PW8001

HIOKI

PW8001-01	PW8001-11
PW8001-02	PW8001-12
PW8001-03	PW8001-13
PW8001-04	PW8001-14
PW8001-05	PW8001-15
PW8001-06	PW8001-16

Instruction Manual

POWER ANALYZER
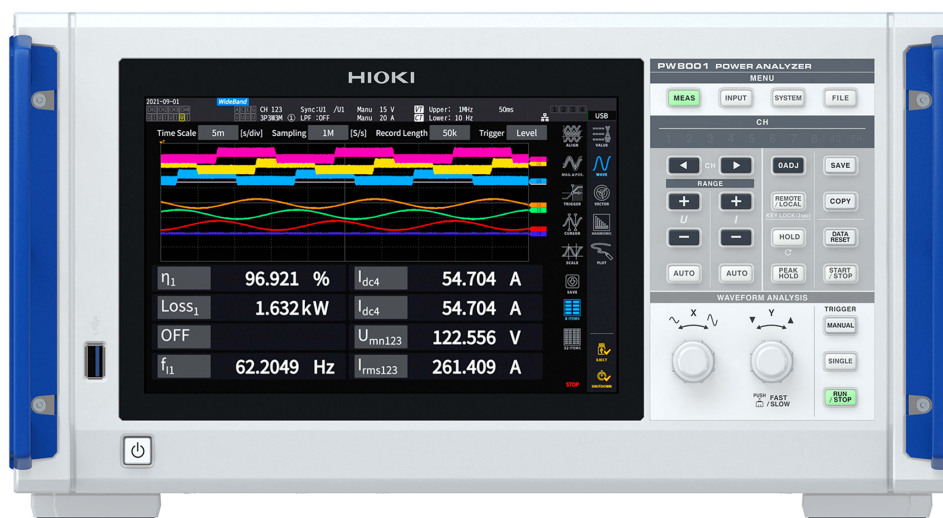
The latest edition of the instruction manual

Read carefully before use.
Keep for future reference.

EN

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Contents

1
2
3
4
5
6
7
8
9
10
11

Index

Contents

1
2
3
4
5
6
7
8
9
10
11

Index

10 Specifications 249

11 Maintenance and Service 309

Index 333

Warranty Certificate

Introduction

Thank you for choosing the Hioki PW8001 Power Analyzer. To ensure your ability to get the most out of this instrument over the long term, please read this manual carefully and keep it available for future reference.

The latest edition of the instruction manual

The contents of this manual are subject to change, for example as a result of product improvements or changes to specifications.
The latest edition can be downloaded from Hioki's website.
https://www.hioki.com/global/support/download/

Product registration

Register your product in order to receive important product information.
https://www.hioki.com/global/support/myhioki/registration/

Refer to the following instruction manuals in accordance with your application.

Name of the instruction manual	Description	Format
Operating Precautions	Information for using the instrument safely. Please review the separate "Operating Precautions" before using the instrument.	Hard copy
Instruction Manual (this manual)	Includes basic operation methods, specifications, function descriptions, and related topics for the instrument.	Hard copy, PDF file (for web download)
Communications Command Instruction Manual	Includes information about the communications commands used to control the instrument.	PDF file (for web download)
GENNECT One User's manual	Includes information about how to install and use the PC application, as well as its operation methods, specifications, and related topics.	PDF file (included on CD, for web download)
Modbus/TCP Communications Instruction Manual	Includes information about communications commands according to Modbus/TCP to control the instrument.	PDF file (for web download)
Data Receiver User's Manual	Includes information about installing and using the PC application and specifications.	PDF file (for web download)
Matlab Toolkit User's Manual	Includes information using the MATLAB toolkit to load waveform binary data recorded with this instrument as MATLAB array data and controlling the instrument connected via Ethernet on MATLAB.	PDF file (for web download)
LabVIEW Driver	Includes information about controlling the instrument and acquiring measured data using the LabVIEW driver.	PDF file (for web download)

Target audience

This manual has been written for use by individuals who use the product or provide information about how to use the product. In explaining how to use the product, it assumes electrical knowledge (equivalent of the knowledge possessed by a graduate of an electrical program at a technical high school).

Trademarks

Windows and Microsoft Edge are either registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.

Font on the screen

DynaFont is a registered trademark of DynaComware Taiwan Inc.

Checking Package Contents

When you receive the instrument, inspect it to ensure that no damage occurred during shipment. Pay particular attention to included accessories, panel keys and switches, and terminals. If you find any damage or discover that the instrument does not perform as indicated in its specifications, please contact your authorized Hioki distributor or reseller.

Confirm the package contents.

☐ PW8001 Power Analyzer

Right side

Model name
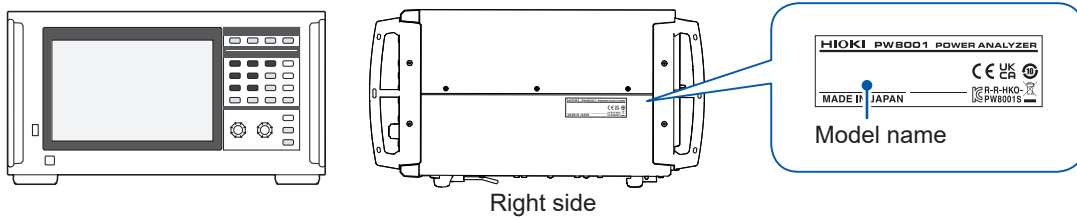
✓: Function available. –: Function not available.

Product name (order code)	Optional feature (additional function)			
	Motor analysis	Waveform and D/A output	CAN/CAN FD interface	Optical link interface
PW8001-01	–	–	–	–
PW8001-02	–	✓	–	–
PW8001-03	–	–	✓	–
PW8001-04	–	–	–	✓
PW8001-05	–	✓	–	✓
PW8001-06	–	–	✓	✓
PW8001-11	✓	–	–	–
PW8001-12	✓	✓	–	–
PW8001-13	✓	–	✓	–
PW8001-14	✓	–	–	✓
PW8001-15	✓	✓	–	✓
PW8001-16	✓	–	✓	✓

The models listed above are equipped with the U7001 2.5MS/s Input Unit and the U7005 15MS/s Input Unit.

Accessories

☐ Power cord

☐ Operating Precautions (0990A903)

☐ Instruction Manual (this manual)

☐ GENNECT One (PC application) CD

☐ D-sub 25-pin connector (PW8001-02, PW8001-05, PW8001-12, and PW8001-15 only)

Options (Sold Separately)

The options listed below are available for the instrument. To order an option, please contact your authorized Hioki distributor or reseller. Options are subject to change. Check Hioki's website for the latest information.

Factory default options

Input modules

U7001 2.5MS/s Input Unit
U7005 15MS/s Input Unit

Optional products that can be specified with the product model number (PW8001-xx)

Motor analysis option	
Waveform and D/A output option	(Cannot be installed in combination with the CAN/CAN FD interface.)
CAN/CAN FD interface option	(Cannot be installed in combination with the Waveform and D/A output option.)
Optical link interface option	

Optional products for voltage measurement

Safety banana plugs (ø4 mm) can be connected to the voltage input terminals of the instrument. Prepare voltage cords appropriate to your applications.

Product name		Maximum rated voltage and current	Cable length (approx.)	Remarks	
L1025	Voltage Cord	CAT II 1500 V DC 1000 V AC, 1 A CAT III 1000 V, 1 A	3 m	Banana plug-banana plug (red, black ×1 each) (alligator clips included)	
L9438-50	Voltage Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	3 m	Banana plug-banana plug (red, black ×1 each) (alligator clips included)	
L1000	Voltage Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	3 m	Banana plug-banana plug (red, yellow, blue, gray ×1 each; black ×4) (alligator clips included)	
L9257	Connection Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	1.2 m	Banana plug-banana plug (red and black, ×1 each) (alligator clips included)	
L1021-01	Patch Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	0.5 m	For distributing voltage input Stackable banana plug– banana plug (red ×1)	
L1021-02	Patch Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	0.5 m	For distributing voltage input Banana plug-banana plug (black ×1)	
L9243	Grabber Clip	CAT II 1000 V, 1 A	–	Red, black ×1 each	
L4940	Connection Cable Set	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	1.5 m	Banana plug-banana plug (red and black, ×1 each) (No alligator clips)	
L4935	Alligator Clip Set	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	–	Red, black ×1 each	
VT1005	AC/DC High Voltage Divider	5000 V, ±7100 V peak CAT III 1500 V CAT II 2000 V	–	For measuring voltage of 1000 V or more	

Optional products for current measurement

For details, refer to the instruction manual that came with the current sensor.

✓: Available. –: Not available

Current sensor type	Auto-recognition function	Model name	Maximum rated current (rms)	Frequency characteristics	Basic accuracy (amplitude)	Measurable conductor diameter	Number of channels, approximate cable length	Operating temperature range
Ultra high accuracy, direct connection	✓	PW9100A-3	50 A	DC to 3.5 MHz	±0.02% rdg ±0.005% f.s.	Measurement terminals M6 screw	3 channels	0°C to 40°C
	–	PW9100-03						
	✓	PW9100A-4					4 channels	
	–	PW9100-04						
Ultra high accuracy, pass-through	✓	CT6904A	500 A	DC to 4 MHz	±0.02% rdg ±0.007% f.s.	ø 32 mm	3 m	−10°C to 50°C
	–	CT6904		DC to 4 MHz				
	✓	CT6904A-1		DC to 2 MHz			10 m	
	✓	CT6904A-2	800 A	DC to 4 MHz	±0.025% rdg ±0.009% f.s.		3 m	
	✓	CT6904A-3		DC to 2 MHz			10 m	
High accuracy, pass-through	–	CT6862-05	50 A	DC to 1 MHz	±0.05% rdg ±0.01% f.s.	ø 24 mm	3 m	−30°C to 85°C
	✓	CT6872		DC to 10 MHz	±0.03% rdg ±0.007% f.s.			−40°C to 85°C
	✓	CT6872-01					10 m	
	–	CT6863-05	200 A	DC to 500 kHz	±0.05% rdg ±0.01% f.s.		3 m	−30°C to 85°C
	✓	CT6873		DC to 10 MHz	±0.03% rdg ±0.007% f.s.			
	✓	CT6873-01					10 m	
	✓	CT6875A	500 A	DC to 2 MHz	±0.04% rdg ±0.008% f.s.	ø 36 mm	3 m	−40°C to 85°C
	–	CT6875						
	✓	CT6875A-1					10 m	
	✓	CT6876A	1000 A	DC to 1.5 MHz			3 m	
	–	CT6876						
	✓	CT6876A-1		DC to 1.2 MHz			10 m	
	✓	CT6877A	2000 A	DC to 1 MHz		ø 80 mm	3 m	
	–	CT6877						
	✓	CT6877A-1					10 m	
High accuracy, clamp	✓	CT6841A	20 A	DC to 2 MHz	±0.2% rdg ±0.01% f.s.	ø 20 mm	3 m	−40°C to 85°C
	–	CT6841-05		DC to 1 MHz	±0.3% rdg ±0.01% f.s.			
	✓	CT6843A	200 A	DC to 700 kHz	±0.2% rdg ±0.01% f.s.			
	–	CT6843-05		DC to 500 kHz	±0.3% rdg ±0.01% f.s.			
	✓	CT6844A	500 A	DC to 500 kHz	±0.2% rdg ±0.01% f.s.			
	–	CT6844-05		DC to 200 kHz	±0.3% rdg ±0.01% f.s.			
	✓	CT6845A		DC to 200 kHz	±0.2% rdg ±0.01% f.s.	ø 50 mm		
	–	CT6845-05		DC to 100 kHz	±0.3% rdg ±0.01% f.s.			
	✓	CT6846A	1000 A	DC to 100 kHz	±0.2% rdg ±0.01% f.s.			
	–	CT6846-05		DC to 20 kHz	±0.3% rdg ±0.01% f.s.			
General purpose clamp*	–	9272-05	20 A 200 A	1 Hz to 100 kHz	±0.3% rdg ±0.01% f.s.	ø 46 mm	3 m	0°C to 50°C

*: For measuring commercial-power frequency band

Connection cables

Product name		Cable length (approx.)	Remarks	
L9217	Connection Cord	1.7 m	CAT II 600 V, 0.2 A CAT III 300 V, 0.2 A For motor analysis input, insulated BNC	
9642	LAN Cable	5 m	CAT5e, cross-conversion connector included	
9637	RS-232C Cable (9 pins-9 pins, 1.8 m)	1.8 m	9 pins-9 pins, cross cable	
9151-02	GP-IB Connector Cable	2 m	–	
9444	Connection Cable	1.5 m	For external control 9 pins-to-9 pins, straight cable	
L6000	Optical Connection Cable	10 m	Equivalent of 50 μm/125 μm multi-mode fiber	
9165	Connection Cord	1.5 m	For BNC synchronization Metallic BNC–to-metallic BNC	
9713-01	CAN Cable	2 m	One end not terminated	

Other optional products

The below-listed products are manufactured on a per-order basis.

Product name		Cable length (approx.)	Remarks	
C8001	Carrying Case	–	Hard trunk type Equipped with casters	
Z5300	Rackmount Fittings	–	EIA-compliant	
Z5301	Rackmount Fittings	–	JIS-compliant	
Z5200	BNC Terminal Box	–	D-sub 25 pins–to-BNC (female) 20-channel conversion box	
PW9100A-3	AC/DC Current Box	–	3 channels Rated current: 5 A	
PW9100A-4	AC/DC Current Box	–	4 channels Rated current: 5 A	
CT6904A-1	AC/DC Current Sensor	10 m	500 A rated output cable	
CT6904A-2	AC/DC Current Sensor	3 m	800 A rated output cable	
CT6904A-3	AC/DC Current Sensor	10 m	800 A rated output cable	
L3000	D/A Output Cable	2.5 m	D-sub 25 pins–to-BNC (male) 20-channel conversion cable	

Symbols and Abbreviations

Safety

In this manual, the risk seriousness and the hazard levels are classified as follows.

⚠ **DANGER**	Indicates an imminently hazardous situation that, if not avoided, will result in serious injury or death.
⚠ **WARNING**	Indicates a potentially hazardous situation that, if not avoided, could result in serious injury or death.
⚠ **CAUTION**	Indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury or potential risks of damage to the supported product (or to other property).
IMPORTANT	Indicates information or content that is particularly important from the standpoint of operating or maintaining the instrument.
⚠	Indicates a high-voltage hazard. Failure to verify safety or improper handling of the instrument could lead to an electric shock, burn, or death.
🚫	Indicates an action that must not be performed.
❗	Indicates an action that must be performed.

Symbols on the product

⚠	Indicates the presence of a potential hazard. For more information about locations where this symbol appears on instrument components, see "Precautions for Use" (p. 10) and warning messages listed at the beginning of operating instructions. In addition, see the accompanying document entitled "Operating Precautions."
⏻	Indicates the power push-button switch that toggles the instrument between on and off.
⏚	Indicates a grounding terminal.
⎓	Indicates direct current (DC).
∿	Indicates alternating current (AC).

Symbols for various standards

🗑	Indicates that the product is subject to the Waste Electrical and Electronic Equipment (WEEE) Directive in EU member nations. Dispose of the product in accordance with local regulations.
CE	Indicates that the product complies with standards imposed by EU directives.

7

Others

(Tips)	Indicates useful advice concerning instrument performance and operation.
*	Indicates additional information is provided below.
(p.)	Indicates the page number to refer to.
START (Bold letters)	Indicates the names of the control keys.
[ ]	Indicates the names of user interface elements on the screen.
Windows	Unless otherwise noted, the term *Windows* is used generically to refer to *Windows 10*.
Current sensor	Sensors for measuring currents are collectively referred to as *current sensors*.
S/s	For this product, the number of times the analog input signal is digitized is indicated in samples per second (S/s). Example: 20 MS/s (20 megasamples per second) signifies 20×10^{6} samples per second.

In this document, the terms "master" and "subordinate/slave" used in the earlier editions have been replaced with "primary" and "secondary," respectively.

Accuracy labeling

The instrument accuracy is expressed by defining a percentage of the reading, a percentage of the range, a percentage of the full scale, a percentage of the setting, or a limit value for errors in terms of digits.

% of reading	**Reading (display value)** Indicates the value displayed by the instrument. Limit values for reading errors are expressed as a percentage of the reading ("% rdg").
% of range	**Range** Indicates the measurement range of the instrument. Limit values for range errors are expressed as a percentage of the range ("% rng").
f.s.	**Full scale (rated current)** For this instrument, this mainly indicates the rated current of the current sensor. Limit values for full-scale errors are expressed as a percentage of the full scale ("% f.s.").
digits	**Digit (resolution)** Indicates the minimum display unit (in other words, the smallest digit that can have a value of 1) for a digital measuring instrument. Limit values for digit errors are expressed using digits.

Safety Information

Please review the safety information below before using the instrument. Read this manual carefully and ensure you understand its contents before using the instrument. Improper use of the instrument could result in serious bodily injury or damage to the instrument.

Measurement categories

IEC 61010 defines measurement categories to facilitate safe use of measuring instruments. Test and measurement circuits designed to be connected to a main power supply circuit are classified into three categories depending on the type of main power supply circuit. A measuring instrument that does not have a measurement category cannot be used to measure a main power supply circuit.

⚠ DANGER

■ **Do not use a measuring instrument to measure a main power supply circuit whose category exceeds the instrument's rated measurement category.**

■ **Do not use a measuring instrument that does not have a rated measurement category to measure a main power supply circuit.**

Doing so may result in serious bodily injury or damage to the instrument or other equipment.

No measurement category (O)	Applicable to the measurement of other circuits that are not directly connected to the main power supply. EXAMPLE: Measurement on the secondary-side equipment from the socket outlet of fixed installation through a transformer, etc.
Measurement category II (CAT II)	Applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of a low-voltage MAINS installation. EXAMPLE: Measurements on household appliances, portable tools, and similar equipment, and on the consumer side only of socket outlets in the fixed installation.
Measurement category III (CAT III)	Applicable to test and measuring circuits connected to the distribution part of the a building's low-voltage MAINS installation. Example: Measurements on distribution boards (including secondary meters), photovoltaic panels, circuit breakers, wiring, including cables, bus-bars, junction boxes, switches, and socket outlets in a fixed installation, as well as equipment for industrial use and some other equipment such as stationary motors with permanent connection to the fixed installation.
Measurement category IV (CAT IV)	Applicable to test and measuring circuits connected at the source of the a building's low-voltage MAINS installation. Example: Measurements on devices installed before the main fuse or circuit breaker in the building installation.
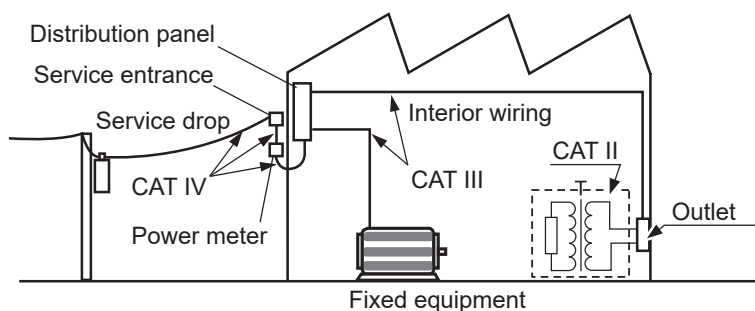
Precautions for Use

Be sure to follow the precautions listed below in order to use the instrument safely and in a manner that allows it to function effectively.

Use of the instrument should conform not only to its specifications, but also to the specifications of all accessories, options, and other equipment in use.

Installing the instrument

⚠WARNING

■ **Do not install the instrument in locations such as the following:**

- In locations where it would be subject to direct sunlight or high temperatures
- In locations where it would be exposed to corrosive or explosive gases
- In locations where it would be exposed to powerful electromagnetic radiation or close to objects carrying an electric charge
- In locations close to inductive heating devices (high-frequency inductive heating devices, IH cooktops, etc.)
- In locations characterized by a large amount of mechanical vibration
- In locations where it would be exposed to water, oil, chemicals, or solvents
- In locations where it would be exposed to high humidity or condensation
- In locations with an excessive amount of dust

  Doing so could damage the instrument or cause it to malfunction, resulting in bodily injury.

⚠CAUTION

■ **Do not place the instrument on an unstable stand or angled surface.**

Doing so could cause the instrument to fall or overturn, resulting in bodily injury or damage to the instrument.

- Leave at least 30 mm of space on every surface other than the underside to keep the instrument's temperature from rising.
- Leave at least 15 mm of space underneath the installation surface (the height of its feet).
- Place with its bottom side facing downward.
- Do not block vent openings.

30 mm or longer   30 mm or longer
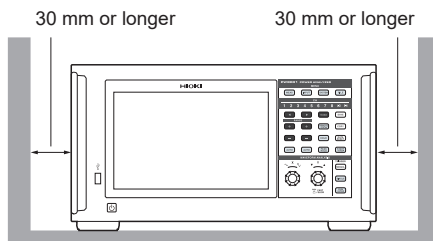
Handling the instrument

⚠DANGER

■ **Never remove the top cover.**

The internal components of the instrument carry high voltages and may become very hot during operation. Touching them could cause burns or electric shock.

⚠WARNING

■ **Do not use cables whose insulation is damaged or whose metal portion is exposed.**

Doing so could result in serious bodily injury.

■ **If smoke, abnormal sounds, strange odor, or other abnormalities occur, immediately turn off the instrument, unplug the power cord from the outlet, and remove measurement leads and sensors.**

Failure to do so could result in serious bodily injury or fire.
See "11.2 Troubleshooting" (p. 312) and "11.3 Messages" (p. 315) before contacting your authorized Hioki distributor or reseller.

⚠CAUTION

■ **Do not route cords between other objects or step on them.**

■ **Do not bend or pull on cables where they connect.**

Doing so could break cables.

The instrument is classified as a Class A device under the EN 61326 standard. Use of the instrument in a residential setting such as a neighborhood could interfere with reception of radio and television broadcasts. If you encounter this issue, take steps as appropriate to address it.

Cautions for measurement

⚠DANGER

■ **Do not use the instrument to measure circuits that exceed the ratings or specifications of the instrument.**

Doing so could cause damage to the instrument or overheating, resulting in serious bodily injury.
See "10.2 Specifications of Input, Output, and Measurement" (p. 250), "10.6 U7001 2.5MS/s Input Unit" (p. 299), and "10.7 U7005 15MS/s Input Unit" (p. 304).

⚠WARNING

■ **Do not touch any conducting wire to be measured.**

A conducting wire to be measured may be hot. There is a risk of the operator being burned.

⚠CAUTION

■ **Do not input voltage or current to the input terminal when the instrument has been turned off.**

Doing so could damage the instrument.

11

Cautions for transporting the instrument

⚠**CAUTION**

🚫	■ **Do not subject the instrument to vibration or mechanical shock while transporting or handling it.** ■ **Do not drop the instrument.** Doing so could damage the instrument.
❗	■ **Working with at least one other person, shift the product using the left and right handles.** ■ **Follow your company's safety guidelines (by using anti-slip gloves, safety boots, etc.).** Failure to do so could result in bodily injury.

When carrying the instrument, remove the cables and the USB flash drive and hold the handles.

Shipping Precautions

- When shipping the instrument, use the box and packaging materials in which it was originally shipped. However, do not use the original box and packaging if they are damaged. If you are unable to use the original box and packaging, contact your authorized Hioki distributor or reseller. You will be sent a suitable box and packaging material.
- When packing the instrument, disconnect test leads and a USB flash drive.
- When transporting the instrument, exercise care to avoid dropping it or otherwise subjecting it to rough handling.

Precautions related to disc usage

- Exercise care to keep the recording surface of the disc free of dirt and damage. If you need to label the disc, for example with text, use a marker with a soft tip.
- Store discs in protective cases. Avoid exposing the disc to direct sunlight, high temperatures, or high humidity.
- Hioki is not liable for any computer system issues that arise in connection with the use of this disc.

Measurement Procedure

The basic measurement procedure with the instrument is as follows.

1 **Inspect the instrument before use**

"2.1 Inspecting the Instrument before Use" (p. 34)

2 **Prepare for measurement**

"2.2 Connecting the Voltage Cords (Voltage Input)" (p. 35)
"2.3 Connecting the Current Sensors (Current Input)" (p. 36)
"2.4 Supplying Power to the Instrument" (p. 41)
For high-precision measurement, allow the instrument to warm up for 30 minutes or more after turning on the instrument before performing the zero adjustment.

3 **Set wiring modes and configure current sensor settings**

"2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43)

4 **Configuring Simple Setup (Quick Set)**

"2.6 Simple Configuration (Quick Set)" (p. 47)

5 **Perform the zero adjustment.**

"2.8 Zero Adjustment and Degaussing (Demagnetization)" (p. 50)
Always perform zero adjustment before connecting measurement leads and sensors.

6 **Connect measurement leads and sensors to lines to be measured.**

"2.9 Connecting Measurement Leads and Sensors to Lines to Be Measured" (p. 51)

7 **Verify proper connection.**

"2.10 Checking Connections" (p. 53)

8 **View the measured values and waveforms**

"3 Displaying Power Numerically" (p. 55)
"4 Displaying Waveforms" (p. 115)

Starting/stopping
the integration

START
/ STOP

Displaying
the waveforms

RUN
/ STOP

9 **Saving data**

"7 Saving Data and Managing Files" (p. 157)

10 **Analyze the data**

"8 Connecting External Devices" (p. 189)
"9.1 Connecting and Setting the LAN Interface" (p. 220)
"9.9 GENNECT One (PC Application Software)" (p. 245)

11 **Finish the measurement**

14

1 Overview

1.1 Product Overview

This instrument is a power analyzer that can analyze the power conversion efficiency by simultaneously measuring the input and output powers of an object under measurement. The instrument can include up to eight input modules and support various lines to be measured according to your applications by combining wiring configurations from single-phase to three-phase four-wire configurations as desired.

1.2 Features

● **Up to eight modules can be included**

By combining two types of input modules with one to eight channels as desired, the measurement system most suitable for your applications can be configured in a single instrument.

● **Combination of the two types of input modules enables the configuration of the most suitable system**

Two types of input modules are available: a general-purpose input module with high withstand voltage, the U7001, and an input module with world-class accuracy of ±0.03% and world-class high resolution and high-speed sampling, the U7005.
According to the performance you need, the two types of input modules can be combined and installed on the PW8001.

U7001 (p. 299)
Measurement for CAT II at 1500 V is now possible during the development, evaluation, and delivery inspection of power conditioners.

Power measurement basic accuracy ±0.07%

U7005 (p. 304)
Efficiency of SiC/GaN inverters and loss of reactors and transformers can be measured with high accuracy.

Power measurement basic accuracy ±0.03% (DC accuracy ±0.05%)

Sampling frequency	2.5 MHz	15 MHz
ADC resolution	16-bit	18-bit
Measurement frequency band	DC, 0.1 Hz to 1 MHz	DC, 0.1 Hz to 5 MHz
Maximum input voltage	1000 V AC, 1500 V DC	1000 V AC, 1000 V DC
Maximum rated line-to-ground voltage	600 V AC, 1000 V DC CAT III 1000 V AC, 1500 V DC CAT II	600 V CAT III 1000 V CAT II

● **Automatically recognizes current sensors (p. 44)**

The instrument automatically acquires information on current sensors connected to itself and compensates for their phase errors.
This significantly reduces the setting time before measurement and strongly supports accurate power measurement.

Automatically acquiring information

Powered by PW8001

● **Simple Settings (Quick Set)(p. 47)**

The Quick Set function allows measurement conditions to be set to typical values at once according to the selected lines to be measured.

● Simultaneously analyzes up to 4 motors with a single instrument (optional)(p. 90)

A single PW8001 can measure and analyze the torque and RPM of four motors simultaneously. This feature is effective for evaluating systems that control wheels with multiple motors, including electric all-wheel drive (AWD) vehicles.
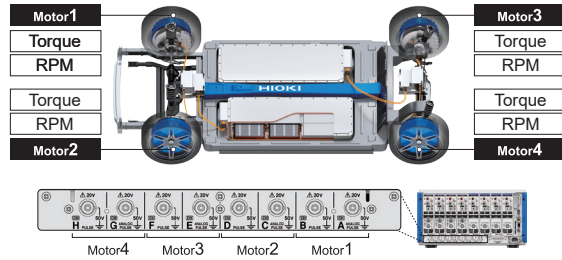
● Measurement of up to 32 channels is supported.

Optical link interface (optional, p. 192)

By connecting two PW8001 units with an optical cable (up to 500 m), measured data can be consolidated in a single PW8001 in real time. The power of a maximum of 16 channels and 8 motors can be simultaneously analyzed and their efficiency and loss can be displayed and recorded with a single unit.

BNC synchronous interface (p. 189)

Up to four instruments, including a primary instrument and up to three secondary instruments, can be synchronized in data update timing and integration control timing.

This system aggregates measured data to one unit.

Primary

Secondary

Real-time transfer

Optical cable (Up to 500 m)

Primary instrument shows all data.

| Power measurement of 16 channels | Power measurement of 8 channels |
| Analysis of 8 motors | Analysis of 4 motors |

● The instrument's ability to combine with various current sensors is expanding usage applications from HILS development to the evaluation of actual equipment.

You can select the most suitable current sensor from a lineup covering various measurement applications to measure current.

High-accuracy clamp type

Clamp-type sensors enable quick and easy connecting work. Excellent environment performances broaden the utilization field from the HILS development to the evaluation of actual equipment.

High-accuracy pass-through type

Pass-through-type sensors overwhelmingly outperform others in accuracy, bandwidth, and stability. Measurement for a wideband of 10 MHz at a maximum and a large current of 2000 A at a maximum can help state-of-the-art research and development.

High accuracy, direct connection type

The DCCT method uniquely developed by Hioki enables world-leading accuracy and bandwidth for the 50 A direct connection type.

● Measured data can be integrated into the existing CAN network with a CAN/CAN FD bus output (optional)

Measured data can be output as CAN/CAN FD signals to the CAN bus in real time. By recording the ECU and measured data on the CAN bus with a data logger, the data can be integrated without causing a time shift or degradation of accuracy and a comprehensive evaluation can be achieved.

Measuring power fluctuation

CAN analysis system

CAN output

Power measuring CAN bus
Automotive CAN bus

1.3 Part Names and Functions

Front

Display area

Handle

Handle

PW8001 POWER ANALYZER
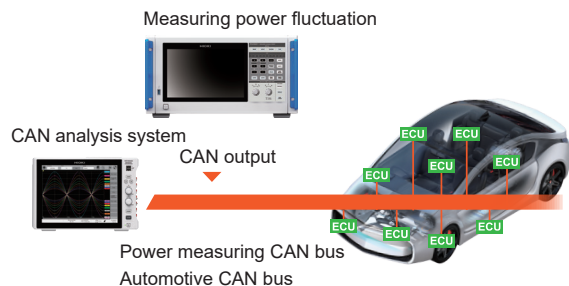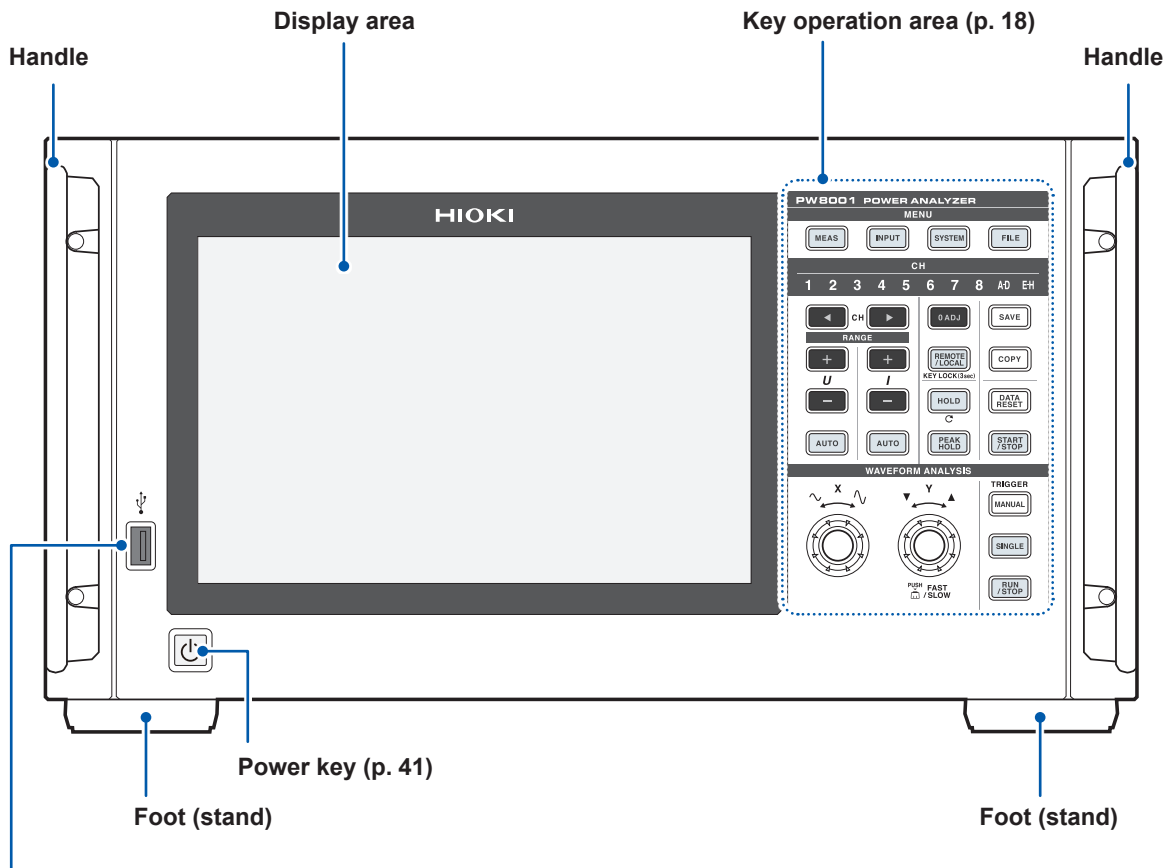
Connect a USB flash drive to save various types of data, including measured data, setting details, and screenshots.
The connector cannot be used with any other devices, including a mouse and a keyboard.

Foot (stand)

Foot (stand)

Engaging key lock
Press the **REMOTE/LOCAL** key for 3 s to lock the key operations.
Both key operation and touchscreen operation are entirely disabled while the key lock function is engaged, except key operation used to cancel the key lock state. The key lock state will persist even if the instrument is cycled.

Handling the touchscreen

⚠CAUTION

- **Do not press the touchscreen too hard.**

- **Do not use hard or sharp objects to operate the touchscreen.**

  Doing so could damage the instrument.

1

Overview

Key operation area

MENU keys (switching screens)
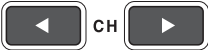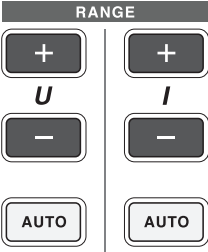
Pressing a key causes the selected key to light up and the screen to switch over to the selected screen.

MEAS	Displays the Measurement screen. The Measurement screen displays measured values and waveforms.	p. 55
INPUT	Displays the Input Settings screen. The Input Settings screen is used to configure settings related to input, wiring mode, measurement, and calculations.	p. 43
SYSTEM	Displays the System Settings screen. The System Settings screen is used to configure settings related to time control, interfaces, and other functionality.	p. 153
FILE	Displays the File Operation screen. The File Operation screen is used to handle files.	p. 157

Channel indicators
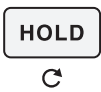
The display settings of the RANGE key and the setting indicator affect the input channels that are lit up.
The channels included in a single wiring configuration based on the wiring settings light up simultaneously.

CH
1 2 3 4 5 6 7 8 A-D E-H

◄ CH ►	Channel selection key Selects the channel to display on the Measurement screen. The channel indicators light up linking to the channel selection key.	—
RANGE + U − + I − AUTO AUTO	RANGE keys The + and − keys of U can switch the voltage range, while the + and − keys of I can switch the current range. These affect the ranges of the channel with it channel indicator LED lit up. When the [A-D] channel indicator is lit up, the U keys functions for Ch. A analog input, while the I keys functions for Ch. C analog input. When the [E-H] indicator is lit up, the U keys functions for Ch. E analog input, while the I keys functions for Ch. G analog input. When the AUTO key is lit up, auto-ranging operation is canceled at the time when the range is switched.	—
	AUTO keys The AUTO key in the U area enables the auto-ranging function for voltage, while the AUTO key in the I area enables the auto-ranging function for current. The keys will light up. The key light turns off if pressed again, and the range will be fixed to the present setting at that time. The keys function for the channels with their channel indicators are lit up.	—
0 ADJ	Performs zero adjustment for the input channels.	p. 50
SAVE	Saves measured data onto the USB flash drive when the key is pressed.	p. 157
COPY	Saves the screen image onto the USB flash drive when the key is pressed.	p. 174
REMOTE / LOCAL KEY LOCK (3sec)	REMOTE/LOCAL key (key lock) The key lights up when the instrument enters the remote state during the GP-IB communications. The key light turns off if it is pressed again and the instrument returns to the local state. If the key is held down for at least 3 s, the key lock is activated and the key lock icon is displayed on the screen. If the key is held down again for at least 3 s, the setting is released and the key light turns off.	p. 239
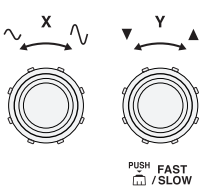
Measurement control keys

The measurement control keys function primarily to control power measurement functions. They do not affect the waveform display.

HOLD ↻	Turns the hold function on and off. The key is lit up when the hold function is enabled. Pressing the **HOLD** key while the peak hold function is enabled will clear the peak hold data.	p. 141
PEAK HOLD	The key is lit up when the peak hold function is enabled. Pressing the **PEAK HOLD** key while the hold function is enabled will update the hold data.	p. 143
DATA RESET	Resets integrated data. This key functions for the channels in which the integration is stopped.	p. 72
START / STOP	Controls starting and stopping of the integration and auto-save operation. The key does not lights up when the each wiring-configuration integration is enabled.	p. 72
	START / STOP (Lit up in green) — Integration or auto-save operation is in progress.	
	START / STOP (Lit up in red) — Integration or auto-save operation is stopped. If the **DATA RESET** key is pressed, the **START/STOP** key light turns off.	

Waveform control keys (rotary knobs)

The waveform control keys function primarily to control waveform capture.

TRIGGER MANUAL	Forcibly applies a trigger while the instrument is waiting for a trigger (manual trigger). The trigger is applied when the key is pressed, causing recording to start.	p. 120
SINGLE	SINGLE (Off) / RUN / STOP (Lit up in red) — Recording will stop once data has been recorded for the recording length. Pressing the **RUN/STOP** key while the instrument is in the standby state will cause recording to stop.	p. 123
	SINGLE (Lit up in green) — If the key is pressed, the key lights up in green and the instrument enters the trigger standby state. If the trigger is applied, the waveforms are recorded only once and the key light turns off.	
RUN / STOP	Enables waveforms to be recorded continuously. The key lights up in green when pressed and then turns red when pressed again.	p. 115
	RUN / STOP (Lit up in green) — The instrument is in the trigger standby state. Recording will start when the trigger is applied. The instrument will enter the trigger standby state repeatedly.	
	RUN / STOP (Lit up in red) — Recording will stop.	
X Y ⌂ PUSH FAST /SLOW	**Rotary knobs** The rotary knobs function primarily to zoom waveforms in or out and to change the position or cursor. They are also used to set the parameters whose numerical value will increase or decrease. When you tap the button you wish to use on the screen, the corresponding rotary knob lights up. Some items can be changed using the Y rotary knob. Pressing the Y rotary knob toggles between green and red lights, allowing you to change increments. Tapping the original key again will turn the rotary knob light off. When its light stays out, the knob does not work.	p. 117

Rear

	1	Input channels	Insert up to 8 channels in the form of modules that accept input of voltage and current for one phase of power.	—
	2	Voltage input terminals	Connect Hioki's optional voltage cords.	p. 36
	3	Probe 2 terminals (For current sensors)	Connect sensors of the voltage output type, including a current probe and CT.	p. 39
	4	Probe 1 terminals (For high performance current sensors)	Connect Hioki's optional current sensors. The instrument automatically recognizes current sensors. It also supplies power to the current sensors.	p. 37
	5	GP-IB connector	Controls the instrument remotely using GP-IB. Transfers measured data to a computer.	p. 239
	6	RS-232C connector (D-sub 9 pins)	Controls the instrument remotely from a computer or controller via serial RS-232C communications. Controls starting and stopping of integration with a contact switch.	p. 241
	7	RJ-45 connector (Gigabit Ethernet)	Controls the instrument remotely over a LAN. Transfers measured data to a PC.	p. 220
	8	Optical link connector (Optical link interface option)	Connect L6000 Optical Connection Cable. Performs advanced measurement using 2 synchronized instruments.	p. 192
	9	BNC synchronization connector	Connect 9165 Connection Cord. Performs measurement using up to 4 synchronized instruments.	p. 189
	10	Power supply inlet	Connect the included power cord.	p. 41
	11	Waveform and D/A output option	You can input the instrument's output into a recorder to record data over an extended period of time. You can also input this signal to an oscilloscope to observe the waveform.	p. 197
		CAN/CAN FD interface option	Measured data can be output as CAN/CAN FD signals to the CAN bus in real time.	p. 210
	12	Motor analysis option (External input)	You can input torque sensor and tachometer output to measure motor output.	p. 90

Top

Bottom

Handle

Foot

Stand

Foot

Right side

Left side

Air vent

Stand

Stand

Label

HIOKI PW8001 POWER ANALYZER

CE UK 10
CA

MADE IN JAPAN — R-R-HKO-
PW8001S
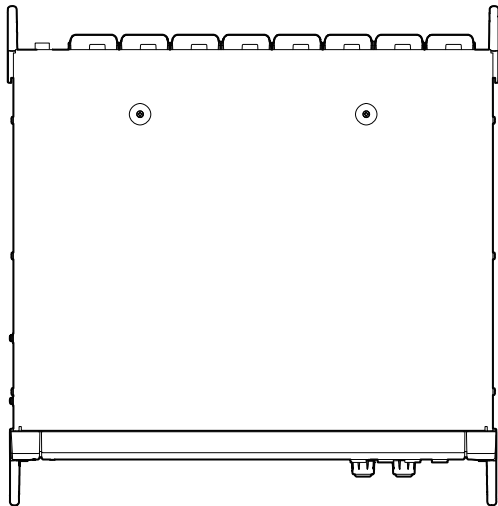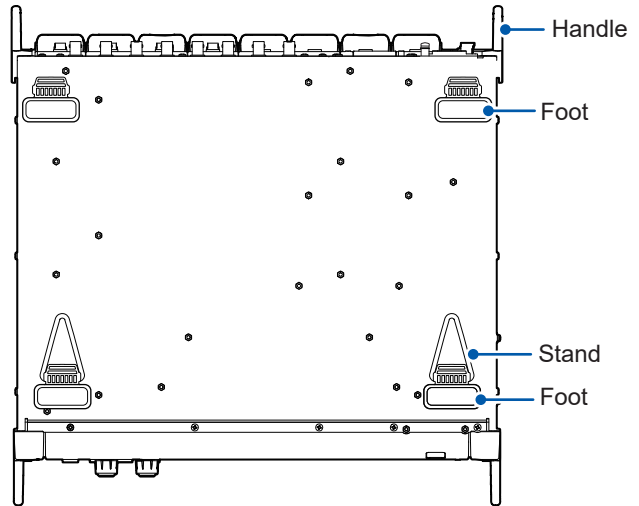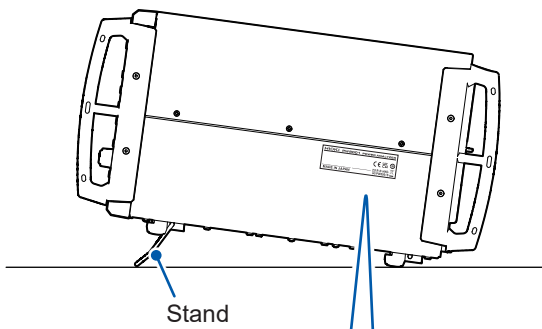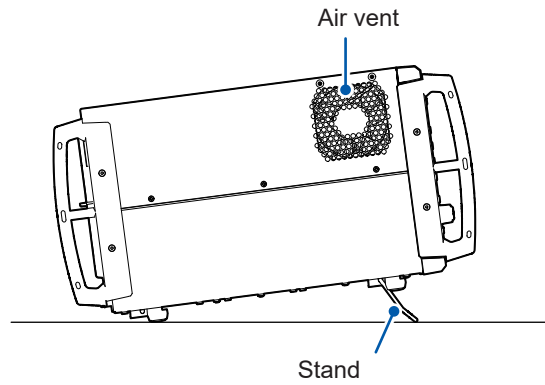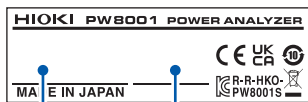
Model name   MAC address
Serial number*

*: Serial number
The serial number consists of 9 digit numbers. Starting from the left, the first pair of digits indicate the year of manufacture (last two digits of the year), and the next pair of digits indicate the month of manufacture. Do not remove this sticker as the number is important.

The serial number can be checked on the System screen.
See "6.1 Checking and Changing Settings" (p. 153).

⚠CAUTION

🚫 ■ **Do not apply excessive force from above when the stands are extended.**

Doing so could damage the stands.

21

1.4 Basic Operation (Screen Display and Layout)

Screen operation

1 **Switch the screens. (p. 27)**

2 **Select a screen.**

Tap an on-screen icon to switch screens.
The icon for the currently selected screen is shown with a blue background.
On the Measurement screen, which appears when the **[MEAS]** key is pressed, tapping an on-screen icon can display other multiple icons to its left.
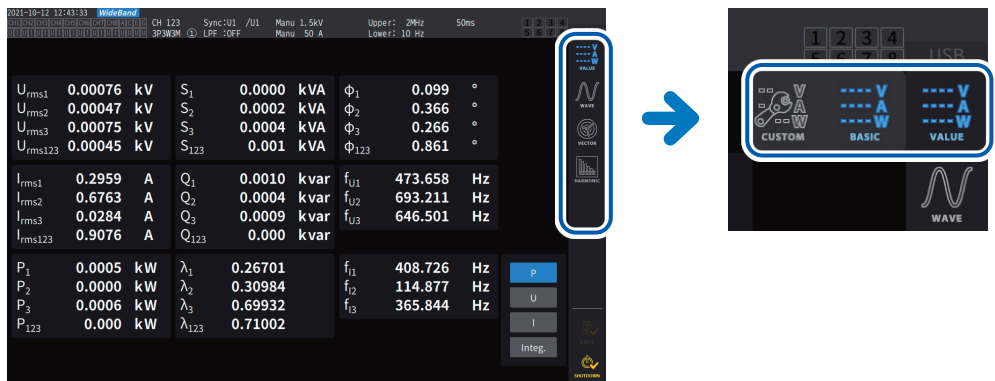
3 **Change the displayed contents and settings.**

Tap active areas of the screen to control it.
Parameter will appear dimmed if they cannot be set (you cannot tap-activate it).

In principle, you can tap-activate the blue, gray, and white buttons and combo box, as well as the icons on the left side of the screen.
There are exceptions including the cursor on the Waveform screen and the switching of the displayed orders on the list screen.
In addition, tapping outside the setting window closes it.
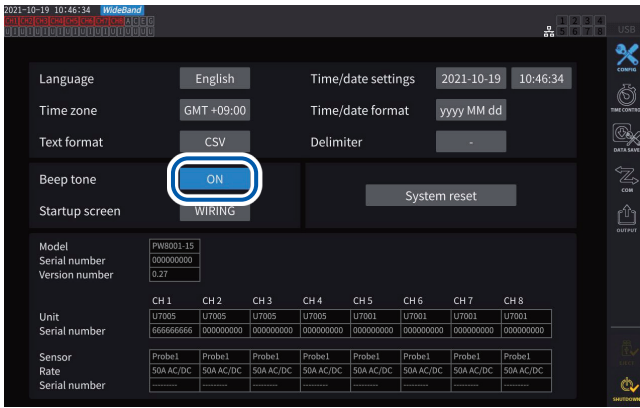
Switching between [ON] and [OFF]

Tap the button to toggle between on and off.
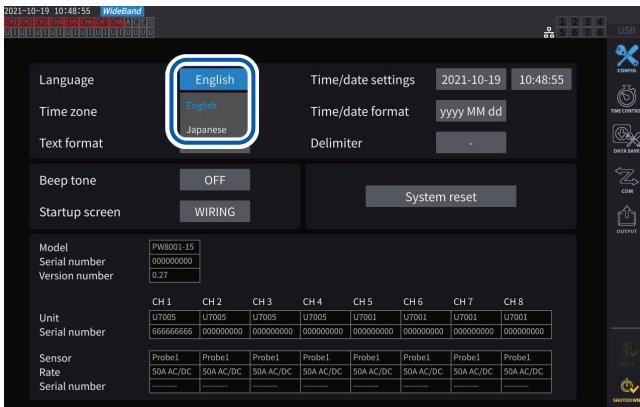
Selecting items

Tap an option to select it.
Tapping outside the list of options will close the list without changing the setting.

Window

While the window is being displayed, the control area and touchscreen keys outside the window may be temporarily disabled.
Once you have finished configuring the settings as desired, tap **[×]** to close the window.

There are three types of window:
• Parameter selection window
• Keyboard window (p. 24)
• Numeric keypad window (p. 24)
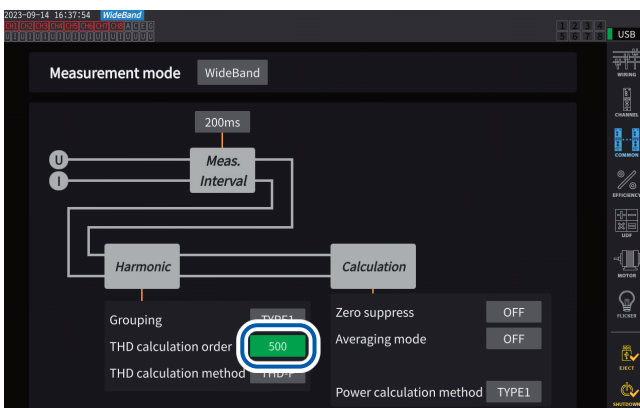
Changing values with rotary knobs

Tap the screen. The edge of one of the instrument's rotary knobs lights up. You can turn that knob to change the value or manipulate the waveform. Tapping the screen can confirm the value you set.

Lit up in green: in 1 increments

Press the knob to switch.

Lit up in red: in 10 increments

1

Overview
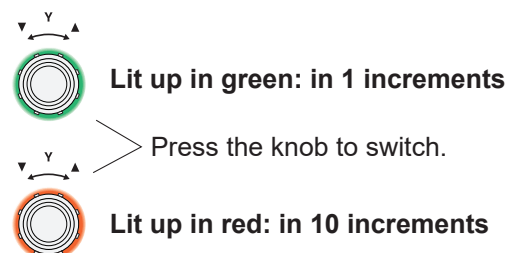
Keyboard window

You can enter comments, units, and folder names using the keyboard.

While this window is open, you can tap the inside of the window only.

Clear	Clears all entered text.
Delete	Deletes the character at the cursor position.
A/a	Toggles between uppercase and lowercase keyboards.
Esc	Cancels text entry and closes the window.
BS	Deletes the character before the cursor position.
Enter	Accepts the entered text and closes the window.
123	Switches among letters, numbers, and symbols.
← →	Moves the cursor position left and right.

Numeric keypad window

You can enter numerical values.

While this window is open, you can tap the inside of the window only.

BS	Deletes the number before the cursor position.
Del	Deletes the number at the cursor position.
Clr	Clears all entered text.
← →	Moves the cursor position left and right.
Enter	Accepts the entered numerical values and closes the window.
Esc	Cancels text entry and closes the window.
+, −	This button is displayed when a sign can be entered.
T, G, M, k _, m, μ, n	These buttons are displayed when a prefix such as k (kilo) or M (mega) can be entered. Choosing the underscore (_) will clear the prefix. These buttons are displayed when a prefix cannot be entered.

Common screen display

The following is an example screen. Actual screens vary depending on the instrument's settings. This section describes the screen elements that are shown on all screens.

Date and time **Setting indicator (p. 26)** **Operating state indicator*[2]**

Warning indicator*[1] **Media indicator*[3]**
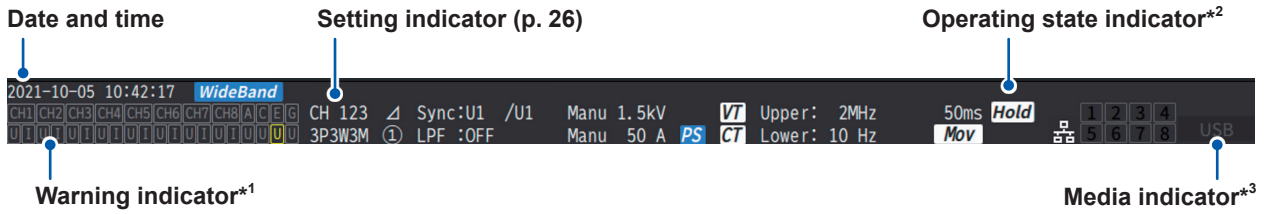
*1: Warning indicator
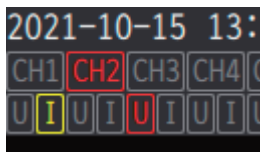
Example, the Ch. 1 current input is in an overloaded condition (yellow), Ch. 2 is in a synchronization-unlocked condition (red), and the Ch. 3 voltage input is in a peak-over condition (red).

The top row displays the synchronization state for each input channel.

CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8	Input channels	Yellow: Fundamental power calculation is in a synchronization-unlocked condition. Red: Harmonic analysis is in a synchronization-unlocked condition. Gray: Measuring normally.
A, C, E, G	Motor input channels	Yellow: The channel is in a synchronization-unlocked condition. Gray: Measuring normally.

The bottom row displays the range-peak-over state for each input channel.

U	Voltage input	Gray: Measuring normally. Yellow: An overload condition occurs. Red: A peak exceeds the threshold.
I	Current input	

*2: Operating state indicator

Hold	In the hold state	[1][2][3][4] [5][6][7][8]	Displays the operation status of each channel in the following colors during integration measurement. (p. 70) 1 (green) Integration starts. 1 (red) Integration stops. 1 (yellow) Integration standby 1 (colorless) Data reset
Peak	In the peak hold state		
🔒	Key locked	🔲	When connected to a network via the LAN interface
Link Primary	Set as the opt-link primary instrument.	Link Secondary	Set as the opt-link secondary instrument.
Sync Primary	Set as the BNC-sync primary instrument.	Sync Secondary	Set as the BNC-sync secondary instrument.

*3: Storage media indicator

Usage of the USB flash drive is indicated using a level meter.
The indicator lights up in red if the free space rate of the drive reduces to less than 95% or ERROR occurs.

Measurement screen

The following is an example of the Measurement screen. Actual screens vary depending on the instrument's settings.
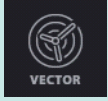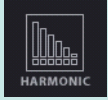
This section describes contents shown only on the Measurement screen. This area is called the setting indicators.
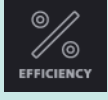
1	**Combined channels**	Displays channels that have been combined in the same wiring configuration.	p. 43
2	**Synchronization source**	Displays the setting for the source that determines the period (between zero-crossing points) that serves as the basis for measurement. Left: Synchronization source for the basic measurement items Right: Synchronization source for the harmonic measurement items	p. 64
3	**Switching ranges**	The top row indicates the voltage setting, while the bottom row indicates the current setting. **[Auto]**: Auto-ranging function enabled **[Manu]**: Auto-ranging function disabled	p. 59
4	**Scaling**	Shown when the VT ratios and CT ratios have been set.	p. 69
5	**Measurement upper frequency limit** **Measurement lower frequency limit**	**[Upper]**: Measurement upper frequency limit setting **[Lower]**: Measurement lower frequency limit setting	p. 67
6	**Data update interval**	Displays the data update interval setting.	p. 63
7	**Wiring mode**	Displays wiring configuration settings.	p. 43
8	**Current sensor connection terminals**	**[1]**: Probe 1 is selected as the current sensor **[2]**: Probe 2 is selected as the current sensor	p. 36
9	**Delta conversion setting**	Displays the operating state of the delta conversion function. **[Δ]**: Delta conversion enabled Blank: Delta conversion disabled	p. 145
10	**LPF**	Displays the low-pass filter setting.	p. 66
11	**PS**	Shown when the phase compensation function is enabled.	–
12	**Average**	Displays the average setting. **[Mov]**: Moving average **[Exp]**: Exponential average Blank: Disabled	p. 139

Screen configurations

Measurement screen (displayed with the MEAS key)

[VALUE] Measured value screen		[BASIC] Basic display	Displays measured power values for each channel and motor input measured values for each wiring configuration.
		[CUSTOM] Selection display	Displays measured values for user-selected basic measurement items.
[WAVE] Waveform screen		[WAVE] Waveform display	Displays the voltage, current, power and motor input waveforms.
		[WAVE+VALUE] Waveform + measured value display	Displays measured values, which are expressed numerically, together with waveforms.
		[WAVE+ZOOM] Waveform + zoom display	Displays an enlarged view of waveforms.
		[WAVE+FFT] Waveform + FFT analysis display	Displays FFT analysis (power spectrum) results of waveforms.
[VECTOR] Vector screen		[VECTOR×1] 1-vector-diagram	Displays a vector diagram along with measured harmonic values, which are expressed numerically, of selected order components.
		[VECTOR×2] 2-vector-diagram	Displays vectors of selected wiring configurations on two vector diagrams.
		[VECTOR×4] 4-vector-diagram	Displays vectors of selected wiring configurations on four vector diagrams.
[HARMONIC] Harmonic screen		[LIST] List display	Displays a list that includes measured harmonic values, which are expressed numerically, of selected harmonic items.
		[BAR GRAPH] Graph display	Displays bar graphs that include measured harmonic data of selected channels.

Input screen (displayed with the INPUT key)

	[WIRING] Wiring setting	Allows you to set the wiring pattern (input channel configuration) based on the lines to be measured.
	[CHANNEL] Channel-specific settings	Allows you to set detailed measurement conditions for each channel selected based on the wiring pattern.
	[COMMON] Common input settings	Allows you to set measurement conditions applied to all channels commonly.
	[EFFICIENCY] Efficiency calculation settings	Allows you to set the equations to calculate efficiency.
	[UDF] User-defined formula	Allows you to arbitrarily set up math formulas by combining values measured by the instrument, numbers, and functions.

1

Overview

	[MOTOR] Motor input settings	Allows you to configure motor input settings.
	[Flicker] Flicker calculation settings	Allows you to configure flicker calculation setting in IEC measurement mode.

System Settings screen (displayed with the SYSTEM key)

	[CONFIG] System settings	Allows you to review and set up the system environments.
	[TIME CONTROL] Time control settings	Allows you to configure time control settings.
	[DATA SAVE] Data save settings	Allows you to set which items of data to store on a USB flash drive.
	[COM] Communications settings	Allows you to configure the communications interface.
	[OUTPUT] D/A output settings	Shown only when the waveform and D/A output option is installed. Allows you to configure the D/A output settings.
	[CAN OUTPUT] CAN settings	Allows you to configure the CAN settings. Shown only when the CAN/CAN FD interface option is installed.

File Operation screen (displayed with the FILE key)

The File Operation screen is used to manage files on the USB flash drive and to save and load settings files.

1.5 System Architecture

Battery   Inverter   Motor   Torque sensor   Pulse encoder

Motor analysis option

Motor input	External input
Torque sensor	Solarimeter output
Encoder signal	Thermometer analog output
	Pulse signal
	Waveform trigger

Voltage input, up to 8 channels
Current sensor input, up to 8 channels

U7001 2.5MS/s Input Unit
U7005 15MS/s Input Unit

BNC synchronous interface

BNC cable

Primary

Either one

LAN
GP-IB
RS-232C

Communication interface
Computer, controller, etc.

Secondary

Secondary

Up to 4 units

Either one

External control
Start, stop, and reset integration.

Secondary

CAN/CAN FD option
HILS system

Optical link

Optical link option

Up to 2 units

Optical Connection Cable

Waveform and D/A output option

MR6000

Waveform output
Oscilloscope
Memory HiCorder

LR8450

Analog output
Data logger
Comparator

Secondary

- Motor analysis, CAN/CAN FD, waveform and D/A output, and optical link are optional.
- The BNC synchronization and the optical link interface cannot be used simultaneously.
- The waveform and D/A output option and the CAN/CAN FD option cannot be installed simultaneously.

1.6 Example Measurement Setups

Measuring efficiency of power conditioners

The instrument can be used effectively from R&D of power conditioners to performance assessment at the time of shipping inspections.
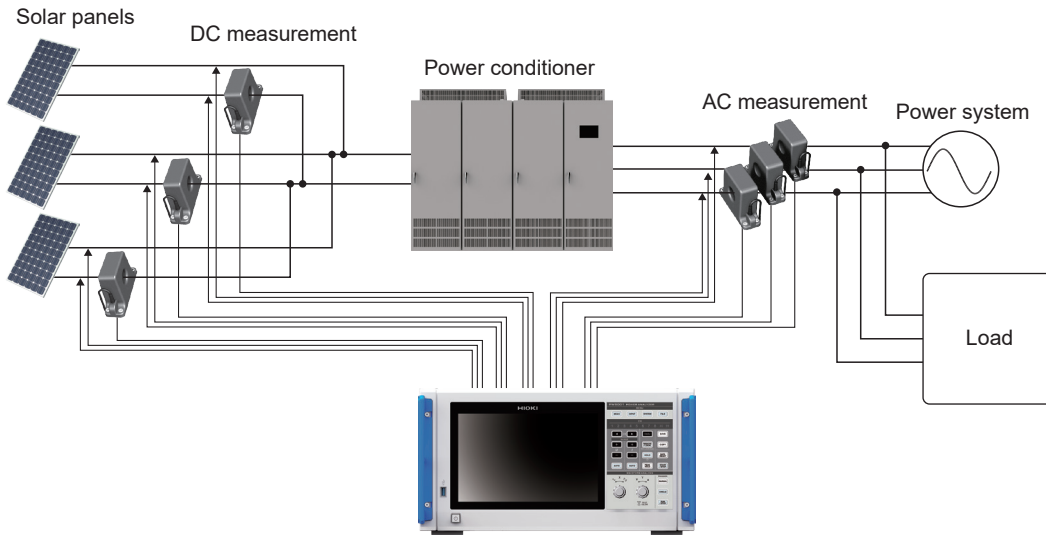
Evaluating the performance of a power interchange system with a power conditioner

Since the instrument can simultaneously and accurately measure power at multiple points, such as the input and output of DC-DC converters, inverters, and accumulators, it is effective for the performance evaluation of power conditioners.
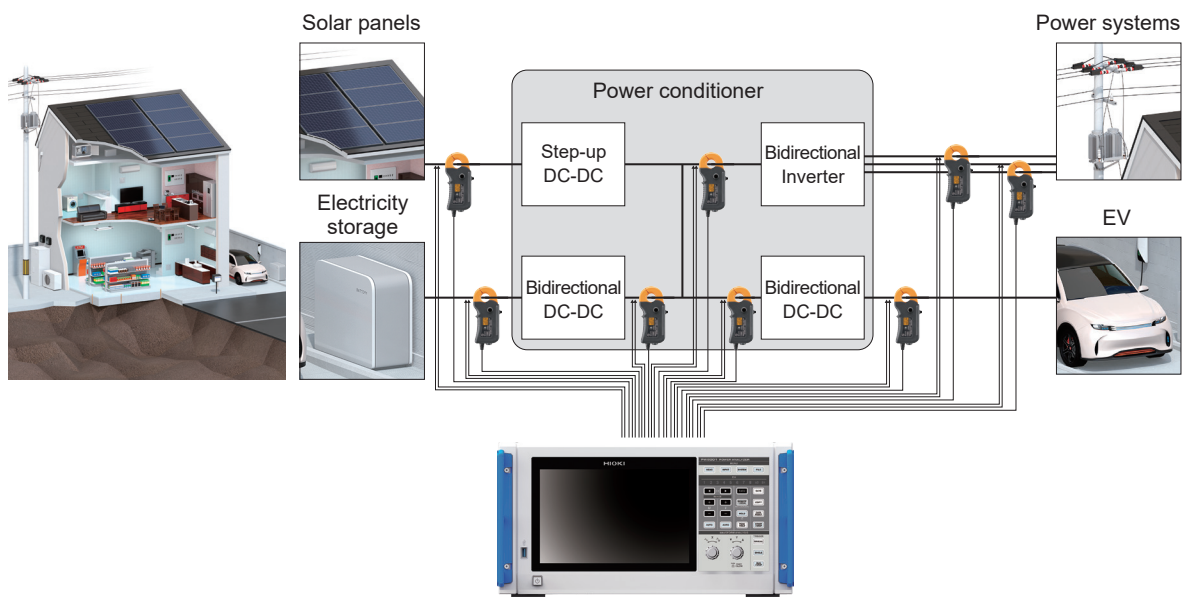
Evaluating conversion efficiency of inverters with built-in SiC

The instrument can measure the conversion-efficiency of inverters using modern devices such as SiC and GaN at high precision.
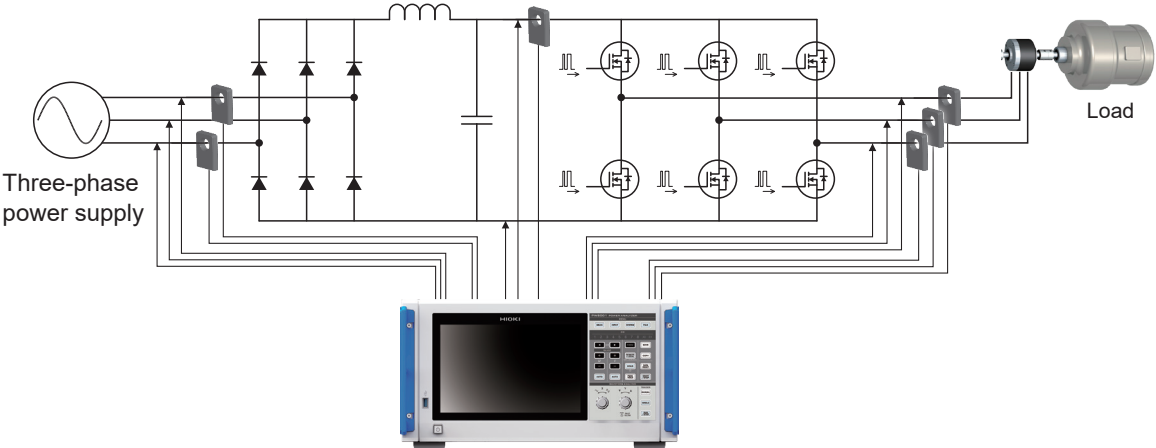
Analyzing of motors used for vehicles including EV and HEV

The instrument automatically follows a frequency that fluctuates from a frequency of at least 0.1 Hz, allowing power to be measured in transient conditions, such as motor behavior during start and acceleration.
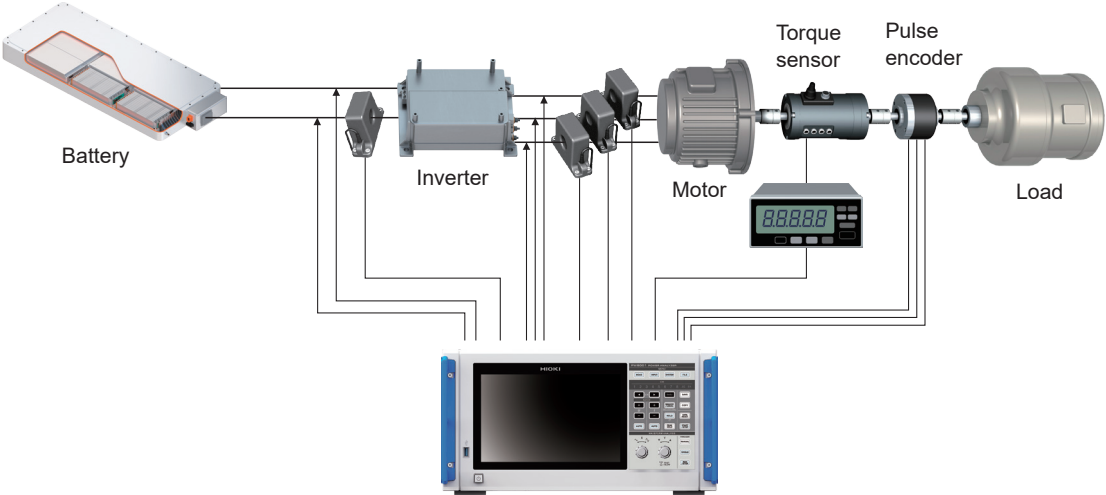
Evaluating performance of dual inverter drive systems

Since the instrument can accurately and reproducibly measure power of eight channels over a wide frequency band, it is very effective for performance evaluation of the dual inverter systems.
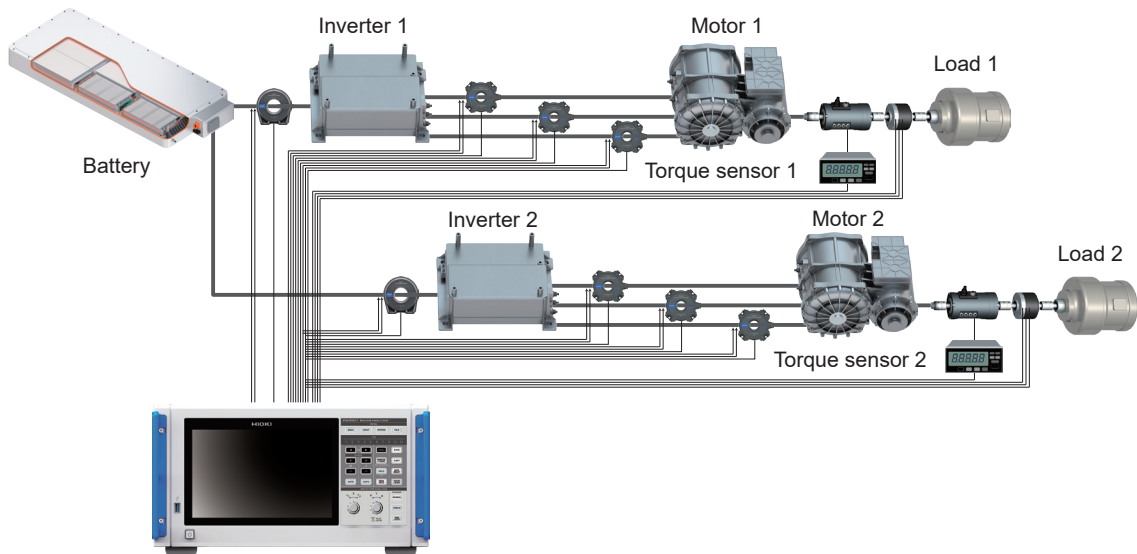
Capable of handling special wiring configurations, such as for measuring performance of 6-phase motors and for loss of reactors

The instrument can also measure the performance of 6-phase motors and loss of reactors at high precision.
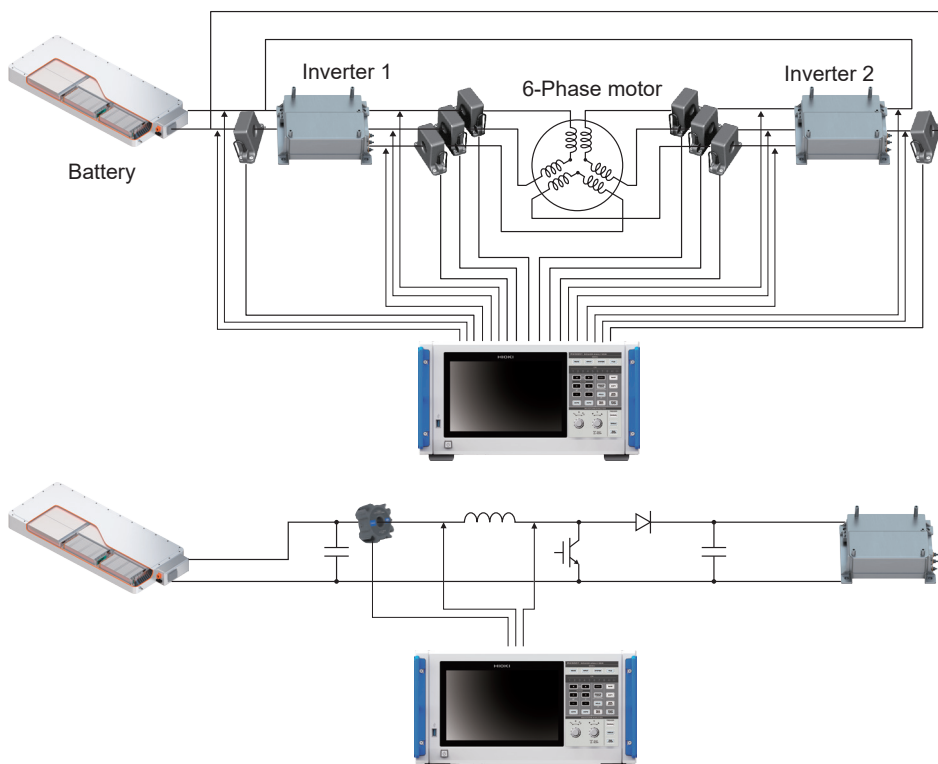
DANGER

- **Do not connect any voltage cord and any current sensor to the primary side of a distribution panel.**

    If a short circuit occurs on the primary side, an unrestricted current flow can damage the instrument and facilities, resulting in serious bodily injury. Even if a short circuit occurs on the secondary side of the distribution panel, the panel will interrupt the short circuit current.

The procedure for preparation before measurement is as follows.

1 **Inspect the instrument before use.**

"2.1 Inspecting the Instrument before Use" (p. 34)

2 **Connect the voltage cords and current sensors to the instrument.**

"2.2 Connecting the Voltage Cords (Voltage Input)" (p. 35)
"2.3 Connecting the Current Sensors (Current Input)" (p. 36)

3 **Supply power to the instrument.**

"2.4 Supplying Power to the Instrument" (p. 41)

4 **Set the measurement conditions.**

"2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43)
"2.6 Simple Configuration (Quick Set)" (p. 47)

5 **Perform zero adjustment.**

"2.8 Zero Adjustment and Degaussing (Demagnetization)" (p. 50)

6 **Connect the cords and sensors to lines to be measured.**

"2.9 Connecting Measurement Leads and Sensors to Lines to Be Measured" (p. 51)

7 **Verify proper connection.**

"2.10 Checking Connections" (p. 53)

External control

Integration control (Start/Stop/Reset)
See "8 Connecting External Devices" (p. 189).

Communication interface
- LAN
- GP-IB
- RS-232C
See "9 Connecting with Computers" (p. 219).
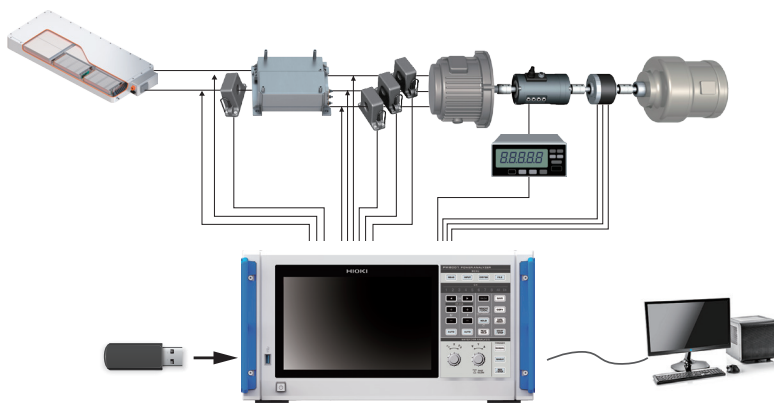
Saving data
See "7.1 USB Flash Drive" (p. 157).

2.1 Inspecting the Instrument before Use

Before starting measurement, inspect the instrument, accessories, and options.

⚠**DANGER**
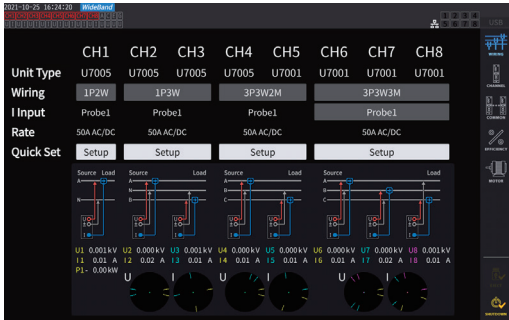
■ **Inspect the instrument and verify proper operation before use.**

Use of the instrument while it is malfunctioning could result in serious bodily injury.
If you find any damage, contact your authorized Hioki distributor or reseller.

Inspecting accessories and options

Make sure that . . .	Action
Insulation of the power cords and voltage cords is not damaged. No metal exposed.	If you find any damage, do not use the instrument as the damage may result in an electric shock or short circuit. The instrument will not be able to perform normal measurement in its present state. Contact your authorized Hioki distributor or reseller.
The current sensors' clamps are not cracked or otherwise damaged.	

Inspecting the instrument

Make sure that . . .	Action
The instrument is not damaged.	If you find any damage, request repair.
The instrument displays **[PW8001 POWER ANALYZER]** after being turned on. (The self-test is started internally.)	If **[PW8001 POWER ANALYZER]** is not displayed, the power cord may have a break in it, or the instrument's internal circuitry may be damaged. Contact your authorized Hioki distributor or reseller.
After the self-test is complete, the instrument displays the **[WIRING]** screen or the screen shown when it was last turned off. 	If the screen is not displayed, the instrument's internal circuitry may be damaged. Contact your authorized Hioki distributor or reseller.
The instrument's clock is accurate.	Set the instrument's clock to the present time. See "6.1 Checking and Changing Settings" (p. 153).

2.2 Connecting the Voltage Cords (Voltage Input)

Connect the voltage cords (optional) to the voltage input terminals. Connect as many cords as required based on the lines to be measured and the wiring configuration.

⚠DANGER

■ **Do not cause a short circuit between the wire to be measured and another wire with the metallic parts of the tips of the voltage cord.**

Doing so can cause arc flash, resulting in serious bodily injury or damage to the instrument or other equipment.

■ **Never touch the metal areas on test leads or at the tips of voltage cords during measurement.**

Doing so could result in serious bodily injury or a short circuit.

⚠WARNING

■ **Disconnect power to the line under measurement before connecting the test leads.**

Failure to do so could damage the instrument, resulting in bodily injury.

■ **When using the instrument, use only Hioki-specified connection cords.**

Using a cord other than the specified parts could cause bodily injury or a short circuit. See "Optional products for voltage measurement" (p. 4).

IMPORTANT

To ensure accurate measurement, firmly insert the voltage cords completely.

Rear panel of the instrument
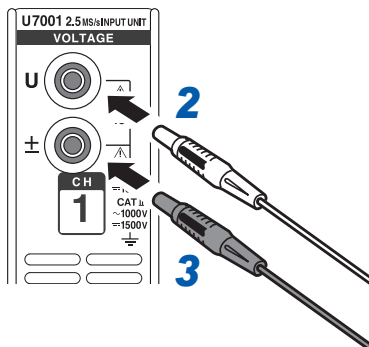
1 **Turn off the instrument.**

2 **Insert the red voltage cord into of the U voltage input terminal.**

3 **Insert the black voltage cord into the ± voltage input terminal.**

2.3 Connecting the Current Sensors (Current Input)

Connect current sensors to the Probe 1 or Probe 2 terminals.

⚠DANGER

- **Do not use the current sensors to measure a circuit carrying a voltage greater than the maximum rated line-to-ground voltage.**

- **Do not use the current sensors for measuring bare conductors.**

  Doing so could result in serious bodily injury or a short circuit.
  *: For details about the maximum rated line-to-ground voltage of the current sensor, refer to the instruction manual that came with the current sensor.

- **Connect an optional current sensor only with the Probe 1 terminal.**

  Using a current sensor other than the optional current sensors could cause serious bodily injury.

⚠WARNING

- **Turn off all devices before connecting a pass-through-type current sensor of the through type, such as the CT6875.**

  There is a risk of the operator experiencing an electric shock. A short circuit may also occur.

⚠CAUTION

- **Do not connect or disconnect connectors while the instrument has been turned on.**

  Doing so could damage the sensor.

- **When disconnecting cables, disengage the lock and then pull out the connector while gripping it at the connection (do not pull on the cable).**

  The BNC connectors or junctions may be damaged.

- **Use the L9217 Connection Cord (plastic) for connection with an isolated BNC connector (plastic).**

- **Use the 9165 Connection Cord (metallic) for connection with a metallic BNC connector.**

  If a metallic BNC cable is connected with an isolated BNC connector, the isolated BNC connector or connected devices may be damaged.

IMPORTANT

- Connect a current sensor to either the Probe 1 or Probe 2 terminal of a single input module. Connecting two current sensors with both the Probe 1 and Probe 2 terminals can affect measurement.

- Do not drop a current sensor onto a floor or other surface.
- Do not subject the current sensor to mechanical shock.
  Doing so could adversely affect the measurement accuracy and the opening/closing mechanism.

Rear panel of the instrument
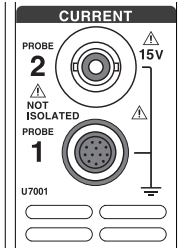
Probe 1 terminal	Terminal for high-performance current sensors. Connect an optional current sensor. The instrument automatically recognizes the current sensor. It also supplies power to the current sensor.
Probe 2 terminal	Terminal for current sensors. Connect a sensor of the voltage output type, including a current probe and CT.

For detailed specifications and instructions for the current sensors being used, refer to the instruction manual that came with the current sensors.

Probe 1 terminal

How to plug the connector

> **IMPORTANT**
>
> The current sensor connected to the Probe 1 terminal is automatically recognized. However, when the CT6846 or CT6865 is connected via the CT9900 Conversion Cable, the sensor is recognized as a 500 A AC/DC sensor. Set the CT ratio to *2.00* in such a case.
> See "Scaling (when using VTs [PTs] or CTs)" (p. 69).

When the connector is metallic
Current sensors including the 9709-05, the CT6860-05 series, and the CT6840-05 series can be connected to the Probe 1 terminal directly.
The current sensors with the sub number *-05* in their product name have a metallic connector.

1 Hold the connector with its broader part facing upward.

1 **Turn the instrument off, then align the positions of the connector guides of the instrument and the current sensor.**

2 **Hold the plastic part of the connector and insert it straight until it is locked.**

The instrument automatically recognize the type of the current sensor.

2

Preparing for Measurement

When the connector is plastic

Current sensors including the 9709, the CT6860 series, and the CT6840 series can be connected to the Probe 1 terminal by using the optional CT9900 Conversion Cable.
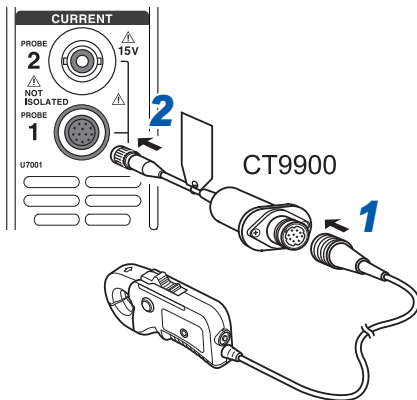
CT9900

1   Turn the instrument off, then align the positions of the connector guides of the CT9900 Conversion Cable and the current sensor to connect them.

2   Insert the connector of the CT9900 straight until it is locked.

How to plug the connector
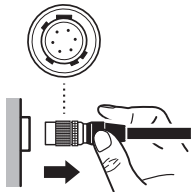
1   Hold the metallic part of the connector and slide it toward the cable side to unlock the connector.

2   Pull out the connector.

IMPORTANT

• Connect a current sensor to either the Probe 1 or Probe 2 terminal of a single input module. Connecting two current sensors with both the Probe 1 and Probe 2 terminals can affect measurement.

• Do not drop a current sensor onto a floor or other surface.
• Do not subject the current sensor to mechanical shock.
   Doing so could adversely affect the measurement accuracy and the opening/closing mechanism.

Probe 2 terminal

How to plug the connector

2

3
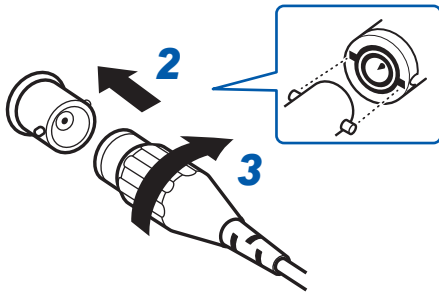
1 **Turn off the instrument.**

2 **Align the slots in the connector of the current sensor with the lugs on the Probe 2 terminal (BNC connector), and insert the connector.**

3 **Turn the connector clockwise to lock it.**

4 **Supply power to the current sensor.**

For Hioki's current sensors

PW8001
(U7001)

CT6700 series,
3273-50, etc.

Probe 2
BNC

1 MΩ

GND

Power supply
(3269/3272)
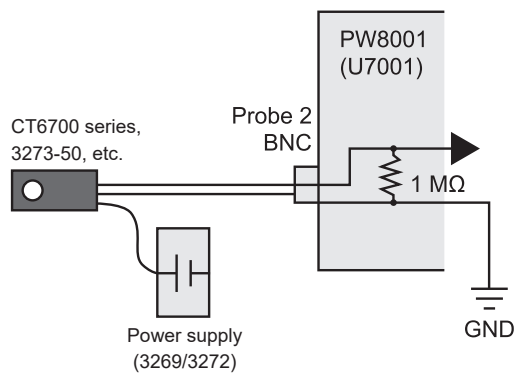
When connecting Hioki's optional current sensors (including the CT6700 series and 3273-50), supply power to the current sensor from Hioki's 3269 or 3272 Power Supply.

For current-output type current sensors

PW8001
(U7001)

Current-output type
current sensors

Probe 2
BNC

5 V rms f.s. max.

1 MΩ

Shunt resistor

GND
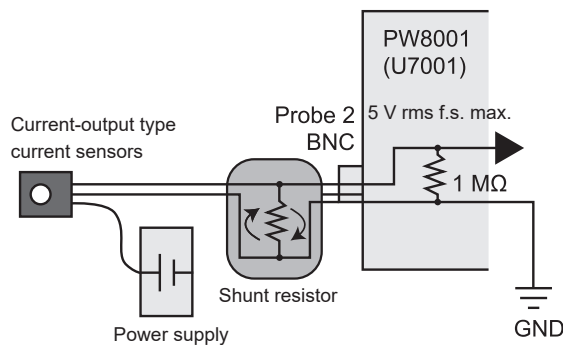
Power supply

Similarly, when connecting a current-output type current sensor to the instrument, supply power to the current sensor from a power supply prepared by the customer.
In addition, connect a shunt resistor between the sensor and the Probe 2 terminal. Shield the shunt resistor part and arrange the wires so that the loop area produced by the grounding wire is minimized. Do not input signals other than those from the output of current sensors that are electrically isolated from the object under measurement. In addition, keep the input within ±15 V.

How to remove the connector

2

1
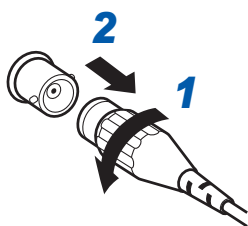
1 **Turn the connector of the current sensor counterclockwise to unlock it.**

2 **Pull out the connector.**

2

Preparing for Measurement

If the input exceeds the measurable range (using VTs and CTs)

Use instrument transformers: voltage transformers (VTs [potential transformers, PTs]) and current transformers (CTs) externally. VT ratios and CT ratios can be set on the instrument to allow primary-side input values to be read directly.

See "Scaling (when using VTs [PTs] or CTs)" (p. 69).

⚠DANGER

🚫 ■ **Do not touch VTs (PTs), CTs, or any input terminals of the instrument when they are energized.**

Doing so could result in serious bodily injury.

⚠WARNING

■ **When using VTs (PTs) externally, do not short the secondary side.**

Applying a voltage to the primary side while in the shorted state may cause a large current to flow to the secondary side, resulting in equipment damage or fire.

🚫 ■ **When using CTs externally, do not leave the secondary side open.**

If a current flows to the primary side while in the open state, a high voltage may occur on the secondary side, resulting in a risk of the operator experiencing an electric shock.

IMPORTANT

The phase difference between the external VTs (PTs) and CTs may introduce a large error component into power measurement. If you wish to make more accurate power measurement, use VTs (PTs) and CTs with a small phase error in the frequency band of the circuit being used.

2.4 Supplying Power to the Instrument

<div style="text-align:center">⚠️DANGER</div>

■ **Use only the specified power cord to provide power to the instrument.**

Using a power cord other than those specified could cause a fire, resulting in serious bodily injury.

<div style="text-align:center">⚠️CAUTION</div>

■ **Do not use a power supply that generates rectangular wave or pseudo-sine wave output (such as an uninterruptible power supply and a DC/AC inverter) to power the instrument.**

Doing so could damage the instrument, resulting in bodily injury.

■ **Unplug the power cord from the instrument before connecting measurement leads and sensors with an object under measurement.**

■ **Unplug the power cord while the instrument is not used.**

Failure to do so could cause the operator to experience an electric shock.

■ **Before connecting the power cord, verify that the supply voltage you plan to use falls within the supply voltage range noted on the instrument's AC inlet.**

Supplying a voltage that falls outside the specified range to the instrument could damage the instrument, causing bodily injury.

■ **Use the same ground for the instrument and the devices being connected.**

Failure to do so could damage the instrument and the devices being connected or cause them to malfunction.

■ **When unplugging the power cord from the outlet or instrument, pull on the plug (not the cord).**

The cable may be broken or the output terminal may be damaged.

Connecting the power cord

1 **Turn off the instrument.**

2 **Confirm that the power supply voltage is within the rated range, and then, connect the power cord to the power inlet.**
(100 V AC to 240 V)

3 **Connect the plug of the power cord to the outlet.**

<div style="text-align:right">2

Preparing for Measurement</div>

<div style="text-align:right">41</div>

Turning the instrument on

1 **Connect the voltage cords, current sensors, and power cord.**

2 **Press the power key.**

The instrument is turned on and starts a self-test (self-diagnosis by the instrument, approx. 10 s).
Once the self-test is finished, the Input screen's **[WIRING]** page will be displayed (default setting)
If the startup screen is set to **[LAST]**, the screen when the instrument was last turned off will be displayed.
See "2.1 Inspecting the Instrument before Use" (p. 34).

