA
9657-10	5.0000 A/500.00 mA
9660	100.00 A/50.000 A
9661	500.00 A/50.000 A
9667 (500 A)	500.00 A/50.000 A
9667 (5 kA)	5.0000 kA/500.00 A
CT9667 (500 A)	500.00 A/50.000 A
CT9667 (5 kA)	5.0000 kA/500.00 A
9669	1.0000 kA/100.00 A
9675	5.0000 A/500.00 mA
9694	50.000 A/5.0000 A
9695-02	50.000 A/5.0000 A
9695-03	100.00 A/50.000 A
CT9691 (10 A)	10.000 A/5.0000 A
CT9691 (100 A)	100.00 A/50.000 A
CT9692 (20 A)	50.000 A/5.0000 A
CT9692 (200 A)	500.00 A/50.000A
CT9693 (200 A)	500.00A/50.000 A
CT9693(2kA)	5.0000 kA/500.00 A

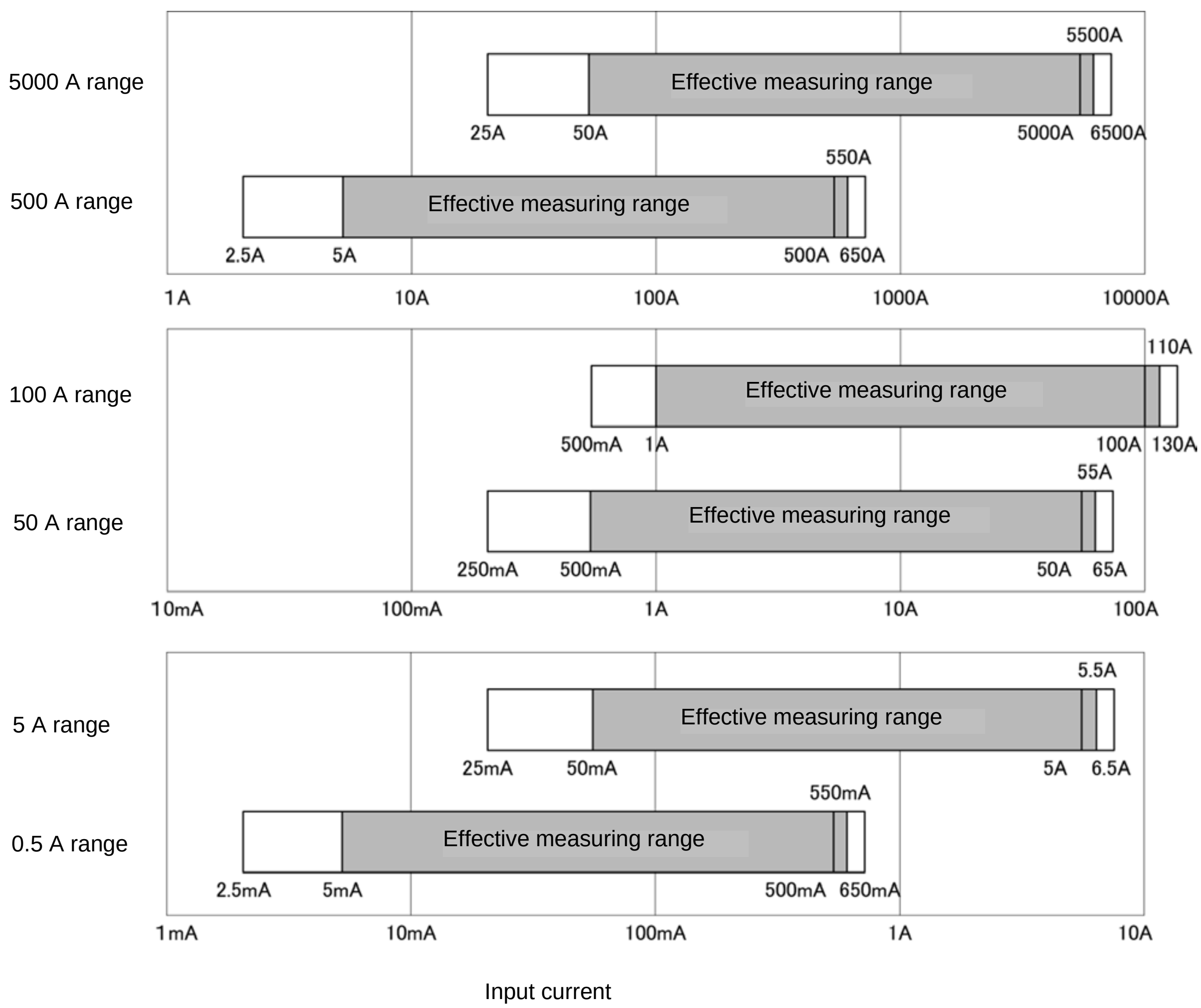
The instrument's power ranges are as follows:

The effective power (unit, W), apparent power (unit, VA) and reactive power (unit, var) per channel.

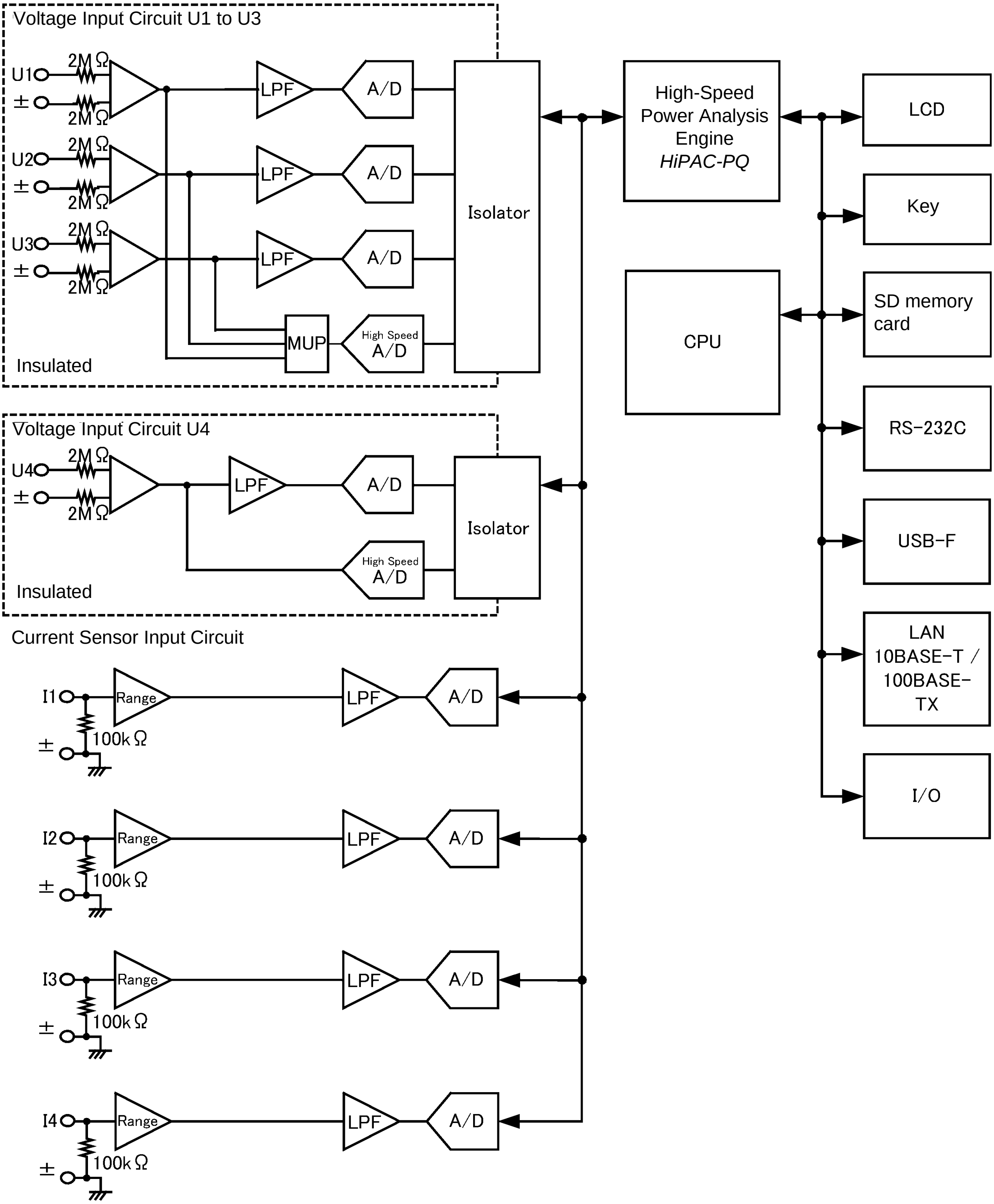
Current range	Power range
5.0000kA	3.0000M
1.0000kA	600.00k
500.00A	300.00k
100.00A	60.000k
50.000A	30.000k
10.000A	6.0000k
5.0000A	3.0000k
1.0000A	600.00
500.00mA	300.00

The display range and valid measurement range (guaranteed accuracy range) for each current range are as follows:

○ Current range



13.12 Block Diagram



Maintenance and Service
Chapter 14

14.1 Cleaning

Instrument

NOTE

- To clean the instrument/ device/ product, 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.

Clamp Sensor

⚠CAUTION

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.

14.2 Trouble Shooting

Before having the instrument repaired or inspected, check the information described in "Before having the instrument repaired" (p.217) and "14.3 Error Indication" (p.218).

Inspection and Repair

⚠ WARNING

Do not attempt to modify, disassemble or repair the instrument; as fire, electric shock and injury could result.

- If damage is suspected, check the "Before having the instrument repaired" (p.217) section before contacting your dealer or Hioki representative.

However, in the following circumstances, you should stop using the instrument, unplug the power cord, and contact your nearest Hioki distributor:
- When you are able to confirm that the instrument is damaged
- When you are unable to make measurements
- When the instrument has been stored for an extended period of time in a hot, humid, or otherwise undesirable environment
- When the instrument has been subjected to the stress of being transported under harsh conditions
- When the instrument has gotten wet or soiled with oil or dust (ingress of water, oil, or dust into the enclosure may cause electrical insulation to deteriorate, increasing the hazard of electric shock or fire)

When transporting the instrument

When transporting the instrument, use the original packing materials in which it was shipped, and pack in a double carton. Pack the instrument so that it will not sustain damage during shipping, and include a description of existing damage. We do not take any responsibility for damage incurred during shipping.

Replaceable Parts and Operating Lifetimes

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	Remarks
Electrolytic Capacitors	Approx. 10 years	The service life of electrolytic capacitors varies with the operating environment. Requires periodic replacement.
Lithium battery	Approx. 10 years	The instrument contains a built-in backup lithium battery, which offers a service life of about ten years. If the date and time deviate substantially when the instrument is switched on, it is the time to replace that battery. Contact your dealer or Hioki representative.
LCD backlight (50% drop-off in brightness)	Approx. 50,000 hr	Requires periodic replacement.
Z1003 Battery Pack	Approx. 1 year or approx. 500 charge/recharge cycles	Requires periodic replacement.
Z4001 SD Memory Card 2GB	Data storage of approx. 10 years or approx. 2 million rewrites	The SD card service life varies with the manner in which it is are used. Requires periodic replacement.

Before having the instrument repaired

Before returning for repair

Symptom	Check Item, or Cause	Remedy and Reference
The display does not appear when you turn the power on.	Has the power cord been disconnected? Is it connected properly?	Verify that the power cord is connected properly. See: "3.4 Connecting the AC Adapter" (p.32)
Keys do not work.	Has the key lock been activated?	Press and hold the **ESC** key for at least 3 seconds to cancel the key lock.
Cannot print.	Has recording paper been properly loaded into the printer? Is the printer configured properly (baud rate, interface, etc.)? Is the instrument connected to the printer with the appropriate cable?	-
Voltage or current measured values are not being displayed.	Are the voltage cords or clamp sensors connected improperly?	Verify connections. See: "3.6 Connecting the Voltage Cords" (p.34) to "4.6 Verifying Correct Wiring (Connection Check)" (p.48)
	Are the input channels and display channels incorrect?	-
The instrument cannot measure the frequency. Measured values do not stabilize.	Is the input frequency within the guaranteed accuracy range? For a measurement frequency of 50 Hz, 40 to 58 Hz For a measurement frequency of 60 Hz, 51 to 70 Hz For a measurement frequency of 400 Hz, 360 to 440 Hz Measurement cannot be performed if the input frequency is outside the guaranteed accuracy fundamental wave range.	-
	Is the input frequency lower than the setting? Is a signal being input to U1? Stable measurement may not be possible if input of at least 2% f.s. is not being supplied to U1 (the reference channel).	

When no apparent cause can be established

Perform a system reset.
This will return all settings to their factory defaults.

See: "5.6 Initializing the Instrument (System Reset)" (p.73)

14.3 Error Indication

Any instrument errors are displayed on the screen. If you experience an error, check the appropriate corrective action. To clear the error display, press any key.

Error display	Cause	Corrective action/more information
FPGA initializing error	FPGA initializing error.	The instrument needs to be repaired. Contact your Hioki distributor.
DRAM1, 2 error	DRAM error.	
SRAM error	SRAM error.	
Invalid FLASH.	FLASH error.	
Invalid ADJUST.	Adjustment value error.	
Invalid Backuped values.	One or more erroneous backed-up system variables have created a conflict.	
*** CARD ERROR *** Error while attempting to access the SD Card.	Attempted to access a corrupt file or corrupt SD memory card. The SD memory card was removed while it was being accessed.	Back up the SD memory card's contents on a computer and then format the card with the instrument. Remove the SD memory card and then insert it again. **See:** "9.2 Formatting SD Memory Cards" (p.138), "3.5 Inserting (Removing) an SD Memory Card" (p.32)
*** CARD ERROR *** Save failed.	Attempted to write data to a write-protected file. The SD memory card was removed while data was being saved, or a similar issue occurred.	Using a computer, check whether the file attributes are set to read-only. If the attributes are set to read-only, clear that setting. Check whether the SD memory card is inserted into the instrument. **See:** "3.5 Inserting (Removing) an SD Memory Card" (p.32)
*** CARD ERROR *** Load failed.	The file being loaded does not exist on the SD memory card. The file being loaded is corrupt.	Update the instrument's file list. You can update the file list by accessing another screen, for example by pressing the **DF1** key, and then pressing the **DF4** key again. If the file is corrupt, it is recommended to back up the file on a computer (if possible) and then format the SD memory card. **See:** "9.2 Formatting SD Memory Cards" (p.138)
*** CARD ERROR *** Formatting failed.	An SD memory card error occurred, or the SD memory card was removed during formatting.	Reinsert the SD memory card or replace the SD memory card. **See:** "3.5 Inserting (Removing) an SD Memory Card" (p.32)
*** CARD ERROR *** SD Card locked.	The SD memory card is locked.	Unlock the SD memory card.
*** CARD ERROR *** SD Card full.	Unable to save file due to insufficient space on the SD memory card.	Delete files to make space or replace the SD memory card. (Insufficient memory capacity will abort storing data into the SD card.) **See:** "3.5 Inserting (Removing) an SD Memory Card" (p.32)
*** CARD ERROR *** SD Card not found.	No memory card is inserted.	Insert an SD memory card. **See:** "3.5 Inserting (Removing) an SD Memory Card" (p.32)
*** CARD ERROR *** SD Card not compatible.	An unsupported card such as an SDXC memory card has been inserted into the instrument.	Use a compatible SD memory card.
*** CARD ERROR *** No readable files found.	Unable to load files in the **[PW3198]** folder as it has been deleted.	The **[PW3198]** folder is created when the SD memory card is formatted. It is also automatically created when recording is started. **See:** "9.2 Formatting SD Memory Cards" (p.138)