3 **Start the measurement after a standby time (warming up) of 30 minutes or more.**

4 **Perform the zero adjustment.**

See "2.8 Zero Adjustment and Degaussing (Demagnetization)" (p. 50).

> **IMPORTANT**
>
> If an issue is found with any of the self-test steps, the startup process will stop on the self-test screen. If the process stops again after you cycle the instrument, it will be malfunctioning. Perform the following steps:
>
> 1. Stop measurement, shut off power to the lines under measurement or disconnect the voltage cords and current sensors from the lines under measurement, and turn off the instrument.
> 2. Disconnect the power cord and all measurement leads and sensors.
> 3. Contact your authorized Hioki distributor or reseller.

Turning the instrument off

To turn off the instrument, shut down the instrument on the screen and then press the power key.

⚠CAUTION

■ **Remove the voltage cords and the current sensors from the lines to be measured before turning off the instrument.**

Doing so could damage the instrument.

1 **Tap [SHUTDOWN] at the lower right of the screen.**

The confirmation window will open.

2 **Tap [Yes] to shutdown the instrument.**

The instrument enters the following state during the shutdown process:
• The fan inside the instrument keeps rotating.
• The **MEAS**, **INPUT**, **SYSTEM**, **FILE** keys light up simultaneously.

3 **After the display on the screen disappears, press the power key.**

2.5 Setting Wiring Mode and Configuring Current Sensor Settings

This section describes how to set wiring modes based on the number of channels with which the instrument is equipped and the lines to be measured.

To combine different input modules for multiple channels (for measurement on multi-phase systems), connect the same current sensors to all the channels to be combined.

Display screen [INPUT] > [WIRING]

1 **Tap the button to select a wiring mode for each channel.**

The Settings window will open.

2 **Select a wiring mode from among 1 module, 2 modules, and 3 modules.**

See "Wiring mode" (p. 44).

When different types of input modules are connected to a single wiring configuration, the circumference of the wiring button is displayed in yellow.

3 **Tap [×] to close the setting window.**

4 **Only for U7001, select the current sensor to be used for each channel.**

Always connect the same type of current sensors within the same wiring configuration.
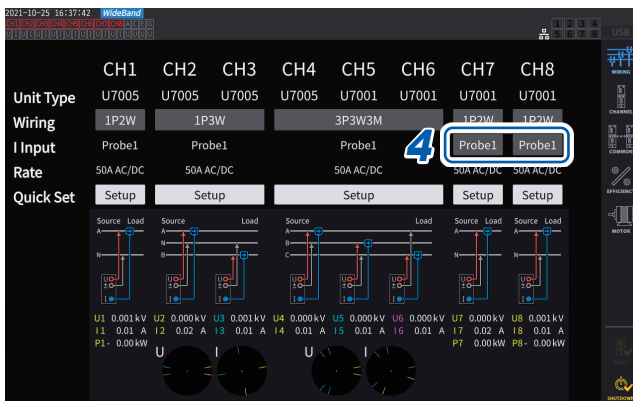
Probe1	Select this option when the current sensor is connected to the Probe 1 terminal (for high-performance current sensors). The rate is automatically set.
Probe2	Select this option when the current sensor is connected to the Probe 2 terminal (for current sensors). Set the rate individually. Tap the rate-selection button, and then select the rate or the product model name of the connected current sensor.

When using a current sensor whose rating can be switched, match the rating of current sensors in the same line.

If a wiring pattern using multiple channels is selected, the parameters that can be set for each channel (such as the voltage range) are unified to those of the first channel.

> **IMPORTANT**
>
> If different types of input modules are used in the same wiring configuration, the measurement accuracy of the U7001 applies to the measurement accuracy of all measured values within the wiring system. The accuracy of values measured with the U7005 is also the same as that of the U7001.

2

Preparing for Measurement

43

Wiring mode

1P2W (single-phase 2-wire)	Select this wiring mode when measuring a DC line. The current sensor can be connected to either the source or ground terminal. The wiring diagrams include examples of both. See "Wiring diagrams" (p. 52).
1P3W (single-phase 3-wire)	—
3P3W2M (3-phase 3-wire)	Select this wiring mode when using the two-wattmeter method with two channels to measure a three-phase delta configuration. It enables accurate measurement of active power even when waveforms are distorted due to an unbalanced state. Apparent power, reactive power, and power factor values for unbalanced lines may differ from corresponding values obtained from other measuring instruments. In such a case, use 3V3A or 3P3W3M wiring mode.
3V3A (3-phase 3-wire)	Select this wiring mode when using the two-wattmeter method with three channels to measure a three-phase delta configuration, which is used when you emphasize compatibility with legacy power meters such as the Hioki 3193. It allows accurate measurement of not only active power, but also apparent and reactive power and power factor even with unbalanced lines.
3P3W3M (3-phase 3-wire)	Select this wiring mode when using the three-wattmeter method with three channels to measure a three-phase delta configuration. It allows accurate measurement even if the instrument in 3V3A wiring mode yields an error due to leakage current with large high-frequency component when measuring a PWM inverter, making it well suited to motor power measurement.
3P4W (3-phase 4-wire)	Select this wiring mode when using the three-wattmeter method with three channels to measure a three-phase Y (star) configuration.

Current sensor auto-recognition function

The instrument automatically acquires the rated current, phase compensation values, and other information of the current sensor connected to the instrument.
This function can significantly reduce the setting time before measurement, and measure the power based on accurate sensor information.
(Only for current sensors supporting the auto-recognition function)

In the following cases, the instrument automatically acquires only the rated current of the current sensor connected to the instrument.
- When a current sensor not equipped with the auto-recognition function is connected to the instrument
- If the instrument fails to read current-sensor information, including phase compensation values

List of optional current sensors

See "Optional products for current measurement" (p. 5).

Compensating for phase errors of current sensors

Current sensors generally exhibit a tendency for phase error to increase gradually in the high-frequency region of their frequency band. By using sensor-specific phase characteristics information to correct the measured values, it is possible to reduce the error component in power measurement made in a high-frequency region.

Conceptual diagram

○: Phase characteristics after compensation
Δ: Phase characteristics before compensation
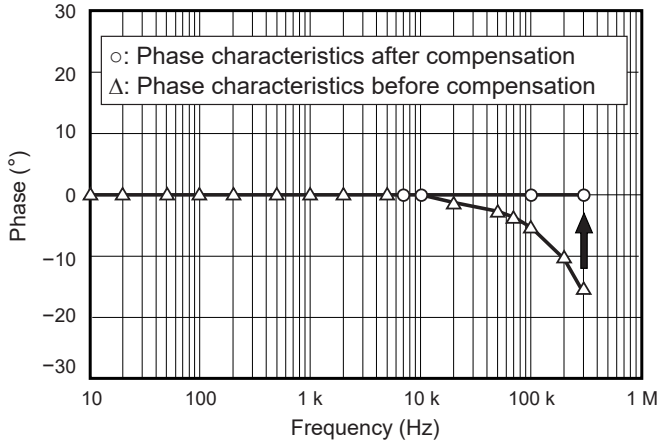
Tips **Phase compensation of current sensors with auto-recognition function**

When using a current sensor with the auto-recognition function, the phase of the current sensor is automatically corrected. If you wish to set any phase compensation values, follow the steps listed in the following "How to enter phase compensation values" section.

How to enter phase compensation values

For current sensors without the auto-recognition function, it is recommended to perform phase compensation for the current sensor before measurement.

Display screen [INPUT] > [CHANNEL]
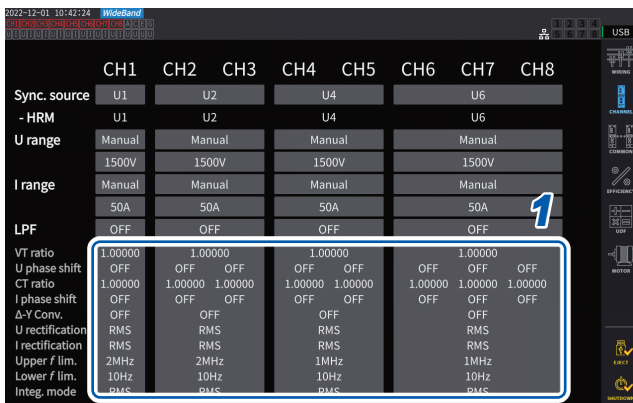
1 Tap the detailed display area for the channel to be configured.

2 Tap the [*Phase Shift*] area box and select [On].

When using a current sensor equipped with the auto-recognition function, [Auto] is displayed as an alternatives. When [Auto] is selected, the compensation values are entered automatically.

3 Tap the frequency box, then enter the frequency with the numeric keypad.

4 Tap the phase difference box, then enter the phase difference with the numeric keypad.

5 Tap [×] to close the setting window.
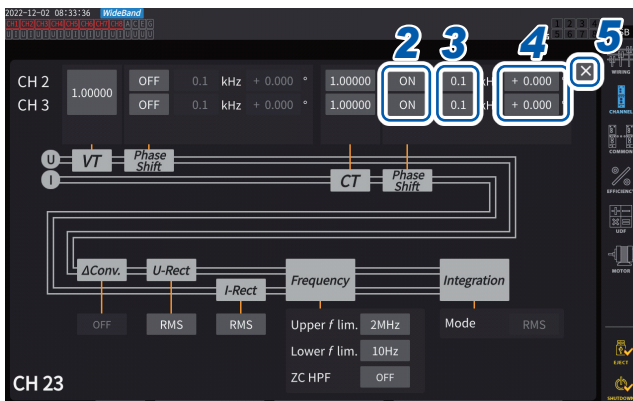
IMPORTANT
• Enter the phase compensation value accurately. Invalid settings can cause the compensation process to increase measurement error.
• Operation outside the frequency range within which the current sensor's phase accuracy is specified is not defined.

Typical values of current sensors' phase characteristics

See the table below for information about the current sensor phase characteristics.

You can find typical values of current sensors' phase characteristics not described in the table below on Hioki's website.

Visit https://www.hioki.com and search for *typical values of current sensors' phase characteristics*.

Model name	Frequency (kHz)	Representative value of phase difference between input and output (°)
CT6841	100.0	−1.82
CT6843	100.0	−1.68
CT6844	50.0	−1.29
CT6845	20.0	−0.62
CT6846	20.0	−1.89
CT6862	300.0	−10.96
CT6863	100.0	−4.60
CT6865	1.0	−1.21
CT6875	200.0	−10.45
CT6875-01	200.0	−12.87
CT6876	200.0	−12.96
CT6876-01	200.0	−14.34
CT6877	100.0	−2.63
CT6877-01	100.0	−3.34
CT6904	300.0	−9.82
9709	20.0	−1.11
PW9100	300.0	−2.80

For all current sensors, the values are representative ones under the following conditions.

• Standard cable length (not using the extension cable)
• With the conductor positioned at the center of the sensor

For the phase characteristics information when using CT9557, contact your authorized Hioki distributor or reseller.

2.6 Simple Configuration (Quick Set)

The measurement conditions are set to the representative values according to the selected lines to be measured. This functionality is useful when you are using the instrument for the first time or when you need to measure lines that differ from those measured last.

Display screen [INPUT] > [WIRING]
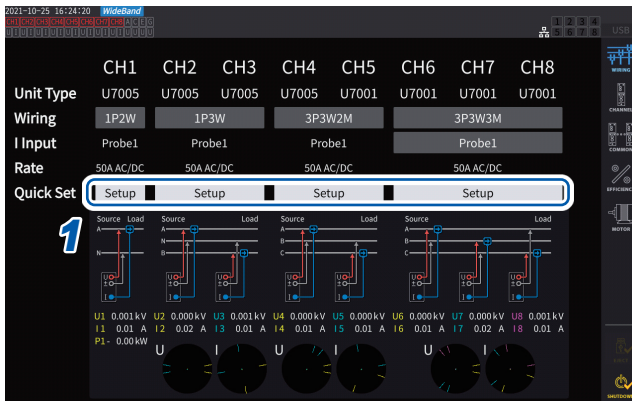
1 Tap [Setup] in the [Quick Set] box.

2 Touch the type of the line to be measured to select it from the list.
A confirmation window will open.

3 Tap [Yes] to accept the setting.

4 Check the setting details on [INPUT] > the [CHANNEL] screen.
Change the settings as necessary.

Types of lines under measurement

50/60Hz	Select this type to measure a commercial power line over a broad range of frequencies.
DC/WLTP	Select this type to measure DC line over a broad range of frequencies. The settings are suitable for measuring the charging/recharging cycle of a battery or a DC line, specified in the worldwide harmonized light vehicles test procedure (WLTP). When making measurement in conformity with WLTP, set the data update interval at 50 ms or less. This setting is selectable only in 1P2W wiring mode.
PWM	Select this type to measure a PWM line. A fundamental frequency of 1 Hz to 1 kHz is used so that it does not synchronize with the carrier frequency of 1 kHz or more. It is recommended to use the sensor phase compensation function to facilitate more accurate measurement.
HIGH FREQ	Select this type to measure a high-frequency source with a frequency of at least 10 kHz. It is recommended to use the sensor phase compensation function to facilitate more accurate measurement.
GENERAL	Select this type to measure lines other than the [50/60Hz], [DC/WLTP], [PWM], or [HIGH FREQ] type. Also use this setting when the object under measurement is not well known. It is recommended to use the sensor phase compensation function to facilitate more accurate measurement.

Setting details

Lines under measurement	Sync. source	Current range	Upper frequency limit	Lower frequency limit	Integration mode	U/I rectification method	LPF
50/60Hz	Voltage	Automatic	100 Hz	10 Hz	RMS	RMS/RMS	OFF
DC/WLTP	DC	Automatic	100 Hz	10 Hz	DC	RMS/RMS	OFF
PWM	Voltage	Automatic	1 kHz	1 Hz	RMS	MEAN/RMS	OFF
HIGH FREQ	Voltage	Automatic	1 MHz	1 kHz	RMS	RMS/RMS	OFF
GENERAL	Voltage	Automatic	1 MHz	0.1 Hz	RMS	RMS/RMS	OFF

2.7 Measurement Mode

This section describes how to choose a measurement mode.

Display screen **[INPUT]** > **[COMMON]**
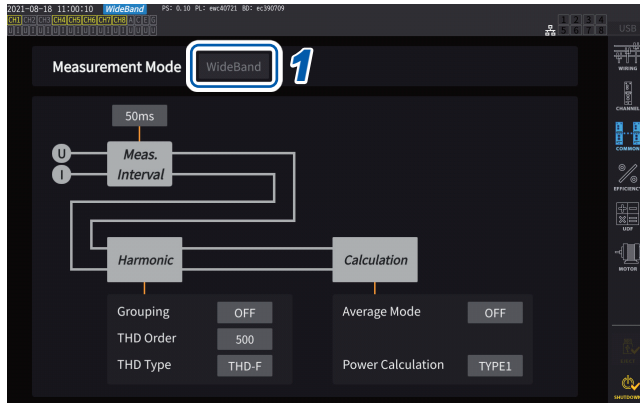
1 Tap the **[Measurement mode]** box and select a measurement mode.

IEC	Select to use IEC measurement mode. When the measured line has a frequency of 50 Hz or 60 Hz, the instrument performs harmonic measurement that complies with the IEC 61000-4-7 standard and voltage fluctuation/flicker measurement that complies with the IEC 61000-4-15 standard. Harmonic measured values will be updated at intervals of 200 ms. Harmonic measurement or voltage fluctuation/flicker measurement will not be performed if the frequency being measured falls outside the range of 45 Hz to 66 Hz. Analysis can be performed up to the 50th order.
WideBand	Select to use wideband measurement mode. It can be used with a wide range of frequencies from 0.1 Hz to 300 kHz. The analysis order varies with the frequency being measured. When the data update interval is set at 10 ms or less, measured harmonic values will be updated at intervals of 50 ms.

- Settings cannot be switched on a wiring configuration or channel basis.
- The same synchronization source will be used for each channel's harmonic measurement.
  Note, however, that if **[Zph1]** is selected as the synchronization source and **[Ext1]** can be selected, either **[Ext1]** or **[Zph1]** can be selected as the synchronization source for harmonic measurement. When **[Zph3]** is selected and **[Ext3]** can be selected, either **[Ext3]** or **[Zph3]** can be selected as the synchronization source for harmonic measurement.
  See "Synchronization source" (p. 64).
- Accurate harmonic measurement is not possible if the frequency of the input signal set as the synchronization source fluctuates or if the input signal exhibits a low level relative to the range.

In IEC measurement mode, internal calculation processing differs from the regular measurement mode to realize measurements in compliance with the IEC standard. Thus, some functions are restricted in IEC measurement mode.

Data update interval	Fixed at 200 ms.
Data outputting interval	100 ms or more
Synchronization source	Only U and I are selectable.
Upper frequency limit	Fixed at 100 Hz
Lower frequency limit	Fixed at 10 Hz
HPF	Fixed to off
Average Mode	Only exponential averaging
Exponential-averaging response speed	No options available
Optical link	Fixed to off
Harmonic analysis order	Up to 200th order
Integration	Fix to integration for all channels
Integration operation	Cumulative integration cannot be performed (function to resume integration in a stopped state from the point where it was stopped).
Simple settings	Only 50 Hz and 60 Hz

2

Preparing for Measurement

49

2.8 Zero Adjustment and Degaussing (Demagnetization)

Before connecting the instrument, perform zero adjustment while no voltage or current is inputted. Zero adjustment is performed for all ranges and for all input channels at the same time. In addition, if a current sensor that can measure both AC and DC currents is connected to the instrument, the current sensor will be degaussed (demagnetization, DMAG) at the same time.

1 **Allow the instrument to warm up for 30 minutes or more while it has been turned on.**

2 **Connect the current sensors and the voltage cords to the instrument.**

Adjustment of measured current values must include the current sensors.

3 **When zero adjustment can be performed on the current sensor connected to the instrument, perform zero adjustment on the current sensor side.**

Some current sensors may have an element, such as a knob, to perform zero adjustment. See the Instruction Manual of the current sensor. If it contains any instructions regarding connecting to equipment with a zero correction function, follow them.

4 **Set wiring modes and configure current sensor settings.**

5 **Press the MEAS key.**

If Ch. 1 through Ch. 8 are lit up, zero adjustment will be performed for voltage and current.
If the **[A-D]** and **[E-H]** channel indicators are lit up, zero adjustment will be performed for the motor input channels.

6 **Press 0ADJ.**

7 **When the confirmation dialog box appears, tap [Yes].**

The screen will display **[Performing zero adjustment.]** and the process will be completed in about 30 s.
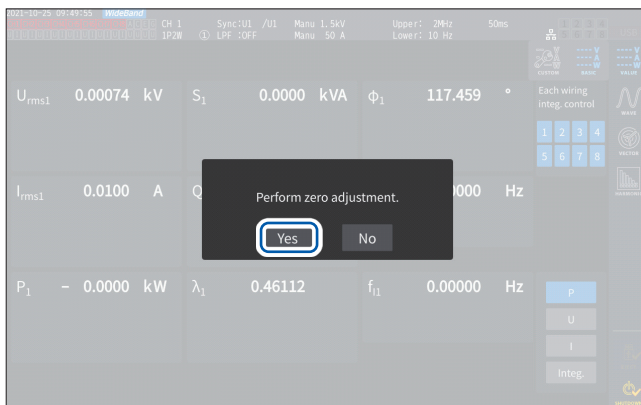
8 **Connecting the sensor and leads to the lines to be measured.**

2.9 Connecting Measurement Leads and Sensors to Lines to Be Measured

Perform zero adjustment, and then connect voltage cords and current sensors to lines to be measured as indicated in the wiring diagram shown on **[INPUT]** > the **[WIRING]** screen. To ensure accurate measurement, connect the instrument exactly as shown on **[INPUT]** > the **[WIRING]** screen.

The wiring diagram will be displayed when you select a wiring mode on **[INPUT]** > the **[WIRING]** screen.

See "2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43).

2

Preparing for Measurement

Voltage Cord
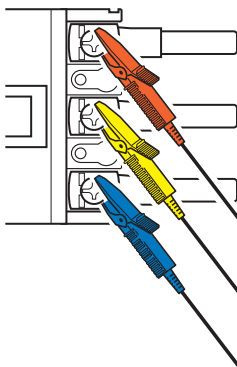
Firmly clip the voltage cords to the metallic parts on the power supply side, such as screws and bus bars

Current sensor
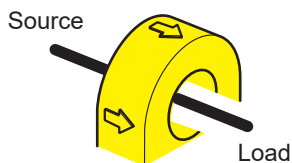
Clamp the current sensor around a conductor so that its current direction mark points at the load side.

Source

Load

OK

NO
Do not clamp the sensor around two or more conductors.

NO
Do not pinch the conductor.
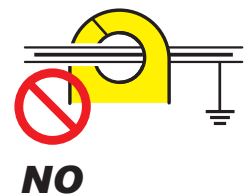
NO
Do not clamp the sensor to a shielded wire.

IMPORTANT
- The phases are labeled as *A*, *B*, *C* on the wiring diagram screen. Connect the instrument based on whatever names you are using, such as *R/S/T* and *U/V/W*, as appropriate.
- Clamp the sensor around only one conductor. Clamping the sensor around two or more of conductors in a bundle prevents the instrument from measuring any current regardless of whether the measurement target is a single-phase or three-phase circuit.

Wiring diagrams

Single-phase 2-wire (1P2W)
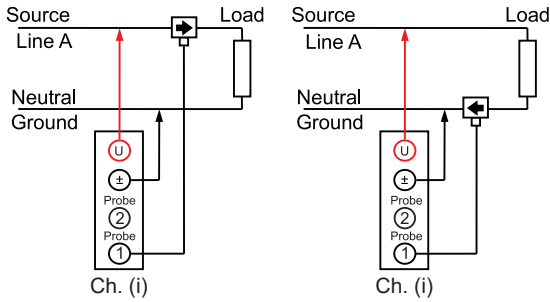
Single-phase 3-wire (1P3W)
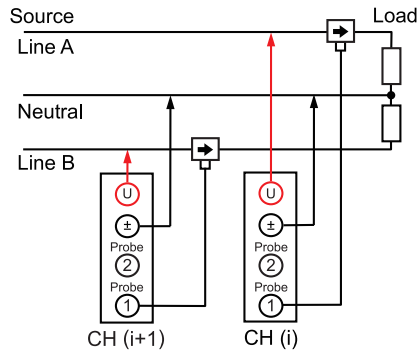
3-phase 3-wire (3P3W2M)
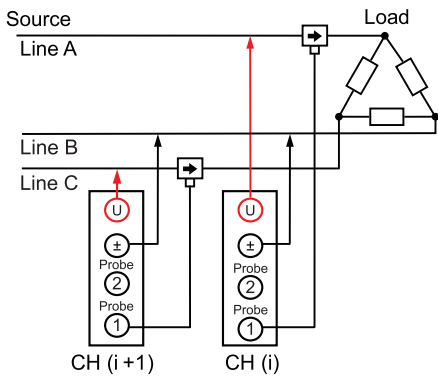
3-phase 3-wire (3V3A)
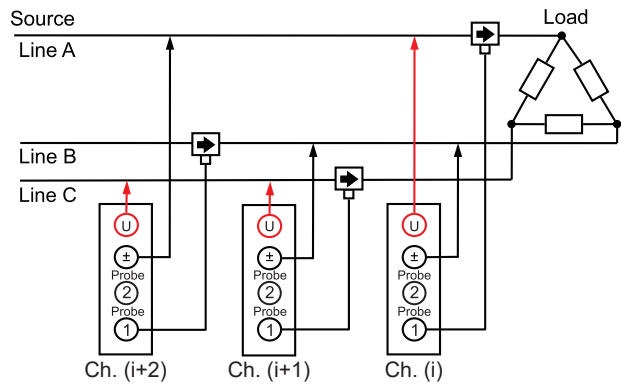
3-phase 3-wire (3P3W3M)
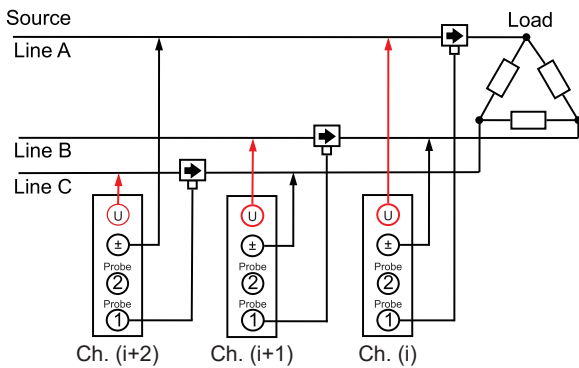
3-phase 4-wire (3P4W)
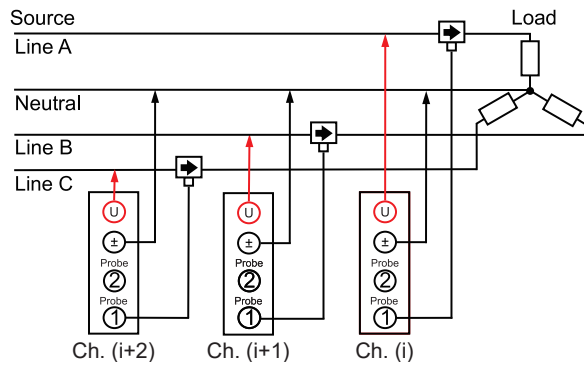
Normal connection when using the PW9100A
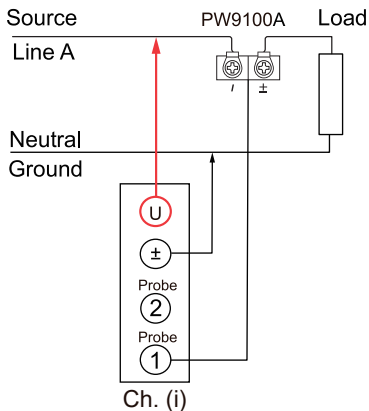
When the PW9100A and either PT or CT are used
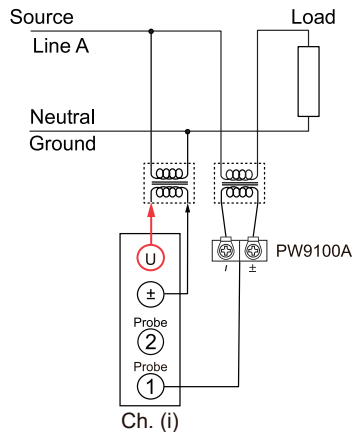
2.10 Checking Connections

Based on the measured values and vectors on the screen, you can check whether the voltage cords and the current sensors are connected properly.

Display screen [INPUT] > [WIRING]

1P2W mode
When the cords and sensors are properly connected, the measured values are displayed.
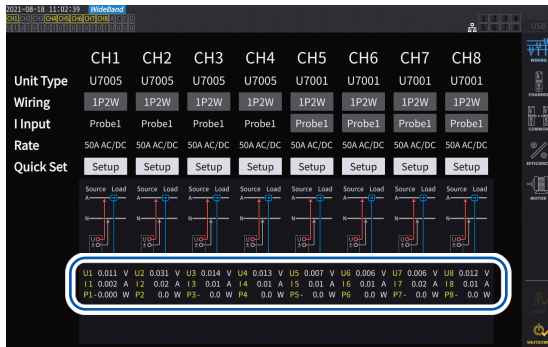
Wiring mode other than 1P2W mode
The measured values and vector lines are displayed. When the cords and sensors are properly connected, the vector lines indicates the proper range.
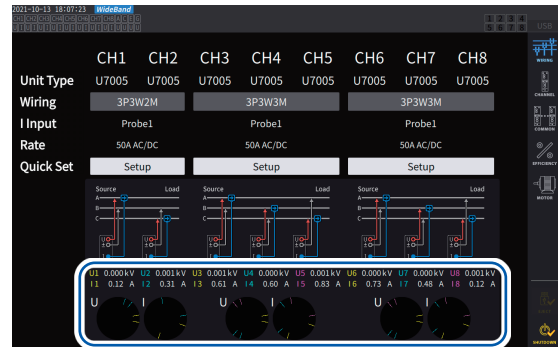
- The vector lines are shown in the same colors as those of measured values' items.
- The indication range used in vector diagrams assumes an inductive load (such as a motor).
- Vectors may exit the range when the power factor approaches zero or when a capacitive load is measured.
- The measured value of active power P for individual channels may be negative for 3P3W2M and 3V3A lines.

Problem	Cause
The measured voltage value is too high or too low.	• The voltage cord connectors have insufficiently been inserted into the instrument's voltage input terminals. • The voltage cords have improperly been connected to the lines under measurement.
The measured current value is not appropriate.	• The current sensor connectors have insufficiently been inserted into the instrument's current sensor input terminals. • The current sensors have improperly been connected to the lines under measurement. • The Probe 1 and Probe 2 settings have not matched the terminals into which the current sensors' connectors have been inserted.
The measured active power value is negative.	• The voltage cords have improperly been connected to the lines under measurement. • The current sensors' current direction mark (arrow) have not pointed at the load side but the source side.
The instrument does not display an active power but zero.	• The zero suppress setting is not set to off.
The vector arrow is too short or the vector lengths differ.	**For voltage vectors** • The voltage cords have improperly been connected to the lines under measurement.
	For current vectors • The current sensors have improperly been connected to the lines under measurement. • The connected current sensors are inappropriate for currents flowing through the line under measurement. • The [Sync. source] setting has been set improperly.
The vector direction (phase) and color differ.	• The voltage cords and current sensors have been connected to the inappropriate terminals.

See "2.2 Connecting the Voltage Cords (Voltage Input)" (p. 35), "2.3 Connecting the Current Sensors (Current Input)" (p. 36), and "2.9 Connecting Measurement Leads and Sensors to Lines to Be Measured" (p. 51).

2

Preparing for Measurement

3 Displaying Power Numerically

All measured data is displayed on the Measurement screen.

If the **MEAS** key does not light up, press the **MEAS** key to activate the Measurement screen.

3.1 Displaying Measured Values

Basic screen

The basic screen displays the measured values of the selected channel.

Display screen **[MEAS]** > **[VALUE]** > **[BASIC]**
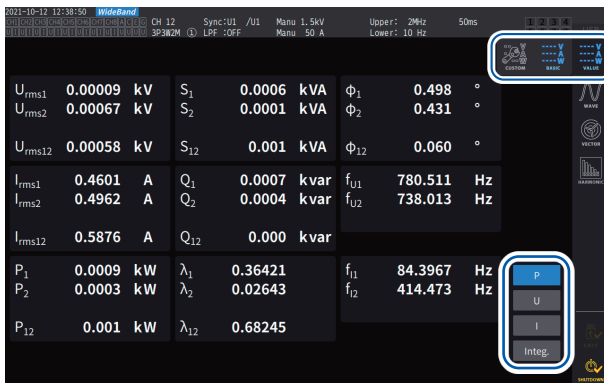
1 **Select the measured values to display.**

P	Measured power value (p.58)
U	Measured voltage value (p.59)
I	Measured current value (p.59)
Integ.	Integrated measured value (p.70)

2 **Switch the displayed channel using the ◄CH► keys for channel selection.**

Custom screen

The custom screen allows you to select necessary items from all the basic measurement items being measured and display them on a single screen.

Display screen **[MEAS]** > **[VALUE]** > **[CUSTOM]**

8-parameter display
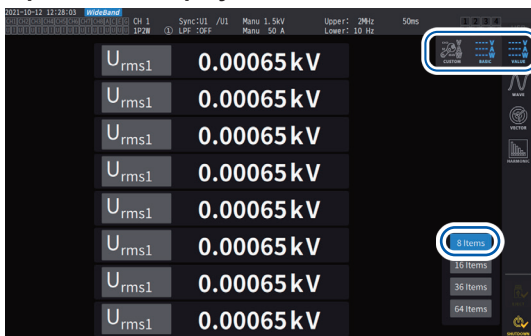
16-parameter display

36-parameter display
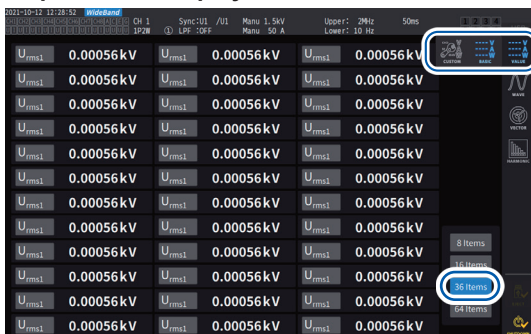
64-parameter display
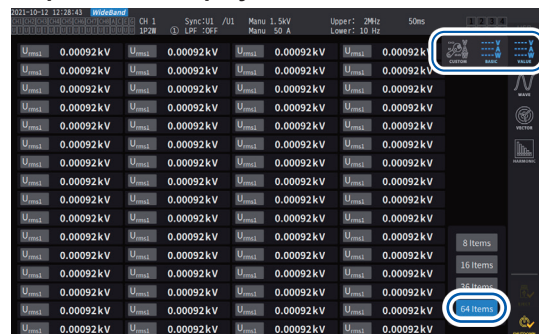
Display item settings

`Display screen` **[MEAS]** > **[VALUE]** > **[CUSTOM]**
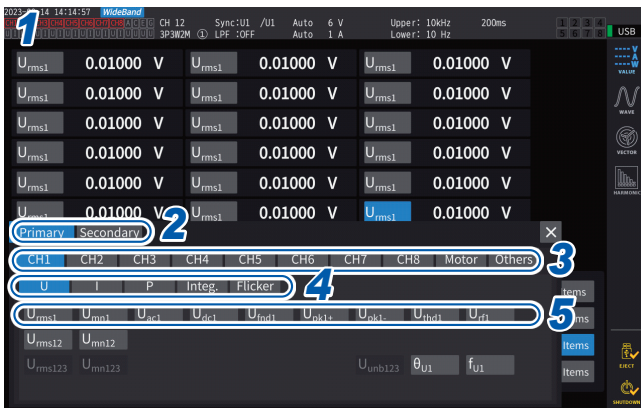
1 Tap the item name box to open the settings window.

2 When making synchronous measurements, tap **[Primary]** or **[Secondary]** to select.

Primary	Set the instrument as the primary instrument.
Secondary	Set the instrument as a secondary instrument.

3 Tap a channel to select it.

CH1 to CH8	Basic measurement items
Motor	Motor analysis item
Others	Items to be set using equations

4 For Ch. 1 to Ch. 8, tap **[U]**, **[I]**, **[P]**, **[Integ.]** or **[Flicker]** to select.

5 Tap an item from the displayable-item list to select it.

Effective measurement range and displayable range

In general, the instrument's effective measurement range (the range in which measurement accuracy is guaranteed) is 1% to 110% of the measurement range. The instrument can display 0% to 150% of the measurement range (up to 135% for the 1500 V range).
See "10.4 Detailed Specifications of Measurement Parameters" (p. 280).
Exceeding either of these ranges will trigger the following display, which indicates an overload condition occurs.

The value display area will be left blank when **[OFF]** is selected as the display parameter or when the setting is such that the selected item becomes invalid.
Example: Selecting P123 while using the 3P4W setting and then reverting the wiring mode to 1P2W so that P123 is invalid, etc.

If the input level is less than 0.5% of the measurement range, the measured value remains zero.
Set the zero suppress setting to off to display to a lower level.

Displayed items

The value calculated as the overall value of the measured values of two or more channels is displayed as follows.

U_{rms123}	Averaged voltage RMS value of the three phases
I_{rms123}	Averaged current RMS value of the three phases
P_{123}	Sum of power RMS values of the three phases

See "10.5 Specifications of Equations" (p. 291).

3

Displaying Power Numerically

3.2 Measuring Power

The basic screen is used to view measured power values for each lines under measurement. The screen provides functions for listing measured power values for each specified wiring configuration and displaying measured voltage and current values in detail.

You can change the on-screen channels using the channel-selection keys as well as the voltage and current range.

Press the **[MEAS]** key, then tap **[VALUE]** > **[BASIC]**, and then select the basic screen.

Select **[P]** (power screen), **[U]** (voltage screen), **[I]** (current screen), or **[Integ.]** (integration screen) from the screen icons.

Displaying measured power values

Display screen　**[MEAS]** > **[VALUE]** > **[BASIC]**
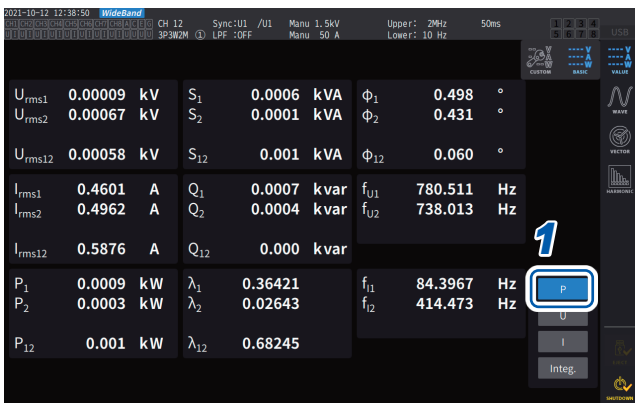
1 Tap **[P]**.

2 Switch the displayed channel using the **◄CH►** keys for channel selection.

Urms	Voltage RMS value
Irms	Current RMS value
P	Active power
S	Apparent power
Q	Reactive power
λ	Power factor
Φ	Power phase angle
fU	Voltage frequency
fI	Current frequency

- Depending on the rectification setting, mean-value rectified RMS equivalent values (mean values) will be displayed in the voltage RMS value (Urms) and current RMS value (Irms) display areas.
  See "Rectification method" (p. 68).

- Polarity signs for power factor (λ), reactive power (Q), and power phase angle (ϕ) indicate the lead/lag polarity, with no sign indicating lag and a minus sign (−) indicating lead.

- The polarity sign for fundamental wave power factor (λfnd) and fundamental wave reactive power (Qfnd), which are calculated using measured harmonic values, indicates the sign of the calculation, which is the opposite of the signs of power factor (λ) and reactive power (Q). (when the power equation is set to Type 1)
  See "10.5 Specifications of Equations" (p. 291).

- The polarity sign for power factor, reactive power, and power phase angle may not stabilize when there is a large difference between the voltage and current levels or when the power phase angle approaches 0°.

- In 3P3W2M or 3V3A wiring mode, active power (P), reactive power (Q), apparent power (S), and power factor (λ) are undefined for all channels. Use only the sum value*.

  *: When using a connection other than 1P2W, measured power value calculated as the sum of measured values of at least two channels (for example, P123, S456, Q34).

> **IMPORTANT**
>
> Measured values may be displayed for channels without input due to the effects of surrounding noise. Due to induced voltage, displayed values may become unstable with no input; however, this is not a malfunction.

Displaying measured voltage or current values

Display screen **[MEAS]** > **[VALUE]** > **[BASIC]**

Example: Displaying measured voltage values

*1: When DC has been selected as the integration mode, the ripple rate will be displayed instead of the total harmonic distortion.

*2: This is displayed in 3V3A, 3P3W3M, or 3P4W wiring mode.
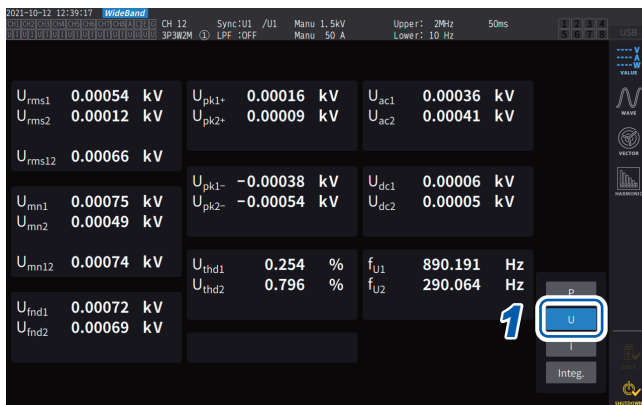
1 Tap **[U]** (voltage) or **[I]** (current).

2 Switch the channel to be displayed using the ◀**CH**▶ keys for channel selection.

Urms	Voltage RMS value
Umn	RMS equivalent of average rectified voltage value
Uac	Voltage AC component (AC)
Udc	Voltage simple average (DC)
Ufnd	Voltage fundamental wave component
Upk+	Voltage waveform peak (+)
Upk−	Voltage waveform peak (−)
Uthd	Total harmonic distortion*1
Uunb	Unbalance rate*2
fu	Voltage frequency

3

Displaying Power Numerically

Voltage range and current range

Set the optimal voltage range and current range according to voltage and current of the object under measurement. To ensure precise measurement, select the smallest range that is larger than the input level for both voltage and current.

Range settings on the Measurement screen
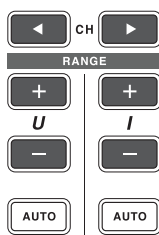
1 Use the ◀**CH**▶ keys for channel selection to light up the channel you wish to change the range.

The displayed channel will change each time the ◀**CH**▶ keys are pressed.
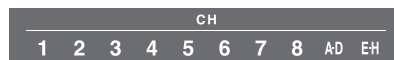
2 Set the range with the **RANGE** key or the **AUTO** key.

See "1.3 Part Names and Functions" (p. 17).

Auto-ranging and manual ranging

AUTO (Off)	**Manual ranging** Allows you to set the range as desired. (Repeatedly press the **+** and **−** keys under **RANGE** for both voltage U and current I until the desired range is shown.)
AUTO (Lit up in green)	**Auto-ranging** Sets the optimal voltage range and current range for each wiring configuration automatically based on the input. (Press the **AUTO** keys under the **RANGE** key.)

Display of ranges

The voltage and current ranges are displayed in the settings indicator area on the Measurement screen as shown below at all times.

The on-screen ranges and other information are for the channels whose indicators are lit up.
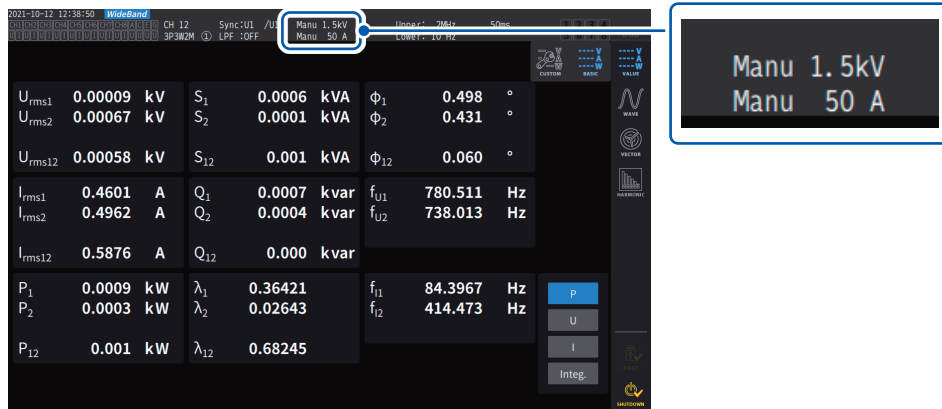
Power range

The power range is used to measure active power P, apparent power S, and reactive power Q.

The power range is determined as follows based on the voltage range, current range, and wiring configuration.

See "Power range configuration" (p. 288).

Example: For active power P (same applies to S and Q)	Power range
P1, P2, P3, P4, P5, P6, P7, P8	(Voltage range) × (Current range)
P12, P23, P34, P45, P56, P67, P78	2 × (Voltage range) × (Current range)
P123, P234, P345, P456, P567, P678 of 3V3A and 3P3W3M	2 × (Voltage range) × (Current range)
P123, P234, P345, P456, P567, P678 of 3P4W	3 × (Voltage range) × (Current range)

Range settings on [INPUT] > the [CHANNEL] screen

You can choose between the manual and auto-ranging. When multiple channels are combined in any mode other than 1P2W mode, all combined channels are forced to use the same range.

Display screen [INPUT] > [CHANNEL]
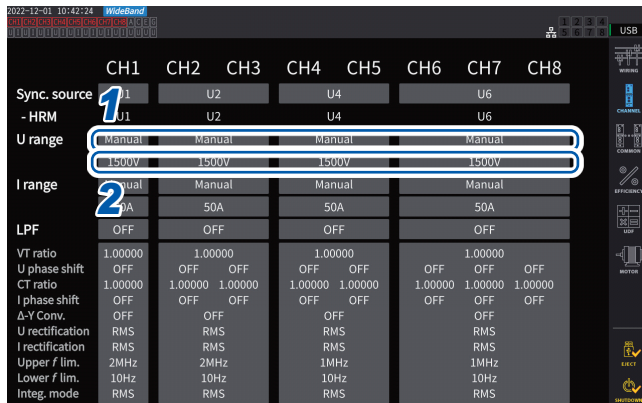
1 Tap the [U range] box of the wiring configuration you wish to set and select [Manual] or [Auto].

When [Auto] is selected, the voltage range will be selected automatically.

2 When [Manual] is selected, set the voltage range.

Set the current range in the same way.

Automatic range switching conditions

When Δ–Y conversion is enabled, the range switching is determined by multiplying the range by $1/\sqrt{3}$ (multiplying by approximately 0.57735).

See "Δ–Y conversion" (p. 145).

Switching range above	When one wiring configuration meets one of the following conditions, the range is switched over to a one immediately above. • RMS value is greater than or equal to 110% of range. • Absolute value of peak value is greater than or equal to 300% of range.
Switching range below	If all channels in the wiring configuration meet all of the following conditions, the range is switched over to a one immediately below. • RMS value is less than or equal to 40% of range. • Absolute value of peak value is less than or equal to 280% of the range immediately below.

(Tips) When the range does not switch immediately

Make sure that the inputs are synchronized, and then set the [Lower f lim] in the [CHANNEL] screen to 1 Hz or higher. Synchronization of the inputs can be confirmed if the synchronization-unlocked indicator is not lit up in yellow.

When the range switches frequently

It is recommended to select a range manually.
See "Voltage range and current range" (p. 59).

Setting the zero suppress

The zero suppress capability allows values less than the value set for the measurement range to be treated as zero.

If you want to measure even a tiny input relative to the range, set it to **[OFF]**

Display screen **[INPUT]** > **[COMMON]**
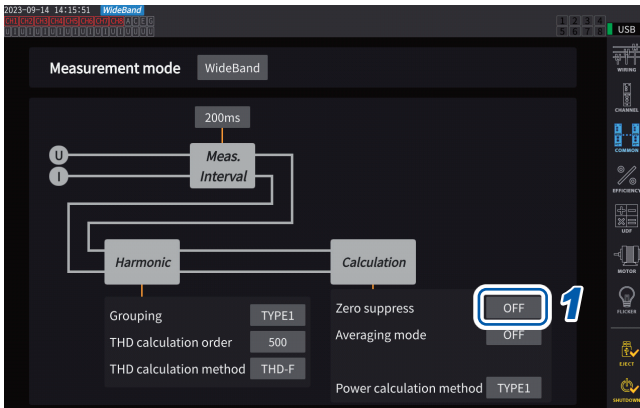
OFF	Does not enable the zero suppress capability.
ON (0.5% f.s.)	Allows values less than the value set for the measurement range to be zero.

Data update interval

Measured values are calculated from the voltage and current waveforms, and the period for updating the measured data is set.

Data acquired through communications, analog output data from D/A output, and data saved in interval saving will be updated at the update intervals set here.

Display screen [INPUT] > [COMMON]
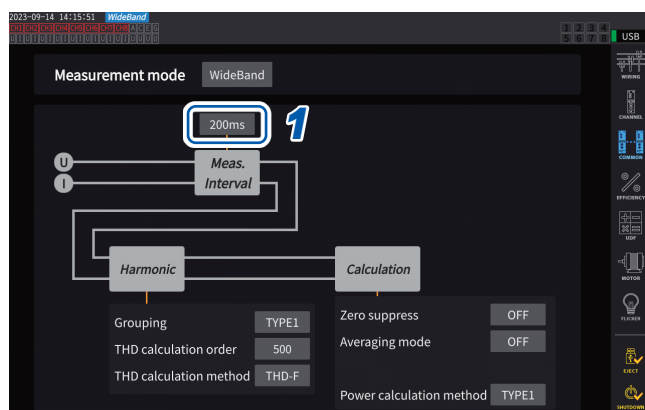
1 Tap the [*Meas. Interval*] box and select the data update interval from the list.

Data update interval

1 ms	Select when you wish to acquire slight fluctuations.
	Even when 1 ms is selected, harmonic analysis operates at 50 ms intervals.
	The 1 ms interval cannot be used during the optical link and BNC-synchronization.
	For frequencies lower than 1 kHz, the update interval may be a whole number multiple of 1 ms.
	
	This setting cannot be used with each of the following functions:
	• Average
	  If the data update interval is set to 1 ms, the average function will be set to OFF.
	• User-defined formula
	  The instrument will display [-------].

10 ms	Select this interval when measuring fast power fluctuations. Even when 10 ms is selected, harmonic analysis operates at 50 ms intervals. The 10 ms interval cannot be used during the optical link and BNC-synchronization. For frequencies lower than 100 Hz, the update interval may be a whole number multiple of 10 ms.
50 ms	In general, select [50 ms]. This option provides a good balance between speed and accuracy. For frequencies lower than 20 Hz, the update interval may be a whole number multiple of 50 ms.
200 ms	Select this interval when the measured values are unstable at 50 ms due to large fluctuations. Also select when IEC measurement mode is used for harmonics measurement. The data is updated almost simultaneously with the display refresh interval. For frequencies lower than 5 Hz, the refresh rate may be a whole number multiple of 200 ms.

- Settings cannot be switched by on a wiring configuration or channel basis.
- The display refresh interval is fixed at approximately 200 ms regardless of this setting.
- If the measured values are unstable even when 200 ms is selected, use the average function together.
- To obtain a D/A output close to the smooth analog output of the previous model, 3193, select 10 ms and combine this setting with the exponential average or moving average of the average function.

Synchronization source

This section describes how to set the source for each wiring configuration, which determines the period (between zero-crossing points) that serves as the basis for various calculations.

In general use, select the measurement channel's voltage for channels measuring AC current or [DC] for channels measuring DC current.

Display screen [INPUT] > [CHANNEL]

1 Tap the [Sync. source] box of the wiring configuration you wish to set to open the setting window.

The set synchronization source will be displayed by the [Sync] setting indicator at the top of the Measurement screen.

2 Tap a synchronization source module to select it.

Synchronization source module

U1 to **U8**	Set this when performing measurement with respect to a voltage signal.
I1 to **I8**	Set this when performing measurement with respect to a current signal.
DC	Set this when performing measurement with respect to the data update interval.
Ext1 to **Ext4**	This may be used be set when the input settings of the following channels of the motor analysis-equipped model are [Speed] (pulse input) and the remainder of {(pulse count) / [(Number of poles) / 2]} is zero. Ext1: Ch. B, Ext2: Ch. D, Ext3: Ch. F, Ext4: Ch. H Set this for measurement with respect to a pulse pulses in motor analysis or when measuring electrical angles.
Zph1, **Zph3**	This can be set when the input settings of the following channels of the motor analysis-equipped model are [Origin] (pulse input). Zph1: Ch. D, Zph3: Ch. H Set this if you wish to obtain measurement results synchronized to one cycle of the motor's mechanical angle during motor analysis.
CH B, **CH D**, **CH F**, **CH H**	This may be used be set when the operation mode of the relevant channel of the motor analysis-equipped model is [Individual] mode. Set this when you wish to perform measurement synchronized to an external signal (pulse input).

- The same synchronization source will be set for each channel's voltage and current.
- The same synchronization source will be used for each channel's harmonic measurement. Note, however, that if **[Zph1]** is selected as the synchronization source and **[Ext1]** is selectable, either **[Ext1]** or **[Zph1]** is selectable as the synchronization source for harmonic measurement. When **[Zph3]** is selected and **[Ext3]** is selectable, either **[Ext3]** or **[Zph3]** is selectable as the synchronization source for harmonic measurement.
- For channels measuring AC current, select an input with the same frequency as the measured signal's frequency as the synchronization source. If the frequency of the signal selected as the synchronization source differs significantly from the measured signal's frequency, the instrument may display a frequency that differs from the input, and measured values may become unstable.
- Segments for which **[DC]** has been selected will be matched with the data update interval (1 ms, 10 ms, 50 ms, 200 ms). If AC input is measured using the **[DC]** setting, the displayed values may fluctuate, making accurate measurement impossible.
- If a frequency lower than the measurement lower frequency limit setting or higher than the measurement upper frequency limit setting is inputted as the synchronization source while the synchronization source is set to a setting other than **[DC]**, the instrument may display a frequency that differs from the input, and measured values may become unstable.
- Selecting **[Ext]** makes it easier to achieve synchronization when the motor's RPM varies over short periods of time, making it useful in power analysis.
  See "Measuring the electric angle of the motor" (p. 104).
- When you select **[Zph.]**, you can perform harmonic analysis based on one motor revolution (one cycle of the mechanical angle).
- The zero-crossing interval cannot be acquired when the synchronization source for a channel to which DC is being input is set to voltage or current. The instrument will operate with a synchronization frequency equivalent to approximately one period of the measurement lower frequency limit.
- Frequencies lying close to the measurement lower frequency limit setting may cause channels to enter a synchronization-unlocked condition, resulting in unstable measured values.
- By inputting a pulse signal to Ch. B, Ch. D, Ch. F, or Ch. H of the instrument with the motor analysis and selecting Ch. B, Ch. D, Ch. F, or Ch. H, respectively, as the synchronization source, you can set the measurement timing as desired. Note that the rising edge of the input pulse is detected for Ch. B, Ch. D, Ch. F, and Ch. H.

Synchronization-unlocked condition

Channels that cannot be synchronized to the synchronization source will fall into a synchronization-unlocked condition, preventing accurate measurement.
Check synchronization source input.
A warning indicator will come on to indicate a synchronization-unlocked condition occurs.
See "Common screen display" (p. 25).

3

Displaying Power Numerically

Low-pass filter (LPF)

The instrument provides a low-pass filter function to limit the frequency band.
This filter can eliminate frequency components and unnecessary external noise components that exceed the set frequency. Normally, you should disable the low-pass filter during measurement.

Display screen **[INPUT]** > **[CHANNEL]**
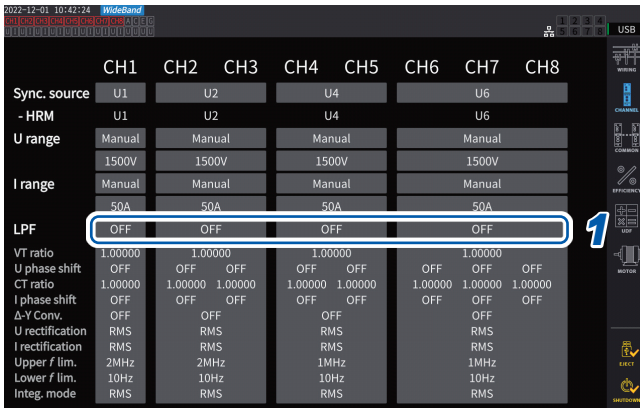
1 **Tap the [LPF] box of the wiring configuration you wish to set, and select a low-pass filter (LPF) from the list.**

This can be set for each wiring configuration. Swipe the touchscreen to scroll the list, then select the cutoff frequency for other wiring configurations.

500 Hz, **1 kHz**, **5 kHz**, **10 kHz**, **50 kHz**, **100 kHz**, **500 kHz**, **2 MHz** (selectable for the U7005 only), **OFF**

The set low-pass filter will be displayed by the **[LPF]** setting indicator at the top of the Measurement screen.
See "Measurement screen" (p. 26).

Measurement upper frequency limit and lower frequency limit (configuring frequency measuring range)

The instrument can simultaneously measure multiple circuits' frequency values. Frequency measurement includes a measurement lower frequency limit setting and a measurement upper frequency limit setting so that you can limit the range of frequencies you wish to measure for each wiring configuration. When measuring waveforms with multiple frequency components such as a PWM waveform's fundamental frequency and carrier frequency, configure the settings based on the input frequencies you wish to measure.

Display screen [INPUT] > [CHANNEL]
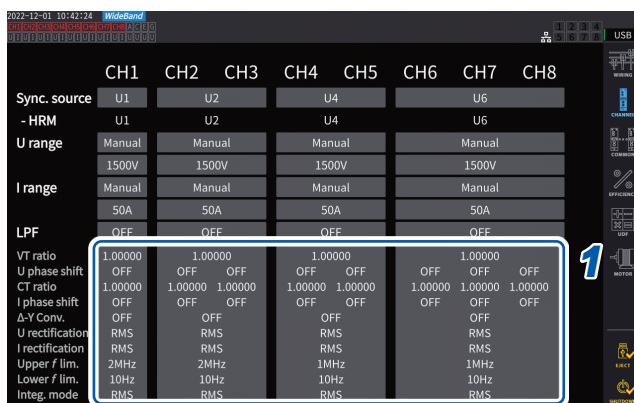
1 To open the settings window, tap the channel detailed display area.

Detailed settings for each wiring configuration can be seen in this window.

2 Tap the [Upper *f* lim.] box, then select the upper frequency limit from the list.

> **100 Hz**, **500 Hz**, **1 kHz**, **5 kHz**, **10 kHz**, **50 kHz**, **100 kHz**, **500 kHz**, **1 MHz**, **2 MHz** (selectable for the U7005 only)

3 Tap the [Lower *f* lim.] box, then select the lower frequency limit from the list.

> **0.1 Hz**, **1 Hz**, **10 Hz**, **100 Hz**, **1 kHz**, **10 kHz**, **100 kHz**

4 Tap [×] to close the setting window.
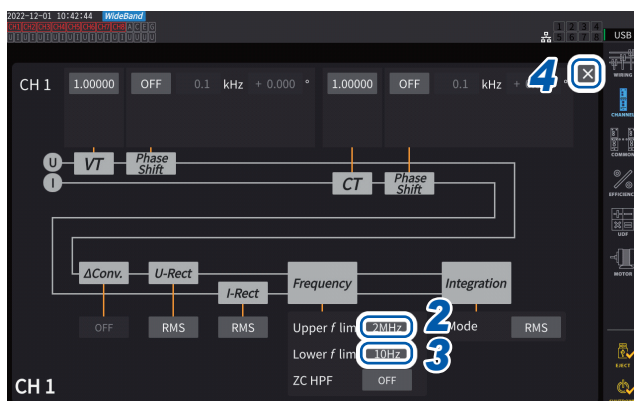
IMPORTANT

Accuracy for frequency measurement is guaranteed for sine wave input greater than or equal to 30% of the voltage or current range. The instrument may not be able to measure input outside that range.

- When receiving input at a frequency lower than the data update interval setting's period, the data update interval will vary with the input frequency.
- The instrument may display a frequency that differs from the input if a frequency significantly higher than the measurement upper frequency limit or a frequency lower than the measurement lower frequency limit is inputted.

Zero-cross high-pass filter (ZC HPF)

- This high-pass filter setting is used to detect waveform zero-crossing points.
- If the frequency does not stabilize during measurement of low frequencies, setting **[ZC HPF]** to **[OFF]** can stabilize the frequency.
- Set the **[ZC HPF]** to **[ON]** while measuring ripple current.

Rectification method

This section describes how to select the rectification method for voltage values and current values used to calculate apparent power, reactive power, and power factor.

You can select a rectification method for each wiring configuration's voltage and current independently.

Display screen [INPUT] > [CHANNEL]
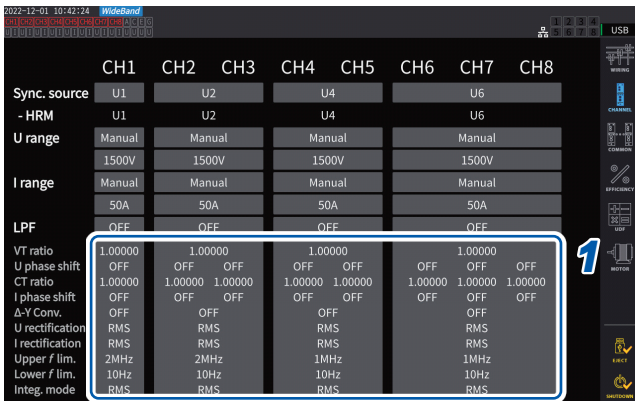
1 To open the settings window, tap the channel detailed display area.

2 Tap the [*U-Rect*] box, then select the rectifier from the list.

RMS	(True RMS value) Select this setting for ordinary use.
MEAN	(RMS equivalent of average rectified value) In general, this setting is only used when line voltage with a PWM waveform on the secondary side of an inverter is measured.
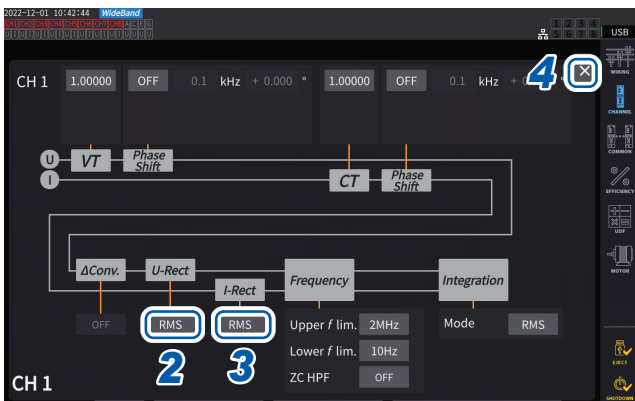
3 Tap the [*I-Rect*] box, then select the rectifier from the list.

4 Tap [×] to close the setting window.

Scaling (when using VTs [PTs] or CTs)

This section describes how to set the ratio (VT ratio, CT ratio) when using VTs (PTs) or CTs externally.

When a VT ratio or CT ratio has been set, **VT** or **CT** will be displayed with the setting indicators at the top of the Measurement screen.

Display screen [INPUT] > [CHANNEL]
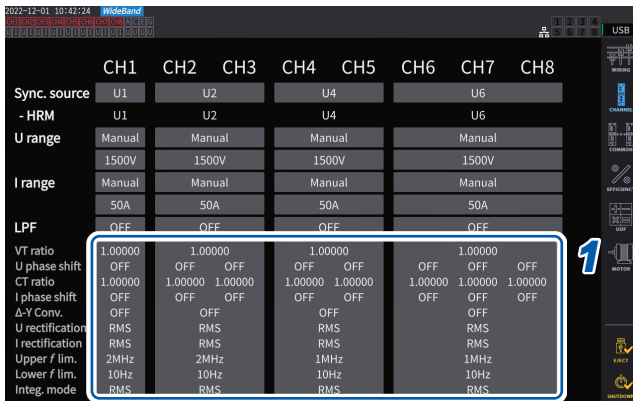
1 **To open the settings window, tap the channel detailed display area.**

2 **Tap the [*VT*] box, then set the VT ratio using the numeric keypad.**

See "Numeric keypad window" (p. 24).
Set the VT ratio to a common value for channels in the same wiring configuration.

0.00001 to **9999.99**

3 **Tap the [*CT*] box and set the CT ratio using the numeric keypad.**

The CT ratio can be set individually for each channel in the same wiring configuration.

0.00001 to **9999.99**
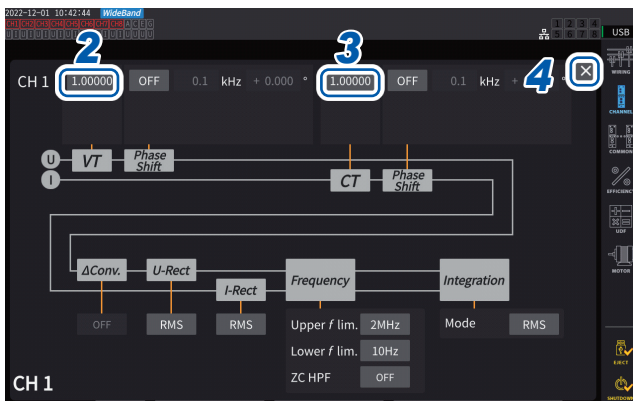
The settings cannot be configured such that the product of VT and CT is greater than 1.0E+06.
When a VT ratio has been set, all voltage measurement items, including voltage peak values, harmonics, and waveforms, and all measured values for power measurement items calculated using voltage will be multiplied by the set ratio.
When a CT ratio has been set, all current measurement items, including current peak values, harmonics, and waveforms, and all measured values for power measurement items calculated using current will be multiplied by the set ratio.
To set it to **[OFF]**, enter *1.00000*.

4 **Tap [×] to close the setting window.**

Displaying Power Numerically

3.3 Integrating Current and Power

Integration control setting

There are two types of integration measurement available: integration for all wiring configurations, which controls all installed channels at once, and integration by wiring configuration, which controls each set wiring configuration.

When you wish to control the integration independently for each set wiring configuration, use the function of integration by wiring configuration.

By selecting buttons displayed on the screen, you can change the wiring configuration to be controlled, and set the integration start time, stop time, and timer setup for each wiring configuration to control the time.

Display screen **[SYSTEM] > [TIME CONTROL]**
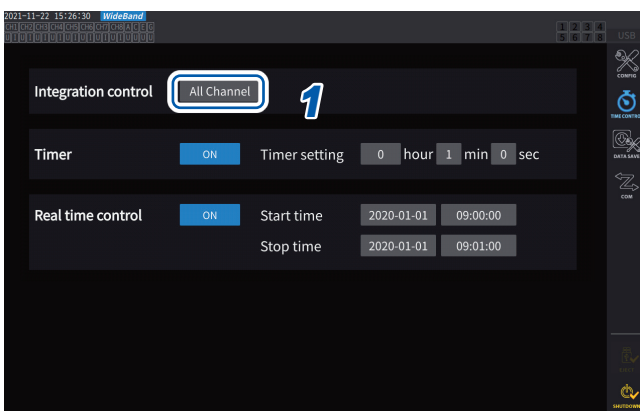
1 Tap the **[Integration control]** box to select an integration control setting from the list.

All Channel	(All wiring-configuration integration) Controls integration with the same timing for all wiring configurations.
Each Wiring	(Each wiring-configuration integration) Controls integration with an independent timing for each set wiring configuration.

Displaying integrated measured values

The instrument can simultaneously integrates the current (I) and active power (P), and displays positive, negative, and total values.

Displaying integration information

Display screen [MEAS] > [VALUE] > [BASIC]
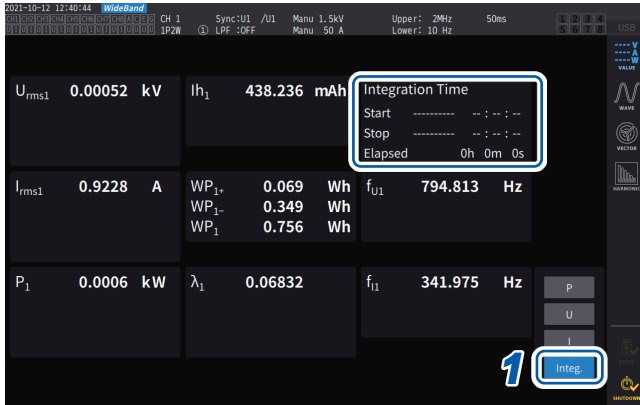
When the integration control is set to **[All Channel]**, the **[Integration Time]** field displays the integration start time, integration stop time, and elapsed time common to all wiring configurations.
When the integration control is set to **[Each Wiring]**, it displays the integration start time, integration stop time, and elapsed time of the wiring configuration selected using the ◀CH▶ keys.

1 Tap **[Integ.]**.

2 Switch the displayed channel using the ◀CH▶ keys for channel selection.

The displayed channel will change each time the ◀CH▶ keys are pressed.

Ih1+	Integrated positive current value of Ch. 1 (displayed only when the integration mode is DC)
Ih1−	Integrated negative current value of Ch. 1 (displayed only when the integration mode is DC)
Ih1	Sum of integrated current values of Ch. 1
WP1+	Integrated positive active power value of Ch. 1
WP1−	Integrated negative active power value of Ch. 1
WP1	Sum of integrated active power values of Ch. 1

- The parameters that can be integrated vary with the wiring mode and the integration mode.
  See "2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43) and "Integration mode" (p. 75).

- This information can also be selected and displayed on the **CUSTOM** screen.
  See "3.1 Displaying Measured Values" (p. 55).

3

Displaying Power Numerically

71

Before starting integration

1 **Adjust the clock.**

See "6.1 Checking and Changing Settings" (p. 153).

2 **Set the integration mode.**

See "Integration mode" (p. 75).

3 **Set the necessary control times.**

See "Integration measurement while using the time control function" (p. 76).
Set the time settings to **[OFF]** when performing integration manually or with an external signal.

4 **When saving data on a USB flash drive or generating D/A output, configure the recording and D/A output settings.**

See "7.1 USB Flash Drive" (p. 157) and "7.3 Saving Measured Data" (p. 161).

How to start/stop integration and resetting integrated values

These operations can be performed using the instrument's control keys, external signals, or communications.
Always reset integrated values when changing settings.

When the integration control is set to [All Channel]

START / STOP (Lit up in green)

1 **Press the START/STOP key.**

Integration starts.
The key lights up in green.
The integration state indicator will turn green.

START / STOP (Lit up in red)
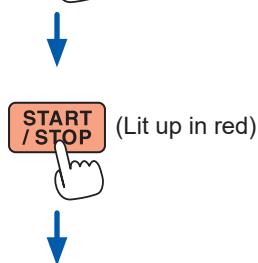
2 **Press the START/STOP key.**

Integration stops.
The key lights up in red.
The integration state indicator turns red.

DATA RESET

3 **Press the DATA RESET key to reset integrated values.**

The **START/STOP** key light is turned off.
The integration state indicator will be colorless.

START / STOP (Off)

When the timer control or real time control setting is used, integration will stop automatically at the set end time.

This section describes how to start and stop integration manually.

Manual integration operation

Integrated display value

Start   Stop   Reset

Hold

Time

START / STOP   START / STOP   DATA RESET
(Lit up in green)   (Lit up in red)

Cumulative integration operation

Integrated display value

Start   Stop   Addition start

Hold

Addition

Time

START / STOP   START / STOP   START / STOP
(Lit up in green)   (Lit up in red)   (Lit up in green)

3

Displaying Power Numerically
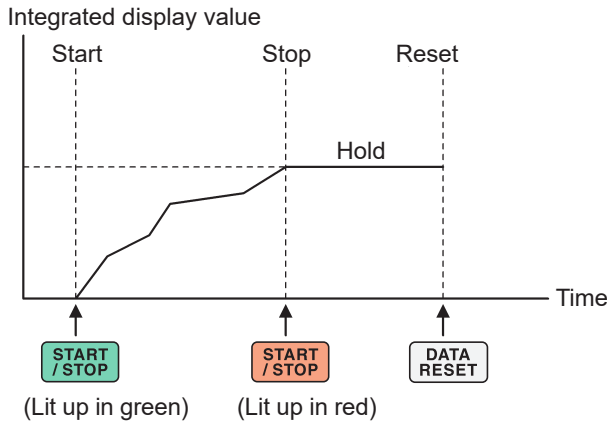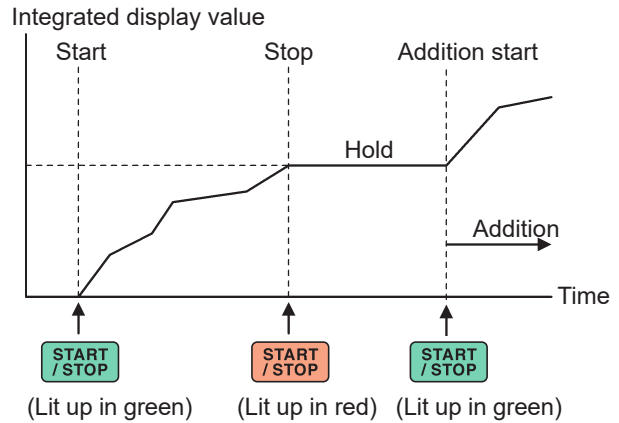
When the integration control is set to [Each Wiring]

Select the channels to be operated by the **START/STOP** key or the **DATA RESET** key in either of the following screens to control.

Display screen **[SYSTEM]** > **[TIME CONTROL]**

	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	
Integration control	Each Wiring								
Timer	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	Setup
Real time control	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	Setup
Control channel	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	1

Display screen **[MEAS]** > **[VALUE]**

U_{rms1} 0.00075 kV Ih_1 354.868 mAh   Integration Time
Start   ---------   -- : -- :
Stop   ---------   -- : -- :
Elapsed   0h 0m 0

Each wiring integ. control
1 2 3 4
5 6 7 8

I_{rms1} 0.4297 A WP_{1+} 0.858 Wh f_{U1} 360.210 Hz
WP_{1-} 0.203 Wh
WP_1 0.418 Wh

P_1 0.0003 kW λ_1 0.03707 f_{I1} 209.149 Hz

P
U
I
Integ.

1 **Select a button on the [TIME CONTROL] screen or a channel number button in the upper right corner of [MEAS] > the [VALUE] screen.**

2 **Press the START/STOP key.**

The instrument starts integrating values of channels whose integration has been reset or stopped among the channels selected in step 1. The key does not light up, but the integration state indicator in the upper right corner of the screen turns green.

3 **Press the START/STOP key.**

The instrument stops integrating values of channels whose integration is in progress among the channels selected in step 1. The key does not light up, but the integration state indicator in the upper right corner of the screen turns red.

4 **Press the DATA RESET key as necessary.**

The instrument resets integrated values of the channels selected in step 1. When using the timer control or real time control settings, integration will stop at the set end time.

73

Precautions when starting and stopping integration and resetting integrated values

- Integration will stop automatically when the integration time reaches 9999 h 59 min. 59 s.
- Starting and stopping of integration and resetting of integrated values performed using the instrument's control keys or external control affect all parameters being integrated in synchronization.
- The following parameters can be integrated depending on the wiring mode and integration mode:

Mode	Parameters that can be integrated
1P2W, DC mode	Ih+, Ih−, Ih, WP+, WP−, WP
1P2W	Ih, WP+, WP-, WP
1P3W, 3P3W2M **(When using Ch. 1, Ch. 2)**	Ih1, Ih2, WP12+, WP12−, WP12
3V3A, 3P3W3M, 3P4W **(When using Ch. 1, Ch. 2, Ch. 3)**	Ih1, Ih2, Ih3, WP123+, WP123−, WP123

- Calculation results from each channel are integrated at the data update intervals. Consequently, integrated values may differ from those of an instrument whose response speed, sampling speed, or calculation methods differ.
- In current integration, the instantaneous current values are integrated when the integration mode is DC mode, and RMS values are integrated when the integration mode is RMS mode.
- In power integration, the instantaneous power values are integrated when the integration mode is DC mode, and active power values are integrated when the integration mode is RMS mode.
- While integration is being performed (including when the instrument is in standby mode during real time control integration), the instrument will not accept any settings changes other than screen changes, hold/peak hold function operation, and range changes.
- Even when the display is held during hold operation, integration operation continues internally. However, displayed data are output as the D/A output.
- The integration display is not affected by peak hold operation.
- If a power outage occurs during integration, integrated values will be reset, and integration operation will stop.

IMPORTANT

No data is integrated while the ranges are being switched manually or automatically.

Integration mode

This section describes how to set the integration mode for each channel. The two integration modes, DC and RMS, are available and can be selected separately for each wiring configuration.

Display screen [INPUT] > [CHANNEL]
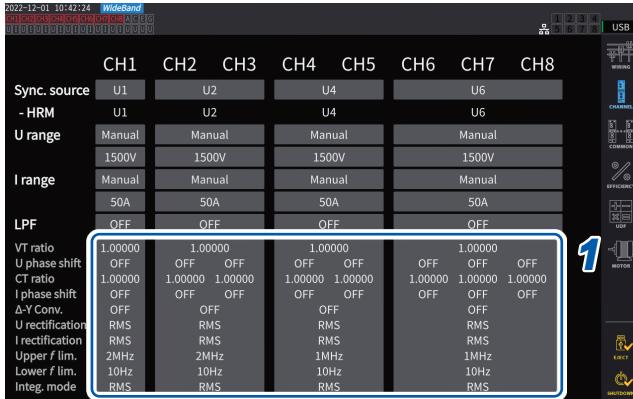
1 **To open the settings window, tap the channel detailed display area.**

Detailed settings for each wiring configuration will be displayed.

2 **Tap the [Mode] box, then select the integration mode from the list.**

DC	Instantaneous current values and instantaneous power values for each sampling are integrated separately for each polarity. This can be selected only in 1P2W wiring mode. The six items of current integration (Ih+, Ih−, Ih) and active power integration (WP+, WP−, WP) are calculated simultaneously.
RMS	Current RMS value and active power value acquired at data update intervals are integrated. Only active power values are integrated by polarity.
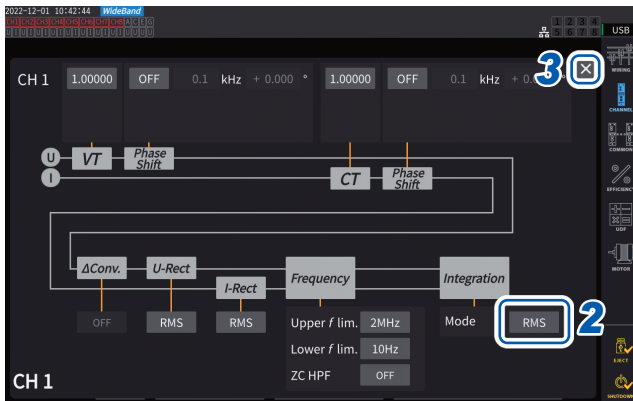
3 **Tap [×] to close the setting window.**

Integration measurement while using the time control function

If you set the timer setting value and real time control time in advance and then press the **START/STOP** key, you can start or stop the integration at the set times. When the integration control is set to **[All Channel]**, the timer setting value and real time control time, which apply commonly to all wiring configurations, can be set.

If the integration control is set to **[Each Wiring]**, timer set value and real time control time can be set for each set wiring. Pressing the **START/STOP** key can start or stop integration at the set times for selected channels.

Manual integration setting

Start integration	Press the **START/STOP** key.
Stop integration	Press the **START/STOP** key again.
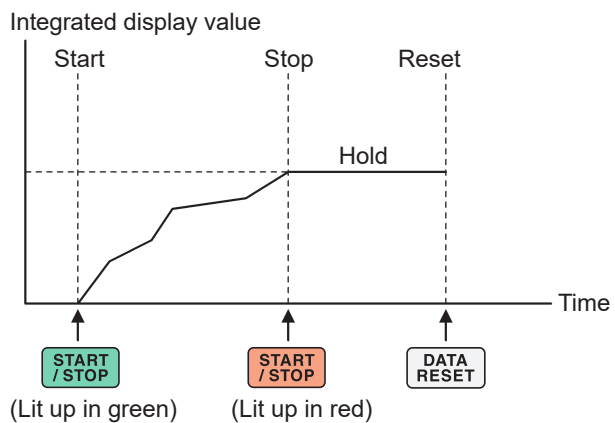
Timer integration setting

Start integration	Press the **START/STOP** key.
Stop integration	Press the **START/STOP** key again.
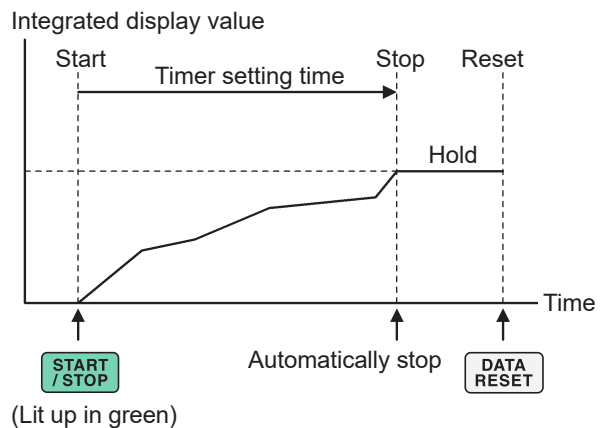
Real time control integration setting

Start integration, stop integration	Press the **START/STOP** key places the instrument in the standby state. Integration will then start and stop at the set start time and stop time. To stop integration while the instrument is in the standby state, press the **START/STOP** key again.
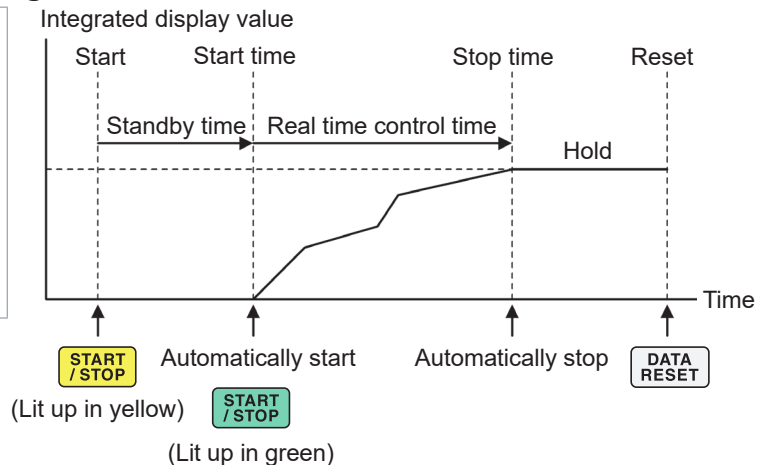
3.4 Measuring Harmonic

The instrument includes harmonic measurement functions as a standard feature and can acquire measured harmonic values synchronous with measured power values for all channels. These measured harmonic values are used to calculate the fundamental wave component (fnd value) and total harmonic distortion (THD), which are included in the instrument's basic measurement items.
See "10.5 Specifications of Equations" (p. 291).
In addition, setting the wideband measurement mode and IEC measurement mode allows the instrument to perform harmonic measurements that support wideband and harmonic measurements that conform to IEC standards.
See "2.7 Measurement Mode" (p. 48).

Wideband measurement mode

- This mode can measure over a wide frequency range from 0.1 Hz to 1.5 MHz (up to 1 MHz for U7001).
- The analysis order differs depending on the frequency to be measured.
- Only harmonic measured values are updated at intervals of 50 ms.

IEC measurement mode

- This mode can measure IEC harmonics and IEC voltage fluctuation/flicker.
- When measuring a frequency of 50 Hz or 60 Hz, the instrument performs harmonic measurements according to IEC 61000-4-7, and voltage fluctuation/flicker measurements according to IEC 61000-4-15.
- The instrument always updates data at intervals of 200 ms.
- If measuring a frequency that falls outside the range of 45 Hz to 66 Hz, the instrument does not perform harmonic or voltage fluctuation/flicker measurements.
- The harmonic analysis can be performed for the 0th to 200th orders; and the intermediate harmonic analysis, from the 0.5th to 200.5th orders.

In IEC measurement mode, internal calculation processing differs from the regular measurement mode to realize measurements in compliance with the IEC standard. Thus, some functions are restricted in IEC measurement mode.
See "2.7 Measurement Mode" (p. 48).

3

Displaying Power Numerically

Displaying measured harmonic values

Harmonics can be displayed using a bar graph, list, or vectors.

Displaying a harmonics bar graph

Harmonic analysis is performed on the voltage, current, and active power values for the same channel, and the results are displayed as bar graphs.

Numerical data of the on-screen order is also displayed at the same time.

Display screen **[MEAS]** > **[HARMONIC]** > **[BAR GRAPH]**
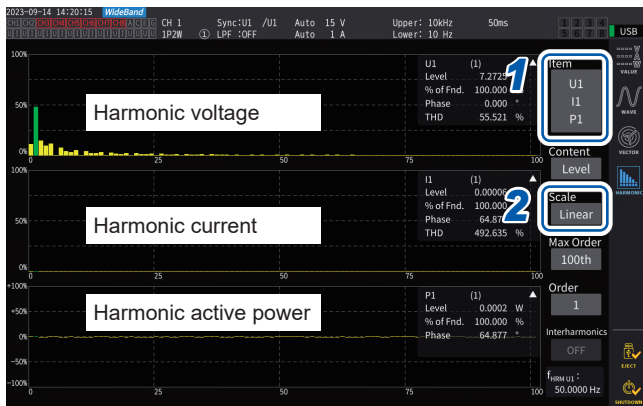
1 Tap the **[Item]** box, then select channels to be displayed on the bar graph.

2 Tap the **[Scale]** box, then select a scale of the vertical axis from the list.

Log	Logarithmic scale
Linear	Linear scale This can display data down to minuscule levels. When **[Phase]** is selected, the vertical axis display is fixed to **[Linear]**.

On-screen measured values of the selected orders

W	Amplitude value (Level)
%	Content percentage (% of Fnd)
°	Phase angle (phase)

- The vertical axis scale is a percentage of the range when the amplitude value is selected.
- When the phase angle is selected, dimmed bars may be displayed to indicate that the corresponding amplitude value is small (0.01% or less of the range).

Changing the display settings and an order to be displayed

To change the display settings
Tap each setting and change it as desired.

To change an order to be displayed
Tap the **[Order]** box to select the order using the Y rotary knob. Tapping the **[Order]** box again turns the rotary knob light off.

Y rotary knobs

Lit up in green: in 1 increments

Press the knob to switch.

Lit up in red: in 10 increments

A bar of the selected order will turn green.

Measured values of the selected order is displayed. Tapping ▲ on the screen hides the measured values.

Displaying an inter-harmonic bar graph

The instrument in IEC measurement mode can display inter-harmonic.

Setting **[Interharmonics]** to **[ON]** allows the instrument to display a bar graph showing inter-harmonic components, as cyan bars, of a combination of current and voltage RMS values or that of current and voltage percentage contents. The numerical value area shows the measured values of the inter-harmonic adjacent to the selected order (**[Order]**).

1 **Tap [Interharmonics] to set it to [ON].**

The bar graph is displayed.

For power measurement, which does not include inter-harmonic measurement items, only harmonics components are displayed. In addition, setting **[Content]** to **[Phase]** sets **[Interharmonics]** to **[OFF]**.

3

Displaying Power Numerically

Displaying a harmonics list

This section describes how to display the results of harmonic analysis as a numerical list for each parameter. The same settings affect the bar graph screen and the list screen. Swiping the list horizontally or tapping the **[<]** and **[>]** symbols on either side of the list can change the orders to be displayed.

Display screen   **[MEAS] > [HARMONIC] > [LIST]**
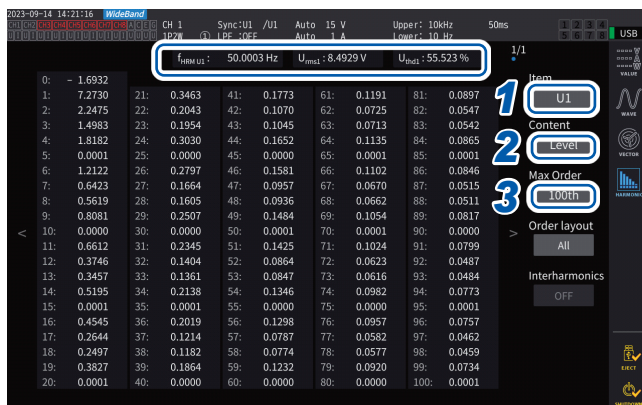
1 **Tap the [Item] box, then select channel to be displayed in a list.**

2 **Tap the [Content] box, then select the contents to be displayed from the list.**

Level	Amplitude value
% of Fnd	Content percentage
Phase	Phase angle

The phase angle for harmonic active power refers to the harmonic voltage-vs.-current phase difference.

3 **Tap the [Max Order] box and select the highest order to be displayed from the list.**

50th, **100th**, **200th**, **500th**

The instrument may not be able to display data up to the set highest order depending on the synchronization frequency being measured.

$f_{HRM\ U1}$	Synchronization source frequency
U_{rms1}	RMS value of displayed item
U_{thd1}	Total harmonic distortion

79

Displaying an inter-harmonic list

The instrument in IEC measurement mode can display inter-harmonic.

Setting the [Interharmonics] setting to [ON] allows the inter-harmonic components to display next to the harmonic readings.

The measured values of harmonics are displayed on the left and those of inter-harmonic are displayed on the right.

1 Tap the [Interhamonics] box to set it to [ON].

The inter-harmonic list can be displayed for RMS values and harmonic factors of voltage and current.
If any other option is selected, [Interharmonics] will be set to [OFF].

Changing the layout of the harmonic list display

You can change the list-layout by setting **[Order layout]**.

All
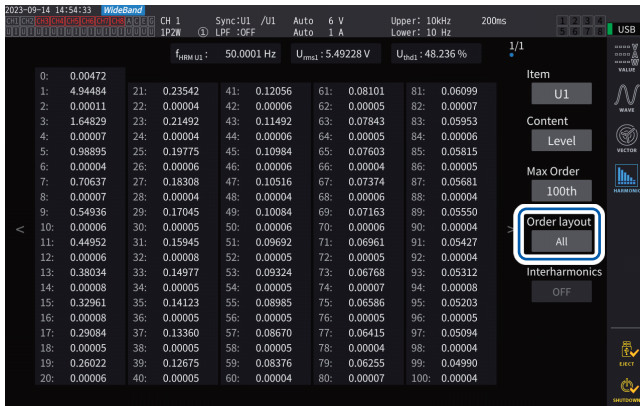
Select to display all orders side by side in one column. One type of measured values are displayed from the 0th to 50th or 100th orders on a single screen.

Odd/Even
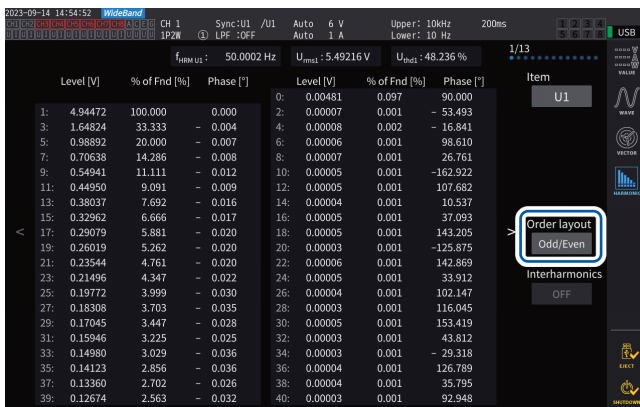
Select to display a list with odd-order measured values arranged on the left side of the screen and even-order measured values on the right side. Three type of measured values (RMS values, harmonic factors, and phase angles) of voltage, current, and power are displayed from the 0th to 40th orders on a single screen.

3

Displaying Power Numerically

Displaying harmonic vectors

This section describes how to display the voltage, current, and phase angle for each harmonic order as a vector graph.

1-vector-diagram display

Displays vectors for all channels on a single vector graph.

Display screen [MEAS] > [VECTOR] > [VECTOR×1]
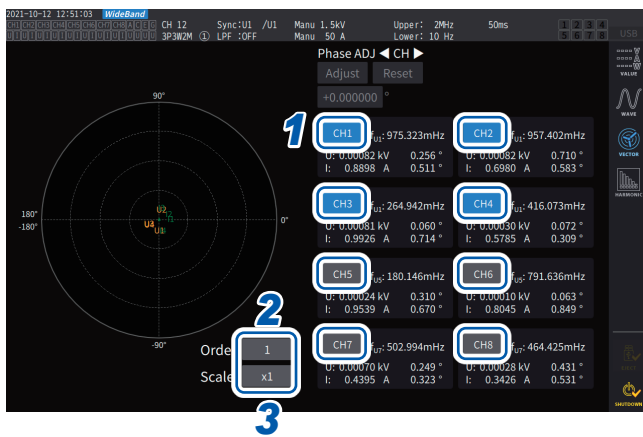
1 **Tap a channel button to be displayed.**

2 **Tap the [Order] box, rotate the Y rotary knob to set the display order, and then tap the [Order] box to confirm.**

Lit up in green: in 1 increments
Lit up in red: in 10 increments

3 **Tap the [Scale] box, rotate the Y rotary knob to set the magnification, and then tap the [Scale] box to confirm.**

2-vecror-diagram display

Display screen [MEAS] > [VECTOR] > [VECTOR×2]
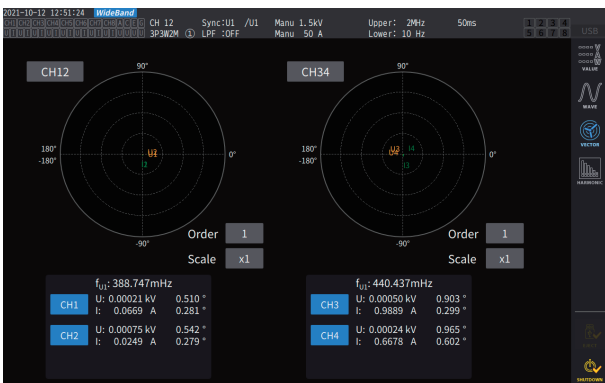
The 2-vector-diagram display illustrates two graphs of each selected wiring configuration.

4-vector-diagram display

Display screen [MEAS] > [VECTOR] > [VECTOR×4]
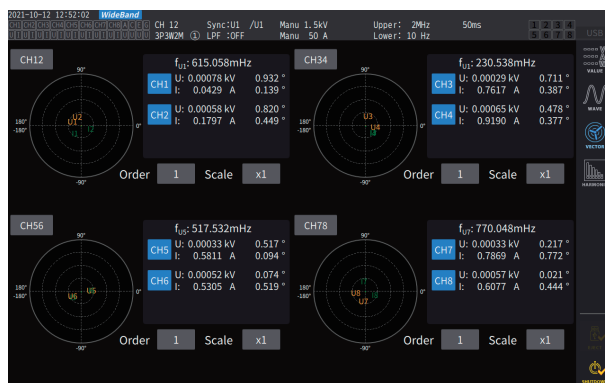
The 4-vector-diagram display illustrates four graphs of each selected wiring configuration.

Configuring settings common to harmonics

Display screen [INPUT] > [COMMON]
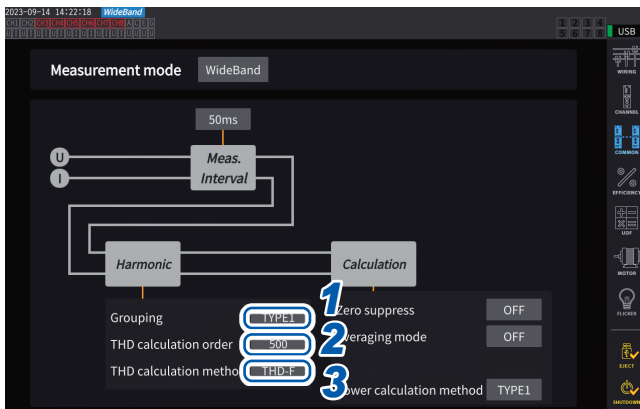
1 Tap the [Grouping] box, then from the list, select a calculation method of the intermediate harmonic for the measured harmonic values.

OFF	Treats only components of a whole number multiple of the fundamental wave as the harmonic of the corresponding order.
TYPE1	Treats the harmonic sub-group as the harmonic of the corresponding order. This setting provides compatibility with the Hioki PQ3198's harmonic measurement functions.
TYPE2	Treats the harmonic group as the harmonic of the corresponding order.

2 Tap the [THD calculation order] box, rotate the Y rotary knob to set the THD calculation order, and then tap the [THD calculation order] box to confirm.

Lit up in green: in 1 increments
lit up in red: in 10 increments

THD calculation order: Upper limit order, which means the highest order to which the total harmonics are calculated.

2 to **500** (per step)

- If the analysis order does not reach the set upper limit value due to the measurement mode and fundamental frequency, the calculation will be performed using the analysis order as the upper limit.
- Measured harmonic values displayed in list and graph forms and measured harmonic values obtained via the instrument's communications functionality are not constrained by the upper limit order set here.

3 Tap the [THD calculation method] box, then from the list select the equation for total harmonic distortion THD.

This setting is valid for all voltage and current harmonic measurement for all channels.

THD-F	Ratio of the total harmonic component to the fundamental wave. This setting is typically used in applications such as IEC standard-compliant measurement.
THD-R	Ratio of the total harmonic component to the total harmonic component including the fundamental wave. This setting yields values lower than those of THD-F for waveforms with a large amount of distortion.

3

Displaying Power Numerically

83

What is *THD*?

THD, which stands for total harmonic distortion factor, is a ratio of the RMS value of the harmonic content to the RMS value of the fundamental component or the reference fundamental component of an alternating quantity.

What is *grouping*?

The harmonic measurement determines the number of the window waves depending on the measurement mode and the fundamental wave frequency. When the number of window waves is other than one, spectrum lines (output bin), the number of which is proportional to the number of the window waves ([number of window waves] − 1), can be acquired between the harmonic components having a frequency of a whole number multiple of (n times) the fundamental wave. They are known as the intermediate harmonic (inter-order harmonic).

Since measured values yielded by harmonic measurement differ depending on how these intermediate harmonics are treated, IEC and other standards define grouping rules.
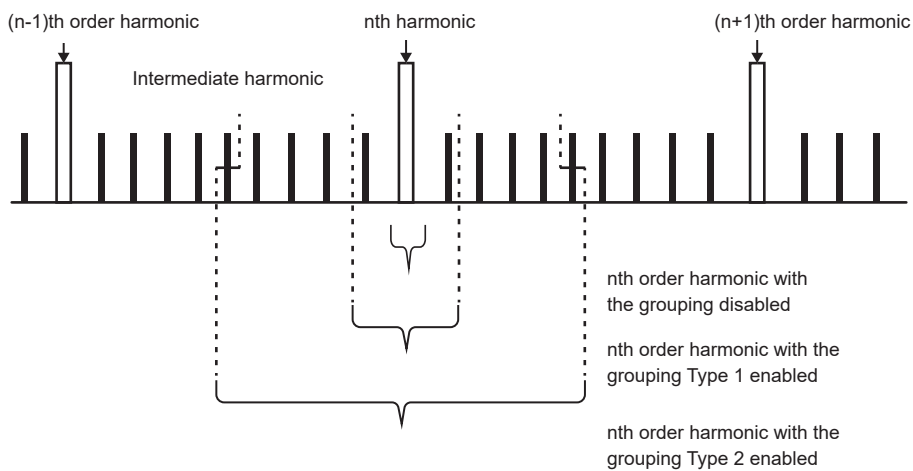
In general, the Type 1 range is known as the harmonic sub-group, and the Type 2 range is known as the harmonic group, which are calculated by determining the square-root of sum of squares the output bins.

If no intermediate harmonic exists, or the number of the window waves is one in wideband measurement mode, measured values will agree regardless of what grouping method has been chosen. If intermediate harmonics exist, measured harmonic values will generally exhibit the relationship of *OFF < Type 1 < Type 2*.

Note that inter-harmonic subgroup and inter-harmonic group in IEC measurement mode are as shown in the following diagram.
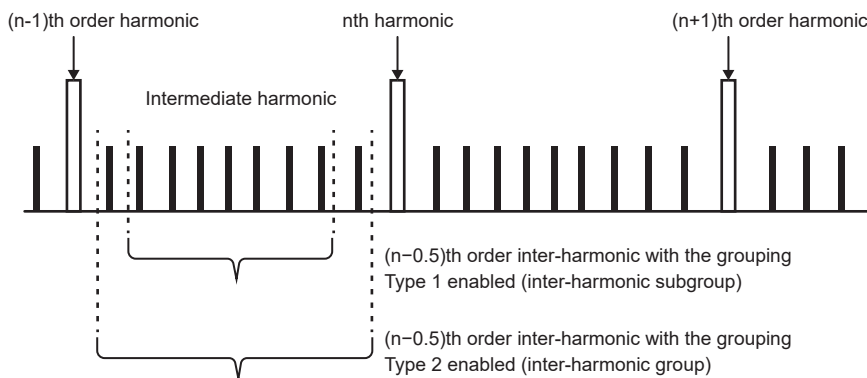
In addition, note that measured inter-harmonic values become zero with the grouping disabled.

3.5 Measuring Efficiency and Loss

The instrument can calculate the efficiency η (%) and loss (W) using the active power values and motor power values, and display them. For example, the instrument can calculate efficiency and loss between input and output of various power converters (e.g., inverters, power conditioners) as well as motors, and simultaneously calculate the overall efficiency.

Selecting the calculation method

You can select either **[Fixed]** or **[Auto]** as the efficiency/loss measurement calculation method.

Display screen **[INPUT]** > **[EFFICIENCY]**
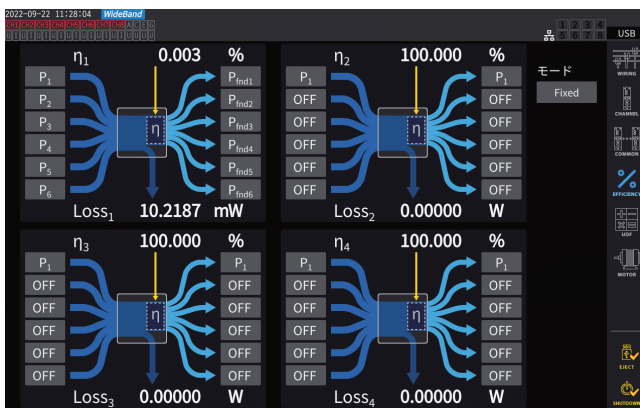
1 **Tap the [Mode] box to select the integration mode.**

Fixed	Fixed mode
Auto	Automatic mode

[Fixed] mode

This mode can calculate efficiency and loss for set input and output items, displaying computational results. You can set four or fewer equations (η1 to η4 and **Loss1** to **Loss4**) for each of efficiency (η) and loss (Loss).

Display screen **[INPUT]** > **[EFFICIENCY]**
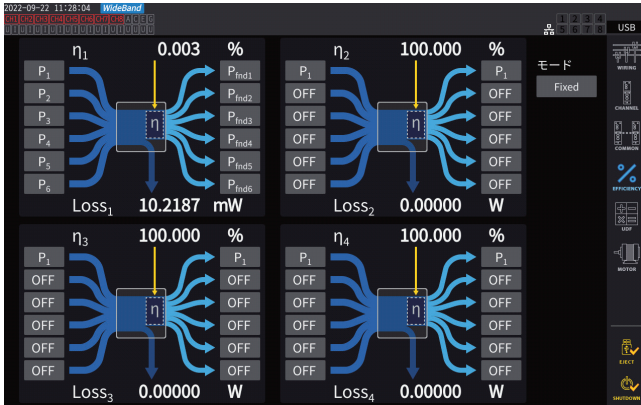
1 **Select the parameters of the input side of the equation.**

2 **Select the parameters of the output side of the equation.**

Select the input-side measured power value on the left and the output-side measured power value on the right for each figure on the screen. Up to six inputs and outputs can be selected for each efficiency calculation equation. Efficiency is calculated using the sum of the six.

Most recently calculated efficiency value

Input parameters

Output parameters

Most recently calculated efficiency value
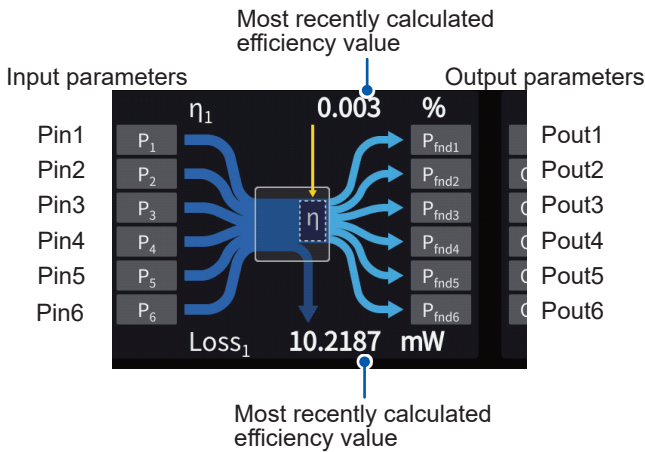
Input side	$Pin = Pin1 + Pin2 + Pin3 + Pin4 + Pin5 + Pin6$
Output side	$Pout = Pout1 + Pout2 + Pout3 + Pout4 + Pout5 + Pout6$
η	$100 \times |Pout| / |Pin|$
Loss	$|Pin| - |Pout|$

- Motor power (Pm) measurement is selectable only for the motor analysis-equipped model. Configure settings using the motor input settings screen to measure the motor power (Pm).
- See "Configuring the motor input settings" (p. 97).
- Calculations across wiring configurations with different power ranges are performed using data for the larger of the two power ranges.
- Calculations across wiring configurations with different synchronization sources are performed using the most recent data at the time of calculation.

> **(Tips)** **To moderate measured value fluctuation**
>
> - Measured values may exhibit variations when loads fluctuates severely or transiently. In this case, reduce the data update interval (to 200 ms) and also use the average function's moving average mode.
> - When either the input or output is DC, variation in measured efficiency values can be limited by using the same synchronization source setting for the channel used for DC measurement as for the AC side.

[Auto] mode

This mode automatically determines whether measurement targets that change over time are input and output, enabling calculating efficiency and loss.

Assign the following items to both ends of the efficiency chart:

- Left end

  Those considered as input when positive

  Those considered as output when negative

- Right end

  Those considered as output when positive

  Those considered as input when negative

Setting example

Measurement of PCU in hybrid cars
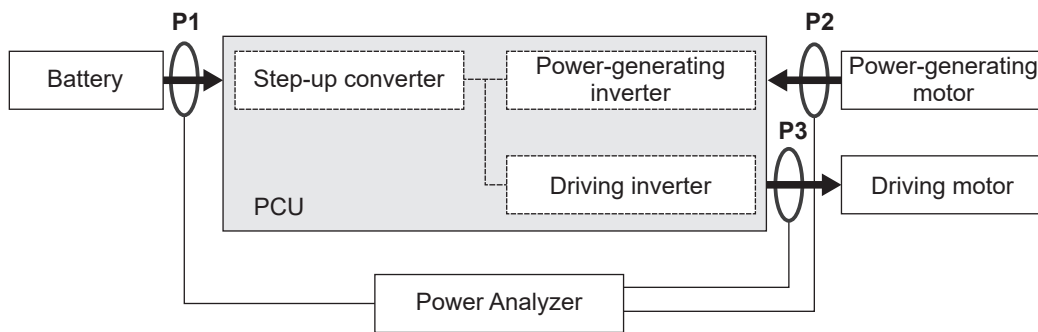
Measure between the PCU and the battery (P1), between the power-generating motors (P2), and between the driving motors (P3) with the instrument.

The inputs and outputs of P1, P2, and P3 change over time depending on the running state of the hybrid vehicle.

During sudden acceleration	P1: input	P2: input	P3: output
During deceleration and braking	P1: output	P2: input	P3: input
During normal operation	P1: output	P2: input	P3: output

The screen and equations of efficiency and loss under the respective driving conditions are as follows: The directions of the arrows change according to the state of input and output of P1, P2, and P3.

3

Displaying Power Numerically

During sudden acceleration
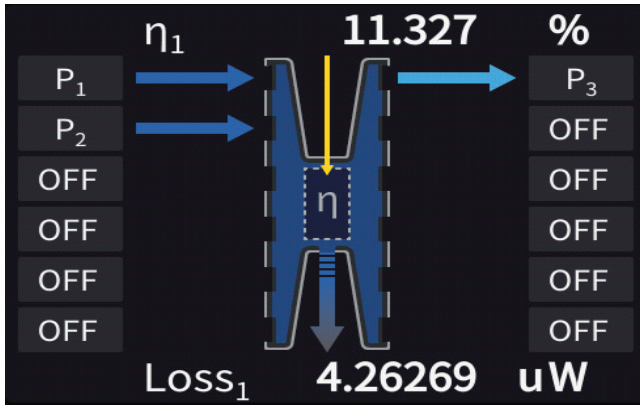
Efficiency: $\eta = \dfrac{|P3|}{|P1| + |P2|} *100$

Loss: Loss = |P1| + |P2| − |P3|

During deceleration and braking
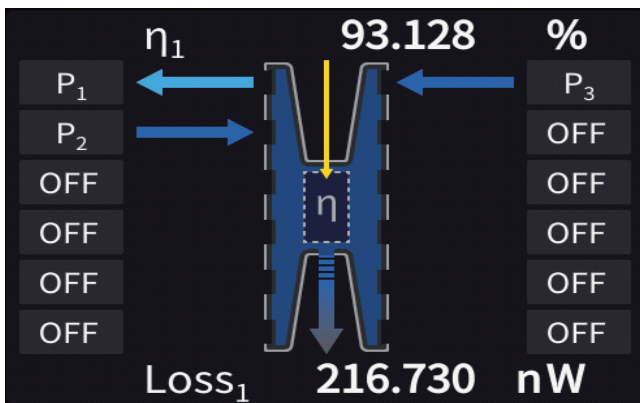
Efficiency: $\eta = \dfrac{|P1|}{|P2| + |P3|} *100$

Loss: Loss = −|P1| + |P2| + |P3|

During normal operation
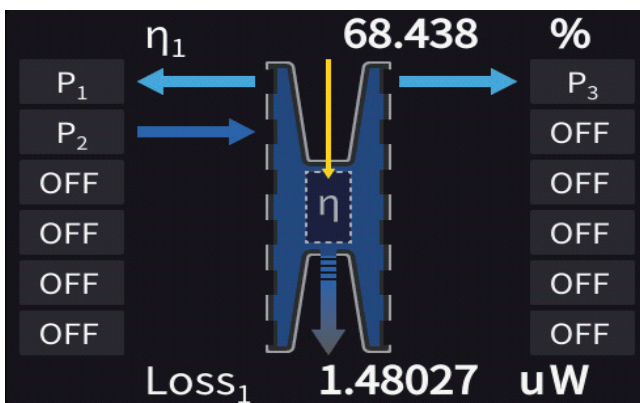
Efficiency: $\eta = \dfrac{|P1| + |P3|}{|P2|} *100$

Loss: Loss = −|P1| + |P2| − |P3|

Displaying efficiency and loss

Display screen [MEAS] > [VALUE] > [CUSTOM]

1 Select the number of items to be displayed on the screen.

2 Tap the item name to open the window to set the basic measurement items.

3 Tap [Other].

4 Select one from among the following alternatives: [η₁] to [η₄] (efficiency) or [Loss₁] to [Loss₄] (loss).

3

Displaying Power Numerically

89

3.6 Motor Measurement (Motor Analysis-Equipped Model)

The motor analysis-equipped model can perform motor analysis when used with an external torque sensor and tachometer. In addition, the motor input parts used in motor analysis can also be used as independent inputs, such as analog DC (up to four channels) or pulse (up to eight channels), or waveform measurement triggers.

See "Configuring the trigger settings" (p. 120).

Motor measurement wiring

The motor analysis-equipped model can perform motor analysis when used with external torque sensors and tachometers. The motor analysis function can be used to measure torque, RPM, motor power, and slip by inputting the signals from torque sensors and tachometers, such as rotary encoders (incremental type).

In addition, the input parts can be used as four analog channels and four pulse input channels.

Connecting torque meters and tachometers

The motor analysis-equipped model have eight input connectors (insulated BNC connectors) on the rear panel of the instrument. Because each connector (labeled Ch. A through Ch. H) is insulated from the instrument itself and from each other, various types of sensors with differing ground potentials are connectable.

Ch. A, Ch. C, Ch. E, Ch. G	Analog DC, frequency, and pulse inputs
Ch. B, Ch. D, Ch. F, Ch. H	Frequency and pulse inputs

In addition to using the channels in combination for motor analysis, they can also be used as independent analog signal/pulse signal input channels.

⚠WARNING

When connecting input terminals to Ch. A through Ch. H

🚫 ■ **Do not input a signal that exceeds the rating of any connector.**

Doing so could cause damage to the instrument or cause it to overheat, resulting in serious bodily injury.

❗ ■ **Turn off the instrument and other equipment being connected before making any connections, and make sure the connections are secure.**

Failure to do so could cause connectors to loosen and come into contact with other conductive parts, resulting in bodily injury and damage to the equipment.

90

⚠CAUTION

■ **When disconnecting cables, disengage the lock and then pull out the BNC connector while gripping it at the connection (do not pull on the cable).**

Failure to do so could damage the BNC connector.

Lugs on the instrument's
input terminal
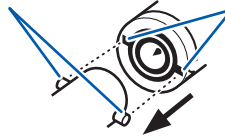
BNC connector' slots

Lock

To connect torque meters and tachometers

Necessary items: L9217 Connection Cord (necessary quantity),
device to be connected (such as torque sensor and tachometer)

1 **Verify that the instrument and the device being connected have been turned off.**

2 **Connect the device's output terminal to the instrument with a connection cord.**
See "Connection examples of motor analysis" (p. 94).

3 **Turn on the instrument.**

4 **Turn on the connected device.**

Connection method

There are several different operating modes and connection patterns available for the motor inputs.

Display screen **[INPUT]** > **[MOTOR]**
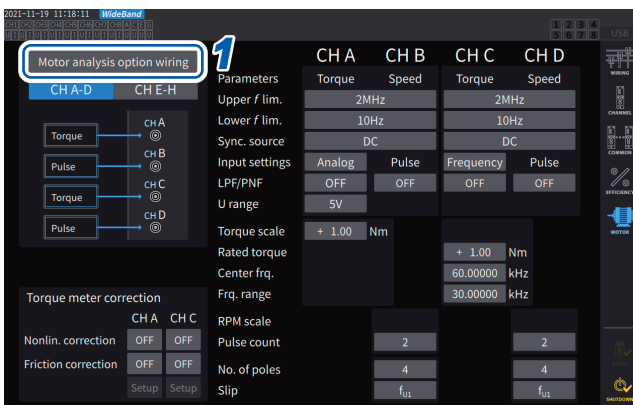
1 Tap **[Motor analysis option wiring]** to open the settings window.

2 Select the operation mode for the motor analysis option channels.

3 Tap **[×]** to close the setting window.
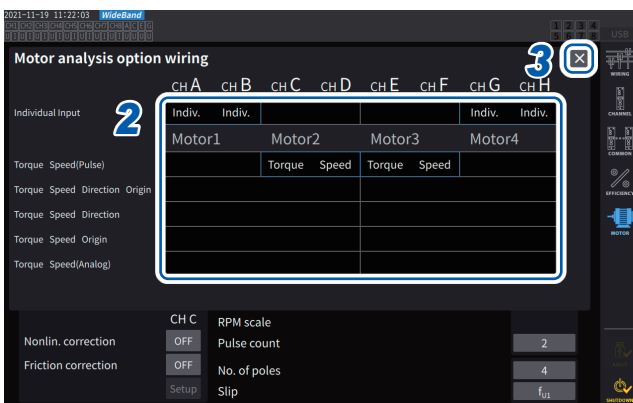
[Individual input] mode

The motor inputs can be used as independent analog DC inputs or as pulse inputs.

Operating mode	Settable channels	Description
Individual Input	AB, CD, EF, GH	For measuring voltage signals and pulse signals

Using this mode can measure and display the signal from a voltage-output sensor, or measure the frequency of a pulse input and display the waveform.

Motor analysis mode

This mode can analyze motors performances by measuring signal inputted from torque sensors and tachometers.

Connection pattern	Settable channels	Description
Pattern 1 Torque, Speed(Pulse)	AB, CD, EF, GH Simultaneous analysis of up to four motors	Motor analysis based on inputs of torque signal and RPM pulse signal
Pattern 2 Torque, Speed, Direction, Origin	ABCD, EFGH Simultaneous analysis of up to two motors	Motor analysis based on inputs of torque signal, RPM pulse signal, rotational direction signal, and origin signal
Pattern 3 Torque, Speed, Direction	ABCD, EFGH Simultaneous analysis of up to two motors	Motor analysis based on inputs of torque signal, RPM pulse signal, and rotational direction signal
Pattern 4 Torque, Speed, Origin	ABCD, EFGH Simultaneous analysis of up to two motors	Motor analysis based on inputs of torque signal, RPM pulse signal, and origin signal
Pattern 5 Torque, Speed(Analog)	ABCD, EFGH Simultaneous analysis of up to two motors	Motor analysis based on inputs of torque signal and RPM analog DC signal

Pattern 1: This mode can analyze motors using a pair of adjacent channels. Motor power and motor efficiency can be measured for up to four systems simultaneously.

Pattern 2, 3, 4, and 5: This mode can analyze motors using one set of four channels. Up to two systems can be measured simultaneously. These patterns permit more advanced analysis, measuring not only motor power and motor efficiency, but also rotational direction and regeneration/power running in combination, or electrical angle measurement. Furthermore, these patterns allow for measurement based on one motor revolution (one cycle of the mechanical angle).

• When inputting the origin (Z-phase pulse) signal in motor analysis mode, always input the pulses outputted from the same encoder. If the order of the RPM pulse signal's rising edges and the origin signal's rising edges reversed, RPM measurement may become unstable.

• When taking measurement using a pulse as a reference for motor analysis, use a signal with the number of pulses that is an integer multiple of the number of motor pole pairs (which is half the total number of poles in the motor). (p.64)

• In an electrically noisy environment, ground the instrument and the connected sensors at the same electric potential.

Motor analysis option wiring

	Ch. A	Ch. B	Ch. C	Ch. D	Ch. E	Ch. F	Ch. G	Ch. H
Individual Input	Indiv.	Indiv.	Indiv.	Indiv.	Indiv.	Indiv.	Indiv.	Indiv.
	Motor 1		Motor 2		Motor 3		Motor 4	
Torque Speed(Pulse)	Torque	Speed	Torque	Speed	Torque	Speed	Torque	Speed
Torque Speed Direction Origin	Torque	Speed	Direction	Origin	Torque	Speed	Direction	Origin
Torque Speed Direction	Torque	Speed	Direction	OFF	Torque	Speed	Direction	OFF
Torque Speed Origin	Torque	Speed	OFF	Origin	Torque	Speed	OFF	Origin
Torque Speed(Analog)	Torque	OFF	Speed	OFF	Torque	OFF	Speed	OFF

93

Connection examples of motor analysis

In these examples, a torque meter and a tachometer are being connected with Ch. A to Ch. D. You can connect them to Ch. E through Ch. H as well.

Example 1: Motor power measurement (settings of motor analysis mode pattern 5)

Ch. A or Ch. E	—	Torque output
Ch. B or Ch. F		RPM output
Ch. C or Ch. G		
Ch. D or Ch. H		
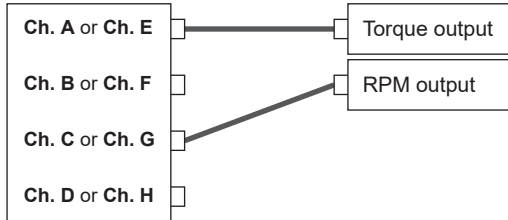
Input the torque signal to Ch. A and the RPM signal to Ch. C. Then measure the motor power and motor efficiency.
The torque signal can use an analog DC signal or pulse-based frequency input.
The RPM signal must be an analog DC signal.
The torque signal and RPM signal can be inputted from different sensors.

Example 2: Motor power measurement with forward/reverse detection (setting of motor analysis mode pattern 3)

Ch. A or Ch. E	—	Torque output
Ch. B or Ch. F	—	A-phase pulse output
Ch. C or Ch. G	—	B-phase pulse output
Ch. D or Ch. H		
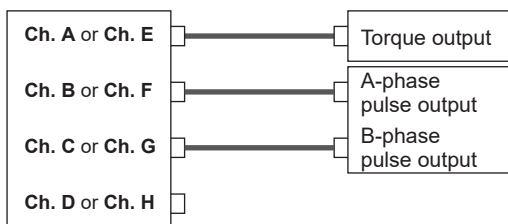
Input the torque signal to Ch. A, the A-phase pulse signal to Ch. B, and the B-phase pulse signal to Ch. C. Then measure the motor power and motor efficiency while viewing the direction of the motor's rotation based on the phase difference between the A-phase pulse and the B-phase pulse.
The torque signal can use an analog DC signal or pulse-based frequency input.

Example 3: Motor power measurement with electrical angle measurement (settings of motor analysis mode pattern 2)

Ch. A or Ch. E	—	Torque output
Ch. B or Ch. F	—	A-phase pulse output
Ch. C or Ch. G	—	B-phase pulse output
Ch. D or Ch. H	—	Z-phase pulse output
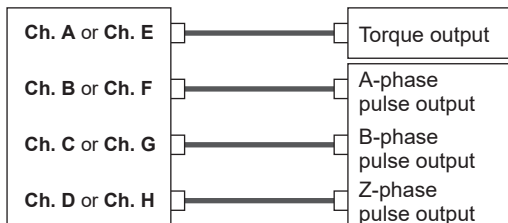
Input the torque signal to Ch. A, the A-phase pulse signal to Ch. B, the B-phase pulse signal to Ch. C, and the Z-phase pulse (origin) signal to Ch. D. Then measure the motor power and motor efficiency while measuring the electrical angle.
By setting the synchronization source to Zph., you can synchronize measurement to the mechanical angle instead of the electrical angle.
The torque signal can use an analog DC signal or pulse-based frequency input.
If you do not need to detect the direction of the motor's rotation, it is not necessary to input the B-phase pulse to Ch. C, and you can select pattern 4 instead.
When using Zph. as the synchronization source, you need to input not only the Z-phase pulse to Ch. D, but also the A-phase pulse to Ch. B.

Example 4: Motor power measurement (settings of motor analysis mode pattern 1)

Ch. A or Ch. E	—	Torque output
Ch. B or Ch. F	—	RPM output
Ch. C or Ch. G	—	Torque output
Ch. D or Ch. H	—	RPM output
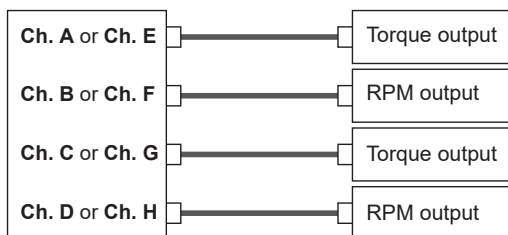
Input the torque signal and the RPM signal to Ch. A and Ch. B to measure the motor power and motor efficiency of the first system. Input the torque signal and the RPM signal to Ch. C and Ch. D to measure the motor power and motor efficiency of the second system.
The torque signal can use an analog DC signal or pulse-based frequency input.
Only pulse-based RPM signal can be input.

Configuring connected motor input settings and displaying measured values

For details about the display of measured values and the settings for inputting signals, see "3.6 Motor Measurement (Motor Analysis-Equipped Model)" (p. 90).

Displaying measured motor values

Displaying measured motor values on the [BASIC] screen

Display screen [MEAS] > [VALUE] > [BASIC]
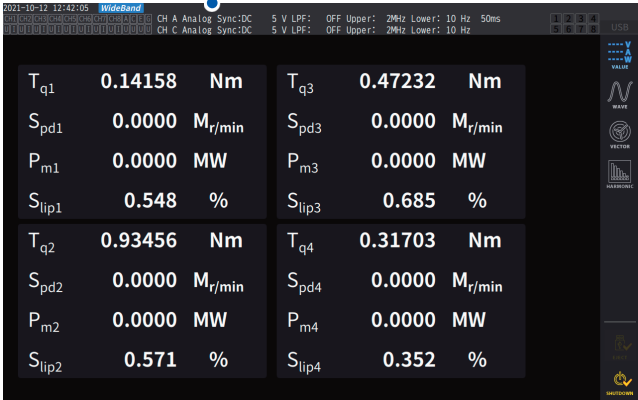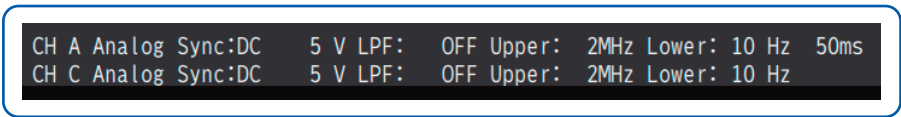
```
CH A Analog Sync:DC    5 V LPF:   OFF Upper:  2MHz Lower: 10 Hz  50ms
CH C Analog Sync:DC    5 V LPF:   OFF Upper:  2MHz Lower: 10 Hz
```


1 **Press the ◀CH▶ keys for channel selection to switch the display to [A-D] or [E-H].**

The displayed channel will change each time the ◀CH▶ keys are pressed.
Regardless whether [A-D] or [E-H] is selected, all measured motor values that can be displayed according to the settings will be displayed.

When [A-D] is displayed, the following displays will appear at the top of the screen.

Input of Ch. A and Ch. C	The top row indicates the input settings for [CH A], and the bottom row indicates that for [CH C]. [Analog], [Freq], or [Pulse] is displayed.
Synchronization source for motor input	Displays the source settings that determine the period (between zero-crossing points) that serves as the basis for measurement. Depending on the connection setting of the motor analysis option, the sources will be displayed in the top and bottom rows.
Filter settings	The top row indicates the range and filter for [CH A], and the bottom row indicates those for [CH C]. For the [Analog] setting, the range and filter setting values will be displayed. For the [Freq] and [Pulse] settings, the filter setting values will be displayed.

When the channel display is set to [E-H], Ch. A and Ch. C in the table above should read Ch. E and Ch. H, respectively.

Displaying measured motor values on the [CUSTOM] screen

Display screen [MEAS] > [VALUE] > [BASIC]

1 **For optical link mode, choose between [Primary] (set the instrument as the primary) and [Secondary] (set the instrument as a secondary).**

2 **Tap [Motor].**

3 **Select the parameter to display.**

Tq	Torque value
Spd	RPM
Pm	Motor power
Slip	Slip

95

Zero adjustment of motor input

In the following circumstances, perform zero adjustment to eliminate errors caused by input signal offsets:

- When an analog DC voltage is inputted to Ch. A, Ch. C, Ch. E, and Ch. G
- When frequency-based torque signal is input

In the following circumstances, perform zero adjustment while the instrument is receiving zero input for the torque and RPM signals:

- When a torque value is displayed even though no torque signal is generated
- When an RPM value is displayed even though no rotation signal is generated
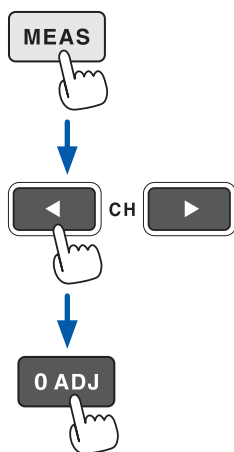
1 **Press the MEAS key.**

2 **Use the ◄ CH ► key for channel selection to switch the display to [A-D] or [E-H].**

The displayed channel will change each time the ◄CH► keys are pressed.

3 **Press 0ADJ.**

The confirmation dialog box will be displayed.

4 **Tap [Yes].**

Zero adjustment is started.

- When the **[A-D]** channel indicator or **[E-H]** channel indicator is lit up, you can also perform motor input zero adjustment by pressing the **0ADJ** key even on any page of the Measurement screen.
- Zero adjustment is unavailable for channels with the input setting set to **[Pulse]**.
- Zero adjustment can be performed within an input range of ±10% of range. Inputting our-of-range signals cause zero-adjustment to fail.

Configuring the motor input settings

Connect torque sensors and tachometers by referring to "Motor measurement wiring" (p. 90).
Configure the motor analysis settings based on those connections.

Display screen [INPUT] > [MOTOR]
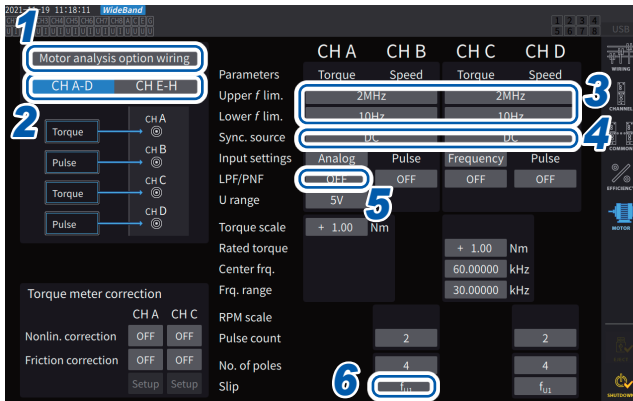
1 Tap **[Motor analysis option wiring]** to select.

2 Tap **[CH A-D]** or **[CH E-H]** to display channels you wish to change the settings.

3 Tap the **[Upper *f* lim.]** and **[Lower *f* lim.]** box, and select the frequency from the list.

Set this when pulses are to be input for the motor input.

Upper *f* lim.	100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, 2 MHz
Lower *f* lim.	0.1 Hz, 1 Hz, 10 Hz, 100 Hz

Upper frequency limit

This setting specifies the lowest frequency that exceeds the maximum frequency of the input pulse signal.
When **[Motor analysis option wiring]** is set to **[Individual Input]**, the setting is used as the upper limit for D/A output.
When using motor analysis mode, this setting is used as the pulse frequency that is used to display RPMs and motor powers and as a pulse frequency to calculate the upper limit value for the D/A output.

$$(\text{RPM upper limit value}) = \frac{60 \times (\text{Set upper frequency limit})}{(\text{Pulse count setting})}$$

$$(\text{Motor power upper limit value}) = (\text{Maximum torque value}) \times \frac{2 \times \pi \times (\text{RPM upper limit value})}{60}$$

If the input RMS signal setting is **[Analog]**, the RMS upper limit is calculated by multiplying the scaled RMS value by the voltage range value.

Lower frequency limit

This setting specifies the lower frequency limit for measurement of the input pulse signal.
When the following synchronization sources are selected, the lower limit frequency is also used as the lower frequency limit for measurement.

Ext1, Ext2, Ext3, Ext4
Zph1, Zph3
Ch. B, Ch. D, Ch. F, Ch. H

3

Displaying Power Numerically

97

4 Tap the [Sync. source] box to open the settings window.

Set the source that determines the period that serves as the basis for calculating motor analysis parameters.
Motor analysis parameters are measured using intervals of the source selected here.
See "Synchronization source" (p. 64).

U1 to U8, I1 to I8, DC, Ext1 to Ext4, Zph1, Zph3 CH B, CH D, CH F, CH H

When setting Ch. D or Ch. H to the origin signal (Origin), you can select [Zph1] or [Zph3] as the synchronization source.
The set motor synchronization source is displayed in [Sync] at the top of the screen when [A-D] or [E-H] is displayed on [Meas] > the [Basic] screen.

IMPORTANT

- When [DC] is selected as the synchronization source, segments will be matched with the data update interval.

  (1 ms, 10 ms, 50 ms, 200 ms)

- When measuring motor efficiency under a fluctuating load, select the same synchronization source as that for the motor input measurement channel. Efficiency can be measured more accurately by using the same calculation interval for motor input and motor output.

---

5 Tap the [LPF/PNF] box and select a low-pass filter or pulse-noise filter from the list.

LPF	OFF (20 kHz), 1 kHz
PNF	OFF, Strong (100 kHz), Weak (1.8 MHz)

Low-pass filter (LPF)
Applicable channels
• Ch. A, Ch. C, Ch. E, and Ch. G (when input is set to [Analog])

Set the filter to [1 kHz] if external noise in analog DC input destabilizes measurement.
The LPF setting has no effect on input when input is not set to analog DC input.

Pulse-noise filter (PNF)
Applicable channels
• Ch. A, Ch. C, Ch. E, and Ch. G (when input is set to [Pulse] or [Frequency])
• Ch. B, Ch. D, Ch. F, and Ch. H

Use this setting when the measured values for frequency or RPM data input using a pulse signal are unstable due to noise.

IMPORTANT

- This setting has no effect on channels for which the input is set to analog DC input.
- When the PNF is set to [Weak (1.8 MHz)] , pulses of approx. 1.8 MHz or higher will not be detected; when it is set to [Strong (100 kHz)], pulses of 100 kHz or higher will not be detected.

---

6 Tap the [Slip] box, then select a input frequency source from the list.

This sets the frequency of the measurement channel inputted to the motor in order to calculate the motor's slip.

fU1, fI1, fU2, fI2, fU3, fI3, fU4, fI4, fU5, fI5, fU6, fI6, fU7, fI7, fU8, fI8

Slip equations

When the unit is r/min.

$$100 \times \frac{2 \times 60 \times (\text{input frequency}) - |\text{RPM}| \times (\text{setting value of the number of motor poles})}{2 \times 60 \times (\text{input frequency})}$$

Select the voltage or current supplied to the motor, whichever is more stable, as the input frequency source.

Setting the torque input

Select the type of signal used by the torque sensor connected to the instrument.

Analog	For sensors that output a DC voltage signal proportional to the torque
Frequency	For sensors that output a frequency signal proportional to the torque

The setting parameters vary with the selected input setting as follows.

When [Analog] is selected

When the torque input is set to [Analog], set the scale value and unit together in [U range] and [Torque scale] according to the sensor.

Display screen [INPUT] > [MOTOR]
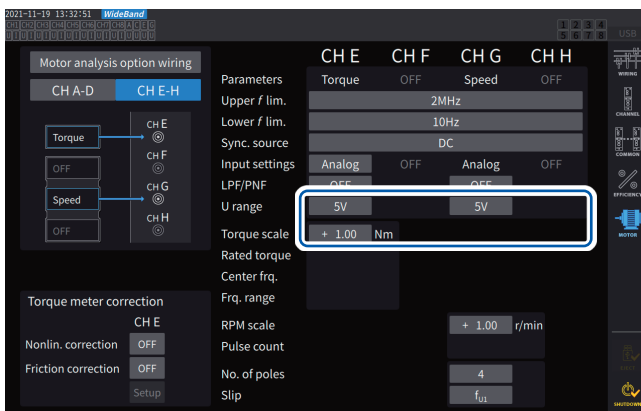
Example: For a torque sensor with a rated torque of 500 N·m and an output scale of ±10 V

U range	10 V
Torque scale	50.00

[U range]

Select a voltage range according to the output voltage of the torque sensor to be connected. When the A-D or D-E channel indicator is lit up, you can use the range keys to select a voltage range.
When A-D is lit up, the **U RANGE** key functions for Ch. A; the **I RANGE** key functions for Ch. C.
When E-H is lit up, the **U RANGE** key functions for Ch. E; the **I RANGE** key functions for Ch. G.

1 V, **5 V**, **10 V**

[Torque scale]

Enter the scaling value using the numeric keypad window.
Measured torque values are displayed as the result of multiplying the input voltage by the scaling value. Set the torque value per 1 V of output from the connected torque sensor in conjunction with the unit-of-torque setting.
([Scaling value] = [Torque sensor rated torque value] / [Output full-scale voltage value])
In the example, the scaling value would be 50. (50 = 500 N·m / 10)

−9999.99 to **−0.01**, **0.01** to **9999.99**

3

Displaying Power Numerically

When [Frequency] is selected

When the torque input is set to **[Frequency]**, set the scale value and unit of measurement together in **[Rated torque]**, **[Center freq.]**, and **[Frq. range]** according to the sensor.

Display screen **[INPUT]** > **[MOTOR]**
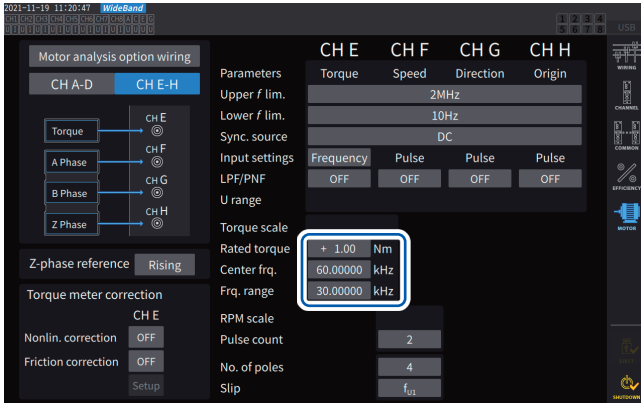
[Rated torque]

Enter the rated torque of the torque sensor to be connected.

±0.01m to **9999.99k**

[Center frq.], **[Frq. range]**

Enter the center frequency corresponding to a torque value of zero in the **[Center frq.]** box. Enter the difference between the frequency corresponding to the sensor rated torque and the center frequency in the **[Frq. range]** box.

1.000000 kHz to **500.0000 kHz**

The settings must satisfy the following constraints:
• The center frequency plus the frequency range is less than or equal to 500 kHz.
• The center frequency minus the frequency range is more than or equal to 1 kHz.

Example 1: For a torque sensor with a rated torque of 500 N·m and output of 60 kHz ±20 kHz

Rated torque	500.00
Center Frq.	60.00000
Frq. range	20.00000

Example 2: For a torque sensor with a rated torque of 2 kN·m, positive rated torque of 15 kHz, and negative rated torque of 5 kHz

Rated torque	2.00 k
Center Frq.	10.00000
Frq. range	5.000000

Setting rotation signal input

Setting items of RPM signal input varies depending on the pattern of the motor analysis mode connection.

Analog	For a DC voltage signal proportional to the RPM
Pulse	For a pulse signal proportional to the RPM

The setting items vary depending on the setting.

When the input setting is set to [Analog]

Configure the voltage range and RPM scaling settings based on the rotation signal.

Display screen [INPUT] > [MOTOR]

[U range]

Select a voltage range according to the output voltage of the rotation signal inputted to the instrument.
The voltage range of the rotation signal input can also be set using the current range keys while the [A-D] or [E-H] channel indicator is lit up.

> 1 V, 5 V, 10 V

[RPM scale]

Enter the RPM scale using the numeric keypad window.
The result of multiplying the input voltage by the scaling value is displayed as the measured RPM value.
Enter the RPM per volt of the rotation signal output.

> ±0.00001 to 99999.9

When the input setting is set to [Pulse]
Display screen [INPUT] > [MOTOR]
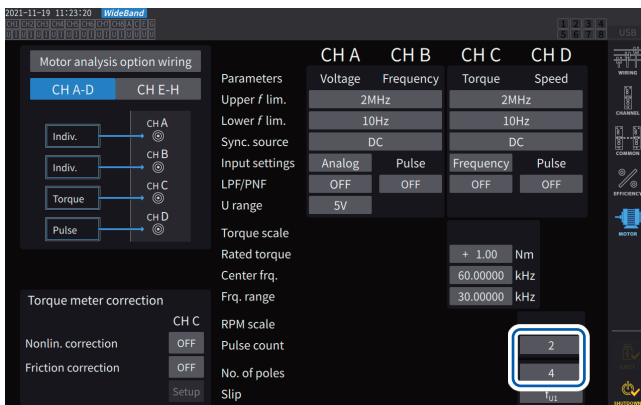
[Pulse count]

If an incremental-type rotary encoder with 1000 pulses per rotation is connected, enter *1000*.
You can use the numeric keypad window.
Specifying this parameter with a multiple of half of the motor's pole number setting will enable to select Ext as the synchronization source.

> ±1 to 60000
> (number of pulses per mechanical angle rotation)

[No. of poles]

This value is used to perform slip calculation as well as convert the RPM signal into a frequency corresponding to the electrical angle.
You can use the numeric keypad window.

> 2 to 254 (even number)

3

Displaying Power Numerically

101

Torque meter compensation function

Display screen **[INPUT]** > **[MOTOR]**
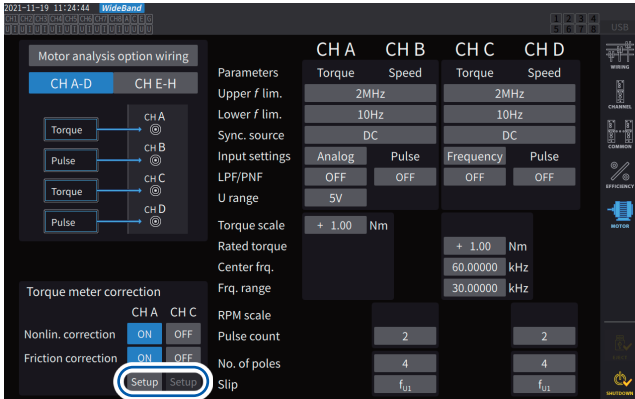
When the torque meter to be used provides calibration values, you can compensate for errors of the torque meter by entering the target values and calibration points.

There are two compensation methods available: the nonlinearity compensation, which uses the *Torque calibration point (N·m)-to-Torque calibration value (N·m)* table, and the friction compensation, which uses the *RPM calibration points (taking account of direction, r/min.)-to-Torque calibration value (N·m)* table.
You can use either one or both of them to perform compensation.
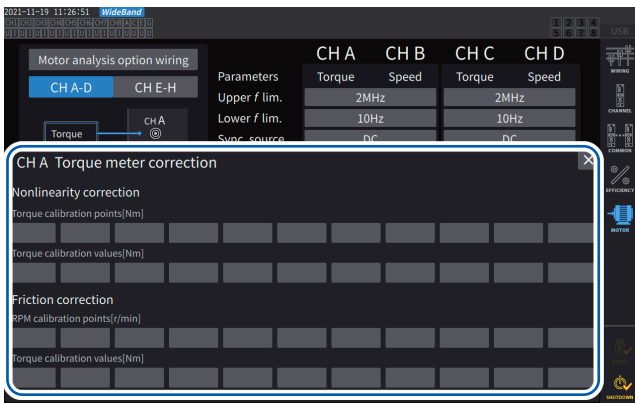
A compensation table can contain value sets of up to 11 points.
The number of the compensation value sets (measured values and target values) can be set as desired.
Entering all of 11 sets is not required.

Calibration values (target values) should be expressed in the unit same as the on-screen measured values.
Measured values falling outside the compensation table will not be corrected.

Input range of each value in the correction table:
±1.00000 n to 999.999 T

> **IMPORTANT**
>
> Motor input waveforms displayed on the waveform screen are not subject to the torque meter compensation.

Conceptual diagram

Nonlinearity compensation
Torque calibration point-to-Torque calibration value
(N·m)   (N·m)
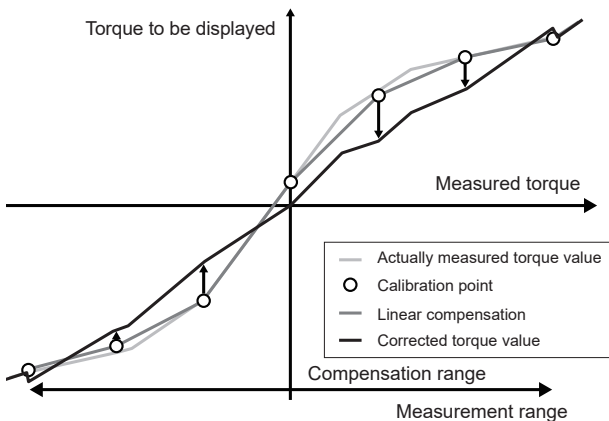
Friction compensation (no-load output)
RPM calibration points-to-Torque calibration value
(taking account of direction,
r/min.)   (N·m)
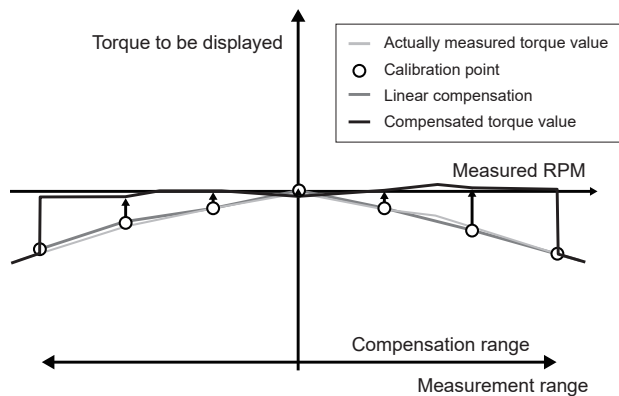
Equations

When the torque meter compensation is enabled:

(Torque value) = S × [X − (Zero-compensation value)] − At − Bt

At = atc − att*

Bt = btc*

S: Scaling

X: Input signal-to-torque converted value

At: Nonlinearity target value

Bt: Target friction value

atc: Torque calibration value of nonlinearity compensation table

att: Torque calibration point of nonlinearity compensation table

btc: Torque calibration value of friction compensation table

*: Target values between the entered calibration points are calculated by linear interpolation.

- The calibration values should be obtained by the customer through calibration or contact the torque meter manufacturer.

- Zero adjustment of the motor analysis also applies to offsets of devices, including torque meters, regardless of whether the compensation function is enabled or disabled.

- The instrument does not indicate about zero for a torque value outputted when no torque is generated or the motor is not rotating because it corrects measured values by applying calibration values after zero adjustment. Performing zero adjustment of this instrument sets the offsets of the entire system, including itself, to zero; thus, you should usually set the calibration value of the zero-torque point to zero.

- If you have torque meters' information on hysteresis characteristics or drift that occurs during a test, entering the calibration value of the zero-torque point will enable more accurate measurement.

- The unit of torque, newton-meter (N•m) in this section, varies depending on the setting.

- Compensation values for points that exceed the measuring range will not be used in the compensation calculation.

- When calibration values are expressed in % of full scale (% f.s.), the following equation can yield the calibration values you can enter.
  (Calibration value to be entered) = (f.s. of torque meter) × (% of full scale)

- Torque meter compensation is valid only values within the range of set torque calibration points. If you want to correct torque values outside the range, set a wider range of torque calibration points.

Measuring the electric angle of the motor

When a pulse signal is used as rotation signal input, you can view changes in the voltage and current phase using the pulse as the reference by setting the [Sync. source] for input channels 1 to 8 to [Ext1], [Ext1], [Ext2], [Ext3], or [Ext4].
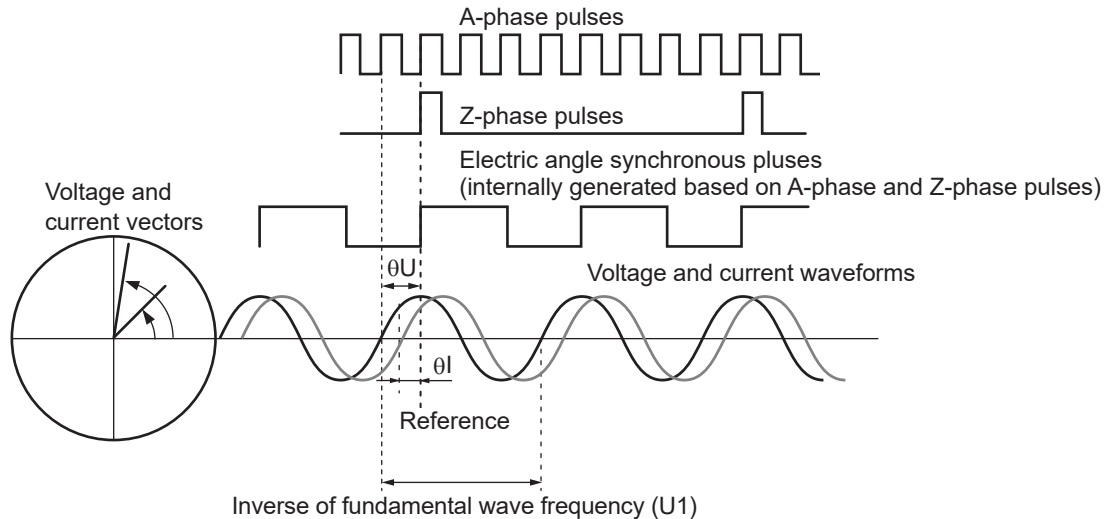
When measuring the electrical angle using multiple pulses

- It is recommended to use the origin signal (Z-phase). When the origin signal (Z-phase) is used, the reference pulse is determined based on the origin signal, enabling phase measurement using a fixed pulse as the reference at all times.
- To use a rising edge of the origin signal (Z-phase) as the reference, set the Z-phase reference to *Rising*; to use a falling edge, set to *Falling*.
- When the origin signal (Z-phase) is not used, the pulse that serves as the reference is determined during synchronization. If synchronization is fails, a different pulse may be used as the reference each time resynchronization is performed.

- Performing harmonic analysis in synchronization with the inputted rotation signal pulse requires pulses, the number of which is a whole number multiple of the input frequency. For example, a four-pole motor would require pulses, the number of which is a whole number multiple of 2, while a six-pole motor would require pulses, the number of which is a whole number multiple of 3.
- When measuring a motor that uses a Y connection internally in 3P3W3M wiring mode, phase angles of the phase voltage and phase current can be measured by using the Δ–Y conversion function.

Phase zero adjustment (PHASE ADJ)

This section describes how to compensate for the phase difference between the harmonic-measurement synchronization source's pulses and the voltage fundamental wave components of the connected first channel to zero.

Display screen **[MEAS]** > **[VECTOR]** > **[VECTOR×1]**
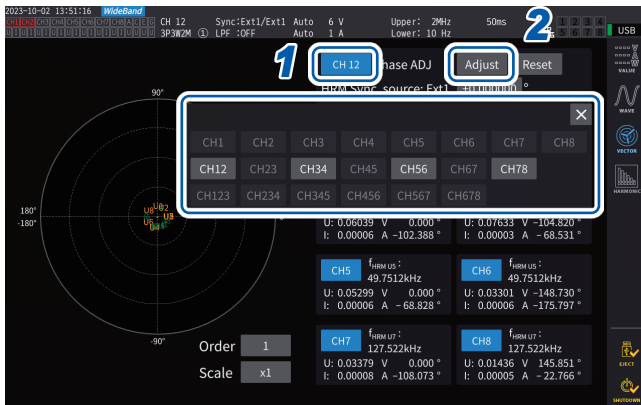
1 Select the channel for which you wish to perform phase angle zero adjustment using the channel selection window.

2 To obtain the compensation value according to the input, tap **[Adjust]** under **[Phase ADJ]**.

3 To enter a user-defined compensation value, tap the compensation value display area, then enter the compensation value with the numeric keypad window.

- Phase zero-adjustment is available only when the synchronization source is set to **[Ext1]**, **[Ext2]**, **[Ext3]**, or **[Ext4]**. Even if keys are operated, phase zero-adjustment has no effect when other settings are used.
- No key operation is available when the channel is in a synchronization-unlocked condition.
- The compensation value has a valid setting range of −180° to +180°. For the environments where phase angles are expressed as numbers between 0° and 360°, convert a compensation value into a number between −180° to +180° and enter it.
- The compensation display area indicates the present compensation value for the phase zero adjustment. Tapping **[Adjust]** can replace the existing compensation value with a new one.
- The set phase zero-adjustment compensation value will be subtracted from the measured pulse-based voltage- and current-phase values.
- Compensation values will be maintained even if the instrument is turned on or off.
- Tapping **[Reset]** will clear the compensation values and revert to operation in which the instrument displays the phase difference with the pulse being used as the reference.
- Compensation values will be cleared by the system reset.

Example of electrical angle measurement

1 Rotate the unenergized motor from the load side to measure the inductive voltage generated across the motor's input terminals.

2 Perform phase zero adjustment.

Zero adjustment will zero the phase difference between the fundamental wave component of the inductive voltage waveform inputted to U1 and the pulse signal.

3 Energize the motor to rotate it.

Voltage and current phase angles measured with the instrument will indicate an electrical angle based on the inductive voltage phase.

IMPORTANT

Because the phase difference includes the effects of the rotation input signal's pulse waveform and the instrument's internal circuit delay, it will appear as measurement error when the instrument measures a frequency that differs greatly from the frequency at which phase zero adjustment was performed.

3

Displaying Power Numerically

Detecting the motor's direction of rotation

If an incremental-type rotary encoder's A-phase pulse and B-phase pulse are inputted to Ch. B and Ch. C input terminals or Ch. F and Ch. G input terminals, which are for the rotation signals, the instrument can detect the direction in which the shaft is rotating, assigning a corresponding polarity sign to the RPM values.

When [Motor Analysis option wiring] is set to [Torque Speed Direction Origin] or [Torque Speed Direction], the direction of rotation can be detected.
Direction of rotation is judged based on the level of the other's pulse (high/low) when rising and falling edges of the A-phase and B-phase pulses are detected.

Forward operation
RPM polarity: plus sign (+)

A-phase

B-phase
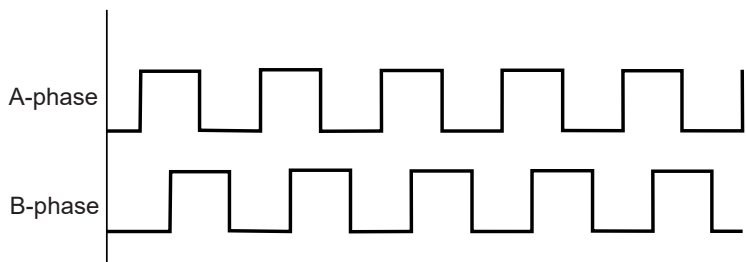
Backward operation
RPM polarity: minus sign (−)

A-phase

B-phase
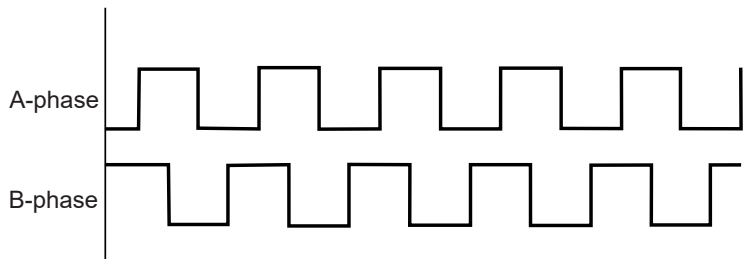
The detected direction of rotation affects the polarity sign assigned to measured RPM values as well as measured motor power (Pm) values.

When **[Motor analysis option wiring]** is set to **[Torque Speed Direction Origin]** or **[Torque Speed Origin]** and the synchronous sources from Ch. 1 to Ch. 8 are set to **[Zph1]** or **[Zph3]**, the measured voltage and current based on one motor spinning (one mechanical angle cycle) are displayed.

Example for a 4-pole motor
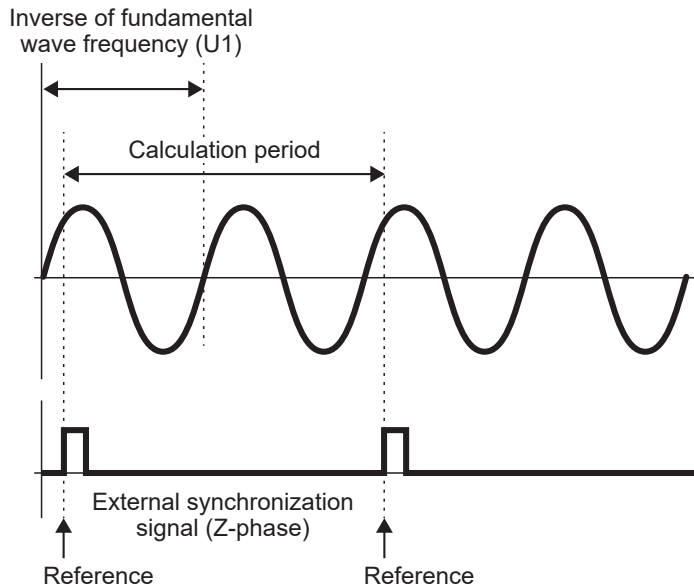
- To use a rising edge of the external synchronization signal (Z-phase) as the reference, set the Z-phase reference to *Rising*; to use a falling edge, set to *Falling*.
- Since one motor rotation is always used as the calculation range regardless of the number of poles the motor has, measurement can be performed by averaging the variations for each pole that are caused by the motor's mechanical characteristics.
- For measured values of voltage and current harmonic values, measured values of fundamental wave appear as the order of half the number of motor poles. Subsequently, the nth-order harmonics of voltage and current appear at the product of half the number of motor poles and n.
- The voltage and current fundamental frequencies are measured to obtain measured voltage and current frequency values.
- Provide input as appropriate based on measurement parameters of Ch. A through Ch. D or Ch. E through Ch. H. In addition to inputting the origin signal to Ch. D or Ch. H (Z-phase pulse), the rotation signals need to be correctly inputted to Ch. B or Ch. F (A-phase pulse) and Ch. C or Ch. G (B-phase pulse when the direction is used).
- To use other pulses as the calculation scope's reference instead of pulses outputted from a rotary encoder, you are recommended to use in **[Indiv.]** operating mode of the motor analysis and set the synchronization source of input channels 1 through 8 to Ch. B, Ch. D, Ch. F, or Ch. H, respectively. Input the reference pulses as the selected synchronization source.

3.7 Measuring IEC Voltage Fluctuation/Flicker

The instrument in IEC measurement mode can be used as a flicker meter in compliance with IEC61000-4-15, enabling flicker measurement.

The start of flicker measurement is linked with the start of integration.

In IEC measurement mode, internal calculation processing differs from the regular measurement mode to realize measurements in compliance with the IEC standard. Thus, some functions are restricted in IEC measurement mode.

See "2.7 Measurement Mode" (p. 48).

Display screen **[INPUT]** > **[COMMON]**
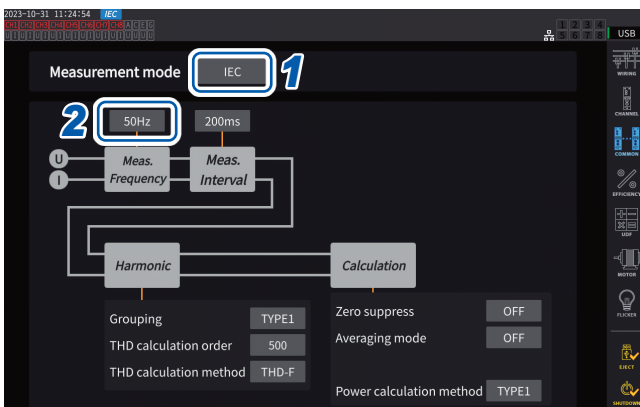
1 **Set the measurement mode to IEC measurement mode.**

See "2.7 Measurement Mode" (p. 48).

2 **Tap the [Meas. Frequency] box to choose the measurement frequency.**

50Hz, **60Hz**

The transfer function of the flicker meter could be altered; thus, select an appropriate one.

IEC measurement mode.

- The instrument in this mode can measure IEC harmonics and IEC voltage fluctuation/flicker.
- When the measurement line has a frequency of 50 Hz or 60 Hz, the instrument can perform harmonic measurements according to IEC61000-4-7 and voltage fluctuation/flicker measurements according to IEC61000-4-15.
- The data update interval is fixed at 200 ms.
- The instrument do not perform harmonic measurement and voltage fluctuation/flicker measurement if the frequency to be measured falls outside the range of 45 Hz to 66 Hz.

Making the IEC flicker measurement settings

This section describes how to make the IEC flicker measurement settings.

Display screen [INPUT] > [FLICKER]
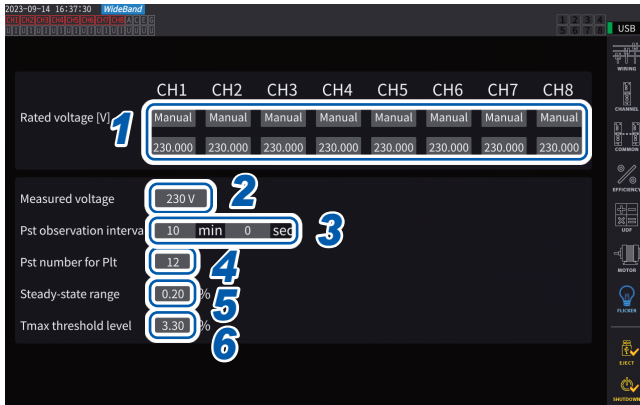
1 **Tap the boxes of wiring configurations you want to set under [Rated voltage] to select the rated voltage.**

Auto	Select to automatically set the rated voltage based on the previous input voltage.
Manual	Select to enter a value manually. Settable range: **0.001** to **999.999**

2 **Tap the [Measured voltage] box to set the voltage to be measured.**

The transfer function of the flicker meter changes according to this setting; thus, select an appropriate one.

120V, **230V**

3

Displaying Power Numerically

109

3 **Tap the [Pst observation interval] boxes to set the Pst observation interval.**

Usually, set the observation interval to 10 minutes.

00 min 30 sec to **15 min 00 sec**

4 **Tap [Pst number for Plt] box to set the number of Pst intervals used for Plt calculation.**

Usually, set the number of target Pst to 12.

1 to **1008**

5 **Tap [Steady-state range] to set the steady range (dmin: allowable range of relative voltage change regarded as a steady state).**

0.10 to **9.99%**

6 **Tap the [Tmax threshold level] box to set the threshold value for Tmax evaluations.**

1.00 to **99.99%**

How to measure IEC flicker

To perform the IEC flicker measurement, you must set the wire configuration setting of the measurement target channel to 1P2W. The correct values will not be output if any other wiring configuration is selected.

To initialize various filters, wait about 1 minute before starting measurements with the voltage input after the setting is completed.

The IEC flicker measurement is started in sync with the start of the integration and stopped at the completion of the Plt calculation. If the **[Pst observation interval]** and **[Pst number for Plt]** are set to 10 minutes and 12, respectively, the calculation will be stopped in 120 minutes, obtained by multiplying 10 minutes by 12 points. Note that the integration does not stop even after the flicker calculation stops.

For detail about how to control integration, see "3.3 Integrating Current and Power" (p. 70).

In IEC measurement mode, cumulative integration is not possible. It is necessary to reset the data once to start integration again after the integration is stopped.

Saving the measured values of flicker calculations requires saving data including that acquired after the Plt calculation is completed.

Measurement item	Description
d_c	Relative steady-state voltage change
d_{max}	Maximum relative voltage change
T_{max}	Period while the relative voltage change exceeds the threshold
P_{st}	Short-term flicker value
P_{stMax}	Maximum short-term flicker value
P_{lt}	Long-term flicker value
$P_{instMax}$	Maximum instantaneous flicker value
$P_{instMin}$	Minimum instantaneous flicker value

Checking flicker measured values

You can check the flicker measurement items on the curstom screen.
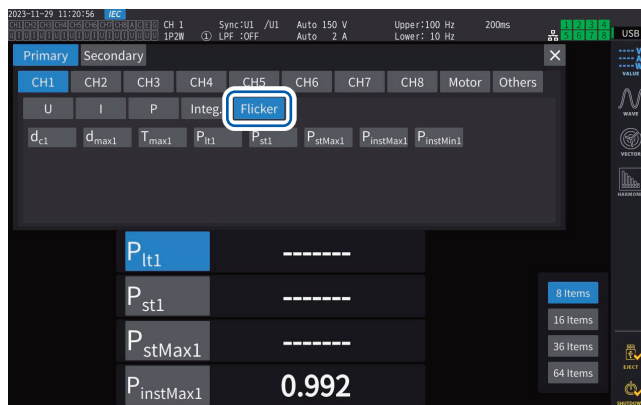
Displaying selected measured flicker values on the [CUSTOM] screen
Display screen   [MEAS] > [CUSTOM]

1   Tap [Flicker].

2   Select items you want to display.

Description of measurement items

Flicker

Generally speaking, the term *flicker* is a directly visible change in brightness of a light source. If a heavy-load facility starts up or a large current flows due to a temporary overload, each facility is affected by a voltage drop, resulting in a flicker.

In lighting loads, it primarily refers to the flashing of lighting fixtures. Discharge lamps, such as fluorescent lamps and mercury lamps, are particularly susceptible to the effects of voltage drops. As the frequency of briefly darkening due to voltage drops increases, flickers will repeatedly occur, making people very uncomfortable visually.

Short-term flicker value, P_{st}

This value indicates susceptibility to a flicker measured in a short period. Any Pst measuring period can be set; however, it is generally set at 10 minutes.

Long-term flicker value, P_{lt}

This value indicates susceptibility to a flicker measured in a long period using consecutively obtained Pst values. Any number of Pst to be calculated can be set; however, it is usually calculated from twelve Pst values (two hours when the Pst is observed for 10 minutes).

Instantaneous flicker value, P_{inst}

This value is obtained by performing various filter processing, including the visibility filter for the input waveform.

Steady state

The RMS voltage value for each half cycle remains within the specified ±0.2% allowable band for approximately 1 s or more, considered stable.

Relative steady-state voltage change, d_c

This value is a difference between two consecutive stationary values.

This value is obtained by dividing the difference between the two steady voltages before and after a single voltage fluctuation by the rated voltage, expressed in percent.

Maximum relative voltage change, d_{max}

This value is obtained by dividing the absolute value of the most significant fluctuation value in one-time voltage fluctuation by rated voltage based on the previous steady-state value, expressed in percent.

Period while the relative voltage change exceeds the threshold level, T_{max}

This value indicates the period while the relative voltage change is exceeding the threshold level during one voltage change period. Any threshold level can be set; however, it is generally set at 0.20%.

3

Displaying Power Numerically

113

4 Displaying Waveforms

The instrument can display voltage, current measured on all channels and motor input waveforms.

The waveform display is completely independent of power measurement.

The operation described in this chapter will not affect measured power or harmonics values.

4.1 Waveform Display Method

Displaying waveforms on the waveform (WAVE) screen

The waveform screen displays only waveforms.

Starting waveform recording

Display screen [MEAS] > [WAVE] > [WAVE]

Settings area   Setup menu area

Measured value display area
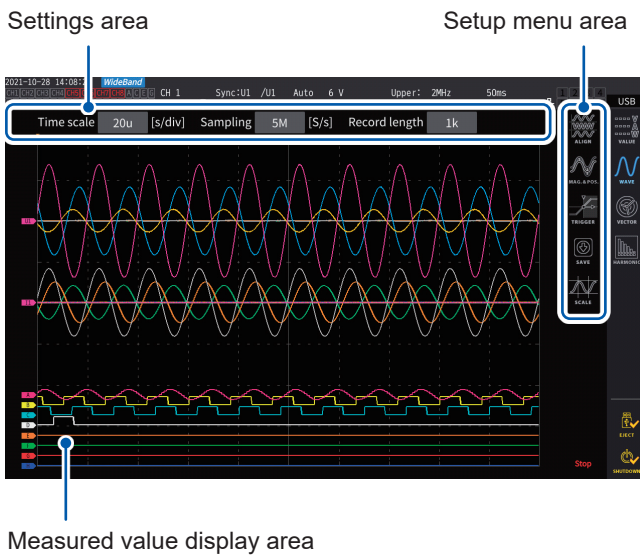
1 **Press the RUN/STOP key.**

RUN/STOP (Lit up in green)

Waveform recording begins, and the screen display is updated. Recording will start when the trigger is applied.
See "4.3 Recording Waveforms" (p. 123).

2 **Press the RUN/STOP key again.**

RUN/STOP (Lit up in red)

Waveform recording stops, and the screen display is no longer updated.

Waveform recording status display

The waveform recording status display provides helpful information if it takes time for the instrument to display waveforms or if waveforms cannot be displayed.

Trigger position (p. 120)
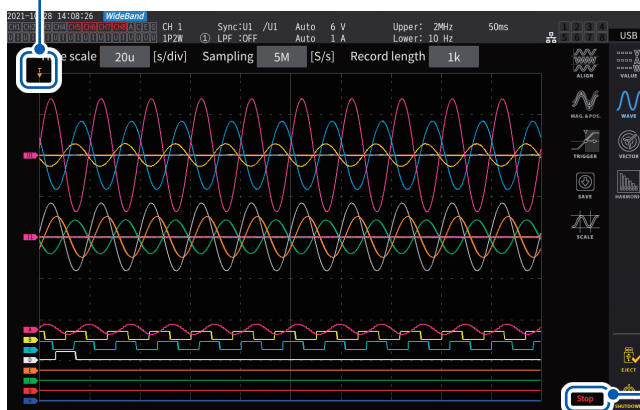
Waveform recording status

Status	Description
Stop	Recording has stopped.
PreTrig.	The instrument is recording pre-trigger waveforms.
Trigger	The instrument is in the trigger standby state.
Storage	The instrument is recording post-trigger waveforms.
Compress	The instrument is creating waveforms for display.
Abort	The instrument is performing processing to stop waveform recording.

115

Displaying waveforms and measured values on the waveform and measured value (WAVE+VALUE) screen.

This screen displays waveforms and measured values. The timing between when on-screen waveforms were recorded and when on-screen values were measured are not synchronized.

Starting waveform recording

Display screen   [MEAS] > [WAVE] > [WAVE]

Waveform display area
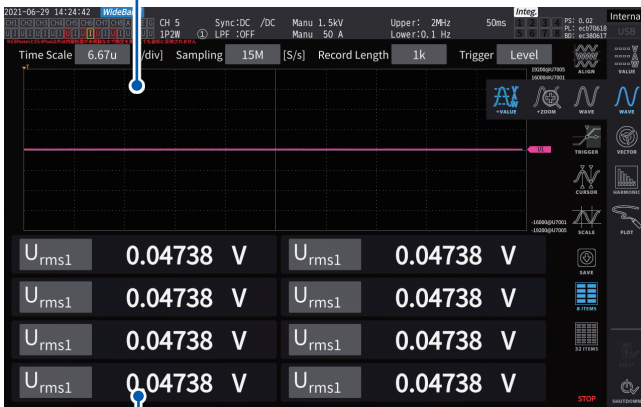
Measured value display area

The measured values display area can display 32 freely-selected basic measurement parameters.
See "1.4 Basic Operation (Screen Display and Layout)" (p. 22).

To stop display updating of measured values

Pressing the **HOLD** key can stop display updating of measured values. Waveform recording is not stopped.

Aligning waveforms

There are four patters available to align waveforms.

Display screen   [MEAS] > [WAVE]
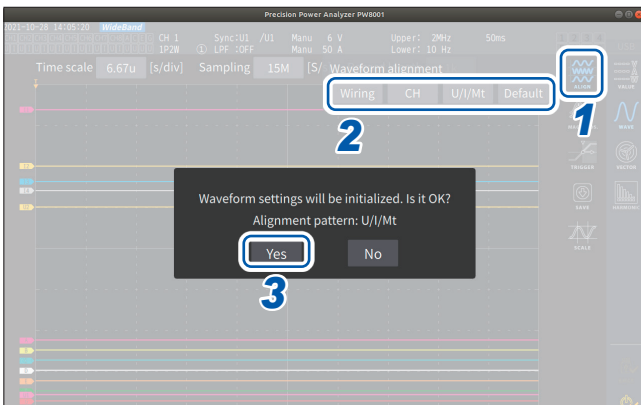
1 Tap [Align].

2 Tap any one of the [ALIGN] patterns.

The confirmation dialog box is displayed.

3 Tap [Yes] to align the waveforms.

Wiring	Places waveforms of the same wiring configuration at the same position. The positions differ according to the wiring configuration.
CH	Places waveforms of the same channel at the same position.
U/I/Mt	Places waveforms in the order of voltage, current, and motor from the top.
Default	Places waveforms separated into (1) voltage and current waveforms and (2) motor waveforms. If the motor analysis option is not installed, voltage and current waveforms are centrally located.

The vertical axis of the waveforms is positioned relative to the zero positions of each input.
- The vertical axis display magnification is adjusted to match the vertical axis size of the range and area.
- When waveforms are aligned, the colors of the waveforms are also changed. Colors differ depending on the alignment pattern.

4.2 Changing the Waveform Display and Configuring Recording

Time axis setting

This section describes how to configure the waveform time axis settings using the **[Time scale]**, **[Sampling]**, and **[Record length]**. The time axis settings are automatically changed according to sampling frequency and recording length settings.

Display screen [MEAS] > [WAVE] > [WAVE]
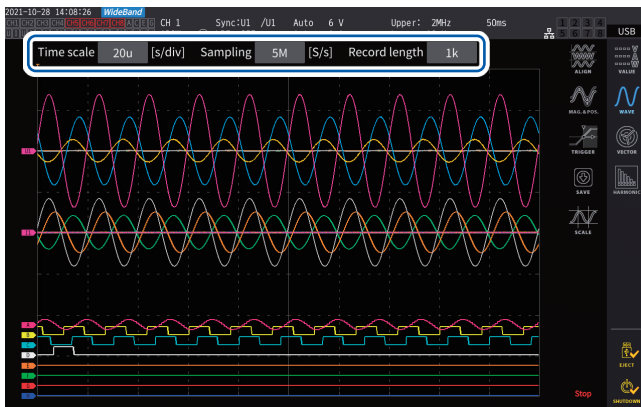
Tap each box, and then rotate the X rotary knob to set each setting items.

See "Changing values with rotary knobs" (p. 23).

> **IMPORTANT**
>
> Motors' analog waveforms are sampled at a rate of 1 MS/s. For the sampling speed setting of 1 MS/s or faster, the same value is supplementary displayed at points between sampling points.

4

Displaying Waveforms

Time axis

Sampling frequency and recording length settings are changed in conjunction with the time axis setting. The sampling frequency and recording length change to the settings to be updated at the shortest interval (highest sampling frequency, shortest recording length) among the time axis settings combinations determined by sampling frequencies and recording lengths.

> **6.67 µs/div**, **13.3 µs/div**, **20 µs/div**, **33.3 µs/div**, **40 µs/div**, **66.7 µs/div**, **100 µs/div**, **133 µs/div**, **200 µs/div**, **333 µs/div**, **400 µs/div**, **500 µs/div**, **666 µs/div**, **1 ms/div**, **1.33 ms/div**, **2 ms/div**, **3.33 ms/div**, **4 ms/div**, **5 ms/div**, **6.67 ms/div**, **10 ms/div**, **13.3 ms/div**, **20 ms/div**, **33.3 ms/div**, **40 ms/div**, **50 ms/div**, **66.7 ms/div**, **100 ms/div**, **200 ms/div**, **400 ms/div**, **500 ms/div**, **1 s/div**, **2 s/div**, **4 s/div**, **5 s/div**, **10 s/div**, **20 s/div**, **50 s/div**

Sampling frequency

> **15 MHz**, **7.5 MHz**, **5 MHz**, **2.5 MHz**, **1 MHz**, **500 kHz**, **250 kHz**, **100 kHz**, **50 kHz**, **25 kHz**, **10 kHz**

Recording length

> **1 k**, **5 k**, **10 k**, **50 k**, **100 k**, **500 k**, **1 M**, **5 M** (unit of measurement: words)

1 k = 1000 sampled data point, 1 sampled data point = 1 word

The waveforms are displayed once data has been recorded for the set recording length with the specified sampling frequency.
If the time scale setting is set to slower than 200 ms/div, the waveforms are displayed as they are recorded in real time (roll mode).

> **IMPORTANT**
>
> Since the sampling frequencies of the U7005 and the U7001 are 15 MHz and 2.5 MHz, respectively, there is a difference in the smoothness of waveforms when sampling frequency of the instrument is set to 2.5 MHz or higher.

117

Peak-to-peak compression

Values sampled at rate of 15 MS/s

Maximum value

Minimum value

Waveform drawn at a rate of 500 kS/s

Maximum value

Minimum value

To compress a waveform sampled with a rate of 15 MS/s to that composed of points with a rate of 500 kS/s by using the peak-to-peak compression
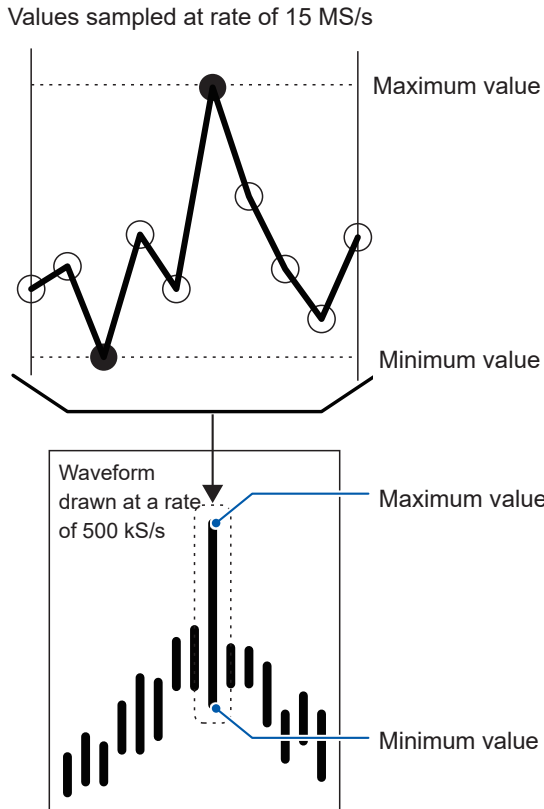
Even if you change the sampling frequency setting, the instrument samples signals internally with a sampling rate of 15 MS/s. When reducing the sampling frequency, decimate of sampling points from a waveform sampled with the rate of 15 MS/s at regular intervals may decimate the maximum and minimum values in the interval. The peak-to-peak compression is the way to select and decimate other points leaving the maximum and minimum values in the interval.

In this way, you can reduce the sampling frequency maintaining accurate waveforms that preserve the peaks of the uncompressed waveforms.
The waveform data to be saved consists of two values per data point, the maximum and minimum values as illustrated in the figure on the left.

Aliasing

Actual input signal

Sampling interval

Observed waveform
Aliasing has occurred because the sampling frequency is low relative to synchronization of the incoming signal.

When the change of a signal under measurement becomes faster with respect to the sampling frequency, a slow signal changes that do not exist at a certain frequency are recorded.
This phenomena is called aliasing.

Vertical axis zoom factor and display position settings

This section describes how to set display preferences, including choosing to disable or enable the waveform display setting, the vertical axis zoom factors, and display positions for each parameters.

Display screen [MEAS] > [WAVE] > [WAVE]

The div. display ranges and display positions for the parameter being changed will be displayed.

The parameter name for each waveform will be displayed.

1 **Tap [MAG.&POS.].**

The settings window for the vertical axis zoom factor and display position is displayed.

2 **Tap a channel button.**

The button of selected channel button turns green and the X rotary knob lights up in green. Multiple channel numbers can be selected simultaneously.

U	Voltage waveforms
I	Current waveforms
A through H	Motor input waveforms

3 **Configure the settings by rotating the X rotary knob and Y rotary knob.**

The vertical axis zoom factor and vertical axis display position settings change in response to the knobs rotated.

Vertical axis zoom factor

×1/10, ×1/9, ×1/8, ×1/7, ×1/6, ×1/5, ×1/4, ×1/3, ×2/5, ×1/2, ×5/9, ×5/8, ×2/3, ×5/7, ×4/5, ×1, ×10/9, ×5/4, ×4/3, ×10/7, ×5/3, ×2, ×20/9, ×5/2, ×10/3, ×4, ×5, ×20/3, ×8, ×10, ×25/2, ×50/3, ×20, ×25, ×40, ×50, ×100, ×200

Vertical axis display position

−9999.99 div to 9999.99 div

4 **Tap [MAG.&POS.] or the area out of the window.**

The window closes.

4

Displaying Waveforms

Vertical axis zoom list display

The instrument can list the vertical axis magnifications of all waveforms.

Display screen [MEAS] > [WAVE] > [WAVE]
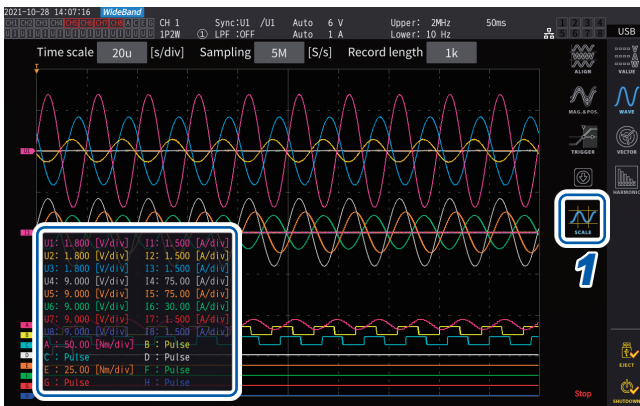
1 Tap [SCALE].

The settings list window of the vertical axis zoom factors are displayed.
Only the information of the on-screen waveforms is displayed in the window.

2 Tap [SCALE] again.

The settings list window of the vertical axis zoom factor closes.

Configuring the trigger settings

This section describes how to set conditions where the instrument can start waveform recording, called the trigger function.
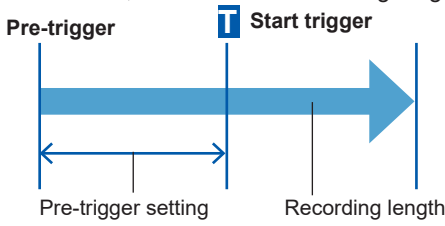
When the user-defined trigger conditions are satisfied, a trigger is activated, starting waveform recording.

Display screen [MEAS] > [WAVE] > [WAVE]

1 Tap [TRIGGER].

The trigger setup window will open.

2 Tap the button.

You can set the relevant items.
For details on each setup parameter, see "Description of parameter settings and selectable ranges" (p. 121).

3 After completing the setup, tap [Trigger] or the area out of the window.

The trigger setup window will close.