Error display	Cause	Corrective action/more information
*** CARD ERROR *** File or folder could not be deleted.	Unable to delete file or folder.	If the SD memory card is locked, unlock it. If the file or folder is set to read-only, change its attributes on a computer and then delete it.
*** CARD ERROR *** Maximum files reached. Additional files cannot be created.	The maximum number of files that can be created during a single recording period was exceeded. The number of settings files exceeded 102. The number of measurement folders created on a single day exceeded 100.	Change the event detection items and detection levels to reduce the number of events that occur. Delete unnecessary settings files. Delete unnecessary measurement folders. **See:** "5.5 Changing Event Settings" (p.66), "9.6 Saving and Deleting Settings Files (Settings Data)" (p.145), "9.4 Saving, Display and Deleting Measurement Data" (p.141)
*** CARD ERROR *** SD Card is not formatted for this device.	The SD memory card has not been formatted using the SD format.	Format the card with the instrument. **See:** "9.2 Formatting SD Memory Cards" (p.138)
*** SETTING ERROR *** Folder cannot be moved.	Attempted to move to a folder other than the **[PW3198]** folder.	When viewing folders other than the **[PW3198]** folder, use the mass storage function or access the card directly using a computer. **See:** "12.1 Downloading Measurement Data Using the USB Interface" (p.156)
*** OPERATION ERROR *** This folder cannot be deleted.	Attempted to delete the **[PW3198]**, **[SETTING]**, or **[HARDCOPY]** folder.	These folders are required for the instrument to operate. To delete them, use a computer.
*** CARD ERROR *** SD-CARD ERROR.	An SD memory card error other than those listed above occurred.	Contact Hioki with information about the instrument's operational status at the time of the error.
*** PRINTER ERROR *** Printer Communication Error	Unable to recognize printer protocol or unable to configure printer. An RS-232C cable error may have occurred, or a non-recommended printer model may be connected to the instrument.	Check whether the printer and RS-232C cable are recommended models. Verify that the RS-232C cable is securely connected to the instrument and printer.
*** OPERATION ERROR *** Outside of settings range.	Attempted to set a voltage outside the valid range when using a user-defined nominal input voltage.	Use a nominal input voltage of 50 to 780 V.
*** OPERATION ERROR *** Cannot modify settings while recording is in progress.	Attempted to change a setting that cannot be changed while recording is in progress.	If you need to change the settings, stop recording operation with the **START/STOP** key and then reset the measurement data with the **DATA RESET** key.
*** OPERATION ERROR *** Cannot modify settings while analyzing is in progress.	Attempted to change a setting that cannot be changed while analyzing data.	If you need to change the settings, reset the measurement data with the **DATA RESET** key.
*** OPERATION ERROR *** Cannot modify settings while waiting is in progress.	Attempted to change a setting that cannot be changed while in the standby state.	If you need to change the settings, stop recording operation with the **START/STOP** key. If the instrument is in the standby state during repeated recording (after recording has paused and before recording starts again), reset the measurement data with the **DATA RESET** key after stopping recording operation with the **START/STOP** key.
*** OPERATION ERROR *** Operation not available while recording is in progress.	A key such as the **DATA RESET** key that cannot be used during recording was pressed.	If you need to change the settings, stop recording operation with the **START/STOP** key and then reset the measurement data with the **DATA RESET** key.
*** OPERATION ERROR *** Operation not available while analyzing is in progress.	A key such as the **START/STOP** key that cannot be used during analysis was pressed.	If you need to change the settings, reset the measurement data with the **DATA RESET** key.

Error display	Cause	Corrective action/more information
*** OPERATION ERROR *** Operation not available while waiting is in progress.	A key such as the **DATA RESET** key that cannot be used while in the standby state was pressed.	In the standby state before recording has begun, stop recording with the **START/STOP** key. If the instrument is in the standby state during repeated recording (after recording has paused and before recording starts again), reset the measurement data with the **DATA RESET** key after stopping recording operation with the **START/STOP** key.
*** OPERATION ERROR *** Recovering from a power interruption. Please wait.	A key such as the **START/ STOP** key that cannot be used while performing power outage recovery processing immediately after the instrument was turned on was pressed.	Wait a while and then press the key again.
*** OPERATION ERROR *** Settings cannot be modified under present 4ch wiring.	Attempted to change a setting whose value is constrained by the CH4 setting conditions, for example by changing a DC fluctuation event while CH4 is set to ACDC.	Change the connection (CH4) as necessary.
*** OPERATION ERROR *** Settings cannot be made under present wiring.	Attempted to change a setting whose value is constrained by the connection, for example by changing the Urms type (phase/line voltage) while CH123 is set to 1P2W.	Change the connection (CH123) as necessary.
*** OPERATION ERROR *** Cannot be configured when the RMS level is set to OFF.	Attempted to set a sense event while the RMS event is in the OFF state.	Set the sense event after setting the RMS event threshold.
*** OPERATION ERROR *** This operation is unavailable when using Preset. ESC to exit.	A key other than **F1** to **F4**, the cursor arrows, **ENTER**, or the **ESC** key was pressed on the quick setup screen.	Exit the quick setup display with the **ESC** key.
*** SETTING ERROR *** Preset configuration could not be completed.	Unable to perform quick setup.	Check connections, verify that appropriate input is being provided, and repeat the quick setup process.
*** SETTING ERROR *** Check the actual time control settings.	Unable to start recording because the start and stop time and date for real-time control were set to a time and date in the past.	Change the start and stop time and date for real-time control. **See:** "5.2 Changing the Measurement Period" (p.58)
*** Zero Adjustment Failed *** Zero adjustment failed.	Zero adjustment did not terminate normally.	Perform zero adjustment again with the instrument in the no-input state. If the instrument is located close to a noise source, place it further away and repeat zero adjustment.
Maximum number of recordable events exceeded.	More than 1,000 events occurred during the recording period. Consequently, recorded results could not be saved.	Change the event threshold setting so that the number of events does not exceed 1,000 during the recording period.

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

NOTE Turning on the instrument while the measurement target line is live may damage the instrument, causing an error to be displayed when it is turned on. Always turn on the instrument first and only activate power to the measurement line after verifying that the instrument is not displaying any errors.

14.4 Disposing of the Instrument

The PW3198 uses lithium batteries as a power source for saving measurement conditions. When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.
Dispose the other options appropriately.

⚠WARNING

- **To avoid electric shock, turn off the POWER switch and disconnect the power cord, voltage cord, and clamp sensor before removing the lithium battery.**
- **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.**
- **Keep batteries away from children to prevent accidental swallowing.**

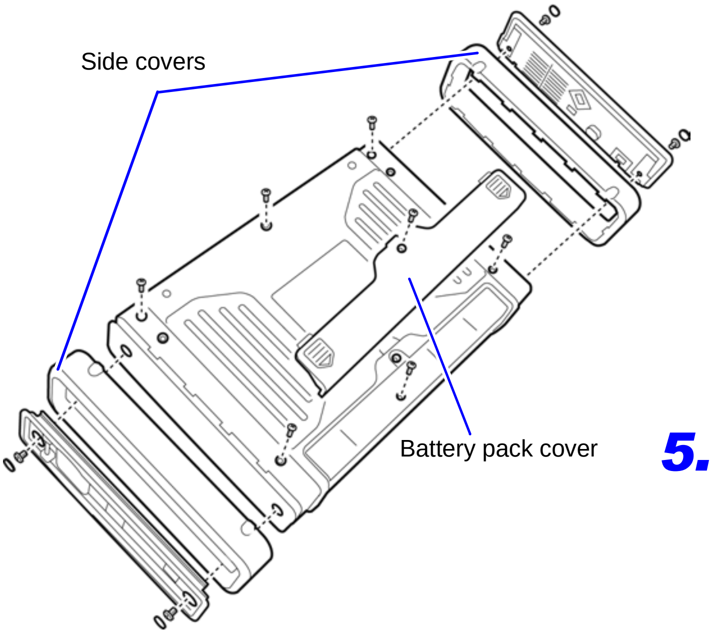
Lithium Battery Removal

You will need: 1 Phillips head screwdriver (No. 2) and 1 pair of tweezers

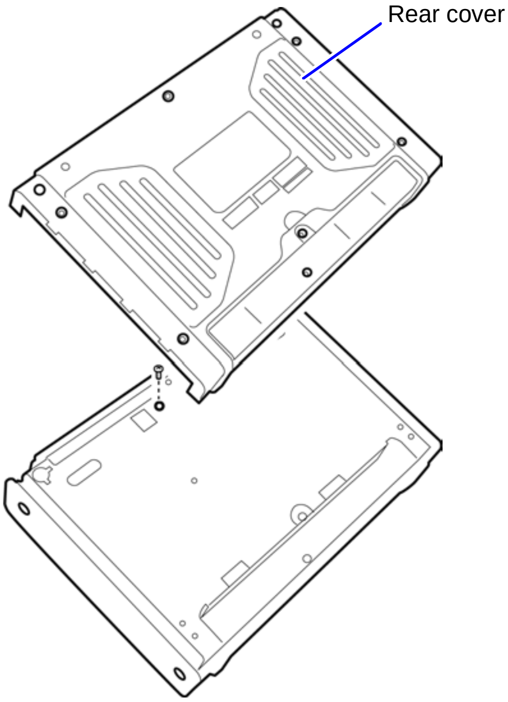
1. **Turn off the instrument's power switch.**

2. **Disconnect all cords, including clamp sensors, voltage cords, and the AC adapter.**

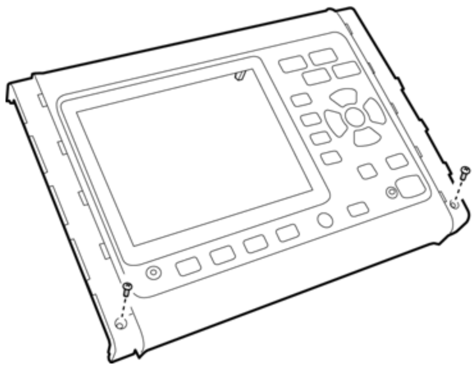
3. **Remove the 11 screws shown in the following diagram with the Phillips head screwdriver and remove the battery pack cover and side covers.**



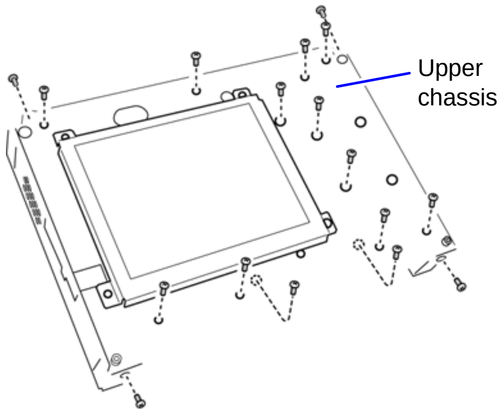
4. **Remove the rear cover and remove the screw attaching the metal plate.**



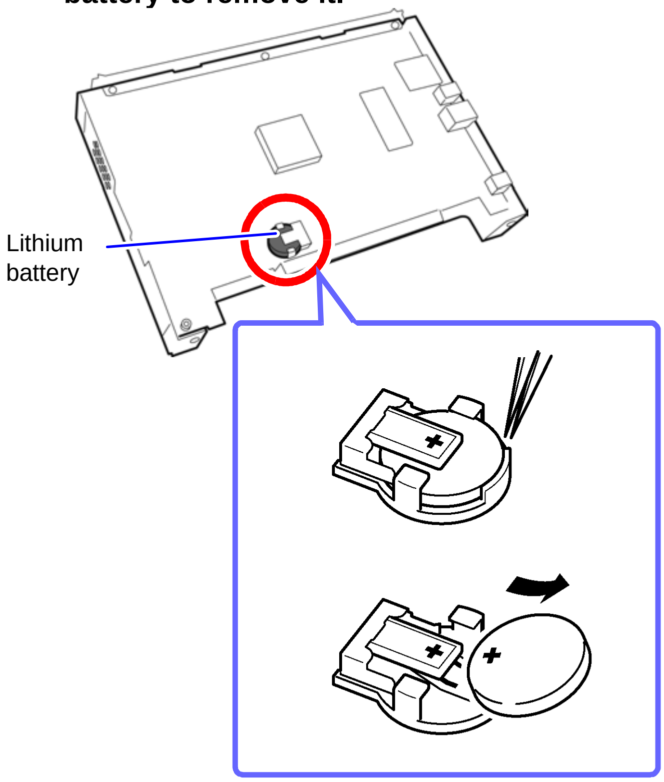
5. **Remove the 2 screws on the front cover.**



6. **Remove the 17 screws shown in the following diagram and remove the upper chassis.**



7. **Insert the tweezers between the battery holder and the battery and lift up the battery to remove it.**



CALIFORNIA, USA ONLY
This product contains a CR Coin Lithium Battery which contains Perchlorate Material - special handling may apply.
See www.dtsc.ca.gov/hazardouswaste/perchlorate

Appendix

Appendix 1 Procedure for Investigating Power Supply Quality

By measuring power supply quality parameters, you can assess the power supply's quality and identify the causes of various power supply malfunctions. The PW3198's ability to measure all power supply quality parameters simultaneously makes this process a quick and simple one.

This appendix describes the power supply quality investigation process.

Step 1: Identifying a clear objective

1

To assess power supply quality (power quality)
(There is no known problem with the power supply, and you simply wish to assess its quality.)

- Periodic power supply quality statistical investigations
- Testing after the installation of electric or electronic equipment
- Load investigation
- Preventive maintenance

Go to Step 3.

2

To find the cause of a power supply malfunction
(You have discovered a power supply malfunction such as an equipment failure or malfunction and wish to address it quickly.)

Go to Step 2.

Step 2: Identifying the malfunctioning component (measurement location)

Check the following:

1

Where is the issue occurring?

- Principal electrical system
  (Large copier, uninterruptible power supply, elevator, air compressor, air conditioning compressor, battery charger, cooling system, air handler, time-controlled lighting, variable-speed drive, etc.)
- Electric distribution system
  (Conduit [electrical conduit] damage or corrosion, transformer heating or noise, oil leak, circuit breaker operation or overheating)

2

When does the issue occur?

- Does it occur continuously, regularly, or intermittently?
- Does it occur at a specific time of day or on a specific day?

3

What type of investigation (measurement) should be performed to find the cause?
(It is recommended to measure voltage, current, and possibly power continuously. By analyzing voltage and current trends when the issue occurs, it will be easier to pinpoint the cause of the problem. Additionally, simultaneously measuring multiple locations is an effective way to quickly identify the cause.)

- Electrical substation internal lines (power companies only)
- High or low voltage at a service line entrance
- Distribution boards and switchboards
- Outlets and other points of power supply for electric and electronic equipment

4

What is the expected cause?

- Voltage abnormalities (RMS value fluctuations, waveform distortion, transient voltages, high-order harmonics [noise at frequencies of several kilohertz and above])
- Current abnormalities (leak current, inrush current)

Step 3: Checking investigation (measurement) locations (collecting site data)

Collect information (site data) from as many locations as possible to prepare for the investigation. Check the following:

1. Connection (1P2W/1P3W/3P3W2M/3P3W3M/3P4W/3P4W2.5E)
2. Nominal input voltage (100 to 600 V)
3. Frequency (50/60 Hz)
4. Need for neutral wire measurement and DC voltage measurement
5. Current capacity (necessary in order to select clamp sensor to use for measurement)
6. Other items related to the facility as a whole (check for presence of other systems with malfunctioning power supplies, principal electrical system operating cycle, additions or changes to facility equipment, facility distribution circuitry)

Step 4: Making measurements with the power supply quality analyzer

Measurements are performed using the following procedure:

1. Perform quick setup and adjust the relevant settings.

- Connect the measurement line and select the quick setup according to your objective.(When using the instrument to identify a power supply malfunction whose cause is unknown, it is recommended to select the voltage abnormality detection pattern.)
- Verify that the proper connection has been selected on the **[SYSTEM]** screen and that the settings have been configured appropriately (nominal input voltage, frequency, range, interval time, etc.). Verify that events are not being generated too frequently.
- If, based on the information obtained in Steps 2 and 3 above, you find that some necessary settings have not been configured by the quick setup process, reconfigure them on the **[SYSTEM]** screen.
- Check instantaneous values (voltage level, voltage waveform, current waveform, voltage waveform distortion [THD]) on the **[VIEW]** screen.

2. Start recording.

- Press the **START/STOP** button to start recording. (Thresholds will have already been set during the quick setup process.)
- Check the event detection state on the **[EVENT]** screen. If necessary, cancel recording and change the settings or thresholds. (If too many events are occurring, you can increase the thresholds based on measurement results.)
- Continue recording for the necessary period, check the state of the power supply malfunction based on the detected events, and take corrective action as appropriate. (The PW3198 can be used not only for the investigation phase, but also to verify the effectiveness of corrective action taken.)

Advice for identifying the cause of abnormalities

■ Record voltage and current trends at the power circuit inlet.