Description of parameter settings and selectable ranges

Parameter	Settings	Description
Auto trigger	**ON**	Waveform recording will be forcibly started if the next trigger is not activated within about 100 ms after the activation of the previous trigger. This setting is useful to observe DC input waveforms.
	OFF	Waveform recording starts only when the set condition is met.
Pre trigger[%]	**0%** to **100%** (Can be set in 10 percent points increments.)	Sets how much of the waveform to allocate before the trigger is activated, relative to the recording length. Configure the settings by rotating the X rotary knob. See "Changing values with rotary knobs" (p. 23).
Trigger type	**Level**	Changes in a storage waveform level activate the trigger. Advanced settings of the level trigger can be configured.
	Event	Changes in the value of a selected measurement item activate trigger. Advanced settings of the event trigger can be configured.
Source	Sets the waveform to use as the trigger source.	
	U1 to **U8**	Voltage waveforms
	I1 to **I8**	Current waveforms
	CH A to **CH H**, **Ext1** to **Ext4**	Motor waveforms (available only for motor analysis-equipped model) Available settings vary with the motor input operating mode.
ZCF (Zero-cross filter)	**ON**, **OFF**	This function can eliminate noises of a waveform used as the trigger source by a noise filter when the trigger source setting is set to voltage waveform or current waveform. Set **[ZCF]** to **[ON]** to obtain stable trigger timing when using a waveform containing noise. This setting is particularly effective to observe PWM waveforms. This does not affect the display waveform. If **[Source]** is set to Ch. A to Ch. H or Ext1 to Ext4, the ZCF is forcibly disabled.
Slope	**Rising**	The trigger will be activated at a rising edge of the waveform.
	Falling	The trigger will be activated at a falling edge of the waveform.
Level[%]	**−300%** to **+300%**	Sets the level at which the trigger is activated using a percentage of the source range. A level monitor appears on the right side of the window. This setting cannot be used when the trigger source is set to **[Pulse]** of a motor waveform. Configure the settings by rotating the Y rotary knob. Lit up in green: in 0.1 increments Lit up in red: in 1 increments See "Changing values with rotary knobs" (p. 23). You can move the trigger level line after tapping it.

4

Displaying Waveforms

Parameter	Settings	Description
Ev1 to **Ev4** (event 1 to 4)		Composed of measurement items, inequality signs (<, >), and numerical values (0.00000 to ±99999.9T). The logical OR and AND of **[Ev1]** through **[Ev4]** determine the trigger conditions. The logical AND takes precedence over the logical OR.

4.3 Recording Waveforms

Recording waveforms continuously

RUN /STOP (Lit up in green)

RUN /STOP (Lit up in red)
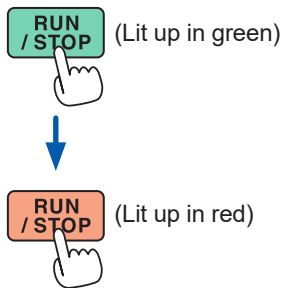
1 **Press the RUN/STOP key.**

The instrument enters the trigger standby state.
Recording will start when a trigger is activated.
The instrument will repeatedly wait for a trigger after recording waveforms of the recording length.

2 **Press the RUN/STOP key.**

Recording will stop.

- If the **RUN/STOP** key is pressed to stop waveform storage operation, waveforms may not be saved correctly.
- Always press the **SINGLE** key to acquire waveforms to be saved.

Recording a waveform once

SINGLE (Lit up in green)

SINGLE (Off)

RUN /STOP (Lit up in red)
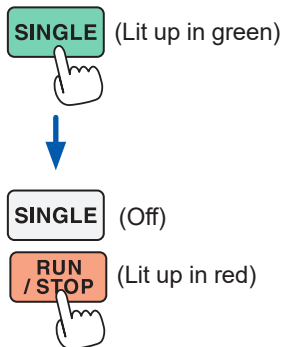
1 **Press the SINGLE key.**

The instrument enters the trigger standby state.
Recording will start when a trigger is activated.

Once waveforms of the recording length have been recorded, recording will stop.

Pressing **[RUN/STOP]** while the instrument is in the standby state will stop recording.

Activating the trigger manually

TRIGGER

MANUAL

1 **Press the MANUAL key while the instrument is in the standby state.**

Pressing the key can activate a trigger, starting recording waveforms.

4

Displaying Waveforms

123

Displaying measured values of waveforms (cursor measurement)

You can use the two cursors to display cursor-measured values for the selected waveform. Cursor-measured values can be displayed for a voltage waveform, a current waveform, and a motor input waveform of each wiring configuration, along with the differences between the two cursors' respective values.

Display screen   [MEAS] > [WAVE] > [WAVE]

Cursor-value display window

1   Tap [CURSOR] to display the cursors.

2   Use the X and the Y rotary knobs to move the cursors and to display the maximum and minimum cursor-measured values in order.
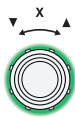
Moving the X cursor
Rotate the knob to switch the values to be displayed in the following order:
Displaying minimum value, moving cursor, displaying maximum value, displaying minimum value display, moving cursor, and displaying maximum value.

Moving the Y cursor
The Y rotary knob moves in the same manner as the X rotary knob.
You can also drag the cursor.

The following parameters are displayed on the cursor display window:
• X cursor-measured values (level and time axis), maximum/minimum indication
• Y cursor-measured values (level and time axis), maximum/minimum indication
• Difference (Δ) between X and Y cursor-measured values (level difference and time axis difference)
• Reciprocal of the cursor X and cursor Y time-axis difference (1/Δ)

• For each dot on the displayed waveform, there are two pieces of data (the maximum and minimum values). Consequently, you can switch between the maximum and minimum value display during cursor measurement.
  See "Time axis setting" (p. 117) and "Peak-to-peak compression" (p. 118).
• Cursor measurement can be available on the following waveform-related screens:
• [WAVE] screen (waveform display)
• [WAVE+ZOOM] screen (waveform + zoom display)
• [WAVE+VALUE] screen (waveform + measured value display)
• [WAVE+FFT] screen (waveform + FFT analysis)

Displaying enlarged views of waveforms (zoom function)

The displayed waveforms can be enlarged along the time axis (horizontal axis).
The waveforms within the section indicated in yellow (zoom section) in the waveform display area
are enlarged in the time axis direction to display them in the enlarged waveform display area.
Straight lines interpolate between two adjacent points when the magnification is certain or more.

Display screen [MEAS] > [WAVE] > [+ZOOM]
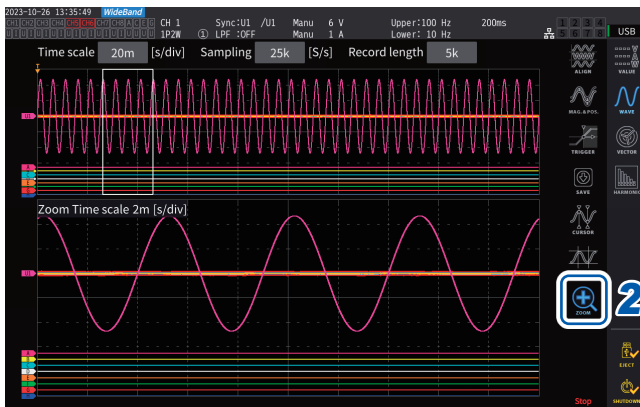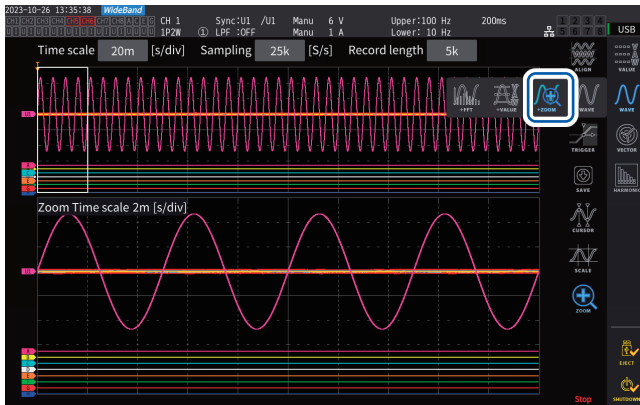
1 **Tap the SINGLE key to acquire waveforms.**

See "4.1 Waveform Display Method" (p. 115).

2 **Tap the [Zoom] icon.**

3 **Use the X rotary knob to select the magnification (the zoom section size).**

The selectable magnifications depend on the number of storage points (**×2** to **×1M**).

4 **Use the Y rotary knob to move the zoom section.**

The zoom section moves horizontally. Pressing the Y rotary knob can switch among the three zoom-section moving speeds. Using the lowest speed mode can update the zoom section in increments of one point of storage data point.

4

Displaying Waveforms

IMPORTANT

- The broken green line represents the zoom section after the change of position and magnification.
- The waveforms in the solid-white-line zoom section are displayed at the bottom of the screen.
- To use the zoom function, acquire waveforms using the SINGLE trigger. (p. 123)

What do they indicate?

[magnifier icon] is displayed.	There is no waveform data to display, such as immediately after startup.
[Zoom Time scale] is displayed in red.	The setting is changed while the enlarged waveform display area shows enlarged waveforms, resulting in a discrepancy between the zoom setting and that of the actual waveform display.

4.4 FFT Analysis (Power Spectrum Analysis) Capability

This section describes how to perform FFT analysis (power spectrum analysis) on recorded waveforms and display the analysis results. This capability can perform FFT analysis on voltages and currents of a selected wiring configuration, displaying the results with a frequency of up to 6 MHz graphically and numerically. The motor analysis-equipped model can perform FFT analysis on analog-input signals. This is useful for observing the carrier frequency of an inverter or high-frequency noises on commercial power supply lines or DC power supplies. As for an FFT analysis on voltage and current, the power FFT analysis results can be displayed based on the respective calculation results.

Displaying waveforms and FFT analysis results

The instrument can display waveforms before FFT-analyzed and the FFT analysis results on a single screen.
FFT analysis is performed on the waveforms shown in the window display area (see the figure below).
Thus, FFT analysis cannot be performed when no waveform is displayed.

4

Displaying Waveforms

Display screen **[MEAS]** > **[WAVE]** > **[+FFT]**

Waveform display area

FFT-graph display area
Displays FFT analysis results on the waveform in the window.
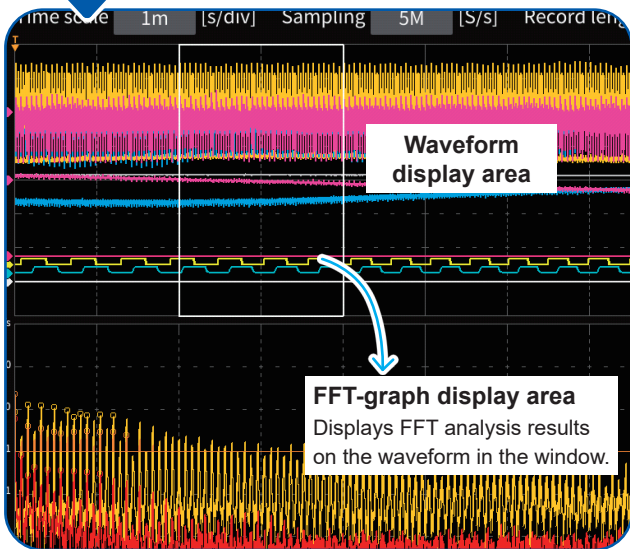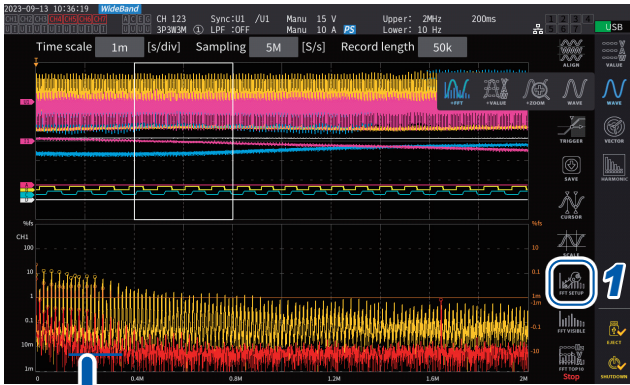
1 Tap **[FFT SETUP]**.

The FFT analysis setting window is displayed.

2 Tap **[Source]**.

FFT analysis is performed on the waveforms of the channels selected in this step.

> **CH1** to **CH8**, **CH12** to **CH78**, **CH123** to **CH678**, **Motor** (for motor analysis-equipped model only)

3 Tap the **SINGLE** key to acquire waveforms.

See "4.1 Waveform Display Method" (p. 115). The FFT graph display area shows the FFT analysis results of the waveforms in the window.

Graph axes	
Vertical axis	Plots the levels (expressed in percent of range or RMS values) on a logarithmic scale.
Horizontal axis	Plots the frequencies on a liner scale.

Graph colors	
Yellow	Voltage or Ch. A
Red	Current or Ch. C
Orange	Power or Ch. E
Green	Ch. G

4 Tap **[FFT SETUP]** or the area out of the window.

The window closes.

FFT graph display area

- After the window position or the number of points is changed, it may take some time for the changed settings to apply to the window.
- When performing FFT analysis, acquire the waveform using the SINGLE trigger.
  See "Recording a waveform once" (p. 123).

Changing the window size and moving the window

You can change the window size by moving the window position horizontally or changing the number of points for FFT analysis.

Display screen **[MEAS]** > **[WAVE]** > **[+FFT]**
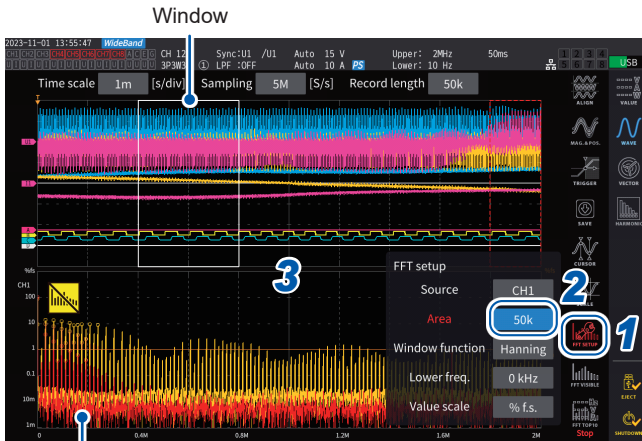
Window

FFT graph display area (p. 127)

- The broken green line shows the window position after the change of the position and the number of points.
- The FFT results on the waveforms displayed in the solid-white-line window are shown at the bottom of the screen.

1 **Tap [FFT SETUP].**

The FFT analysis setting window is displayed.

2 **Tap [Window].**

Tapping the numeric box turns the rotary-knob light on in green.

3 **Use the X rotary knob to set the number of points (the window size) for FFT analysis.**

1 k, **5 k**, **10 k**, **50 k**, **100k**, **500k**, **1M**, **5M**

Turn the rotary knob to select, then press to confirm.

4 **Use the Y rotary knob to change the window position.**

The green broken line moves horizontally.

Green: Moves in steps of one dot.

Press the knob to switch.

Red: Moves in steps of one grid.

5 **Tap [FFT SETUP] or the area out of the window.**

The window closes.

4

Displaying Waveforms

IMPORTANT

- Setting the sampling speed to more than 2.5 MS/s for FFT calculation on the wiring configuration that includes the U7001, which has the maximum sampling speed of 2.5 MS/s, requires a bigger window to regulate the FFT-window width at 2.5 MS/s. Thus, the FFT results may not be displayed depending on the sampling rate, recording length, and FFT-window width settings. For FFT calculation, it is recommended to set the sampling speed to 2.5 MS/s or less.
- Similarly, it is recommended to set the sampling rate to 1 MS/s or less for FFT calculation on analog waveforms of the motor input, which has the maximum sampling speed of 1 MS/s.

What do they indicate?

A red broken line is displayed.	The window position is inappropriate. FFT analysis cannot be performed in this state. Re-set the window position. **Example** • The number of points is more than the recording length • The window size and the number of points do not match
⬛ is displayed.	A storage task may be stopped by pressing the **RUN/STOP** key. Tap the **SINGLE** key to acquire waveforms. (p. 123)
⬛ is displayed	It may take some time to make the FFT analysis.
[Area] is displayed in red.	The **[Area]** setting has been changed while the FFT analysis results are displayed, causing it to differ from the FFT analysis result display.

The maximum FFT-analysis frequency varies depending on the sampling speed (Sampling) setting as follows. The maximum analysis frequency is obtained by subtracting the frequency resolution from the frequency, shown on the table.

Maximum analysis frequency for each sampling rate setting

Sampling	15 MS/s	7.5 MS/s	5 MS/s	2.5 MS/s	1 MS/s	500 kS/s	250 kS/s	100 kS/s	50 kS/s	25 kS/s	10 kS/s
Highest frequency (U7005) (voltage, current, power)	6 MHz	3 MHz	2 MHz	1 MHz	400 kHz	200 kHz	100 kHz	40 kHz	20 kHz	10 kHz	4 kHz
Highest frequency (wiring with U7001) (voltage, current, power)	1 MHz	1 MHz	1 MHz	1 MHz	400 kHz	200 kHz	100 kHz	40 kHz	20 kHz	10 kHz	4 kHz
Highest frequency (motor input)	400 kHz	400 kHz	400 kHz	400 kHz	400 kHz	200 kHz	100 kHz	40 kHz	20 kHz	10 kHz	4 kHz

The combination of the settings of the sampling rate and the number of points also changes the frequency resolution of the FFT analysis as follows.

Frequency resolution when the settings of sampling rate and the number of points are combined

Voltage and current waveforms of U7005

Number of points \ Sampling	15 MS/s	7.5 MS/s	5 MS/s	2.5 MS/s	1 MS/s	500 kS/s	250 kS/s	100 kS/s	50 kS/s	25 kS/s	10 kS/s
1000	15 kHz	7.5 kHz	5 kHz	2.5 kHz	1 kHz	500 Hz	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz
5000	3 kHz	1.5 kHz	1 kHz	500 Hz	200 Hz	100 Hz	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz
10000	1.5 kHz	750 Hz	500 Hz	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz
50000	300 Hz	150 Hz	100 Hz	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz	1 Hz	0.5 Hz	0.2 Hz
100000	150 Hz	75 Hz	50 Hz	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz
500000	30 Hz	15 Hz	10 Hz	5 Hz	2 Hz	1 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.05 Hz	0.02 Hz
1000000	15 Hz	7.5 Hz	5 Hz	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz	0.05 Hz	0.025 Hz	0.01 Hz
5000000	3 Hz	1.5 Hz	1 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.05 Hz	0.05 Hz	0.01 Hz	0.005 Hz	0.002 Hz

Wiring with U7001, voltage and current waveforms

Number of points \ Sampling	15 MS/s to 2.5 MS/s	1 MS/s	500 kS/s	250 kS/s	100 kS/s	50 kS/s	25 kS/s	10 kS/s
1000	2.5 kHz	1 kHz	500 Hz	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz
5000	500 Hz	200 Hz	100 Hz	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz
10000	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz
50000	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz	1 Hz	0.5 Hz	0.2 Hz
100000	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz
500000	5 Hz	2 Hz	1 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.05 Hz	0.02 Hz
1000000	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz	0.05 Hz	0.025 Hz	0.01 Hz
5000000	0.5 Hz	0.2 Hz	0.1 Hz	0.05 Hz	0.05 Hz	0.01 Hz	0.005 Hz	0.002 Hz

Motor-input waveforms

Number of points \ Sampling	15 MS/s to 1 MS/s	500 kS/s	250 kS/s	100 kS/s	50 kS/s	25 kS/s	10 kS/s
1000	1 kHz	500 Hz	250 Hz	100 Hz	50 Hz	25 Hz	10 Hz
5000	200 Hz	100 Hz	50 Hz	20 Hz	10 Hz	5 Hz	2 Hz
10000	100 Hz	50 Hz	25 Hz	10 Hz	5 Hz	2.5 Hz	1 Hz
50000	20 Hz	10 Hz	5 Hz	2 Hz	1 Hz	0.5 Hz	0.2 Hz
100000	10 Hz	5 Hz	2.5 Hz	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz
500000	2 Hz	1 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.05 Hz	0.02 Hz
1000000	1 Hz	0.5 Hz	0.25 Hz	0.1 Hz	0.05 Hz	0.025 Hz	0.01 Hz
5000000	0.2 Hz	0.1 Hz	0.05 Hz	0.05 Hz	0.01 Hz	0.005 Hz	0.002 Hz

IMPORTANT

- The U7001, which has the maximum sampling rate of 2.5 MS/s, has the maximum FFT-analysis frequency different from that of the U7005 for voltage and current waveforms.
- The maximum FFT-analysis frequency for motor-input analog waveforms, sampled at the maximum of 1 MS/s, differs from that for voltage and current waveforms.

The instrument performs FFT calculations only when displaying the **[WAVE+FFT]** screen. Thus, task processing on this screen, such as updating displayed waveforms, may become slow.

4

Displaying Waveforms

Displaying numerical values of FFT analysis results

From the highest in descending order, the instrument can pick up ten local maximum values of each voltage, current, and power (for power, the local maximum of the absolute values) from the numerical values of FFT analysis results to display their frequencies and levels. (hereinafter referred to as *FFT peak-value display*)

The motor analysis-equipped model can similarly display the FFT analysis results on analog-input signals.

Display screen [MEAS] > [WAVE] > [+FFT]
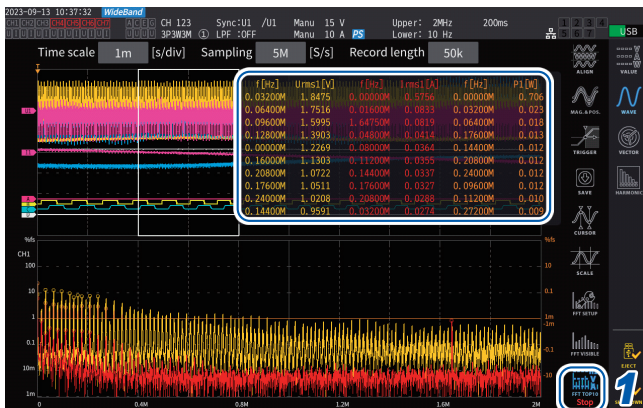
1 Tap [FTP TOP10].

The FFT TOP10 window is displayed.

Display item	Level
Display digit	6 digits, interlocked with the range of the target waveform.

Display item	Frequency
Display digit	6 or 7 digits, depending on the frequency resolution.

Unhiding/hiding FFT analysis results.

FFT analysis results can be unhidden and hidden.

Display screen [MEAS] > [WAVE] > [+FFT]
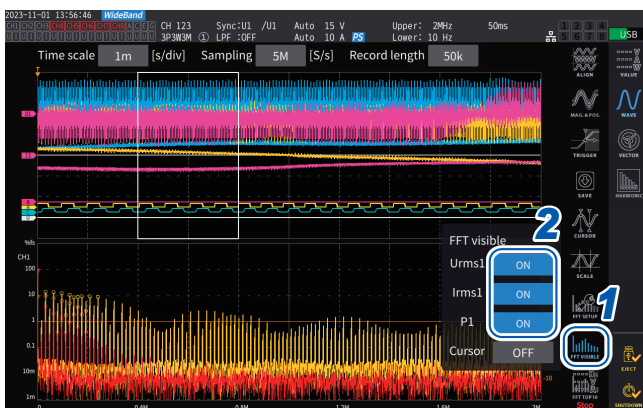
1 Tap [FFT Visible].

2 Tap [ON] and [OFF] of each parameter to unhide and hide it.

Displaying FFT analysis results within a specific frequency range

Using the cursor can display the FFT analysis results within the selected frequency range.

Display screen [MEAS] > [WAVE] > [+FFT]

1 Tap [FFT Visible].

2 Tap [Cursor] to display the cursor.

3 Use the Y rotary knob to move the cursor.

Dragging the cursor can move it.
You can also use the numeric keypad, which can be displayed by tapping [f], to enter values.

Setting the lower frequency limit of the FFT peak-value display

This section describes how to set the lower frequency limit of the FFT peak-value display. The lower frequency limit can be set in the range of 0 Hz to 6000 kHz in steps of 1 kHz.

Display screen [MEAS] > [WAVE] > [+FFT]
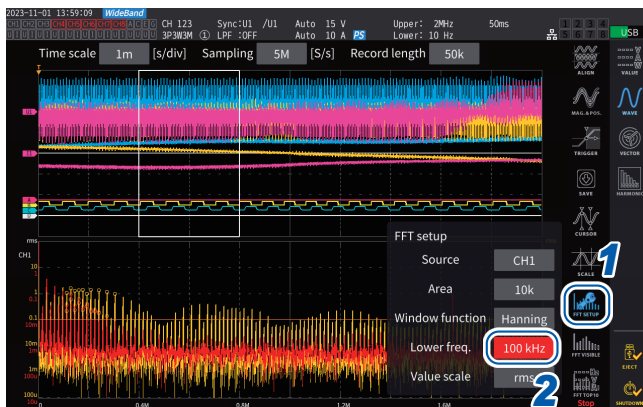
1 Tap [FFT SETUP].

2 Tap the [Lower freq.] box and use the knob to enter the lower frequency.
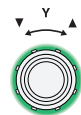
Green: Moves in steps of 1 kHz.

Press the knob to switch.

Red: Moves in steps of 100 kHz/10 kHz.*

* Changeable in steps of 100 kHz for the rate of 2.5 MS/s or more; 100 kHz for 1 MS/s or less.

4

Displaying Waveforms

On the FFT peak-value display, the instrument considers a value with both adjacent values lower as a peak value on the voltage, current, and motor-input waveforms and acquire the ten data points from the highest in the descending order. For power, the peak value is obtained from the absolute values.

At this time, the peak value is not displayed for frequencies lower than the FFT analysis lower frequency limit setting.
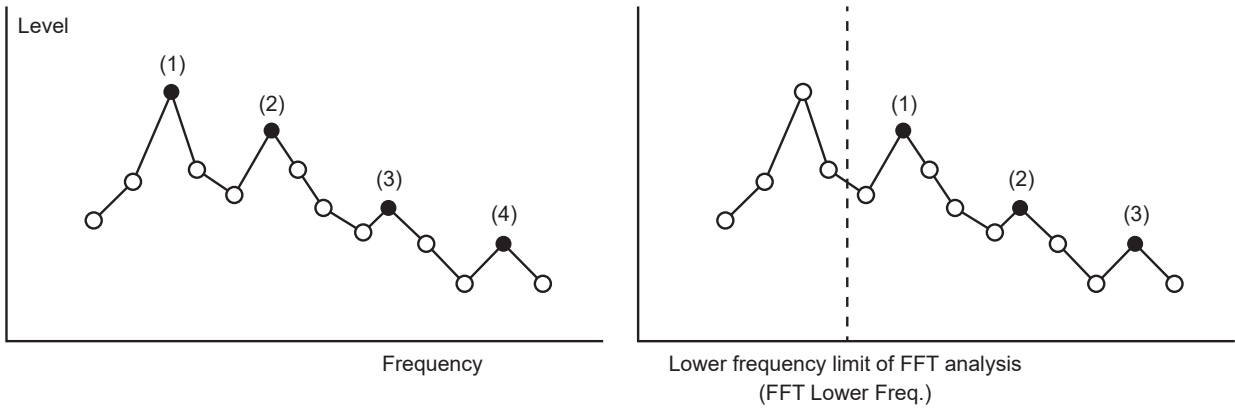
Making window function setting

This section describes how to apply a window function to FFT analysis.

Display screen [MEAS] > [WAVE] > [+FFT]

1 Tap [FFT SETUP].

2 Tap the [Window function] box to choose the window function.

Rectangular	Practical when the measurement waveform has a period of an integer multiple of the FFT-operation period.
Hanning	Practical when the rectangular window is ineffective and you want to emphasize on the frequency resolution.
Flat Top	Practical when the rectangular window is ineffective and you want to emphasize on the level resolution.

What is window function?

Before the FFT calculation, the measured waveforms of the number of set points is extracted at the set sampling speed. This waveform extracting process is called *windowing*.
The FFT operation assumes that the waveforms extracted with a finite interval repeat periodically. In this instrument, the interval enclosed by the solid white line corresponds to this window.

Original time waveform

FFT-supposed waveform
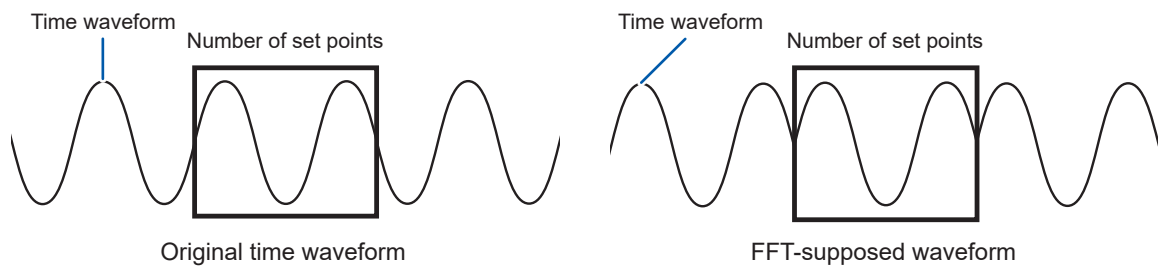
If the number of FFT calculation points differs from the period of the measured waveform, a leakage error occurs due to a discontinuity at both edges of the waveform in the window, detecting imaginary FFT analysis results.
The window function can suppress this leakage error. The window function processes both edges of the extracted waveform to connect smoothly.

4

Displaying Waveforms

Making the vertical-axis setting of the FFT analysis result display.

This section describes how to choose whether values expressed in percent of full scale (% f.s.) or RMS values to plot along the vertical axis in the FFT calculation result display.

Display screen [MEAS] > [WAVE] > [+FFT]

When [% f.s.] is selected

When [rms] is selected

1 Tap [FFT SETUP].

2 Tap the [Value scale] box to choose the vertical axis scale.

% f.s., rms
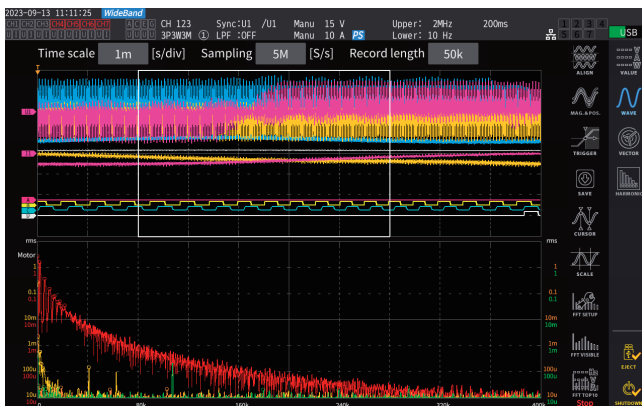
5 Various Functions

5.1 Time Control Function

The time control function can control the auto-save operation and the integration function by specifying time. Two control methods are available: timer control and real time control. Valid settings depend on the integration control method.

See "Integration measurement while using the time control function" (p. 76) and "Automatically saving measured data" (p. 165).

Timer control

The timer control stops auto-save operation and integration automatically once the timer control time has elapsed.

- If the real-time-control time has been set so that it is longer than the timer-control time, integration will start at the real-time-control start time and stop at the timer-control time. (The real-time-control stop time will be ignored.)
- If you press the **START/STOP** key before the timer control ends, integration will stop, and integrated values will be retained. If the **START/STOP** key is pressed again in this state, integration will resume and will be performed for the duration of the timer setting. (cumulative integration).

Timer set value

This can be set when **[Timer]** is set to **[ON]**. Enter the value using the numeric keypad window (p.24).

Valid setting range: 0 h 0 min. 10 s to 9999 h 59 min. 59 s

Real time control

The real time control can start or stop operation at predetermined times.

- If the real-time-control time has been set so that it is longer than the timer time, integration will start at the real-time-control start time and stop at the timer time. (The real-time-control stop time will be ignored.)
- If the set time is the past time as viewed from the present, real-time control cannot be started.
- If the integration is stopped during the real-time-control operation, the real time control is disabled.

Start time and stop time

The start time and stop time can be set when **[Real time control]** is set to **[ON]**. Use the numeric keypad window (p.24).

Use the 4-digit year and 24-hour format. The times can be set in increments of 1 min.

Example: 1:11 pm on January 11, 2022 → **[2022/1/11 13:11:00]**

Upper limit for time

Start time	At 23:59:59 on December 31, 2099
Stop time	At 23:59:59 on December 31, 2099

Time control function setting method

When using the all-wiring-configuration integration

Display screen [SYSTEM] > [TIME CONTROL]
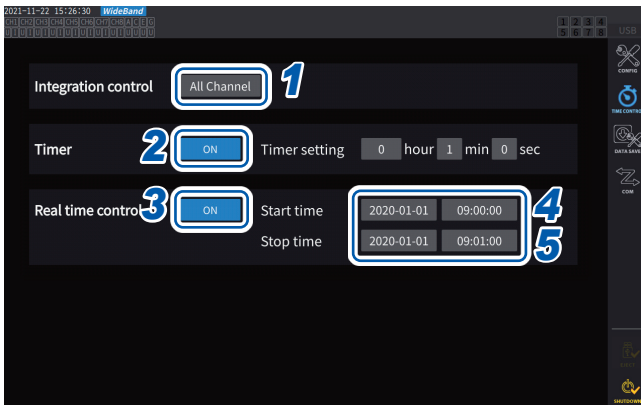
1 Tap **[Integration control]** box indicating **[All Channels]**.

2 (When using the timer control)
Tap the **[Timer]** box to set it to **[ON]**.

3 (When using the real time control)
Tap the **[Real time control]** box to set it to **[ON]**.

4 Tap the **[Start time]** box to set the integration start time.

5 Tap the **[Stop time]** box to set the integration stop time.

When using each-wiring-configuration integration

Display screen [SYSTEM] > [TIME CONTROL]
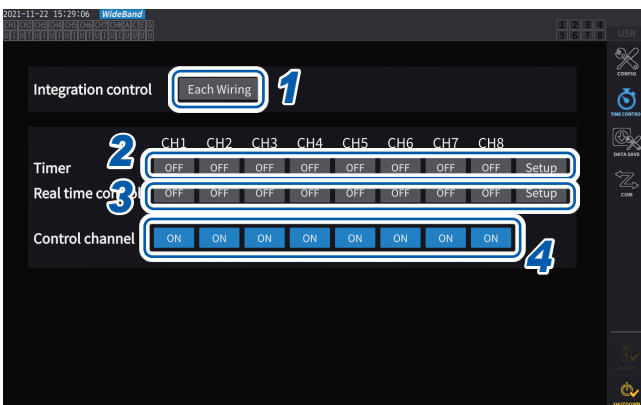
1 Tap **[Each Wiring]** box under **[Integration control]**.

2 (When using the timer control)
Tap the **[Timer]** box of which you wish to control to set it to **[ON]**, and then tap **[Setup]** to enter the timer setting value.

3 (When using real time control)
Tap the **[Real time control]** box of which you wish to control to set it to **[ON]**, and then tap **[Setup]** to enter the start and stop time.

4 Tap the **[Control channel]** box to set the channel to be controls to **[ON]**.

Before performing integration or saving data using the time control function

- Make sure that you set the clock (current time) before automatically saving data or using the integration function.
  See "6 System Settings" (p. 153).
- The auto-save operation and the integration function cannot be configured separately.
- When the integration control setting is set to **[All Channel]**, the integration function is always active. After stopping the time control, press the **DATA RESET** key to reset integrated values.
- When the integration control setting is set to **[Each Wiring]**, the auto-save operation is not available.

5.2 Average Function

The average function averages measured values and displays results. This function can be used to obtain more stable display values when measured values fluctuate and cause large variations in the display.

During average operation, an average indicator appears in the setting indicators area at the top of the screen.

See "Measurement screen" (p. 26).

Average settings

There are two averaging modes: exponential average and moving average. Exponential averaging mode calculates averages of values after multiplying time factors to give different weights, according to the response speed setting. Moving averaging mode creates averages of subsets containing the user-specified number of most recent values.

Display screen **[INPUT]** > **[COMMON]**
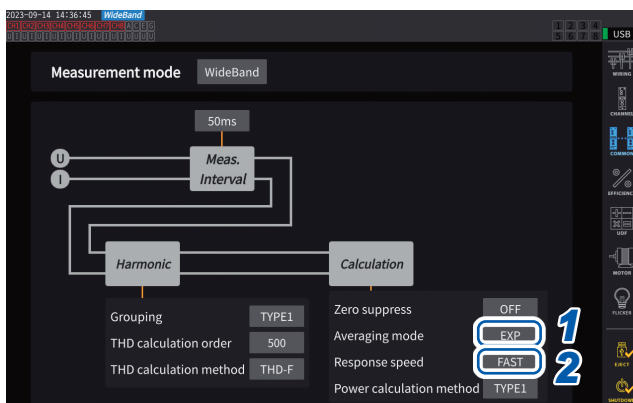
1 Tap the **[Averaging mode]** box, then select the averaging mode from the list.

OFF	Not perform average.
EXP	Exponential average (Set the response speed.)
MOV	Moving average (Set the averaging count.)

When the data update interval setting is changed to 1 ms, the averaging mode is changed to OFF. If the averaging mode is set to other than OFF when the data update interval is set to 1 ms, the data update interval setting is changed to 10 ms.

2 **(If you have selected [EXP])**
Tap the **[Response speed]** box, then select the response speed from the list.

FAST, **MID**, **SLOW**

It does not affect the display update interval. The response speed varies depending on the data update interval setting.

Data update interval	Response speed		
	FAST	MID	SLOW
10 ms	0.1 s	0.8 s	5 s
50 ms	0.5 s	4 s	25 s
200 ms	2.0 s	16 s	100 s

5

Various Functions

139
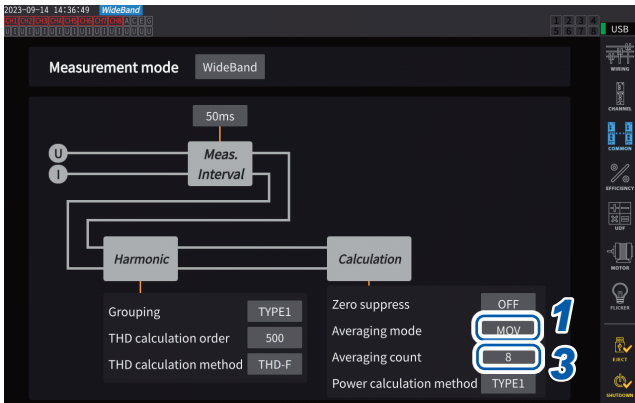
3 **(If you have selected [MOV])**

Tap the [Averaging count] box, then select the averaging count from the list.

8, 16, 32, 64

Average operation

- The average function works for peak and integrated values, and all measured values except harmonic data acquired at data update intervals of 10 ms or less.
  The instrument displays the following values as the peak voltage and peak current values:
    In exponential averaging mode, the peak values of all data that consists of the most recent points
    In moving averaging mode, the peak values of a subset that forms from the user-specified number of the most recent values
- It applies not only to display values but also to measured values saved on a USB flash drive, measured values acquired using communications, and measured values output as an analog signal.
- When a measured-value-related setting, such as the wiring mode or range, changes, average calculation is restarted.
- When averaging and auto-ranging are used together, it may take longer than usual to stabilize measured values on the correct value.
- Integrated measured values during average operation are calculated from measured values prior to average operation.
- Internal average calculations continue even when the hold function is freezing on-screen measured values.
- The peak hold function applies to measured values after average operation.

Behavior when an overload condition occurs

If an overload condition occurs in moving averaging mode, an over-range average value will be calculated. If an overload condition occurs in exponential averaging mode, average calculations will continue using internal calculation values.

IMPORTANT
- Settings cannot be switched on a wiring configuration or channel basis.
- Waveforms shown on the screen and D/A output waveforms are not affected by overload.
- For more information about average calculation methods for different types of measured values, see the average section in "10.5 Specifications of Equations" (p. 291).

5.3 Hold Function

By pressing the **HOLD** key, you can stop display updating for all measured values and freeze the on-screen data at the time when the key was pressed. By switching screens in that state, you can view other measured data at the time when the on-screen data was frozen.
In addition, the same operation as the **HOLD** key can be performed using the HOLD external control signal.
See "8.3 Controlling Integration with External Signals" (p. 207).

During hold operation, the **HOLD** key is lit up in red, and the **[HOLD]** icon appears in the screen's operating status indicator.
See "1.4 Basic Operation (Screen Display and Layout)" (p. 22).
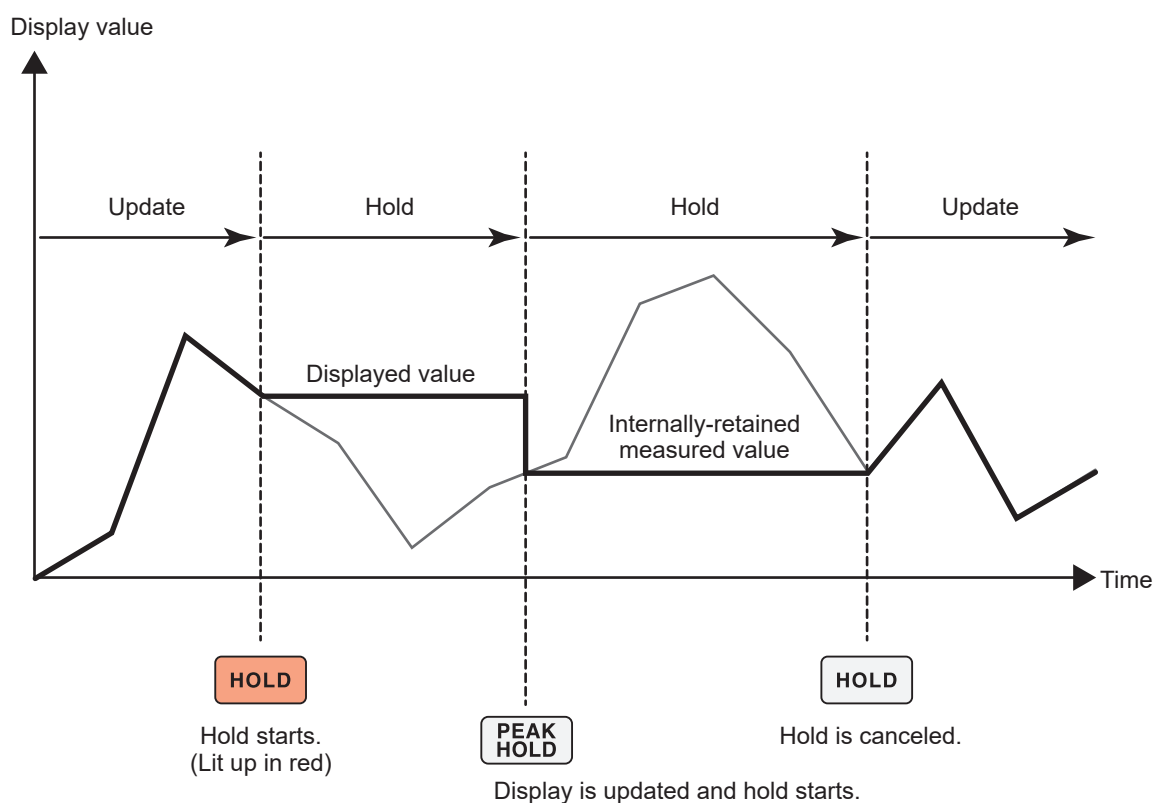
Each time **PEAK HOLD** is pressed, measured values at that point in time are displayed.
Measurement, calculations, and averaging continue internally.

Canceling the hold state

Press the **HOLD** key again during hold operation to cancel the hold state.

Operation in the hold state

- Hold operation also applies to the following measured values:
  (1) Measured values to be stored onto the USB flash drive
  (2) Measured values to be acquired using communications
  (3) Measured values to be outputted as an analog signal

- Waveforms, the clock, and the peak-over display are updated.
- When the **PEAK HOLD** key is pressed, data is replaced with the latest internal data.
- The instrument retains the data without updating it even if the interval time set in the time control function has elapsed.
- Average and integration calculations continue to be performed internally.
- Settings that affect measured values, such as range and the LPF settings, cannot be changed.
- When the range setting is set to **AUTO**, the range is fixed to that at the time when the **HOLD** key was pressed.
- The hold function cannot be used together with the peak hold function.
- Waveforms shown on the screen and D/A output waveforms are not affected by the hold operation.
- The data frozen during hold operation is not displayed when the **HOLD** key was pressed, but rather the data is retained internally when the **HOLD** key was pressed among those acquired at data update intervals.

5.4 Peak Hold Function

Pressing the **PEAK HOLD** key places the instrument in the peak hold state. Only parameters whose values exceed the past peak value are updated. This function is useful to thoroughly capture phenomena characterized by instantaneously large values, for example rush current.

During peak hold operation, the **PEAK HOLD** key is lit up in red, and the **[PEAK HOLD]** icon on the screen's operating status indicator appears.
See "Common screen display" (p. 25).

Display value

Update   Peak hold   Update

Displayed value

Internally-retained
measured value

Time

PEAK
HOLD

PEAK
HOLD

Peak hold starts.
(Lit up in red)

Peak hold is released.
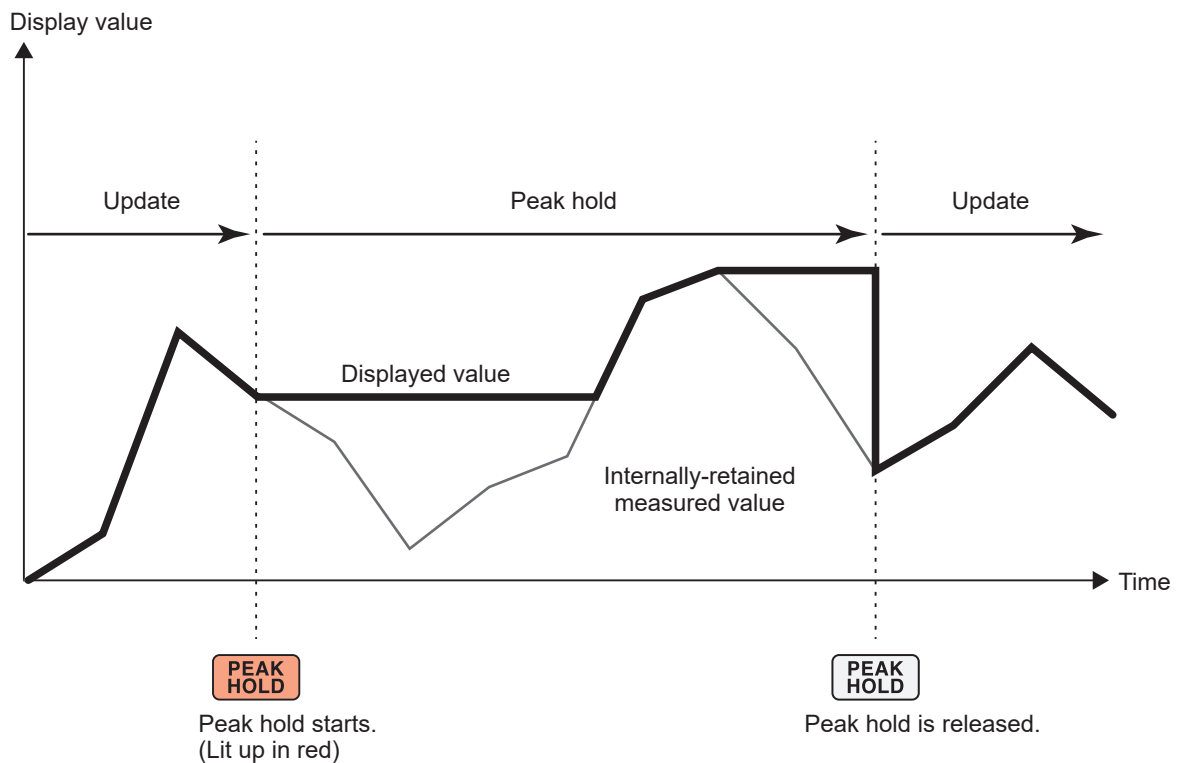
When the past peak value is exceeded, the displayed value for that parameter is updated.
Measurement continues internally.

Canceling the peak hold state

Press the **PEAK HOLD** key again during the peak hold operation to cancel the peak hold state.

5

Various Functions

Operation in the peak hold state

- Peak hold operation also applies to the following measured values:
  (1) Measured values to be stored onto the USB flash drive
  (2) Measured values to be acquired using communications
  (3) Measured values to be outputted as an analog signal

- Waveforms, the clock, and the peak-over display are updated.
- When the display is overloaded, it will show **[------]**. In this case, cancel the peak hold operation, then switch the present range over to a range in which the overload condition will not occur.
- The maximum value is determined using the absolute value of measured values. (However, this method does not affect voltage or current peak values.)
- For example, if a power of −60 W is inputted after that of 50 W was inputted, the display will indicate **[−60 W]** because the absolute value of *−60 W* is greater than that of *50 W*.
- When the **HOLD** key is pressed, the peak hold value is reset, and another peak hold operation starts from that point.
- The instrument retains the peak-hold value without updating it even if the interval time set in the time control function has elapsed.
- During average calculation, peak hold operation applies to measured values after averaging.
- Settings that affect measured values such as range and the LPF settings cannot be changed.
- When the range setting is set to **[AUTO]**, the range is fixed to that at the time when the **PEAK HOLD** key was pressed.
- The hold function cannot be used together with the peak hold function.
- Waveforms shown on the screen and D/A output waveforms are not affected by the peak hold operation.
- The time when the maximum value occurred is not displayed.
- The peak hold function does not affect to integrated values.

5.5 Delta Conversion Function

The delta conversion function measures a three-phase line after converting a delta connection into a Y connection (star connection) or vice versa. The conversion is performed using voltage waveform data sampled at a frequency of 15 MHz between different channels based on the formula.

Δ–Y conversion

This function can be enabled when the wiring mode is set to 3P3W3M or 3V3A.

This function can measure phase voltages across internally-Y-connected motor coils even if the motor is used as a delta-connected load, whose neutral point cannot be connected to the instrument.

The voltage waveforms, various measured voltage values, and harmonic voltages are all inputted as line voltages; however, they are calculated as phase voltages.

In 3P3W3M wiring mode
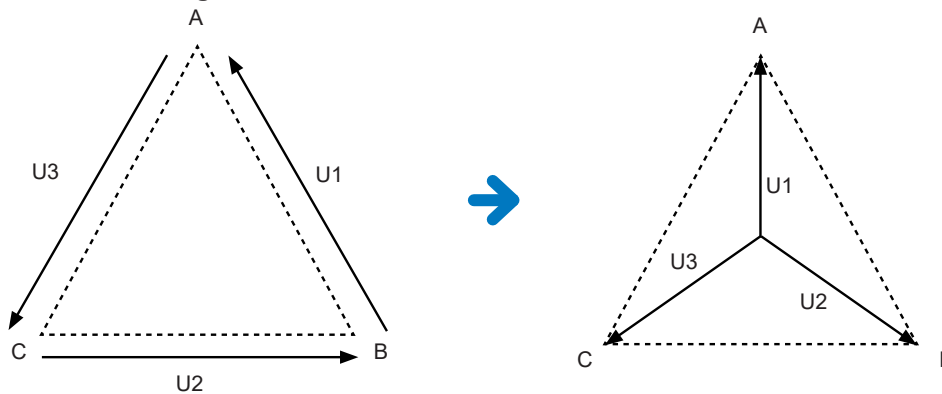
In 3V3A wiring mode
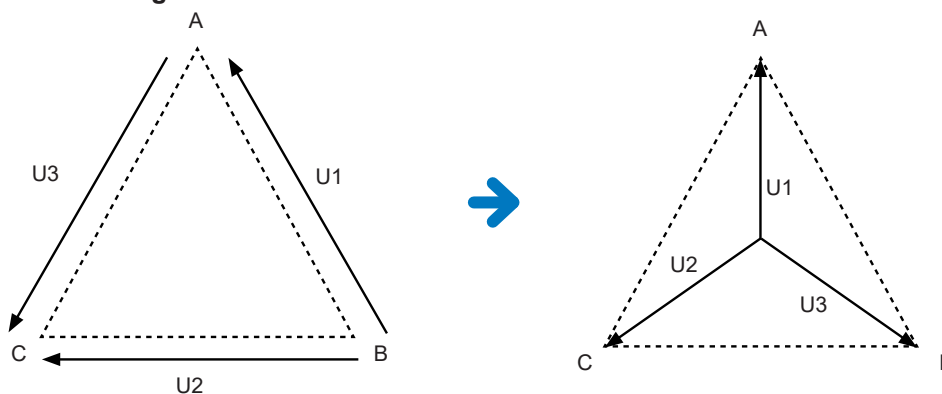
- In Δ–Y conversion, voltage waveforms are converted into vectors and analyzed using a virtual neutral point.
- The result may differ from the actual phase voltages.
- In 3V3A wiring mode, active power is measured with the two-wattmeter method; however, the converted value is equal to that measured with the three-wattmeter method.
- The two-wattmeter method is used to calculate active power in 3V3A wiring mode, but the three-wattmeter method is used after conversion.
- Peak-over judgment uses not-converted values.
- When the voltage range is set to the auto-ranging, voltage range switching is determined by multiplying the range by $1/\sqrt{3}$ (multiplying by approximately 0.57735).

5

Various Functions

Y–Δ conversion

This function can be enabled in 3P4W wiring mode.

This can measure line voltages when phase voltages are inputted from a Y-connected circuit.

The voltage waveforms, various measured voltage values, and harmonic voltages are all inputted as phase voltages; however, they are calculated as line voltages.

Conceptual diagram of Y–Δ conversion

In 3P4W wiring mode
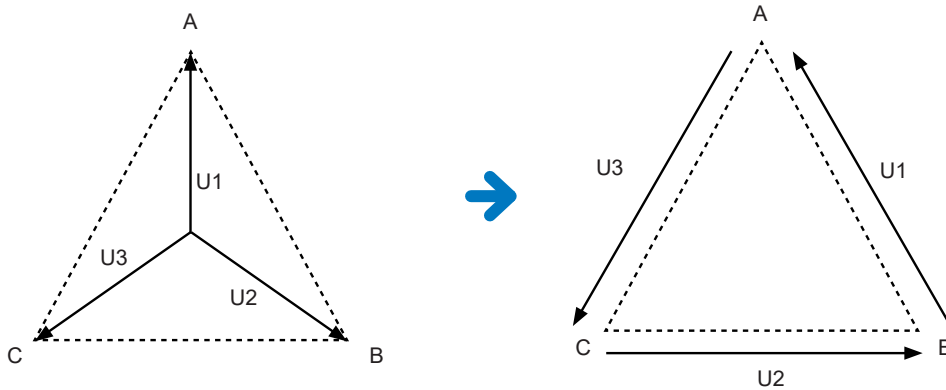
- The vector diagram shown on the wiring screen is the same as the 3P3W3M vector diagram.
- Peak-over judgment and the voltage peak value display range are determined using not-converted values.
- When the voltage range is set to auto-ranging, voltage range switching is determined using converted measured values.

Display screen **[INPUT] > [CHANNEL]**
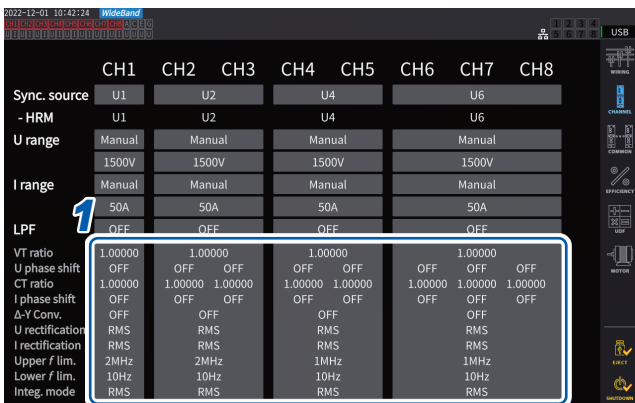
1 Tap the channel detail display area for the channel you wish to configure to open the settings window.
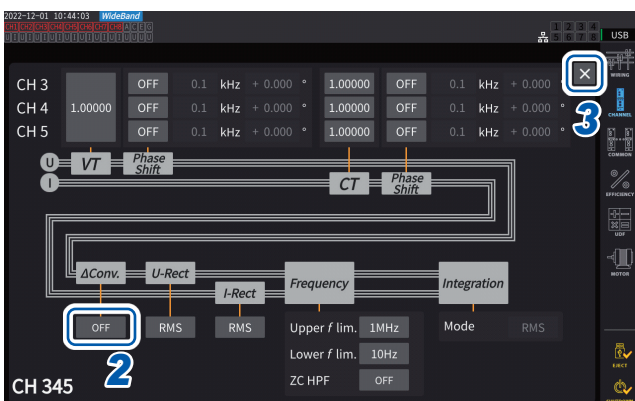
2 Tap the **[ΔConv.]** box to set Y–Δ conversion to **[ON]**.

3 Tap **[×]** to close the setting window.

5.6 Power Calculation Method

This function enables you to select equations of reactive power, power factors, and power phase angles to follow those of legacy Hioki instruments.

Since no standardized equations for apparent power and reactive power have been defined for distorted three-phase AC signals, different instruments use different equations. To improve its compatibility with previous models, the instrument allows you to choose from among three equation settings.

See "10.5 Specifications of Equations" (p. 291).

Display screen **[INPUT]** > **[COMMON]**
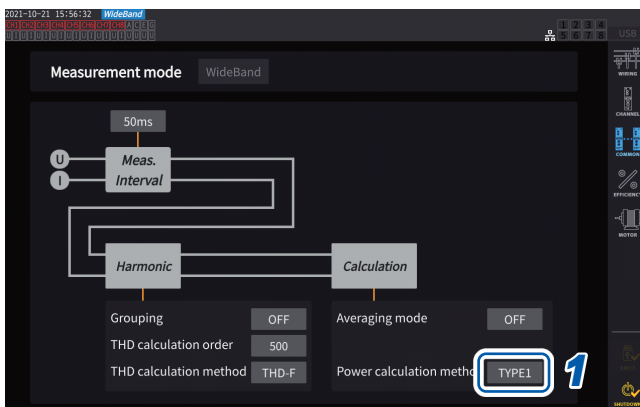
1 Tap the **[Power calculation method]** box, then select the calculation type from the list.

> **IMPORTANT**
>
> Type 1, Type 2, and Type 3 are compatible with each equation types used in Hioki PW6001 Power Analyzer.

Equation types

TYPE1	When any mode other than 3V3A is selected	Provides compatibility with the Type 1 setting used by Hioki PW3390, 3390, and 3193.
	When 3V3A is selected	Provides compatibility with the Type 2 setting used by Hioki 3192 and 3193.
TYPE2	Provides compatibility with the Type 2 setting used by Hioki 3192 and 3193.	
TYPE3	Uses signs of active power as those of power factors.	

If you do not use any model listed above or cannot decide a type to be used, select **[TYPE1]**. The different formulas do not yield different results for active power (even when waveforms are distorted) since active power is calculated directly from values sampled from voltage and current waveforms.

5.7 User-Defined Formula (UDF)

Setting the user-defined formulas (UDF)

You can define computing equations by combining the instrument's measurement values, numerical values, and functions.

The set calculated values can be displayed on the measurement screen or calculated using the set calculated values.

When the data update interval is set to 1 ms, **[-------]** is always displayed as calculated values.

When using user-defined formulas, set the data update interval to a value other than 1 ms.

Display screen **[INPUT]** > **[UDF]**
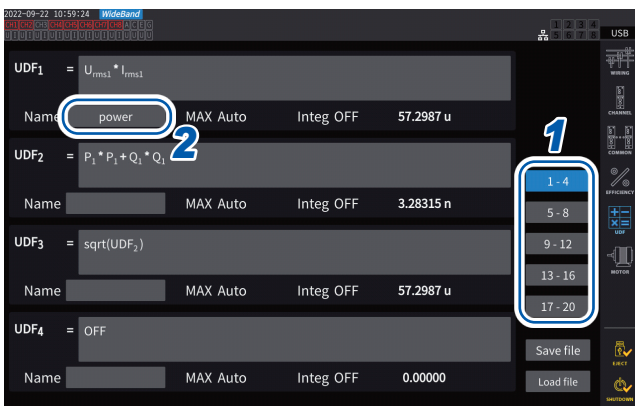
1 Tap a UDF you wish to set.

| **1-4**, **5-8**, **9-12**, **13-16**, **17-20** |

2 Tap the **[Name]** box and then enter a UDF name using a keyboard.

The names you entered here will also be reflected UDFs displayed on the measurement screen.
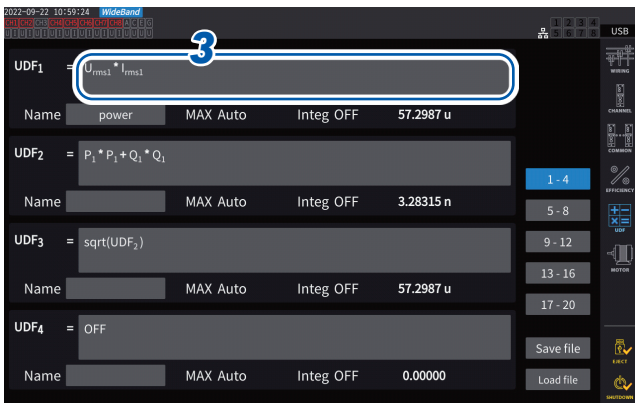
3 Tap the **[UDFn]** box.

The setting window will be displayed.
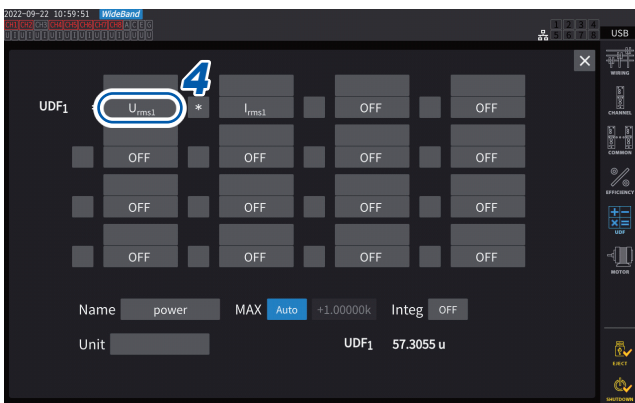
4 Tap a parameter name to select it.

The setting window will be displayed.
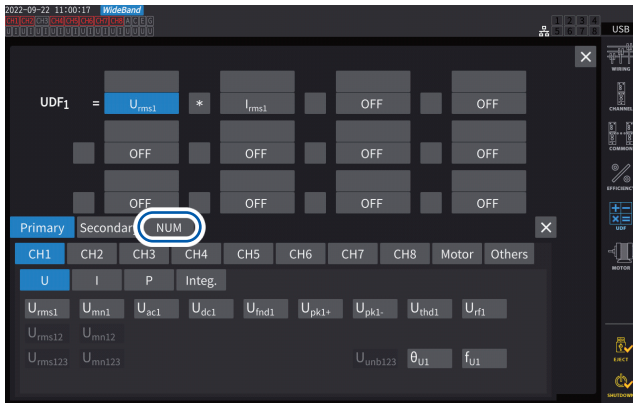
You can select the basic measurement parameters on the parameter selection window. (Other UDF calculation results can also be selected as parameters.)

To delete a selected parameter, select **[OFF]** in **[Others]**.

You can also use the numeric keypad, which can be displayed by tapping **[NUM]**, to enter values.
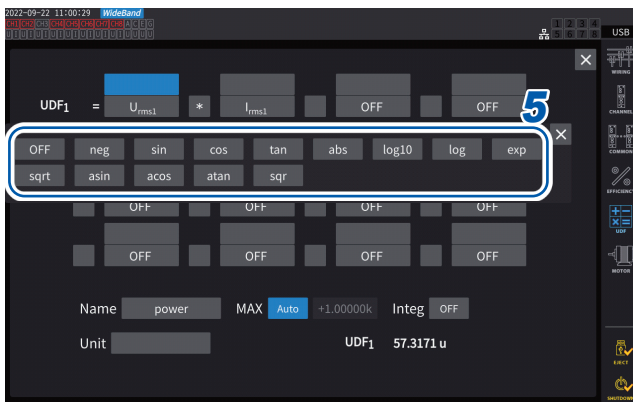
5 **Configure the functions.**

Option	Function	Valid range
neg	Negative (minus)	–
sin	Sine*	–
cos	Cosine*	–
tan	Tangent*	–
abs	Absolute value	–
log10	Common logarithm	item > 0
log	Logarithm	item > 0
exp	Exponential function	–
sqrt	Square root	item > 0
asin	Arcsine*	-1 <= item <= 1
acos	Arccosine*	-1 <= item <= 1
atan	Arctangent*	–
sqr	Square	–

* Angles are not expressed in radians, but in degrees (°).

Item values outside the valid input range are treated as invalid values.
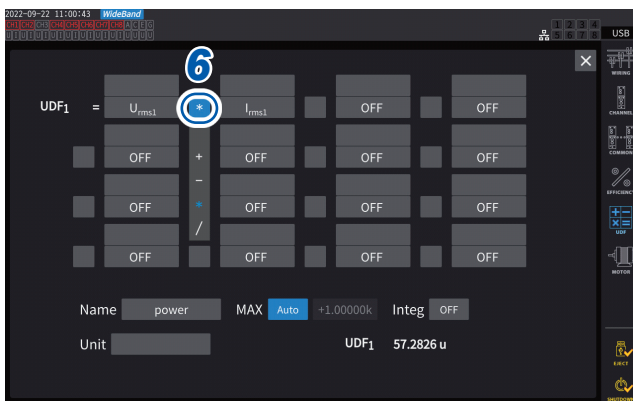
6 **Select one of the four arithmetic operations.**

+, −, *, /
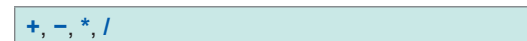
- The computing order of the four arithmetic operations in equations follows the four-arithmetic-operation rule.
- If you wish to calculate an equation including parentheses, divide it into two.

Calculation example:
  To calculate (P1 + P2) / P123
  UDF1 = P1 + P2
  UDF2 = UDF1 / P123

5

Various Functions

149

IMPORTANT

If any parameter in the equation satisfies the following conditions, all subsequent equations are not reflected in the UDF.

• Calculation parameter is set to **[OFF]**.

• No parameters of the four arithmetic operations are selected.

Example

The following equation yields 1.00000.
Let Urms1 = 1.00000, Urms2 = 2.00000 V, and Urms3 = 3.00000 V.
UDF1 = Urms1 + OFF + Urms3
Alternatively, the following equation yields 3.00000.
UDF1 = Urms1 + Urms2␣Urms3 * 2
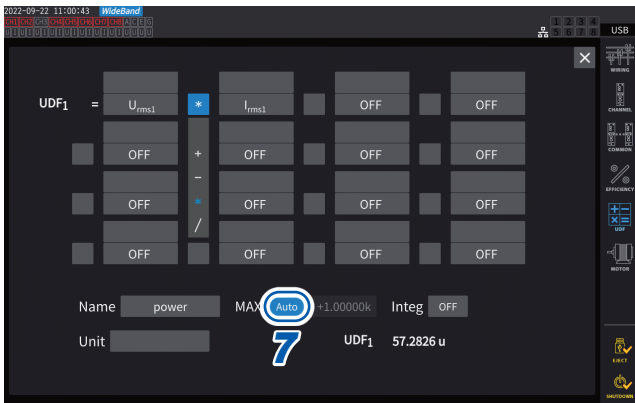
7 Tap the [MAX] box to select the maximum UDF value.

Auto	The maximum value is automatically set based on the value of the calculation result.
Fixed	Enter the value using the numeric keypad window.
	When [+1.00000] is set UDF display digits: X.XXXXX Effective measurement range: 0.00000 to±1.00000
	When [+10000.0] is set UDF display digits: XX.XXXX k Effective measurement range: 0.0000 k to ±10.0000 k

When selecting **[UDF]** for the D/A output parameter, set the maximum UDF value to **[Fixed]**. When **[Auto]** is set, the full-scale value is always output.
The value calculated from the display values may differ from the UDF value due to rounding errors.
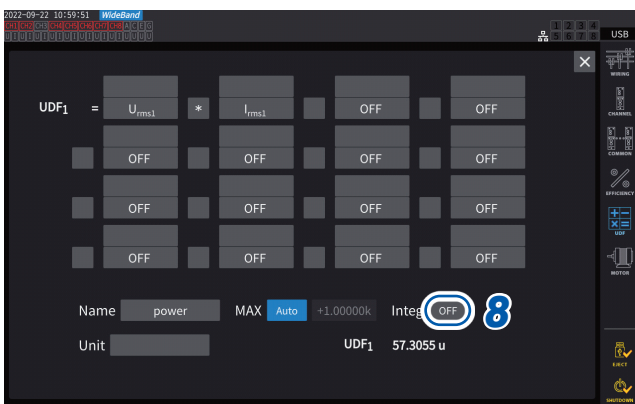
8 Tap the [Integ] box to select the integration setting.

ON	During integration, the integrated calculation value is displayed. The UDF value does not change while the integration is stopped, and the UDF value is also reset by the integration reset. Integration is stopped when the data reaches the maximum value, ±999.999Y.

150
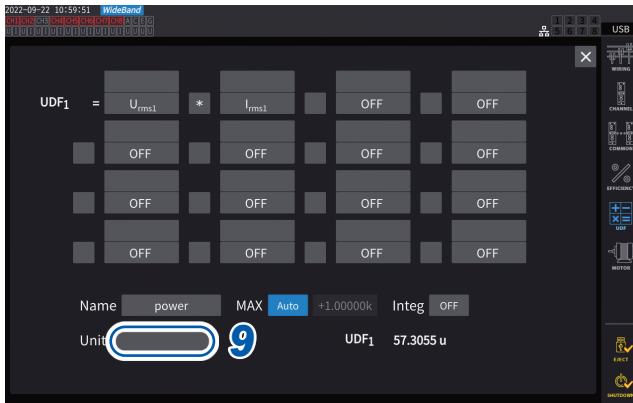
9 Tap the **[Unit]** box and enter the unit on the keyboard.

The unit entered here will also be applied to the UDF displayed on the measurement screen.

IMPORTANT

If using user-defined formulas containing values measured with secondary instruments in combination with optical link mode, be careful not to disrupt the synchronization.

Accidental disconnection of the synchronization causes values to differ from the original values. The instrument may display the results of calculation formulas; however, the instrument has behaved as follows:

Calculation formulas that include secondary-instrument-measured values are affected. Other calculation formulas that include those formulas are also affected.

- If secondary-instrument-measured values are selected for efficiency calculations or user-defined formulas, and synchronization is disrupted, the instrument does not display the results of the calculation formulas containing such measured values on the screen.
- In the above conditions, the instrument performs calculations regarding secondary-instrument-measured values as zero and applies the results to other user-defined formulas.

Saving user-defined formula (UDF) setting data

The instrument's UDF configuration information is saved as a UDF configuration file.

Saving destination location	USB flash drive, FTP server
Filename	Set as desired (up to 8 characters), with *SET* extension. Example: PW8001.JSON

Display screen **[INPUT]** > **[UDF]**
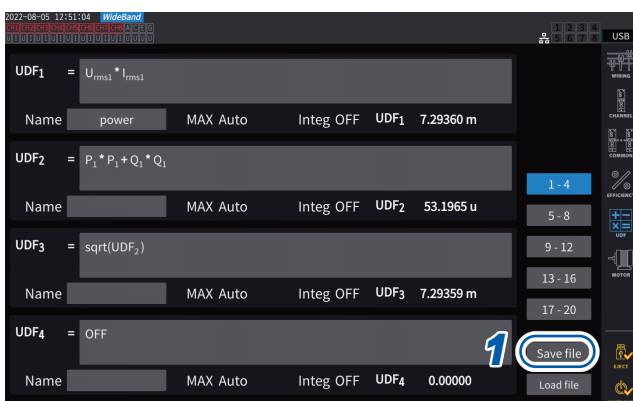
1 Tap **[Save file]**.

The keyboard window will be displayed.

2 Enter a filename.

Filenames cannot be saved while auto-saving is in progress.

Various Functions

5

Loading user-defined formula (UDF) setting data

Loading saved UDF settings files can restore the UDF settings.

Display screen **[INPUT]** > **[UDF]**
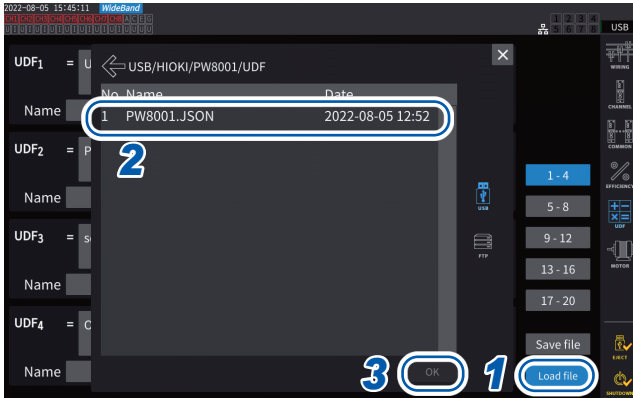
1 Tap **[Load file]**.

The UDF settings file loading window will be displayed.

2 Tap the folder in which UDF settings files are saved.

3 Select a UDF settings file and then tap **[OK]**.
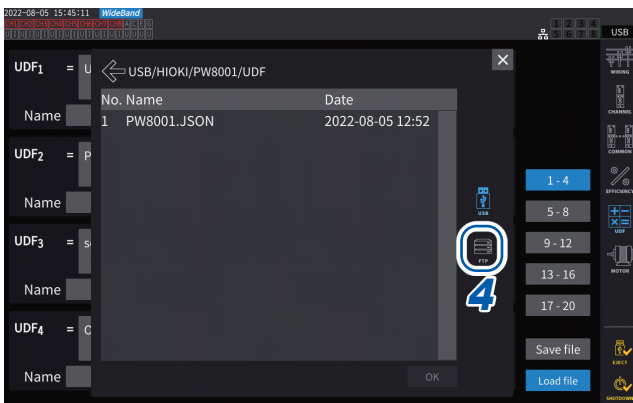
When loading a UDF settings file from the FTP server

4 Tap **[FTP]**.

The FTP server file window will be displayed.
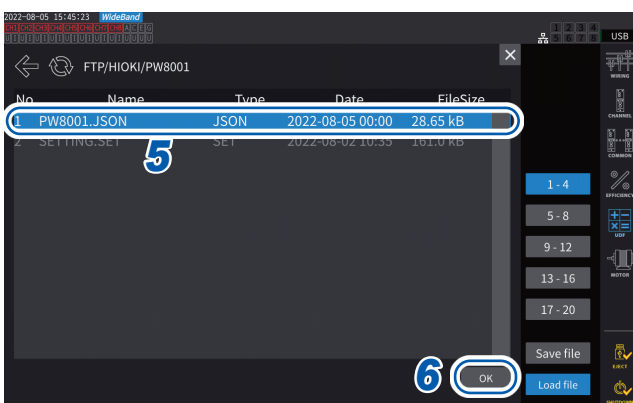
5 Tap the folder in which UDF settings files are saved.

6 Select a UDF settings file and then tap **[OK]**.

Settings cannot be loaded while auto-saving is in progress.

6 System Settings

6.1 Checking and Changing Settings

This section describes how to check the firmware version number and change settings, such as the display language and beep tone.

`Display screen` **[SYSTEM] > [CONFIG]**
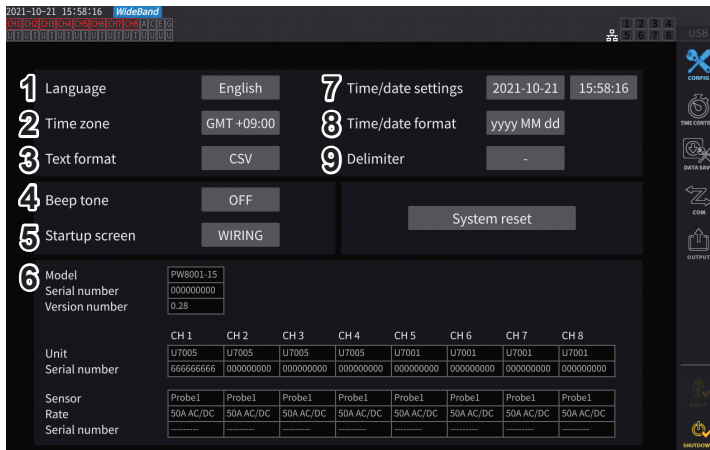
The MAC address can be verified on the **[SYSTEM] >** the **[COM]** screen.

(1) Language

Japanese, English, Chinese

(2) Time zone

GMT +14:00 to GMT −12:00

(3) Text format

CSV	Measured data is saved comma-separated (,) format; the decimal point is represented by a period (.).
SSV	Measured data is saved semicolon-separated (;) format; the decimal point is represented by a comma (,).

(4) Beep tone

ON	Beeps when a key is pressed and a on-screen button is tapped.
OFF	Does not beep even if a key is pressed or a on-screen button is tapped.

(5) Startup screen

WIRING	Displays the wiring screen.
LAST	Displays the screen that was being shown when the instrument was last turned off.

(6) Details

Model	Model number of the instrument
Serial number	Serial number: The serial number consists of 9 digit numbers. Starting from the left, the first pair of digits indicate the year of manufacture (last two digits of the year), and the next pair of digits indicate the month of manufacture.
Version number	Firmware version number

Unit	Model numbers of input modules installed in the instrument
Serial number	Serial numbers of input modules
Sensor	Current sensors connected to each input module
Rate	Output rates of current sensors connected to each input module
Serial number	Serial numbers of current sensors connected to each input module

(7) Time/date settings

2020-01-01 00:00:00 to **2099-12-31 23:59:59**

Set the date and time in *yyyy-MM-dd hh:mm:ss* format for the instrument's internal clock. This clock affects the real time control and properties of files.
Verify that the date and time have been set accurately before using the instrument.
See "Numeric keypad window" (p. 24).

(8) Date format

yyyy MM dd	Year (four digits), month, and date
MM dd yyyy	Month, date, and year (four digits)
dd MM yyyy	Date, month, and year (four digits)

(9) Delimiter

-	Hyphen
/	Slash
.	Period

Tips **Time zone**

Set the time zone for the area where you use the instrument.
GMT stands for Greenwich Mean Time.

Country (capital)	Time difference from GMT (daylight saving time)	Country (capital)	Time difference from GMT (daylight saving time)
New Zealand (Wellington)	GMT +12:00 (+13:00)	Greece (Athens)	GMT +2:00 (+3:00)
Australia (Canberra)	GMT +10:00 (+11:00)	Germany (Berlin)	GMT +1:00 (+2:00)
Japan (Tokyo)	GMT +9:00	France (Paris)	GMT +1:00 (+2:00)
South Korea (Seoul)	GMT +9:00	Netherlands (Amsterdam)	GMT +1:00 (+2:00)
China (Beijing)	GMT +8:00	Italy (Rome)	GMT +1:00 (+2:00)
Taiwan (Taipei)	GMT +8:00	Poland (Warsaw)	GMT +1:00 (+2:00)
Singapore (Singapore)	GMT +8:00	Switzerland (Bern)	GMT +1:00 (+2:00)
Mongolia (Ulaanbaatar)	GMT +8:00	Czech (Prague)	GMT +1:00 (+2:00)
Indonesia (Jakarta)	GMT +7:00	Belgium (Brussels)	GMT +1:00 (+2:00)
Thailand (Bangkok)	GMT +7:00	Sweden (Stockholm)	GMT +1:00 (+2:00)
India (New Delhi)	GMT +5:30	Denmark (Copenhagen)	GMT +1:00 (+2:00)
Pakistan (Islamabad)	GMT +5:00	Norway (Oslo)	GMT +1:00 (+2:00)
United Arab Emirates (Abu Dhabi)	GMT +4:00	Spain (Madrid)	GMT +1:00 (+2:00)
Oman (Muscat)	GMT +4:00	Hungary (Budapest)	GMT +1:00 (+2:00)
Iran (Tehran)	GMT +3:30 (+4:30)	Austria (Vienna)	GMT +1:00 (+2:00)
Romania (Bucharest)	GMT +2:00 (+3:00)	Slovenia (Ljubljana)	GMT +1:00 (+2:00)
Finland (Helsinki)	GMT +2:00 (+3:00)	Egypt (Cairo)	GMT +2:00
Qatar (Doha)	GMT +3:00	South Africa (Pretoria)	GMT +2:00
Turkey (Ankara)	GMT +3:00	United Kingdom (London)	GMT +0:00 (+1:00)
Russia (Moscow)	GMT +3:00	Portugal (Lisbon)	GMT +0:00 (+1:00)
Ukraine (Kyiv)	GMT +2:00 (+3:00)	USA (Washington DC)	GMT −5:00 (−4:00)

As of October 2021

6.2 Initializing the Instrument

If the instrument is operating in a strange manner, check it as described in "11.2 Troubleshooting" (p. 312).

If you are unsure of the cause, perform the system reset or boot key reset.

System reset

This system describes how to initialize all settings other than the language setting and communications settings to their default settings.
See "6.3 Factory Default Settings" (p. 156).

Display screen [SYSTEM] > [CONFIG]
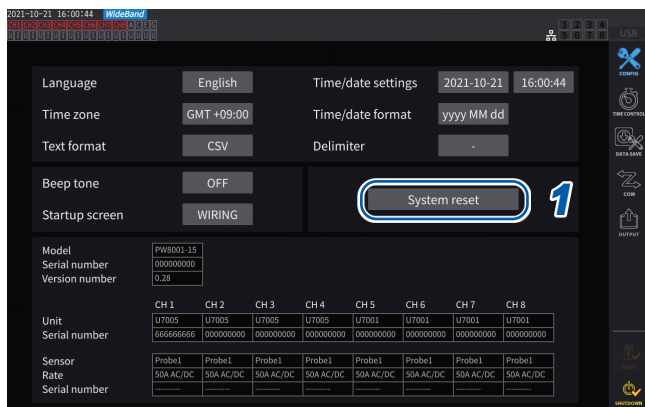
1 **Tap [System reset].**
A confirmation dialog box will be displayed.

2 **Tap [Yes] to reset the system.**

Boot key reset

This section describes how to initialize all settings including the language setting and communications settings to their default settings.
You can initiate the boot key reset by pressing the **SYSTEM** key while the operating system is starting up immediately after the instrument is turned on.

6

System Settings

6.3 Factory Default Settings

The following tables list the instrument's factory default settings.

The measurement screen and recorded data settings will also be reset.

Parameter	Default setting
Current input	Probe 1
Wiring	1P2W
Synchronization source	U1, U2, U3, U4, U5, U6, U7, U8 (depends the number of installed modules)
U range	1500 V
U auto-ranging	Off
U rectifier	RMS
VT ratio	1.0 (off)
Voltage probe phase compensation	Off
I range	Sensor's rated current
I auto-ranging	Off
I rectifier	RMS
CT ratio	1.0 (off)
LPF	Off
Sensor phase compensation	Off[*1]
Integration mode	RMS
Upper frequency limit	U7001: 1 MHz U7005: 2 MHz
Lower frequency limit	10 Hz
ZC HPF	Off
Delta conversion	Off
Data update interval	50 ms
Measurement mode	Wideband
Grouping	Type 1
THD calculation order	500th
THD calculation method	THD-F
Averaging mode	Off
Zero suppress	Off
Power calculation method	Type 1
Efficiency calculation mode	Fixed
UDF setting	Calculation item: Off Function: ␣ Four arithmetic operations: ␣ UDF name: ␣ Max. value: +1.00000 k (Auto) Integration: Off Unit: ␣
Efficiency calculation Pin, Pout	P1
Display language[*2]	English
Beep tone	On
Startup screen selection	Wiring (Wiring screen)
BNC-and-opt synchronization	Off
(Motor) synchronization source	DC

Parameter	Default setting
Motor analysis option wiring setting	Torque, Speed
Torque input	Analog
(Motor) LPF	Off
Motor voltage range	5 V
RPM input	Pulse
Torque scaling	1.0
Pulse count	2
Number of motor poles	4
Slip input frequency	fU1
Phase ADJ	0.000
Output range	1 V f.s.
Integration full scale	1
Output items	D/A1 to D/A16: WAVE U1, I1U2, I2, U3, I3, . . . , U8, I8 D/A17 to D/A20: Trend Urms1 (depends on the number of installed modules)
Integration control	All channels
Timer	Off
Timer setup	1 min.
Real time control	Off
Auto-save	Off
Data saving interval	1 s
Manual save	Off
Screenshot	Off
Comment entry	Off
Simultaneous saving of settings	Off
DHCP[*2]	Off
IP address[*2]	192.168.1.1
Subnet mask[*2]	255,255,255.0
Default gateway[*2]	0.0.0.0
GP-IB address[*2]	1
RS-232C host[*2]	RS-232C
RS-232C baud rate[*2]	115200 bps
Optical link, BNC-synchronization	Off
CAN settings	CAN mode: CAN Communication speed: 500 kbps Sampling point: 80% Output rate: Off
Time zone[*2]	GMT +09:00
Text saving format[*2]	CSV
Date format[*2]	yyyyMMdd
Delimiter for date[*2]	Hyphen (-)

*1: Automatically set to AUTO when a current sensor with the automatic recognition function is connected.
*2: Parameter not initialized by the system reset, but by the boot key reset. See "Boot key reset" (p. 155).

7 Saving Data and Managing Files

The following keys are used to save data onto and load it from a USB flash drive.

Key	Operation
SAVE	**Saves measured data manually.**
START / STOP	**Saves measured data automatically.**
On the touchscreen [Save]	**Saves waveform data.**
COPY	**Saves a screenshot.**
FILE	**Saves settings data and a settings file.** **Loads settings data and a settings file.** **Saves data on a USB flash drive.**

7.1 USB Flash Drive

Data can be saved on a USB flash drive. Use only mass storage class USB flash drives.
Data is saved in the **[HIOKI/PW8001]** folder. All files created by the instrument will be stored in this folder. Sub-folders can also be created in this folder.

⚠CAUTION

🚫 ■ **Do not transport the instrument with a USB flash drive connected.**

Doing so could damage the USB flash drive.

❗ ■ **Take steps to ensure that static electricity is not applied to USB flash drives.**

Application of static electricity could damage the USB flash drive, or cause the instrument to malfunction.

IMPORTANT
- USB flash drives have a service life. They lose the ability to store and load data after extended use. If you encounter this issue, purchase a new drive.
- Hioki is not liable for data stored on USB flash drives, regardless of the nature or cause of the accident or damage involved. Be sure to back up any important data stored on USB flash drives.

USB flash drive requirements for this instrument
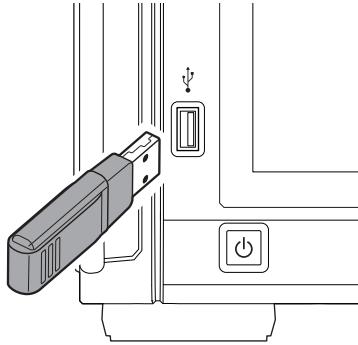
Connector	USB Type A connector
Electrical specifications	USB 3.0
Current that can be supplied	Up to 500 mA
Number of ports	1
Supported USB flash drives	USB Mass Storage Class compatible
File system	FAT16, FAT32

If the instrument cannot recognize a USB flash drive, press the reload button (🔄) on the **[FILE]** screen. If the instrument does not recognize a USB flash drive, try to use a different one. The instrument does not support all USB flash drives available on the market.

Formatting the USB flash drive

See "Formatting the USB flash drive" (p. 179).

Removing the USB flash drive
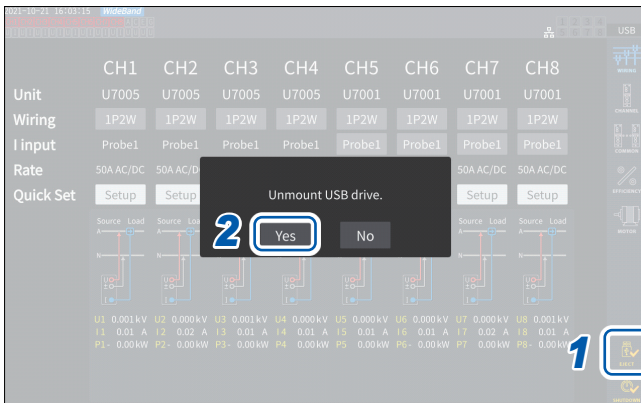
1 Tap **[EJECT]**.

2 When the confirmation dialog box appears, tap **[Yes]**.

3 Remove the USB flash drive from the instrument.

IMPORTANT

Failure to follow the correct procedure for removing the USB flash drive could damage the data on the USB flash drive.

Media indicator

The media indicator appears in the upper right corner of the screen.

USB	**[USB]** appears (background changes from gray to black). The instrument has recognized the USB flash drive.
USB	**[USB]** appears (background is red). Indicates the USB flash drive is more than 95% full. Stop measurement, then replace the USB flash drive with another one. Alternatively, transfer the data to your computer.
SLOW	**[SLOW]** appears. The instrument has recognized the USB flash drive as a drive with a slow write speed. The instrument will only be able to save about one-third of the maximum number of recordable parameters sampled for each interval time.
ERROR	**[ERROR]** appears. The USB flash drive lacks sufficient capacity, or the instrument could not recognize the USB flash drive.

7.2　File Operation Screen

This section describes the File Operation screen. You cannot access the USB flash drive during auto-save operation.
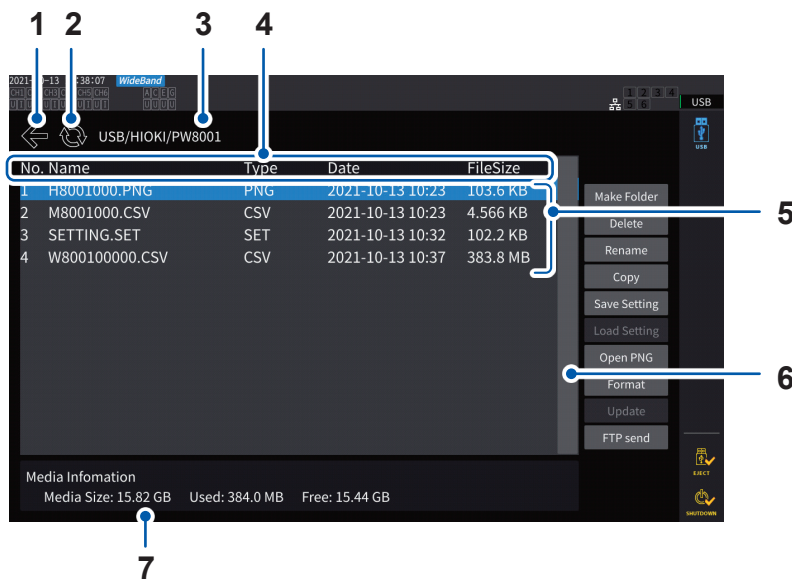
1	Takes you one level higher.
2	Updates the file list.
3	Displays the folder tree structure.
4	Tap the header row of the list to sort the files in the list according to their type. Example: Tapping **[Date]** sorts the files by creation date. 　　　　　 Tapping **[FileSize]** sorts the files by size.
5	Lists the saved files.
6	Use to scroll when there are too many files to display on one screen or to change the display position.
7	Displays the USB flash drive information.