If current consumption in a building is high while the voltage is low, the cause likely lies inside the building. If the voltage and current are both low, the cause is likely to lie outside the building. It's extremely important to select the right measurement locations and to measure current.

■ Check power trends.

Overloaded equipment can cause problems. By understanding power trends, you can more easily identify problematic equipment and locations.

■ Check when the problem occurs.

Equipment that is operating or turning off or on when abnormalities (events) are recorded may be problematic. By understanding the precise times at which abnormalities (events) start and stop, you can more easily identify problematic equipment and locations.

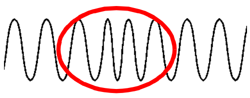
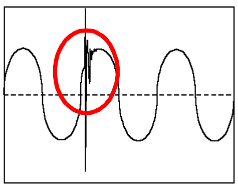
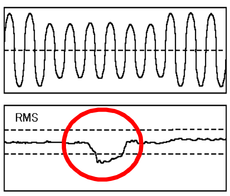
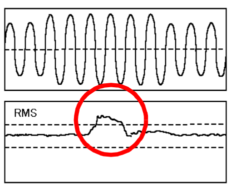
■ Check for heat and unusual sounds.

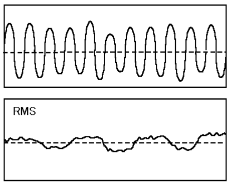
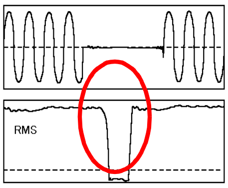
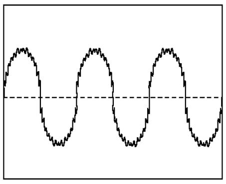
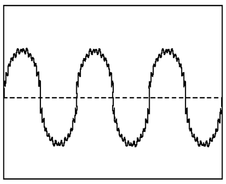
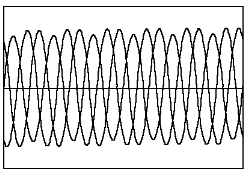
Motors, transformers, and wiring may produce heat or unusual sounds due to causes such as overloading or harmonics.

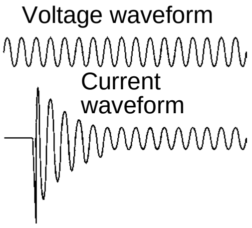
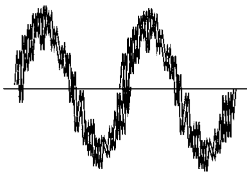
Appendix 2 Explanation of Power Supply Quality Parameters and Events

Power supply quality parameters are necessary in order to investigate and analyze the phenomenon of power supply problems*. By measuring these parameters, it is possible to assess power supply quality. In order to allow the PW3198 to detect abnormal values and abnormal waveforms, you set thresholds. When these thresholds are exceeded, events are generated.

*: Thresholds are set based on an estimation of abnormal values, so events do not necessarily indicate a problem.

Principal parameters indicating power quality	Waveform	Phenomenon	Primary issues	PW3198 events and measurements
Frequency fluctuations		Occurs due to line separation caused by changes in the supply/demand balance of active power, the shut-down of a high-capacity generator, or circuit issues.	Changes in the speed of synchronized motors may cause product defects.	Events are detected using frequency (Freq) and frequency cycle (Freq_wav). Measurement items include IEC61000-4-30 10-second average frequency and 10-second frequency (Freq10s).
Transient overvoltage (impulse)		Occurs due to phenomena such as lightning, breaker point damage, or closure on the circuit breaker or relay. Often occurs when there is a radical change in voltage or when the peak voltage is high.	Close to the source of the break, the device's power is damaged because of exceptionally high voltages and this may cause the device to reset.	Events involving transients of 5 kHz or more are detected using transient overvoltage. They can also be detected as voltage waveform distortions using voltage waveform peak and voltage waveform comparison functionality.
Voltage dip (SAG)		Most dips are caused by natural phenomena such as lighting. When an equipment fault is detected and taken offline due to the occurrence of a power system ground fault or short-circuit, a large inrush current caused by a motor startup or other load can occur, causing a temporary voltage dip.	Dips in the supply voltage can cause equipment to stop operating or be reset, discharge lamps to turn off, electric motors to increase or decrease in speed or stop, or synchronized motors and generators to lose synchronization.	Events are detected using dips.
Voltage swell (SURGE)		Swells occur when the voltage rises momentarily, for example when a power line turns on or off due to lightning or a heavy load, when a high-capacity capacitor bank is switched, when a one-line ground occurs, or when a high-capacity load is cut off. This phenomenon also includes voltage surges due to grid-tied dispersed power supplies (solar power, etc.).	A surge in voltage may cause the device's power to be damaged or the device to reset.	Events are detected using swells.

Principal parameters indicating power quality	Waveform	Phenomenon	Primary issues	PW3198 events and measurements
Flicker		Flicker consists of voltage fluctuations resulting from causes such as blast furnace, arc welding, and thyristor control loads. Manifestations include light bulb flicker.	Because this phenomenon reoccurs regularly, it may cause the light to flicker or the device to malfunction. Large flicker values indicate that most people would find the flickering of lighting unpleasant.	Events are measured using ΔV10 flicker and IEC flicker Pst and Plt.
Interruption ((momentary power outage)		Interruptions consist of momentary, short-term, or extended power supply outages as a result of factors such as circuit breakers being tripped due primarily to power company issues (interruption of power due to lightning strikes, etc.) or power supply short-circuits.	Recently, due to the spread of UPS (uninterruptible power sources), most of these problems can be fixed using a computer, but this may cause the device to stop operating due to an interruption or to reset.	Events are detected using interruptions.
Harmonic		Harmonics are caused by distortions of the voltage and current waveforms when a device's power supply uses semiconductor control devices.	Large harmonic components can lead to major malfunctions, including overheating of motors and transformers and burnout of reactors connected to phase advance capacitors.	Events are detected using harmonic voltage, harmonic current, and harmonic power. They can also be detected as voltage waveform distortions using voltage waveform comparison functionality.
Inter-harmonics		Inter-harmonics are caused when the voltage or current waveform is distorted due to static frequency conversion equipment, cycloconverters, Scherbius machines, induction motors, welders, or arc furnaces. The term refers to frequency components that are not a whole multiple of the fundamental wave.	Displacement of the voltage waveform zero-cross may damage equipment, cause it to malfunction, or degrade its performance.	Inter-harmonics are measured using inter-harmonic voltage and inter-harmonic current. Events are not supported, but it may be possible to detect events as voltage waveform distortions using voltage waveform comparison functionality.
Unbalance		Unbalance is caused by increases or decreases in the load connected to each phase of a power line, or by distortions in voltage and current waveforms, voltage dips, or negative-phase voltage caused by the operation of unbalanced equipment or devices.	Voltage unbalance, negative-phase voltage, and harmonics can cause issues including variations in motor speed and noise, reduced torque, tripping of 3E breakers, overloading and heating of transformers, and increased loss in capacitor smoothing rectifiers.	Events are detected using voltage unbalance factor and current unbalance factor.

Principal parameters indicating power quality	Waveform	Phenomenon	Primary issues	PW3198 events and measurements
Inrush current		Inrush current is a large current that flows momentarily, for example when electric equipment is turned on.	Inrush current can cause power switch contact and relay fusing, fuse blowouts, circuit breaker disconnections, issues with rectifying circuits, and supply voltage instability, causing equipment sharing the same power supply to stop operating or be reset.	Events are detected using inrush current.
High-order harmonic component		The high-order harmonic component consists of noise components of several kHz or more caused by voltage and current waveform distortions when equipment power supplies use semiconductor devices. It includes various frequency components.	The high-order harmonic component can damage equipment power supplies, cause equipment operation to be reset, or result in abnormal sound from TVs and radios.	Events are detected using high-order harmonic voltage component RMS values and high-order harmonic current component RMS values.

Note: Meaning issues caused by a reduction in power supply quality, resulting in the following substation issues and electronically controlled device malfunctions: lighting flicker, frequent burning out of incandescent light bulbs, malfunctioning office equipment, occasional abnormal machine operation, overheating of reactor-equipped capacitor equipment, and occasional malfunctioning of overload, negative-phase, and open-phase relays.

Appendix 3 Event Detection Methods

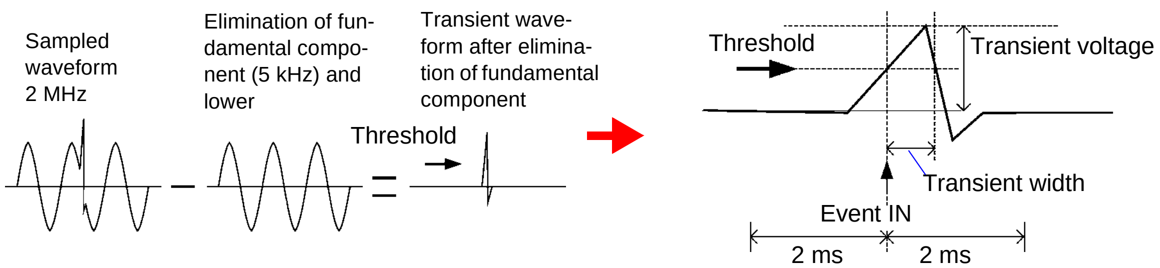
Transient overvoltage

Measurement method:

- Detected when the waveform obtained by eliminating the fundamental component (50/60/400 Hz) from a waveform sampled at 2 MHz exceeds a threshold specified as an absolute value.
- Detection occurs once for each fundamental voltage waveform, and voltages of up to ±6,000 V can be measured.

Recorded data:

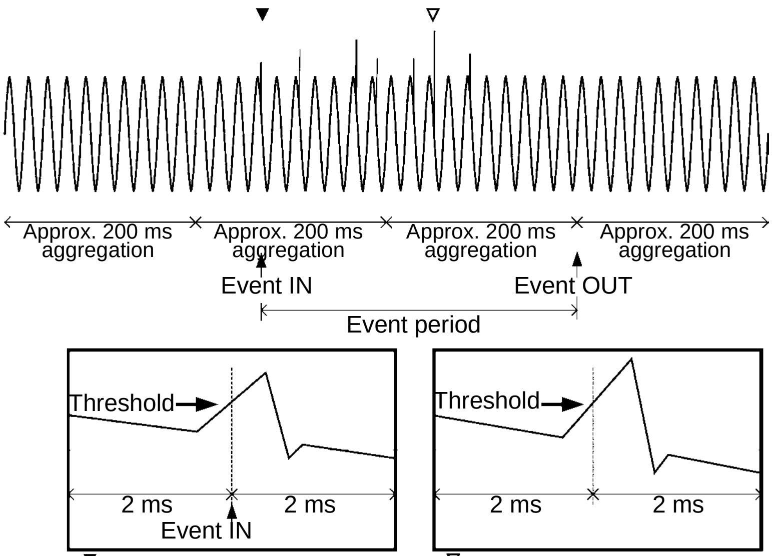
Transient voltage value	: Peak value of waveform during 4 ms period after elimination of fundamental component
Transient width	: Period during which threshold is exceeded (2 ms max.)
Max. transient voltage value:	: Max. peak value of waveform obtained by eliminating the fundamental component during the period from transient IN to transient OUT (leaving channel information)
Transient period	: Period from transient IN to transient OUT
Transient count during period	: Number of transients occurring during period from transient IN to transient OUT (transients occurring across all channels or simultaneously on multiple channels count as 1)
Transient waveforms	: Event waveform and transient waveform (Waveforms are saved for 2 ms before and after the position at which the transient overvoltage waveform was detected for the first transient IN and 2 ms before and after the point at which the transient maximum voltage waveform was detected between the IN and OUT points.)



Event IN and OUT

Event IN : The event occurrence time when the first transient overvoltage is detected during an aggregation period of approx. 200 ms. indicates the peak voltage value and transient width detected when the threshold was exceeded.

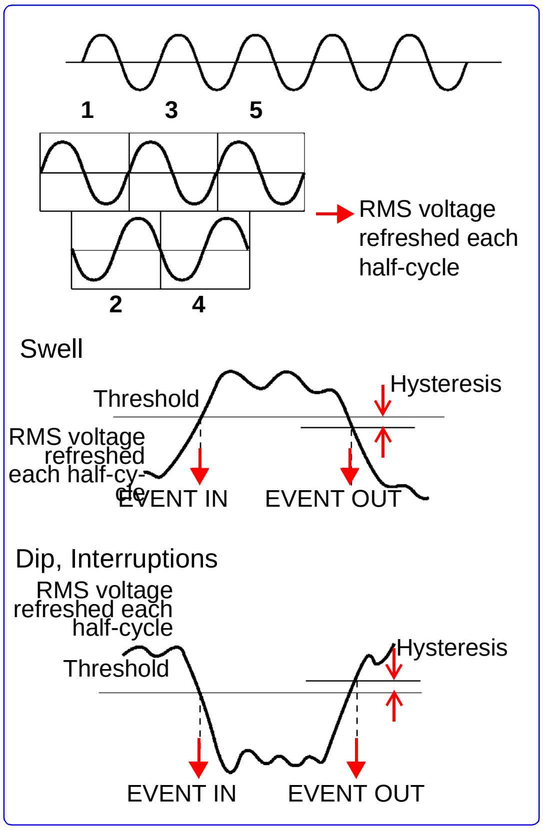
Event OUT : Indicates the first transient period (difference between the IN time and OUT time) for the approx. 200 ms aggregation period during which no transient overvoltage was detected for any channel within the first approx. 200 ms aggregation period following the transient event IN state.



▼ **Transient waveform (including fundament component)**
The first detected transient waveform after event IN is saved.

▽ **Transient waveform (including fundament component)**
The waveform with the largest transient voltage value from the IN to the OUT point is saved at event OUT.

Voltage Swells, Voltage Dips, and Interruptions



Measurement method:

- When the measurement frequency is set to 50/60 Hz, events are detected using the RMS voltage refreshed each half-cycle based on sample data for 1 waveform derived by overlapping the voltage waveform every half-cycle.
- When the measurement frequency is set to 400 Hz, events are detected using the RMS voltage refreshed each half-cycle based on sample data for each waveform.
- Events are detected using line voltage for 3-phase 3-wire connections and phase voltage for 3-phase 4-wire connections.
- Swells are detected when the RMS voltage refreshed each half-cycle exceeds the threshold in the positive direction, while dips and interruptions are detected when the RMS voltage refreshed each half-cycle exceeds the threshold in the negative direction (hysteresis applies in all cases).

Event IN and OUT:

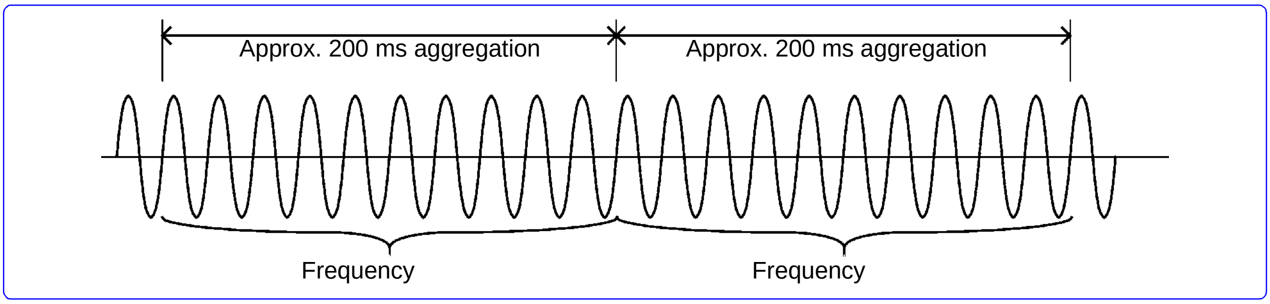
Event IN : Start of the waveform during which the RMS voltage refreshed each half-cycle exceeds the threshold in the positive direction

Event OUT : Start of the waveform during which the RMS voltage refreshed each half-cycle exceeds the value obtained by subtracting the hysteresis from the threshold in the negative direction

Frequency

Measurement method:

Frequency is calculated as the reciprocal of the accumulated whole-cycle time during 10, 12, or 80 U1 (reference channel) cycles. This value is detected when the absolute value is exceeded.