File types

File name	Type	Description
M8001nnn.CSV	CSV	Manually saved measured data
F8001nnkkk.CSV	CSV	FFT data
MMDDnnkkk.CSV	CSV, BIN	Automatically saved measured data BIN format can only be loaded by GENNECT One.
W8001nnnkk.CSV	TEXT, BIN, MAT	Waveform data
PW8001.DBC	DBC	CAN database information
PW8001.JSON	JSON	Setting data of UDF1-20
H8001nnn.PNG	PNG	Screenshot data
MMDDnn000.SET	SET	Automatically saved settings data
xxxxxxxx.SET	SET	Folder
xxxxxxxx	FOLDER	Folder
xxxxxxxx	???	File that cannot be controlled by the instrument

- In filenames, *nnn* or *nn* indicates sequential numbering in the folder (*000* to *999* or *00* to *99*); *kk* indicates the file segment number (*000* to *999* or *00* to *99*) for files larger than 500 MB; and *MMDD* indicates the month and day.
- Settings data filenames may be set as desired (up to eight characters).
- The File Operation screen can display only one-byte alphanumeric characters and symbols. Two-byte characters will be replaced by question marks (?).

7

Saving Data and Managing Files

Number of characters that can be used

Item to be entered	Maximum number of characters that can be entered
Folder name	8 alphanumeric characters and symbols
Comment	40 alphanumeric characters and symbols

Explore folders

- Tapping a line associated with a folder will display its contents.
- Tapping **[←]** at the top left will take you back one level higher in the tree structure.

Updating the contents of a folder

- Tap the circular arrow to update the displayed contents of the present folder.
- Use this when the file size differs from the actual size.

7.3 Saving Measured Data

There are two ways to save data: manually and automatically.

You can select data to be saved from among all measured values for basic measurement items and harmonic measurement items.

File format

Manual save	CSV format (data delimiter can be selected)
Auto-save	CSV format (data delimiter can be selected) or BIN format

Text saving format

Set the text saving format using the system screen.
See "6.1 Checking and Changing Settings" (p. 153).

CSV	Measured data is saved comma-separated (,) format; the decimal point is represented by a period (.).
SSV	Measured data is saved semicolon-separated (;) format; the decimal point is represented by a comma (,).

> **IMPORTANT**
> - Data cannot be saved manually or automatically while the USB flash drive is being accessed.
> - When viewing a file created in text format using spreadsheet software, save the file under a different name. Overwriting may result in fewer significant digits of measured data.

Settings which measurement parameters to save

These settings affect both manual save and auto-save. This section describes how to set which parameters are to be saved onto the USB flash drive.

The number of parameters that can be saved is subject to the following limits depending on the set intervals (p. 165).

Data saving interval	1 ms*	10 ms	50 ms	100 ms	200 ms	500 ms	1 s	Others
Maximum number of recordable parameters (text)	50	200	1000	2000	4000	10000	20000	No limit
Maximum number of recordable parameters (binary)	400	4000	20000	40000	No limit	No limit	No limit	No limit

* When the data storage interval is set to 1 ms, the harmonic measurement items cannot be selected.

Display screen **[SYSTEM]** > **[DATA SAVE]**
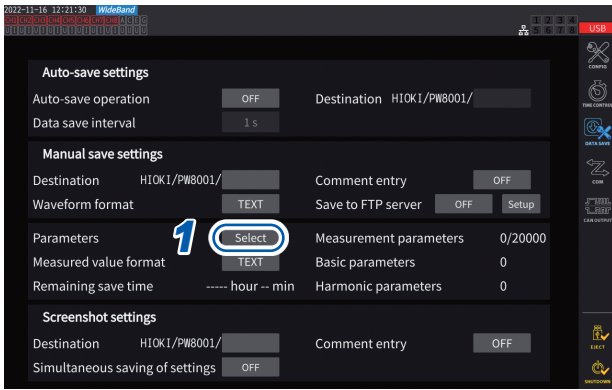
Tap here to switch between on and off for all items.
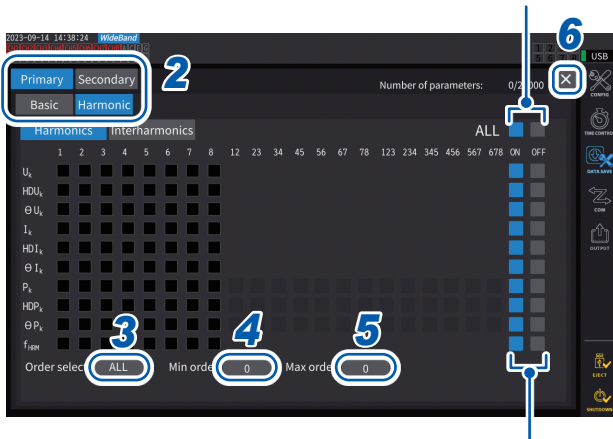
Tap here to switch between on and off for all items in that row.

1 Tap the **[Parameters]** box to open the settings window.

2 Tap the parameters to be saved to select check boxes **[☑]**.

Primary	Items measured with the optically linked primary instrument
Secondary	Items measured with the optically linked secondary instruments

Basic	Basic measurement items
Harmonic	Harmonic measurement items

3 (When **[Harmonic]** is selected)

Tap the **[Order Select]** box, then select the rectifier from the list.

ALL	All orders
ODD	Odd-numbered orders
EVEN	Even-numbered orders

Regarding inter-harmonic, the orders 1.5, 3.5, 5.5, . . . are considered ODD, while the orders 0.5, 2.5, 4.5, . . . are considered EVEN.

4 Tap the **[Min Order]** box, and then set the lowest order using the Y rotary knob.

Lit up in green: in 1 increments
Lit up in red:　in 10 increments
See "Changing values with rotary knobs" (p. 23).

In **[WideBande]** mode:　0 to 500
In **[IEC]** mode:　0 to 200
With **[Secondary]** setting:　0 to 50
Setting such that a minimum order greater than the maximum order is not allowed.

5 Tap the **[Max Order]** box, and then set the highest order using the Y rotary knob.

Lit up in green: in 1 increments
Lit up in red:　in 10 increments

0 to 500 (Values lower than the lowest order are unsettable.)

6 Tap **[×]** to close the setting window.

> **(Tips)** **To find out the times when operations were performed**
>
> Time data is always stored in measurement data files. The columns **[Date]**, **[Time]**, and **[Time(ms)]** represent the time data (at data intervals of less than 1s).
> When the measurement mode is set to **[IEC]**, along with them, the columns **[Date n]**, **[Time n]**, and **[Time(ms) n]** (at data intervals of less than 1 s, *n* represents the channel number) are shown.
>
> **To save measured data in milliseconds**
>
> If the data saving interval is set to less than 1 s, a column of **[Time (ms)]** is added to the saved file. Even if you save the integration elapsed time (the **[Elapsed Time]** check box in the Others tab is selected), the **[ETime (ms)]** column is added if you set the data saving interval to less than 1 s in the same way.

Manually saving measured data

Pressing the **SAVE** key saves measured values at that point in time. Set measured items to be saved and the saving destination in advance.

Saving destination location	USB flash drive
Filename	Automatically generated; filename extension: CSV *M8001nnn*.CSV (where *nnn* indicates sequential numbering in the folder from *000* to *999*) Ex.: M8001000.CSV (the first file to be saved)
Remarks	A new file is created when first saving data. Subsequently, the same file is appended.

> **(Tips)** Saved data may differ from display values at the instant the **SAVE** key was pressed due to the time difference. To ensure saved data and on-screen values match, manually save data while using the hold function.

7

Saving Data and Managing Files

Display screen   [SYSTEM] > [DATA SAVE]
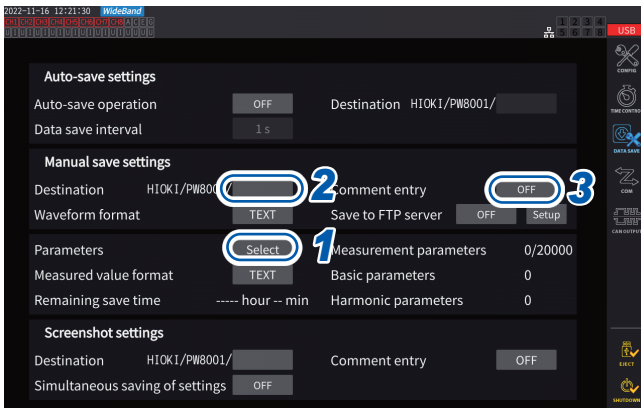
- During auto-save operation, manual save operation cannot be performed.

- Up to 1000 files can be created inside the same folder. When the sequential number used for files in the folder reaches 1000, an error will be displayed. Set a new destination folder.

1 **Follow the procedure described in "Settings which measurement parameters to save" (p. 161)**

2 **Tap the [Destination] box and use the keyboard window to specify the name of the folder.**

(Up to 8 alphanumeric characters and symbols)
See "Keyboard window" (p. 24).

3 **To add a comment, tap the [Comment entry] box to set it to [ON].**

(Up to 40 alphanumeric characters and symbols)

4 **Press the SAVE key when you wish to save data.**

5 **When [Comment entry] is set to [ON], use the keyboard window to enter the comment.**

The comment will be added to the end of the measured data in the CSV file.

6 **Tap [Enter].**

The data is saved.

Timing at which new files are created

Once the following settings were changed or operation was performed, a new file will be created the next time data is saved:

Settings	Saving destination folder Wiring mode Measured items to be saved, text saving format, and comment entry settings
Operation	Press the **DATA RESET** key. (This can be convenient when you wish to change the sequential numbering.)

Automatically saving measured data

This function automatically saves measured values at the set time. Parameters that have been set in advance will be saved.

Saving destination location	USB flash drive
Filename	Automatically generated based on the time and date at start of saving with *CSV* or *BIN* extension for measured data or *SET* for settings data *MMDDnnkkk*.CSV, *MMDDnn000*.SET (*MM*: month, *DD*: date, *nn*: sequential number from *00* to *99* within the same folder *kkk*: sequential number from 000 to 999 for file segments when the file size exceeds 500 MB) Example: 110400000.CSV (first file saved on November 4) See "Folder and file structure when saving data automatically" (p. 168).

> **IMPORTANT**
> - If auto-save operation starts during manual save operation, waveform save operation, or screenshot operation, some data sets that should be saved may be discarded.
> - No auto-save file is created when each wiring integration is enabled. (p.70)

Display screen [SYSTEM] > [DATA SAVE]

- During auto-save operation, neither manual save operation nor waveform save operation can be performed.

- The maximum number of recordable parameters varies depending on the data saving interval time. The longer the data saving interval time becomes, the more the maximum number of recordable parameters becomes. See "Settings which measurement parameters to save" (p. 161) and "Copying a file" (p. 178).

- When the data update interval is set to 1 ms, the UDF value is invalid, so its invalid value is saved.

- When the data storage interval is set to 1 ms, harmonic measurements cannot be saved (they cannot be selected).

1 Follow the procedure described in "Settings which measurement parameters to save" (p. 161)

2 Tap the [Auto-save operation] box to set it to [ON].

3 Tap the [Data save interval] box, then set the data saving interval.

The selections vary depending on the data update interval setting [Meas. Interval] (p.63).

> (When the data update interval is set at 10 ms)
> **OFF**, **1 ms**, **10 ms**, **50 ms**, **100 ms**, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
> (When the data update interval is set at 50 ms)
> **OFF**, **50 ms**, **100 ms**, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
> (When the data update interval is set at 200 ms)
> **OFF**, **100 ms**[*1], **200 ms**, **500 ms**[*1], **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
> * Only in IEC measurement mode

4 Tap the [Destination] box, then enter a folder name using the keyboard window.

(Up to 8 alphanumeric characters and symbols)
See "Keyboard window" (p. 24).

7

Saving Data and Managing Files

5 **Set the save time.**

See "5.1 Time Control Function" (p. 137) and "Auto-save operation using time control" (p. 169).

6 **Press the START/STOP key.**

Auto-save operation will start. The set folder will be created automatically, and data will be saved there.

7 **Press the START/STOP key again to stop the auto-save operation.**

Recordable time and data

When **[Auto-save operation]** is set to **[ON]**, the remaining save time for the USB flash drive being used will be displayed. An estimate of the remaining save time is calculated based on the amount of usable space on the USB flash drive, the number of parameters being recorded, and the data saving interval time.

Approximate recordable time for text format and common format

When the data output interval is set to 50 ms

Number of measurement items to be recorded per USB capacity	32 GB (1x)		64 GB (approx. 2x)		128 GB (approx. 4x)	
	Text	Binary	Text	Binary	Text	Binary
100	301 h	996 h	602 h	1992 h	1204 h	3984 h
200	158 h	517 h	316 h	1034 h	632 h	2068 h
500	65 h	212 h	130 h	424 h	260 h	848 h
1000	33 h	107 h	66 h	214 h	132 h	428 h
2000	16 h	54 h	32 h	108 h	64 h	216 h
5000	7 h	21 h	14 h	42 h	28 h	84 h

The table above does not take file segmentation into consideration. If file segmentation is considered, the recordable times will be slightly shorter.

In text format, one measured data set consists of up to 13 bytes; in binary format, one measured data set consists of four bytes.

Estimated data sizes of waveforms are as follows. Data files are segmented every 500 MB.

Volume of waveform data	Text format	Binary format
1 channel, 1000 points	26 kB	6 kB
1 channel, 5 megapoints	130 MB	20 MB
24 channels, 1000 points	456 kB	118 kB
24 channels, 5 megapoints	2270 MB	584 MB

Timing at which new files are created

If data is being saved onto a USB flash drive, a new file will be created when integration starts.

Example 1: If the amount of data exceeds approximately 500 MB per file, a new file will be created. (A maximum of 1000 files will be saved per measurement.)

Example 2: When you stop integration and then press the **DATA RESET** key, a new file will be created upon the start of the next time integration. (A maximum of 100 files will be saved per folder.)

Example 3: A new file is created when the number of data points per file exceeds one megasampling point.

Example 4: When the saving format is set to binary format, a new file is created when the integration stops and the voltage and current ranges are changed.

See "Folder and file structure when saving data automatically" (p. 168).

7

Saving Data and Managing Files

Folder and file structure when saving data automatically

The following explanation assumes that a folder named **[AAA]** has been created as the destination location so that data can automatically be saved on November 4.

Example 1

A new file will be created if data size exceeds approx. 500 MB per file.

PW8001 — AAA — 110400000.csv   110400001.csv ······· 110400999.csv

Stop integration and press the **DATA RESET** key.
A new file will be created upon the next integration.

An error will be displayed when the 101st file is created

110401000.csv   110401001.csv ·······

Example 2

When integration is stopped and the **DATA RESET** key is pressed, a new file will be created upon the next integration.

PW8001 — AAA — 110400000.csv   110401000.csv ······· 110499000.csv

An error will be displayed when the 101st file is created

Specify a new folder in **[Destination]**.

BBB — 110400000.csv   110401000.csv ·······

168

Auto-save operation using time control

Settings cannot be changed while time control is operating. If the USB flash drive becomes full during auto-save operation, an error will be displayed, and no further data will be saved.
See "5.1 Time Control Function" (p. 137).

Data save interval other than [OFF]
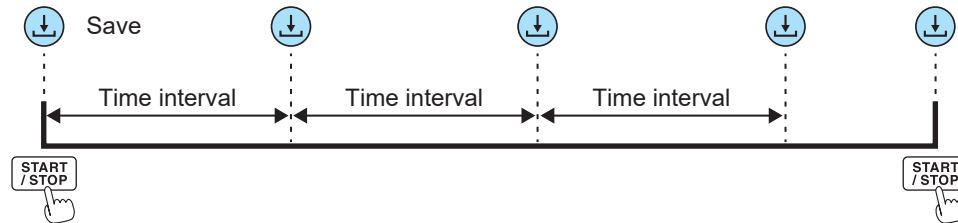
Timer control + Data saving interval [OFF]
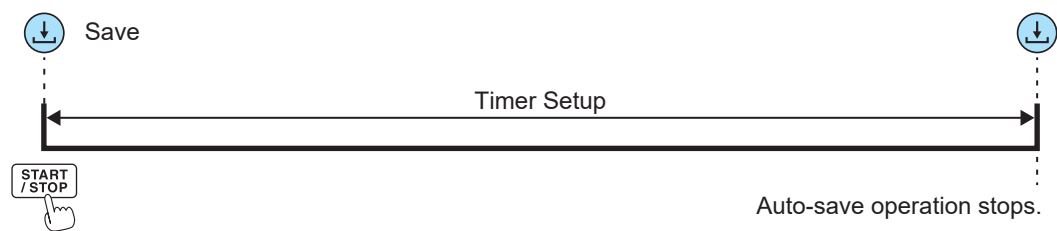
Real time control + Data save interval [OFF]
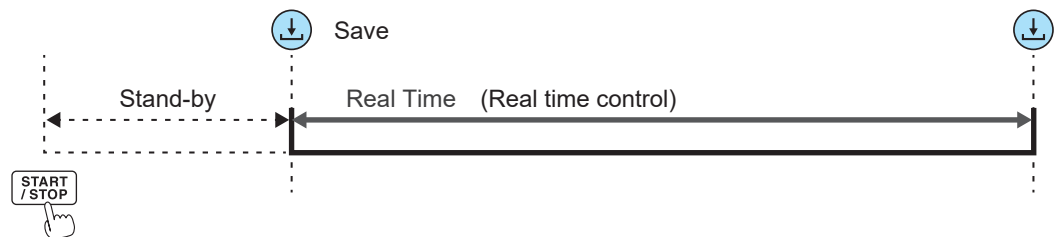
Timer control + Data save interval other than [OFF]

Real time control + Data save interval other than [OFF]

7

Saving Data and Managing Files
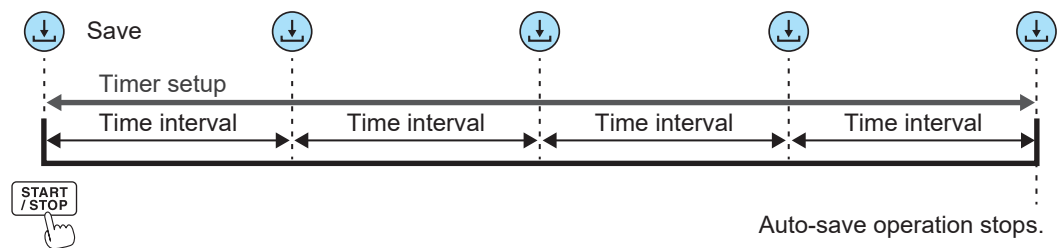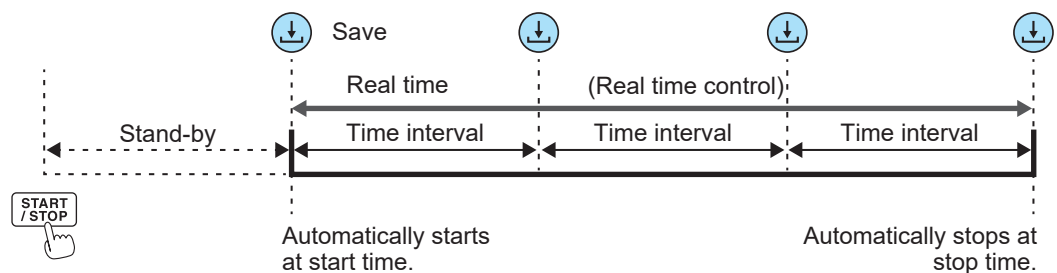
7.4 Saving Waveform Data

Waveform data displayed on the screen can be saved onto the USB flash drive by tapping **[SAVE]** on **[MEAS]** > the **[WAVE]** screen.

The same **[Destination]** and **[Comment entry]** settings as those for manual saving of measured data are used.

Saving destination location	USB flash drive

Filename	The file name is generated automatically.
	The extension can be selected from among CSV, BIN or MAT (depending on the waveform saving format setting).
	• W8001*nnnkk*.CSV
	   (where *nnn* indicates the sequential number within the same folder, and *kk* indicates the file segment number)
	   Ex.: W800100000.CSV (the first saved file)
	• W8001*nnnkk*.BIN
	   Ex.: B800100000.BIN (the first saved file)
	• W8001*nnnkk*.MAT

Save settings

Display screen **[SYSTEM]** > **[DATA SAVE]**

Up to 1000 files can be created in the same folder. When the sequential number used for files in the folder reaches 1000, an error will be displayed. Set a new destination folder.
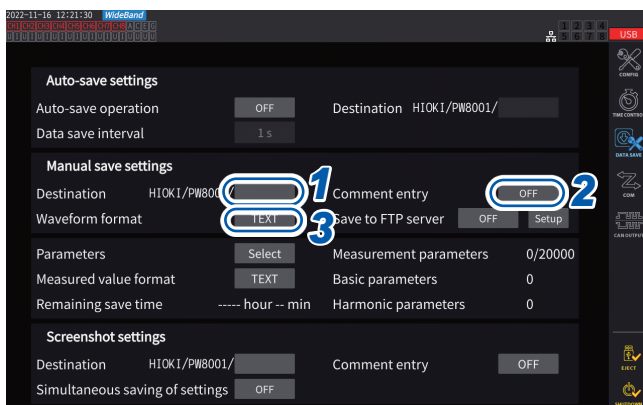
1 Tap the **[Destination]** box, and then enter a folder name using the keyboard.

(Up to 8 alphanumeric characters and symbols)
See "Keyboard window" (p. 24).

2 Tap the **[Comment entry]** box to set it to **[ON]** or **[OFF]**.

3 Tap the **[Waveform format]** box, then select the desired format from the list.

TEXT	CSV format (text data)
BIN	Binary format, which can be displayed with the viewer of GENNECT One
MAT	MATLAB* format (MAT format) *: Third-party company's trademark

Save operation

Display screen [MEAS] > [WAVE] > [+FFT]
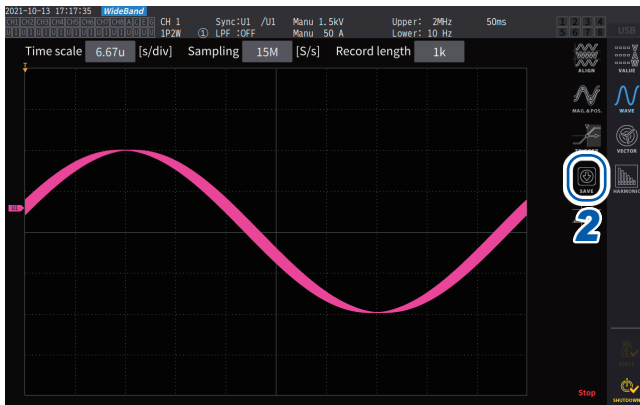
1 Tap the SINGLE key to acquire waveforms.

After waveforms of the recording length have been recorded, the **RUN/STOP** key lights up in red.
See "4.3 Recording Waveforms" (p. 123).

2 Tap [SAVE] > [Waveforms].

If the instrument has not recognized the USB flash drive, the button will be dimmed so that you cannot tap it.

3 When [Comment entry] is set to [ON], use the keyboard window to enter the comment.

(Up to 40 alphanumeric characters and symbols)
See "Keyboard window" (p. 24).

Once you confirm the comment, the data will be saved.

The following strings will be added before measured data in the CSV file:
- SAMPLING (sampling frequency)
- POINT (recording length)
- COMMENT (entered comment string)

- You may not be able to save the waveform if it was acquired by pressing the **RUN/STOP** key.
- For more information about saving BIN files, see "7.10 BIN Saving Format" (p. 188).
- Parameters for which the waveform display is set to OFF will not be saved.
- Waveform data cannot be saved while auto-save operation is in progress.
- Waveform data of voltage, current, and motor analysis option will be saved as a set of the maximum and minimum data compressed using the peak-to-peak compression.
- A dialog box will be displayed while saving the data. To cancel save operation, tap **[Cancel]** in the dialog box.

7

Saving Data and Managing Files

171

7.5 Saving FFT data

The FFT data displayed on the **[+FFT]** screen (accessible from the **[WAVE]** screen) is saved at the time of pressing **[Save]** then **[FFT]**. The same **[Destination]** and **[Comment entry]** settings as those for manual saving of measurement data are used.

Saving destination location	USB flash drive
Filename	Automatically generated; extension: CSV F8001nnkkk.CSV (where *nn* indicates sequential numbering in the folder from 000 to 999 and *kkk* indicates sequential numbering of the divided files) Ex.: F800100000.CSV (the first saved file)

Save settings

Display screen **[SYSTEM]** > **[DATA SAVE]**
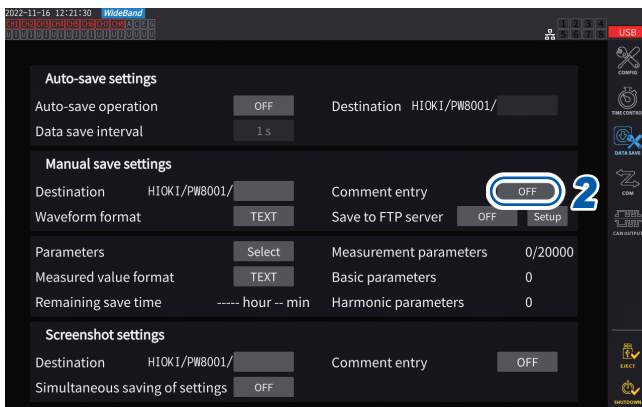
1 **Touch the [Destination] box and set to the desired folder.**

See "Keyboard window" (p. 24).

2 **Tap the [Comment entry] box to set it to [ON] or [OFF].**

ON	Allows you to enter a comment when saving data.
OFF	Does not allow you to enter a comment when saving data.

(Up to 8 alphanumeric characters and symbols)

IMPORTANT

FFT data is also saved in CSV format when **[BIN]** or **[MAT]** is selected for waveform save format.

MATLAB* format (MAT format)

*: Third-party company's trademark

Saving operation

Display screen [MEAS] > [WAVE] > [+FFT]
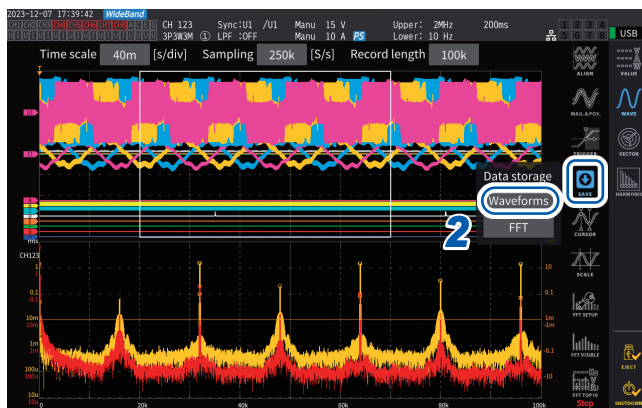
##EN##

1 **Tap the SINGLE key to acquire waveforms.**

The **RUN/STOP** key lights up in red when waveforms of the recording length are acquired.

2 **Tap [SAVE] > [FFT].**

If the instrument has not recognized the USB flash drive, the button will be dimmed so that you cannot tap it.

3 **When [Comment entry] is set to [ON], use the keyboard window to enter the comment.**

(When **[Comment entry]** is set to **[ON]**)

Allows you to enter a comment using the keyboard window (p. 24).

Once you confirm the comment, the data will be saved.

The following will be added before FFT data in the CSV file:
- HIOKI **[model name]** (firmware version number)
- SAMPLING SPEED (sampling frequency)
- SIZE (window size)
- COMMENT (entered comment string)

- Parameters for which the FFT display is set to OFF will not be saved.
- FFT data cannot be saved while auto-saving or storage operation is in progress.
- FFT data cannot be saved when waveform data or FFT analysis data is invalid.
- When the sequential number used for files in the folder reaches 100, an error will be displayed. Set a new destination (p. 172).
- You can enter comments containing up to 40 alphanumeric characters and symbols.
- A dialog box will be displayed while saving the data. To cancel save operation, tap **[Cancel]** in the dialog box.

7

Saving Data and Managing Files

7.6 Saving and Loading Screenshots

Saving screenshots

You can save a screenshot as a PNG file on a USB flash drive by pressing the **COPY** key. Screenshots can be saved during auto-save operation. However, auto-save operation will have priority, and screenshots cannot be made when the interval is set to less than 1 s.

Saving destination location

Screenshots are saved on the USB flash drive.

Filename

The file name is generated automatically. The file extension is PNG.

H8001nnn.PNG (where *nnn* indicates sequential numbering in the folder from *000* to *999*)

Ex.: H8001000.PNG (the first saved file)

Display screen   **[SYSTEM]** > **[DATA SAVE]**
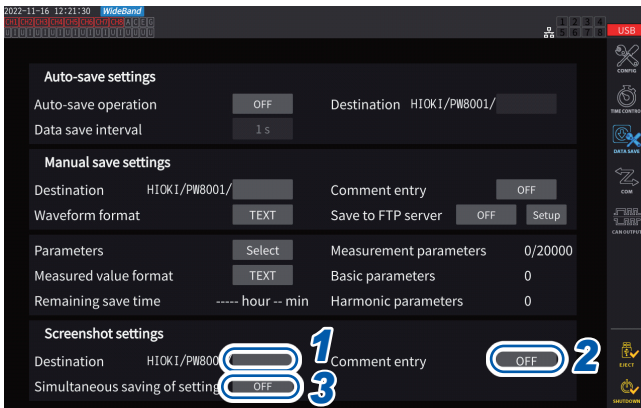
Up to 1000 files can be created in the same folder. When the sequential number used for files in the folder reaches 1000, an error will be displayed. Set a new destination folder.

1 **Tap the [Destination] box to specify a folder.**

(Up to eight alphanumeric characters and symbols)
See "Keyboard window" (p. 24).

2 **Tap the [Comment entry] box to select an entry way.**

(Up to 40 alphanumeric characters and symbols)

OFF	Disables comment entry.
TEXT	Allows you to enter comments with the keyboard window.
PNG	Allows you to enter comments as handwriting on the screen. (Comments will be added to the screenshot and saved.)

3 **Tap the [Simultaneous saving of settings] box to set it to [ON] or [OFF].**

OFF	Disables saving of settings information.
ON	Saves a screenshot of each channel's measurement condition settings.

4 **Press the COPY key, then enter a comment.**
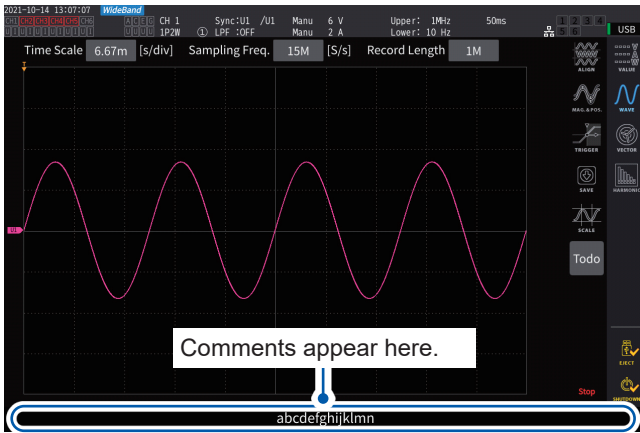
(If you select TEXT)

This allows you to enter a comment using the keyboard window.

Once you confirm the comment, the data will be saved.
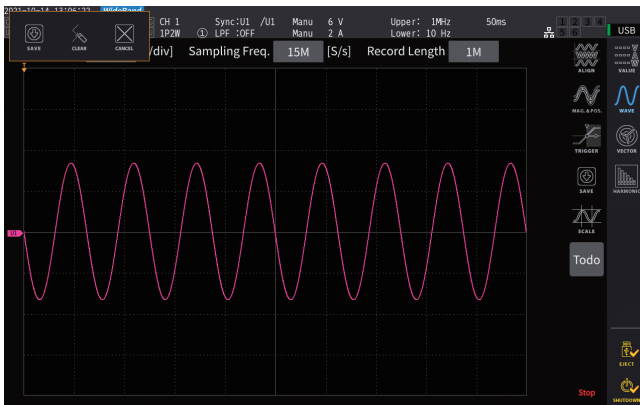
(If you select PNG)

This allows you to enter a comment in handwriting.

Tapping **[SAVE]** can save the data along with your hand-written comment.

Tapping **[CLEAR]** can clear your hand-written comment.

Tapping **[CANCEL]** can stop to save the data.

Loading a screenshot

You can load saved screenshots to display them.

Display screen **[FILE]**
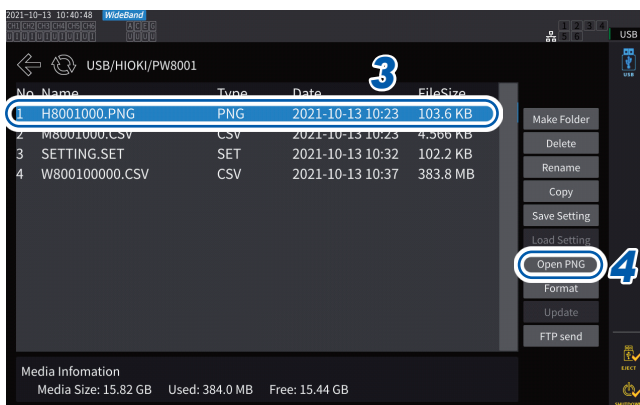
1 **Press the FILE key.**

2 **Tap the folder that contains screenshots.**

3 **Tap a PNG file.**

4 **Tap [Open PNG].**

7

Saving Data and Managing Files

175

7.7 Saving and Loading the Settings Data

Saving settings data

Information about the instrument's settings can be saved on a USB flash drive as a settings file.

Saving destination location	USB flash drive
Filename	Optional (up to eight characters), with *SET* extension. Example: SETTING1.SET

Display screen [FILE]
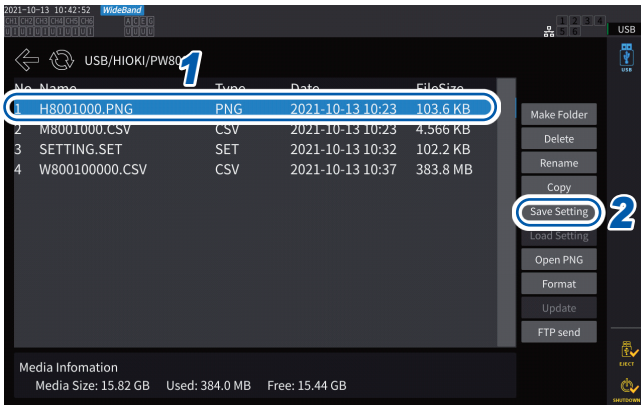
1 Tap the folder in which you wish to save the file.

2 Tap [Save Setting], then enter a filename.

See "Keyboard window" (p. 24).

- Language and communications settings cannot be saved.
- Settings cannot be saved while auto-save operation is in progress.

Loading settings data

You can load a saved settings file to restore the settings.

Display screen [FILE]
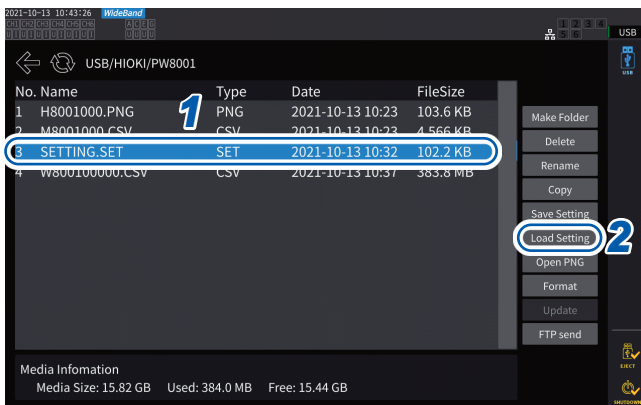
1 Tap the folder that contains the settings file.

2 Select the settings file, and then tap [Load Setting].

A confirmation dialog box is displayed.

3 Tap [Yes].

To restore the settings, the present module and options configurations must be the same as those in the settings file. If the configuration is different, the settings file cannot be loaded.

If the current sensor configuration in the configuration file to be loaded is different from the present current sensor configuration of the PW8001 of which you wish to restore the settings, the following settings are not restored.
- Settings of wiring
- Settings related of current sensors
After loading the settings file, check the restored settings again.

Checking settings data

Check the various settings data stored in the settings file.

1 **Press the FILE key.**

2 **Tap the folder that contains the settings file.**

3 **Select the settings file, and then tap [Open PNG].**

> **(Tips) Checking settings data on a computer**
>
> You can also check the settings data stored on a computer using a general-purpose test viewer.

7.8 File and Folder Operation

File and folder operation with a USB flash drive

This section describes how to manage files and folders created on a USB flash drive.

Display screen [FILE]
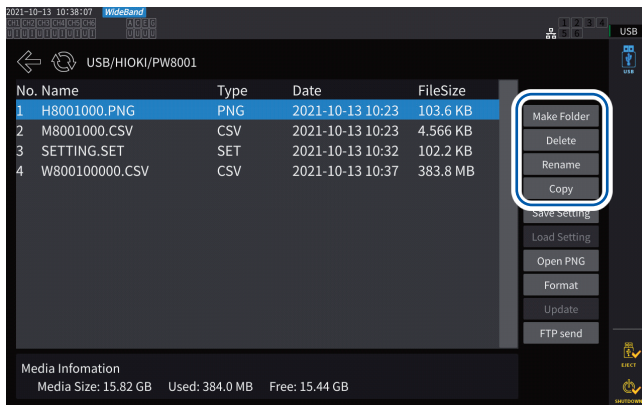
Creating a folder

1 Tap **[Make Folder]** to open the keyboard window.

2 Enter the folder name (up to eight characters in length).
See "Keyboard window" (p. 24).

3 Tap **[Enter]** to close the keyboard window.

Deleting a file or folder

1 Tap a file or a folder you wish to delete.

2 Tap **[Delete]**.

3 When the confirmation dialog box appears, select **[Yes]**.
The *HIOKI* and *HIOKI/PW8001* folders cannot be deleted.

Renaming a file or folder

1 Tap a file or a folder you wish to rename.

2 Tap **[Rename]**, and then enter a filename (up to eight characters).
See "Keyboard window" (p. 24).

Copying a file

1 Tap **[Copy]** to open the copy destination folder selection dialog box.

2 Select the copy destination folder, and then tap **[Yes]**.
If a file with the same name exists, it cannot be overwritten. Rename the file, then copy it.

178

Formatting the USB flash drive

This section describes how to format a USB flash drive for use with the instrument. Always disconnect the instrument from an FTP server before formatting a USB flash drive.

Display screen **[FILE]**
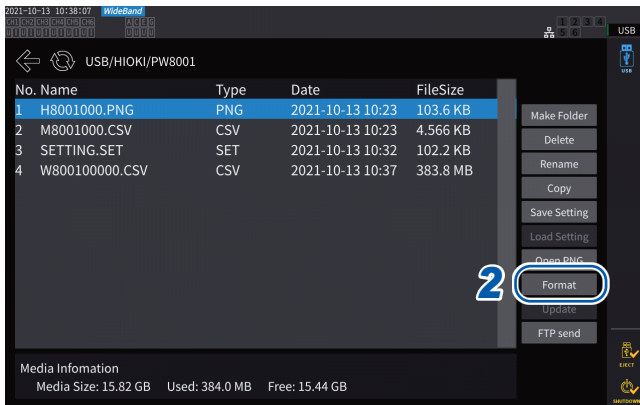
1 **Insert the USB flash drive in the instrument.**

2 **Tap [Format] to start formatting the USB flash drive.**

Once formatting is complete, a folder named **[HIOKI/PW8001]** will be created automatically in the top level of the tree structure.

> **IMPORTANT**
>
> Formatting a USB flash drive will erase all data stored on the drive. This operation cannot be undone. Check the contents of the drive carefully before formatting it. It is recommended to back up important data stored on USB flash drives.

Manual file transfer (uploading to an FTP server)

You can upload a selected file onto an FTP server.

1 **Press the FILE key.**

2 **Select the a file you wish to transfer.**

3 **Tap [FTP send] to open the FTP client settings dialog box.**

4 **Set the FTP client.**

See "9.4 Sending Data Using the FTP Client Function" (p. 230).

5 **Tap [Send].**

7

Saving Data and Managing Files

179

7.9 Measured Value Save Data Format

Header structure

The following header information (which consists of parameter names saved in the first line of the file) is used when measured data is automatically or manually saved in a file.

- The selected parameters are outputted beginning from top to bottom and from left to right of the table.
- Measured data is outputted starting from the first line immediately below the header in the header order.
- The first four parameters (Date, Time, Status, and Status 1 to Status 8) and the harmonic status (HARM Status) are always outputted regardless of whether they have been selected.
- The instrument outputs the Status 1 to Status 8 information of installed input modules.
- If the motor analysis option is installed, the status (Status M) of the motor channel is outputted.

Output items	Instrument symbol	Header and order
Year, month, day		Date
Time		Time
Time (ms)		Time (ms) (Outputted only when the interval setting is less than 1 s)
Elapsed time		Etime
Elapsed time (ms)		Etime (ms) (Outputted only when the interval setting is less than 1 s)
Year, month, and day of the start the flicker calculation period (only in IEC measurement mode)		Date1, Date2, Date3, Date4, Date5, Date6, Date7, Date8
Start time of the flicker calculation period (only in IEC measurement mode)		Time1, Time2, Time3, Time4, Time5, Time6, Time7, Time8
Start time of the flicker calculation period (ms, only in IEC measurement mode)		Time (ms) 1, Time (ms) 2, Time (ms) 3, Time (ms) 4, Time (ms) 5, Time (ms) 6, Time (ms) 7, Time (ms) 8 (Output only with the interval setting of less than 1 s)
Status		Status
Channel status		Status1, Status2, Status3, Status4, Status5, Status6, Status7, Status8
Motor status		StatusM
Basic measurement items The prefix *SC* is added to each header of the basic measurement items for the secondary instruments when it is operating in optical link mode. The basic measurement items for secondary units are outputted after the basic measurement items for the primary instrument is outputted.		
Voltage RMS value	Urms	Urms1, Urms2, Urms3, Urms4, Urms5, Urms6, Urms7, Urms8 Urms12, Urms23, Urms34, Urms45, Urms56, Urms67, Urms78 Urms123, Urms234, Urms345, Urms456, Urms567, Urms678
RMS equivalent of average rectified voltage value	Umn	Umn1, Umn2, Umn3, Umn4, Umn5, Umn6, Umn7, Umn8 Umn12, Umn23, Umn34, Umn45, Umn56, Umn67, Umn78 Umn123, Umn234, Umn345, Umn456, Umn567, Umn678
Voltage AC component	Uac	Uac1, Uac2, Uac3, Uac4, Uac5, Uac6, Uac7, Uac8
Voltage simple average	Udc	Udc1, Udc2, Udc3, Udc4, Udc5, Udc6, Udc7, Udc8

Output items	Instrument symbol	Header and order
Voltage fundamental wave component	Ufnd	Ufnd1, Ufnd2, Ufnd3, Ufnd4, Ufnd5, Ufnd6, Ufnd7, Ufnd8
Voltage waveform peak (+)	Upk+	PUpk1, PUpk2, PUpk3, PUpk4, PUpk5, PUpk6, PUpk7, PUpk8
Voltage waveform peak (−)	Upk−	MUpk1, MUpk2, MUpk3, MUpk4, MUpk5, MUpk6, MUpk7, MUpk8
Total harmonic voltage distortion	Uthd	Uthd1, Uthd2, Uthd3, Uthd4, Uthd5, Uthd6, Uthd7, Uthd8
Voltage ripple factor	Urf	Urf1, Urf2, Urf3, Urf4, Urf5, Urf6, Urf7, Urf8
Voltage unbalance rate	Uunb	Uunb123, Uunb234, Uunb345, Uunb456, Uunb567, Uunb678
Current RMS value	Irms	Irms1, Irms2, Irms3, Irms4, Irms5, Irms6, Irms7, Irms8 Irms12, Irms23, Irms34, Irms45, Irms56, Irms67, Irms78 Irms123, Irms234, Irms345, Irms456, Irms567, Irms678
RMS equivalent of average rectified voltage value	Imn	Imn1, Imn2, Imn3, Imn4, Imn5, Imn6, Imn7, Imn8 Imn12, Imn23, Imn34, Imn45, Imn56, Imn67, Imn78 Imn123, Imn234, Imn345, Imn456, Imn567, Imn678
Current AC component	Iac	Iac1, Iac2, Iac3, Iac4, Iac5, Iac6, Iac7, Iac8
Current simple average	Idc	Idc1, Idc2, Idc3, Idc4, Idc5, Idc6, Idc7, Idc8
Current fundamental wave component	Ifnd	Ifnd1, Ifnd2, Ifnd3, Ifnd4, Ifnd5, Ifnd6, Ifnd7, Ifnd8
Current waveform peak (+)	Ipk+	PIpk1, PIpk2, PIpk3, PIpk4, PIpk5, PIpk6, PIpk7, PIpk8
Current waveform peak (−)	Ipk−	MIpk1, MIpk2, MIpk3, MIpk4, MIpk5, MIpk6, MIpk7, MIpk8
Total harmonic current distortion	Ithd	Ithd1, Ithd2, Ithd3, Ithd4, Ithd5, Ithd6, Ithd7, Ithd8
Current ripple factor	Irf	Irf1, Irf2, Irf3, Irf4, Irf5, Irf6, Irf7, Irf8
Current unbalance rate	Iunb	Iunb123, Iunb234, Iunb345, Iunb456, Iunb567, Iunb678
Active power	P	P1, P2, P3, P4, P5, P6, P7, P8 P12, P23, P34, P45, P56, P67, P78 P123, P234, P345, P456, P567, P678
Fundamental wave active power	Pfnd	Pfnd1, Pfnd2, Pfnd3, Pfnd4, Pfnd5, Pfnd6, Pfnd7, Pfnd8 Pfnd12, Pfnd23, Pfnd34, Pfnd45, Pfnd56, Pfnd67, Pfnd78 Pfnd123, Pfnd234, Pfnd345, Pfnd456, Pfnd567, Pfnd678
Apparent power	S	S1, S2, S3, S4, S5, S6, S7, S8 S12, S23, S34, S45, S56, S67, S78 S123, S234, S345, S456, S567, S678
Fundamental wave apparent power	Sfnd	Sfnd1, Sfnd2, Sfnd3, Sfnd4, Sfnd5, Sfnd6, Sfnd7, Sfnd8 Sfnd12, Sfnd23, Sfnd34, Sfnd45, Sfnd56, Sfnd67, Sfnd78 Sfnd123, Sfnd234, Sfnd345, Sfnd456, Sfnd567, Sfnd678
Reactive power	Q	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8 Q12, Q23, Q34, Q45, Q56, Q67, Q78 Q123, Q234, Q345, Q456, Q567, Q678
Fundamental wave reactive power	Qfnd	Qfnd1, Qfnd2, Qfnd3, Qfnd4, Qfnd5, Qfnd6, Qfnd7, Qfnd8 Qfnd12, Qfnd23, Qfnd34, Qfnd45, Qfnd56, Qfnd67, Qfnd78 Qfnd123, Qfnd234, Qfnd345, Qfnd456, Qfnd567, Qfnd678
Power factor	λ	PF1, PF2, PF3, PF4, PF5, PF6, PF7, PF8 PF12, PF23, PF34, PF45, PF56, PF67, PF78 PF123, PF234, PF345, PF456, PF567, PF678
Fundamental wave power factor	λfnd	PFfnd1, PFfnd2, PFfnd3, PFfnd4, PFfnd5, PFfnd6, PFfnd7, PFfnd8 PFfnd12, PFfnd23, PFfnd34, PFfnd45, PFfnd56, PFfnd67, PFfnd78 PFfnd123, PFfnd234, PFfnd345, PFfnd456, PFfnd567, PFfnd678
Voltage phase angle	θU	Udeg1, Udeg2, Udeg3, Udeg4, Udeg5, Udeg6, Udeg7, Udeg8
Current phase angle	θI	Ideg1, Ideg2, Ideg3, Ideg4, Ideg5, Ideg6, Ideg7, Ideg8

7

Saving Data and Managing Files

Output items	Instrument symbol	Header and order
Power phase angle	φ	DEG1, DEG2, DEG3, DEG4, DEG5, DEG6, DEG7, DEG8 DEG12, DEG23, DEG34, DEG45, DEG56, DEG67, DEG78 DEG123, DEG234, DEG345, DEG456, DEG567, DEG678
Voltage frequency	fU	FU1, FU2, FU3, FU4, FU5, FU6, FU7, FU8
Current frequency	fI	FI1, FI2, FI3, FI4, FI5, FI6, FI7, FI8
Integrated positive current value	Ih+	PIH1, PIH2, PIH3, PIH4, PIH5, PIH6, PIH7, PIH8
Integrated negative current value	Ih−	MIH1, MIH2, MIH3, MIH4, MIH5, MIH6, MIH7, MIH8
Sum of integrated positive and negative current values	Ih	IH1, IH2, IH3, IH4, IH5, IH6, IH7, IH8
Integrated positive power value	WP+	PWP1, PWP2, PWP3, PWP4, PWP5, PWP6, PWP7, PWP8 PWP12, PWP23, PWP34, PWP45, PWP56, PWP67, PWP78 PWP123, PWP234, PWP345, PWP456, PWP567, PWP678
Integrated negative power value	WP−	MWP1, MWP2, MWP3, MWP4, MWP5, MWP6, MWP7, MWP8 MWP12, MWP23, MWP34, MWP45, MWP56, MWP67, MWP78 MWP123, MWP234, MWP345, MWP456, MWP567, MWP678
Sum of integrated positive and negative power values	WP	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8 WP12, WP23, WP34, WP45, WP56, WP67, WP78 WP123, WP234, WP345, WP456, WP567, WP678
Efficiency	η	Eff1, Eff2, Eff3, Eff4
Loss value	Loss	LOSS1, LOSS2, LOSS3, LOSS4
Torque	Tq	Tq1, Tq2, Tq3, Tq4
RPM	Spd	Spd1, Spd2, Spd3, Spd4
Motor power	Pm	Pm1, Pm2, Pm3, Pm4
Slip	Slip	Slip1, Slip2, Slip3, Slip4
Free input during independent input mode operation	CH	CHA, CHB, CHC, CHD, CHE, CHF, CHG, CHH
User-defined formula	UDF	UDF1, UDF2, UDF3, UDF4, UDF5, UDF6, UDF7, UDF8, UDF9, UDF10, UDF11, UDF12, UDF13, UDF14, UDF15, UDF16, UDF17, UDF18, UDF19, UDF20
Short-term flicker value	Pst	Pst1, Pst2, . . ., Pst8
Maximum short-term flicker value	PstMax	PstMax1, PstMax2, PstMax3, PstMax4, PstMax5, PstMax6, PstMax7, PstMax8
Long-term flicker value	Plt	Plt1, Plt2, Plt3, Plt4, Plt5, Plt6, Plt7, Plt8
Maximum instantaneous flicker value	PinstMax	PinstMax1, PinstMax2, PinstMax3, PinstMax4, PinstMax5, PinstMax6, PinstMax7, PinstMax8
Minimum instantaneous flicker value	PinstMin	PinstMin1, PinstMin2, PinstMin3, PinstMin4, PinstMin5, PinstMin6, PinstMin7, PinstMin8
Relative steady-state voltage change	dc	DC1, DC2, DC3, DC4, DC5, DC6, DC7, DC8
Maximum relative voltage change	dmax	DMax1, DMax2, DMax3, DMax4, DMax5, DMax6, DMax7, DMax8
Period while the relative voltage change exceeds the threshold	Tmax	TMax1, TMax2, TMax3, TMax4, TMax5, TMax6, TMax7, TMax8

Output items		Instrument symbol	Header and order
Harmonic measurement items			
Status			HRMStatus
0th order	Harmonic voltage RMS value	Uk	HU1L000, HU2L000, HU3L000, HU4L000, HU5L000, HU6L000, HU7L000, HU8L000
	Harmonic voltage content percentage	HDUk	HU1D000, HU2D000, HU3D000, HU4D000, HU5D000, HU6D000, HU7D000, HU8D000
	Harmonic voltage phase angle	θUk	HU1P000, HU2P000, HU3P000, HU4P000, HU5P000, HU6P000, HU7P000, HU8P000
	Harmonic current RMS value	Ik	HI1L000, HI2L000, HI3L000, HI4L000, HI5L000, HI6L000, HI7L000, HI8L000
	Harmonic current content percentage	HDIk	HI1D000, HI2D000, HI3D000, HI4D000, HI5D000, HI6D000, HI7D000, HI8D000
	Harmonic current phase angle	θIk	HI1P000, HI2P000, HI3P000, HI4P000, HI5P000, HI6P000, HI7P000, HI8P000
	Harmonic active power	Pk	HP1L000, HP2L000, HP3L000, HP4L000, HP5L000, HP6L000, HP7L000, HP8L000, HP12L000, HP23L000, HP34L000, HP45L000, HP56L000, HP67L000, HP78L000, HP123L000, HP234L000, HP345L000, HP456L000, HP567L000, HP678L000
	Harmonic power content percentage	HDPk	HP1D000, HP2D000, HP3D000, HP4D000, HP5D000, HP6D000, HP7D000, HP8D000, HP12D000, HP23D000, HP34D000, HP45D000, HP56D000, HP67D000, HP78D000 HP123D000, HP234D000, HP345D000, HP456D000, HP567D000, HP678D000
	Harmonic voltage-vs.-current phase difference	θk	HP1P000, HP2P000, HP3P000, HP4P000, HP5P000, HP6P000, HP7P000, HP8P000, HP12P000, HP23P000, HP34P000, HP45P000, HP56P000, HP67P000, HP78P000, HP123P000, HP234P000, HP345P000, HP456P000, HP567P000, HP678P000
nth order	(omitted)	—	The last three digits indicate the order *n*.

Output items		Instrument symbol	Header and order
500th order	Harmonic voltage RMS value	Uk	HU1L500, HU2L500, HU3L500, HU4L500, HU5L500, HU6L500, HU7L500, HU8L500
	Harmonic voltage content percentage	HDUk	HU1D500, HU2D500, HU3D500, HU4D500, HU5D500, HU6D500, HU7D500, HU8D500
	Harmonic voltage phase angle	θUk	HU1P500, HU2P500, HU3P500, HU4P500, HU5P500, HU6P500, HU7P500, HU8P500
	Harmonic current RMS value	Ik	HI1L500, HI2L500, HI3L500, HI4L500, HI5L500, HI6L500, HI7L500, HI8L500
	Harmonic current content percentage	HDIk	HI1D500, HI2D500, HI3D500, HI4D500, HI5D500, HI6D500, HI7D500, HI8D500
	Harmonic current phase angle	θIk	HI1P500, HI2P500, HI3P500, HI4P500, HI5P500, HI6P500, HI7P500, HI8P500
	Harmonic active power	Pk	HP1L500, HP2L500, HP3L500, HP4L500, HP5L500, HP6L500, HP7L500, HP8L500, HP12L500, HP23L500, HP34L500, HP45L500, HP56L500, HP67L500, HP78L500, HP123L500, HP234L500, HP345L500, HP456L500, HP567L500, HP678L500
	Harmonic power content percentage	HDPk	HP1D500, HP2D500, HP3D500, HP4D500, HP5D500, HP6D500, HP7D500, HP8D500, HP12D500, HP23D500, HP34D500, HP45D500, HP56D500, HP67D500, HP78D500, HP123D500, HP234D500, HP345D500, HP456D500, HP567D500, HP678D500
	Harmonic voltage-vs.-current phase difference	θk	HP1P500, HP2P500, HP3P500, HP4P500, HP5P500, HP6P500, HP7P500, HP8P500, HP12P500, HP23P500, HP34P500, HP45P500, HP56P500, HP67P500, HP78P500, HP123P500, HP234P500, HP345P500, HP456P500, HP567P500, HP678P500
	Harmonic synchronization frequency	fHRM	HF1, HF2, HF3, HF4, HF5, HF6, HF7, HF8
0.5th order	Inter-harmonic voltage RMS value	iUk	IHU1L000, IHU2L000, IHU3L000, IHU4L000, IHU5L000, IHU6L000, IHU7L000, IHU8L000
0.5th order	Inter-harmonic voltage content percentage	iHDUk	IHU1D000, IHU2D000, IHU3D000, IHU4D000, IHU5D000, IHU6D000, IHU7D000, IHU8D000
0.5th order	Inter-harmonic current RMS value	iIk	IHI1L000, IHI2L000, IHI3L000, IHI4L000, IHI5L000, IHI6L000, IHI7L000, IHI8L000
0.5th order	Inter-harmonic current content percentage	iHDIk	IHI1D000, IHI2D000, IHI3D000, IHI4D000, IHI5D000, IHI6D000, IHI7D000, IHI8D000
nth order	(an omission)	—	The last three digits represent the order *n*.
200.5th order	Inter-harmonic voltage RMS value	iUk	IHU1L200, IHU2L200, IHU3L200, IHU4L200, IHU5L200, IHU6L200, IHU7L200, IHU8L200
200.5th order	Inter-harmonic voltage content percentage	iHDUk	IHU1D200, IHU2D200, IHU3D200, IHU4D200, IHU5D200, IHU6D200, IHU7D200, IHU8D200
200.5th order	Inter-harmonic current RMS value	iIk	IHI1L200, IHI2L200, IHI3L200, IHI4L200, IHI5L200, IHI6L200, IHI7L200, IHI8L200
200.5th order	Inter-harmonic current content percentage	iHDIk	IHI1D200, IHI2D200, IHI3D200, IHI4D200, IHI5D200, IHI6D200, IHI7D200, IHI8D200

Status data

Status information is used to express measurement conditions at the time the measured data was saved using a 32-bit hexadecimal values.

Status is the logical sum of Status 1 to Status 8 as well as Status M.

Example: If Bit 11 (ZU) of Status 2 is on and Bit 17 (ZM) of Status M is on, Bit 11 and Bit 17 of Status will be set to on.

Status of each channel (Status 1 through Status 8)

Status 1 through Status 8 indicate the status of individual channels.

Example: Status 3 indicates the status of channel 3.

Each of the 32 bits is assigned to contain the following information:

Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24
–	–	–	–	–	–	–	–
Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 17	Bit 16
–	–	–	–	–	–	–	–
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
–	UCU	ZP	ZI	ZU	DP	DI	DU
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
–	–	–	–	RI	RU	PI	PU

Bit	Abbreviation	Description
Bit 14	UCU	Calculation was not possible. (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 13	ZP	Power calculation (synchronization source) forced zero-crossing
Bit 12	ZI	Current frequency forced zero-crossing
Bit 11	ZU	Voltage frequency forced zero-crossing
Bit 10	DP	No power calculation (synchronization source) data update
Bit 9	DI	No current frequency data update
Bit 8	DU	No voltage frequency data update
Bit 3	RI	Current overload
Bit 2	RU	Voltage overload
Bit 1	PI	Current peak-over
Bit 0	PU	Voltage peak-over

Example: When Bit 12 (ZI, current frequency forced zero-crossing) and Bit 2 (RU, voltage overload) are enabled, the status is represented as *1004* in hexadecimal notation.

For reference, the representation in binary would be 00000000000000000001000000000100.

Motor channel status (Status M)

Each of the 32 bits is assigned to contain the following information:

Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24
–	–	UCUG	ZMG	RMG	UCUE	ZME	RME
Bit 23	**Bit 22**	**Bit 21**	**Bit 20**	**Bit 19**	**Bit 18**	**Bit 17**	**Bit 16**
–	–	UCUC	ZMC	RMC	UCUA	ZMA	RMA
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**
–	–	–	–	–	–	–	–
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
–	–	–	–	–	–	–	–

Bit	Abbreviation	Description
Bit 29	UCUG	Ch. G calculation was not possible. (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 28	ZMG	Ch. G motor synchronization source forced zero-crossing
Bit 27	RMG	Overload while using Ch. G analog input
Bit 26	UCUE	Ch. E calculation not possible (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 25	ZME	Ch. E motor synchronization source forced zero-crossing
Bit 24	RME	Overload while using Ch. E analog input
Bit 21	UCUC	Ch. C calculation not possible (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 20	ZMC	Ch. C motor synchronization source forced zero-crossing
Bit 19	RMC	Overload while using Ch. C analog input
Bit 18	UCUA	Ch. A calculation not possible (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 17	ZMA	Ch. A motor synchronization source forced zero-crossing
Bit 16	RMA	Overload while using Ch. A analog input

Harmonic status (HARM Status)

Status information expresses measurement conditions at the time the measured data was saved using a 32-bit hexadecimal value.

The status of the measured harmonics data is one of the Status blocks.

Each of the 32 bits is assigned to contain the following information: (numbers one through eight at the end of the abbreviation indicate the channel numbers.)

Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24
–	–	–	–	–	–	–	–
Bit 23	**Bit 22**	**Bit 21**	**Bit 20**	**Bit 19**	**Bit 18**	**Bit 17**	**Bit 16**
UCU8	UCU7	UCU6	UCU5	UCU4	UCU3	UCU2	UCU1
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**
ZH8	ZH7	ZH6	ZH5	ZH4	ZH3	ZH2	ZH1
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
RF8	RF7	RF6	RF5	RF4	RF3	RF2	RF1

Bit	Abbreviation	Description
Bit 16 to bit 23	UCU	Calculation not possible (for example, measurement data was invalid because it was sampled immediately after range switching.)
Bit 8 to bit 15	ZH	Harmonic waveform forced zero-crossing
Bit 0 to bit 7	RF	The frequency exceeds the range.

Data format for measured values

General measured values	±□□□□□□□E±□□ 7-digit mantissa including the decimal point and 2-digit exponent (The plus sign at the beginning of the mantissa and any leading zeroes are omitted.)	
Integrated values	±□□□□□□□E±□□ 7-digit mantissa including the decimal point and 2-digit exponent (The plus sign at the beginning of the mantissa and any leading zeroes are omitted.)	
Date and time	yy/MM/dd hh/mm/ss Elapsed time Elapsed time (ms)	□□□□/□□/□□ □□:□□:□□ □□□□□:□□:□□ □□□
Errors	Peak-over value	When **[-------]** is displayed due to a over load or peak over, the value +99999.9E+99 is saved.
	Invalid value	When **[-------]** is displayed due to a range change or operation impossible value, the value +77777.7E+99 is saved.

7.10 BIN Saving Format

BIN format, which can be selected as the saving format for automatically saved files and for waveform files, can only be loaded by GENNECT One.
For information on GENNECT One, see "9.9 GENNECT One (PC Application Software)" (p. 245).

8 Connecting External Devices

8.1 Synchronous Measurement

You can use either BNC synchronous mode or optical link mode to perform synchronous measurements on multiple PW8001 instruments. The data update timing and control of the secondary instruments are synchronized with the primary instrument.

Synchronous mode	Description	Number of synchronizable instruments
BNC synchronization	Only timings, such as data update, integration, and HOLD, can be synchronized.	Up to four (one primary, up to three secondaries)
Optical link	Some measurement items of the secondary instruments are transferred to the primary instrument at each synchronized data update rate, allowing the instruments to operate as a wattmeter with up to 16 channels. The instruments can freely display measurement-item data of up to 16 channels on the screens without distinguishing between the primary and secondary. They can efficiently calculate data and save the results in files.	Two (one primary, one secondary)

BNC synchronization

Connecting the up to four PW8001 instruments using the optional 9165 Connection Cord (BNC cables) allows the instruments to perform the synchronous measurement. Using this function to operate the primary PW8001 instrument can control the secondary PW8001 ones, which achieves simultaneous measurements on multiple systems.

The secondary PW8001 instruments operate in sync with the timings and operation of the primary PW8001 one for the following:

- Internal calculations and data update
- Starting and stopping integration and resetting integrated values
- Freezing displays (**HOLD**/**PEAK HOLD**) and updating data during the display freeze
- Zero adjustment
- **SAVE**
- **COPY**
- Present time

Connecting the instruments

> ⚠**CAUTION**
>
> ■ **Do not connect or disconnect the cables while the instruments have been turned on.**
>
>   Doing so could damage the instrument.
>
> 🚫 ■ **Do not input signals other than those dedicated to the synchronous measurement.**
>
>   The synchronous measurement uses signals dedicated to the instruments. Doing so could damage the instruments or cause them to malfunction.

> ⚠ **CAUTION**
>
> ❗
>
> ■ **Use the common earthing for the PW8001 instruments under synchronous measurement.**
>
> Earthing to the different points causes a potential difference between the GND terminals of any two of the primary and secondary instruments. Connecting the connection cords (for synchronizing) while there is a potential difference could cause a malfunction or damage to the instruments.

During synchronous measurements, control signals are transmitted via the 9165 Connection Cord. Never disconnect the connection cables during synchronous measurements. Doing so disrupts signals, possibly causing the secondary instrument to go out of control.

You will need: PW8001 ×2, 9165 Connection Cord ×2

1 Make sure that the two PW8001 instruments have been turned off.

2 Connect the EXT SYNC terminals of the two PW8001 instruments using the 9165 Connection Cord.

3 Turn the two PW8001 on (any order).

9165
Connection Cord
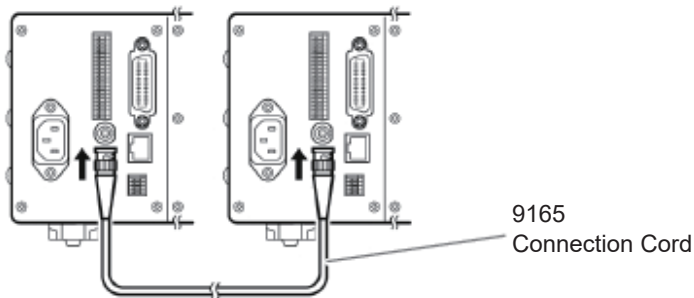
Performing the synchronous measurement with three or more PW8001 instruments
Use BNC T-shaped adapters (plug-to-two jacks) to connect the instruments in parallel.

Connect to the instrument

BNC T-shaped adapter
(plug-to-two jacks)

9165 Connection Cord
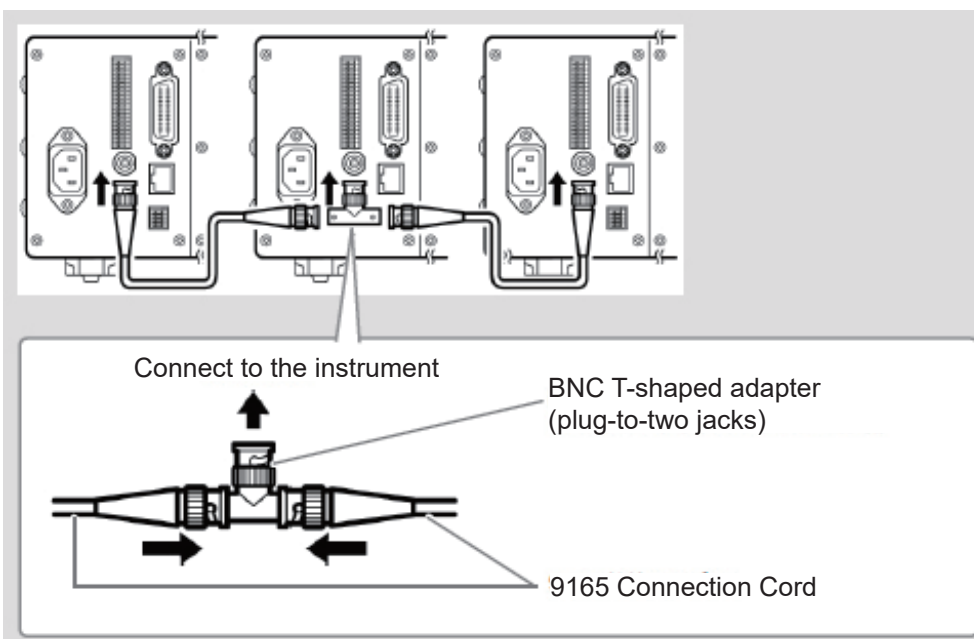
Making the synchronous measurement settings

Display screen [SYSTEM] > [COM]
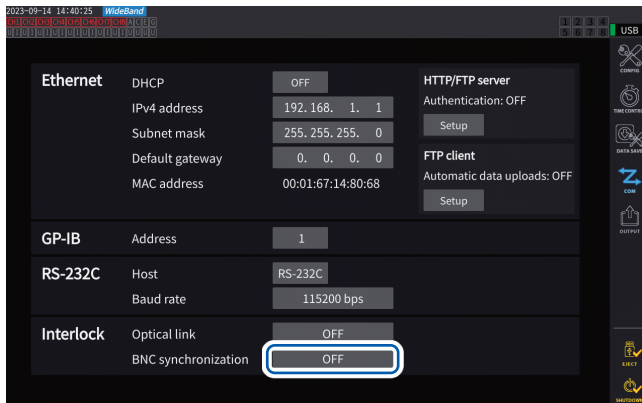
1 Tap the [BNC synchronization] box under [Interlock] to set it to [ON].

You can check the sync status with the operation status indicator in the upper right of the screen.

See "Common screen display" (p. 25).

Sync Primary (blue)	Set as the primary instrument in BNC sync mode.
Sync Secondary (white)	Set as a secondary instrument in BNC sync mode.
Sync Primary (red)	Synchronous error

IMPORTANT

- Set only one instrument as the primary for the synchronous measurement.
- Match the measurement mode and data update interval between the primary and the secondary instruments, reset the integrated values, and then start synchronous measurements.
- The instruments cannot be synchronized if a discrepancy in the measurement mode and data update interval is found between the primary and secondary instruments or the integrated values have not been reset.
- During synchronous measurements, the above items synchronized with those of the primary instrument cannot be controlled or set using the secondary instruments.
- Note that if a synchronization error occurs while the integration is being performed or stopped, the secondary instruments stop the integration immediately, resetting the integrated values.
- Note that if a synchronization error occurs while a hold or peak-hold functions is activated, the secondary instruments deactivate the hold or peak-hold function.

8

Connecting External Devices

Optical link (Optical link interface)

Connecting two PW8001 instruments with the optional L6000 Optical Connection Cable allows the instruments to perform synchronous measurement.

The optical link does not use electrical signals but optical signals passing through optical fibers, allowing the PW8001 instruments with a different ground potential to synchronize.

During the optical link, internal calculations and data update timings of the secondary PW8001 instrument are synchronized with those of the primary PW8001 one.

In addition, the secondary instruments transfers some measured data to the primary one.

On the other hand, the primary PW8001 instrument transfers some setting data to the secondary one.

The optical link allows the primary instrument to do the following for the secondary one.
- Letting the secondary instrument display measured values (basic measurement items except calculation measurement items and flicker measurement items, up to 50th order of harmonics)
- Making the settings of **[INPUT]** > **[WIRING]**
- Making the settings of **[INPUT]** > **[CHANNEL]**
- Making the settings of **[INPUT]** > **[MOTOR]**
- Making the phase zero-adjustment settings of **[MEAS]** > **[VECTOR]** > **[VECTOR×1]**
- Displaying module-and-sensor configurations of **[SYSTEM]** > **[CONFIG]**

In addition, the following measurement items and trigger source of the secondary instrument can be selected in the same way as the primary one.
- Items displayed on the custom screen
- Items in the efficiency formulas
- Items to be computed in user-defined formulas
- Analog-output items
- CAN-output items
- Items to be saves in the USB flash drive
- Event trigger source of waveform storage

Connectible cables

- L6000 Optical Connection Cable (optional)
- Commercially available optic fiber cable
  With duplex LC (dual-core LC) connectors, 50/125 μm multimode fiber, up to 500 m in length

> **IMPORTANT**
> Connect two PW8001 instruments with each other. Connecting the PW8001 to other equipment may cause a malfunction.

Handling the L6000 Optical Connection Cable

⚠WARNING

■ **Do not look directly at the distal ends (ferrules) of the L6000 connected to the optic output of any equipment under operation conditions.**

■ **Do not observe the end faces with optical devices, such as a loupe.**

Doing so could affect your eyes, causing visual impairment.
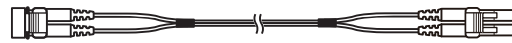
⚠CAUTION

■ **Do not connect or disconnect connectors while the instrument has been turned on.**

Doing so could damage the instrument or the sensors.

■ **To avoid damaging the L6000, observe the following:**

• Do not insert a connector in an oblique direction.

• Do not bend the cable in the proximity of the strain relief.

• Do not bend or twist the cable.

• Do not pull the cable excessively.

• Do not allow the cable to kink.
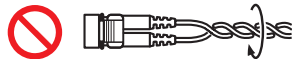
• Do not touch the end faces (ferrules).
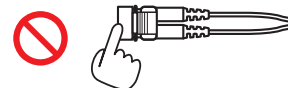
IMPORTANT

• When connecting the L6000 to the instrument, keep the mating parts free of dirt and dust. In particular, pay close attention to the end faces.
Connecting the cable with an end face dirty or scratched could cause a synchronization failure.
• Always keep the accompanying protective caps attached to both ends of the cable when the cable is not in use. The optical link connector of this instrument and the mating parts of the L6000 are processed with high precision.

8

Connecting External Devices

Connecting the instruments

You will need: PW8001 ×2, L6000 Optical Connection Cable ×1

Remove the protective caps.

OUT

IN

Remove the protective cap.
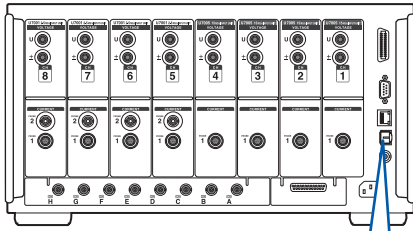
1 **Make sure that the two instruments have been turned off.**

2 **Connect the Optical Connection Cable to the optical link connector on the rear panel of the primary and secondary instrument.**

3 **Turn the primary instrument on, then the secondary one on (turn them off in the reverse order).**
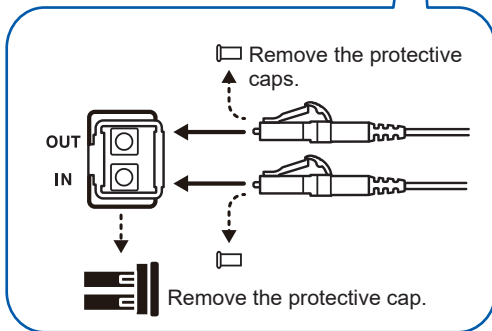
How to disconnect the L6000

Pull it out while pressing on the connector left face of the L6000 (do not pull the cable forcibly).

- During synchronous controlling, control data is transmitted through the L6000 Optical Connection Cable. Never disconnect the L6000 during synchronization because disconnection disrupts synchronization.
- If either the primary or secondary instrument has been turned off, a synchronization error occurs.
- Use the primary and secondary instruments with the same version firmware installed. A discrepancy in the firmware version causes a synchronization error.

Making the synchronous measurement settings

This section describes how to make the synchronous measurement settings for both the primary and secondary instruments. Connect the two PW8001 instruments using the L6000 Optical Connection Cable, and make the following settings while they have been turned on.

Display screen [SYSTEM] > [COM]
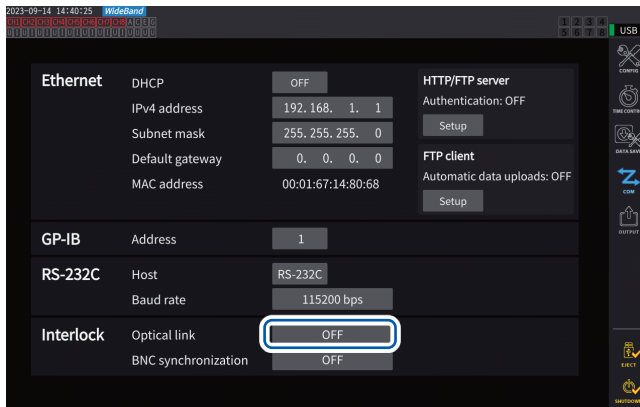
1 **Tap the [Optical Link] box under [Interlock] to set it [ON].**

You can check the sync status with the operation status indicator in the upper right of the screen.
See "Common screen display" (p. 25).

Link Primary (blue)	Set as the primary instrument in optical link mode.
Link Secondary (white)	Set as the secondary instrument in optical link mode.
Link Primary (red)	Synchronous error

IMPORTANT

- Select a data update interval of 50 ms or more. Even if the optical synchronization is enabled with the interval set to less than 50 ms, the interval is set to 50 ms instead.
- If you find a discrepancy in the data update interval between the primary and secondary instruments, set the interval of the secondary instrument the same as that of the primary one. See "Data update interval" (p. 63).

Secondary instrument   Primary instrument

Transferring measured values of basic measurement items and harmonic measurement items

8

Connecting External Devices

195
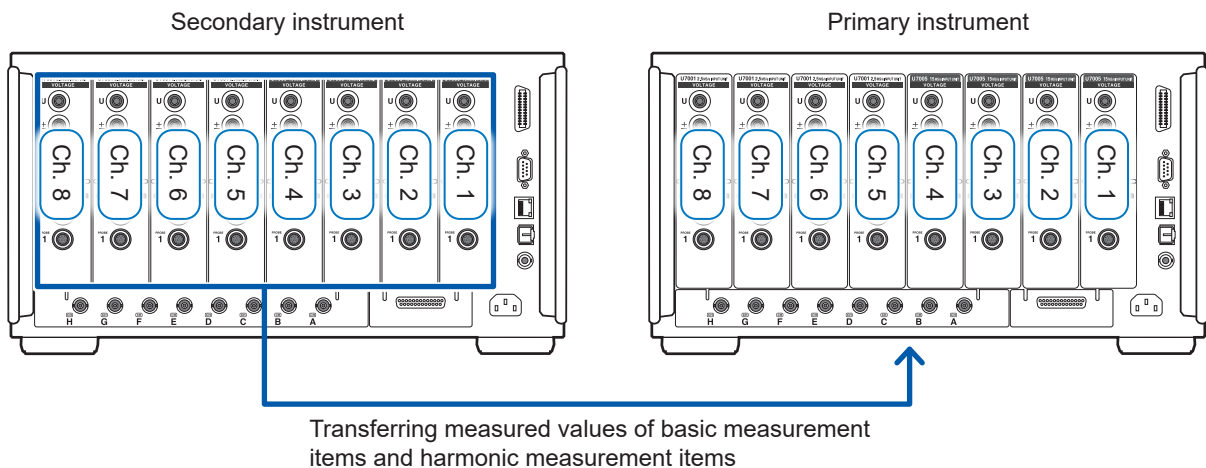
Display screen [MEAS] > [VALUE] > [CUSTOM]
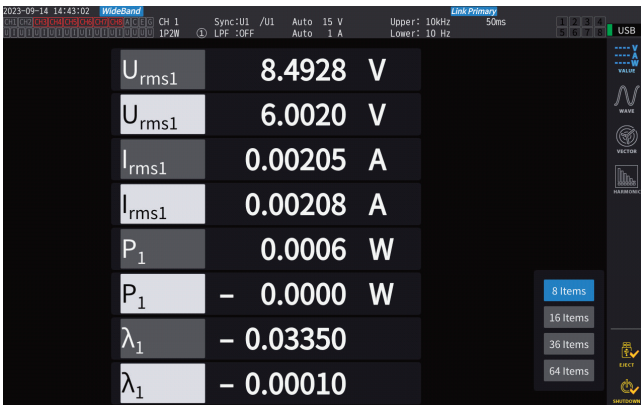
When you choose items measured with the secondary instrument as display items on the custom screen, they are highlighted in reverse video.

Display screen [INPUT] > [WIRING]
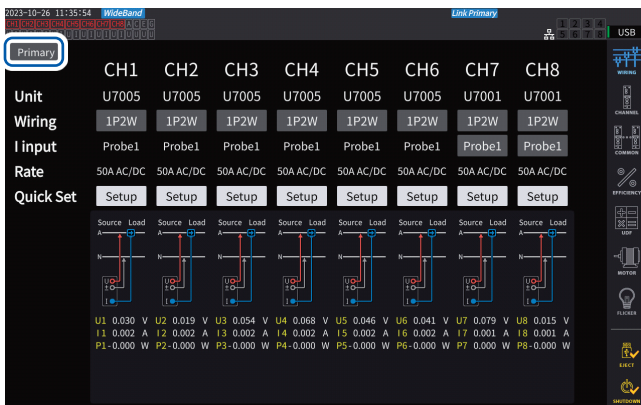
Tap the button at the top left of the screen to switch between **[Primary]** and **[Secondary]**.
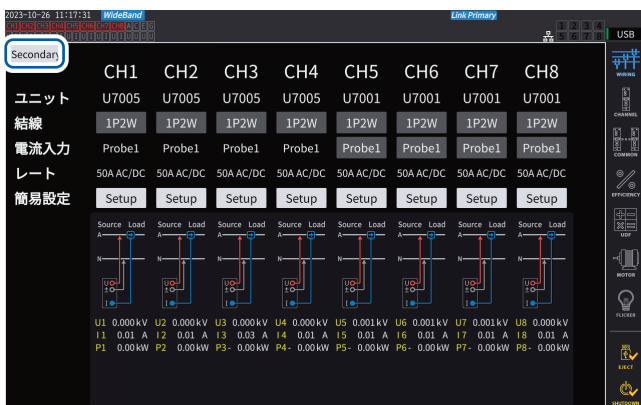
IMPORTANT

- The primary instrument cannot display waveforms acquired using the secondary instrument.
- During synchronous connection, the following operations are invalid on the secondary instrument. However, some settings, such as the language and communications, can be changed.
  (1) Starting and stopping integration and resetting integrated values (including CAN output)
  (2) Operating the following keys: **HOLD**, **PEAK HOLD**, **COPY**, and **SAVE**.
  (3) Changing the settings on calculation, storage, and output.

8.2 Waveform/Analog Output (Waveform and D/A Output Option)

This instrument's waveform and D/A output option includes analog output of freely-selected measured values as well as unmodified voltage and current waveforms.

The analog output can be used to record fluctuations over extended periods of time based on the data update interval.

The waveform output generates output of voltage and current waveforms sampled at a rate of 2.5 MS/s or 15 MS/s without modification at a rate of 1 MS/s, allowing the waveforms to be observed through another device, such as an oscilloscope.

Connecting external devices

This section describes how to connect an application-specific device (for example, an oscilloscope, data logger, or recorder) to the instrument's D/A output terminal using its D-sub connector.

To ensure safe operation, be sure to turn off the instrument and device before connecting them. Once the instrument and device have been connected, turn them back on.

Output circuit
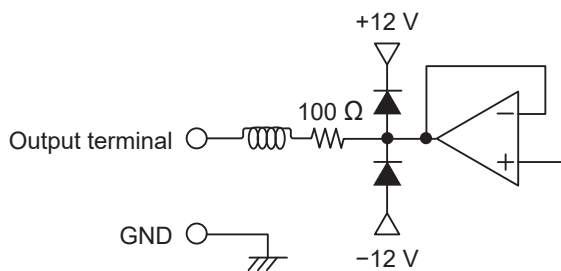
The output impedance of each output terminal is approximately 100 Ω.

When connecting a recorder, a DMM, or another device, use a model with high input impedance (1 MΩ or more). See "Specifications of waveform and D/A output (optional)" (p. 262).

Connector pin layout

The output on each pin can be set as desired.
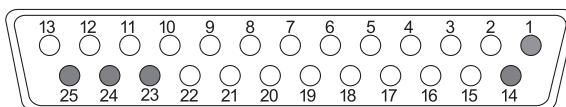
Pin no.	Output	Pin no.	Output
1	GND	14	GND
2	D/A1	15	D/A13
3	D/A2	16	D/A14
4	D/A3	17	D/A15
5	D/A4	18	D/A16
6	D/A5	19	D/A17
7	D/A6	20	D/A18
8	D/A7	21	D/A19
9	D/A8	22	D/A20
10	D/A9	23	GND
11	D/A10	24	GND
12	D/A11	25	GND
13	D/A12		

Connection method

Use the connector included with the instrument (DB-25PNR, DB19678-2R, Japan Aviation Electronics Industry) or equivalent part to make connections between the D/A output terminal and equipment according to the use. Be sure to use shielded cables.

1 **Solder wires to the solder-type connector securely.**

2 **Fit the connector covers to the solder-type connector and secure the covers with the included screws (M2.6×6).**
Secure the covers to prevent the connector from coming out.
Hold the covers when inserting and disconnecting the connector.

3 **Connect the cable's shielding to the connector cover or cable bracket if it is not grounded.**

D/A output terminal
(WAVEFORM & D/A OUTPUT)

Rear panel of the instrument

Cables

Cable bracket

Solder-type connector

Screw (M2.6×6)

Connector cover

Screw (M2.6×6)

Shielded cable
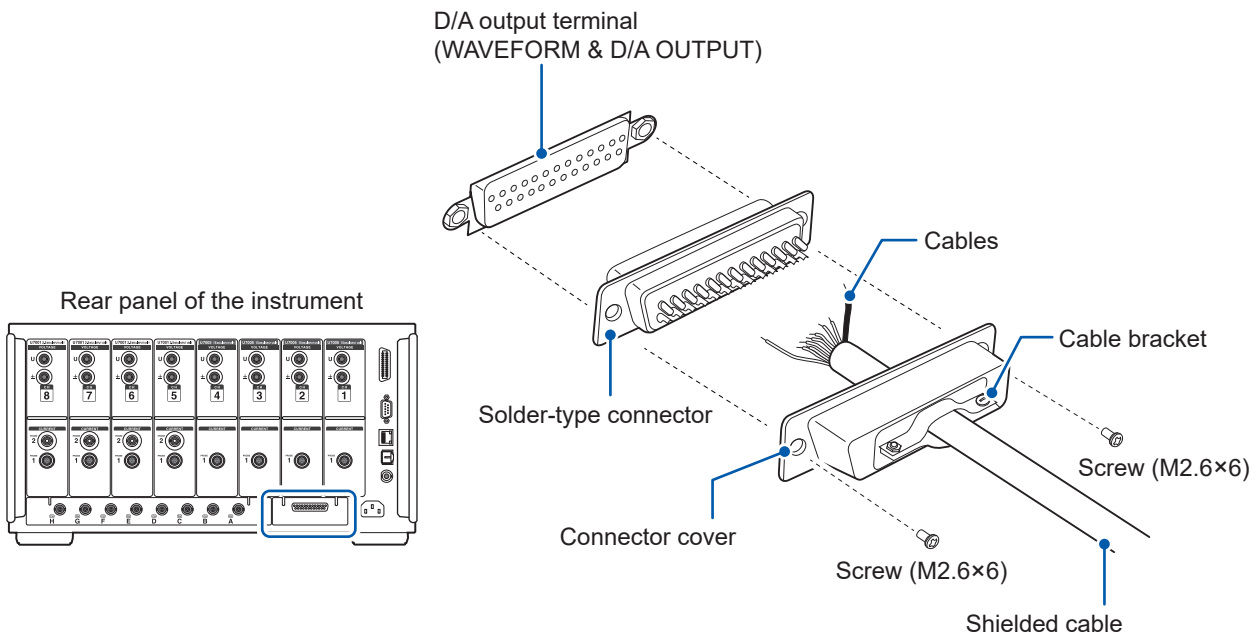
Selecting output parameters

Up to 20 output parameters can be selected for D/A output.

Display screen **[SYSTEM]** > **[OUTPUT]**
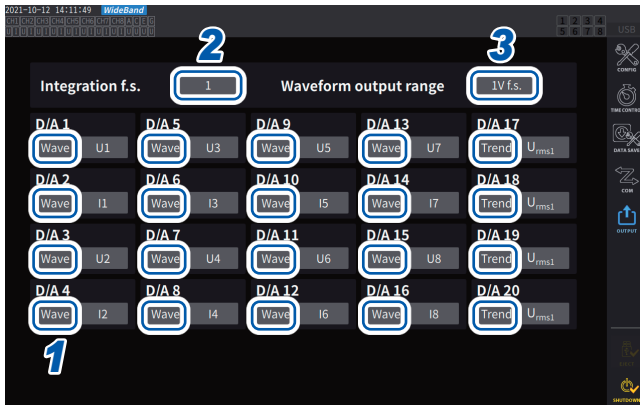
1 Choose between the two output types: **[Trend]** and **[Wave]** for each channel.

Trend	Analog output Select from among the on-screen measured items (except the flicker measurement items).
Wave	Waveform output Select waveforms to be outputted from the list.

(When outputting integrated values during analog output)

2 Tap the **[Integration f.s.]** box, then select the full scale value from the list.

1/10, 1/2, 1, 5, 10, 50, 100, 500, 1000, 5000, 10000

3 Tap the **[Waveform output range]** box, then set the output voltage value for full scale input during waveform output.

1 V f.s., **2 V f.s.**

See "Output terminal" (p. 197).

The instrument continuously outputs signals of selected items no matter what it displays, the Measurement, Input Settings, System Settings, and the File Operation screens.

8

Connecting External Devices

199

Analog output

- The instrument outputs measured values as level-converted DC voltage signals.
- Voltage input and current input (current sensor input) are isolated from each other.
- You can select an item from among the basic measurement items for each output channel; thus, 20 parameters in total can be outputted.
- By using the instrument in combination with a data logger or a recorder, you can record fluctuations over extended periods of time.

Specifications

Output voltage (Output range)	±5 V DC f.s. (valid output range: 1% f.s. to 110% f.s.) For the output rate of each parameter, see "Output rates" (p. 202).
Output resistance	100 Ω ± 5 Ω
Output update interval	Varies with the data update interval for the selected parameters.

- The instrument will generate an output of approximately 6 V during positive over-range events (for voltage peak and current peak, approximately 5.3 V). For negative over-range events, the instrument will generate an output of approximately −6 V (for voltage peak and current peak, approximately −5.3 V).
- The instrument may generate the maximum output of approximately ±12 V in the event of a malfunction.
- When a VT ratio or CT ratio is used, the instrument will output the value obtained by multiplying the range by the VT ratio or CT ratio within the range of ±5 V DC.
- While in the hold state or peak hold state, and during average operation, the instrument will output the appropriate operational value.
- When the hold function has been enabled and an interval time has been set, the instrument updates the output at set intervals once starting the integration.
- When the measurement range has been set to auto-ranging, the analog output rate will vary with range switching. In instances such as abruptly fluctuating measured values, exercise care to avoid making any mistakes in range conversion. In addition, it is recommended to fix the range manually during such measurement.
- Data cannot be output using the harmonic analysis function for parameters other than basic measurement items.
- The actual data update intervals have an error of ±1 ms from the data update interval setting.

(Tips) **To change the full-scale value for active power integration D/A output**

When using analog output, set the integration full-scale value.
For example, if the integrated value is small relative to the full-scale value, it will take a longer time for the integrated value to reach the full-scale value, causing the D/A output voltage to vary gradually.
Conversely, if the integrated value is large relative to the full-scale value, it will take a shorter time for the integrated value to reach the full-scale value, causing the D/A output voltage to vary abruptly.
By setting the integration full scale, you can change the active power integration D/A output full-scale value.

Waveform output

- The instrument will generate instantaneous waveforms for the input voltage and current.
- Voltage input and current input (current sensor input) are isolated from each other.
- The instrument can be used in combination with an oscilloscope or another device to observe input waveforms, such as equipment rush current.

Specifications

Output voltage (Output range)	Can choose between ±1 V and ±2 V Crest factor: 2.5 or greater
Output resistance	100 Ω ± 5 Ω
Output update rate	1 MHz (16-bit)

- It will take approximately 20 µs (i.e., the delay time) from receiving a signal inputted in a voltage/ current input terminal to output a signal from the D/A output connector.
- Waveforms are clipped at approximately ±7 V.
- The instrument will generate an output of 0 V at all times for channels that have not been installed. Channels for which D/A output has been enabled are shown in red.
- The instrument may generate the maximum output of approximately ±12 V in the event of a malfunction.
- When a VT ratio or CT ratio is used, the instrument will output the voltage obtained by multiplying the range by the VT ratio or CT ratio.
- Waveform output consists of continuous instantaneous value output, without regard to hold, peak hold, or average operation.
- When the measurement range has been set to auto-ranging, the analog output rate will vary with range switching. In instances such as abruptly fluctuating measured values, exercise care to avoid making any mistakes in range conversion. In addition, it is recommended to fix the range during such measurement.

8

Connecting External Devices

Output rates

Analog output is generated as a voltage of ±5 V DC for a value of the full scale.

At full scale, the voltage listed in the following table will be output.

✓: Has polarity

Selected output parameter	Notation	Output voltage polarity	Rated output voltage
Voltage RMS value	Urms		0 V to +5 V DC for a value of 0% to 100% of the range
RMS equivalent of average rectified voltage value	Umn		0 V to +5 V DC for a value of 0% to 100% of the range
Voltage AC component	Uac		0 V to +5 V DC for a value of 0% to 100% of the range
Voltage simple average	Udc	✓	±5 V DC for a value of ±100% of the range
Voltage fundamental wave component	Ufnd		0 V to +5 V DC for a value of 0% to 100% of the range
Voltage waveform peak (+)	Upk+	✓	±5 V DC for a value of ±300% of the range
Voltage waveform peak (−)	Upk−	✓	±5 V DC for a value of ±300% of the range
Total harmonic voltage distortion	Uthd		0 V to +5 V DC for a value of 0% to 500%
Voltage ripple factor	Urf		0 V to +5 V DC for a value of 0% to 500%
Voltage unbalance rate	Uunb		0 V to +5 V DC for a value of 0% to 100%
Current RMS value	Irms		0 V to +5 V DC for a value of 0% to 100% of the range
RMS equivalent of current average rectified value	Imn		0 V to +5 V DC for a value of 0% to 100% of the range
Current AC component	Iac		0 V to +5 V DC for a value of 0% to 100% of the range
Current simple average	Idc	✓	±5 V DC for a value of ±100% of the range
Current fundamental wave component	Ifnd		0 V to +5 V DC for a value of 0% to 100% of the range
Current waveform peak (+)	Ipk+	✓	±5 V DC for a value of ±300% of the range
Current waveform peak (−)	Ipk−	✓	±5 V DC for a value of ±300% of the range
Total harmonic current distortion	Ithd		0 V to +5 V DC for a value of 0% to 500%
Current ripple factor	Irf		0 V to +5 V DC for a value of 0% to 500%
Current unbalance rate	Iunb		0 V to +5 V DC for a value of 0% to 100%
Active power	P	✓	P1, P2, P3, P4, P5, P6, P7, P8: (Voltage range) × (Current range) P12, P23, P34, P45, P56, P67, P78: [(Voltage range) × (Current range)] × 2 P123, P234, P345, P456, P567, P678 (3V3A, 3P3W3M): [(Voltage range) × (Current range)] × 2 P123, P234, P345, P456, P567, P678 (3P4W): [(Voltage range) × (Current range)] × 3 Example: For 3P4W, P123, 300 V range, 10 A range 300 V × 10 A × 3 = 9 kW (Thus, the full scale is calculated.) ±5 V DC for a value of ±9 kW f.s.
Fundamental wave active power	Pfnd	✓	Same as active power (P)

Selected output parameter	Notation	Output voltage polarity	Rated output voltage

Apparent power	S		S1, S2, S3, S4, S5, S6, S7, S8:
			   (Voltage range) × (Current range)
			S12, S23, S34, S45, P56, S67, S78:
			   [(Voltage range) × (Current range)] × 2
			S123, S234, S345, S456, S567, S678 (3V3A, 3P3W3M):
			   [(Voltage range) × (Current range)] × 2
			S123, S234, S345, S456, S567, S678 (3P4W):
			   [(Voltage range) × (Current range)] × 3
			Example: For S34, 150 V range, 10 A range
			   150 V × 10 A × 2 = 3 kW
			   (Thus, the full scale is calculated.)
			   0 V to +5 V DC for a value of 0 to 3 kW f.s.

Fundamental wave apparent power	Sfnd		Same as apparent power (S)
Reactive power	Q	✓	Same as active power (P)
Fundamental wave reactive power	Qfnd	✓	Same as active power (P)
Power factor	λ	✓	±5 V DC for a power factor of ±1
Fundamental wave power factor	λfnd	✓	±5 V DC for a fundamental wave power factor of ±1
Voltage phase angle	θU	✓	±5 V DC for a voltage phase angle of ±180°
Current phase angle	θI	✓	Same as voltage phase angle (θU)
Power phase angle	φ	✓	Same as voltage phase angle (θU)
Voltage frequency, current frequency	fU, fI		+5 V DC for the upper frequency limit setting
Integrated positive current value	Ih+		Same as sum of positive and negative current values (Ih)
Integrated negative current value	Ih−	[2]	Same as sum of positive and negative current values (Ih)
Sum of positive and negative current values	Ih	✓	(Current range) × (Integration full scale) Example: If integrating for 1 h with the 10 A range The current integration full scale is determined to be 10 Ah.[1] ±5 V DC for a value of ±10 Ah
Integrated positive power value	WP+		Same as total positive- and negative- direction power integrated value (WP)
Integrated negative power value	WP-	[2]	Same as sum of positive and negative power values (WP)

Sum of integrated positive and negative power values	WP	✓	WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8:
			   (Voltage range) × (Current range) × (Integration full scale)
			WP12, WP23, WP34, WP45, WP56, WP67, WP78:
			   [(Voltage range) × (Current range) × (Integration full scale)] × 2
			WP123, WP234, WP345, WP456, WP567, WP678 of 3V3A, 3P3W3M:
			   [(Voltage range) × (Current range) × (Integration full scale)] × 2
			WP123, WP234, WP345, WP456, WP567, WP678 of 3P4W:
			   [(Voltage range) × (Current range) × (Integration full scale)] × 3
			Example: If integrating the power value for 1 hour with the 300 V range and the 10 A range for WP123, the integrated active power full scale is determined to be 9 kWh.
			±5 V DC for a value of ±9 kWh

*1: If the voltage for the integrated value would exceed ±5 V, analog output will switch to 0 V before continuing to vary again.
*2: Value always has a negative sign.

8

Connecting External Devices

Selected output parameter	Notation	Output voltage polarity	Rated output voltage
Efficiency	η		0 V to +5 V DC for a value of 0% to 200%
Loss value	Loss	✓	Pin = Pin1 + Pin2 + Pin3 + Pin4 + Pin5 + Pin6 Pout = Pout1 + Pout2 + Pout3 + Pout4 + Pout5 + Pout6 The larger of Pin and Pout is used as the P range. ±5 V DC for a value of ±100% of the P range Example: With the 3 kW P range, ±5 V DC for a value of ±100 % of 3 kW
Torque	Tq	✓	Analog DC input: (Voltage range) × (Scale value) = (Rated torque) ±5 V DC for a value of ±100% of the rated torque Frequency input: (Scale value) = (Rated torque) ±5 V DC for a value of ±100% of the rated torque

RPM	Spd	✓	Analog DC input:
			    (Voltage range) × (Scale value) = (Rated RPM)
			Pulse input:
			    [60 × (Upper frequency limit)] / (Pulse count setting)
			    = (Rated RPM)
			±5 V DC for a value of ±100% of the rated RPM

Motor power	Pm	✓	±5 V DC for a value of ±100% of the Pm range[2]
Slip	Slip	✓	± 5 V DC for a value of ±100%
Free input during independent input mode operation	CH*	✓[1]	Analog DC input: ±5 V DC for a value of ±100% of the voltage range Pulse input: ±5 V DC for a value of ±100% of the upper frequency limit
User-defined calculation	UDF	✓	±5 V DC for a value of ±100% of the maximum value set for each user-defined calculation

*1: Analog DC input has polarity, but pulse frequency input does not.
*2: The PM range is calculated by substituting the rated torque and rated RPM respectively for the torque and RPM of the motor power equation.

Examples of D/A output
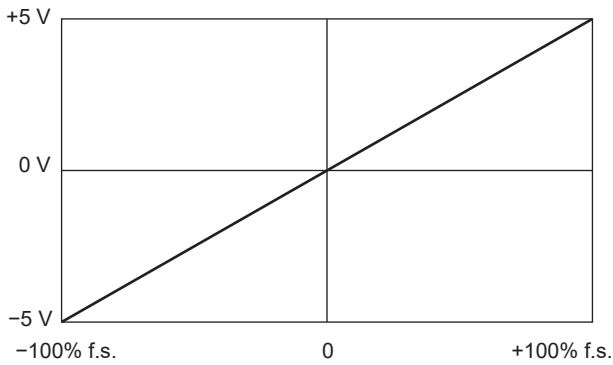
Voltage/current (dc), active power, reactive power
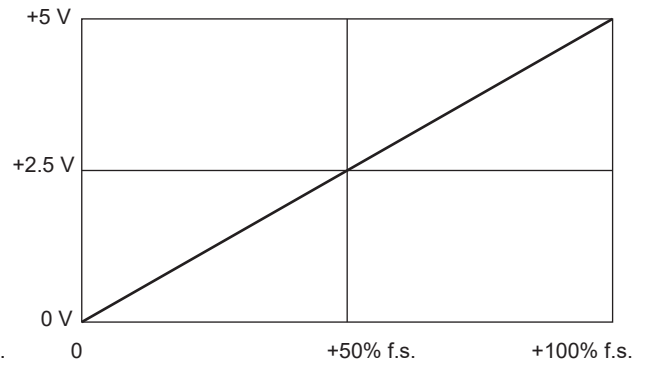
Voltage/current (rms, mn, ac, fnd, unb), apparent power
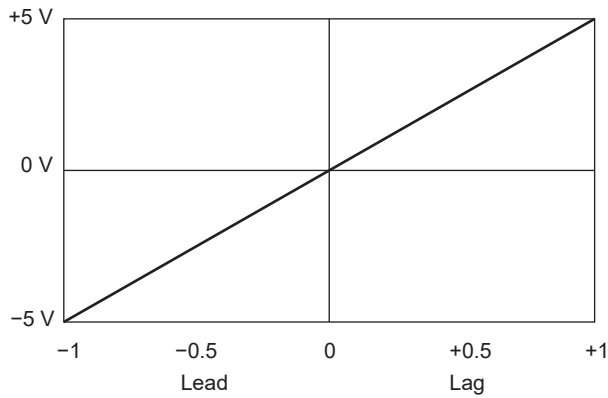
Power factor
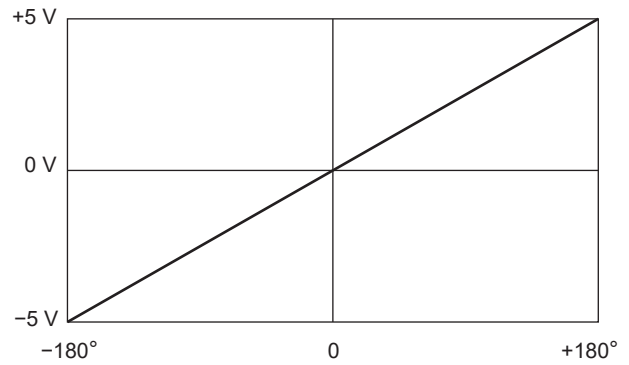
Voltage, current, power phase angle
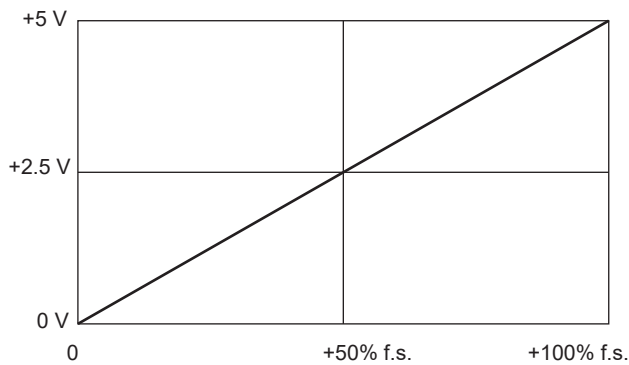
Frequency

The upper frequency limit setting is used as 100% f.s.

8

Connecting External Devices

Integrated current, integrated power
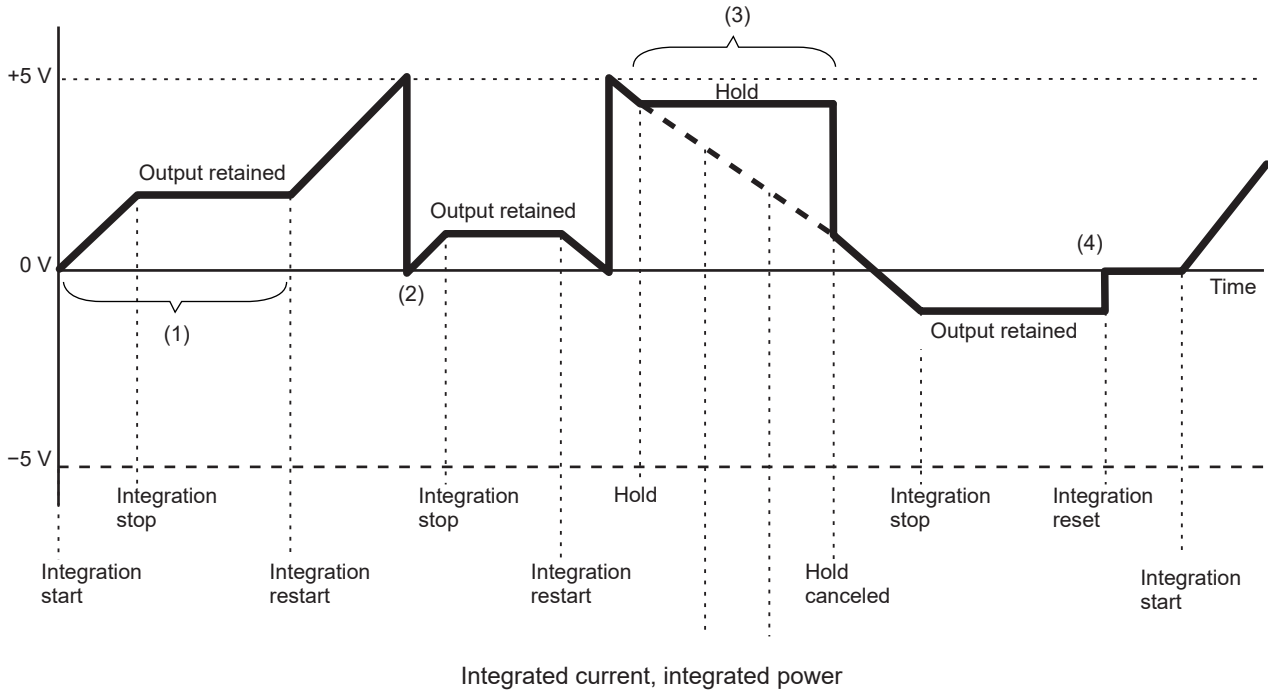
(1)   Analog output varies with the start of integration. Analog output is retained when integration stops.

(2)   If the voltage for the integrated value exceeds ±5 V, analog output will switch to 0 V before continuing to vary again.

(3)   Analog output is retained when the display is frozen during integration. When the hold operation is canceled, analog output will vary based on the original integrated value.

(4)   When the integrated value is reset, analog output will switch to 0 V.

8.3 Controlling Integration with External Signals

Integration can be started and stopped, and integration data can be reset with 2-level (0 to 5 V) logic signals or by shorting/opening contact signals of the instrument's external control interface.

⚠DANGER

🚫 ■ **Do not input a voltage in excess of the maximum input voltage to the external input terminal.**

Doing so may damage the instrument, resulting in serious bodily injury.

Cable connections

Required equipment: External device to control this instrument, and the 9444 Connection Cable

1 **Connect one end of the 9444 Connection Cable to the instrument's 9-pin D-sub connector, and tighten the screws to secure the connector in place.**

2 **Connect the other end of the 9444 Connection Cable to the external device being connected to this instrument.**

Either use the 9-pin D-sub female connector on the cable or cut off the male connector on the 9444 Connection Cable and hard-wire it to the device, using the internal cable colors for reference.

9-pin D-sub plug (male)
Locking screws: #4-40
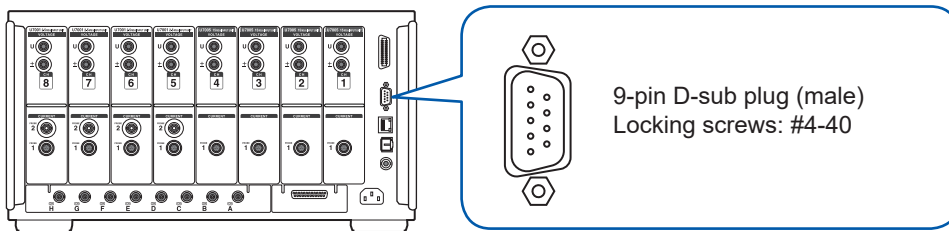
Device for controlling this instrument

Prepare a device and the cable so that the functions are assigned to the pins listed below. Leave unused pins open.

Pin no.	Cable color	Functions
1	Brown	Start/stop integration When this pin's level changes from high (5 V or open) to low (0 V or shorted), integration will start. When it changes from low to high, integration will stop.
2	Red	Unused
3	Orange	Unused
4	Yellow	Hold When this pin's level changes from high (5 V or open) to low (0 V or shorted), the display will be held. When it changes from low to high, the hold will be canceled.
5	Green	GND
6	Blue	Resetting integrated values When this pin's level has been low for at least 200 ms, integrated values will be reset. This function is valid only while integration is stopped.
7	Purple	Unused
8	Gray	Unused
9	White	Unused

8

Connecting External Devices

Setting the connected device
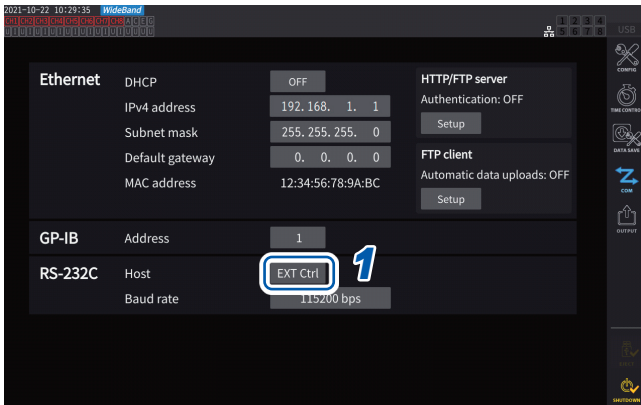
1 Tap the [Host] box of RS-232C, and select [EXT Ctrl] from the list.

EXT Ctrl	Functions as an external control interface. You can control the instrument connected with an external device using logic signals or short/open contact signals.
RS-232C	Functions as an RS232C interface. You can control the instrument connected with an external device using communications commands. See "9.8 Connecting and Setting the RS-232C" (p. 241).

Internal circuit diagram of each external control terminal
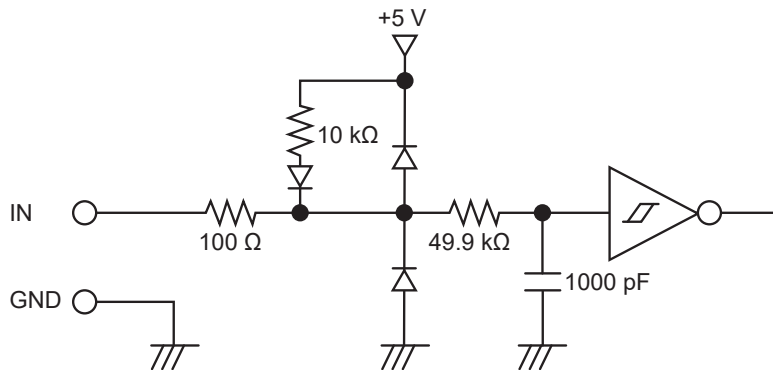
Control signal timing

External control interface signals are detected during the intervals shown on the timing chart below.
Updating on-screen information may delay depending on the frequency being measured and the synchronization state between the instrument and external device.

Starting and stopping integration

Using this signal can start/stop integration.
This operation is the same as that performed by the **START/STOP** key on the instrument's panel.

(When auto-save function is enabled, 1 s or more)
450 ms or more
450 ms or more

5 V (open)

0 V (shorted)

Integration start   Integration stop   Addition start
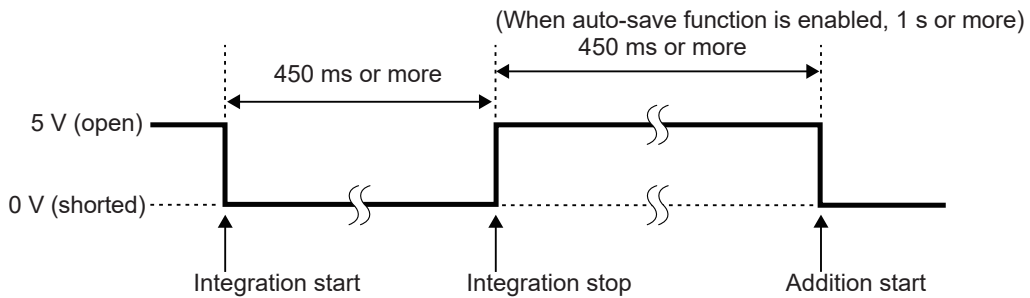
Resetting integrated values

Using this signal can reset integrated values to zero.
This operation is the same as that performed by the **DATA RESET** key on the instrument's panel.

200 ms or more

5 V (open)

0 V (shorted)

Integrated values are
reset during this interval.
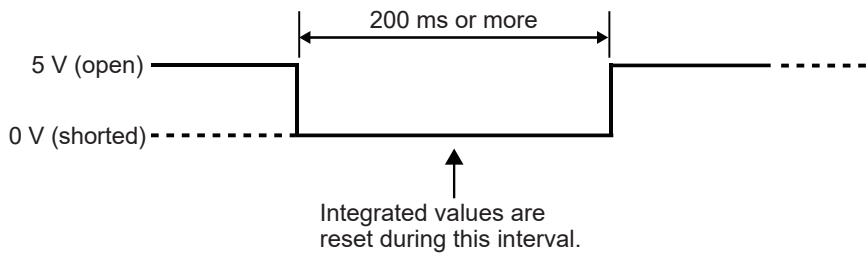
This signal is ignored while integration is being performed.
Input this signal at least 450 ms (or at least 1 s when the auto-save operation is enabled) after integration stops.

Hold

This operation is the same as that performed by the **HOLD** key on the instrument's panel.

200 ms or more

5 V (open)

0 V (shorted)

Display hold
start

Display hold
cancel
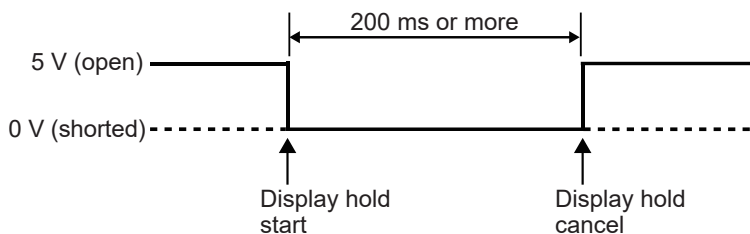
To avoid instrument damage, do not input a signal at a voltage of 5.5 V or more.
Use chatter-free control signals.

8

Connecting External Devices

8.4 CAN Output Function

Overview of the CAN output function

What is a *CAN*?

A CAN, which stands for controller area network, is a serial communication protocol established as a standard by the International Organization for Standardization (ISO).

Using this communication protocol, the instrument's CAN output function can output measured data on a CAN bus in real time so that it can be recorded together with data from electronic control units (ECUs). Consolidating data on a CAN logger enables data to be centralized without degrading accuracy, resulting in a comprehensive evaluation.

CAN data output procedure

1 **Preparing for measurement**

"2 Preparing for Measurement" (p. 33)

2 **Setting the CAN output**

"Setting CAN output" (p. 210)

Setting the destination device

Creating a DBC file

"Creating a DBC file" (p. 214)

Loading the DBC file in the destination device

3 **Wiring a CAN bus**

4 **Outputting CAN signals**

"Outputting CAN signals" (p. 216)
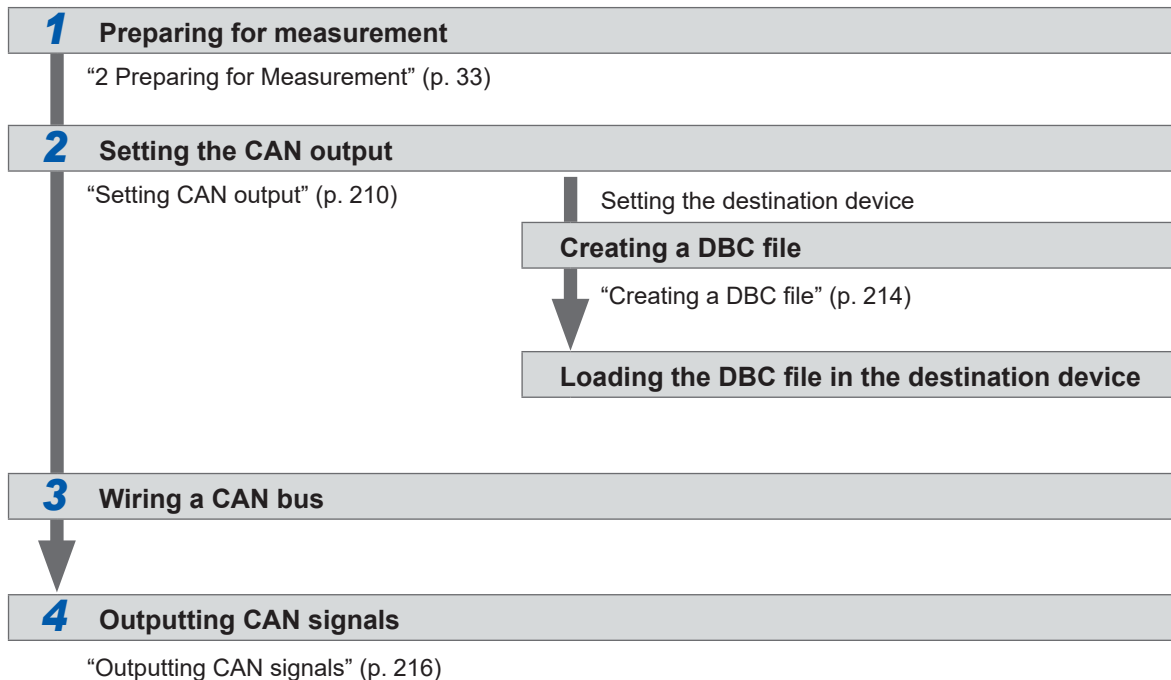
Setting CAN output

Setting CAN communications

To enable the instrument to communicate correctly with a device to which CAN signals are sent, set the CAN protocol setting, the communication speed, and the terminator resistor.

Display screen [SYSTEM] > [OUTPUT]
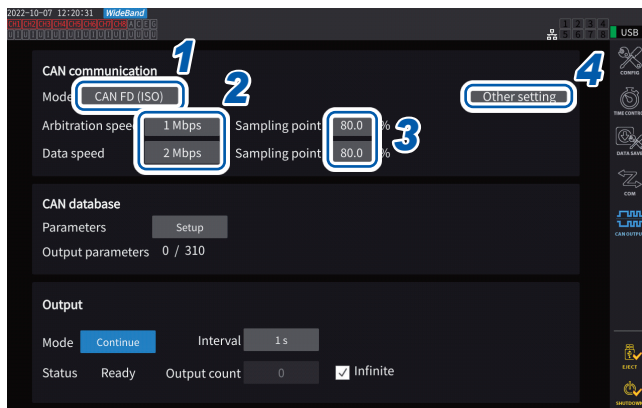
The [CAN OUTPUT] icon is displayed only when the CAN/CAN FD option is installed.

1 **Tap the [Mode] box and select the integration mode from the list.**

CAN	CAN mode
CAN FD (ISO)	CAN FD mode (in conformity with ISO 11898-1:2015)
CAN FD (nonISO)	CAN FD mode (not in conformity with ISO)

When the CAN protocol is changed, the settings of the CAN output parameters, described below, are initialized.

2 **When CAN mode is selected**

Tap the [Communication speed] box and select the communication speed from the list.

125 kbps, 250 kbps, 500 kbps, 1 Mbps

When CAN FD mode is selected

Tap the [Arbitration speed] box and select the communication speed.

500 kbps, 1 Mbps

Tap the [Data speed] box and select the communication speed.

500 kbps, 1 Mbps, 2 Mbps, 4 Mbps

3 **Tap the [Sampling point] box and set the sampling point using the numeric keypad.**

0.0% to 99.9%

4 **Tap [Other settings].**

The [Other settings] window will be displayed.
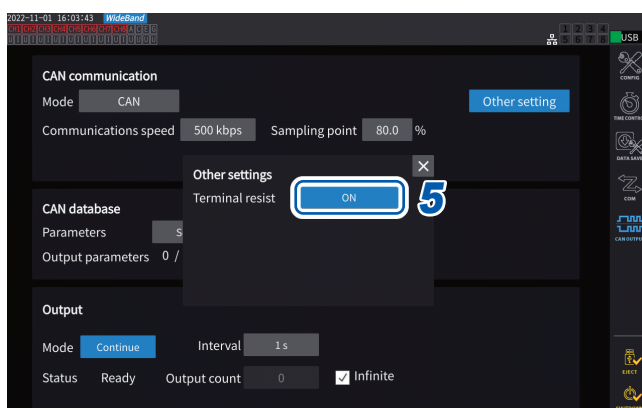
5 **Tap the [Terminal resist] box to set it to ON or OFF.**

ON	Uses a terminator resistor.
OFF	Do not use a terminator resistor.

8

Connecting External Devices

211

Setting the CAN database

Set CAN signals output from the instrument.

Display screen   **[SYSTEM] > [OUTPUT]**
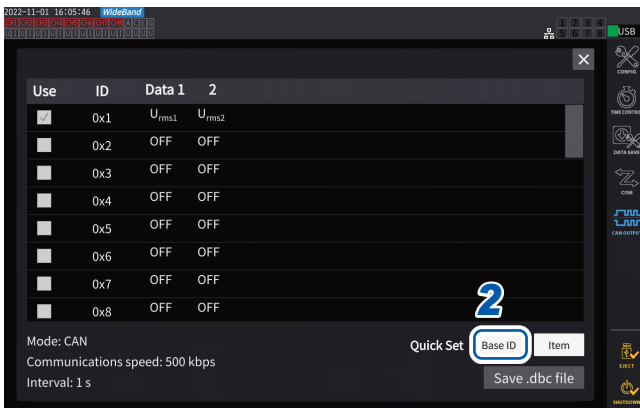
1 Tap **[Setup]** in the **[Parameters]** box

The setting window will be displayed.

2 Tap **[Base ID]** in the **[Quick Set]** box

You can collectively set the IDs of CAN signals.
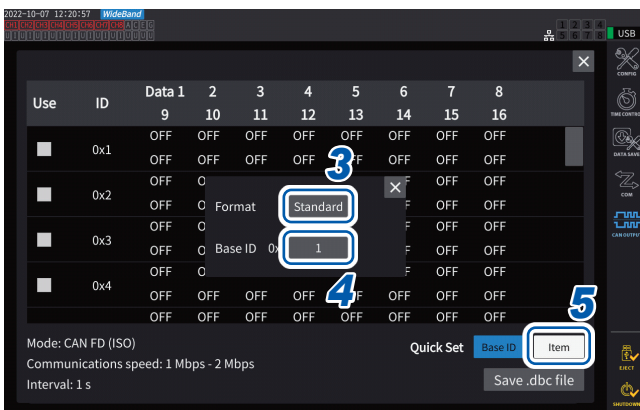
3 Tap the **[Format]** box and select a format from the list.

Standard	Use a standard format.
Extension	Use an extended format.

4 Tap the **[Base ID]** box and set a reference ID using the numeric keypad.

When **[Standard]** is selected

0 to **7FF** (enter in hexadecimal)

When **[Extension]** is selected

0 to **1FFFFFFF** (enter in hexadecimal)

The output CAN signals' IDs are added by one based on the set ID.
Set the IDs of the CAN signals flowing on the CAN buses used for communications so that they are unique.

5 Tap **[Item]**.

The setting window will be displayed.

6 Select the measured data to output.

7 Tap **[Apply and save .dbc file]**.
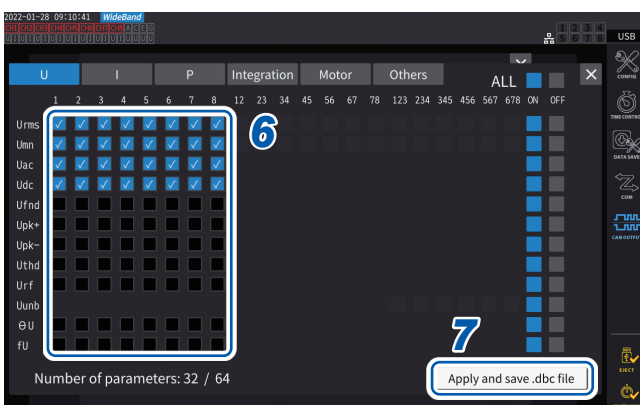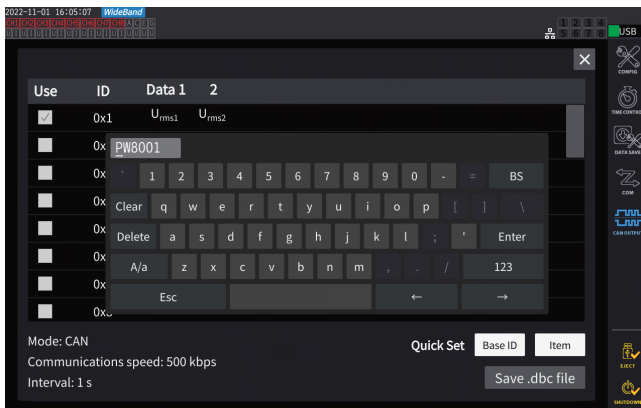
8 **Set a filename using a keyboard.**

Insert a USB flash drive in advance.

Selectable measurement data types

Basic measurement parameter	Data measured with the instrument (except the flicker measurement items)
Time (Select on the Other tab)	The time elapsed after CAN output has been started is divided into hours, minutes, seconds, and milliseconds before being output.
Count (Select on the Other tab)	Outputs the number of times the signals were output after CAN output started.

Number of selectable measurement data sets

The number of selectable measurement data sets is determined by the settings of the CAN protocol, communication speed, and output interval. If you want to change the number of selectable sets, change the settings of the CAN protocol, communication speed, and output interval.

CAN protocol	Communication speed	Number of selectable data sets		
		1 ms interval setting	10 ms interval setting	50 ms interval setting
CAN	125 kbps	0	4	20
	250 kbps	0	8	40
	500 kbps	2	16	64 (maximum number)
	1 Mbps	4	32	64 (maximum number)
CAN FD	□ − 500 kbps	0	32	160
	□ − 1 Mbps	0	64	320
	□ − 2 Mbps	0	128	512 (all selectable parameters)
	□ − 4 Mbps	16	256	512 (all selectable parameters)

- The number with a 100 ms interval becomes twice as many as that with a 50 ms interval, and that with a 200 ms interval becomes four times as many as that with a 50 ms interval.
- The number of CAN FD data sets that can be output depends only on the communication speed in the data area. It does not change with the communication speed in the arbitration field.
- The □ characters in the table indicate any numerical values.

8

Connecting External Devices

Creating a DBC file

After setting the CAN output parameters, you can move to the DBC file creation screen. You can also move to the DBC file creation window by tapping **[Save .dbc file]**.

Display screen **[SYSTEM]** > **[OUTPUT]**
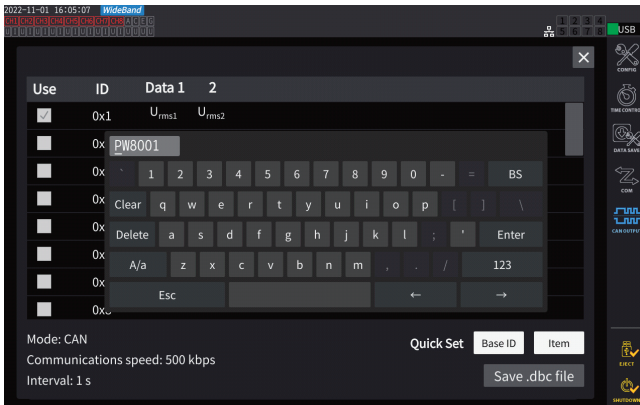
1 **Insert the USB flash drive into the instrument.**

2 **Tap [Save .dbc file].**

3 **Set a file name using a keyboard.**
Insert a USB flash drive in advance.

Saving destination location	USB flash drive
Filename	Enter as desired (up to 8 characters), with *DBC* extension Example: PW8001.DBC
Remark	Files are saved in the folder specified as the save destination in the manual-save settings. See "Manually saving measured data" (p. 163).

> **Tips** **What is a DBC file?**
> A DBC file contains the definitions of the CAN database needed to decode output CAN signals by the destination device.
> Use this file as the CAN definitions for the device to which the CAN signals are sent.

DBC files are created based on the present of the CAN database settings. Thus, always set the CAN database before creating a DBC file; if you change the CAN database, recreate a DBC file each time.

Setting CAN output

Set a method to output CAN signals from the instrument.

Display screen **[SYSTEM]** > **[CAN OUTPUT]**
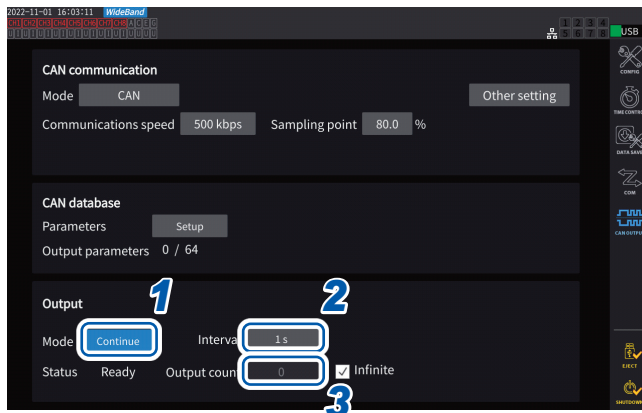
1 **Tap the [Mode] box and select the output mode from the list.**

Continue	Outputs signals continuously according to the setting of the interval and the number of outputs.
OFF	Does not output any CAN signals.

The CAN interface has been activated while the output mode is set to one other than OFF. An error may occur if the instrument is connected to the CAN bus with an inappropriate CAN communication setting.

2 **Tap the [Interval] box and select a CAN-signal-outputting interval from the list.**

(For the data update interval of 1 ms)
1 ms, **10 ms**, **50 ms**, **100 ms**, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
(For the data update interval of 10 ms)
10 ms, **50 ms**, **100 ms**, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
(For the data update interval of 50 ms)
50 ms, **100 ms**, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
(For the data update interval of 200 ms)
200 ms, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**
(For IEC measurement mode)
100 ms, **200 ms**, **500 ms**, **1 s**, **5 s**, **10 s**, **15 s**, **30 s**, **1 min**, **5 min**, **10 min**, **15 min**, **30 min**, **60 min**

The actual data update intervals have an error of ±1 ms from the data update interval setting. See its time-stamp information if you need to acquire data at the set update intervals.

3 **Tap the [Output count] box and select the number of times the CAN signals are output using the numeric keypad.**

When the **[Infinite]** check box is selected, the CAN signals are output infinitely many times.

If the **[Infinite]** check box is cleared, the number of times the CAN signals are output can be set as desired.

0 to **10000** (**0**: infinite)

8

Connecting External Devices

Outputting CAN signals

Complete the following procedure before outputting the CAN signals from the instrument.

1 **Load the created DBC file to the device to which the CAN signals are sent.**
"Creating a DBC file" (p. 214)

2 **Connect the instrument to the CAN-signal destination device using a CAN bus.**

Start

Press the **START/STOP** key to output CAN signals.

- Integration starts in conjunction with CAN-signal output.
- The setting cannot be changed until the integration is reset.

Stop

CAN output is stopped by either of the following measures:
- Press the **START/STOP** key again.
- CAN signals have been output the set number of times.

Integration stops in conjunction with CAN-signal output stop.

Over value and error value in the output data

Measurement data output from the instrument is replaced with an over value or an error value in the following circumstances.

Over value **+99999.9E+30**	Indicates the maximum displayable value corresponding to the presently set range has been exceeded.
Error value **+77777.7E+30**	Indicates calculation was impossible because it was attempted immediately after the setting changed.

Checking the output status

The output status can be checked with the **[Status]** field.

None	The CAN interface is stopped.
SetupError	CAN interface startup failed.
Ready	The CAN interface is booting. Press the **START/STOP** key to start to output the CAN signals.
OK	The CAN signals are outputting normally.
Warning	A CAN output error occurred most recently.
Send error	The CAN output has an anomaly.
Bus OFF	The instrument has been disconnected from the CAN bus due to a CAN error.

(Tips) **If the CAN output status does not become OK**

Check the following points:
• The instrument is properly connected to the CAN bus.
• The device to which the CAN signals are sent is properly connected.
• The terminator resistor is positioned properly.
• The CAN communications have been set properly.
• The CAN protocol, communications speed, and sampling point settings are the same as those of the device to which the instrument connects.

If the output CAN signal data shows an abnormal value

Check the following points:
• The instrument's CAN database settings have not been changed after creating the DBC file.
• If another device sent a CAN signal, its ID number is unique.

8.5 VT1005 AC/DC High Voltage Divider

The VT1005 is an AC/DC voltage divider that converts an input voltage of up to 5 kV (no measurement category) into a one-thousandth for output with high accuracy.

The device has good flatness in frequency characteristics and stable temperature characteristics. It can be used not only for voltage measurement but also for high-precision power measurement by combining it with a wattmeter.

Display screen [INPUT] > [CHANNEL]
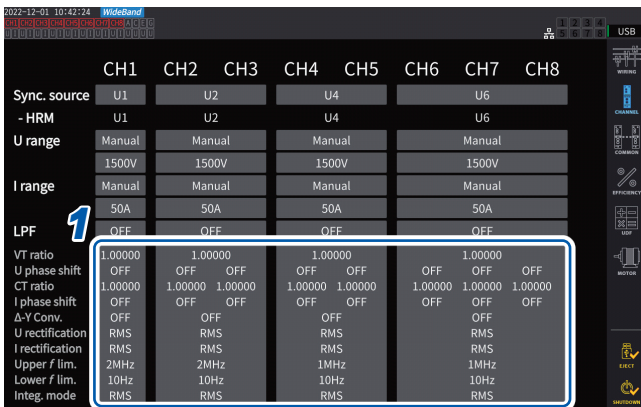
1 Tap the channel detail display area for the channel you wish to configure to open the settings window.
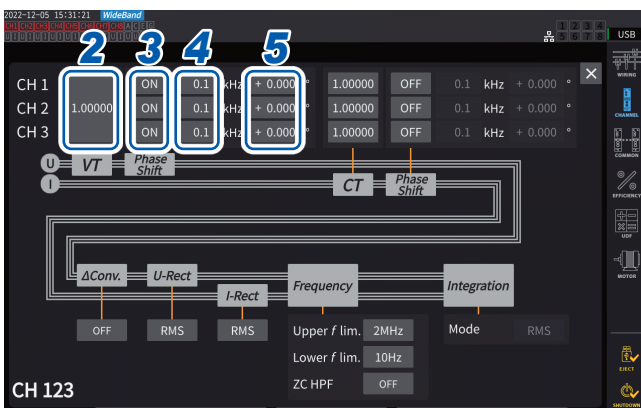
2 Tap the [VT] box and enter [1000.00] using the numeric keypad.

You can directly read values input from the VT1005 by setting the VT1005's dividing ratio to the Power Analyzer.

3 Set the voltage phase compensation to [ON].

4 Set the frequency to [100.0] kHz.

5 Enter a phase compensation value appropriate for the length of the L9217 Connection Cord used with the VT1005.

Model name (length)	Compensation value of phase difference between input and output (°)
L9217 (1.6 m)	−4.01
L9217-01 (3.0 m)	−4.26
L9217-02 (10 m)	−5.52

By setting the phase compensation value in the Power Analyzer, the instrument can perform phase compensation for the Divider and reduce errors in power measurement in the high-frequency region. The setting varies with the Power Analyzer in use.

IMPORTANT

Enter the phase compensation value accurately. Mistaken settings can cause the compensation process to increase measurement error.

9 Connecting with Computers

The instrument comes with LAN, GP-IB, and RS-232C interfaces. When connected to a computer, the instrument can be controlled using communications commands and measured data can be transferred to the computer.

> **IMPORTANT**
> Use one of the above interfaces. Simultaneous use of multiple interfaces may cause the instrument to malfunction, such as communication interruption.

Interface function list

Interface	Functions	Reference
LAN	Remotely operates the instrument (setting, screen monitoring) from a general web browser, such as Microsoft Edge®, using the HTTP server function.	p. 224
	Downloads data saved on a USB flash drive to a computer using the FTP server function.	p. 226
	Automatically sends waveform data saved the USB flash drive connected to the instrument to a computer on the network or the FTP server of a remote computer using the FTP client function.	p. 230
	Controls the instrument using communications commands. (You can control the instrument TCP/IP-connected with a computer through the communications command port by sending communications commands from a program you created.)	p. 238
	Remotely operates the instrument and transfers measured data to a computer using GENNECT One (PC application software).	p. 245
	Uses the Modbus/TCP communication function to acquire the control and measured data of the tester in real-time.	p. 247
GP-IB	Controls the instrument by sending communications commands.	p. 238
RS-232C	Controls the instrument by sending communications commands.	p. 238
	Starts/stops integration, and resets data using external signals.	p. 207

Please download GENNECT One (with the instruction manual) and the communications command instruction manual from the Hioki website.
See "9.9 GENNECT One (PC Application Software)" (p. 245).

9.1 Connecting and Setting the LAN Interface

The instrument ships standard with a LAN interface. Use a LAN cable to connect the instrument and a computer.
See "Interface function list" (p. 219).

Connecting a LAN cable

Connect a LAN cable to the RJ-45 (Gigabit Ethernet) connector of the instrument.

⚠CAUTION

■ **Do not unplug data cables while the instrument is sending or receiving data.**

Doing so could damage the instrument and the computer.

■ **If routing a LAN cable outdoors or over more than 30 m, attach a LAN surge protector or other suitable protective device.**

Failure to do so could cause damage to the instrument due to increased susceptibility to the effects of induced lightning.

■ **Use the same ground for the instrument and the computer.**

Connecting data cables while there is a potential difference between the instrument and computer's ground levels could damage the instrument and computer or cause them to malfunction.

■ **Turn off the instrument and computer before connecting or disconnecting cables.**

Failure to do so could damage the instrument and the computer being connected or cause them to malfunction.

■ **Seat connectors securely.**

Failure to do so could damage the instrument or cause nonconformity to the specifications.

IMPORTANT

When using the LAN interface, do not use the R-232C or GP-IB interface. Simultaneous use of multiple interfaces may cause the instrument to malfunction, such as communication interruption.

LAN connection
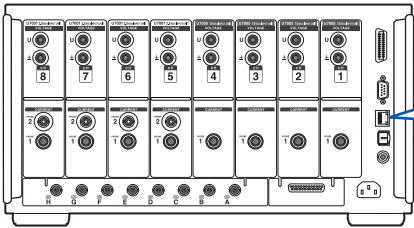
1000BASE-T

RJ-45 connector

ACT LED (orange)
Flashing: Sending/receiving data

LINK LED (green)
On: Connection established
Off: Connection not established

Example connection: Connecting one instrument and one computer (connecting the instrument to a computer)

RJ-45 connector

Cross-conversion connector
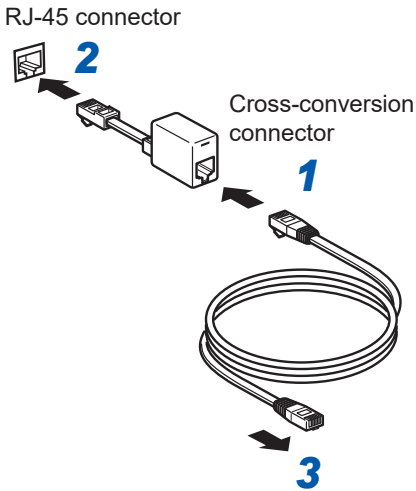
1 **Connect the cross-conversion connector to the LAN cable.**

2 **Connect the cross-conversion connector to the instrument's LAN interface.**

3 **Connect the LAN cable to the computer's 100Base-TX connector.**

> (Tips) **When a cross-conversion connector is not available**
> The instrument can be connected to a computer using a hub.

Connecting with Computers

9

221

Configuring LAN settings and building a network environment

LAN settings (for the instrument)

You must configure the LAN settings before connecting the instrument to a network. If you change the LAN settings while the instrument is connected to a network, the instrument may have the same IP address as another device on the LAN, causing incorrect address information to be sent to the LAN.

Display screen [SYSTEM] > [COM]
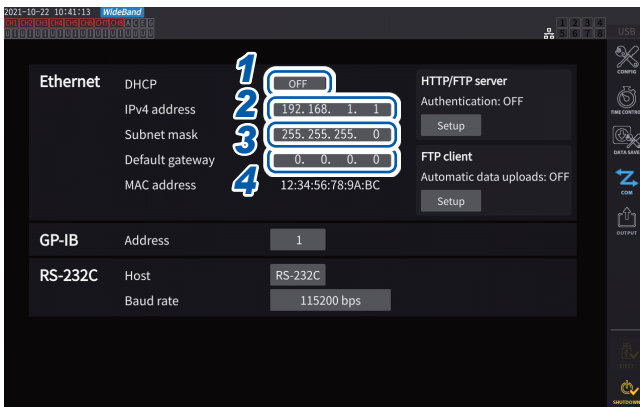
1 **Tap the [DHCP] box to set it to [ON] or [OFF].**

The Dynamic Host Configuration Protocol (DHCP) is a method by which devices can automatically acquire and configure themselves with an IP address and other information. When this DHCP function is enabled and there is a DHCP server operating on the same network, the instrument can automatically acquire the settings of IP address, subnet mask, and default gateway.

(Follow the steps below only when [DHCP] is set to [OFF].)

2 **Tap the [IPv4 address] box, then enter the IPv4 address using the numeric keypad.**

The IP address is used to identify individual devices connected to the network. Use a unique address no other device on the network is using.
The instrument uses IP version 4, and IP addresses are expressed as a series of four decimal numbers separated by periods, such as *192.168.1.1*. If the DHCP setting is enabled, the IP address setting will be configured automatically by DHCP.

3 **Tap the [Subnet mask] box, then enter the subnet mask using the numeric keypad.**

The subnet mask is used to separate the IP address into the portion that indicates the network and the other portion that indicates the device.
The subnet mask typically consists of a series of four decimal numbers separated by periods, such as *255.255.255.0*.
If you enter an invalid value, the subnet mask is not changed.
If the DHCP setting is enabled, the default gateway will be configured automatically by DHCP.

4 **Tap the [Default gateway] box and enter the default gateway using the numeric keypad.**

The default gateway specifies the IP address of the device that serves as the gateway when the computer with which you are communicating is on a different network than the instrument.
When not using a gateway (for example, when using a one-to-one connection), set the instrument's gateway to *0.0.0.0*.
If the DHCP setting is enabled, the default gateway will be configured automatically by DHCP.

Example network environment architectures

Example 1: Connecting the instrument to an existing network

When connecting the instrument to an existing network, you must first have the network system administrator (department) allocate the following settings. Ensure that the instrument uses a unique address not being used by any other device on the network.

IP address	_____ . _____ . _____ . _____
Subnet mask	_____ . _____ . _____ . _____
Default gateway	_____ . _____ . _____ . _____

When connecting a measuring instrument to an existing network (provide one of the following)

- 1000Base-T-compatible straight cable (commercially available cable, up to 100 m in length)
  (For 100Base or 10Base networking, you can also use a 100Base-TX or a 10Base-T cable.)
- 9642 LAN Cable with cross-conversion connector (optional)

Example 2: Adding a LAN port to a computer connected to an existing network and connecting the instrument to the new port

Configure the IP address, subnet mask, and default gateway of the new LAN port after verifying the proper settings with your network system administrator.

Example 3: Connecting one computer and multiple instruments using a hub

When creating a local network not connected externally, it is recommended to use private IP addresses such as those shown in the example.
When creating a network with a network address of 192.168.1.0/24

IP address	Computer: 192.168.1.1 Instrument: 192.168.1.2, 192.168.1.3, 192.168.1.4, etc. (progressing in order)
Subnet mask	255.255.255.0
Default gateway	0.0.0.0

Example 4: Connecting a computer and the instrument one-to-one with the 9642 LAN Cable

When connecting a computer and the instrument one-to-one with the conversion connector included with the 9642 LAN Cable, you may set the IP address as desired. However, it is recommended to use a private IP address.

IP address	Computer: 192.168.1.1 Instrument: 192.168.1.2 (Use a different value.)
Subnet mask	255.255.255.0
Default gateway	0.0.0.0

When connecting the measuring instrument and a computer one-to-one, you will need one of the following:

- 1000Base-T-compatible cross cable (up to 100 m)
- 1000Base-T-compatible straight cable and cross-conversion connector (up to 100 m)
- 9642 LAN Cable with cross-conversion connector (optional)

Connecting with Computers

9

9.2 Remotely Operating the Instrument through the HTTP Server

The instrument comes with the HTTP server function. This function enables the instrument to be controlled remotely using a general web browser, such as Microsoft Edge®. The web browser will display the instrument's screen and control panel. The control panel also allows you to check the channel indicators' on/off status.

The remote operation can be performed in the same manner as with the actual instrument. However, the control panel does not allow the keys to be held down or pressed simultaneously. When you set the clock of the instrument while connecting the HTTP server, the communication may be lost.

Connecting to the HTTP server

1 Open a web browser, such as Microsoft Edge®.

2 Enter the instrument's address in the address bar (e.g., http://192.168.1.1).

3 (When [HTTP/FTP server settings] is set to [ON])
Enter the username and password to log in.

Display of the main page indicates that you have successfully connected to the instrument.
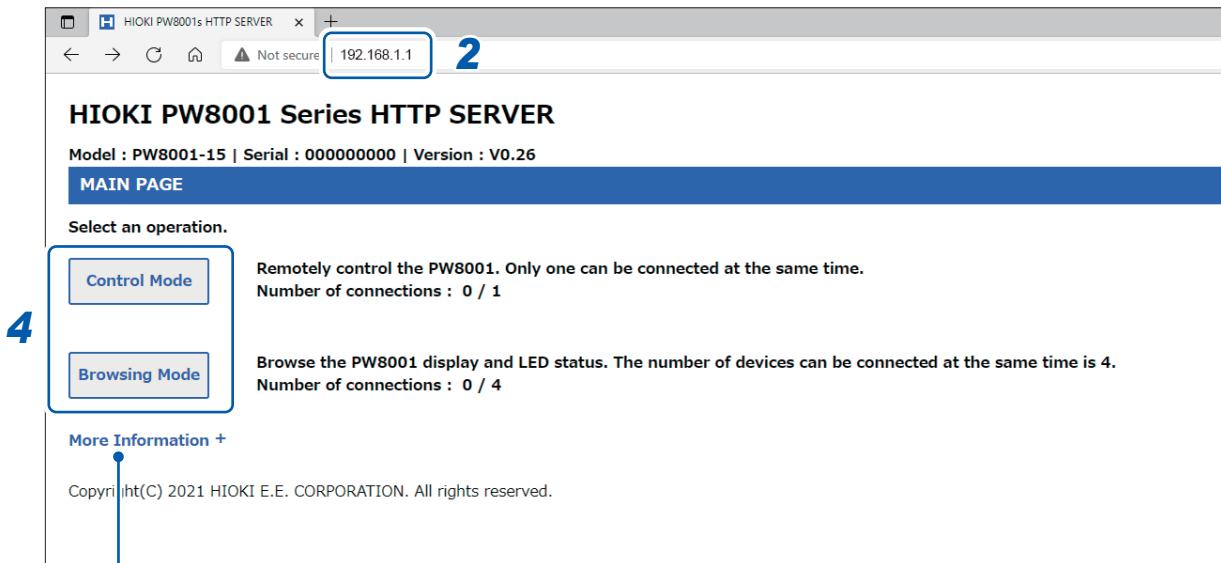
Clicking [More Information] on the main page allows you to check the detailed information including the serial numbers of the instrument, modules, and current sensors as well as the calibration date and adjustment date.

4 **Choose between [Control Mode] and [Browsing Mode].**

Up to five computers can connect to a single PW8001.

Control Mode	Allows you to check the instrument screen, control panel, and channel indicators' on/off status in a web browser. Clicking the screen in the web browser enables you to operate the instrument in the same manner as with the touchscreen and control panel. Rotating the wheel button while pointing to the X or Y knob can operate the X or Y knob, respectively. Display update interval: 200 ms, 1 s, 5 s, 10 s, 30 s
Browsing Mode	Allows you to check the instrument screen, control panel, and channel indicator's on/off status in a web browser. Tapping and operating keys are not available. Up to four computers can connect to a single PW8001. Display update interval: 200 ms, 1 s, 5 s, 10 s, 30 s
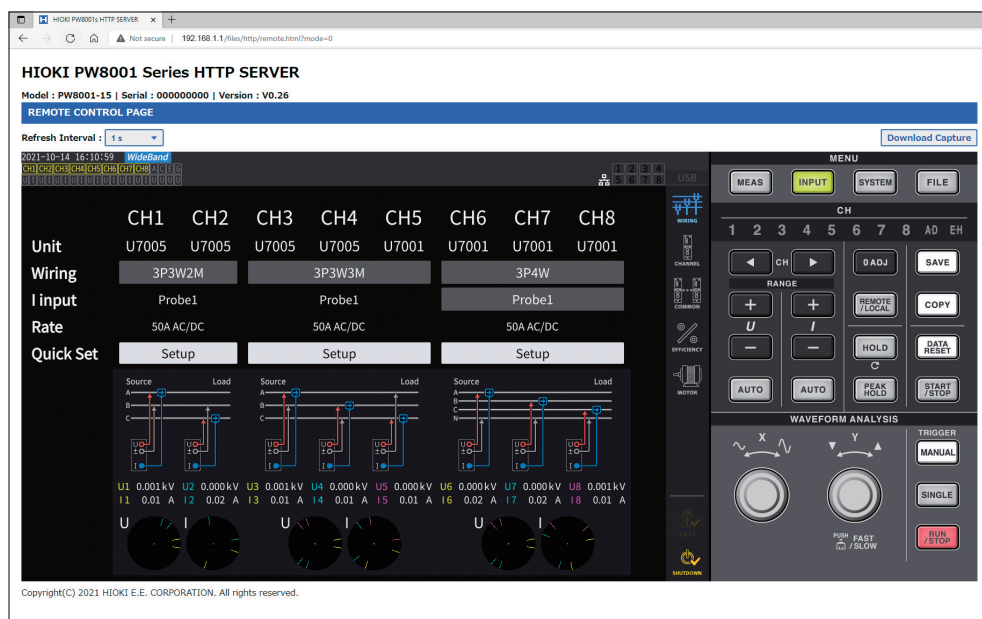
(Tips) **If the main page is not displayed**

- Check the instrument's LAN settings and the computer's IP address.
  See "Configuring LAN settings and building a network environment" (p. 222).

- Make sure that the LAN interface's LINK UP LED is lit up and that the LAN mark (🖧) is shown on the instrument's screen.
  See "Connecting a LAN cable" (p. 220).

- Some web browsers may not perform proper operation. Try to use other web browsers.

To save screenshots

Pressing the [Download Capture] button in the upper right allows you to save the currently displayed screen.

9.3 Acquiring Data through the FTP Server

With the FTP server function, files stored on the USB flash drive can be acquired on a computer.
- The instrument has a built-in FTP (file transfer protocol, RFC959-compliant) server.
- Various free software programs are available for use as an FTP client.
- File update dates and times may not be displayed correctly depending on the FTP client.
- The instrument's FTP server supports only one connection. It is not possible to access it simultaneously from multiple computers.
- The FTP connection may be disconnected if one minute or more has elapsed without a command being sent after the connection is established. In this case, connect to the FTP server again.
- Disconnect the FTP connection before inserting and ejecting a USB flash drive.
- Do not perform file operation on the instrument while there is an active FTP connection.

You must configure the instrument and connect it to a computer using a LAN cable in order to use the FTP server function.
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

> **IMPORTANT**
>
> Some computer's FTP clients and web browsers delete all files and folders being moved if the move operation is canceled, regardless of whether the files and folders had been transferred or not. Exercise caution when using the move command. It is recommend to copy (download) the files and folders, and then delete them.

Be aware of the following items before using the FTP server function:

Relationship of storage media and directories	All storage media is shown as directories in the FTP session. /usb .... USB flash drive
Constraint	Files cannot be accessed while measurement is in progress.

Accessing the instrument's FTP server

This example explains how to access the FTP server using File Explorer in Windows 10.
Launch File Explorer on the computer and enter the instrument's address into the address bar.

When **[HTTP/FTP server Authentication]** is set to **[ON]**, enter the username and password to log in.
Set the username and password to prevent third parties from deleting files by accident.
See "FTP server connection restriction (FTP authentication)" (p. 229).
[ftp://Username:Password@Instrument's IP address]

For the username *HIOKI* and the password *PW8001*
Enter *ftp://HIOKI:PW8001@192.168.0.2*.

If the instrument's address is *192.168.0.2*

The USB flash drive connected to the instrument
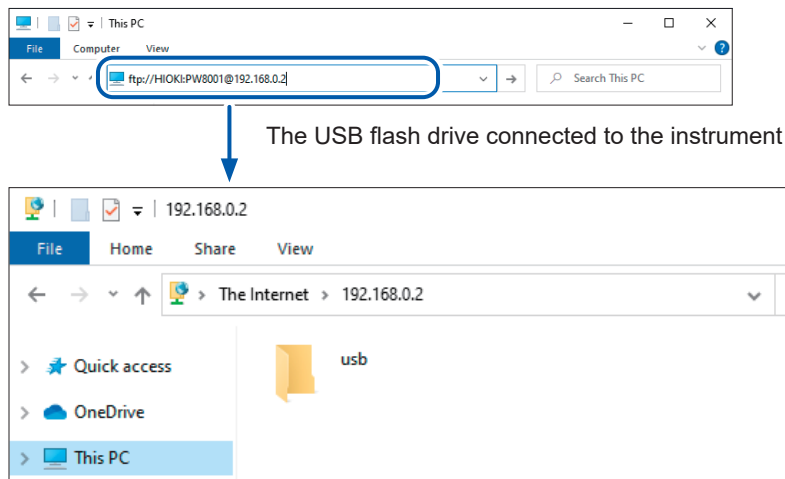
If connection is disabled

Check the instrument's communications settings.
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

Performing file operation in the FTP server

Downloading files

Select the file you wish to download from the list of folders and drag and drop* the file to the download destination (the desktop or a folder outside the explorer (File Explorer) using the mouse.

*: Click on the file and then move the mouse while holding down the mouse button.

Drag and drop

On the computer screen
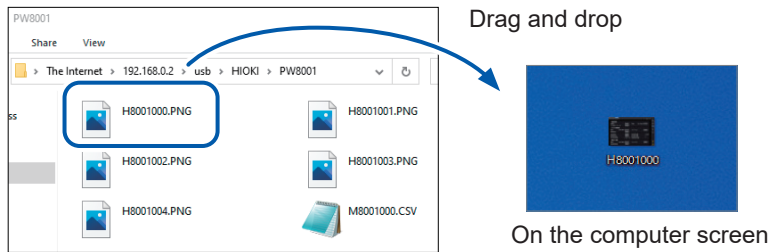
The seconds or hours, minutes, and seconds of the file's timestamp (date and time) may not reflect the real time.

Deleting files

Right-click the mouse on a file in the FTP folder list and select **Delete** from the context menu.

1 Right-click

2 Click
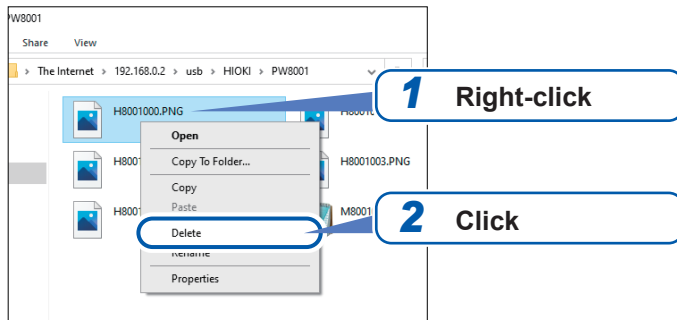
FTP server connection restriction (FTP authentication)

Access to the HTTP/FTP server can be restricted.

Normally the FTP server of the instrument is controlled by anonymous authentication and can be accessed from all the devices in the network.

Enable **[HTTP/FTP server settings]** and set the username and password to restrict connection to the FTP server.

It is recommended to set the username and password and restrict access to prevent third parties from deleting files by accident.

Display screen **[SYSTEM]** > **[COM]**
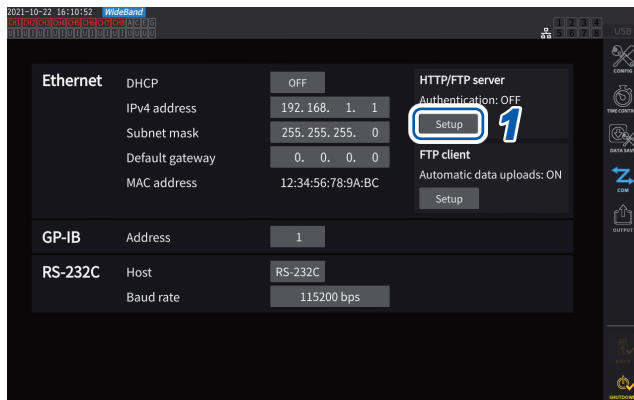
1 Tap the **[Set up]** under **[HTTP/FTP server]** to open the setting window.

2 Tap the **[Authentication]** box to set it to **[ON]**.

3 Tap the **[Username]** box, then set the username using the numeric keypad window.

Up to 12 one-byte characters

4 Tap the **[Password]** box, then set the password using the numeric keypad window.

Up to 12 one-byte characters

5 Tap **[Apply]** to confirm.

Connecting with Computers

9

229
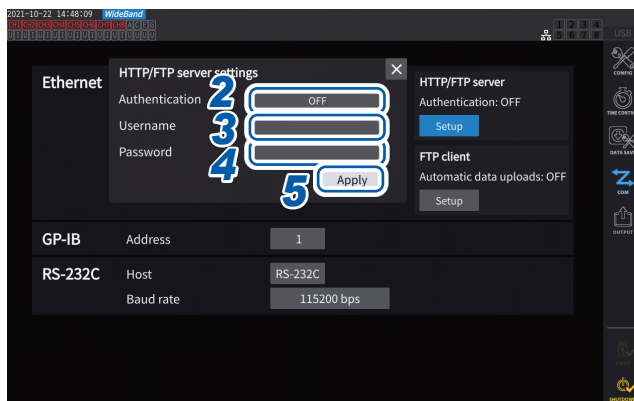
9.4 Sending Data Using the FTP Client Function

Any files saved on a USB flash drive connected to the instrument can be sent to the FTP server of the computer.
Specify the IP address of the computer with the FTP server on the instrument.
Register the username and password of the instrument in the FTP server of the computer as well.
FTP servers, such as Windows® FTP server can be used.

> **(Tips)** **When sending data with low available space on the USB flash drive**
> Select **[SYSTEM]** and then **[COM]**, and set **[Delete files after upload]** to **[ON]**.
> The files of the instrument are deleted after they are sent to the FTP server.

Data can be sent automatically or manually.
See "Uploading files manually" (p. 234).

Setting automatic file upload

Any files saved in the USB flash drive connected to the instrument can be sent to the FTP server of the computer automatically.
The following shows an example of sending data to FTP server 192.168.1.1.
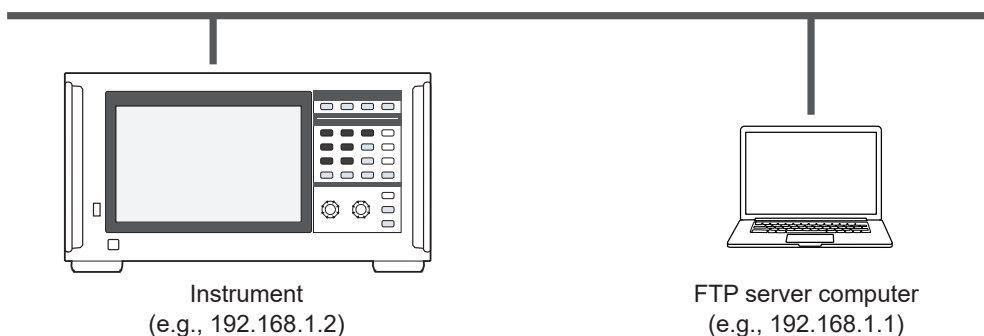
Instrument
(e.g., 192.168.1.2)

FTP server computer
(e.g., 192.168.1.1)

Operating procedure

1 **Configure the LAN settings using the instrument and connect the instrument to the LAN.**
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

2 **Set the FTP server on the receiving side (computer).**

3 **Perform FTP auto-sending using the instrument.**

4 **Configure the auto-save settings using the instrument.**
See "Setting automatic file upload" (p. 230).

5 **Start measurement using the instrument.**
When the instrument has finished automatically saving a file, it will be automatically sent to the FTP server on a computer.

6 **Check communications status between the instrument and the computer.**
See "Checking FTP communication status" (p. 233).

Display screen **[SYSTEM]** > **[COM]**
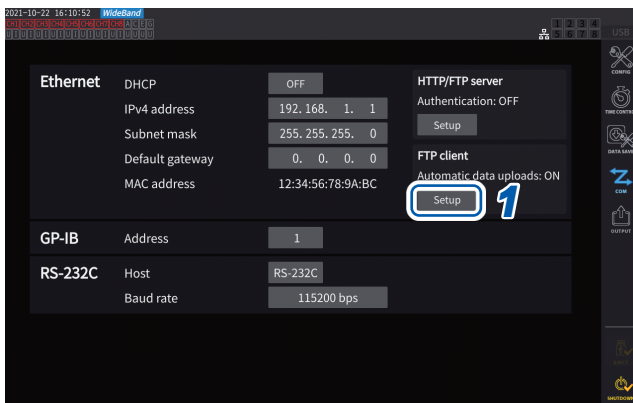
1 Tap the **[Setup]** box under **[FTP client]** to open the setting window.

2 Set each item under **[FTP client settings]**.

3 When the FTP setting is completed, tap **[Test Upload]**.
See "File upload test" (p. 232).

4 Tap **[×]** to close the setting window.
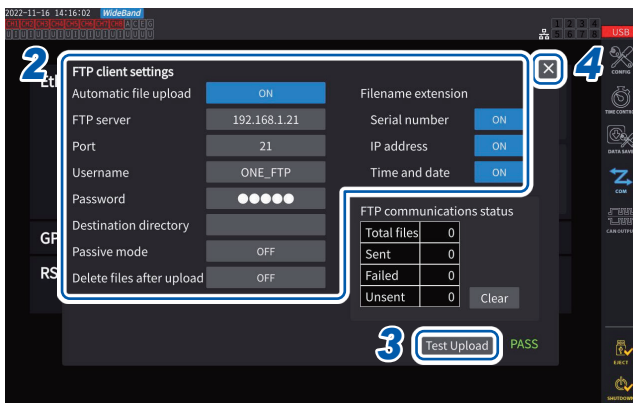
Configuring FTP client

Parameter	Setting	Description
Automatic file upload	**ON** or **OFF**	
FTP server	Up to 45 one-byte character strings Example 1: FTPSERVER Example 2: 192.168.1.1	Sets the host name or IP address of the FTP server.
Port	**1** to **65535**	Sets the port number of the FTP server.
Username	Up to 32 one-byte character strings Example: HIOKI	Sets the username for logging on to the FTP server.
Password	Up to 32 one-byte character strings Example: PW8001	Sets the password for logging on to the FTP server. The password is displayed as [●●●●●].
Destination directory	Up to 45 one-byte character strings Example: data	Specifies the director on the FTP server for saving data.
Passive mode	**ON** or **OFF**	Allows you to select whether or not to use the PASV mode during communication.
Delete files after upload	**ON** or **OFF**	Deletes the original file after it is successfully uploaded.

Filename extension
  Serial number
  IP address
  Time and date
	ON or **OFF**	Adds a selected identification name

File name example

When the [Serial number], [IP address], and [Time and date] check boxes are set to [ON], the file is named [123456789_192-168-1-2_210110-123005_01100000.CSV].
Files can be identified when multiple wattmeters are used.

Serial number	123456789	Date and time	21-01-10 12:30:05
IP address	192.168.1.2	Auto-save file name	01100000.CSV

File upload test

Check whether files can be sent using the FTP client.

Display screen [SYSTEM] > [COM]
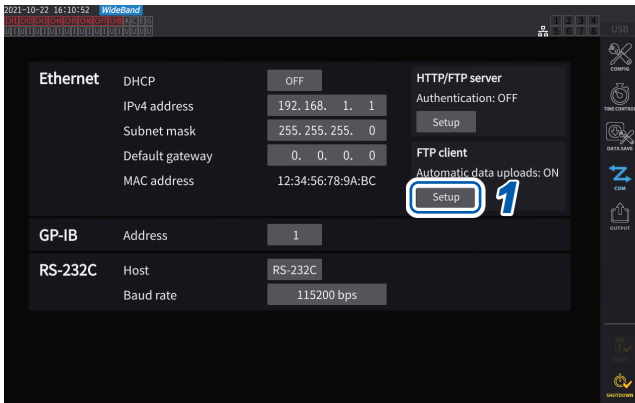
1 Tap the [Setup] box under [FTP client] to open the setting window.

The identification name selected under [Filename extension] is added to the test file name.

2 Tap [Test Upload].

Test file [FTP_TEST.TXT] is sent to the folder specified in [Destination directory].
When [PASS] is displayed, the file has been successfully sent. When [FAIL] is displayed, the file upload has failed.
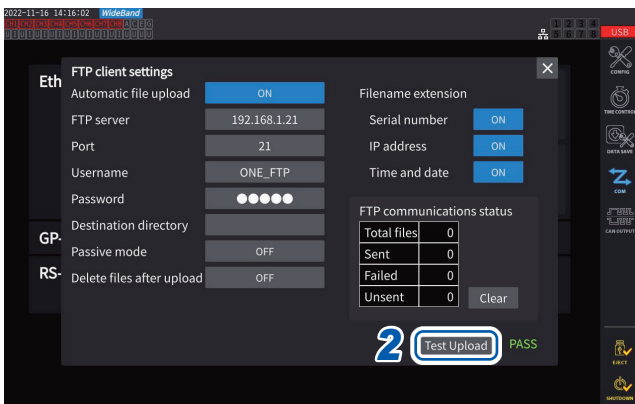
When the test file cannot be sent, check the automatic file upload settings of the instrument and the FTP settings of the computer.

3 Start measurement when the result of the test upload is [PASS].

The instrument automatically uploads the data of the measured waveforms to the FTP server.

Files to be uploaded automatically

The following files are automatically uploaded after being created.
• Auto-save file
• Settings file
• Waveform file
• Screenshot

Data send time

(Transfer time [s]) = (File size [KB]) / (Transfer speed [KB/s]) + (Transfer preparation time [s])

For details about the file size, see "Recordable time and data" (p. 167).

For reference, assume that the transfer speed is 4 MB/s and the transfer preparation time is 3 s.

Example: When the file size is 40 MB

(Transfer time) = 40 (MB) / 4 (MB/s) + 3 (s)

$\qquad$ = 10 + 3 (s) = 13 (s)

Checking FTP communication status

The FTP communication status can be checked.

The numbers of files, such as those the FTP client successfully sent and failed to send, are displayed.

Display screen [SYSTEM] > [COM]
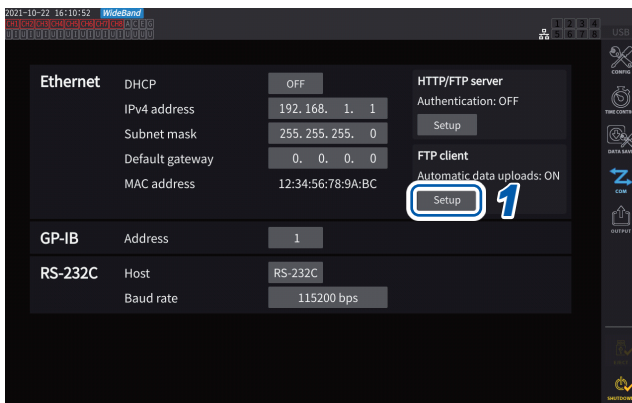
1 **Tap the [Setup] box under [FTP client] to open the setting window.**
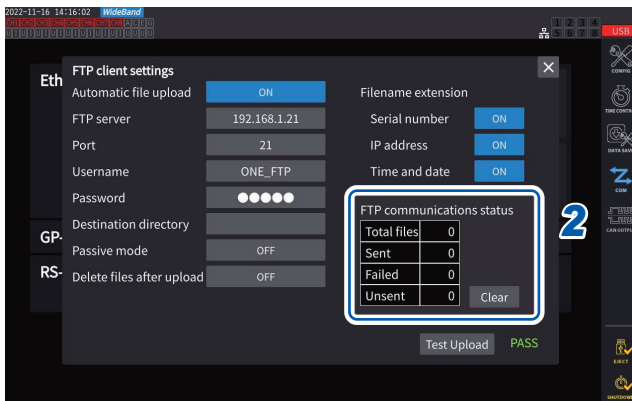
2 **Check the numbers of files under [FTP communications status].**

The following occasions zero the counters.

- When **[Clear]** is tapped
- When the instrument is turned on

Once a file fails to be sent, the *Unsent* count increases by one. After a certain period, the file is retransmitted, reducing the *Unsent* count by one. Successful transmission of this file increments the *Sent* count by one, and failure increments the *Failed* count by one.

Tapping **[Clear]** zeros all counters and stops retransmission of unsent files.

Uploading files manually

Any files saved in the USB flash drive connected to the instrument can be sent to the FTP server of the computer anytime.

Only files can be manually sent. No folders can be sent manually.

Operating procedure

1 **Set and connect the LAN on the instrument.**

See "9.1 Connecting and Setting the LAN Interface" (p. 220).

2 **Set the FTP server on the receiving side (computer).**

3 **Configure the FTP client using the instrument.**

See "9.4 Sending Data Using the FTP Client Function" (p. 230).

4 **Send files to the FTP server on the [FILE] screen.**

See "Manual file transfer (uploading to an FTP server)" (p. 179).

Display screen **[FILE]**
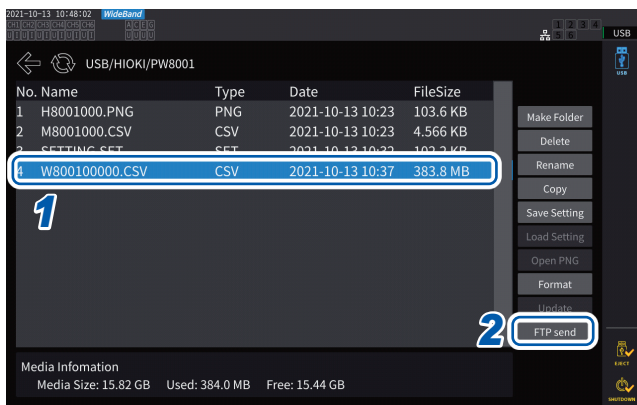
1 **Tap the file to be sent.**

2 **Tap [FTP send] to open the setting window.**
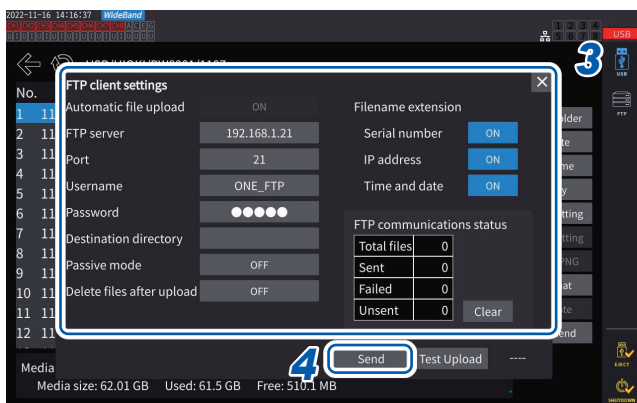
3 **Configure the FTP client.**

See "Setting automatic file upload" (p. 230).

4 **Tap [Send].**

The file is transferred to the specified FTP server.

234

9.5 FTP Sever Mounting Function

Some files of those that can be created by the instrument can be created directly on the FTP server, without using recording media (USB flash drive), by communicating with the FTP server on a computer. You can also load settings files on the FTP server to the instrument.
Register the user name and password of the instrument on the FTP server before using this function.
You can use some FTP servers, such as a Windows ® FTP server.

Settings file saving on the FTP server

Files can be created directly on the FTP server without using the recording media of the instrument. The following shows an example of sending data to FTP server with the IP address of 192.168.1.1.

Instrument
(e.g., 192.168.1.2)

FTP server computer
(e.g., 192.168.1.1)
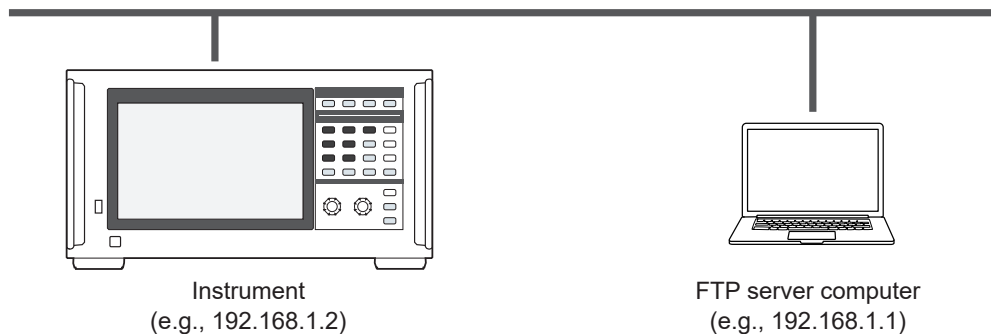
Only settings files and screenshot files can be created on the FTP server.
Other files are created on the instrument's recording media.

Operating procedure

1 **Configure the LAN settings using the instrument and connect the instrument to LAN.**
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

2 **Configure the FTP server settings using the receiving side equipment (computer).**

3 **Configure the file saving settings for the FTP server using the instrument.**
See "Configuring FTP client" (p. 231).

4 **Create a settings file or a screenshot file with the instrument.**

Connecting with Computers

9

Display screen [SYSTEM] > [DATA SAVE]
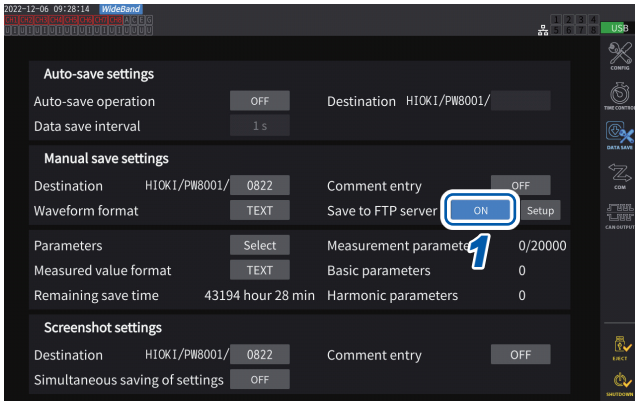
1 Tap the **[Save to FTP Server]** box to set it to **[ON]**.
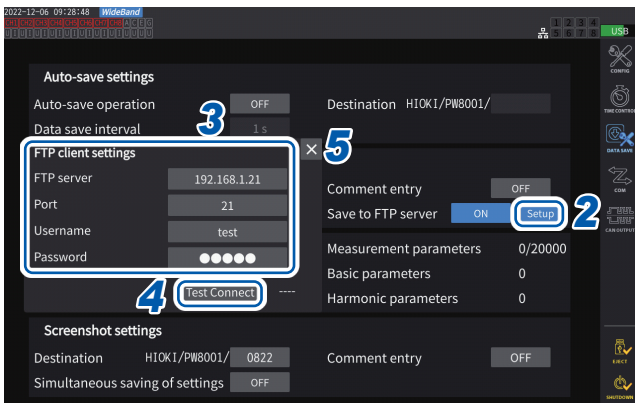
2 Tap **[Setup]**.

The setting window will be displayed.

3 Set each item under **[FTP client settings]**.

4 When the FTP settings are completed, tap **[Test Connect]**.

When it successfully communicates, the instrument displays **[PASS]**.

5 Tap **[×]** to close the setting window.

Configuring FTP client settings

Item	Number of characters, format	Description
FTP server name	Up to 45 one-byte character strings Example 1: FTPSERVER Example 2:192.168.1.1	Enter the host name or IP address of the FTP server.
Port number	1 to 65535	Enter the port number of the FTP server.
Username	Up to 32 one-byte character strings Example: HIOKI	Enter the user name for logging on to the FTP server.
Password	Up to 32 one-byte character strings Example: PW8001	Enter the password for logging on to the FTP server. The password is displayed as **[●●●●●]**.

These settings are common to those used when automatically sending files using the FTP client.

Saving destination folders of created files

The saving destination folders for files created on the FTP server vary with the file type.

File type	Saving destination folder
Instrument settings file (extension: SET)	Folder of the FTP server currently displayed on the **[FILE]** screen Tap **[Save Setting]** and enter a filename to create.
User-defined formula (UDF) settings file (extension: JSON) CAN database settings file (extension: DBC)	Folder specified for the save destination for manual save settings
Screenshot	Folder specified for the save destination for screenshot settings

Loading settings files from the FTP server

A saved settings file on the FTP server is loaded to restore settings.

Display screen **[FILE]**
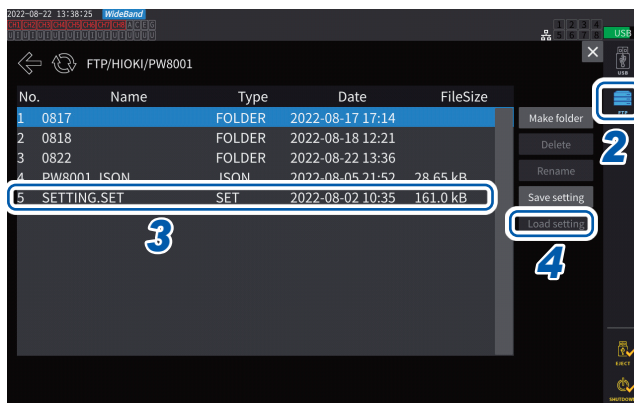
1 **Tap [Setup] in [Save to FTP Server] to configure the settings for the destination FTP server.**

See "Configuring FTP client settings" (p. 236).

2 **Tap [FTP].**

3 **Select a file to select.**

4 **Tap [Load setting].**

The confirmation dialog box is displayed.

5 **Tap [Yes].**

The combination of options, etc., must be identical to restore the settings. If not, the settings cannot be restored.

Connecting with Computers

9

9.6 Controlling the Instrument with Communications Commands

The computer sends communications commands, which can control the instrument and communicate with it.

Connect the instrument and computer using an RS-232C, GP-IB, or LAN cable.

For details about the communications commands, see the Communication Command Instruction Manual.

Do not operate the instrument remotely from an HTTP server or control the instrument from GENNECT One while communication commands control the instrument. Controlling the instrument from multiple devices simultaneously may cause malfunctions, such as stopping communication.

9.7 Connecting and Setting the GP-IB

The instrument comes with a GP-IB interface. Use a GP-IB cable to connect the instrument and a computer.
See "Interface function list" (p. 219).

Connecting the GP-IB cable

Connect the GP-IB cable to the instrument's GP-IB connector.

⚠WARNING

■ **Turn off all devices before connecting or disconnecting interface connectors.**

Failure to do so could cause the operator to experience an electric shock.

⚠CAUTION

■ **Do not short-circuit the output terminal or input a voltage to the GP-IB connector.**

Doing so could damage the instrument.

■ **Do not unplug the cable while the instrument is sending or receiving data.**

Doing so could damage the instrument and the computer.

■ **Use the same ground for the instrument and the computer.**

Connecting data cables while there is a potential difference between the instrument and computer's ground levels could damage the instrument and computer or cause them to malfunction.