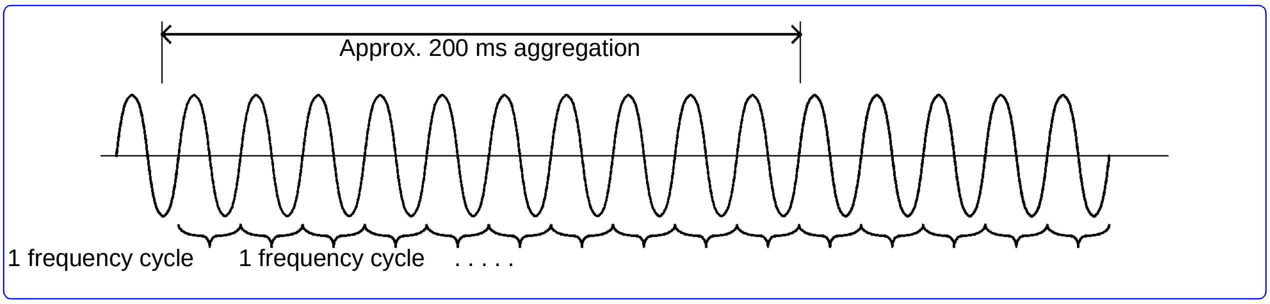
Event IN and OUT:

Event IN : Start of the approx. 200 ms aggregation in which the reading is greater than ±threshold
Event OUT : Start of the approx. 200 ms aggregation in which the reading returns to ± (threshold - 0.1 Hz)
Note: Equivalent to 0.1 Hz frequency hysteresis.

Frequency cycle

Measurement method:

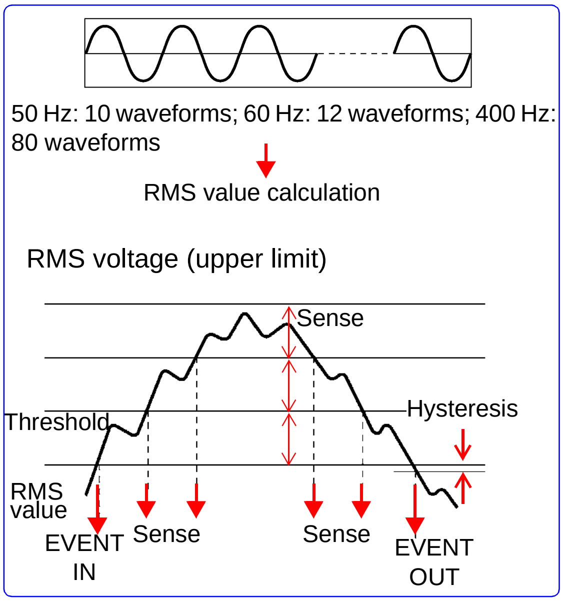
- Frequency for every U1 (reference channel) waveform, calculated using the reciprocal method.
- When the measurement frequency is set to 400 Hz, the frequency cycle is calculated as the reciprocal of the accumulated whole-cycle time during 8 cycles.
- The frequency cycle is calculated as the average frequency for 8 waveforms.



Event IN and OUT:

Event IN : Start time of waveform exceeding ±threshold
Event OUT : Start time of waveform returning to ±(threshold -0.1 Hz)
Note Equivalent to 0.1 Hz frequency hysteresis.

Voltage Waveform Peak, Current Waveform Peak, RMS Voltage, RMS Current, Active Power, Reactive Power, Apparent Power, Power Factor, and Displacement Power Factor



Measurement method:

- Events are detected when the value in question calculated from the approx. 200 ms aggregation of 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz) is greater than or less than the threshold.
- RMS values are calculated from an approx. 200 ms aggregation of 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz) as per IEC61000-4-30.

Event IN and OUT:

Event IN : Start of the approx. 200 ms aggregation in which the reading is greater than the upper limit or less than the lower limit

Event OUT : Start of the first approx. 200 ms aggregation in which the reading is less than (the upper limit - hysteresis) after being greater than the upper limit, or in which the reading is greater than (the lower limit + hysteresis) after being less than the lower limit

Sense : Sense events are detected when the reading is greater than or less than the sense upper limit between the event IN and event OUT. (When event OUT conditions are fulfilled, the event OUT takes precedence.)

Voltage DC Value, Current DC Value (CH4 only)

Measurement method:

Values are detected when the average value for the approx. 200 ms aggregation synchronized to the reference channel U1 exceeds a threshold specified as an absolute value.

Event IN and OUT:

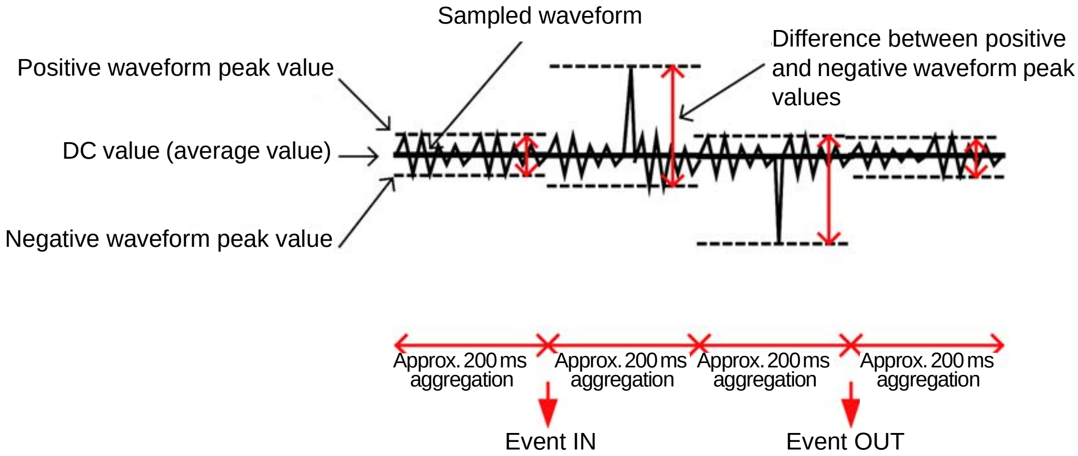
Event IN : Start of the approx. 200 ms aggregation in which the reading is greater than the upper limit or less than the lower limit

Event OUT : Start of the first approx. 200 ms aggregation in which the reader is less than (the upper limit - hysteresis) after being greater than the upper limit, or in which the reading is greater than (the lower limit + hysteresis) after being less than the lower limit

Voltage DC Change and Current DC Change (CH4 only)

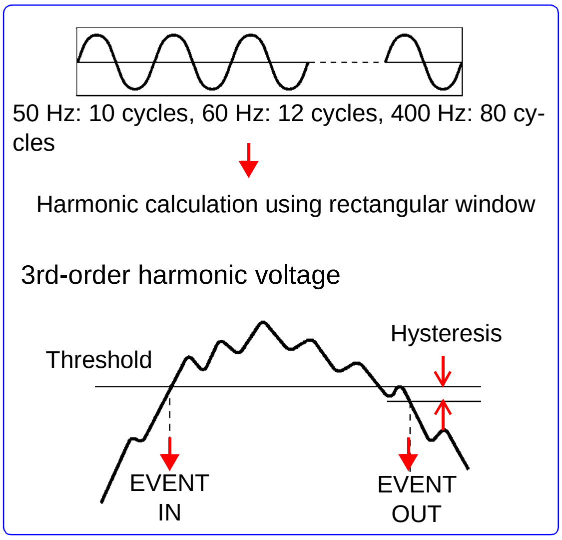
Measurement method:

DC fluctuation events are detected when the difference between the positive and negative waveform peak values in an approx. 200 ms aggregation exceeds the set threshold.



Measured values in the event list are displayed as the voltage or current value for the difference between the positive and negative waveform peak values. (These measured values are not recorded.)

Voltage Unbalance Factor, Current Unbalance Factor, Harmonic Voltage, Harmonic Current, Harmonic Power, Harmonic Voltage-Current Phase Difference, Total Harmonic Voltage Distortion Factor, Total Harmonic Current Distortion Factor, and K Factor



Measurement method:

Measured values are calculated for a rectangular window of 4,096 points in an approx. 200 ms aggregation of 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz), and events are detected when the calculated values are greater than or less than the corresponding threshold.

Event IN and OUT:

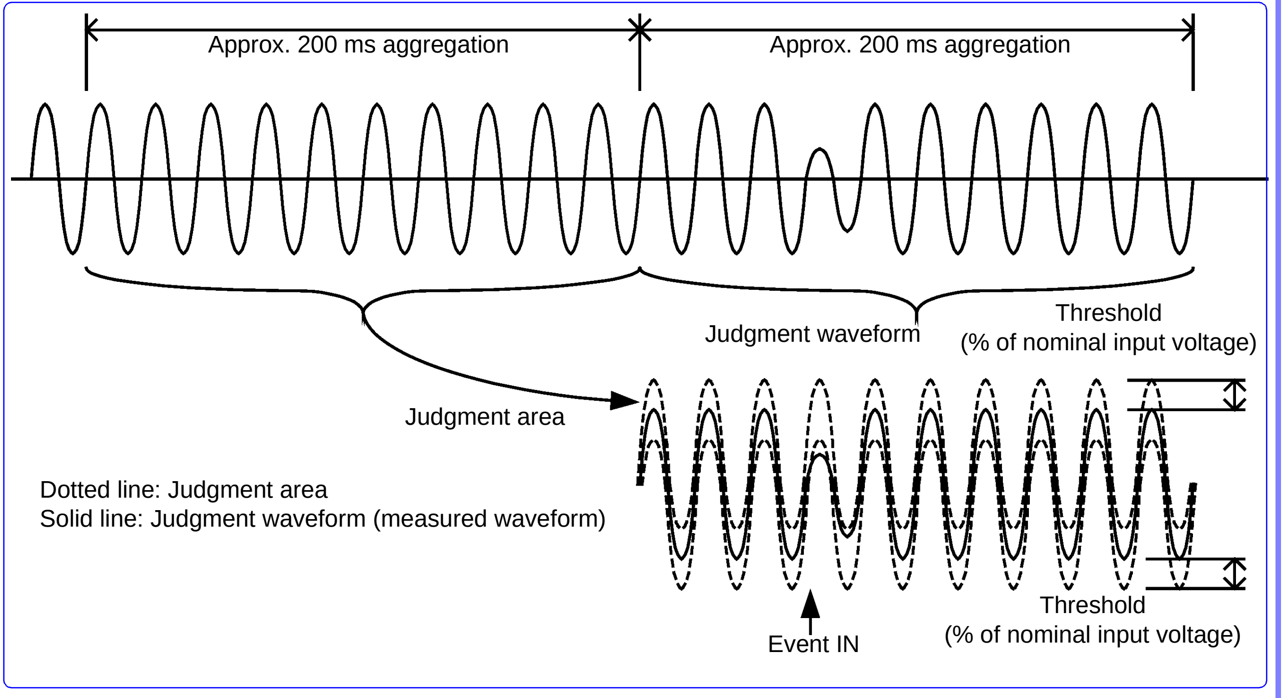
Event IN : Start of the approx. 200 ms aggregation in which the reading is greater than the threshold

Event OUT : Start of the approx. 200 ms aggregation in which the reading is less than (the threshold - hysteresis)

Voltage Waveform Comparison

Measurement method:

- A judgment area is automatically generated from the previous 200 ms aggregation waveform, and events are generated based on a comparison with the judgment waveform.
- Waveform comparison is performed at once for the entire 200 ms aggregation. Thresholds are applied as a percentage of the nominal input voltage RMS value.



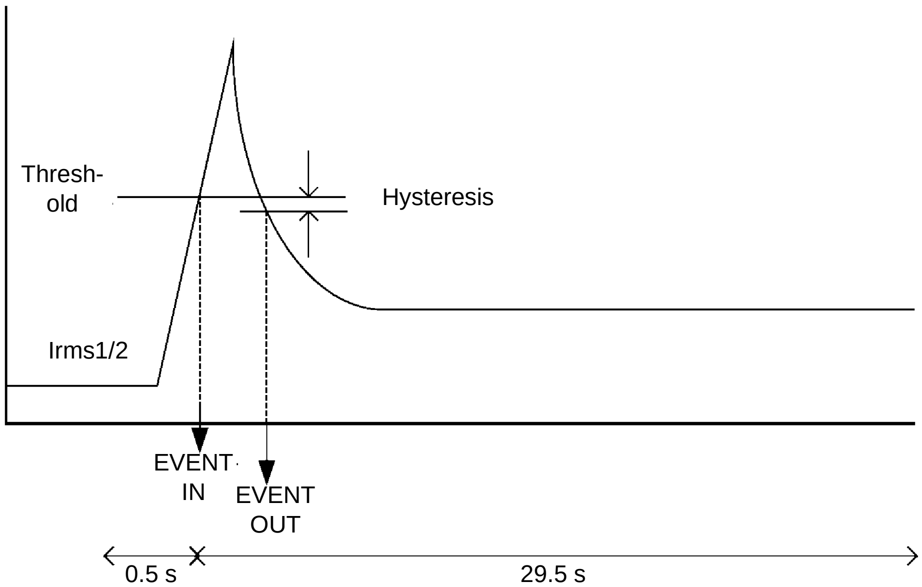
Event IN and OUT:

Event IN : First time at which waveform diverges from judgment area
Event OUT : None

Inrush current

Measurement method:

- Events are detected when the RMS current refreshed each half-cycle Irms1/2 is greater than the threshold.
- For 400 Hz measurement, events are detected when the maximum of 4 RMS current values existing within the same 10 ms period (calculated values for one 400 Hz waveform) is greater than the threshold in the positive direction.

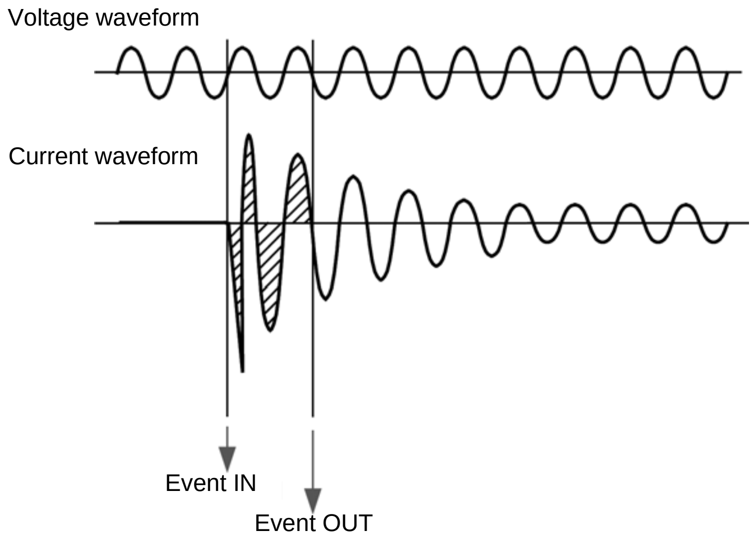


RMS current refreshed each half-cycle Irms1/2 values are saved from 0.5 s before the event to 29.5 s after the event as fluctuation data.

Event IN and OUT:

Event IN : Time of start of channel half-cycle voltage waveform in which the RMS current refreshed each half-cycle was greater than the threshold.