■ **Turn off the instrument and computer before connecting or disconnecting cables.**

Failure to do so could damage the instrument and the computer being connected or cause them to malfunction.

■ **After connecting the cable, tighten the screws attached to the connector.**

Otherwise, data may not be transferred properly.

■ **Seat connectors securely.**

Failure to do so could damage the instrument or cause nonconformity to the specifications.

IMPORTANT

When using the GP-IB interface, do not use the LAN or RS-232C interface. Simultaneous use of multiple interfaces may cause the instrument to malfunction, such as communication interruption.

Connecting with Computers

9

GP-IB connection
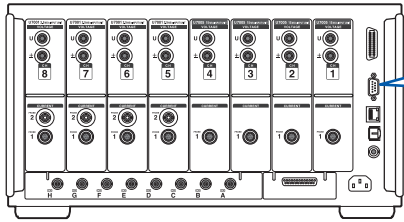
GP-IB

Recommended cable:
9151-02 GP-IB Connection Cable (2 m)

About GP-IB

- IEEE-488-2 1987 common commands (required) may be used.
- The interface complies with the following reference standard: (Applicable standard: IEEE-488.1 1987[1])
- The interface has been designed based on the following reference standard. (Reference standard: IEEE-488.2 1987[2])

  For details, see the Communications Command Instruction Manual.

[1]: ANSI/IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation (ANSI/IEEE Standard 488.1-1987. IEEE Standard Digital Interface for Programmable Instrumentation)

[2]: ANSI/IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols, and Common Commands (ANSI/IEEE Standard 488.2-1987. IEEE Standard Codes, Formats, Protocols, and Common Commands)

Setting the GP-IB address

Set the GP-IB address before using the GP-IB interface.

Display screen [SYSTEM] > [COM]
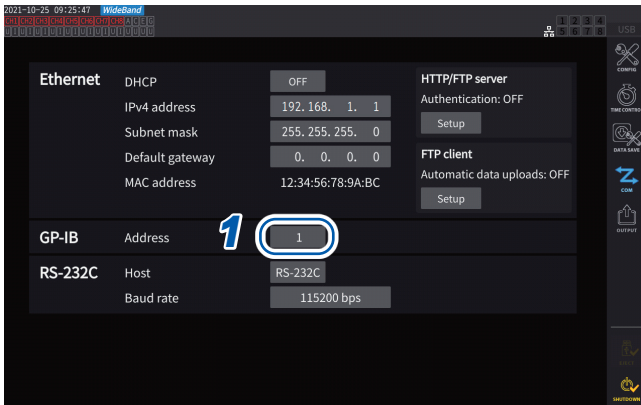
1 Tap the [Address] box, then enter the address on the numeric keypad.

0 to 30

Resetting the remote control

Pressing the **REMOTE/LOCAL** key while the **REMOTE/LOCAL** key stays is lit up can reset the remote control.

Key status

REMOTE / LOCAL (Lit up in red)	Remote control (remote operation) underway Keys other than the **REMOTE/LOCAL** key cannot be operated.
REMOTE / LOCAL (Off)	Key operation is available.

9.8 Connecting and Setting the RS-232C

The instrument comes with an RS-232C interface. Use an RS-232C cable to connect the instrument and a computer.
See "Interface function list" (p. 219).

Connecting the RS-232C cable

Connect the RS-232C cable to the instrument's RS-232C connector.

⚠WARNING

■ **Turn off all devices before connecting or disconnecting interface connectors.**

Failure to do so could cause the operator to experience an electric shock.

⚠CAUTION

■ **Do not short-circuit or input a voltage to the RS-232C connector.**

Doing so could damage the instrument.

■ **Do not unplug the cable while the instrument is sending or receiving data.**

Doing so could damage the instrument and the computer.

■ **Use the same ground for the instrument and the computer.**

Connecting data cables while there is a potential difference between the instrument and computer's ground levels could damage the instrument and computer or cause them to malfunction.

■ **Turn off the instrument and computer before connecting or disconnecting cables.**

Failure to do so could damage the instrument and the computer being connected or cause them to malfunction.

■ **After connecting the cable, tighten the screws attached to the connector.**

Otherwise, data may not be transferred properly.

■ **Seat connectors securely.**

Failure to do so could damage the instrument or cause nonconformity to the specifications.

IMPORTANT

When using the RS-232C interface, do not use the LAN or GP-IB interface. Simultaneous use of multiple interfaces may cause the instrument to malfunction, such as communication interruption.

Connecting with Computers

9

241
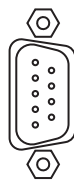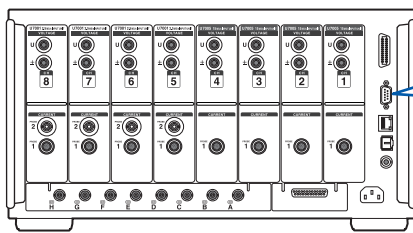
RS-232C connection

Recommended cable:
9637 RS-232C Cable
(1.8 m, 9 pins-9 pins, cross cable
9-pin D-sub plug)
Locking screws: #4-40

1 Connect the RS-232C cable to the instrument's D-sub 9-pin connector and secure the cable using the screws.

2 Set the controller communication protocol as follows (same settings as for the instrument).

Communications method	Asynchronous
Communications speed	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps (Follow the instrument setting.)

Stop bit	1 bit
Data length	8 bits
Parity check	None
Flow control	None

IMPORTANT

- When connecting the RS-232C cable to the controller (DTE), prepare a cross cable compatible with the instrument's connector and controller's connector.
- When using a USB-serial cable, a gender changer, and a straight-cross converter may be required. Prepare them according to the specifications of the instrument's connector and USB-serial cable connector.

The input and output connectors use the terminal (DTE) specifications.
Pin Nos. 2, 3, 5, 7, and 8 are used for this instrument. Other pins are not to be used.

Pin No.	Interchange circuit name		CCIT circuit No.	EIA code	JIS code	Common code
1	Data channel receiving carrier detection	Carrier Detect	109	CF	CD	DCD
2	Received data	Receive Data	104	BB	RD	RxD
3	Sent data	Send Data	103	BA	SD	TxD
4	Data terminal ready	Data Terminal Ready	108/2	CD	ER	DTR
5	Signal ground	Signal Ground	102	AB	SG	GND
6	Data set ready	DATA Set Ready	107	CC	DR	DSR
7	Request to send	Request to Send	105	CA	RS	RTS
8	Clear to send	Clear to Send	106	CB	CS	CTS
9	Ring indicator	Ring Indicator	125	CE	CI	RI

When connecting the instrument and a computer

Use a D-sub 9-pin female-to-D-sub 9-pin male cross cable.

Recommended cable: 9637 RS-232C Cable (1.8 m, 9-pin/9-pin, cross cable)

Cross wiring

D-sub 9-pin female
PW8001 side

D-sub 9-pin female
PC/AT compatible

	Pin No.			Pin No.	
DCD	1		1		DCD
RxD	2		2		RxD
TxD	3		3		TxD
DTR	4		4		DTR
GND	5		5		GND
DSR	6		6		DSR
RTS	7		7		RTS
CTS	8		8		CTS
RI	9		9		RI

Specifications

Communications method	Full duplex, asynchronous
Communications speed	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps
Data length	8 bits
Parity	None
Stop bit	1 bit
Message terminator (Delimiter)	When receiving: CR+LF When sending: CR+LF
Flow control	None
Electrical specifications	
Input voltage level **Output voltage level**	5 to 15 V: On, −15 to −5 V: Off +5 V or more: On, −5 V or less: Off
Connector	Interface connector pin assignments (D-sub 9-pin male with #4-40 locking screws) The input and output connector implements terminal (DTE) specifications. Recommended cable: 9637 RS-232C Cable (for computer) When using a USB-to-serial converter to connect the instrument to a computer, you must use a gender changer (male-to-female conversion) and a straight-to-cross converter.

Character code: ASCII

9

Setting the communications speed

The D-sub 9-pin connector for the instrument can be switched between the RS-232C interface and external control interface.

Display screen [SYSTEM] > [COM]
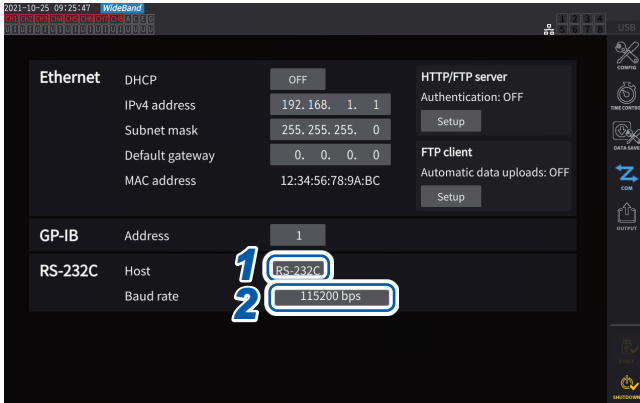
1 Tap the **[Host]** box to select **[RS-232C]** from the list.

RS-232C	Functions as an RS-232C interface. You can control the instrument connected with an external device using communications commands.
EXT Ctrl	Functions as an external control interface. You can control the instrument connected with an external device using logic signals or short/open contact signals. See "8.3 Controlling Integration with External Signals" (p. 207).

2 Tap the **[Baud rate]** box to select the communication speed from the list.

9600 bps, **19200 bps**, **38400 bps**, **57600 bps**, **115200 bps**

9.9 GENNECT One (PC Application Software)

GENNECT One is application software for observing measured values in real time and acquiring measurement files with the instrument and computer connected with a LAN cable.

Main functions

Logging	This can log measured values of the LAN-connected measuring instrument at specified intervals, displaying graphs and lists in real-time.
Dashboard	This can position measured values on a background image and monitor the measurement status to be visually easy to follow. A threshold value can be set for each measurement item and alarm information can be saved in the computer when a measured value exceeds the threshold value.
Remote operation	You can operate the LAN-connected measuring instrument using its HTTP server function.
File acquisition Automatic file upload	You can acquire files from external storage devices connected with the measuring instrument. Files created on the measuring instrument can be received on the computer using the FTP function between the measuring instrument and computer. This function can also be used for measured data of other Hioki measuring instruments. For GENNECT One compatible models, check the Hioki website.

For more details, visit GENNECT One Special Website.
The latest edition can be downloaded from the Hioki website.

Installation

Contents on the companying CD

Filename	Description about files
Readme_Jpn.pdf	Description about GENNECT One (Japanese)
Readme_Eng.pdf	Description about GENNECT One (English)
setup.exe	GENNECT One installer

System requirements

Supported operating system	Windows 8.1 (32-bit, 64-bit) Windows 10 (32-bit, 64-bit) Windows 11
Software environment	Microsoft .NET Framework 4.6.2 or later
CPU	Operation clock of 2 GHz or more
Memory	4 GB or more
Display	Resolution 1366 × 768 dots
Hard disk	1 GB or more of free space
CD-ROM drive	Required for software installation

See "GENNECT One User's manual" for details about how to user GENNECT One.
Select *Help* on the GENNECT One information menu to display the manual.

Connecting with Computers

9

Installation procedure

Screen example for Windows 10
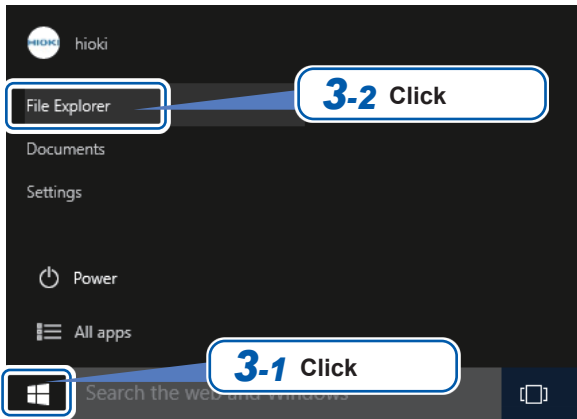
1 **Start a computer.**

You may need administrator privileges to install.

2 **Put the accompanying CD in a CD-ROM drive.**

3 **Click [File Explorer] from the start menu to start File Explorer.**

4 **Click [This PC], and then click [CD-ROM Drive].**
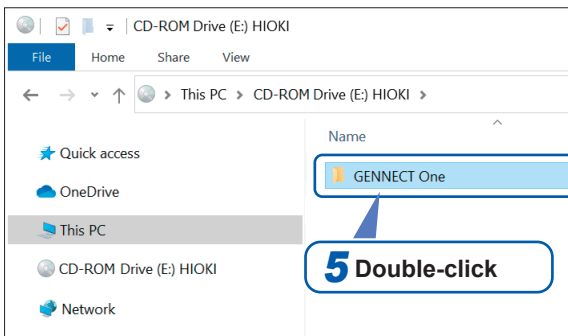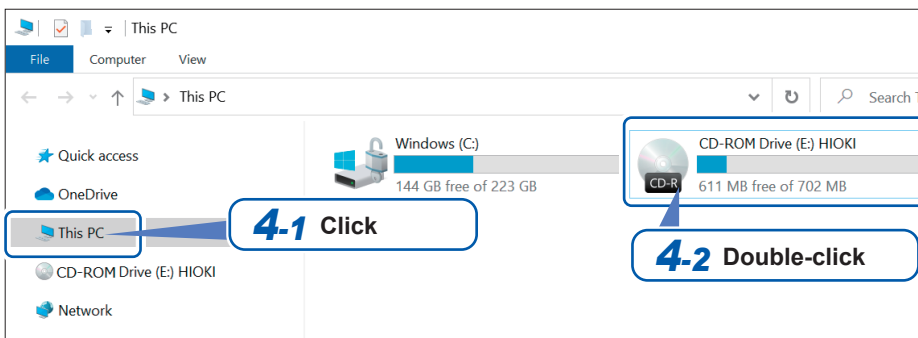
5 **Double-click the [GENNECT One] folder.**
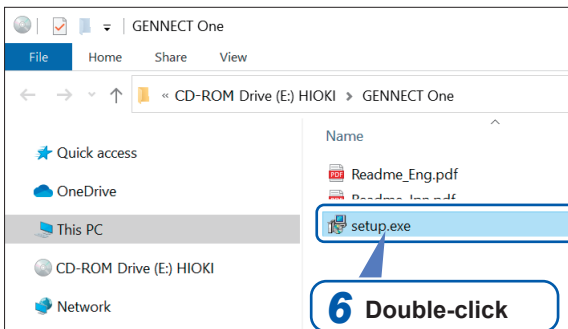
6 **Double-click [setup.exe].**

9.10 Controlling the Instrument and Acquiring Data Using the Modbus/TCP Server Communications

Overview of Modbus/TCP communication function

Modbus is a communications protocol developed for use with programmable logic controllers (PLCs). You can acquire data and control connected devices through reading and writing registers. Communications using the TCP/IP protocol via Ethernet are called Modbus/TCP communications. The instrument's Modbus/TCP communications function has a server function that responds to commands sent from connected external devices (client devices). This function enables real-time control of the instrument and acquisition of measurement data.

How to connect

Connect a LAN cable to the RJ-45 connector (Gigabit Ethernet) of the instrument to connect the instrument with a Modbus client equipment.
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

Modbus specifications

Function	Modbus/TCP server
IP address	IPv4 address presently set (To change and confirm settings, see "9.1 Connecting and Setting the LAN Interface" (p. 220).)
Port number	502 (fixed)
Server address	1 (fixed)
Related function codes	(0x03) Read holding register (0x04) Read input register (0X03) Write comment to holding register

For information about assigning registers, see the separate volume "Modbus/TCP Communication Instruction Manual."

Connecting with Computers

9

10 Specifications

10.1 General Specifications

Operating environment	Indoor use, pollution level 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dust resistance and water resistance	IP20 (EN 60529) The protection rating for the enclosure of this instrument (based on EN 60529) is *IP20.
Conforming standards	Safety EN 61010 EMC EN 61326 Class A
Complying standards	The instrument in IEC measurement mode complies with IEC 61000-4-7:2002. The instrument in IEC measurement mode complies with IEC 61000-4-15:2010.

Power supply	Commercial power supply
	    Rated supply voltage: 100 V to 240 V AC
	    (Assuming voltage fluctuation of ±10%)
	    Rated power-supply frequency: 50 Hz, 60 Hz
	    Anticipated transient overvoltage: 2500 V
	    Maximum rated power: 230 VA

Backup battery life	Lithium battery About 10 years (Reference value at 23°C) Time and setting conditions
Dimensions	Approx. 430W × 221H × 361D mm (16.93″W × 8.7″H × 14.21″D) (excluding protruding parts)
Weight	Approx. 14 kg (493.8 oz., PW8001-15 with four U7001 and four U7005 installed)
Product warranty duration	3 years (also applied to installed input modules)

Accuracy guarantee conditions	Accuracy guarantee duration: 12 months
	    (for voltage, current, power of the U7001 and U7005, for power of the motor analysis option: 6 months)
	    (1.5 times reading errors of each specified accuracy are guaranteed for 12 months.)
	
	Accuracy guarantee temperature and humidity range:
	    23°C ±3°C (73°F ±5°F), 80% RH or less
	Warm-up time: 30 minutes or longer
	Other conditions: Within the effective measurement ranges, sine waveforms or DC input, a line-to-earth voltage of 0 V
	After zero adjustment has been performed and a change in an ambient temperature does not exceed ±1°C after zero adjustment.

Accessories	See p. 3.
Options	See p. 4.

*IP20

This indicates the degree of protection provided by the enclosure of the instrument for use in hazardous locations, entry of solid foreign objects, and the ingress of water.

2: Protected against access to hazardous parts with fingers. The equipment inside the enclosure is protected against entry by solid foreign objects larger than 12.5 mm in diameter.

0: The equipment inside the enclosure is not protected against the harmful effects of water.

10.2 Specifications of Input, Output, and Measurement

Basic specifications

(1) Specifications common to voltage, current, power measurement

Number of input modules	Up to 8 modules (co-existence of different types of input modules acceptable)
Input module type	U7001 2.5MS/s Input Unit U7005 15MS/s Input Unit
Manner of input module installation	When different types of input modules coexist, install the U7005 15MS/s Input Units all together on the Ch. 1 side.
Wiring configuration to be measured	Single-phase 2-wire (1P2W), single-phase 3-wire (1P3W), 3-phase 3-wire (3P3W2M, 3V3A, 3P3W3M), 3-phase 4-wire (3P4W)
Wiring configuration setting	Installed input modules can be assigned to any wiring channels. (However, only adjacent input modules can be used to the same wiring configuration). Different types of input modules can coexist in the same wiring configuration. Different types of current sensors cannot coexist in the same wiring configuration.
Measurement method	Voltage/current simultaneous digital sampling with zero-crossing synchronized calculation
Sampling frequency, sampling bit rate	U7001: 2.5 MHz, 16-bit U7005: 15 MHz, 18-bit
Effective measurement range	1% of range to 110% of range
Effects of conducted radio-frequency electromagnetic field	For current and active power measurement, 6% of full scale or less at 10 V (*full scale* means the sensor's rated current, only when the 9272-05 is used)
Effects of radiated radio-frequency electromagnetic field	For current and active power measurement, 6% of full scale or less at 10 V/m (*full scale* means the sensor's rated current, only when the 9272-05 is used)
Display range	See "10.4 Detailed Specifications of Measurement Parameters" (p. 280).
Measurement mode	Wideband measurement mode, IEC measurement mode
Data update interval	1 ms, 10 ms, 50 ms, 200 ms The harmonic data update interval is specified separately. Average and user-defined operations are unavailable when the data update interval is set to 1 ms. In IEC measurement mode, the data update interval is fixed at approx. 200 ms (10 waves for 50 Hz measurement-frequency setting; and 12 waves for 60 Hz).

LPF	Cutoff frequency fc
	U7001:
	  500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz, 500 kHz, off
	  (The 500 kHz LPF setting uses an analog circuit.)
	U7005:
	  500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz, 500 kHz, 2 MHz, off
	  (The 2 MHz LPF setting uses an analog circuit.)
	
	Analog LPF + Digital LPF
	Add ±0.05% of reading to the accuracy except if the LPF is set to off.
	The accuracy specifications are specified for frequencies less than or equal to one tenth the set cutoff frequency.
	The peak value is based on the LPF-processed values, whereas the peak-over judgment uses not-digital-LPF processed values.

Synchronization source	U1 to U8, I1 to I8, DC (fixed at the data update interval for DC only)
	For the PW8001-1x, the model equipped with the motor analysis option
	Ext1 to Ext4: When the input settings of the following channels are set to Speed (pulse input) and the remainder left over when the pulse count is divided by half the number of poles is zero. Ext1: Ch. B, Ext2: Ch. D, Ext3: Ch. F, Ext4: Ch. H
	Zph1: When the Ch. D input setting is set to Origin (pulse input)
	Zph3: When the Ch. H input setting is set to Origin (pulse input)
	Ch. B, Ch. D, Ch. F, Ch. H: When the corresponding channel enters **[Individual input]** operating mode
	• Can be selected for each wiring configuration. (U and I of the same channel are measured in sync with the same synchronization source.) • The zero-crossing point of the waveform after passing through the zero-cross filter is used as the reference when U or I is selected. • In IEC measurement mode, only U or I can be selected.
Effective frequency range of synchronization source	DC, 0.1 Hz to 2 MHz (up to 1 MHz for the U7001)
Effective input range of synchronization source	1% of range to 110% of range
Zero-cross filter	Used in zero-crossing detection for voltage and current waveforms. Does not affect measured waveforms. Consists of a digital LPF and HPF filters. Cutoff frequencies are automatically determined based on the settings of the measurement upper and lower frequency limits as well as measurement frequencies. HPF is selectable between on and off (fixed at off in IEC measurement mode).
Measurement lower frequency limit	Choose from among the following frequency values for each wiring configuration: 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz The frequency is fixed (not selectable) in IEC measurement mode.
Measurement upper frequency limit	Choose from the following frequency values for each wiring configuration: 100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, 2 MHz (up to 1 MHz for the U7001) The frequency is fixed (not selectable) in IEC measurement mode.
Polarity detection	Voltage/current zero-crossing timing comparison method
Measurement item	Voltage (U), current (I), active power (P), apparent power (S), reactive power (Q), power factor (λ), phase angle (ϕ), voltage frequency (fU), current frequency (fI), efficiency (η), loss (Loss), voltage ripple factor (Urf), current ripple factor (Irf), current integration (Ih), power integration (WP), voltage peak (Upk), current peak (Ipk) See "10.4 Detailed Specifications of Measurement Parameters" (p. 280).

(2) Specifications common to voltage measurement

See "10.6 U7001 2.5MS/s Input Unit" (p. 299) and "10.7 U7005 15MS/s Input Unit" (p. 304).

(3) Specifications common to current measurement

See "10.6 U7001 2.5MS/s Input Unit" (p. 299) and "10.7 U7005 15MS/s Input Unit" (p. 304).

Specifications

10

(4) Frequency measurement specifications

Number of measurement channels	Up to 8 channels (fU1 to fU8, fI1 to fI8), depending on the number of installed modules
Measurement method	Reciprocal method The waveforms processed with the zero-cross filter are measured.
Measurable range	0.1 Hz to 2 MHz (The display shows *0.00000 Hz* or *− − − − − − Hz* if measurement was not possible.) The range is limited by the input module's measurement band and the measurement lower frequency limit setting.
Measurement accuracy	±0.005 Hz Assuming all the following conditions are met: • Measurement parameter: voltage frequency • Data update interval: 50 ms or more • Voltage range: 15 V range or higher • Inputted waveform: a sine wave with a magnitude of at least 50% of the range • Frequency range: 45 Hz to 66 Hz Under conditions other than listed above: ±0.05% of reading (With a sine wave at least 30% of the measurement range of the measurement source)
Display resolution	0.10000 Hz to 9.99999 Hz, 9.9000 Hz to 99.9999 Hz, 99.000 Hz to 999.999 Hz, 0.99000 kHz to 9.99999 kHz, 9.9000 kHz to 99.9999 kHz, 99.000 kHz to 999.999 kHz, 0.99000 MHz to 2.00000 MHz

(5) Integration measurement specifications

Measurement mode	Can be chosen between RMS and DC for each wiring. (The DC mode is selectable for the 1P2W wiring configuration only.)
Measurement item	Current integration (Ih+, Ih−, Ih), Active power integration (WP+, WP−, WP) The instrument measures Ih+ and Ih− only in DC mode; Ih only in RMS mode.
Measurement method	Digital calculation based on current and active power. (Calculations are performed using not-averaged values during averaging.) In DC mode: Integrates current values and instantaneous power values for each polarity at every sampling point. In RMS mode: Integrates current RMS values and active power values at the measurement intervals. Only the active power is integrated by polarity. (Active power is integrated by polarity at every period of the synchronization source.) (The sum of integrated effective power values of a polyphase wiring configuration is the sum of effective power values by polarity at the measurement intervals.)
Measurement interval	Same as the data update interval
Display resolution	999999 (6 digits + decimal point), Starts from the resolution assuming 1% of each range to be 100% of range.
Measurable range	0 to ±99.9999 PAh 0 to ±99.9999 PWh
Integration time	0 s to 9999 h 59 min. 59 s Integration stops if the integration time exceeds the range.
Integration time accuracy	±0.02% of reading (−10°C to 40°C)
Integration accuracy	±(Current or active power) ±(Integration time accuracy)
Backup function	None If a power outage occurs during integration, the integration stops after power is restored and the integration data is reset.

Integration control	All-channel synchronized integration:
	• Manual (keys, communications commands, external) control:
	  Start, stop, data reset
	• Real time control: Start, stop
	• Timer control: Stop after a lapse of the set time.
	
	Configuration-specific independent integration:
	      (No data will be saved.)
	      (Unavailable in IEC measurement mode and during BNC synchronization and
	      optical-linking)
	• Manual (keys, communications commands, external) control:
	  Start, stop, and data reset by the wiring configuration
	• Real time control: Start and stops by the wiring configuration
	• Timer control: Stop by the wiring configuration after a specified time
	
	Cumulative integration available
	(Restarting after integration stop is available. Integration resumes, adding values to the previous integrated values.)
	Unavailable in IEC measurement mode (restart not possible)

(6) Specifications common to harmonic measurement

Number of measurement channels	Up to 8 channels, depending on the number of installed input modules
Synchronization source	Same as those specified in the basic measurement specifications Based on the synchronization source setting of the voltage, current, and power measurement selected for each wiring configuration. However, for the wiring configuration with Zph1 or Zph3 respectively selected as the synchronization source of the voltage, current, and power measurement, you can choose whether harmonic measurement is in sync with Ext1 or Ext3 or in sync with Zph1 or Zph3.
Measurement mode	Selectable between wideband measurement mode and IEC measurement mode (setting common to all channels)
Measurement item	Harmonic voltage RMS value, harmonic voltage content percentage, harmonic voltage phase angle, harmonic current RMS value, harmonic current content percentage, harmonic current phase angle, harmonic active power, harmonic power content percentage, harmonic voltage-vs.-current phase difference, total harmonic voltage distortion, total harmonic current distortion, voltage unbalance rate, current unbalance rate (Only in IEC measurement mode) Inter-harmonic voltage RMS value, inter-harmonic current RMS value
FFT processible word length	32 bits
Anti-aliasing	Digital filter (automatically set based on synchronization frequency)
Window function	Rectangular
Grouping	Off, Type 1 (harmonic sub-group), Type 2 (harmonic group) (Setting common to all channels)
THD calculation method	THD_F, THD_R Select the calculation order from between 2nd and 500th. (However, limited to the maximum analysis order of each mode.) (Setting common to all channels)

Specifications

10

(7) Specifications of IEC-compliant harmonic measurement in IEC measurement mode

Measurement method	Compliant with IEC 61000-4-7:2002, without gaps or overlaps
Measurement frequency setting	50 Hz, 60 Hz
Synchronous frequency range	For 50 Hz setting: 45 Hz to 55 Hz For 60 Hz setting: 56 Hz to 66 Hz
Data update interval	Fixed at approx. 200 ms (10 waves for 50 Hz measurement-frequency setting; 12 waves for 60 Hz)
Analysis order	Harmonics: 0th to 200th orders Inter-harmonic: 0.5th to 200.5th orders
Number of window waves	10 waves for 50 Hz measurement-frequency setting; 12 waves for 60 Hz
Number of FFT points	8192 points
Measurement accuracy	Add ±0.04% of range to the following measurement accuracy of each module within the synchronous frequency range of each frequency setting: voltage, current, power, and phase. For a frequency of 10 kHz or more, add another ±0.04% of range.

(8) Specifications of wideband harmonic measurement in wideband measurement mode

Measurement method	Zero-crossing sync calculation method (the same window for each synchronization source), with gaps Fixed sampling interpolation calculation method
Synchronization frequency range	0.1 Hz to 1.5 MHz (up to 1 MHz for the U7001)
Data update interval	Fixed at 50 ms. When it is set to 10 ms, only harmonic data is updated at 50 ms intervals. When it is set to 200 ms, values are obtained by averaging four sets of 50 ms data.

Maximum analysis order and the window wave number

Fundamental wave frequency	Window wave number	Maximum analysis order
0.1 Hz ≤ f ≤ 2 kHz	1	500th
2 kHz < f ≤ 5 kHz	1	300th
5 kHz < f ≤ 10 kHz	2	150th
10 kHz < f ≤ 20 kHz	4	75th
20 kHz < f ≤ 50 kHz	8	30th
50 kHz < f ≤ 100 kHz	16	15th
100 kHz < f ≤ 200 kHz	32	7th
200 kHz < f ≤ 300 kHz	64	5th
300 kHz < f ≤ 500 kHz	128	3rd
500 kHz < f ≤ 1.5 MHz	256	1st

However, the fundamental wave frequency is limited to 1 MHz for the U7001.

Phase zero-adjustment function	Phase zero-adjustment can be started by using keys or communications commands. (Only available when the synchronization source is set to Ext) Phase zero-adjustment values can be set automatically or manually. Valid setting range of the phase zero-adjustment: 0.000° to ±180.000° (in 0.001° increments)
Number of FFT points	Automatically selected from among 2048, 4096, and 8192 points.

Measurement accuracy	Add the following values to the voltage, current, power, and phase accuracy of each input module. However, add 0.05% of reading when the fundamental wave has a frequency of 2 kHz or more.	

Frequency	Voltage, current, power ±(% of reading)	Phase ±(degree)
DC	0.05%	–
0.1 Hz ≤ f ≤ 100 Hz	0.01%	0.1°
100 Hz < f ≤ 1 kHz	0.03%	0.1°
1 kHz < f ≤ 10 kHz	0.08%	0.6°
10 kHz < f ≤ 50 kHz	0.15%	$(0.020 \times f) \pm 0.5°$
50 kHz < f ≤ 1 MHz	0.20%	$(0.030 \times f) \pm 2.0°$
1 MHz < f ≤ 1.5 MHz	0.25%	$(0.040 \times f) \pm 2.5°$

- In the expressions listed above, the unit of frequency (f) is kilohertz (kHz).
- The figures for voltage, current, power, and phase difference for frequencies over 300 kHz are values for reference purposes.
- When the fundamental wave has a frequency outside the range of 16 Hz to 850 Hz, the figures for voltage, current, power, and phase difference for frequencies other than the fundamental wave are values for reference purposes.
- When the fundamental wave has a frequency within the range of 16 Hz to 850 Hz, the figures for voltage, current, power, and phase difference over 6 kHz are values for reference purposes.
- Accuracy values for phase difference are specified for input with the voltage and current of the same order that have an amplitude of at least 10% of range.

Accuracy specifications

See "10.6 U7001 2.5MS/s Input Unit" (p. 299) and "10.7 U7005 15MS/s Input Unit" (p. 304).

Specifications

10

Specifications of waveform recording

Number of channels to be measured	Voltage and current waveforms:	Up to 8 channels (depending on the number of installed input modules; up to 16 waveforms can be displayed, however.)
	Motor waveform:	Up to 4 analog DC channels + up to 8 pulse channels
Recording capacity	(5 megawords) × [(Number of measured items, including voltage and current) × (Number of channels, up to 8) + (Number of motor waveforms)] No memory segmentation function	
Waveform resolution	16-bit (Top 16 bits are used for voltage and current waveforms from the U7005.)	
Sampling speed	Voltage and current waveforms:	Always 15 MS/s (For the U7001, 2.5 MS/s sampled data is interpolated with 0th held.)
	Motor waveform (Analog DC):	Always 1 MS/s (1 MS/s sampled data is interpolated with 0th held.)
	Motor waveform (pulse):	Always 15 MS/s
Compression ratio	1/1, 1/2, 1/3, 1/6, 1/15, 1/30, 1/60, 1/150, 1/300, 1/600, 1/1500 (15 MS/s, 7.5 MS/s, 5 MS/s, 2.5 MS/s, 1.0 MS/s, 500 kS/s, 250 kS/s, 100 kS/s, 50 kS/s, 25 kS/s, 10 kS/s) However, compression ratios of 1 MS/s or less only are available for motor waveforms (analog DC).	
Recording length	1 kiloword, 5 kilowords, 10 kilowords, 50 kilowords, 100 kilowords, 500 kilowords, 1 megaword, 5 megawords	
Storage mode	Peak-to-peak compression	
Trigger mode	Single, normal (auto-trigger setting available)	
Pre-trigger	0% to 100% of the recording length, in 10 percent points increments	
Trigger detection method	• Level trigger (detects triggers based on fluctuations in the level of storage waveforms.)	
	Trigger source: Voltage and current waveforms, voltage and current waveforms processed by the zero-cross filter, manual trigger, motor waveform, motor pulse	
	Trigger slope: Rising edge, falling edge	
	Trigger level: ±300% of the range for waveforms in 0.1 percent points increments	
	• Event trigger Triggers are detected based on fluctuations in the values of basic measurement items (except the flicker measurement items). The trigger-detecting conditions are determined based on the logical OR and AND of the following four events. The logical AND takes precedence over the logical OR.	
	Event: Composed of basic measurement items (except the flicker measurement items), inequality signs (<, >), and numerical values (0.00000 to ±99999.9T).	
	Ev n: Item □ X.XXXXX y n: 1 to 4 Item: basic measurement item □: inequality signs X.XXXXX: six-digit constant y: SI prefix	

Specifications of FFT analysis

Measurement channels	Voltage and current waveforms: Selectable between for each channel and for each wiring configuration, up to 3 channels Motor waveform: Analog DC Only the FFT screen can perform analysis.
Calculation type	RMS spectrum (average value of each channel are computed when multiple channels are selected) Power spectrum (active power [P]; however, only with the voltage and current waveforms selected, sum of each channel power [Psum] is computed when multiple channels are selected)
Number of FFT points	1,000 points, 5,000 points, 10,000 points, 50,000 points, 100,000 points, 500,000 points, 1,000,000 points, 5,000,000 points
FFT processing word length	32 bits
Analysis point	Anywhere in recorded waveform data
Anti-aliasing	Digital filter applied automatically
Window function	Rectangular, hamming, flat top
Maximum analysis frequency	Varies in conjunction with the waveform-recording compression ratio.
Voltage and current waveform	6 MHz, 3 MHz, 2 MHz, 1 MHz, 400 kHz, 200 kHz, 100 kHz, 40 kHz, 20 kHz, 10 kHz, 4 kHz (Up to 1 MHz when multiple channels that include those of the U7001 and U7001 are selected)
Motor waveform input	400 kHz, 200 kHz, 100 kHz, 40 kHz, 20 kHz, 10 kHz, 4 kHz The maximum analysis frequency is obtained by subtracting the frequency resolution from the above-listed frequency.
FFT peak value display	Levels and frequencies of the peak values (maxima) of voltage, current, and power each are calculated from the top 10 in order of level. In the FFT calculation results, when both adjacent values are lower in level, that value is recognized as the peak value.

Specifications of flicker measurement

Number of measurement channels	Up to 8
Measuring method	Compliant with IEC 61000-4-15:2010 Ed 2.0 Flicermeter Class F1
Measurement items	Short-term flicker (Pst) Maximum short-term flicker value (PstMax) Long-term flicker value (Plt) Maximum instantaneous flicker value (PinstMax) Minimum instantaneous flicker value (PinstMin) Relative steady-state voltage change (dc) Maximum relative voltage change (dmax) Period while the relative voltage change exceeds the threshold (Tmax)
Measurement frequency	50 Hz, 60 Hz (measurable in IEC measurement mode only)
Measurement range	Pst, Plt: 0.0001 P.U. to 6400 P.U. (logarithmic 1400-way split)
Flicker filter	230 V lamp, 120 V lamp
Measurement accuracy	dc, dmax: ±4% (at a dmax of 4%) Pst: ±5% (Pst = 0.2 to 5)

Specifications

10

257

Specifications of motor analysis (optional)

(1) Specifications common to analog DC input, frequency input, and pulse input

Number of input channels	8 channels

Channel	Input parameter
Ch. A, Ch. C, Ch. E, Ch. G	Analog DC, frequency, pulse
Ch. B, Ch. D, Ch. F, Ch. H	Frequency, pulse

Operating mode	• Motor analysis mode

	Measurement or detection item (input type)	Number of maximum analysis parameters
Pattern 1	Torque (analog/frequency), speed (pulse)	4 motors
Pattern 2	Torque (analog/frequency), speed (pulse), direction, Origin (pulse)	2 motors
Pattern 3	Torque (analog/frequency), speed (pulse), direction	2 motors
Pattern 4	Torque (analog/frequency), speed (pulse), origin (pulse)	2 motors
Pattern 5	Torque (analog/frequency), speed (analog)	2 motors

• Individual input mode
Ch. A, Ch. C, Ch. E, Ch. G: DC voltage measurement, frequency measurement
Ch. B, Ch. D, Ch. F, Ch. H: Frequency measurement

Input terminal profile	Isolated BNC connector
Input method	Function-isolated input and single-end input Between-channels function isolation
Input resistance (DC)	1 MΩ ±50 kΩ
Maximum input voltage	20 V
Maximum rated line-to-ground voltage	50 V (50 Hz/60 Hz)
Measurement item	Voltage, torque, RPM, frequency, slip, motor power
Synchronization source	Same as those specified in the basic measurement specifications (The effective frequency range and effective input range are also the same.) • In motor analysis mode Pattern 1: Two types, for Ch. A and Ch. B as well as Ch. C and Ch. D, can be set in **[A-D]**. Two types, for Ch. E and F as well as Ch. G and Ch. H, can be set in **[E-H]**. Pattern 2 to Pattern 5: One type can be set in each of **[A-D]** and **[E-H]**. • In individual input mode Two types, for Ch. A and Ch. B as well as Ch. C and Ch. D, can be set in **[A-D]**. Two types, for Ch. E and Ch. F as well as Ch. G and Ch. H, can be set in **[E-H]**.
Lower measurement frequency limit	Select from among the following frequency values for each motor synchronization source: 0.1 Hz, 1 Hz, 10 Hz, 100 Hz
Upper measurement frequency limit	Select from among the following frequency values for each motor synchronization source: 100 Hz, 500 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, 2 MHz
Input frequency source	Select from among fU1 to fU8 or fI1 to fI8. The frequency for slip calculation can be set.
Number of motor poles	2 to 254
Z-phase pulse detection reference	The reference for detecting Zph of the synchronization source can be set in operating mode 2 or 4. Rising edge, falling edge

258

(2) Analog DC input specifications (Ch. A, Ch. C, Ch. E, Ch. G)

Measurement range	1 V, 5 V, 10 V
Crest factor	1.5
Effective input range	1% to 110% of range
Sampling frequency, sampling bit rate	1 MHz, 16-bit
LPF	1 kHz, off (20 kHz)
Response time	0.2 ms (when the LPF is disabled)
Measurement method	Simultaneous digital sampling, zero-crossing synchronization calculation method (Between-zero-crossing averaging)
Measurement accuracy	±0.03% of reading ±0.03% of range
Effects of temperature	Add the following value within the range of 0°C to 20°C or 26°C to 40°C: ±0.01% of reading per degree centigrade ±0.01% of range per degree centigrade
Effects of common-mode voltage	±0.01% of range or less When a voltage of 50 V (DC, 50 Hz/60 Hz) is applied between the input terminals and the enclosure
Effects of external magnetic fields	±0.1% of range or less (in a magnetic field of 400 A/m, DC or 50 Hz/60 Hz)
Display range	See "(4) Motor analysis measurement items (only when the motor analysis option is installed)" (p. 283) in "10.4 Detailed Specifications of Measurement Parameters" (p. 280).
Scaling	For torque: ±0.01 to 9999.99 For RPM: ±0.00001 to 99999.9
Zero adjustment	Scaled input offsets less than or equal to ±10% of range are compensated for to zero. When the torque meter compensation is enabled, input offsets are compensated for to zero after adding the compensation values.

Torque meter compensation	Off/on (selectable by motor)
	
	• Nonlinearity compensation
	  Torque values are corrected using a 11-point (at a maximum) compensation table of torque calibration points (N·m) vs. torque calibration values (N·m).
	
	• Friction compensation
	  Torque values are corrected using an 11-point (at a maximum) compensation table of RPM values (r/min.) with consideration of rotation directions vs. torque compensation values (N·m).
	
	Each interval between torque calibration values are lineally interpolated.
	The unit for the compensation table depends on the setting.
	Enter a 6-digit compensation value.
	The sign of torque calculation is used for detecting rotation directions: forward (plus sign) and backward (minus sing).

Torque calculation and compensation	When disabled: (Torque value) = S × [X − (Zero-compensation value)]
	When enabled: (Torque value) = S × [X − (Zero-compensation value)] − At − Bt
	  S: Scaling
	  X: Input signal-to-torque converted value
	  At: Nonlinearity compensation value
	  Bt: Friction compensation value

(3) Frequency input specifications (Ch. A, Ch. B, Ch. C, Ch. D, Ch. E, Ch. F, Ch. G, Ch. H)

Detection level	Low: approx. 0.8 V or less; high: approx. 2.0 V or more
Measurement frequency band	0.1 Hz to 2 MHz (when the duty ratio is set at 50%)
Minimum detection width	0.25 μs or more
Measurement range	The zero-point frequency fc and frequency fd at rated torque in *fc* ±*fd* (Hz) can be set. Set fc and fd using 7-digit figures in the range of 1 kHz to 500 kHz. However, values must be set so that both the following inequalities, (fc + fd) ≤ 500 kHz and (fc − fd) ≥ 1 kHz both are met.
Measurement accuracy	±0.01% of reading When the data update interval is set to 1 ms, add ±0.01% of reading to the measuring accuracy.
Display range	1.000 kHz to 500.000 kHz
Scaling	±0.01 to 9999.99
Zero adjustment	Offsets of input within the range of fc ±1 kHz can be compensated for to zero. When the torque meter compensation is enabled, compensation values are added to compensate for offsets to zero.
Unit	Millinewton-meter (mN·m), newton-meter (N·m), kilonewton-meter (kN·m)

Torque meter compensation	Off/on
	• Nonlinearity compensation
	  Torque values are corrected using a 11-point (at a maximum) compensation table of torque calibration points (N·m) vs. torque calibration values (N·m).
	• Friction compensation
	  Torque values are corrected using the 11-point (at a maximum) compensation table of RPM values (r/min.) with consideration of rotation directions vs. torque calibration values (N·m).
	
	Each interval between torque calibration values are lineally interpolated.
	The unit for the compensation table depends on the setting.
	Enter a 6-digit compensation value.
	The signs of torque calculation are used for detecting rotation directions: forward (plus sign) and backward (minus sing).

Torque calculation and compensation	When disabled: (Torque value) = S × [X − (Zero-compensation value)]
	When enabled: (Torque value) = S × [X − (Zero-compensation value)] − At − Bt
	  S: Scaling
	  X: Input signal-to-torque converted value
	  At: Nonlinearity compensation value
	  Bt: Friction compensation value

(4) Pulse input specifications (Ch. A, Ch. B, Ch. C, Ch. D, Ch. E, Ch. F, Ch. G, Ch. H)

Detection level	Low: approx. 0.8 V or less; high: approx. 2.0 V or more
Measurement frequency band	0.1 Hz to 2 MHz (when the duty ratio is set at 50%)
Minimum detection width	0.25 μs or more
Pulse-noise filter (PNF)	Off, weak, strong (positive/negative pulses of less than 0.25 μs is ignored with the weak setting; less than 5 μs with the strong setting)
Measurement range	2 MHz
Measurement accuracy	±0.01% of reading When the data update interval is set to 1 ms, add ±0.01% of reading to the measuring accuracy.
Display range	0.1 Hz to 2.00000 MHz
Unit	Hertz (Hz), revolutions per minute (r/min.)
Frequency division setting range	±1 to 60000
Rotation direction detection	Settable in **[A-D]** and **[E-H]** each Pattern 2 to Pattern 5 of motor analysis mode Detects direction based on lead/lag of Ch. B and Ch. C in **[A-D]**. Detects direction based on lead/lag of Ch. F and Ch. G in **[E-H]**.
Mechanical angle origin detection	Settable in **[A-D]** and **[E-H]** each Pattern 2 to Pattern 5 of motor analysis mode Ch. B frequency division is cleared at Ch. D rising or falling edge in **[A-D]**. Ch. F frequency division is cleared at Ch. H rising or falling edge in **[E-H]**.

Specifications

10

Specifications of waveform and D/A output (optional)

Number of output channels	20 channels
Output terminal profile	D-sub 25-pin connector ×1
Output details	Switchable between waveform output and analog output (selectable from basic measurement items except the flicker measurement items)
D/A conversion resolution	16-bit (polarity + 15 bits)
Output refresh rate and interval	Waveform output: 1 MHz Analog output: 1 ms, 10 ms, 50 ms, 200 ms (depending on data update intervals of selected items, with an error of ±1 ms)
Output voltage	Waveform output: Switchable between ±2 V f.s. and ±1 V f.s., crest factor: 2.5 or more The settings affect all channels. Analog output: ±5 V DC f.s. (approx. up to ±12 V DC)
Output resistance	100 Ω ±5 Ω
Output accuracy	Waveform output: Add ±0.5% f.s. to measurement accuracy with the ±2 V f.s. setting. Add ±1.0% f.s. to measurement accuracy at the ±1 V f.s. setting. Specified assuming DC to 50 kHz output Analog output: Add ±0.2% f.s. to the measurement accuracy of output measurement items (DC level).
Temperature coefficient	±0.05% f.s. per degree centigrade

Pin assignment

Pin no.	Output	Pin no.	Output
1	GND	14	GND
2	D/A1	15	D/A13
3	D/A2	16	D/A14
4	D/A3	17	D/A15
5	D/A4	18	D/A16
6	D/A5	19	D/A17
7	D/A6	20	D/A18
8	D/A7	21	D/A19
9	D/A8	22	D/A20
10	D/A9	23	GND
11	D/A10	24	GND
12	D/A11	25	GND
13	D/A12		
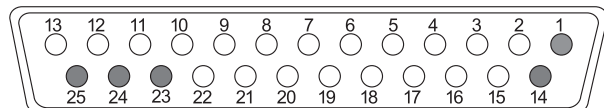
Display specifications

Display language	Japanese, English, Chinese (simplified)
Display	10.1″ WXGA TFT color LCD (1280 × 800 dots)
Dot pitch	0.1695 (V) mm × 0.1695 (H) mm
Display value resolution	999999 count (including integrated values)
Display update interval	Measured values: Approx. 200 ms (independent of internal data update interval) Waveforms: Based on waveform recording settings
Screen	Measurement screen, Input Settings screen, System Settings screen, File Operation screen
Warning display	When input-channel a voltage or a current peak-over condition is detected, when no synchronization source is detected. Warning marks for all channels will be displayed on any page of the screen.

Specifications of operating part

Control device	Power button ×1, rubber keys ×23, rotary knobs ×2, touchscreen
Touchscreen	Projected capacitive type
Rotary knob	30 notches, 15 pulses, lamp-equipped

Key	Mechanical switch type, lamp-equipped ×12, no-lamp-equipped ×11
	 • Lamp-equipped
	   Green: **MEAS**, **INPUT**, **SYSTEM**, **FILE**, **AUTO** ×2, **SINGLE**
	   Red: **HOLD**, **PEAK HOLD**, **REMOTE/LOCAL**
	   Red/green: **START/STOP**, **RUN/STOP**
	 • No-lamp-equipped
	   Pages (right and left), **SAVE**, **COPY**, up for U, down for U, up for I, down for I
	   0 ADJ, **DATA RESET**, **MANUAL**

Key lock	Holding down the **REMOTE / LOCAL** key for 3 s can turn the key lock on/off. While the key lock is engaged, the key lock icon is displayed on the screen.
System reset	The instrument setting is reset to the initial state. However, the language and communications settings are not reset.
Boot-key reset	The instrument's settings are reverted to their factory defaults if the instrument is turned on while the **SYSTEM** key is held down. All settings, including the language and communications settings, are reverted to their factory defaults.
File operation	Displaying data list stored on a USB flash drive, formatting a USB flash drive, creating new folders, renaming folders/files, copying/deleting files, updating the firmware, displaying screenshots, creating/loading settings files

Specifications

10

External interface specifications

(1) USB flash drive

Connector	USB Type A receptacle connector ×1
Standard/method	USB 3.0 (Super Speed)
Device to be connected	USB flash drive
Data to be recorded on USB flash drives	Saving/loading settings files Saving measurement values and automatically recorded data Saving waveform data and screenshots

(2) LAN

Connector	RJ-45 connector ×1
Standard/method	IEEE 802.3 compliant
Transmission method	100Base-TX, 1000Base-T (automatic detection)
Protocol	TCP/IP (with DHCP function)
Functions	HTTP server (remote operation) Dedicated port (data transfer, command control) FTP server (file transfer) FTP client Modbus/TCP server

(3) GP-IB

Connector	Micro-ribbon 24-pin connector ×1
Standard/method	In conformity with IEEE-488.1 1987, in consultation with IEEE-488.2 1987
Addresses	00 to 30
Remote control	The **REMOTE/LOCAL** key is lit up while the instrument is in remote mode. Pressing the **REMOTE/LOCAL** key allows the instrument exit remote mode.

(4) RS-232C

Connector	D-sub 9-pin connector ×1, 9 pins, shared with the external control
Standard/method	RS-232C, in conformity with EIA RS-232D, CCITT V.24, and JIS X5101 Full duplex, start-stop synchronization, data length: 8, no parity, stop bit: 1
Flow control	Not equipped
Communications speed	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps
Function	Switchable between command control and external control (simultaneous use not supported)

(5) External control

Connector	D-sub 9-pin connector ×1, commonly used with RS-232C
Pin assignment	No. 1 pin: Start/stop No. 4 pin: Hold No. 5 pin: Ground No. 6 pin: Data reset
Electrical specifications	Tow-level (low: 0 V, high: 2.5 V to 5 V) logic signals or contact signal with terminal shorted/open

264

Function	Same operation as the **START/STOP** key, **DATA RESET** key, or **HOLD** key on the control panel Switchable with RS-232C (simultaneous use not supported)

(6) Optical link interface (optional)
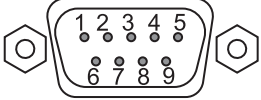
Number of instruments that can be synchronized	2 (one primary and one secondary)
Optical signal	850 nm VCSEL, 1 Gbps
Laser classification	Class 1
Available fiber	50/125 µm multi-mode fiber or equivalent, a length of up to 500 m
Capabilities	Primary instrument • Displaying received values measured with the secondary instrument (basic measurement items except the calculation measurement items and flicker measurement items, up to 50th-order harmonics). • Displaying and changing the following settings of the secondary instrument: **[WIRING]**, **[CHANNEL]**, and **[MOTOR]** • Setting the phase zero-adjusting function of the secondary instrument (**[VECTOR×1]** screen) • Displaying the configurations including the modules of the secondary instrument and the connected current sensors (**[CONFIG]** screen)

	Secondary instrument
	• Synchronizing timing of internal calculations and data updating with those of the primary instrument.
	• Sending some data to the primary instrument
	• Importing some settings of the primary instrument
	• During optical-linking, the following operations are NOT available:
	  - Changing the settings except some settings that include the optical link, communications, and language.
	  - Starting and stopping integration and resetting integration data.
	  - Outputting CAN signals
	  - Operating the instrument by pressing the keys, such as the **HOLD**, **PEAK HOLD**, **COPY**, and **SAVE** keys.
	
	The instruments with the data update interval set at 10 ms or less cannot synchronize with each other.
	The primary instrument in IEC measurement mode cannot synchronize with the secondary instrument.
	The optical link and BNC synchronization are mutually exclusive.

Specifications

10

(7) BNC synchronization

Connector	BNC
Number of instruments that can be synchronized	4 (one primary and three secondary)
Capabilities	Primary instrument Sending control signals to the secondary instruments
	Secondary instruments Synchronizing the following capabilities and operations with those of the primary instrument • Timing of internal calculations and data updating • Start and stop of integration and integration-data reset • Freeze of the on-screen values when the **HOLD** or **PEAK HOLD** key of the primary instrument are pressed, update of data during the display freezing. • Zero adjustment • Operation of the instrument by pressing the **SAVE** and **COPY** keys • Present time (Synchronizable items cannot be controlled; their settings cannot be change during synchronization) The primary and secondary instruments can synchronize only when they have the same settings of the measurement mode and data update interval; those with a data update interval of 10 ms or less cannot. The optical link and BNC synchronization are mutually exclusive settings.

CAN/CAN FD interface specifications (optional)

Protocol	CAN (classical) CAN FD (in conformity with ISO 11898-1:2015) CAN FD (not in conformity with ISO)	
Function	Data output	
CAN port	1 port	
Number of installed modules	1 (Cannot be installed in combination with the Waveform and D/A output option.)	
Baud rate	CAN:	125 k, 250 k, 500 k, 1 Mbps
	CAN FD:	(The baud rate options are common to the following two CAN FD protocols: ISO-compliant and ISO-non-compliant.) Arbitration area: 500 k, 1 Mbps Data area: 500 k, 1 M, 2 M, 4 Mbps
Format	Standard, extended	
Setting mode	Off, output mode	
Data frame output	Continuous	
Continuous	Output interval:	1 ms, 10 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 5 s, 10 s, 15 s, 30 s, 1 min., 5 min., 10 min., 15 min., 30 min., 60 min. With an error of ±1 ms from each data update interval setting However, the output interval less than the data update interval cannot be set. The output interval of 500 ms is unavailable with the data update interval of 200 ms. In IEC measurement mode, the output intervals of 100 ms and 500 ms are available with the data update interval of 200 ms.
	Repeated output count:	0 to 10000 (0: unlimited count)
Sample point setting	0.0% to 99.9%	

Output items	See "Output parameters" (p. 268).
CAN transmitter/ receiver	MCP2544 FD
Communication connector	D-sub 9-pin connector (male) Locking screw (hexagonal pillar): Inch screw #4-40 UNC Pin assignment

Pin	Assignment	I/O	Function
1	N.C.	—	Unused
2	CAN_L	OUT	CAN_Low communication line
3	GND	—	GND
4	N.C.	—	Unused
5	Shield	—	Shield (internally connected to GND)
6	N.C.	—	Unused
7	CAN_H	OUT	CAN_High communication line
8	N.C.	—	Unused
9	N.C.	—	Unused

Setting ID	Standard format: 0x000 to 0x7FF Extended format: 0x00000000 to 0x1FFFFFFF
Terminal resistance	On/off Resistance value: 120 Ω ±10 Ω
Data conversion	Measurement data — Floating-point type (float: 4 bytes) Output count, output time: Unsigned integer
Byte order (Endianness)	Intel (little-endian)

Specifications

10

Output parameters

Selected output parameter	Notation	Selected output parameter	Notation
Voltage RMS value	Urms	Reactive power	Q
Voltage mean value rectification RMS equivalent	Umn	Fundamental wave reactive power	Qfnd
Voltage AC component	Uac	Power factor	λ
Voltage simple average	Udc	Fundamental wave power factor	λfnd
Voltage fundamental wave component	Ufnd	Voltage phase angle	θU
Voltage waveform peak (+)	Upk+	Current phase angle	θI
Voltage waveform peak (−)	Upk−	Power phase angle	Φ
Total harmonic voltage distortion	Uthd	Voltage frequency	fU
Voltage ripple factor	Urf	Current frequency	fI
Voltage unbalance rate	Uunb	Integrated positive current value	Ih+
Current RMS value	Irms	Integrated negative current value	Ih−
Current mean value rectification RMS equivalent	Imn	Sum of positive and negative current values	Ih
Current AC component	Iac	Integrated positive power value	WP+
Current simple average	Idc	Integrated negative power value	WP−
Current fundamental wave component	Ifnd	Sum of integrated positive and negative power values	WP
Current waveform peak (+)	Ipk+	Efficiency	n
Current waveform peak (−)	Ipk−	Loss value	Loss
Total harmonic current distortion	Ithd	Torque	Tq
Current ripple factor	Irf	RPM	Spd
Current unbalance rate	Iunb	Motor power	Pm
Active power	P	Slip	Slip
Fundamental wave active power	Pfnd	Output count	Count
Apparent power	S	Output time	Time
Fundamental wave apparent power	Sfnd	User-defined formula	UDF

10.3 Functional Specifications

Auto-ranging

Function	The voltage and current ranges for each wiring configuration are automatically switched in response to the input. (excluding motor input ranges)
Operating mode	Off/on (selectable for each wiring configuration)
Action	Measured values for the corresponding wiring configuration or motor input when the range changes become invalid. However, data for other wiring configurations is not affected. The waveform's period may become longer than the invalidation period if the synchronization frequency is low. In this case, measured values will take longer to stabilize than the invalid data displaying period. This affects not only auto-range switching, but also manual range switching.
Range switching conditions	**Switch to the range immediately above** When either of the following conditions is satisfied in any one of the channels in the connection: • The RMS value is greater than or equal to 110% of the range. • The absolute value of the peak value is greater than or equal to 300% of the range. **Switch to the range immediately below** When all channels in a connection satisfy both the following conditions: • The RMS value is less than or equal to 40% of the range. • The absolute value of the peak value is less than or equal to 280% of the range immediately below. The following values are used to determine which range to use: • RMS value: Instantaneous value (not averaged) When Δ-Y conversion is set to on, multiply the voltage range by $\frac{1}{\sqrt{3}}$. • Peak value: Value not digital-LPF-processed

Time control

Function	Other functions are controlled based on the time. Timer control, real time control
Operation	Timer control: Stops once the set amount of time has elapsed. Real time control: Starts at the specified time and stops at the specified time.
Timer control	Off, 1 s to 9999 h 59 min. 59 s (in 1 s increments)
Real time control	Off, start time, stop time (in 1 s increments)

Specifications

10

269

Hold function

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(1) Hold

Functions	Stops updating display of all measured values, freezing the presently on-screen figures. However, updating continues for waveforms, the clock, and on-screen peak-over conditions. Internal calculations, for example integration and averaging, continue. Cannot be used in combination with the peak hold function.
Operating mode	Off/on
Action	Pressing the **HOLD** key can activate the function, lighting up the **HOLD** key and displaying the hold icon on the screen. Pressing the **PEAK HOLD** key can update data when the hold function has been enabled. Data is updated at the internal data intervals (which is distinct from the display update interval).
Output data	Internally retained frozen data is outputted as analog output and stored on a USB flash drive. (However, waveform output continues).
Backup	None (The function is disabled when the instrument is turned off.)
Constraint	While the hold function is activated, settings that affect measured values cannot be changed.

(2) Peak hold

Function	The display is updated by replacing all measured values with the maximum values obtained by comparing the absolute values for each measured value. However, the waveform display and integrated values continue to be updated by replacing them with instantaneous data. During average operation, the maximum value affects values measured after averaging. Cannot be used in combination with the hold function.
Operating mode	Off/on
Action	Pressing the **PEAK HOLD** key can activate the function, lighting up the **PEAK HOLD** key and displaying the peak hold icon on the screen. Pressing the **PEAK HOLD** key again can turn the function off. When the peak hold function is enabled, data is updated when the **HOLD** key is pressed.
Output data	During the peak-hold operation, internally retained peak-hold data is outputted as analog output and stored on a USB flash drive. (However, waveform output continues).
Backup	None (The function is disabled when the instrument is turned off.)
Constraint	While the peak-hold function is activated, settings that affect measured values cannot be changed.

Calculation function

(1) Rectification method

Function	The voltage and current values used to calculate apparent and reactive power and power factor can be selected.
Operating mode	RMS, mean (Can be selected for each wiring configuration's voltage and current.)

(2) Scaling

Function	The VT ratio and CT ratio can be set so that they can affect measured values.
VT (PT) ratio	Can be set for each wiring configuration. 0.00001 to 9999.99 (The settings cannot be configured such that (VT × CT) is greater than 1.0E+06.)
CT ratio	Can be set for each channel. 0.00001 to 9999.99 (The settings cannot be configured such that (VT × CT) is greater than 1.0E+06.)
Display	While the scaling enabled, the **[VT]** and **[CT]** icons are displayed on the screen.

(3) Average (AVG)

Function	All instantaneous measured values, including harmonics, are averaged. (Excluding peak values, integrated values, and harmonic data during the 10 ms-interval data update.) Voltage (U), current (I), and power (P) values are averaged. Calculated values are computed from those values. For harmonics, instantaneous values are averaged for RMS values and content percentages. The phase angles are calculated from the average results of FFT-processed real and imaginary parts. The phase difference, distortion, and unbalance rate are calculated from data obtained by the above averaging. The ripple factor is calculated from data computed by averaging the difference between the positive and negative peak values. Measured motor-analysis values are calculated from data computed by averaging the Ch. A to Ch. H values. When the data update interval is set to 1 ms, all measurements are not averaged (averaging is forcibly set to off). Moving average is not selectable in IEC measurement mode. The flicker measurement items are totally not averaged.	
Operating mode	Off, exponential average, moving average	
Operation	Exponential average	Data is exponentially averaged using a time constant specified by the data update intervals and the exponential average response speed. During average operation, averaged data affects all analog output and save data.
	Moving average	Averaging is performed for the moving averaging count at the data update interval to update the output data. Same as the data update interval without averaging

Exponential average response speed	Averaging count	Fast	Mid	Slow
	10 ms	0.1 s	0.8 s	5 s
	50 ms	0.5 s	4 s	25 s
	200 ms	2.0 s	16 s	100 s

These values indicate the time required for the final stabilized value to converge on the range of ±1% when the input changes from 0% to 90% of the range.
Although harmonic data is not averaged when the data update interval is set at 10 ms, harmonic data contained in basic measurement items is averaged using the exponential average coefficient every 10 ms.
The speed is fixed in IEC measurement mode.

Moving averaging count	8, 16, 32, 64 times

(4) Efficiency-loss calculations

Function	The efficiency η (%) and loss (W) of each channel are calculated between wiring configurations' active power values.
Calculation item	Active power value (P), fundamental wave active power (Pfnd), and motor power (Pm) of each channel and wiring configuration
Calculation precision	Performs 32-bit floating-point arithmetic operation for measured values of the parameters substituted into equations. When performing calculations between wiring configurations with different power range settings, the largest range in the same calculation is used.
Calculation interval	Calculations are updated at the data update intervals. When performing calculations between wiring configurations with different synchronization sources, the most recent data at the time of the calculation is used.
Number of calculations that can be performed	Four for each efficiency and loss
Mode	Fixed mode: Items set on the input and output sides, regardless of the measured value, the position in the arithmetic expression is fixed. Auto mode: Items set on the input and output sides change the position in the calculation formula according to the positive and negative of the measured value.
Equation	Fixed mode: Calculation items can be substituted for Pin(n) and Pout(n) $$Pin = Pin1 + Pin2 + Pin3 + Pin4 + Pin5 + Pin6$$ $$Pout = Pout1 + Pout2 + Pout3 + Pout4 + Pout5 + Pout6$$ $$\eta = 100 \times \frac{|Pout|}{|Pin|}, \ Loss = |Pin| - |Pout|$$ Auto mode: Pin = (Sum of the absolute values of the positive parameter of the input and that of the negative parameter of the output) Pout = (Sum of the absolute values of the positive parameter of the output and that of the negative parameter of the input) $$\eta = 100 \times \frac{|Pout|}{|Pin|}, \ Loss = |Pin| - |Pout|$$

(5) User-defined formula (UDF)

Function	Calculates specified calculation formulas into which set basic measurement parameters (except the flicker measurement items) are substituted. No calculation can be performed if the data update interval is set to 1 ms. (**[-------]** is displayed.)

Calculation items	Basic measurement items (except the flicker measurement items) or 16 terms of constants with up to 6 digits, where the operators are the four fundamental operations
	UDFn = ITEM1 □ ITEM2 □ ITEM3 □ ITEM4 □ ... □ ITEM16
	  ITEMn: Basic measurement items (including UDFn, excluding the flicker measurement items) or constants of up to six digits
	  The □ characters indicate one of the following operators: plus sign (+), minus sign (−), multiplication sign (*), and division sign (/).
	
	  ITEMn functions:
	  Neg (negative sign), sin, cos, tan, abs, log10 (common logarithm), log (logarithm), exp, sqrt, asin, acos, atan, sqr
	  Equations UDFns are calculated in the order of letters n; if a letter n on the right-hand side of an equation is more than that on the left-hand side, the previously calculated value is substituted.

Number of calculations that can be performed	20 (UDF1 to UDF20)
Maximum value setting	Set *Fixed* or *Auto* for each UDFn. Fixed: Can be set within the range of 1.000 n to 999.999 T. Auto: The first 6 digits are always displayed. (effective display range: 0 to ±999.999 Y) The maximum value operates as a range of the UDFn.
UDF name	Up to 8 ASCII characters per UDFn
Unit	Up to 8 ASCII characters per UDFn
Integration	Off/on Can be set for each UDFn Off: Displays the calculated value of the UDFn. On: Displays the integrated value of the UDFn formula. (effective display range: 0 to ±999.999 Y) Other values are not added if the integrated value exceeds the effective display range.

(6) Delta conversion

Function	Δ-Y:	In 3P3W3M or 3V3A wiring mode, the line voltage waveforms are converted into phase voltage waveforms using a virtual neutral point.
	Y-Δ:	In 3P4W wiring mode, the phase voltage waveforms are converted into line voltage waveforms. All voltage parameters with harmonics components, including voltage RMS values, are calculated using the converted voltages. However, the peak-over judgment uses not-converted values.
Equation	Δ-Y 3P3W3M:	U(i)s = (u(i)s − u(i+2)s) / 3, U(i+1)s = (u(i+1)s − u(i)s) / 3, U(i+2)s = (u(i+2)s − u(i+1)s) / 3
	Δ-Y 3V3A:	U(i)s = (u(i)s − u(i+2)s) / 3, U(i+1)s = (u(i+2)s + u(i+1)s) / 3, U(i+2)s = (−u(i+1)s − u(i)s) / 3
	Y-Δ:	u(i)s = U(i)s − U(i+1)s, u(i+1)s = U(i+1)s − U(i+2)s, u(i+2)s = U(i+2)s − U(i)s
	(i): channel under measurement, u(x)s: sampled line-voltage value, U(x)s: sampled phase-voltage value	

10

(7) Power calculation method selection

Function	Equations for reactive power, power factor, and power phase angle can be selected. See "10.5 Specifications of Equations" (p. 291).
Equation	Type 1, Type 2, Type 3 Type 1: Compatible with the Type 1 for each of the PW3390, 3193, and 3390. Type 2: Compatible with the Type 2 for each of the 3192 and 3193. Type 3: The active power's sign can be used as the power factor' sign. (Type 1, Type 2, and Type 3 are compatible with each equation of the PW6001.)

(8) Current sensor phase compensation

Function	Current sensor's harmonic phase characteristics can be compensation using calculations.
Operating mode	Off, on, automatic (set for each channel) Automatic mode can be selected when a current sensor compatible with the automatic recognition function is connected.
Compensation value settings	Compensation points can be set using frequencies and phase differences. Frequency: 0.1 kHz to 5000.0 kHz (in 0.1 kHz increments) Phase difference: 0.000° to ±180.000° (in 0.001° increments) The compensation value is automatically set when the current sensor is connected in the automatic operation mode.
Maximum compensation range	U7005: Approx. 9.4 µs U7001: Approx. 15.8 µs

(9) Voltage-probe phase compensation

Function	Voltage probes' harmonic phase characteristics can be compensated using calculations.
Operating mode	Off/on (can be set for each channel)
Compensation value settings	Compensation points can be set using frequencies and phase differences. Frequency: 0.1 kHz, to 5000.0 kHz (in 0.1 kHz increments) Phase difference: 0.000° to ±180.000° (in 0.001° increments)
Maximum compensation range	U7005: approx. 9.4 µs U7001: approx: 15.8 µs

Display function

(1) Wiring configuration confirmation screen

Function	Wiring diagrams as well as vector diagrams of voltage and current (for wiring configurations other than the single-phase wiring configuration only) can be displayed based on the selected measured line patterns. The on-screen vector diagram shows the vector ranges for correct connections, enabling the operator to check for proper connections.
Startup mode	The setting can be made so that the instrument always show the wiring configuration confirmation screen at startup (startup screen setting).
Simple settings	Settings can be switched over those appropriate for objects under measurement selected for each wiring configuration. **[50/60Hz]**, **[DC/WLTP]**, **[PWM]**, **[HIGH FREQ]**, **[GENERAL]**

(2) Vector display screen

Function	The screen can display wiring-specific vector graphs along with associated level values and phase angles. The display orders and vector magnification can be selected.
Display pattern	1-vector-diagram: Vectors can be drawn for up to eight channels. 2-vector-diagram, 4-vector-diagram: Vectors can be drawn for each selected wiring configuration.

(3) Numerical display screen

Function	The screen can display measured power values and motor values for up to eight installed channels.
Display pattern	Basic display for each wiring configuration: The screen can display measured values of the lines under measurement and motors connected to the instrument. In addition to the four patterns, U, I, P, and Integ as well as motor is available. On-screen values are linked to the channel indicators. Selective display: The screen can display values of any measurement items selected from all basic measurement items at any positions. There are 8-, 16-, 36-, and 64-display patterns available.

(4) Harmonic display screen

Function	The screen can display measured harmonic values.
Display pattern	Bar-graph display: The screen can display measured harmonic items for user-specified channels as bar graphs. (up to 500th) List display: The screen can display numerical values for user-specified parameters of user-specified channels.

(5) Waveform display screen

Functions	The screen can display the motor waveform as well as the voltage and current waveforms.
Display pattern	All-waveform display Waveform+numerical value display, zoom display, FFT display Cursor measurement supported

Specifications

10

Automatic data-saving function

Function	The user-specified measured values can be saved periodically. Auto-save operation is controlled by the time control function. Data is recorded in the same file until the **DATA RESET** key is pressed.
Saving destination location	Off, USB flash drive A folder created on a USB flash drive can be specified as the destination to save data.
Parameters to be saved	Selectable from all measured values, including measured harmonic values. Harmonic readings are not saved automatically when the interval is set to 1 ms.
Maximum number of parameters to be saved	Variable with the interval setting
Maximum data size to be saved	Approx. 500 MB per file (automatically segmented) × 1000 files No function is provided for automatically erasing files when the media is full.
Data saving interval	OFF, 1 ms, 10 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 5 s, 10 s, 15 s, 30 s, 1 min., 5 min., 10 min., 15 min., 30 min., 60 min. However, the interval cannot be set to less than the data update interval. • In wideband measurement mode, the data saving interval of 500 ms is unavailable with the data update interval of 200 ms. • In IEC measurement mode, the output intervals of 100 ms and 500 ms are available with the data update interval of 200 ms.
Data format	Delimiters can be selected. CSV: Measured data is delimited with commas (,), and periods (.) represent decimal points. SSV: Measured data is delimited with semicolons (;), and commas (,) represent decimal points. BIN: Common file-format that can be loaded by GENNECT One
Filename	Automatically generated based on the time and date at which measurement started.

Manual data-saving function

(1) Measured data

Function	Pressing the **SAVE** key can save values measured at the moment. The data is outputted to the same file until the setting is changed, or the **DATA RESET** key is pressed.
Saving destination location	USB flash drive
Parameters to be saved	Selectable from all measured values, including measured harmonic values.
Maximum data size to be saved	500 MB per file (automatically segmented)
Data format	CSV, SSV
Filename	Automatically generated

(2) Waveform data

Function	When **[SAVE]** - **[Waveforms]** is tapped on the waveform screen on the touch screen, the waveform is saved in the specified format.
Saving destination location	USB flash drive
Parameters to be saved	On-screen waveform data on the waveform screen
Maximum data size to be saved	Approx. 400 MB (in binary format) Approx. 2 GB (in text format) 500 MB per file (automatically segmented)
Data format	CSV, SSV, BIN, MAT
Filename	Automatically generated

(3) FFT data

Function	When **[SAVE]** is tapped on the waveform+FFT screen on the touch screen, the FFT calculation results is saved.
Saving destination location	USB flash drive
Items to be saved	On-screen FFT data on the waveform+FFT screen
Maximum number of items to be saved	Same as the number of on-screen items
Maximum data size that can be saved	112 MB (in text format) 1,000.000 data points per file (automatically separated)
Data format	CSV, SSV
Filename	Automatically generated

Specifications

10

277

(4) Screenshot

Function	Pressing the **COPY** key can save the screen displayed at the moment in PNG format. Setting list screenshot function Comment entering function Free drawing function (Concurrent use of the comment entering function and free drawing function is not available.)
Saving destination location	USB flash drive or FTP server
Parameters to be saved	Screenshot
Data format	PNG
Filename	Automatically generated

(5) Settings data

Function	Saves various settings information as settings files using the **[FILE]** screen. In addition, loading a settings file saved using the **[FILE]** screen can restore settings. However, the language and communications settings are not restored. Settings data can be opened with the image viewer because it is inserted into an image that displays a settings list.
Saving destination location	USB flash drive or FTP server
Saved parameters	Settings data
Data format	SET
Filename	File names set at the time of saving (up to 8 characters)

(6) CAN output settings data

Function	Data-output settings can be saved as DBC-files using the **[CAN OUTPUT]** screen.
Saving destination location	USB flash drive or FTP server
Saved parameters	Output settings data
Data format	DBC
Filename	File names set at the time of saving (up to 8 characters)

(7) User-defined formula (UDF) settings data

Function	User-defined formulas can be saved as JSON files using the **[UDF]** screen. Loading a JSON file saved using the **[UDF]** or **[FILE]** screen can restore the calculation formulas. Calculation is not possible if the loaded formulas include calculation items that are invalid (items that cannot be selected according to the module, option configuration, or other setting). (**[-------]** is displayed)
Saving destination location	USB flash drive or FTP server
Saved parameters	User-defined formula
Data format	JSON
Filename	File names set at the time of saving (up to 8 characters)

Other functions

Clock function	Auto-calendar, automatic leap-year detection, 24-hour clock
Real time accuracy	When the instrument is turned on: ±100 ppm When the instrument is turned off: Within ±3 s/day (at 25°C)
Sensor identification	Current sensors connected to input modules can be identified automatically. The instrument can detect sensors' ranges and connection/disconnection of sensors, displaying warning dialogs. Data compensation values provided by current sensors affect compensation data.
Zero suppress capability	Selectable between off and on (0.5 f.s.). When this function is enabled, values of measurement items less than 0.5% of full scale are replaced with zero. Target measurement items are listed in "10.4 Detailed Specifications of Measurement Parameters" (p. 280).

10.4 Detailed Specifications of Measurement Parameters

Basic measurement items

(1) Power measurement items

	Measurement item	Notation	1P2W	1P3W 3P3W2M	3P3W3M 3V3A	3P4W
Voltage	RMS value	Urms	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
	RMS equivalent of average rectified value	Umn	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
	AC component	Uac	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Simple average	Udc	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Fundamental wave component	Ufnd	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Waveform peak +	Upk+	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Waveform peak −	Upk−	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Total harmonic distortion	Uthd	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Ripple factor	Urf	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Unbalance rate	Uunb	—	—	(i, i+1, i+2)	(i, i+1, i+2)
Current	RMS value	Irms	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
	RMS equivalent of average rectified value	Imn	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
	AC component	Iac	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Simple average	Idc	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Fundamental wave component	Ifnd	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Waveform peak +	Ipk+	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Waveform peak −	Ipk−	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Total harmonic distortion	Ithd	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Ripple factor	Irf	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Unbalance rate	Iunb	—	—	(i, i+1, i+2)	(i, i+1, i+2)
Active power		P	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Fundamental wave active power		Pfnd	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Apparent power		S	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Fundamental wave apparent power		Sfnd	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Reactive power		Q	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Fundamental wave reactive power		Qfnd	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Power factor		λ	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Fundamental wave power factor		λfnd	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)
Phase angle	Voltage phase angle	θU	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Current phase angle	θI	i	i, i+1	i, i+1, i+2	i, i+1, i+2
	Power phase angle	φ	i	i, i+1, (i, i+1)	i, i+1, i+2, (i, i+1, i+2)	i, i+1, i+2, (i, i+1, i+2)

i: Channel (Ch. 1 to Ch. 8) with which instrument is equipped

( ):   Indicates SUM values.

Measurement item		Notation	Unit	Display range	Polarity (+/−)
Voltage	RMS value	Urms	V	*Zero* to 150%[*1] of the U range	
	RMS equivalent of average rectified value	Umn	V	*Zero* to 150%[*1] of the U range	
	AC component	Uac	V	*Zero* to 150%[*1] of the U range	
	Simple average	Udc	V	*Zero* to 150%[*2] of the U range	✓
	Fundamental wave component	Ufnd	V	*Zero* to 150%[*1] of the U range	
	Waveform peak +	Upk+	V	*Zero* to 300%[*2] of the U range	✓
	Waveform peak −	Upk−	V	*Zero* to 300%[*2] of the U range	✓
	Total harmonic distortion	Uthd	%	0.000 to 500.000	
	Ripple factor	Urf	%	0.000 to 500.000	
	Unbalance rate	Uunb	%	0.000 to 100.000	
Current	RMS value	Irms	A	*Zero* to 150% of the I range	
	RMS equivalent of average rectified value	Imn	A	*Zero* to 150% of the I range	
	AC component	Iac	A	*Zero* to 150% of the I range	
	Simple average	Idc	A	*Zero* to 150% of the I range	✓
	Fundamental wave component	Ifnd	A	*Zero* to 150% of the I range	
	Waveform peak +	Ipk+	A	*Zero* to 300%[*3] of the I range	✓
	Waveform peak −	Ipk−	A	*Zero* to 300%[*3] of the I range	✓
	Total harmonic distortion	Ithd	%	0.000 to 500.000	
	Ripple factor	Irf	%	0.000 to 500.000	
	Unbalance rate	Iunb	%	0.000 to 100.000	
Active power		P	W	*Zero* to 150% of the P range	✓
Fundamental wave active power		Pfnd	W	*Zero* to 150% of the P range	✓
Apparent power		S	VA	*Zero* to 150% of the P range	
Fundamental wave apparent power		Sfnd	VA	*Zero* to 150% of the P range	
Reactive power		Q	Var	*Zero* to 150% of the P range	✓
Fundamental wave reactive power		Qfnd	Var	*Zero* to 150% of the P range	✓
Power factor		λ	—	0.00000 to 1.00000	✓
Fundamental wave power factor		λfnd	—	0.00000 to 1.00000	✓
Phase angle	Voltage phase angle	θU	degree	0.000 to 180.000	✓
	Current phase angle	θI	degree	0.000 to 180.000	✓
	Power phase angle	φ	degree	0.000 to 180.000	✓

*1: Only for the 1500 V range, 135%.
This range does not change even when the delta conversion function is used.
*2: Only for the 1500 V range, 135%.
*3: Only for the 5 V range of Probe 2, 150%.

When the Upk+ or Upk− voltage waveform peak, or the Ipk+ or Ipk− current waveform peak exceeds the display range, a peak-over condition is considered to have occurred.

Zero: Zero suppress set value (Off: 0%, on, 0.5%)

(2) Integration measurement items

Measurement item		Notation	1P2W	1P3W 3P3W2M	3P3W3M 3V3A	3P4W
Integration	Integrated positive current value[1]	Ih+	i	—	—	—
	Integrated negative current value[1]	Ih−	i	—	—	—
	Sum of integrated positive and negative current values	Ih	i	i	i	i
	Integrated positive power value	WP+	i	(i, i+1)	(i, i+1, i+2)	(i, i+1, i+2)
	Integrated negative power value	WP−	i	(i, i+1)	(i, i+1, i+2)	(i, i+1, i+2)
	Sum of integrated positive and negative power values	WP	i	(i, i+1)	(i, i+1, i+2)	(i, i+1, i+2)

i: Channel (Ch. 1 to Ch. 8) with which instrument is equipped
( ):   Indicates SUM values.
[1]:   Only channels with the integration mode set to DC mode

Measurement item		Notation	Unit	Display range	Polarity (+/−)
Integration	Integrated positive current value	Ih+	Ah	*Zero* to 1% of the I range or more[2]	
	Integrated negative current value	Ih−	Ah	*Zero* to 1% of the I range or more[2]	[3]
	Sum of integrated positive and negative current values	Ih	Ah	*Zero* to 1% of the I range or more[2]	✓
	Integrated positive power value	WP+	Wh	*Zero* to 1% of the P range or more[2]	
	Integrated negative power value	WP−	Wh	*Zero* to 1% of the P range or more[2]	[3]
	Sum of integrated positive and negative power values	WP	Wh	*Zero* to 1% of the P range or more[2]	✓

[2]: Positive, negative, and positive/negative values are acquired using the same range. They are displayed in the digits in which the maximum value of them can be displayed.
[3]: Indicates a parameter whose sign is always negative.

Zero: Zero suppress set value (Off: 0%, on, 0.5%)

(3) Frequency and calculation measurement items

Measurement item	Notation	Unit	Channel	Display range	Polarity (+/−)
Voltage frequency	fU	Hz	i	0.00000 Hz to 2.00000 MHz	
Current frequency	fI	Hz	i	0.00000 Hz to 2.00000 MHz	
Efficiency	η	%	1, 2, 3, 4	0.000 to 200.000	
Loss	Loss	W	1, 2, 3, 4	150% of the P range	✓
User-defined calculation	UDF	Free*	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	User-defined value	✓

i: installed channels among Ch. 1 to Ch. 8
*: Can be set by user.

282

(4) Motor analysis measurement items (only when the motor analysis option is installed)

Wiring pattern	Ch. A		Ch. B		Ch. C		Ch. D	
	Input item	Notation	Input item	Notation	Input item	Notation	Input item	Notation
Individual Input	Voltage, pulse	CH A	Pulse	CH B	Voltage, pulse	CH C	Pulse	CH D
	Motor 1				Motor 2			
Torque Speed (Pulse)	Torque*[1]	Tq1	RPM	Spd1	Torque*[1]	Tq2	RPM	Spd2
	Motor 1							
Torque Speed Direction Origin	Torque*[1]	Tq1	RPM	Spd1	Rotation direction	—	Z phase	—
Torque Speed Direction	Torque*[1]	Tq1	RPM	Spd1	Rotation direction	—	Off	—
Torque Speed Origin	Torque*[1]	Tq1	RPM	Spd1	OFF	—	Z phase	—
Torque Speed (Analog)	Torque*[1]	Tq1	Off	—	RPM	Spd1	Off	—

Wiring pattern	Ch. E		Ch. F		Ch. G		Ch. H	
	Input item	Notation	Input item	Notation	Input item	Notation	Input item	Notation
Individual Input	Voltage, pulse	CH E	Pulse	CH F	Voltage, pulse	CH G	Pulse	CH H
	Motor 3				Motor 4			
Torque Speed (Pulse)	Torque*[1]	Tq3	RPM	Spd3	Torque*[1]	Tq4	RPM	Spd4
	Motor 3							
Torque Speed Direction Origin	Torque*[1]	Tq3	RPM	Spd3	Rotation direction	—	Z phase	—
Torque Speed Direction	Torque*[1]	Tq3	RPM	Spd3	Rotation direction	—	Off	—
Torque Speed Origin	Torque*[1]	Tq3	RPM	Spd3	Off	—	Z phase	—
Torque Speed (Analog)	Torque*[1]	Tq3	Off	—	RPM	Spd3	Off	—

*1: Switchable between analog DC input and frequency input.

Specifications

10

283

Units and display ranges of measurement items

	Measurement item	Setting	Unit	Display range*2	Polarity (+/−)
Ch. A, Ch. E	Torque	Analog DC	N·m	*Zero* to 150% of the range	✓
		Frequency		0% to 150% of the rated torque setting	✓
	Voltage	Analog DC	V, user-specified	*Zero* to 150% of the range	✓
	Pulse frequency	Pulse	Hz		
Ch. B, Ch. F	RPM	Pulse	r/min		
	Pulse frequency	Pulse	Hz		
Ch. C, Ch. G	Torque	Analog DC	N·m	*Zero* to 150% of the range	✓
		Frequency		0% to 150% of the rated torque setting	✓
	RPM	Analog DC	r/min	*Zero* to 150% of the range	✓
	Voltage	Analog DC	V, user-specified	*Zero* to 150% of the range	✓
	Pulse frequency	Pulse	Hz		
Ch. D, Ch. H	RPM	Pulse	r/min		
	Pulse frequency	Pulse	Hz		
Pm	Motor power		W	*Zero* to 150% of the Pm range	✓
Slip	Slip		%	0.000 to 100.000	✓

*2: When scaling is set, add the scaling value to the range.

Zero: Zero suppress set value (Off: 0%, on, 0.5%)
No peak-over detection is performed for measured values for motor analysis measurement items.

(5) Flicker measurement items (only in IEC measurement mode)

Measurement item	Notation	1P2W	1P3W/3P3W2M	3P3W3M/3V3A	3P4W
Short-term flicker value	Pst	i	i	i	i
Maximum short-term flicker value	PstMax	i	i	i	i
Long-term flicker value	Plt	i	i	i	i
Maximum instantanesous flicker value	PinstMax	i	i	i	i
Minimum instantanesous flicker value	PinstMin	i	i	i	i
Relative steady-state voltage change	dc	i	i	i	i
Maximum relative voltage change	dmax	i	i	i	i
Period while the relative voltage change exceeds the threshold	Tmax	i	i	i	i

i: installed channels among Ch. 1 to Ch. 8

Measurement item	Notation	Unit	Display range	Polality (+/−)
Short-term flicker value	Pst	–	From 0.001	Non-polar
Maximum short-term flicker value	PstMax	–	From 0.001	Non-polar
Long-term flicker value	Plt	–	From 0.001	Non-polar
Maximum instantanesous flicker value	PinstMax	–	From 0.001	Non-polar
Minimum instantanesous flicker value	PinstMin	–	From 0.001	Non-polar
Relative steady-state voltage change	dc	%	0.001 to 999.999	Non-polar
Maximum relative voltage change	dmax	%	0.001 to 999.999	Non-polar
Period while the relative voltage change exceeds the threshold	Tmax	s	From 0.001 m	Non-polar

Specifications

10

285

Harmonic measurement items

Measurement item	Notation	1P2W	1P3W 3P3W2M	3P3W3M 3V3A	3P4W
Harmonic voltage RMS value	Uk	i	i	i	i
Harmonic voltage phase angle	θUk	i	i	i	i
Harmonic current RMS value	Ik	i	i	i	i
Harmonic current phase angle	θIk	i	i	i	i
Harmonic active power	Pk	i	i, (i, i+1)	i, (i, i+1, i+2)	i, (i, i+1, i+2)
Harmonic voltage-vs.-current phase difference	θk	i	i, (i, i+1)	i, (i, i+1, i+2)	i, (i, i+1, i+2)
Harmonic voltage content percentage	HDUk	i	i	i	i
Harmonic current content percentage	HDIk	i	i	i	i
Harmonic power content percentage	HDPk	i	i, (i, i+1)	i, (i, i+1, i+2)	i, (i, i+1, i+2)

i: installed channels among Ch. 1 to Ch. 8

Measurement item	Notation	Unit	Display range	Polarity (+/−)
Harmonic voltage RMS value	Uk	V	0% to 150% of the U range	*
Harmonic voltage phase angle	θUk	degree	0.000 to 180.000	✓
Harmonic current RMS value	Ik	A	0% to 150% of the I range	*
Harmonic current phase angle	θIk	degree	0.000 to 180.000	✓
Harmonic active power	Pk	W	0% to 150% of the P range	✓
Harmonic voltage-vs.-current phase difference	θk	degree	0.000 to 180.000	✓
Harmonic voltage content percentage	HDUk	%	0.000 to 100.000	*
Harmonic current content percentage	HDIk	%	0.000 to 100.000	*
Harmonic power content percentage	HDPk	%	0.000 to 100.000	✓

*: Indicates an item the 0th component of which is signed.