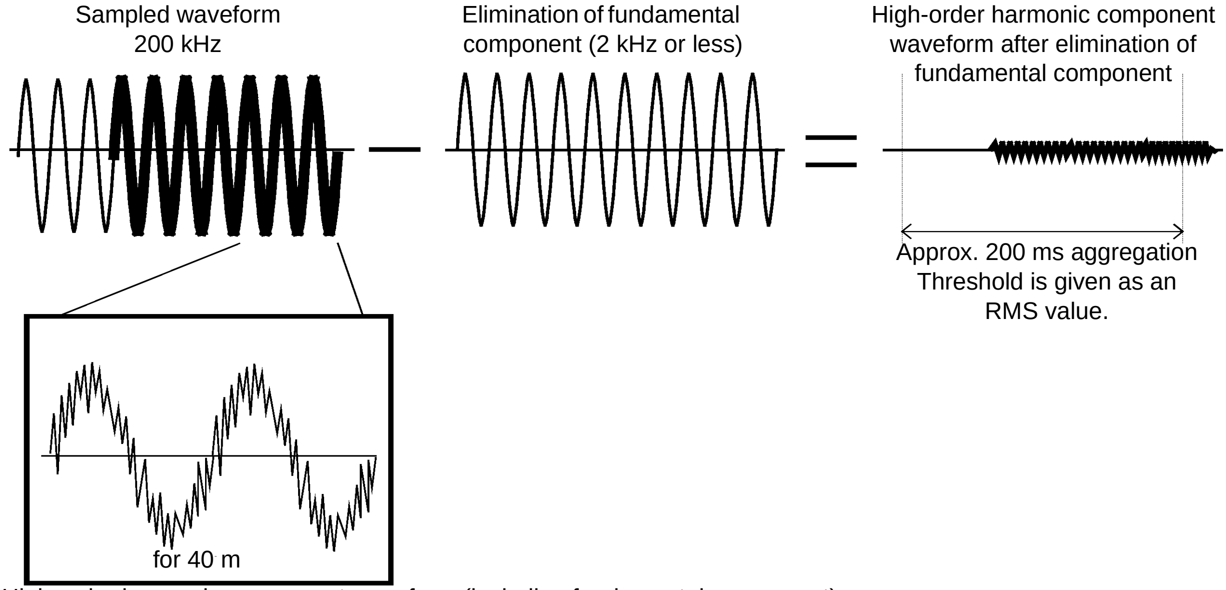
Event OUT : Time at the start of the voltage half-cycle waveform in which the RMS current refreshed each half-cycle exceeded (threshold - hysteresis) in the negative direction



High-order Harmonic Voltage Component and High-order Harmonic Current Component

Measurement method:

- The waveform obtained by eliminating the fundamental component is calculated using the true RMS method during 10 cycles (50 Hz), 12 cycles (60 Hz), or 80 cycles (400 Hz) of the fundamental wave. Events are detected when this RMS value is greater than the threshold.
- When an event is detected, the high-order harmonic waveform is recorded in addition to the event waveform for 40 ms (8,000 points of data) from the end of the first approx. 200 ms aggregation interval in which the reading was greater than the threshold.



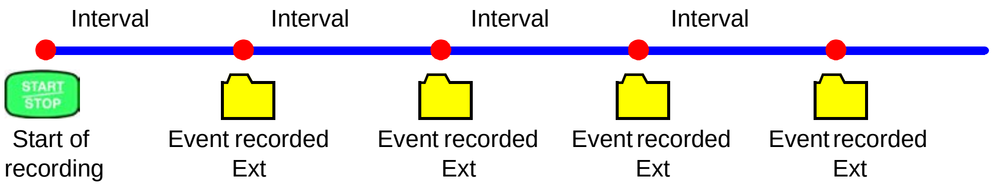
High-order harmonic component waveform (including fundamental component)

Event IN and OUT:

Event IN : Start of the approx. 200 ms aggregation in which the reading is greater than the threshold
Event OUT : Start of the approx. 20 ms aggregation in which no high-order harmonics were detected during the first approx. 200 ms aggregation following the IN state

Timer Events

Events are generated at the set interval.
Once recording has started, timer events are recorded at a fixed interval (the set time) starting with the start time.



External Events

External events are detected using external control terminal (EVENT IN) shorts or pulse signal falling edge input. The voltage and current waveforms and measured values when the external event occurs can be recorded.

See:"11.1 Using the External Control Terminal" (p.149)

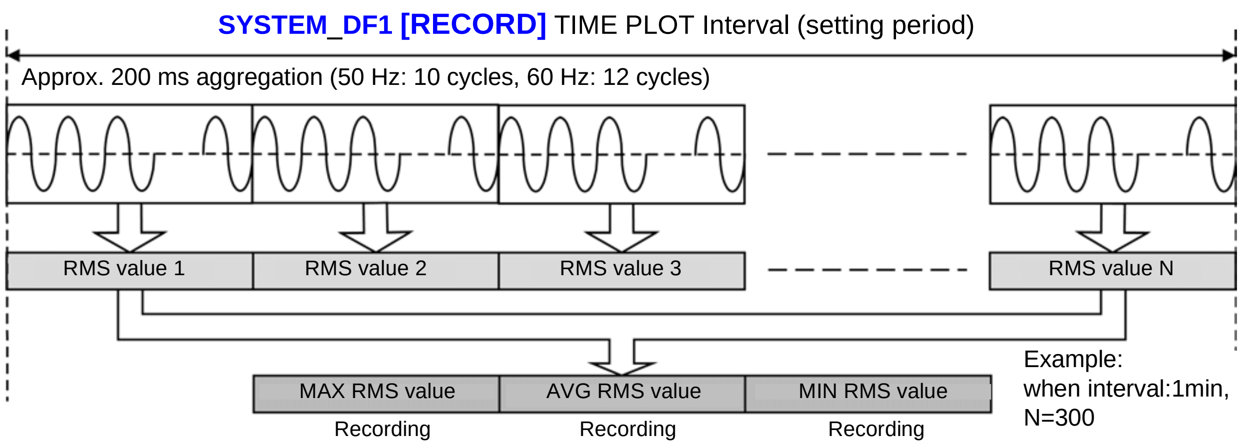
Manual Events

Manual events are detected when the MANU EVENT (manual event) key is pressed. The voltage and current waveforms and measured values when the external event occurs can be recorded.

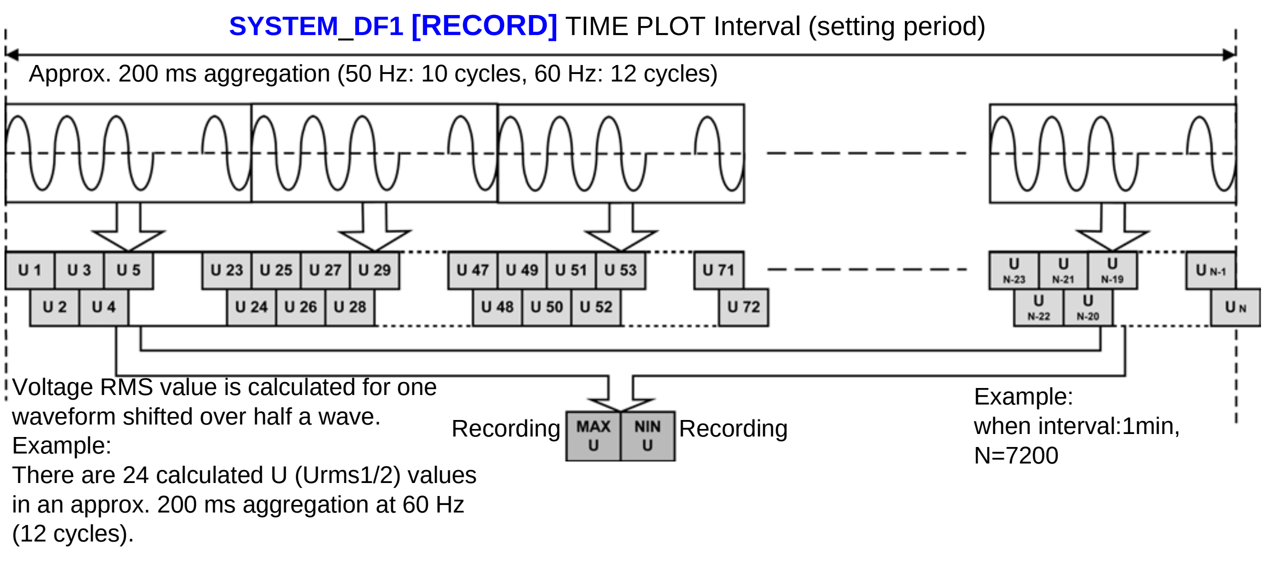
See: For more information about how to record event waveforms: "Appendix 4 Recording TIMEPLOT Data and Event Waveforms" (p.A14)

Appendix 4 Recording TIMEPLOT Data and Event Waveforms

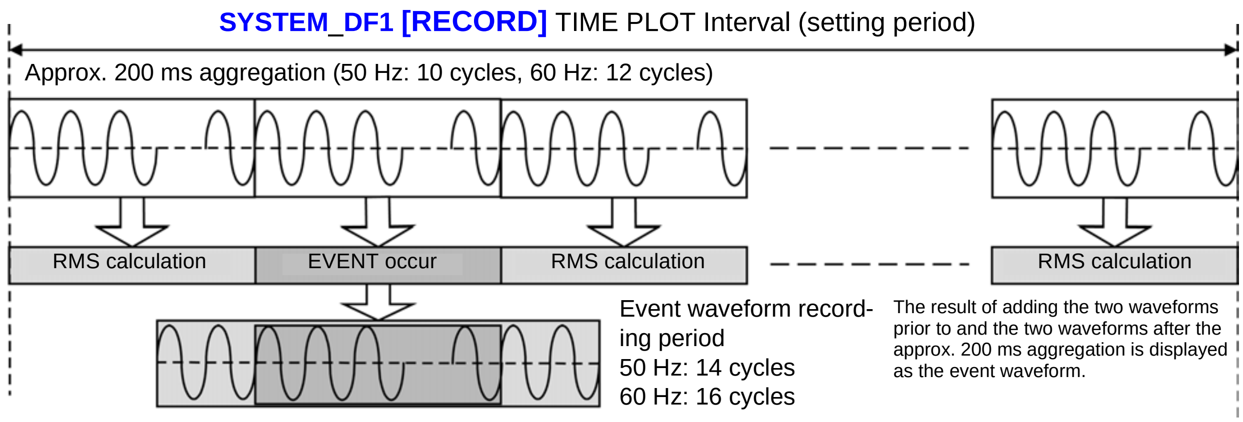
TIME PLOT screen (trends and harmonic trends)



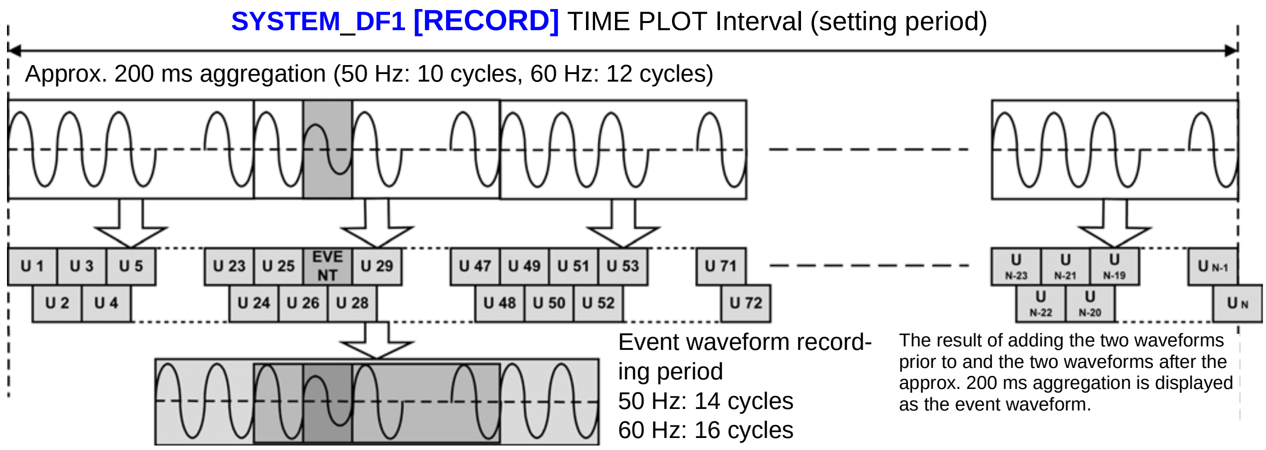
TIME PLOT screen (detailed trends)



Event Waveform Recording Method
Generating events using approx. 200 ms aggregation measured values



Generating events using one- or half-wave measured values



TIMEPLOT time synchronization and overlap

Instruments defined under IEC61000-4-30 Class A must generate measurement results within the stipulated accuracy range when measuring the same signal, even if different instruments are used to make the measurement.

A series of 150/180 cycle time intervals is resynchronized every 10 minutes as shown in the figure to align measurement times and measured values. Consequently, the approx. 200 ms aggregations (10 or 12 cycles) are also resynchronized every 10 minutes.

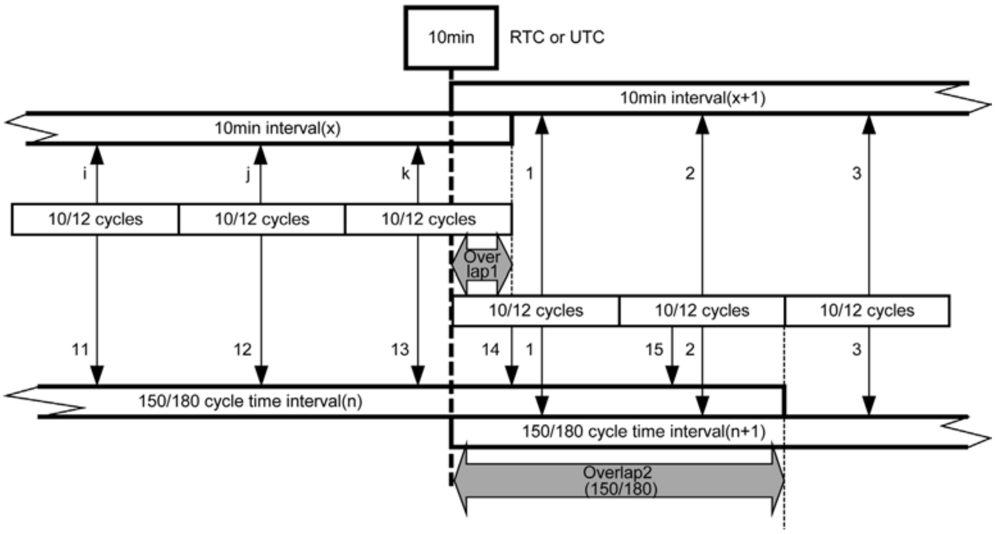


Figure. Synchronization Required by IEC61000-4-30 Class A

A new 150/180 cycle time interval starts every 10 minutes (for example, x+1), while measurement of the existing 150/180 cycle time interval (for example, x) continues until it is complete. In this way, there is an overlap between the two 150/180 cycle time intervals and between approx. 200 ms aggregations (10 or 12 cycles). The PW3198 synchronizes the start of the set TIMEPLOT interval every 10 minutes. For this reason, approx. 200 ms aggregations (10 or 12 cycles) are also resynchronized every 10 minutes.

A new TIMEPLOT interval starts every 10 minutes, while measurement of the existing TIMEPLOT interval continues until it is complete. In this way, there is an overlap between the two TIMEPLOT intervals.

To perform standard-compliant measurement, the TIMEPLOT interval must be set to 50 Hz/150 waves or 60 Hz/180 waves.

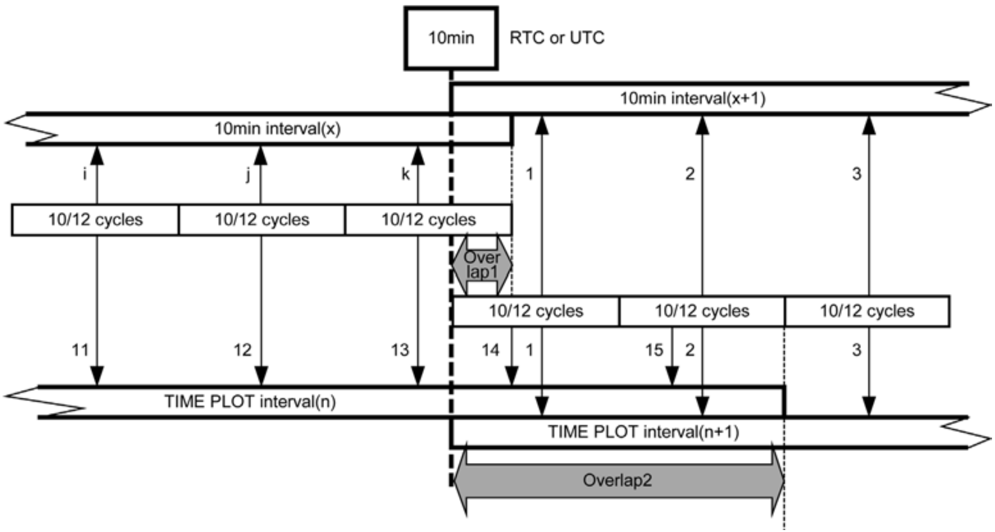


Figure. PW3198 Synchronization

Note: 10/12 cycles = 200 ms aggregation

Method for verifying aggregation values required by IEC61000-4-30

	3-second aggregated values (=150/180cycle data)	10-minute aggregated values	2-hour aggregated values
Magnitude of the Supply Voltage	Applies to average value of channel Urms values on the **[TIMEPLOT]** - **[TREND]** screen.	Applies to average value of channel Urms values on the **[TIMEPLOT]** - **[TREND]** screen.	Applies to average value of channel Urms values on the **[TIMEPLOT]** - **[TREND]** screen.
Voltage harmonics	Applies to average values on the **[TIMEPLOT]** - **[HarmTrend]** screen.	Applies to average values on the **[TIMEPLOT]** - **[HarmTrend]** screen.	Applies to average values on the **[TIMEPLOT]** - **[HarmTrend]** screen.
Voltage inter-harmonics	Applies to average values for each channel's orders on the **[TIMEPLOT] - [Harm Trend]** - **[INTERHARM]** screen.	Applies to average values for each channel's orders on the **[TIMEPLOT] - [Harm Trend]** - **[INTERHARM]** screen.	Applies to average values for each channel's orders on the **[TIMEPLOT] - [Harm Trend]** - **[INTERHARM]** screen.
Supply Voltage unbalance	Applies to average value of unb0 and unb for Uunb on the **[TIMEPLOT]** - **[TREND]** screen.	Applies to average value of unb0 and unb for Uunb on the **[TIMEPLOT]** - **[TREND]** screen.	Applies to average value of unb0 and unb for Uunb on the **[TIMEPLOT]** - **[TREND]** screen.
Measurement conditions	• The TIMEPLOT interval is set to 150/180 cycles. • During analysis, cursor measurement is performed after setting Tdiv to the minimum value. • The order being checked for harmonics and inter-harmonics is selected and displayed. • Recorded items for inter-harmonics are set to **[ALL DATA]**.	• The TIMEPLOT interval is set to 10 minutes. • During analysis, cursor measurement is performed after setting Tdiv to the minimum value. • The order being checked for harmonics and inter-harmonics is selected and displayed. • Recorded items for inter-harmonics are set to **[ALL DATA]**.	• The TIMEPLOT interval is set to 2 hours. • During analysis, cursor measurement is performed after setting Tdiv to the minimum value. • The order being checked for harmonics and inter-harmonics is selected and displayed. • Recorded items for inter-harmonics are set to **[ALL DATA]**.

IEC flicker

For IEC 61000-4-30 Plt values, use only the values shown with even numbered 2-hour intervals, and discard the other Plt values. The other Plt values are provided for information only, and are not IEC 61000-4-30 Plt values.

Time clock accuracy

IEC61000-4-30 Class A requires that regardless of the overall time interval, time clock accuracy must be within ±20 ms for 50 Hz and within ±16.7 ms for 60 Hz. When accurate time synchronization using an external signal is not possible, a tolerance of less than ±1 second over 24 hours is permitted, but regardless of the overall time interval, accuracy must be within ±20 ms for 50 Hz and ±16.7 ms for 60 Hz.

By synchronizing the PW3198 with the PW9005 GPS Box, the instrument time can be synchronized to UTC at a high degree of accuracy. In the event that accurate time synchronization using an external signal, such as that provided by the GPS unit, is not possible, the instrument incorporates a clock capable of operating at a real-time accuracy of within ±1 second per day (within the specified operating temperature and humidity range).

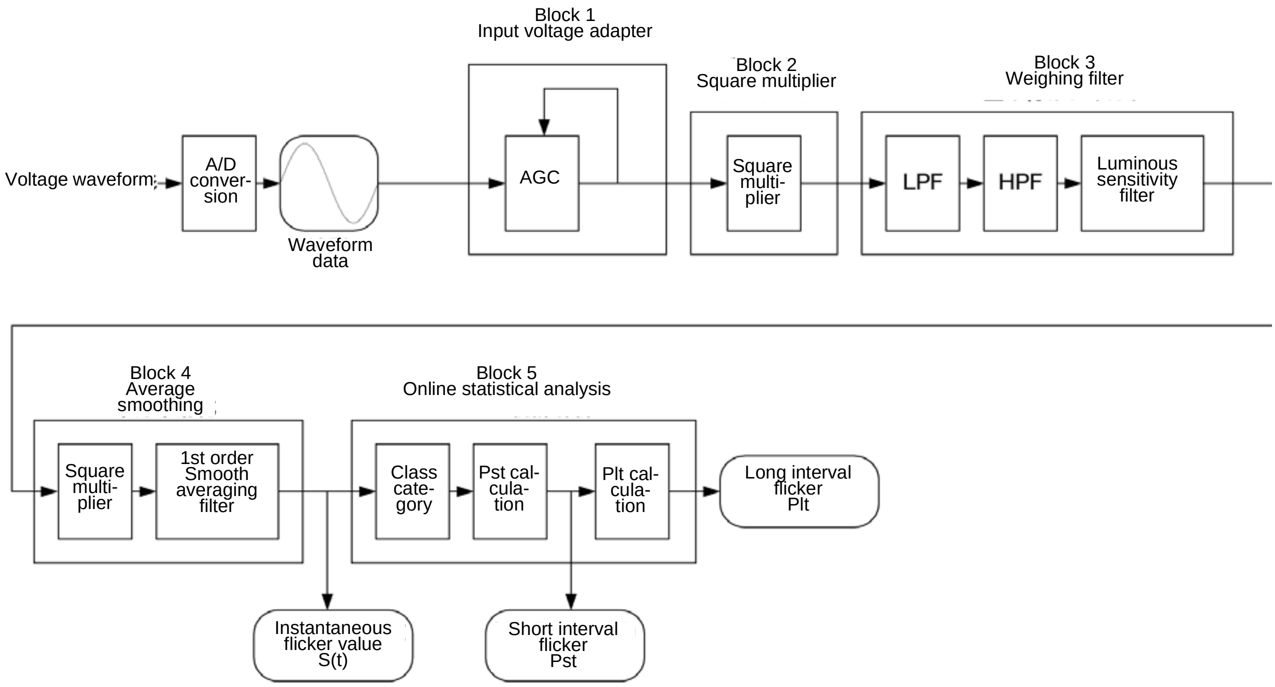
Appendix 5 Detailed Explanation of IEC Flicker and ΔV10 Flicker

To measure the IEC Flicker or ΔV10 Flicker
Flicker calculation and IEC flicker filter settings are configured on the SYSTEM-DF1 [MAIN]-F1 [MEASURE] screen.

See:"5.1 Changing Measurement Conditions" (p.55)

IEC Flicker Meter

The IEC flicker function is based on international standard IEC61000- 4-15, "Flickermeter - Functional and design specifications".



Weighting Filter

You can select a weighted filter for either a 230 V lamp system or a 120 V lamp system.

Statistical Processing

Statistics on flicker are compiled by applying the cumulative probability function (CPF) to 1,024 logarithmic divisions of instantaneous flicker values S(t) in the range from 0.0001 to 10000 P.U. to obtain cumulative probabilities P0.1, P1s, P3s, P10s, and P50s.

Short Interval Flicker Value

Pst

This indicates degree of perceptibility (severity) of flicker measured over a 10-minute period.

Calculation:

$$Pst = \sqrt{0.0314P0.1+0.0525P1s+0.0657P3s+0.28P10s+0.08P50s}$$

P50s = (P30+P50+P80)/3
P10s = (P6+P8+P10+P13+P17)/5
P3s = (P2.2+P3+P4)/3
P1s = (P0.7+P1+P1.5)/3
P0.1 is not smoothed

Long Interval Flicker Value

Plt

Indicates the degree of perceptibility (severity) of flicker determined from successive Pst measurements over a 2-hour period.
To calculate a moving average of Pst, the displayed value is updated every 10 minutes.

Calculation:

$$Plt = \sqrt[3]{\frac{\Sigma(Psti)^3}{N}}$$

ΔV10 Flicker Meter

ΔV10 flicker

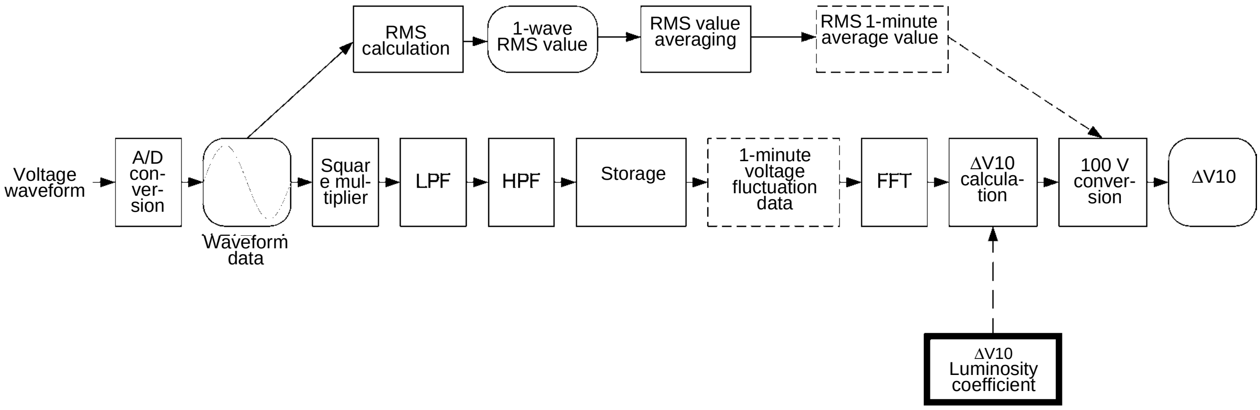
The ΔV10 flicker function is calculated using the "perceived flicker curve" calculation method, which is based on digital Fourier transformation.

Calculation:

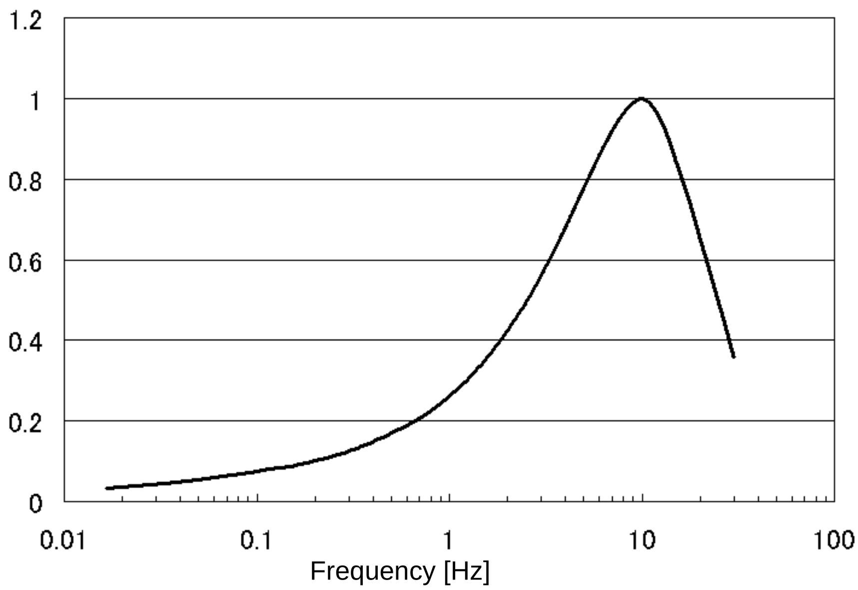
$$\Delta V10 = \sqrt{\sum_{n=1}^{\infty} (a_n \cdot \Delta V_n)^2}$$

ΔV_n : RMS value [V] for voltage fluctuations in frequency fn.
an : Luminosity coefficient for fn where 10 Hz is 1.0.
(0.05Hz to 30Hz)
Evaluation period: for 1 minute

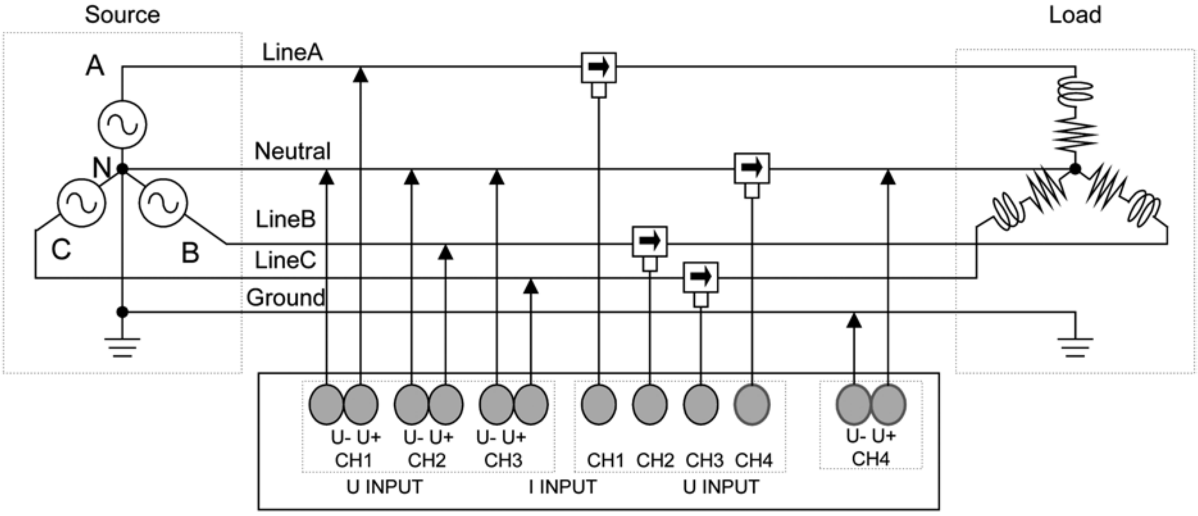
ΔV10 flicker function diagram



V10 Perceived flicker coefficient



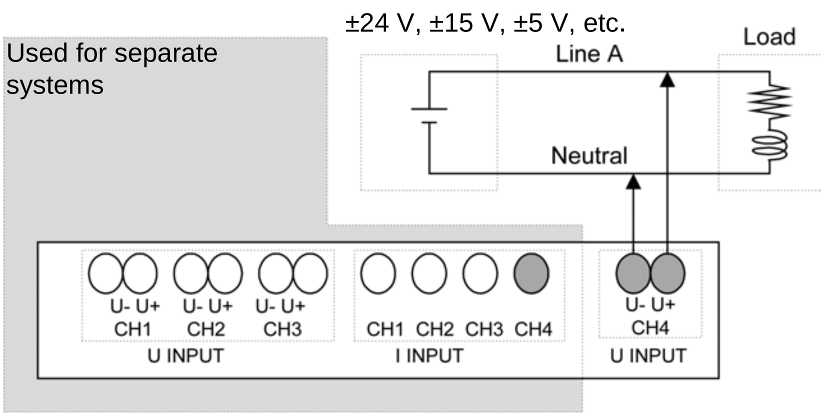
Appendix 6 Making Effective Use of Channel 4



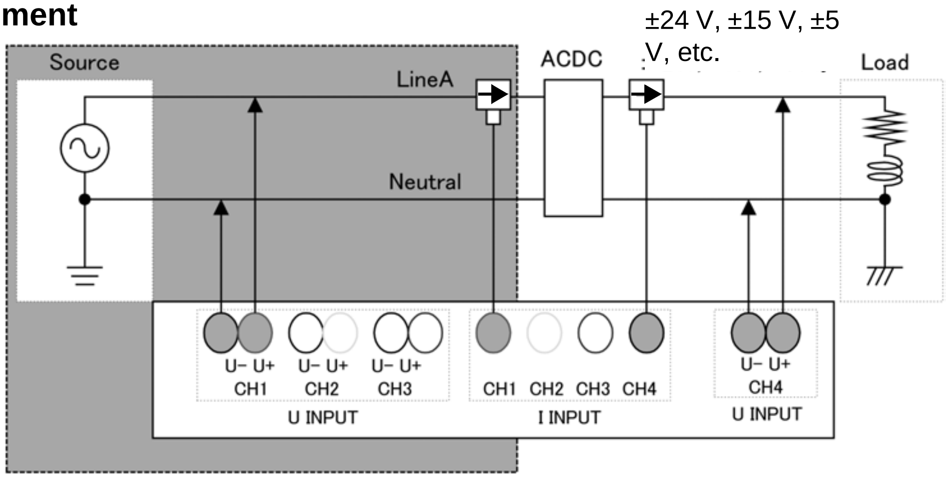
While channel 4 is often used to measure the neutral line of 3-phase 4-wire connections, there are a variety of other uses since it is isolated from the instrument's other channels.

DC power supply measurement

This is an extremely broad range of applications that extends from monitoring DC power supply systems to monitoring hardware internal power supplies. Since events can be detected using DC measured values, it is possible to monitor the AC power supply on channels 1 through 3 when DC power supply disturbances occur.

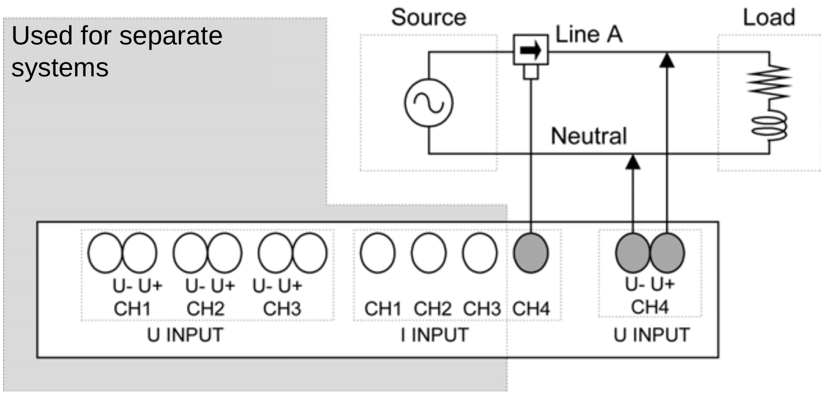


Example of DC power supply measurement

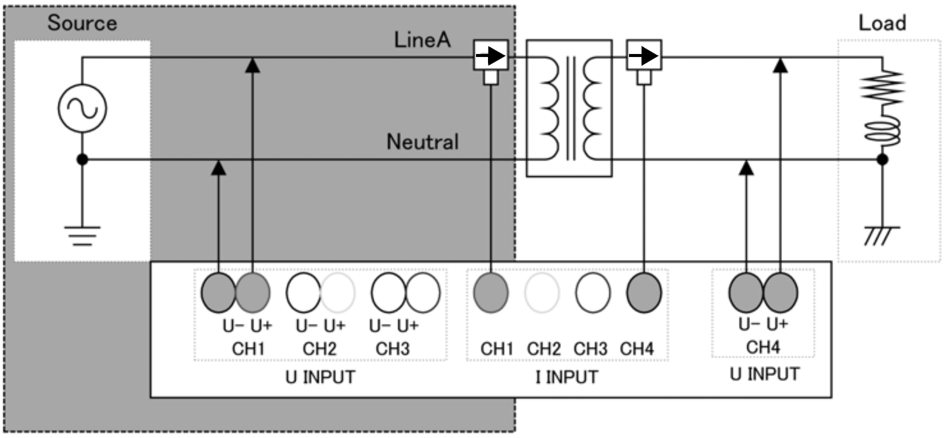


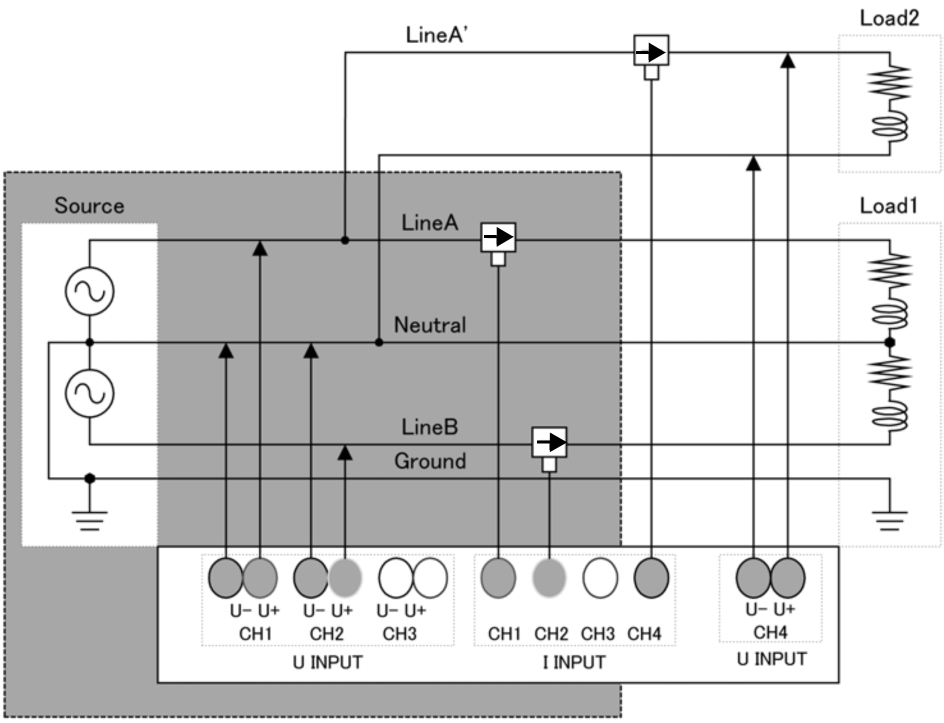
Two-system, two-circuit measurement

Although it is necessary to measure a system synchronized to the reference channel in order to obtain accurate measurements, channel 4 can be used to measure a different system than channels 1 through 3 (other than power elements).

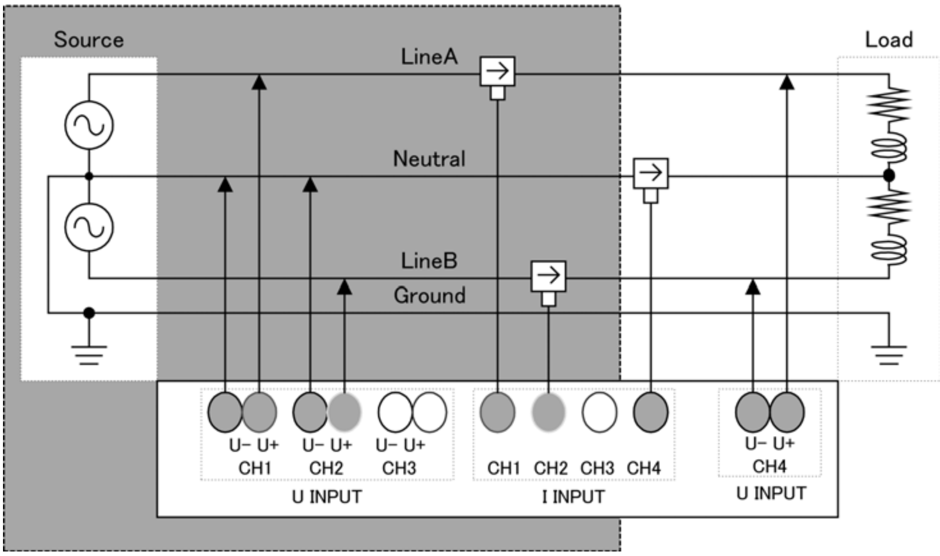


Example of 2-system measurement



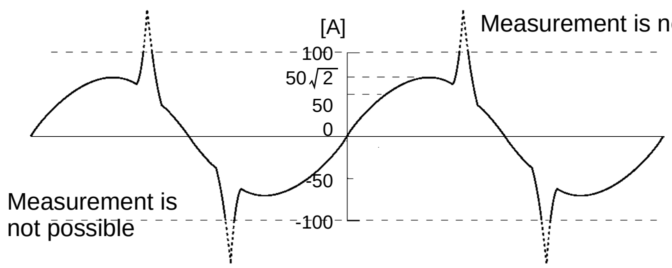


Example of 2-system measurement 2

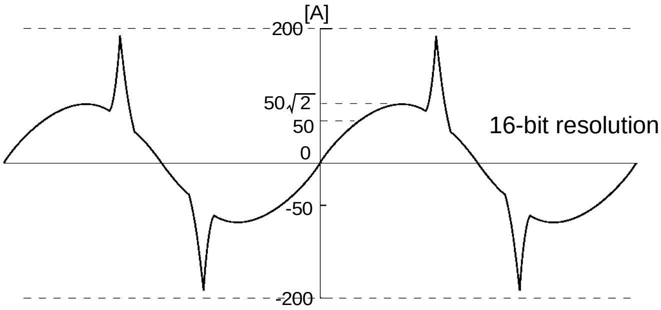
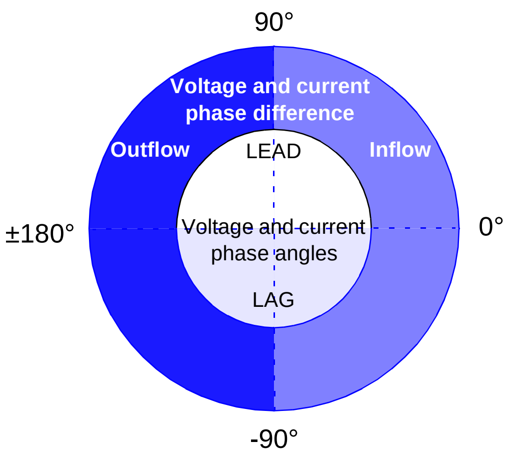


Appendix 7 Terminology

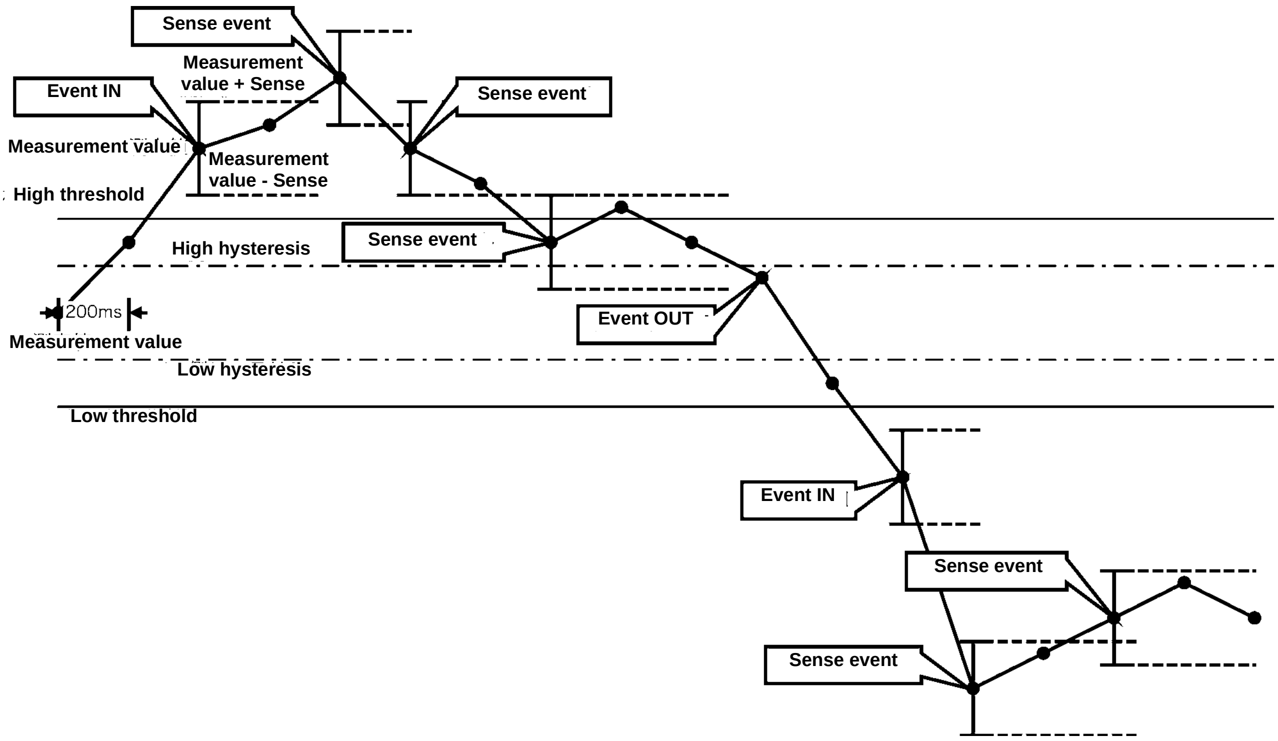
EN50160	A European power supply quality standard that defines limit values for supply voltage and other characteristics. The 9624-50 PQA HiView Pro application can be used with data from the PW3198 to perform standard-compliant evaluation and analysis.
IEC61000-4-7	An international standard governing measurement of harmonic current and harmonic voltage in power supply systems as well as harmonic current emitted by equipment. The standard specifies the performance of a standard instrument.
IEC61000-4-15	A standard that defines testing techniques for voltage fluctuation and flicker measurement as well as associated measuring instrument requirements.
IEC61000-4-30	A standard governing testing involving power quality measurement in AC power supply systems and associated measurement technologies. Target parameters are restricted to phenomena that are propagated in power systems, specifically frequency, supply voltage amplitude (RMS), flicker, supply voltage dips, swells, (momentary) interruptions, transient overvoltages, supply voltage unbalance, harmonics, inter-harmonics, supply voltage carrier signals, and high-speed voltage variations. The standard defines measurement methods for these parameters as well as the necessary instrument performance. It does not define specific thresholds. **Measurement classes** The standard defines three classes (A, S, and B) for various instrument measuring methods and measurement performance levels: <table><tr><td>Class</td><td>Applications</td></tr><tr><td>Class A</td><td>Used in applications where accurate measurement is required, for example verification of standard compliance and dispute settlement. In order to ensure accurate measurement, the standard includes detailed stipulations concerning instrument time clock accuracy, RMS value calculation methods, and TIMEPLOT data grouping.</td></tr><tr><td>Class S</td><td>Used in surveys and power supply quality evaluation.</td></tr><tr><td>Class B</td><td>Used in applications where a high level of accuracy is not required, for example troubleshooting.</td></tr></table>
ITIC curve	A graph created by the Information Technology Industry Council plotting voltage disturbance data for detected events using the event duration and worst value (as a percentage of the nominal input voltage). The graph format makes it easy to quickly identify which event data distribution should be analyzed. The 9624-50 PQA HiView Pro application can be used to create ITIC curves using PW3198 data.
K factor	Shows the power loss caused by the harmonic current in transformers. Also referred to as the "multiplication factor." The K factor (KF) is formulated as shown below: $KF = \dfrac{\sum_{k=1}^{50}\left(k^2 \times I_k^{\,2}\right)}{\sum_{k=1}^{50} I_k^{\,2}}$ k: Order of harmonics Ik: Ratio of the harmonic current to the fundamental wave current [%] Higher-order harmonic currents have a greater influence on the K factor than lower-order harmonic currents. **Purpose of measurement** To measure the K factor in a transformer when subjected to maximum load. If the measured K factor is larger than the multiplication factor of the transformer used, the transformer must be replaced with one with a larger K factor, or the load on the transformer must be reduced. The replacement transformer should have a K factor one rank higher than the measured K factor for the transformer being replaced.

LAN	LAN is the abbreviation of Local Area Network. The LAN was developed as a network for transferring data through a PC within a local area, such as an office, factory, or school. This device comes equipped with the LAN adapter Ethernet 10/100Base-T.Use a twisted-pair cable to connect this device to the hub (central computer) of your LAN. The maximum length of the cable connecting the terminal and the hub is 100 m. Communications using TCP/IP as the LAN interface protocol are supported.
RS-232C	The RS-232C is a serial interface established by the EIA (Electronics Industries Association), and conforms to the specifications for DTE (data terminal equipment) and DCE (data circuit terminating equipment) interface conditions. Using the signal line part of the RS-232C specifications with this unit allows you to use an external printer or GPS box.
SD memory card	A type of flash memory card.
TIME PLOT interval	The recording interval. This setting applies to TIMEPLOT and SD memory card recording.
USB-F (USB function)	An interface for exchanging data with a host controller (typically a computer) connected with a USB cable. For this reason, communication between functions is not possible.
Event	Power supply quality parameters are necessary in order to investigate and analyze power supply issues. These parameters include disturbances such as transients, dips, swells, interruptions, flicker, and frequency fluctuations. As a rule, the term “event" refers to the state detected based on thresholds for which abnormal values and abnormal waveforms for these parameters have been set. Events also include timer and repeat event settings, which are unrelated to power supply quality parameters.
Inter-harmonics	All frequencies that are not a whole-number multiple of the fundamental frequency. Inter-harmonics include intermediate frequencies and inter-order harmonics, and the term refers to RMS values for the spectral components of electrical signals with frequencies between two contiguous harmonic frequencies. (Inter-harmonics of the order 3.5 assume a drive of 90 Hz or similar rather than a frequency synchronized to the fundamental wave of an inverter or other device. However, inter-harmonics do not generally occur in high-voltage circuits under present-day conditions. Most inter-harmonics are currently thought to be caused by the circuit load.)
External event function	Functionality for generating events by detecting a signal input to the instrument's external event input terminal and recording measured values and event waveforms at the time of detection. In this way, events are generated based on an alarm signal from a device other than the PW3198. By inputting an operating signal from an external device, an operation start or stop trigger can be applied in order to record waveforms with the PW3198.
Coordinated universal time (UTC)	The official time used worldwide. Although UTC is almost identical to Greenwich Mean Time (GMT), which is based on astronomical observations, UTC is determined by measuring 1 SI second using an atomic clock. Regular adjustments ensure that GMT and UTC differ by no more than 1 second.
Out of crest factor	The crest factor expresses the size of the dynamic range of input on the measurement device and can be defined with the following expression. Crest factor = crest value (peak value)/RMS value For example, when measuring a distorted wave with a small RMS and a large peak on a measurement device with a small crest factor, because the peak of the distorted wave exceeds the detection range of the input circuit, an RMS or harmonic measurement error occurs.  A measurement device with a small crest factor (When the crest factor is 2 for a 50 A range) When you increase the measurement range, the peak does not exceed the input circuit's detection range, but because the resolution of the RMS decreases, measurement errors may occur. (Continues on next page)

Appendix

Out of crest factor	 Crest factors of the PW3198 (The crest factor of the current input area is 4.) However, when a measurement that exceeds the peak is input, it appears outside the crest factor and you are informed of data that contains measurement errors.
High-order harmonic component	The noise component at and above several kHz. For the PW3198, the term refers to RMS values for the noise component at 2 kHz and above. By measuring the high-order harmonic component, it is possible to monitor harmonic noise at the 50th and higher order emitted by switching power supplies, inverters, LED lighting, and other devices. Recently, increases in the switching frequencies used by switching power supplies and inverters have resulted in the problematic introduction of noise in excess of 10 kHz into power supply lines.
Nominal supply voltage (Uc)	Typically, the system's rated voltage Un. When a voltage that differs from the rated voltage is applied to the contact in accordance with an agreement between the electricity provider and the customer, that voltage is used as the nominal supply voltage Uc. The nominal supply voltage is defined by IEC61000-4-30.
Nominal voltage (Uref)	The same voltage as the nominal supply voltage (Uc) defined by IEC61000-4-30 or the rated voltage (Un). Nominal voltage (Uref) = nominal input voltage (Udin) × VT ratio
Nominal input voltage (Udin)	The value calculated from the nominal supply voltage using the transformer ratio. The nominal input voltage is defined by IEC61000-4-30.
Harmonics	A phenomenon caused by distortions in the voltage and current waveforms that affect many devices with power supplies using semiconductor control devices. In the analysis of non-sine waves, the term refers to one RMS value among the components with harmonic frequencies.
Harmonics phase angle and Phase difference	The harmonic voltage phase angle and harmonic current phase angle are expressed in terms of the synchronized source's fundamental component phase. The difference between each order's harmonic component phase and the fundamental component phase is expressed as an angle (°), and its sign indicates either a lagging phase (negative) or leading phase (positive). The sign is the reverse of the power factor sign. The harmonic voltage-current phase angle expresses the difference between each order's harmonic voltage component phase angle and harmonic current component phase angle for each channel as an angle (°). When using the sum display, the sum of each order's harmonic power factor (calculated from the sums of harmonic power and harmonic reactive power) is converted to an angle (°). When the harmonic voltage-current phase angle is between -90° and +90°, that order's harmonics are flowing toward the load (influx). When the harmonic voltage-current phase angle is between +90° and +180° or between -90° and -180°, that order's harmonics are flowing from the load (outflow).  Harmonic phase angle

Harmonic content percentage	The ratio of the K-order size to the size of the fundamental wave, expressed as a percentage using the following equation: K-order wave / fundamental wave × 100 [%] By observing this value, it is possible to ascertain the harmonic component content for individual orders. This metric provides a useful way to track the harmonic content percentage when monitoring a specific order.
RMS value	The root mean square of instantaneous values for a quantity obtained over a particular time interval or bandwidth.
Frequency cycle (Freq wav or fwav)	The frequency of a single waveform. By measuring the frequency cycle, it is possible to monitor frequency fluctuations on an interconnected system at a high degree of detail.
10-sec frequency (Freq10s or f10s)	The frequency measured value as calculated according to IEC61000-4-30, consisting of a 10-second average of the frequency. It is recommended to measure this characteristic for at least one week.
Interruption	A phenomenon in which the supply of power stops momentarily or for a short or long period of time due to factors such as a circuit breaker tripping as a result of a power company accident or power supply short-circuit.
Swell	A phenomenon in which the voltage rises momentarily due to a lightning strike or the switching of a high-load power line.
Slide reference voltage	The voltage used as the reference for judging voltage dip and swell thresholds. The slide reference voltage is calculated from a 1st-order filter with a time constant of 1 minute relative to RMS values. Although the fixed nominal input voltage value is usually used as the reference voltage, dips and swells can be detected when the voltage value is fluctuating gradually by using the fluctuating voltage value as the reference.
Zero, positive, and negative phases	The positive phase can be considered normal 3-phase power consumption, while the negative phase functions to operate a 3-phase motor backwards. The positive phase causes the motor to operate in the forward direction, while the negative phase act as a break and causes heat to be generated, exerting a negative impact on the motor. Like the negative phase, the zero phase is unnecessary. With a 3-phase 4-wire connection, the zero phase causes current to flow and heat to be generated. Normally, an increase in the negative phase causes an increase of the same magnitude in the zero phase.
Sense	Measured values are continuously compared with the range defined by (the measured value the last time the event occurred + the sense threshold) and (the measured value the last time the event occurred - the sense threshold). When the value falls outside this range, a sense event occurs, and the sense range is updated.



Appendix

Total harmonic distortion factor	THD-F: The ratio of the size of the total harmonic component to the size of the fundamental wave, expressed as a percentage using the following equation: $\frac{\sqrt{\Sigma\,(\text{from 2nd order})^2}}{\text{fundamental wave}} \times 100\ [\%]$ (for the PW3198, calculated to the 50th order) This value can be monitored to assess waveform distortion for each item, providing a yardstick that indicates the extent to which the total harmonic component is distorting the fundamental waveform. As a general rule, the total distortion factor for a high-voltage system should be 5% or less; it may be higher at the terminal point of the system. THD-R: The ratio of the size of the total harmonic component to the size of RMS values, expressed as a percentage using the following equation: $\frac{\sqrt{\Sigma\,(\text{from 2nd order})^2}}{\text{RMS value}} \times 100\ [\%]$ (for the PW3198, calculated to the 50th order) THD-F is typically used.
Measurement frequency (fnom)	The nominal frequency of the system being measured. Select from 50 Hz/60 Hz/400 Hz. (The measurement frequency is automatically set during the quick setup process.)
Timer event function	Functionality for generating events at a set time interval and recording the measured value and event waveform at that time. This function allows you to capture instantaneous waveforms and other data regularly, even if no abnormalities have occurred. Use this functionality when you wish to record a waveform at a fixed time interval.
Multiple-phase system treatment	Method for defining the start and end of events such as dips, swells, and interruptions in multiple-phase systems, for example systems with 3 phases Dip: A dip begins when the voltage of at least one channel is less than or equal to the threshold and ends when voltage readings for all measurement channels exceed (threshold + hysteresis voltage). Swell: A swell begins when the voltage of at least one channel exceeds the threshold and ends when voltage readings for all measurement channels are less than or equal to (threshold + hysteresis voltage). Interruption: An interruption begins when voltage readings for all channels are less than or equal to the threshold and ends when the voltage of a user-specified channel is greater than or equal to (threshold + hysteresis).
Dip	A short-lived voltage drop caused by the occurrence of a inrush current with a large load, such as when a motor starts. When recording voltage and current trends at the power service inlet, you can determine whether you should look for the cause of the dip inside or outside the building. If the voltage drops while the building's current consumption rises, the cause likely lies inside the building. If the voltage and current are both low, the cause is likely to lie outside the building.
Text data	A file containing only data expressed using characters and character codes.
RMS voltage refreshed each half-cycle	The RMS value of one voltage waveform overlapped every half-cycle.
RMS current refreshed each half-cycle	The RMS value of the current waveform every half-cycle.
Inrush current	A large current that flows temporarily, for example when an electric device is turned on. A inrush current can be equal to or greater than 10 times the current that flows when the device is in the normal operating state. Inrush current measurement can be a useful diagnostic when setting circuit breaker capacity.
Transient overvoltage	An event caused by lightning strikes, circuit-breaker and relay contact obstructions and tripping, and other phenomena. Transient overvoltages are often characterized by precipitous voltage variations and a high peak voltage.
Binary data	All data other than text (character) data. Use binary data when analyzing data with the 9624-50 PQA HiView Pro application.
Apparent power	The (vector) power obtained by combining active power and reactive power. As its name suggests, apparent power expresses the “visible" power and comprises the product of the voltage and current RMS values.

<table>
<tr><td>Unbalance factor</td><td>
Balanced (symmetrical) 3-phase voltage (current)
Three-phase AC voltage (current) with equal voltage and current magnitude for each phase and 120 phase separation.
Unbalanced (asymmetrical) 3-phase voltage (current)
Three-phase AC voltage (current) with equal voltage and current magnitude for each phase and 120° phase separation.
Though all of the following descriptions refer to voltage, they apply to current as well.
Degree of unbalance in threephase alternating voltage
Normally described as the voltage unbalance factor, which is the ratio of negative-phase voltage to positive-phase voltage
$$\text{Voltage unbalance factor} = \frac{\text{Negative-phase voltage}}{\text{Positive-phase voltage}} \times 100\ [\%]$$
Zero-phase/positive-phase/negative-phase voltage
The concept of a zero-phase-sequence/positive-phase-sequence/negative-phase- sequence component in a three-phase alternating circuit applies the method of symmetrical coordinates (a method in which a circuit is treated so as to be divided into symmetrical components of a zero phase, positive phase, and negative phase).
• Zero-phase-sequence component: Voltage that is equal in each phase. Described as V_0. (Subscript 0: Zero-phase-sequence component)
• Positive-phase-sequence component: Symmetrical three-phase voltage in which the value for each phase is equal, and each of the phases is delayed by 120 degrees in the phase sequence a->b->c. Described as V_1.(Subscript 1: Positive-phase-sequence component)
• Negative-phase-sequence component: Symmetrical three-phase voltage in which the value for each phase is equal, and each of the phases is delayed by 120 degrees in the phase sequence a->c->b. Described as V_2. (Subscript 2: Negative-phase-sequence component)
If Va, Vb, and Vc are given as the three-phase alternating voltage, the zero-phase voltage, positive-phase voltage, and negative voltage are formulated as shown below.
$$\text{Zero-phase voltage } \dot{V}_0 = \frac{\dot{V}a+\dot{V}b+\dot{V}c}{3}$$
$$\text{Positive-phase voltage } \dot{V}_1 = \frac{\dot{V}a+a\dot{V}b+a^2\dot{V}c}{3}$$
$$\text{Negative-phase voltage } \dot{V}_2 = \frac{\dot{V}a+a^2\dot{V}b+a\dot{V}c}{3}$$
a is referred to as the “vector operator.” It is a vector with a magnitude of 1 and a phase angle of 120 degrees. Therefore, the phase angle is advanced by 120 degrees if multiplied by a, and by 240 degrees if multiplied by a^2. If the three-phase alternating voltage is balanced, the zero-phase voltage and negative-phase voltage are 0, and only positive phase voltage, which is equal to the effective value of the three-phase alternating voltage, is described.
Unbalance factor of three-phase current
Used in applications such as the verification of power supplied to electrical equipment powered by a 3-phase induction motor.
The current unbalance factor is several times larger than the voltage unbalance factor. The less a three-phase induction motor slips, the greater the difference between these two factors. Voltage unbalance causes such phenomena as current unbalance, an increase in temperature, an increase in input, a decline in efficiency, and an increase in vibration and noise.
Uunb must not exceed 2%, and Iunb must be 10% or less. In a 3P4W system with an unbalanced load, the Uunb0 and Inub0 components indicate the current that flows to the N (neutral) line.
</td></tr>
<tr><td>Flag</td><td>A marker used to distinguish unreliable measured values occurring due to disturbances such as dips, swells, and interruptions. Flags are recorded as part of the TIMEPLOT data status information. The concept is defined by the IEC61000-4-30 standard.</td></tr>
<tr><td>Flicker</td><td>A disturbance caused by a voltage drop resulting when equipment with a large load starts up or when a large current flows under a temporary high-load state. For lighting loads, flicker primarily manifests itself as blinking. Electric-discharge lamps such as fluorescent and mercury-vapor lights are particularly prone to the effects of flicker.
When temporary dimming of lights due to voltage drops occurs frequently, it produces a flickering effect (caused by repeated dimming) that produces an extremely unpleasant visual sensation.
Measurement methods can be broadly divided into IEC flicker and XXV10 flicker. In Japan, the ΔV10 method is most frequently used.</td></tr>
</table>

Manual event function	Functionality for generating events when the MANU EVENT key is pressed and recording the measured value and event waveform at that time. In this way, events can be generated as a snapshot of the system being measured. Use this functionality when you wish to record a waveform but cannot find another event that defines the desired phenomenon or when you wish to record data manually to avoid the generation of too many events.
Reactive power	Power that does not perform actual work, resulting in power consumption as it travels between the load and the power supply. Reactive power is calculated by multiplying the active power by the sine of the phase difference (sin θ). It arises from inductive loads (deriving from inductance) and capacitive loads (deriving from capacitance), with reactive power derived from inductive loads known as lag reactive power and reactive power derived from capacitive loads known as lead reactive power.
Reactive power demand	The average reactive power used during a set period of time (usually 30 minutes).
Active power	Power that is consumed doing work.
Active power demand	The average active power used during a set period of time (usually 30 minutes).
Power factor (PF/DPF)	Power factor is the ratio of effective power to apparent power. The larger the absolute value of the power factor, the greater the proportion of effective power, which provides the power that is consumed, and the greater the efficiency. The maximum absolute value is 1. Conversely, the smaller the absolute value of the power factor, the greater the proportion of reactive power, which is not consumed, and the lower the efficiency. The minimum absolute value is 0. For this device, the sign of the power factor indicates whether the current phase is lagging or leading the voltage. A positive value (no sign) indicates that the current phase is lagging the voltage. Inductive loads (such as motors) are characterized by lagging phase. A negative value indicates that the current phase is leading the voltage. Capacitive loads (such as capacitors) are characterized by leading phase. The power factor (PF) is calculated using rms values that include harmonic components. Larger harmonic current components cause the power factor to deteriorate. By contrast, since the displacement power factor (DPF) calculates the ratio of effective power to apparent power from the fundamental voltage and fundamental current, no voltage or current harmonic component is included. This is the same measurement method used by reactive power meters installed at commercial-scale utility customers' facilities. Displacement power factor, or DPF, is typically used by the electric power system, although power factor, or PF, is sometimes used to measure equipment in order to evaluate efficiency. When a lagging phase caused by a large inductive load such as a motor results in a low displacement power factor, there are corrective measures that can be taken to improve the power factor, for example by adding a phase advance capacitor to the power system. Displacement power factor (DPF) measurements can be taken under such circumstances to verify the improvement made by the phase advance capacitor.
Continuous event function	Functionality for automatically generating the set number of events in succession every time a target event occurs. Events after the initial event are recorded as continuous events. This functionality allows an instantaneous waveform of up to 1 s in duration to be recorded after the event occurs. However, continuous events are not generated when an event occurs while continuous events are occurring. Additionally, continuous event generation stops when measurement is stopped. Use this function when you wish to observe a waveform at the instant an event occurs as well as subsequent changes in the instantaneous waveform. For the PW3198, a waveform of up to 1 s in duration will be recorded.

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Warranty Certificate

HIOKI

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

Customer name: ____________________

Customer address: ____________________

Important

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

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

Warranty terms

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

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