Inter-harmonic measurement items (only in IEC measurement mode)

Measurement item	Notation	1P2W	1P3W/3P3W2M	3P3W3M/3V3A	3P4W
Inter-harmonic voltage RMS value	iUk	i	i	i	i
Inter-harmonic voltage content percentage	iHDUk	i	i	i	i
Inter-harmonic current RMS value	iIk	i	i	i	i
Inter-harmonic current content percentage	iHDIk	i	i	i	i

i: installed channels among Ch. 1 to Ch. 8

Measurement item	Notation	Unit	Display range	Polality (+/−)
Inter-harmonic voltage RMS value	iUk	V	0% to 150% of U range	Non-polar
Inter-harmonic voltage content percentage	iHDUk	%	0.000 to 100.000	Non-polar
Inter-harmonic current RMS value	iIk	A	0% to 150% of I range	Non-polar
Inter-harmonic current content percentage	iHDIk	%	0.000 to 100.000	Non-polar

Specifications

10

287

Power range configuration

(1) With a 20 A sensor

Voltage, wiring configuration, current		400.000 mA	800.000 mA	2.00000 A	4.00000 A	8.00000 A	20.0000 A
6.00000 V	1P2W	2.40000	4.80000	12.0000	24.0000	48.0000	120.000
	1P3W, 3V3A 3P3W (2M, 3M)	4.80000	9.60000	24.0000	48.0000	96.0000	240.000
	3P4W	7.20000	14.4000	36.0000	72.0000	144.000	360.000
15.0000 V	1P2W	6.00000	12.0000	30.0000	60.0000	120.000	300.000
	1P3W, 3V3A 3P3W (2M, 3M)	12.0000	24.0000	60.0000	120.000	240.000	600.000
	3P4W	18.0000	36.0000	90.0000	180.000	360.000	900.000
30.0000 V	1P2W	12.0000	24.0000	60.0000	120.000	240.000	600.000
	1P3W, 3V3A 3P3W (2M, 3M)	24.0000	48.0000	120.000	240.000	480.000	1.20000 k
	3P4W	36.0000	72.0000	180.000	360.000	720.000	1.80000 k
60.0000 V	1P2W	24.0000	48.0000	120.000	240.000	480.000	1.20000 k
	1P3W, 3V3A 3P3W (2M, 3M)	48.0000	96.0000	240.000	480.000	960.000	2.40000 k
	3P4W	72.0000	144.000	360.000	720.000	1.44000 k	3.60000 k
150.000 V	1P2W	60.0000	120.000	300.000	600.000	1.20000 k	3.00000 k
	1P3W, 3V3A 3P3W (2M, 3M)	120.000	240.000	600.000	1.20000 k	2.40000 k	6.00000 k
	3P4W	180.000	360.000	900.000	1.80000 k	3.60000 k	9.00000 k
300.000 V	1P2W	120.000	240.000	600.000	1.20000 k	2.40000 k	6.00000 k
	1P3W, 3V3A 3P3W (2M, 3M)	240.000	480.000	1.20000 k	2.40000 k	4.80000 k	12.0000 k
	3P4W	360.000	720.000	1.80000 k	3.60000 k	7.20000 k	18.0000 k
600.000 V	1P2W	240.000	480.000	1.20000 k	2.40000 k	4.80000 k	12.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	480.000	960.000	2.40000 k	4.80000 k	9.60000 k	24.0000 k
	3P4W	720.000	1.44000 k	3.60000 k	7.20000 k	14.4000 k	36.0000 k
1.50000 kV	1P2W	600.000	1.20000 k	3.00000 k	6.00000 k	12.0000 k	30.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	1.20000 k	2.40000 k	6.00000 k	12.0000 k	24.0000 k	60.0000 k
	3P4W	1.80000 k	3.60000 k	9.00000 k	18.0000 k	36.0000 k	90.0000 k

The following units of measurement are used: for active power (P), watt (W); for apparent power (S), volt-ampere (VA); and for reactive power (Q), volt-ampere reactive (var).
Multiply the figures given in this table by 1/10 if using a 2 A sensor, by 10 if using a 200 A sensor, or by 100 if using a 2 kA sensor.

(2) With a 50 A sensor

Voltage, wiring configuration, current		1.00000 A	2.00000 A	5.00000 A	10.0000 A	20.0000 A	50.0000 A
6.00000 V	1P2W	6.00000	12.0000	30.0000	60.0000	120.000	300.000
	1P3W, 3V3A 3P3W (2M, 3M)	12.0000	24.0000	60.0000	120.000	240.000	600.000
	3P4W	18.0000	36.0000	90.0000	180.000	360.000	900.000
15.0000 V	1P2W	15.0000	30.0000	75.0000	150.000	300.000	750.000
	1P3W, 3V3A 3P3W (2M, 3M)	30.0000	60.0000	150.000	300.000	600.000	1.50000 k
	3P4W	45.0000	90.0000	225.000	450.000	900.000	2.25000 k
30.0000 V	1P2W	30.0000	60.0000	150.000	300.000	600.000	1.50000 k
	1P3W, 3V3A 3P3W (2M, 3M)	60.0000	120.000	300.000	600.000	1.20000 k	3.00000 k
	3P4W	90.0000	180.000	450.000	900.000	1.80000 k	4.50000 k
60.0000 V	1P2W	60.0000	120.000	300.000	600.000	1.20000 k	3.00000 k
	1P3W, 3V3A 3P3W (2M, 3M)	120.000	240.000	600.000	1.20000 k	2.40000 k	6.00000 k
	3P4W	180.000	360.000	900.000	1.80000 k	3.60000 k	9.00000 k
150.000 V	1P2W	150.000	300.000	750.000	1.50000 k	3.00000 k	7.50000 k
	1P3W, 3V3A 3P3W (2M, 3M)	300.000	600.000	1.50000 k	3.00000 k	6.00000 k	15.0000 k
	3P4W	450.000	900.000	2.25000 k	4.50000 k	9.00000 k	22.5000 k
300.000 V	1P2W	300.000	600.000	1.50000 k	3.00000 k	6.00000 k	15.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	600.000	1.20000 k	3.00000 k	6.00000 k	12.0000 k	30.0000 k
	3P4W	900.000	1.80000 k	4.50000 k	9.00000 k	18.0000 k	45.0000 k
600.000 V	1P2W	600.000	1.20000 k	3.00000 k	6.00000 k	12.0000 k	30.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	1.20000 k	2.40000 k	6.00000 k	12.0000 k	24.0000 k	60.0000 k
	3P4W	1.80000 k	3.60000 k	9.00000 k	18.0000 k	36.0000 k	90.0000 k
1.50000 kV	1P2W	1.50000 k	3.00000 k	7.50000 k	15.0000 k	30.0000 k	75.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	3.00000 k	6.00000 k	15.0000 k	30.0000 k	60.0000 k	150.000 k
	3P4W	4.50000 k	9.00000 k	22.5000 k	45.0000 k	90.0000 k	225.000 k

The following units of measurement are used: watt (W) for active power (P), volt-ampere (VA) for apparent power (S), and volt-ampere reactive (var) for reactive power (Q).
Multiply the figures given in this table by 1/10 if using a 5 A sensor, by 10 if using a 500 A sensor, or by 100 if using a 5 kA sensor.

Specifications

10

(3) With a 1 kA sensor

Voltage, wiring configuration, current		20.0000 A	40.0000 A	100.000 A	200.000 A	400.000 A	1.00000 kA
6.00000 V	1P2W	120.000	240.000	600.000	1.20000 k	2.40000 k	6.00000 k
	1P3W, 3V3A 3P3W (2M, 3M)	240.000	480.000	1.20000 k	2.40000 k	4.80000 k	12.0000 k
	3P4W	360.000	720.000	1.80000 k	3.60000 k	7.20000 k	18.0000 k
15.0000 V	1P2W	300.000	600.000	1.50000 k	3.00000 k	6.00000 k	15.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	600.000	1.20000 k	3.00000 k	6.00000 k	12.0000 k	30.0000 k
	3P4W	900.000	1.80000 k	4.50000 k	9.00000 k	18.0000 k	45.0000 k
30.0000 V	1P2W	600.000	1.20000 k	3.00000 k	6.00000 k	12.0000 k	30.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	1.20000 k	2.40000 k	6.00000 k	12.0000 k	24.0000 k	60.0000 k
	3P4W	1.80000 k	3.60000 k	9.00000 k	18.0000 k	36.0000 k	90.0000 k
60.0000 V	1P2W	1.20000 k	2.40000 k	6.00000 k	12.0000 k	24.0000 k	60.0000 k
	1P3W, 3V3A 3P3W (2M, 3M)	2.40000 k	4.80000 k	12.0000 k	24.0000 k	48.0000 k	120.000 k
	3P4W	3.60000 k	7.20000 k	18.0000 k	36.0000 k	72.0000 k	180.000 k
150.000 V	1P2W	3.00000 k	6.00000 k	15.0000 k	30.0000 k	60.0000 k	150.000 k
	1P3W, 3V3A 3P3W (2M, 3M)	6.00000 k	12.0000 k	30.0000 k	60.0000 k	120.000 k	300.000 k
	3P4W	9.00000 k	18.0000 k	45.0000 k	90.0000 k	180.000 k	450.000 k
300.000 V	1P2W	6.00000 k	12.0000 k	30.0000 k	60.0000 k	120.000 k	300.000 k
	1P3W, 3V3A 3P3W (2M, 3M)	12.0000 k	24.0000 k	60.0000 k	120.000 k	240.000 k	600.000 k
	3P4W	18.0000 k	36.0000 k	90.0000 k	180.000 k	360.000 k	900.000 k
600.000 V	1P2W	12.0000 k	24.0000 k	60.0000 k	120.000 k	240.000 k	600.000 k
	1P3W, 3V3A 3P3W (2M, 3M)	24.0000 k	48.0000 k	120.000 k	240.000 k	480.000 k	1.20000 M
	3P4W	36.0000 k	72.0000 k	180.000 k	360.000 k	720.000 k	1.80000 M
1.50000 kV	1P2W	30.0000 k	60.0000 k	150.000 k	300.000 k	600.000 k	1.50000 M
	1P3W, 3V3A 3P3W (2M, 3M)	60.0000 k	120.000 k	300.000 k	600.000 k	1.20000 M	3.00000 M
	3P4W	90.0000 k	180.000 k	450.000 k	900.000 k	1.80000 M	4.50000 M

The following units of measurement are used: watt (W) for active power, volt-ampere (VA) for apparent power (S), and volt-ampere reactive (var) for reactive power (Q).

10.5 Specifications of Equations

Equations for basic measurement items

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Voltage RMS value	$Urms_{(i)} = \sqrt{\dfrac{1}{M}\sum_{s=0}^{M-1}\left(U_{(i)s}\right)^2}$	$Urms_{(i)(i+1)}$ $= \dfrac{1}{2}\left(Urms_{(i)} + Urms_{(i+1)}\right)$		$Urms_{(i)(i+1)(i+2)} = \dfrac{1}{3}\left(Urms_{(i)} + Urms_{(i+1)} + Urms_{(i+2)}\right)$		
RMS equivalent of voltage average rectified value	$Umn_{(i)} =$ $\dfrac{\pi}{2\sqrt{2}}\dfrac{1}{M}\sum_{s=0}^{M-1}\left|U_{(i)s}\right|$	$Umn_{(i)(i+1)}$ $= \dfrac{1}{2}\left(Umn_{(i)} + Umn_{(i+1)}\right)$		$Umn_{(i)(i+1)(i+2)} = \dfrac{1}{3}\left(Umn_{(i)} + Umn_{(i+1)} + Umn_{(i+2)}\right)$		
Voltage AC component	$Uac_{(i)} = \sqrt{\left(Urms_{(i)}\right)^2 - \left(Udc_{(i)}\right)^2}$					
Voltage simple average	$Udc_{(i)} = \dfrac{1}{M}\sum_{s=0}^{M-1}U_{(i)s}$					
Voltage fundamental wave component	Harmonic voltage $U_{1(i)}$ in harmonic equation					
Voltage peak	$Upk+_{(i)} = U_{(i)s}$ maximum of M data points $Upk-_{(i)} = U_{(i)s}$ maximum of M data points					
Total voltage harmonic distortion	$Uthd_{(i)}$ in harmonic equation					
Voltage ripple factor	$\dfrac{\left(Upk+_{(i)} - Upk-_{(i)}\right)}{\left(2\times\left|Udc_{(i)}\right|\right)}\times 100$					
Voltage phase angle	$\theta U_{1(i)}$ in harmonic equation					
Voltage unbalance rate				$Uunb_{(i)(i+1)(i+2)} = \sqrt{\dfrac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}}\times 100$ $\beta = \dfrac{U_{(i)(i+1)}^4 + U_{(i+1)(i+2)}^4 + U_{(i+2)(i)}^4}{\left(U_{(i)(i+1)}^2 + U_{(i+1)(i+2)}^2 + U_{(i+2)(i)}^2\right)^2}$ Example: If Ch. 1 to Ch. 3 are used $\beta = \dfrac{U_{12}^4 + U_{23}^4 + U_{31}^4}{\left(U_{12}^2 + U_{23}^2 + U_{31}^2\right)^2}$ • U_{12}, U_{23}, and U_{31} are fundamental wave voltage RMS values (line voltage), which are obtained from harmonic calculation results. • In 3P4W wiring mode, phase voltage is detected, but converted to line voltage before calculation.		

(i): measurement channel, M: number samples between sync timings, s: sample point number

Item \ Wiring	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Current RMS value	$Irms_{(i)} =$ $\sqrt{\dfrac{1}{M}\sum_{s=0}^{M-1}\left(I_{(i)s}\right)^2}$	$Irms_{(i)(i+1)} = \dfrac{1}{2}\left(Irms_{(i)} + Irms_{(i+1)}\right)$		$Irms_{(i)(i+1)(i+2)} = \dfrac{1}{3}\left(Irms_{(i)} + Irms_{(i+1)} + Irms_{(i+2)}\right)$		
RMS equivalent of average rectified current value	$Imn_{(i)} =$ $\dfrac{\pi}{2\sqrt{2}}\dfrac{1}{M}\sum_{s=0}^{M-1}\left|I_{(i)s}\right|$	$Imn_{(i)(i+1)} = \dfrac{1}{2}\left(Imn_{(i)} + Imn_{(i+1)}\right)$		$Imn_{(i)(i+1)(i+2)} = \dfrac{1}{3}\left(Imn_{(i)} + Imn_{(i+1)} + Imn_{(i+2)}\right)$		
Current AC component	$Iac_{(i)} = \sqrt{\left(Irms_{(i)}\right)^2 - \left(Idc_{(i)}\right)^2}$					
Current simple average	$Idc_{(i)} = \dfrac{1}{M}\sum_{s=0}^{M-1}I_{(i)s}$					
Current fundamental wave component	Harmonic current $I_{1(i)}$ in harmonic equation					
Current peak	$Ipk+_{(i)} = I_{(i)s}$ maximum of M data points $Ipk-_{(i)} = I_{(i)s}$ maximum of M data points					
Total current harmonic distortion	$Ithd_{(i)}$ in harmonic equation					
Current ripple factor	$\dfrac{\left(Ipk+_{(i)} - Ipk-_{(i)}\right)}{\left(2\times\left|Idc_{(i)}\right|\right)}\times 100$					
Current phase angle	$\theta I_{1(i)}$ in harmonic equation					
Current unbalance rate				$Iunb_{(i)(i+1)(i+2)} = \sqrt{\dfrac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}}\times 100$ $\beta = \dfrac{I_{(i)(i+1)}^{4}+I_{(i+1)(i+2)}^{4}+I_{(i+2)(i)}^{4}}{\left(I_{(i)(i+1)}^{2}+I_{(i+1)(i+2)}^{2}+I_{(i+2)(i)}^{2}\right)^{2}}$ Example: When Ch. 1 to Ch. 3 are used $\beta = \dfrac{I_{12}^{4}+I_{23}^{4}+I_{31}^{4}}{\left(I_{12}^{2}+I_{23}^{2}+I_{31}^{2}\right)^{2}}$ • I_{12}, I_{23}, and I_{31} are fundamental wave voltage RMS values (line voltage), which are obtained from harmonic calculation results. • In 3P3W3M and 3P4W wiring mode, current is converted to line current before calculation.		

(i): measurement channel, M: number samples between sync timings, s: sample point number

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Active power	$P_{(i)} =$ $\dfrac{1}{M}\sum\limits_{s=0}^{M-1}\left(U_{(i)s}\times I_{(i)s}\right)$	$P_{(i)(i+1)} = P_{(i)} + P_{(i+1)}$		$P_{(i)(i+1)(i+2)}$ $= P_{(i)} + P_{(i+1)}$	$P_{(i)(i+1)(i+2)} = P_{(i)} + P_{(i+1)} + P_{(i+2)}$	

• In 3P3W3M and 3P4W wiring modes, voltage waveform $U_{(i)s}$ is phase voltage.
  In 3P3W3M wiring mode, sampled voltage, which is line voltage, is converted into phase voltage.
  $U_{(i)s} = (u_{(i)s} - u_{(i+2)s}) / 3$, $U_{(i+1)s} = (u_{(i+1)s} - u_{(i)s}) / 3$, $U_{(i+2)s} = (u_{(i+2)s} - u_{(i+1)s}) / 3$
  $u_{(i)s}$: sampled line voltage value of channel (i).
  $U_{(i)s}$: calculated phase voltage value of channel (i)
  In 3P4W wiring mode, Sampled voltage is phase voltage, which does not need conversion.
• In 3V3A mode with Δ-Y conversion set to on, the 3P3W3M or 3P4W equation is used.
• In 3V3A wiring mode, voltage $U_{(i)}$ is line voltage. (3P3W2M and 3V3A wiring modes performs the same calculation.)
• The polarity sign of active power P indicates the flowing direction of power: $+P$ indicates consumption, whereas $-P$ indicates regeneration.

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Apparent power	$S_{(i)} = U_{(i)} \times I_{(i)}$	$S_{(i)(i+1)} = S_{(i)} + S_{(i+1)}$	$S_{(i)(i+1)}$ $= \dfrac{\sqrt{3}}{2}\left(S_{(i)} + S_{(i+1)}\right)$	$S_{(i)(i+1)(i+2)}$ $= \dfrac{\sqrt{3}}{3}\,(S_{(i)} + S_{(i+1)}$ $+ S_{(i+2)})$	$S_{(i)(i+1)(i+2)} = S_{(i)} + S_{(i+1)} + S_{(i+2)}$	

• For $U_{(i)}$ and $I_{(i)}$, the rectification method can be selected between rms and mean.
• In 3P3W3M and 3P4W wiring mode, voltage $U_{(i)}$ is phase voltage.
• In 3V3A mode, voltage $U_{(i)}$ is line voltage.

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Reactive power	If equation Type 1 or Type 3 is selected					
	$Q_{(i)} =$ $si_{(i)}\sqrt{S_{(i)}{}^2 - P_{(i)}{}^2}$	$Q_{(i)(i+1)} = Q_{(i)} + Q_{(i+1)}$		$Q_{(i)(i+1)(i+2)}$ $= Q_{(i)} + Q_{(i+1)}$	$Q_{(i)(i+1)(i+2)} = Q_{(i)} + Q_{(i+1)} + Q_{(i+2)}$	
	If equation Type 2 is selected					
	$Q_{(i)} =$ $\sqrt{S_{(i)}{}^2 - P_{(i)}{}^2}$	$Q_{(i)(i+1)} = \sqrt{S_{(i)(i+1)}{}^2 - P_{(i)(i+1)}{}^2}$		$Q_{(i)(i+1)(i+2)} = \sqrt{S_{(i)(i+1)(i+2)}{}^2 - P_{(i)(i+1)(i+2)}{}^2}$		

• If equation Type 1 or Type 3 is selected, the polarity sign si for the reactive power Q indicates the lead/lag polarity; no sign indicates lag, whereas a negative sign (−) indicates lead.
• The polarity sign $si_{(i)}$ is acquired based on the lead/lag between voltage waveform $U_{(i)s}$ and current waveform $I_{(i)s}$ for each measurement channel (i).
• In 3P3W3M and 3P4W wiring modes, voltage waveform $U_{(i)s}$ is phase voltage.
  In 3P3W3M wiring mode, sampled voltage, which is line voltage, is converted into phase voltage.
  $U_{(i)s} = (u_{(i)s} - u_{(i+2)s}) / 3$, $U_{(i+1)s} = (u_{(i+1)s} - u_{(i)s}) / 3$, $U_{(i+2)s} = (u_{(i+2)s} - u_{(i+1)s}) / 3$
  $u_{(i)s}$: sampled line voltage value of channel (i).
  $U_{(i)s}$: calculated phase voltage of channel (i)
• In 3P4W wiring mode: Sampled voltage, which is phase voltage, does not need conversion.
• If equation Type 2 is selected, results are unsigned.

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Power factor	When equation Type 1 is selected					

Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W

Power factor

When equation Type 1 is selected

$$\lambda_{(i)} = si_{(i)}\left|\frac{P_{(i)}}{S_{(i)}}\right| \qquad \lambda_{(i)(i+1)} = si_{(i)(i+1)}\left|\frac{P_{(i)(i+1)}}{S_{(i)(i+1)}}\right| \qquad \lambda_{(i)(i+1)(i+2)} = si_{(i)(i+1)(i+2)}\left|\frac{P_{(i)(i+1)(i+2)}}{S_{(i)(i+1)(i+2)}}\right|$$

When equation Type 2 is selected

$$\lambda_{(i)} = \left|\frac{P_{(i)}}{S_{(i)}}\right| \qquad \lambda_{(i)(i+1)} = \left|\frac{P_{(i)(i+1)}}{S_{(i)(i+1)}}\right| \qquad \lambda_{(i)(i+1)(i+2)} = \left|\frac{P_{(i)(i+1)(i+2)}}{S_{(i)(i+1)(i+2)}}\right|$$

When equation Type 3 is selected

$$\lambda_{(i)} = \frac{P_{(i)}}{S_{(i)}} \qquad \lambda_{(i)(i+1)} = \frac{P_{(i)(i+1)}}{S_{(i)(i+1)}} \qquad \lambda_{(i)(i+1)(i+2)} = \frac{P_{(i)(i+1)(i+2)}}{S_{(i)(i+1)(i+2)}}$$

- If equation Type 1 is selected, the polarity sign si for power factor λ indicates the lead/lag polarity; no sign indicates lag, whereas negative sign (−) indicates lead.
- The polarity sign $si_{(i)}$ is acquired based on the lead/lag between voltage waveform $U_{(i)s}$ and current waveform $I_{(i)s}$ for each measurement channel (i).
  The signs of si_{12}, si_{34}, and si_{123} are acquired from those of the Q_{12}, Q_{34}, and Q_{123}, respectively.
- If equation Type 3 is selected, the sign of active power P is used without being reversed for a polarity sign.

Power phase angle

When equation Type 1 is selected

$$\phi_{(i)} = si_{(i)}\cos^{-1}|\lambda_{(i)}| \qquad \phi_{(i)(i+1)} = si_{(i)(i+1)}\cos^{-1}|\lambda_{(i)(i+1)}| \qquad \phi_{(i)(i+1)(i+2)} = si_{(i)(i+1)(i+2)}\cos^{-1}|\lambda_{(i)(i+1)(i+2)}|$$

When equation Type 2 is selected

$$\phi_{(i)} = \cos^{-1}|\lambda_{(i)}| \qquad \phi_{(i)(i+1)} = \cos^{-1}|\lambda_{(i)(i+1)}| \qquad \phi_{(i)(i+1)(i+2)} = \cos^{-1}|\lambda_{(i)(i+1)(i+2)}|$$

When equation Type 3 is selected

$$\phi_{(i)} = \cos^{-1}\lambda_{(i)} \qquad \phi_{(i)(i+1)} = \cos^{-1}\lambda_{(i)(i+1)} \qquad \phi_{(i)(i+1)(i+2)} = \cos^{-1}\lambda_{(i)(i+1)(i+2)}$$

- If equation Type 1 is selected, polarity sign si indicates the lead/lag polarity; no sign indicates lag, whereas negative sign (−) indicates lead.
- The polarity sign $si_{(i)}$ is acquired based on the lead/lag between voltage waveform $U_{(i)s}$ and current waveform $I_{(i)s}$ for each measurement channel (i).
  The signs of si_{12}, si_{34}, and si_{123} are acquired from those of the Q_{12}, Q_{34}, and Q_{123}, respectively.
- In equation Type 1 and Type 2, the expression $\cos^{-1}|\lambda|$ is used when the inequality $P \geq 0$ is true; the expression $|180 - \cos^{-1}|\lambda||$ is used instead when $P < 0$.

(i): Measurement channel, M: number samples between sync timings, s: sample point number
The 3P4W equations are used for Y-Δ conversion in 3V3A and 3P3W3M wiring modes.
The 3P4W equations are also used as-is for Y-Δ conversion in 3P4W wiring mode.

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Fundamental wave active power	$P_{1(i)}$ of harmonic active power	$P_{1(i)(i+1)}$ of harmonic active power			$P_{1(i)(i+1)(i+2)}$ of harmonic active power	
Fundamental wave apparent power	$Sfnd_{(i)} = \sqrt{\left(P_{1(i)}\right)^2 + \left(Q_{1(i)}\right)^2}$	$Sfnd_{(i)(i+1)} = \sqrt{\left(P_{1(i)(i+1)}\right)^2 + \left(Q_{1(i)(i+1)}\right)^2}$			$Sfnd_{(i)(i+1)(i+2)}$ $= \sqrt{\left(P_{1(i)(i+1)(i+2)}\right)^2 + \left(Q_{1(i)(i+1)(i+2)}\right)^2}$	
Fundamental wave reactive power	$Q_{1(i)} \times (-1)$ of harmonic reactive power*[1]	$Q_{1(i)(i+1)} \times (-1)$ of harmonic reactive power*[1]			$Q_{1(i)(i+1)(i+2)} \times (-1)$ of harmonic reactive power*[1]	
Fundamental wave power factor*[2]	$\lambda fnd_{(i)} = si_{(i)}\lvert\cos\theta_{1(i)}\rvert$	$\lambda fnd_{(i)(i+1)} = si_{(i)(i+1)}\lvert\cos\theta_{1(i)(i+1)}\rvert$			$\lambda fnd_{(i)(i+1)(i+2)} = si_{(i)(i+1)(i+2)}\lvert\cos\theta_{1(i)(i+1)(i+2)}\rvert$	

If equation Type 1 is selected, the polarity sign si is acquired based on the sign of the fundamental wave reactive power; if equation Type 3 is selected, based on the sign of the fundamental wave active power. If equation Type 2 is selected, results are unsigned.
*1: If equation Type 2 is selected, take the absolute value.
*2: Fundamental wave power factor is also known as displacement power factor (DPF).

Equations for motor analysis option

| Measurement item	Setting	Equation
Voltage	**Analog DC**	$\dfrac{1}{M}\sum\limits_{s=0}^{M-1} A_s$
Pulse frequency	**Pulse**	Pulse frequency
Torque	**Analog DC**	$\dfrac{1}{M}\sum\limits_{s=0}^{M-1} A_s \times$ (Scaling setting value)
	Frequency	$\dfrac{[(\text{Measurement frequency}) - (fc \text{ setting})] \times (\text{Rated torque value})}{(fd \text{ setting value})}$
RPM	**Analog DC**	$\dfrac{1}{M}\sum\limits_{s=0}^{M-1} A_s \times$ (Scaling setting value)
	Pulse	$si\,\dfrac{60 \times (\text{Pulse frequency})}{(\text{Pulse count setting})}$ If the direction of rotation detection is enabled in single mode, the polarity sign si is acquired based on the A-phase pulse's rising/falling edge and the B-phase pulse's logic level (high/low).
Motor power	—	$(\text{Torque}) \times \dfrac{2 \times \pi \times (\text{RPM})}{60} \times (\text{Unit coefficient})$ The unit coefficient is one if the unit of torque measurement is newton-meter (N·m), 1/1000 if it is millinewton-meter (mN·m), and 1000 if it is kilonewton-meter (kN·m).
Slip	—	$100 \times \dfrac{2 \times 60 \times (\text{Input frequency}) - \lvert\text{RPM}\rvert \times (\text{Pole number setting})}{2 \times 60 \times (\text{Input frequency})}$ The input frequency can be selected from among fU1 to fU8 and fl1 to fl8

M: number of samples during synchronized timing period; s: sample number, A: analog waveform

Equations for harmonic measurement items

Item \ Wiring	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Harmonic voltage	$U_{k(i)} = \sqrt{\left(U_{kr(i)}\right)^2 + \left(U_{ki(i)}\right)^2}$ (spanning)					
Harmonic voltage phase angle	$\theta U_{k(i)} = \tan^{-1}\left(\dfrac{U_{kr(i)}}{-U_{ki(i)}}\right)$ (spanning)					
Harmonic current	$I_{k(i)} = \sqrt{\left(I_{kr(i)}\right)^2 + \left(I_{ki(i)}\right)^2}$ (spanning)					
Harmonic current phase angle	$\theta I_{k(i)} = \tan^{-1}\left(\dfrac{I_{kr(i)}}{-I_{ki(i)}}\right)$ (spanning)					
Harmonic active power	$P_{k(i)} = U_{kr(i)} \times I_{kr(i)} + U_{ki(i)} \times I_{ki(i)}$				$P_{k(i)} = \frac{1}{3}(U_{kr(i)} - U_{kr(i+2)}) \times I_{kr(i)} + \frac{1}{3}(U_{ki(i)} - U_{ki(i+2)}) \times I_{ki(i)}$ $P_{k(i+1)} = \frac{1}{3}(U_{kr(i+1)} - U_{kr(i)}) \times I_{kr(i+1)} + \frac{1}{3}(U_{ki(i+1)} - U_{ki(i)}) \times I_{ki(i+1)}$ $P_{k(i+2)} = \frac{1}{3}(U_{kr(i+2)} - U_{kr(i+1)}) \times I_{kr(i+2)} + \frac{1}{3}(U_{ki(i+2)} - U_{ki(i+1)}) \times I_{ki(i+2)}$	Same as 1P2W
	—	$P_{k(i)(i+1)} = P_{k(i)} + P_{k(i+1)}$			$P_{k(i)(i+1)(i+2)} = P_{k(i)} + P_{k(i+1)} + P_{k(i+2)}$	
Harmonic reactive power (used in internal calculations only)	$Q_{k(i)} = U_{kr(i)} \times I_{ki(i)} - U_{ki(i)} \times I_{kr(i)}$				$Q_{k(i)} = \frac{1}{3}(U_{kr(i)} - U_{kr(i+2)}) \times I_{ki(i)} - \frac{1}{3}(U_{ki(i)} - U_{ki(i+2)}) \times I_{kr(i)}$ $Q_{k(i+1)} = \frac{1}{3}(U_{kr(i+1)} - U_{kr(i)}) \times I_{ki(i+1)} - \frac{1}{3}(U_{ki(i+1)} - U_{ki(i)}) \times I_{kr(i+1)}$ $Q_{k(i+2)} = \frac{1}{3}(U_{kr(i+2)} - U_{kr(i+1)}) \times I_{ki(i+2)} - \frac{1}{3}(U_{ki(i+2)} - U_{ki(i+1)}) \times I_{kr(i+2)}$	Same as 1P2W
	—	$Q_{k(i)(i+1)} = Q_{k(i)} + Q_{k(i+1)}$			$Q_{k(i)(i+1)(i+2)} = Q_{k(i)} + Q_{k(i+1)} + Q_{k(i+2)}$	
Harmonic voltage/ current phase difference	$\theta_{k(i)} = \theta I_{k(i)} - \theta U_{k(i)}$ (spanning)					
	—	$\theta_{k(i)(i+1)} = \tan^{-1}\left(\dfrac{Q_{k(i)(i+1)}}{P_{k(i)(i+1)}}\right)$			$\theta_{k(i)(i+1)(i+2)} = \tan^{-1}\left(\dfrac{Q_{k(i)(i+1)(i+2)}}{P_{k(i)(i+1)(i+2)}}\right)$	

- (i): measurement channel, k: analysis order,
  r: real part of FFT processed waveform, i: imaginary part of FFT processed waveform
- For the harmonic voltage phase angle and harmonic current phase angle, the fundamental wave of the harmonic synchronization source that serves as the phase reference is corrected to 0°.
  (However, this compensation is not performed when the harmonic synchronization source is set to Ext.)
  When the synchronization source is DC, the data update timing is defined as 0°.
  If the synchronization source is set to Ext, Zph., B, D, F, or H, the rising edge or falling edge of the pulse used for synchronization is defined as 0°.
- For the harmonic voltage-vs.-current phase difference, each phase difference in 3P3W3M or 3P4W wiring mode is calculated based on the phase voltage, regardless of whether delta conversion is set to on or off.

Wiring / Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Harmonic voltage content percentage	$U hd_{k(i)} = \dfrac{U_k}{U_1} \times 100$					
Harmonic current content percentage	$I hd_{k(i)} = \dfrac{I_k}{I_1} \times 100$					
Harmonic power content percentage	$Phd_{k(i)} = \dfrac{P_k}{P_1} \times 100$					
Total voltage harmonic distortion	$Uthd_{(i)} = \dfrac{\sqrt{\sum\limits_{k=2}^{K}(U_k)^2}}{U_1} \times 100$ (with THD-F setting) or $\dfrac{\sqrt{\sum\limits_{k=2}^{K}(U_k)^2}}{\sqrt{\sum\limits_{k=1}^{K}(U_k)^2}} \times 100$ (with THD-R setting)					
Total harmonic current distortion	$Ithd_{(i)} = \dfrac{\sqrt{\sum\limits_{k=2}^{K}(I_k)^2}}{I_1} \times 100$ (with THD-F setting) or $\dfrac{\sqrt{\sum\limits_{k=2}^{K}(I_k)^2}}{\sqrt{\sum\limits_{k=1}^{K}(I_k)^2}} \times 100$ (with THD-R setting)					
(i): measurement channel, k: harmonic order, K: maximum analysis order (varies with synchronization frequency)						
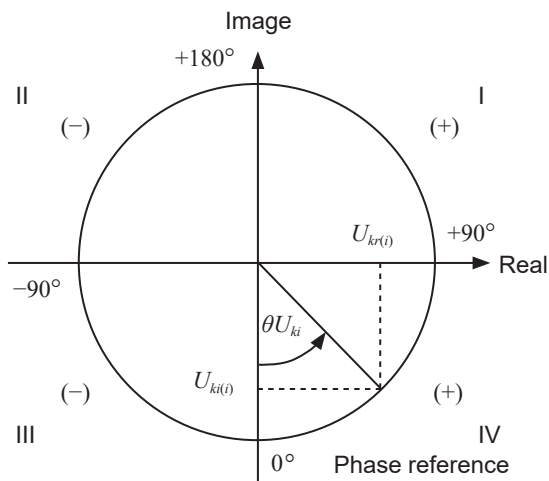
Example: for harmonic voltage

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

Equations for integration measurement

Wiring Item	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
WP+	$WP_i+ = k \sum\limits_1^h (P_i(+))$	$WP_{sum}+ = k \sum\limits_1^h (P_{sum}(+))$				
WP−	$WP_i- = k \sum\limits_1^h (P_i(-))$	$WP_{sum}- = k \sum\limits_1^h (P_{sum}(-))$				
WP	$WP_i = (WP_i+) + (WP_i-)$	$WP_{sum} = (WP_{sum}+) + (WP_{sum}-)$				
Ih+	$Ih_i+ = k \sum\limits_1^h (I_i(+))$	$Ih_{sum}+ = k \sum\limits_1^h (I_{sum}(+))$				
Ih−	$Ih_i- = k \sum\limits_1^h (I_i(-))$	$Ih_{sum}- = k \sum\limits_1^h (I_{sum}(-))$				
Ih	$Ih_i = (Ih_i+) + (Ih_i-)$	$Ih_{sum} = (Ih_{sum}+) + (Ih_{sum}-)$				

- h: measurement time, k: conversion coefficient for 1 h
- (+): Only a positive (consumption) value is used.
- (−): Only a negative value (regeneration) value is used.

10.6 U7001 2.5MS/s Input Unit

Input specifications

(1) Specifications common to voltage, current, and power measurement

Sampling frequency, sampling bit rate	2.5 MHz, 16-bit
Measurement frequency band	DC, 0.1 Hz to 1 MHz
Frequency flatness	±0.1% amplitude band: 100 kHz (typical) ±0.1° phase band: 300 kHz (typical)
Effective measurement range	1% of range to 110% of range

(2) Specifications common to voltage measurement

Input terminal profile	Plug-in terminal (safety terminal)
Input method	Isolated input, resistance voltage division
Range	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V
Crest factor	3 relative to voltage range rating (however, 1.35 for 1500 V range)
Input resistance, input capacity	2 MΩ ±20 kΩ, 1 pF typical
Maximum input voltage	1000 V AC, 1500 V DC or ±2000 V peak
Maximum rated line-to-ground voltage	600 V AC, 1000 V DC in measurement category III Anticipated transient overvoltage: 8000 V 1000 V AC, 1500 V DC in measurement category II Anticipated transient overvoltage: 8000 V

(3) Specifications common to current measurement

Input terminal profile	Probe 1: Dedicated connector (ME15W) Probe 2: Metallic BNC terminal (female) Select either Probe 1 (current sensor input) or Probe 2 (external input) based on the setting. The channels of the same wiring configuration have the same input setting.
Input method	Current sensor input method
Range	Probe 1:
	40 mA, 80 mA, 200 mA, 400 mA, 800 mA, 2 A (with a 2 A sensor)
	400 mA, 800 mA, 2 A, 4 A, 8 A, 20 A (with a 20 A sensor)
	4 A, 8 A, 20 A, 40 A, 80 A, 200 A (with a 200 A sensor)
	40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (with a 2000 A sensor)
	100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (with a 5 A sensor)
	1 A, 2 A, 5 A, 10 A, 20 A, 50 A (with a 50 A sensor)
	10 A, 20 A, 50 A, 100 A, 200 A, 500 A (with a 500 A sensor)
	100 A, 200 A, 500 A, 1 kA, 2 kA, 5 kA (with a 5000 A sensor)
	20 A, 40 A, 100 A, 200 A, 400 A, 1 kA (with a 1000 A sensor)
	Selectable for each wiring (Only when the same sensors are used for all channels of the same wiring configuration)
	Probe 2:
	1 kA, 2 kA, 5 kA, 10 kA, 20 kA, 50 kA (0.1 mV/A)
	100 A, 200 A, 500 A, 1 kA, 2 kA, 5 kA (1 mV/A)
	10 A, 20 A, 50 A, 100 A, 200 A, 500 A (10 mV/A)
	1 A, 2 A, 5 A, 10 A, 20 A, 50 A (100 mV/A)
	100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (0.1 V, 0.2 V, 0.5 V, 1.0 V, 2.0 V, 5.0 V range) (1 V/A)
	The input rate and range can be selected for each wiring. The sensor input rate can be set.
Crest factor	3 relative to current range rating (however, 1.5 for 5 V range of Probe 2)
Input resistance, input capacity	Probe 1: 1 MΩ ±50 kΩ Probe 2: 1 MΩ ±50 kΩ, 22 pF typical
Maximum input voltage	Probe 1: 8 V, ±12 V peak (10 ms or less) Probe 2: 15 V, ±20 V peak (10 ms or less)

Accuracy specifications

Apparent power (S) measurement accuracy	(Voltage accuracy) + (current accuracy) ±10 digits

Reactive power (Q) measurement accuracy	For any condition except if ϕ = 0° or ±180°
	    (Apparent power accuracy) ± {1−sin[ϕ + (Power phase angle accuracy)] / sin ϕ}
	    × (100% of reading)
	    ±[$\sqrt{(1.001 - \lambda^2)} - \sqrt{(1 - \lambda^2)}$] × (100% of range)
	
	For ϕ = 0° and ±180°
	    (Apparent power accuracy) ± [sin(Power phase angle accuracy)] × (100% of range)
	    ± (3.16% of range)
	    The symbol λ designates the display value of the power factor.

Power factor (λ) measurement accuracy	For any condition except if ϕ = ±90°
	    ±{1 − cos[ϕ + (Power phase angle accuracy)] / cos ϕ} × (100% of reading) ±50 digits
	For ϕ = ±90°
	    ±cos[ϕ + (Difference accuracy)] × (100% of range) ±50 digits
	    The symbol ϕ designates the display value of the power phase angle.
	Both of the above are specified when voltage or current of its range rating is inputted.

Waveform peak measurement accuracy	Voltage and current RMS value accuracy ±1% of range (300% of range is applied as a peak range)

Effects of temperature	Add the following to the voltage, current, and active power accuracy within the range of 0°C to 20°C or 26°C to 40°C:
	When Probe 1 is used
	        ±0.01% of reading per degree centigrade
	        Add another 0.01% of range per degree centigrade for DC.
	When Probe 2 is used
	Voltage: ±0.01% of reading per degree centigrade
	                        Add another 0.01% of range per degree centigrade for DC.
	Current, active power: ±0.03% of reading per degree centigrade
	                        Add another 0.06% of range per degree centigrade for DC.

Common-mode voltage rejection ratio (Effects of common-mode voltage)	When frequency is 50 Hz/60 Hz: 100 dB or more When frequency is 100 kHz: 80 dB typical Specified for CMRR when the maximum input voltage is applied between the voltage input terminals and the enclosure for all measurement ranges.
Effects of external magnetic fields	±1% of range or less (in a magnetic field of 400 A/m, DC or 50 Hz/60 Hz)

Effects of the power factor on the active power	For any condition except if ϕ = ±90°
	        ±{1 − cos[ϕ + (Phase accuracy)] / cos ϕ} × (100% of reading)
	For ϕ = ±90°
	        ±cos[ϕ + (Phase accuracy)] × (100% of VA)

Specifications

10

Active voltage, current, power, and power phase angle measurement accuracy

Accuracy	±[(% of reading) + (% of range)]	
	Voltage (U)	**Current (I)**
DC	0.02% + 0.05%	0.02% + 0.05%
0.1 Hz ≤ f < 30 Hz	0.1% + 0.1 %	0.1% + 0.1%
30 Hz ≤ f < 45 Hz	0.1% + 0.1%	0.1% + 0.1%
45 Hz ≤ f ≤ 440 Hz	0.02% + 0.05%	0.02% + 0.05%
440 Hz < f ≤ 1 kHz	0.03% + 0.05%	0.03% + 0.05%
1 kHz < f ≤ 10 kHz	0.15% + 0.05%	0.15% + 0.05%
10 kHz < f ≤ 50 kHz	0.20% + 0.05%	0.20% + 0.05%
50 kHz < f ≤ 100 kHz	0.01 × f % + 0.1%	0.01 × f % + 0.1%
100 kHz < f ≤ 500 kHz	0.02 × f % + 0.2%	0.02 × f % + 0.2%
Frequency band	1 MHz (−3 dB typical)	1 MHz (−3 dB typical)

Accuracy	±[(% of reading) + (% of range)]	Degrees
	Active power (P)	**Power phase angle (ϕ)** **(Phase difference)**
DC	0.02% + 0.05%	—
0.1 Hz ≤ f < 30 Hz	0.1% + 0.2%	±0.05°
30 Hz ≤ f < 45 Hz	0.1% + 0.1%	±0.05°
45 Hz ≤ f ≤ 440 Hz	0.02% + 0.05%	±0.05°
440 Hz < f ≤ 1 kHz	0.05% + 0.05%	±0.05°
1 kHz < f ≤ 10 kHz	0.20% + 0.05%	±0.2°
10 kHz < f ≤ 50 kHz	0.40% + 0.1%	±(0.02 × f) degrees
50 kHz < f ≤ 100 kHz	0.01 × f % + 0.2%	±(0.02 × f) degrees
100 kHz < f ≤ 500 kHz	0.025 × f % + 0.3%	±(0.02 × f) degrees

- In the expressions listed above, the unit of *f* is kilohertz.
- DC values of voltage and current are specified by Udc and Idc.
  Frequencies other than DC are specified by U rms and I rms.
- When U or I is selected as the synchronization source, accuracy is specified for a source input of at least 5% of range.
- The power phase angle is specified for a power factor of zero during 100% input.
- For current, active power, and power phase angle, add the current sensor accuracy to the accuracy figures listed above.
- When 0.1 Hz ≤ f < 10 Hz, the accuracy figures for voltage, current, active power, and power phase angle are values for reference purposes.
- When 10 Hz ≤ f < 16 Hz, the accuracy figures for voltage, active power, and power phase angle over 220 V are values for reference purposes.
- When 30 kHz < f ≤ 100 kHz, the accuracy figures for voltage, active power, and power phase angle over 750 V are reference values.
- When 100 kHz < f ≤ 1 MHz, the accuracy figures for voltage, active power, and power phase angle over (22000 / f [kilohertz]) volts are values for reference purposes.
- For the 6 V range, add ±0.02% of range to voltage and active power.
- When Probe 1 is used, add ±0.02% of range to the current and active power for the 1/50 range of the sensor rating.
- When Probe 2 is used, add ±[(0.05% of reading) + (0.2% of range)] to the current and active power and add ±0.2° to the voltage phase angle for 10 kHz or more.
- The valid measurement range of the 9272-05 is between 0.5% of full scale and 100% of full scale.
- If the input magnitude is between 100% of range (exclusive) between 110% of range (inclusive), multiply the range error by 1.1.
- Add ±0.01% of range per degree centigrade to the voltage DC accuracy if a change in an ambient temperature reaches ±1°C or more after zero adjustment.
  When Probe 1 is used, add ±0.01% of range per degree centigrade to the DC accuracy of the current and active power.
  When Probe 2 is used, add ±0.05% of range per degree centigrade to the DC accuracy of the current and active power.

- For voltages over 600 V, add the following values to the power phase angle accuracy:
  0.1 Hz < f ≤ 500 Hz: ±0.1°
  500 Hz < f ≤ 5 kHz: ±0.3°
  5 kHz < f ≤ 20 kHz: ±0.5°
  20 kHz < f ≤ 200 kHz: ±1°
- If measuring a voltage of 900 V or more, add the following value to the accuracy figures for voltage and active power.
  ±0.02% of reading
  Even when the voltage input values decreases, the effect of self-heating persists until the input resistance temperature falls.
- If the DC voltage is between 1000 V (exclusive) and 1500 V (inclusive), add 0.045% of reading to accuracy figures of voltage and effective power. Values of the measurement accuracy are only designed values.
  (When the DC voltage is between 1000 V (exclusive) and 1500 V (inclusive), accuracy for DC voltage and DC effective power is guaranteed after custom-ordered calibration made by Hioki.)

Specifications

10

10.7 U7005 15MS/s Input Unit

Input specifications

(1) Specifications common to voltage, current, and power measurement

Sampling	15 MHz, 18-bit
Measurement frequency band	DC, 0.1 Hz to 5 MHz
Frequency flatness	±0.1% amplitude band: 300 kHz (typical) ±0.1° phase band: 500 kHz (typical)
Effective measurement range	1% of range to 110% of range

(2) Specifications common to voltage measurement

Input terminal profile	Plug-in terminal (safety terminal)
Input method	Isolated input, resistance voltage division
Range	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V
Crest factor	3 relative to voltage range rating (however, 1.35 for 1500 V range)
Input resistance, input capacity	4 MΩ ±20 kΩ, 6 pF typical
Maximum input voltage	1000 V, ±2000 V peak $(1300 - f)$ volts when 400 kHz < f ≤ 1000 kHz (f: frequency of input voltage) 200 V when 1000 kHz < f ≤ 5000 kHz (f: frequency of input voltage) In the expressions listed above, the unit of f is kilohertz.
Maximum rated line-to-ground voltage	600 V in measurement category III, anticipated transient overvoltage: 6000 V 1000 V in measurement category II, anticipated transient overvoltage: 6000 V

(3) Specifications common to current measurement

Input terminal profile	Probe 1: Dedicated connector (ME15W)
Input method	Current sensor input method
Range	Probe 1: 40 mA, 80 mA, 200 mA, 400 mA, 800 mA, 2 A (with a 2 A sensor) 400 mA, 800 mA, 2 A, 4 A, 8 A, 20 A (with a 20 A sensor) 4 A, 8 A, 20 A, 40 A, 80 A, 200 A (with a 200 A sensor) 40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (with a 2000 A sensor) 100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (with a 5 A sensor) 1 A, 2 A, 5 A, 10 A, 20 A, 50 A (with a 50 A sensor) 10 A, 20 A, 50 A, 100 A, 200 A, 500 A (with a 500 A sensor) 100 A, 200 A, 500 A, 1 kA, 2 kA, 5 kA (with a 5000 A sensor) 20 A, 40 A, 100 A, 200 A, 400 A, 1 kA (with a 1000 A sensor) Selectable for each wiring (Only when the same sensors are used for all channels of the same wiring configuration)
Crest factor	3 relative to voltage range rating
Input resistance	1 MΩ ±50 kΩ
Maximum input voltage	8 V, ±12 V peak (10 ms or less)

Accuracy specifications

Apparent power (S) measurement accuracy	(voltage accuracy) + (current accuracy) ±10 digits

Reactive power (Q) measurement accuracy	For any condition except if ϕ = 0° or ±180°
	    (Apparent power accuracy) ± {1 − sin[ϕ + (Power phase angle accuracy)] / sin ϕ}
	    × (100% of reading)
	    $\pm[\sqrt{(1.001 - \lambda^2)} - \sqrt{(1 - \lambda^2)}]$ × (100% of range)
	
	For ϕ = 0° and ±180°
	    (Apparent power accuracy) ± [sin(Power phase angle accuracy)]
	    × (100% of range) ± (3.16% of range)
	The symbol λ designates the display value of the power factor.

Power factor (λ) measurement accuracy	For any condition except if ϕ = ±90°
	    ±{1 − cos[ϕ + (power phase angle accuracy) / cos ϕ]} × (100% of reading)
	    ±50 digits
	For ϕ = ±90°
	    ±cos[ϕ + (Power phase angle accuracy)] × (100% of range) ±50 digits
	    The symbol ϕ designates the display value of the power phase angle.
	Both of the above are specified at voltage/current range rating input.

Waveform peak measurement accuracy	(Voltage/current RMS value accuracy) ± (1% of range) (300% of range is applied as a peak range)
Effects of temperature	Add the following to the voltage, current, and active power accuracy within the range of 0°C to 20°C or 26°C to 40°C: ±0.01% of reading per degree centigrade Add another 0.01% of range per degree centigrade for DC.
Common-mode voltage rejection ratio (Effects of common-mode voltage)	50 Hz/60 Hz: 120 dB or more 100 kHz: 110 dB or more Specified for CMRR when the maximum input voltage is applied between the voltage input terminals and enclosure for all measurement ranges.
Effects of external magnetic fields	±1% of range or less (in a magnetic field of 400 A/m, DC or 50 Hz/60 Hz)

Effects of the power factor on the active power	For any condition except if ϕ = ±90°
	    ±{1 − cos[ϕ + (Phase difference accuracy)] / cosϕ} × (100% of reading)
	For ϕ = ±90°
	    ±cos[ϕ + (Phase difference accuracy)] × (100% of VA)

Specifications

10

Specially specified combinatorial accuracy with optional products for current measurement

For the following optional products for current measurement, the combinatorial accuracy with the U7005 is specified specially.

For more information, see specifications of each optional products for current measurement.

Outline of the special combinatorial accuracy

Reading accuracy	Simple addition of the reading accuracy of the U7005 and that of each optional products for current measurement
Range accuracy	Simple addition of the range accuracy of the U7005 and that of each optional products for current measurement (Regardless of the U7005 range setting)

However, the above-listed combinational accuracy is specified only for DC and a frequency of between 45 Hz and 66 Hz (for some optional current measuring products, 45 Hz and 65 Hz).

Current sensors

PW9100A-3	AC/DC Current Box
PW9100A-4	AC/DC Current Box
CT6872	AC/DC Current Sensor
CT6872-01	AC/DC Current Sensor
CT6873	AC/DC Current Sensor
CT6873-01	AC/DC Current Sensor
CT6904A	AC/DC Current Sensor
CT6904A-1	AC/DC Current Sensor
CT6904A-2	AC/DC Current Sensor
CT6904A-3	AC/DC Current Sensor
CT6875A	AC/DC Current Sensor
CT6875A-1	AC/DC Current Sensor
CT6876A	AC/DC Current Sensor
CT6876A-1	AC/DC Current Sensor
CT6877A	AC/DC Current Sensor
CT6877A-1	AC/DC Current Sensor

Measurement accuracy for active voltage, current, power, and power phase angle

Accuracy	±[(% of reading) + (% of range)]	
	Voltage (U)	Current (I)
DC	0.02% + 0.03%	0.02% + 0.03%
0.1 Hz ≤ f < 30 Hz	0.1% + 0.1%	0.1% + 0.1%
30 Hz ≤ f < 45 Hz	0.1% + 0.1%	0.1% + 0.1%
45 Hz ≤ f ≤ 440 Hz	0.01% + 0.02%	0.01% + 0.02%
440 Hz < f ≤ 1 kHz	0.02% + 0.04%	0.02% + 0.04%
1 kHz < f ≤ 10 kHz	0.05% + 0.05%	0.05% + 0.05%
10 kHz < f ≤ 50 kHz	0.1% + 0.05%	0.1% + 0.05%
50 kHz < f ≤ 100 kHz	0.01 × f % + 0.1%	0.01 × f % + 0.1%
100 kHz < f ≤ 500 kHz	0.01 × f % + 0.2%	0.01 × f % + 0.2%
500 kHz < f ≤ 1 MHz	0.01 × f % + 0.3%	0.01 × f % + 0.3%
Frequency band	5 MHz (−3 dB typical)	5 MHz (−3 dB typical)

Accuracy	±[(% of reading) + (% of range)]	Degree
	Active power (P)	Power phase angle (ϕ) (Phase difference)
DC	0.02% + 0.03%	—
0.1 Hz ≤ f < 30 Hz	0.1% + 0.2%	±0.05°
30 Hz ≤ f < 45 Hz	0.1% + 0.1%	±0.05°
45 Hz ≤ f ≤ 440 Hz	0.01% + 0.02%	±0.05°
440 Hz < f ≤ 1 kHz	0.02% + 0.04%	±0.05°
1 kHz < f ≤ 10 kHz	0.05% + 0.05%	±0.12°
10 kHz < f ≤ 50 kHz	0.15% + 0.05%	±0.2°
50 kHz < f ≤ 100 kHz	0.01 × f % + 0.2%	±0.4°
100 kHz < f ≤ 500 kHz	0.01 × f % + 0.3%	±(0.01 × f)°
500 kHz < f ≤ 1 MHz	0.01 × f % + 0.5%	±(0.01 × f)°

- In the expressions listed above, the unit of *f* is kilohertz.
- DC values of voltage and current are specified by Udc and Idc.
  Frequencies other than DC are specified by U rms and I rms.
- When U or I is selected as the synchronization source, accuracy is specified for source input of at least 5% of range.
- The phase difference is specified by a power factor of zero during 100% input.
- Add the current sensor accuracy to the accuracy figures listed above for current, active power, and power phase angle.
- When a voltage has a frequency between 0.1 Hz (inclusive) and 10 Hz (exclusive), the accuracy figures for voltage, current, active power, and power phase angle are values for reference purposes.
- When a voltage of over 220 V has a frequency between 10 Hz (inclusive) and 16 Hz (exclusive), the accuracy figures for voltage, active power, and power phase angle are values for reference purposes.
- When a voltage of over 750 V has a frequency between 30 kHz (inclusive) and 100 kHz (exclusive), the accuracy figures for voltage, active power, and power phase angle are values for reference purposes.
- When a voltage of over (22000 / f [kilohertz]) volts has a frequency between 100 kHz (inclusive) and 1 MHz (exclusive), the accuracy figures for voltage, active power, and power phase angle are values for reference purposes.
- For the 6 V range, add ±0.02% of range to the accuracy of voltage and active power.
- Add ±0.02% of range to the accuracy of the current and active power for the 1/10, 1/25, and 1/50 range of the current sensor rating.
- The valid measurement range of the 9272-05 is between 0.5% of full scale and 100% of full scale.
- When the input magnitude is between 100% of range (exclusive) and 110% of range (inclusive), multiply the range error by 1.1 .
- Add ±0.01% of range per degree centigrade to the voltage DC accuracy of the voltage, current, and active power if a change in temperature reaches or exceeds ±1°C after zero adjustment.
- If a voltage is over 600 V, add the following values to the power phase angle accuracy:
  0.1 Hz < f ≤ 500 Hz: ±0.1°
  500 Hz < f ≤ 5 kHz: ±0.3°
  5 kHz < f ≤ 20 kHz: ±0.5°
  20 kHz < f ≤ 200 kHz: ±1°

Specifications

10

- Add the following value to the accuracy figures for voltage and active power if a voltage of 800 V or more is measured.
  ±0.01% of reading
  Even when the voltage input value decreases, the effect of self-heating persists until the input resistance temperature drops.

11 Maintenance and Service

11.1 Repairs, Inspections, and Cleaning

⚠WARNING

🚫
- **Do not attempt to modify, disassemble, or repair the instrument or measurement modules yourself.**

  The internal components of the instrument and measurement modules may carry high voltages. Attempting the above may cause bodily injury or fire.

⚠CAUTION

❗
- **If any protective function of the instrument is damaged, immediately request repair or dispose of the instrument.**
- **If you must store the instrument, label it as damaged.**

  Failure to do so could result in bodily injury.

IMPORTANT

Halt use in the event of the following conditions.
- If the instrument is clearly damaged
- If the instrument is not capable of measurement
- If the instrument has been stored for an extended period of time in an undesirable environment, for example under conditions of high temperature and humidity
- If the instrument has been subjected to stress due to shipment under harsh conditions
- If the instrument is wet or soiled with a large amount of oil or dust (If the instrument gets wet or oil and dust get inside it, internal insulation may deteriorate, posing a significant risk of electric shock or fire.)
- If the instrument is unable to save measurement conditions

Calibration

The calibration interval depends on factors such as the operating conditions and environment. Please determine the appropriate calibration interval based on your operating conditions and environment and have Hioki calibrate the instrument accordingly on a regular basis.

Backing up data

When repairing or calibrating the instrument, we may initialize it. It is recommended to back up (save/write) data such as the settings and measured data before requesting service.

Maintenance and Service

11

Replaceable parts and service life

Some parts used in the instrument are characterized by performance that degrades over years of use.

It is recommended to replace these parts regularly to ensure instrument functionality over the long term.

To order replacements, please contact your authorized Hioki distributor or reseller.

The service life of parts varies with the operating environment and frequency of use. These parts are not guaranteed to operate throughout the period defined by the recommended replacement interval.

Parts	Service life	Remarks and conditions
Electrolytic capacitor	About 10 years	Requires replacement of the printed circuit boards on which such parts are mounted.
Liquid crystal backlight (half life period of brightness)	About 8 years	If operated 24 hours per day
Fan motor	About 10 years	If operated 24 hours per day
Backup battery	About 10 years	Requires replacement if the time and date are significantly deviated when the instrument is turned on.
Optical insulation element	About 10 years	If operated 24 hours per day
Optical connection cable connector	About 10 years	If operated 24 hours per day

Replacing fuses

The instrument's power supply has a built-in fuse. If the instrument cannot be turned on, the fuse may have blown. Fuses cannot be repaired or replaced by the customer. Contact your authorized Hioki distributor or reseller.

Cleaning

PW8001 main body

⚠CAUTION

■ **Periodically clean the vents to avoid blockage.**

When the vents become clogged, the internal cooling effect of the instrument is hampered, and this can lead to damage to the instrument.

■ **If the instrument becomes dirty, wipe the instrument softly with a soft cloth moistened with water or a neutral detergent.**

Do not wipe the instrument strongly and never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners, or gasoline. Failure to follow this instructions can deform and discolor the instrument.

Wipe the display gently with a soft, dry cloth.

L6000 Optical Connection Cable

⚠CAUTION

🚫 ■ **Do not subject the optical fiber ends of the L6000 to excessive force using a cleaning cloth.**

Doing so could damage the connectors, causing performance degradation.

Maintenance and Service

11

311

11.2 Troubleshooting

If damage is suspected, read "Before returning the instrument for repair" (p. 312) and "11.3 Messages" (p. 315) to remedy the issue. If the issue cannot be resolved, contact your authorized Hioki distributor or reseller.

Before returning the instrument for repair

Check the following items.

Issue	Cause	Solution and where to find additional information
The time and date are significantly deviated after the instrument was turned on.	A backup lithium battery is installed in the instrument. The service life of the backup battery is about 10 years.	If the battery requires replacement, the battery cannot be replaced by the customer. Contact your authorized Hioki distributor or reseller.
Nothing is shown on the screen when the power switch is turned on.	The power cord is not connected to the instrument. The power cord is improperly connected.	Verify that the power cord is connected properly. See "2.4 Supplying Power to the Instrument" (p. 41).
The keys are not functioning.	The instrument is in the key-lock state.	Press and hold the **REMOTE/ LOCAL** key for at least 3 s to cancel the key-lock state.
The screen does not react even when you use the touchscreen.	• The instrument is in the key-lock state. • Foreign material, such as dust, settles on the touchscreen.	• Press and hold the **REMOTE/ LOCAL** key for at least 3 s to cancel the key-lock state. • Remove the dust or other foreign material. See "Replaceable parts and service life" (p. 310).
The instrument's settings cannot be changed.	The instrument is performing integration or stopped performing integration.	Perform an integrated value reset (data reset). See "3.3 Integrating Current and Power" (p. 70).
The instrument cannot display any measured voltage or current values.	The voltage cords and current sensors are improperly connected.	Check the connections. See "2 Preparing for Measurement" (p. 33).
	The input channel and display channel do not match with each other. (For example, this issue will arise if the input channel has been set to Ch. 1 while a page other than the **CH1** page has been being displayed.)	Use the **◀CH▶** keys for channel selection to display the page for the input channel. See "3.2 Measuring Power" (p. 58).
The active power is not displayed.	The voltage and current range settings is improperly configured.	Set the voltage and current ranges properly. See "Voltage range and current range" (p. 59).

Issue	Cause	Solution and where to find additional information
Frequency cannot be measured, or measured values are unstable.	The input frequency is set outside the range of 0.1 Hz to 2 MHz.	Check the frequency by viewing the input waveform. See "4 Waveform Display Method" (p. 115).
	The input frequency is lower than the set frequency.	Set the measurement lower frequency limit setting. See "Measurement upper frequency limit and lower frequency limit (configuring frequency measuring range)" (p. 67).
	The synchronization source input is incorrect. The synchronization source input range is too large.	Check the synchronization source setting. See "Synchronization source" (p. 64), "Voltage range and current range" (p. 59)
	A severely distorted waveform, such as a PWM waveform, is measured.	Set the zero-cross filter to **[ON]**. See "ZCF (Zero-cross filter)" (p. 121).
Three-phase voltage measurement results low.	Phase voltages are measured with the Δ-Y conversion function.	Turn off the Δ-Y conversion function. See "Δ–Y conversion" (p. 145).
Measured power values are anomalous.	The instrument is incorrectly connected.	Check the instrument's connection. See "2.10 Checking Connections" (p. 53).
	The rectifier and LPF settings is improperly configured.	Set the rectifier properly. If the LPF is enabled, set it to **[OFF]**. See "Rectification method" (p. 68). "Low-pass filter (LPF)" (p. 66)
The current reading never falls to zero even when receiving zero-input.	A Universal Clamp On CT is used with a lower current range. The current sensor's high-frequency noise may be affecting the current reading.	Perform zero adjustment after setting the LPF to 100 kHz. See "Low-pass filter (LPF)" (p. 66). "2.9 Connecting Measurement Leads and Sensors to Lines to Be Measured" (p. 51)
The apparent power, reactive power, and power factor readings on the secondary-side of an inverter differ from measurements obtained using other instruments. **Voltage values are higher than expected.**	The rectifier settings are not the same as those on the other instruments.	Use the same rectifier setting as with the other instruments. See "Rectification method" (p. 68).
	The calculation methods differ.	Use the same calculation methods as with the other instruments. See "5.6 Power Calculation Method" (p. 147).
Motor RPM cannot be measured.	The pulse output is set to other than voltage output. The instrument cannot detect open collector pulse output.	Set the device to voltage output to match the Ch. B pulse input setting.
	The pulse output contains noise.	Check the cable routing. Ground the encoder that generate the pulse output. Specify the pulse-noise filter (PNF). See "Pulse-noise filter (PNF)" (p. 98).

Issue	Cause	Solution and where to find additional information
The data I saved includes one or more large values that exceed the range.	An overload condition occurs.	Set an appropriate range. See "4.1 Waveform Display Method" (p. 115) and "7.9 Measured Value Save Data Format" (p. 180).
	A large value exceeding the display range was recorded in the saved data. Large values such as **[1.00E+104]** or **[7.78E+103]** are included in the stored data.	The string **[-------]** is displayed because overload or peak overload has occurred, the range has been changed, or the measured value is invalid.
The instrument cannot detect a USB flash drive.	The USB flash memory is broken.	Press the reload button () on the **[FILE]** screen. Cycle the instrument.

If the cause of your problem remains unclear

If you are unsure of the cause, try a system reset.

All settings will be returned to their factory defaults.

See "6 System Settings" (p. 153).

11.3 Messages

- If damage is suspected, read "Before returning the instrument for repair" (p. 312) as well as "11.3 Messages" (p. 315) below to remedy the issue. If the issue cannot be resolved, please contact your authorized Hioki distributor or reseller.
- When an error is displayed on the LCD screen, repair is necessary. Contact your authorized Hioki distributor or reseller.
- Turning on the instrument while the lines to be measured are live may damage the instrument or cause an error to be displayed. Always turn the instrument on first and then activate power to the lines to be measured once you have verified that no error is being displayed by the instrument.

Error messages

Messages	Remedy
The option calibration data is corrupted.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
The option configuration has changed.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
The unit calibration data is corrupted.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
The unit ID setting is incorrect.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
The instrument's settings have been initialized.	If this message appears frequently, the instrument may be in need of repair. Contact your authorized Hioki distributor or reseller.
The fan is broken.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
Communication part of the Unit is broken.	The instrument is in need of repair. Contact your authorized Hioki distributor or reseller.
There is a problem with the optical link module. Please reboot PW8001.	Turn the instrument off, then on. If this message appears frequently, contact your authorized Hioki distributor or reseller.

Warning messages

Messages	Remedy	Reference page
The current sensor has changed.	Tap the button to close the message.	–
Holding values...	While the hold function is activated, settings that affect measured values cannot be changed. If you wish to change settings, disable the hold function.	"5.3 Hold Function" (p. 141)
Holding peak values...	While the peak hold function is activated, settings that affect measured values cannot be changed. If you wish to change settings, disable the peak hold function.	"5.4 Peak Hold Function" (p. 143)

Maintenance and Service

11

315

Messages	Remedy	Reference page
Integration is ongoing, the instrument is standing by for integration, or integration is stopped.	If you want to reset integration while the instrument is integrating or standing by for integration, stop the integration, then press the **DATA RESET** key. During the integration, settings that affect for other measured values cannot be changed.	"3.3 Integrating Current and Power" (p. 70) "Integration measurement while using the time control function" (p. 76)
	If you want to reset integration while integration has been stopped, press the **DATA RESET** key.	
The entered value is out of range. Please check the setting range and enter the value again.	Check the setting range and enter the value again.	–
Unable to switch wiring. The wiring includes one or more different current sensors.	Check the current sensors' connection.	"2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43)
The number of parameters that can be saved has been exceeded. Check the setting.	Set the data saving interval longer than the present setting, or reduce the number of items to be saved.	–
Cannot perform zero adjustment.	Zero adjustment cannot be performed during hold, peak hold, or integration. To perform zero adjustment, cancel hold and peak hold, and reset the integration.	–
Out of the input range.	Check the setting range and enter the value again.	–
The integration start time is in the past.	Check the integration start time of the real time control.	"5.1 Time Control Function" (p. 137)
Unable to switch I input. The wiring includes one or more different current sensors.	Check the current sensor connection.	"2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43)
Failed to delete.	Try again.	–
Failed to load the upgrade file.	The version-up file may be corrupt. Copy the version-file again and execute it.	–
There is not enough space on the USB drive.	Delete unnecessary files or replace the USB flash drive with another one.	–
Unable to automatically generate the filename.	Either specify a different destination folder or create a new folder and save the file in it. Otherwise, delete unnecessary files or replace the USB flash drive with another one.	"7.8 File and Folder Operation" (p. 178)
The name is already being used by a different file or folder.	Use another name for the file or folder.	"Renaming a file or folder" (p. 178)
Unable to find the USB drive.	Make sure that a USB flash drive is inserted.	"7.1 USB Flash Drive" (p. 157)
Unable to switch to the wiring described in the settings file due to differences in the sensor configuration.	The instrument cannot load a configuration file if the combination of options differs from the actual combination.	"7.7 Saving and Loading the Settings Data" (p. 176)
Unable to load the settings data. The option configuration is different.	Same as above	–

Messages	Remedy	Reference page
Unable to load the settings data. The unit configuration is different.	Same as above	–
The instrument's firmware version differs from the version for which the settings data was created.	Same as above	–
Unable to load the settings file.	Put the instrument into an integration reset state, and a hold canceled state, and disable the synchronous control.	–
Failed to write data.	Try again.	–
Unable to switch I input. The wiring includes one or more different current sensors.	Check the current sensor connection.	"2.5 Setting Wiring Mode and Configuring Current Sensor Settings" (p. 43)
Failed to load data.	Same as above	–
Unable to create file.	Same as above	–
Unable to create folder.	Same as above	–
This USB drive is not supported and cannot be used with this instrument.	If the USB flash drive is formatted with a non-FAT file system, reformat it with FAT32.	"7.1 USB Flash Drive" (p. 157)
Unable to access the USB drive.	The instrument may not support the USB flash drive. Check that the instrument is compatible with the USB flash drive. Even if the instrument should support your USB flash drive, format it when it is not accessible.	"USB flash drive requirements for this instrument" (p. 158). "Formatting the USB flash drive" (p. 179)
No files were found for automatic FTP upload.	Check if there is a file to be sent.	–
Failed to copy data.	Try again.	–
The file on the device is being accessed.	If the instrument is automatically saving data, stop it. If the FTP server function is in use, disconnect the connection.	–
Auto-save operation has not completed. Reset the instrument.	Stop the auto-save operation.	–
Failed to rename.	You cannot rename a file the same as other files or leave the filename box blank. Enter a different name.	–
Failed to format.	Try again.	–
Cannot execute screenshot while auto saving.	Set the data saving interval to 1 s or more. Alternatively, stop the auto-save operation.	–
Cannot save measured data manually while auto saving.	Stop the auto-save operation.	–
Cannot save waveform data while auto saving.	Same as above	–
Cannot save settings data while auto saving.	Same as above	–
Cannot execute media operation while auto saving.	Same as above	–
Cannot make DBC file while auto saving.	Same as above	–

Maintenance and Service

11

317

Messages	Remedy	Reference page
Failed to send the FTP file. It will be resent after a certain period of time.	Make sure that the FTP server is . Otherwise, check the FTP client settings.	"9.4 Sending Data Using the FTP Client Function" (p. 230)
Failed to resend the FTP file.	Same as above	–
Saved in a file. Please wait.	Wait a moment.	–
Cannot save data while storing waveform.	Record the waveforms with the **SINGLE** key and then save them.	"4.3 Recording Waveforms" (p. 123)
The waveform and settings are inconsistent. Please update with the SINGLE key and try again.	Same as above	
The saved data includes one or more large values that exceed the display range, such as [1.00E+104] and [7.78E+103].	The displayed value has become [-------] because an overload or peak over has occurred, the range has been changed, or a measurement value is invalid.	Set an appropriate range. See "4.1 Waveform Display Method" (p. 115) and "7.9 Measured Value Save Data Format" (p. 180). Do not change the range while the instrument is saving data. Alternatively, treat them as invalid data.
The waveform data, invalid, cannot be saved.	The displayed waveform data and that held internally differ because the waveform storage operation was stopped by pressing the **[RUN/STOP]** key. Use the **[SINGLE]** key to acquire waveform data.	"4.3 Recording Waveforms" (p. 123)
Operating in the IEC measurement mode.	Unavailable in IEC measurement mode. Set the measurement mode to wideband measurement mode.	"2.7 Measurement Mode" (p. 48)
Operating in or waiting for the BNC synchronization mode.	Unavailable during the BNC sync or in the connection-ready state. Turn the BNC-sync setting off or restore the BNC sync.	"(7) BNC synchronization" (p. 266) in "External interface specifications" (p. 264)
Operating in the BNC synchronization mode.	Unavailable during the BNC-sync secondary operation. Turn the BNC-sync setting off.	"(7) BNC synchronization" (p. 266) in "External interface specifications" (p. 264)
Operating in the optical link mode.	Unavailable in optical link mode. Turn the opt-link setting off.	"Optical link (Optical link interface)" (p. 192)
Operating in the optical link secondary mode.	Unavailable during the opt-link secondary operation. Turn the opt-link setting off.	"Optical link (Optical link interface)" (p. 192)
Waiting for the optical link mode.	Unavailable in the opt-connection-ready state. Turn the opt-link setting off or restore the optical link.	"Optical link (Optical link interface)" (p. 192)

318

11.4 Frequently Asked Questions

Q **The instrument has saved no measured data even though I measured with the auto-save setting. What should I do?**

A Do not press the **RUN/STOP** key but the **START/STOP** key to perform the auto-save measurement.
See "Automatically saving measured data" (p. 165).

Q **The message "Unable to automatically generate the filename." has appeared during the auto-save operation. What should I do?**

A Create another folder to save further files.
Each folder can contain up to 1000 files.
See "Recordable time and data" (p. 167).

Q **My computer has failed to acquire the MAC address even though I have connected the instrument to the computer through our LAN. What should I do?**

A Check the IP address settings.
Except for the last three digits of the IP address, communications cannot be performed unless all the IP addresses are set to the same numbers as the computer's IP address.
See "9.1 Connecting and Setting the LAN Interface" (p. 220).

Q **Can I retrofit channels to my instrument after delivery?**

A You are not allowed to, but Hioki can modify the instrument by custom order.
Contact your authorized Hioki distributor or reseller.

Q **The saved data includes unusual values, such as *1.00E+104* and *7.78E+103*. What does this mean?**

A The value *1.00E+104* indicates that the data is overloaded or peaked. The value *7.78E+103* indicates that **[-------]** is displayed due to range change or operation disabled value.
The instrument outputs data of *+99999.9E+99* and *+77777.7E+99* for the values *1.00E+104* and *7.78E+103*, respectively. These data are displayed after being changed to the notation (number of digits, etc.) according to the data format of the software used to display data.
See "7.9 Measured Value Save Data Format" (p. 180)

Q **Can I use password-protected (secure) USB flash drives with the instrument?**

A Password-protected USB flash drives cannot be used the instrument.
Use USB flash drives that accommodate the mass storage class standard.
See "7.1 USB Flash Drive" (p. 157).

Q **The instrument failed to detect my USB flash drive. What should I do?**

A Cycle the instrument. If the instrument cannot the USB flash drive after the instrument was cycled, try a different USB flash drive. (Not all USB flash drives are supported.)
See "7.1 USB Flash Drive" (p. 157).

Maintenance and Service

11

11.5 Calculation of the Combinatorial Accuracy

If the combinatorial accuracy of PW8001 (U7001, U7005) and the sensor is not specified

The measurement accuracy for the active power and current are the sum of the accuracy of the instrument and the current sensor to be used. For example, measurement accuracy of active power can be calculated from the following equations:

(Reading accuracy) = (Reading accuracy of active power) + (Reading accuracy of sensors)

(Range accuracy) = (Range accuracy of active power) + [(Sensor's rated current) / (Current range)]
          × (Full-scale accuracy of sensor)

Sensor	CT6862 (rated current: 50 A), accuracy ±0.05% of reading ±0.01% of full scale
Instrument setting	Power range: 6.00000 kW, accuracy ±0.02% of reading ±0.03% of range Wiring: 1P2W Voltage range: 600 V Current range: 10 A
Object under measurement	400 V, 5 A, 2.00000 kW, 50 Hz

Reading accuracy = 0.02% of reading +0.05% of reading = ±0.07% of reading

Range accuracy = 0.03% of range + (50 A / 10 A) × 0.01% of full scale = ±0.08% of range

The accuracy for active power is ±0.07% of reading and ±0.08% of range (with power range 6 kW).

11.6 External View

221±2

234±2

430±2

430±2

361±2

442±2

434±2
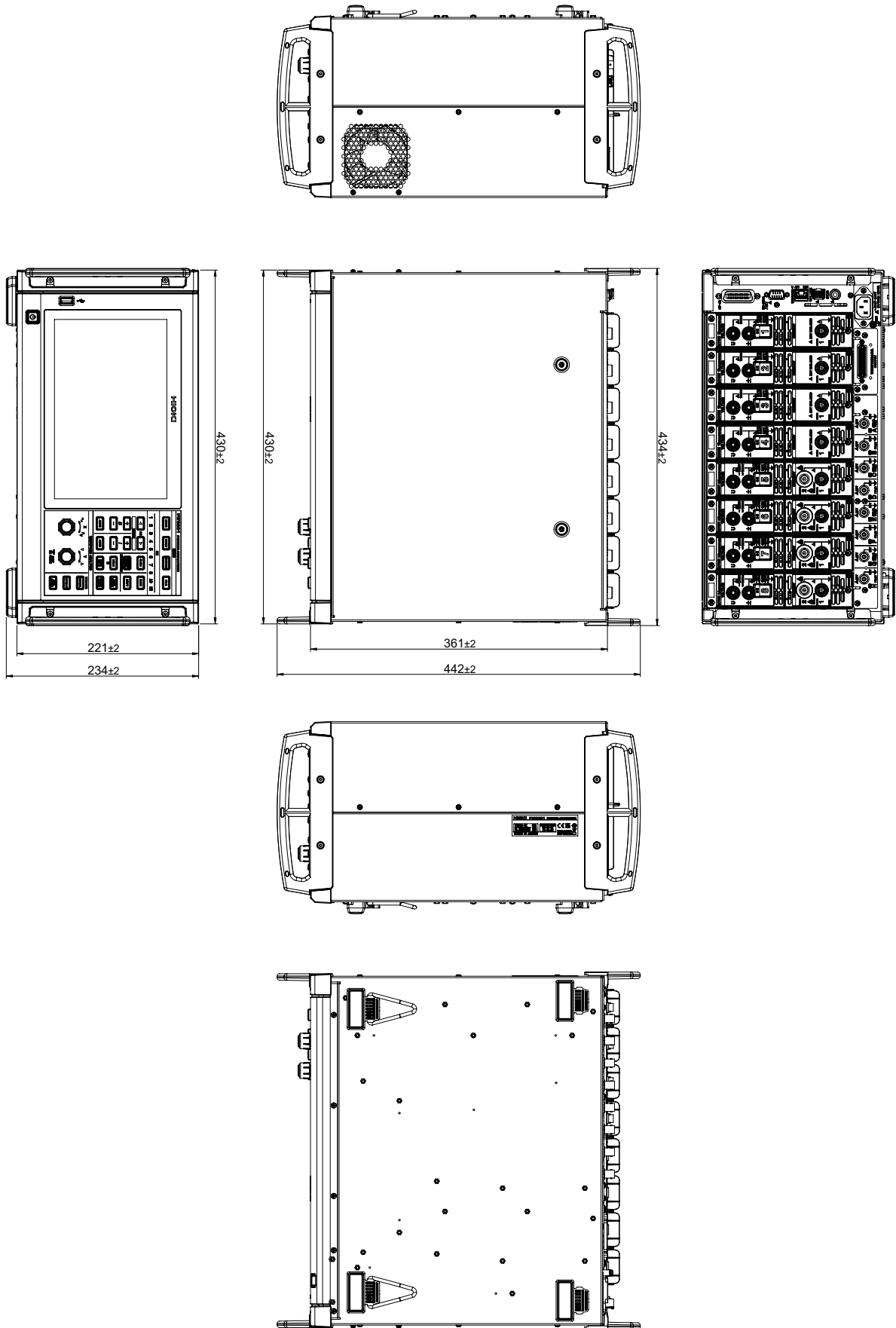
(Unit: mm)

11.7 Rackmount Fittings

The instrument can be installed using rackmount fittings.

JIS-compliant rackmount fitting (for right side)

Material: A5052
Thickness: t3

(Unit: mm)

2×M5 spacer (reference: Fabace FK-M5-7)
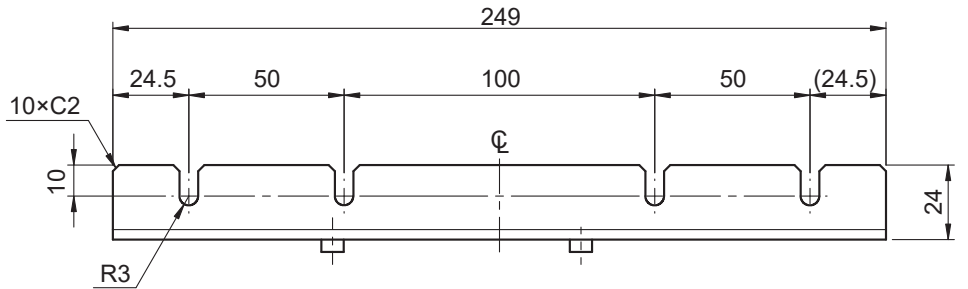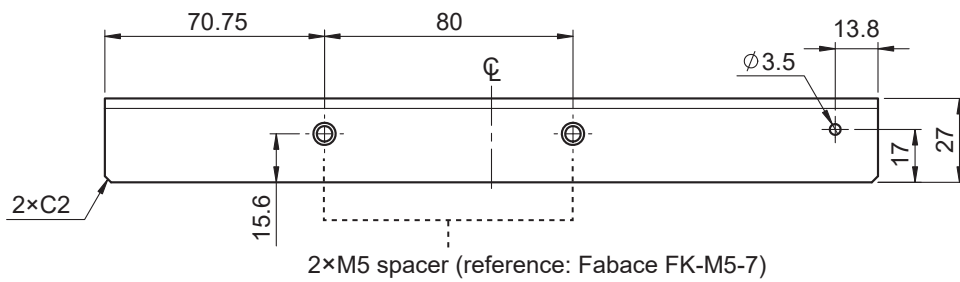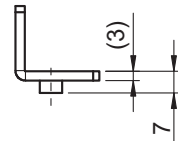
JIS-compliant rackmount fitting (for left side)

Material: A5052
Thickness: t3

(Unit: mm)

2×M5 spacer (reference: Fabace FK-M5-7)
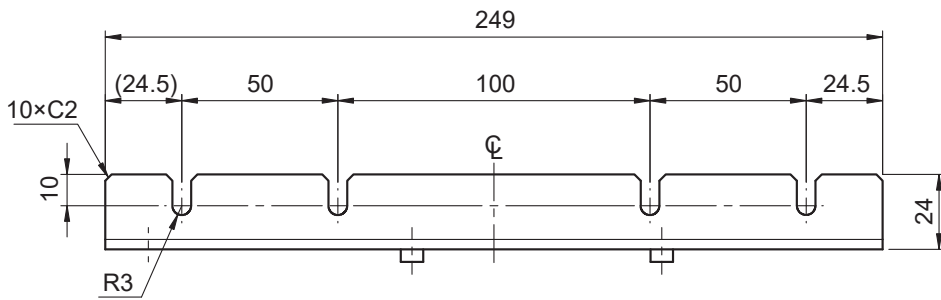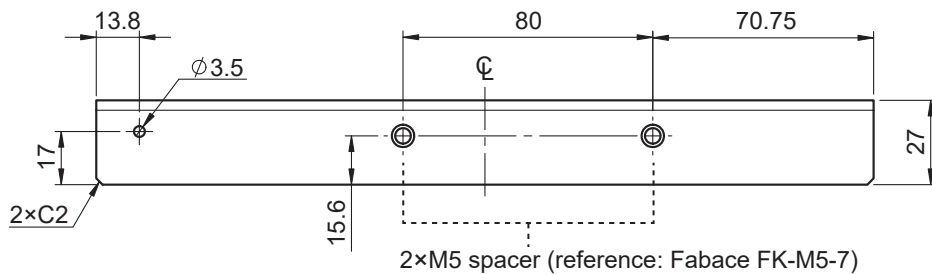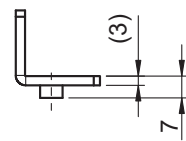
Blank panel for a JIS-compliant rack

Material: A5052
Thickness: t1.6

(Unit: mm)

M3 press nut   M3 press nut

(1.6)

431.6
427.4
23.6
27.6

15
5

2×C3
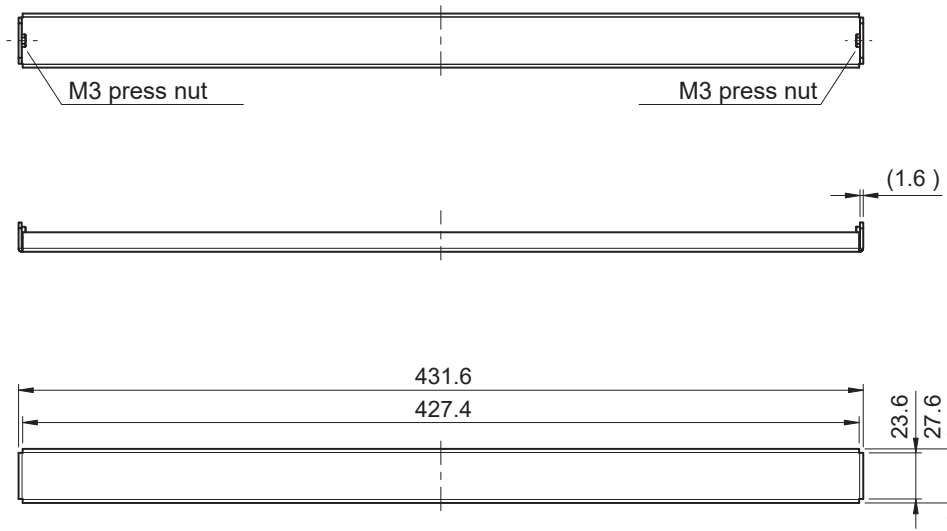
EIA-compliant rackmount fitting

Material: A5052
Thickness: t3

(Unit: mm)

221.5
146.1
8.8
6xC2
℄
25.3
R3.5

(3)
7

80
℄
27
2xC2
15.6

2×M5 spacer (reference: Fabace FK-M5-6)
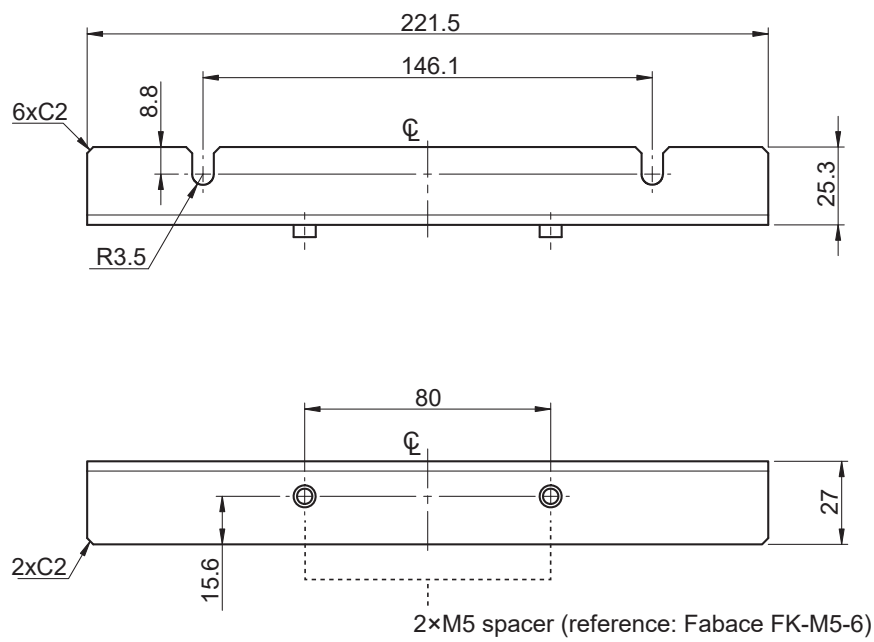
Installation instructions

<div>

⚠ **WARNING**

■ **Use M4×16 mm screws to attach the fittings to the PW8001 main body.**

If fittings are attached with other screws, the instrument may be damaged, causing a risk of bodily injury.

</div>

<div>

IMPORTANT

• Reinforce the inside of the rack with commercially available support braces or other parts as appropriate to bear the weight of the instrument.

• Leave at least 30 mm of space on every surface other than the underside to keep the instrument's temperature from rising.

Leave at least 15 mm of space underneath the instrument (the height of its feet).

</div>

Tools to be prepared:

Rackmount fitting (JIS-compliant Z5301, EIA-compliant Z5300), hexagon wrench (width across flats: 2.5 mm), Phillips screwdriver (No. 2)

To mounting the instrument in a JIS-compliant rack
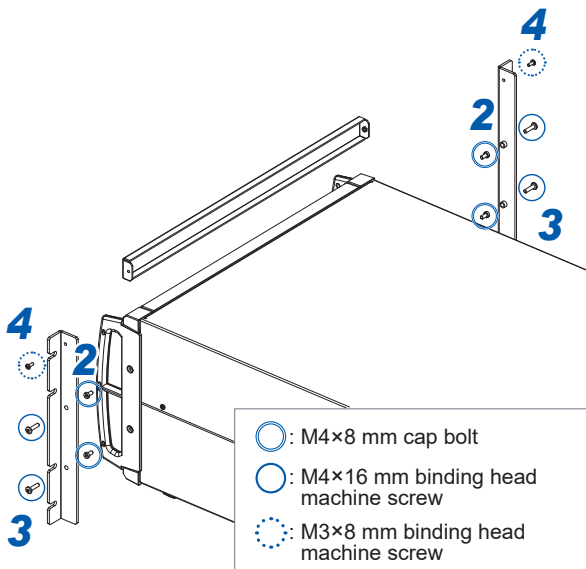
○ : M4×8 mm cap bolt

○ : M4×16 mm binding head machine screw

⊙ : M3×8 mm binding head machine screw

1 Turn off the instrument and remove all cables.

2 Remove the M4 cap bolts (two each on the left and right) that hold each handle in place using the hexagon wrench.

Keep the removed M4 cap bolts.

3 Attach the rackmount fittings to the instrument with M4×16 mm screws (two each on the left and right).

4 Attach the rackmount fitting (blank panel) with M3×8 mm screws (one each on the left and right).

To mounting the instrument in a EIA-compliant rack
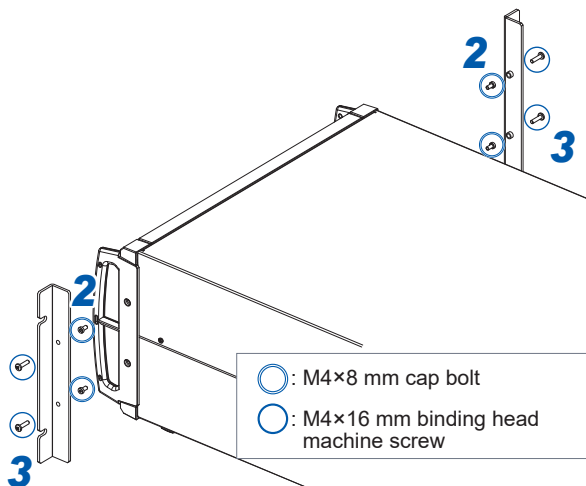
○ : M4×8 mm cap bolt

○ : M4×16 mm binding head machine screw

1 Turn off the instrument and remove all cables.

2 Remove the M4 cap bolts (two each on the left and right) that hold each handle in place using the hexagon wrench.

Keep the removed M4 cap bolts.

3 Attach the rackmount fittings to the instrument with M4×16 mm screws (two each on the left and right).

324

11.8 About Technical Information

Examples of technical information related to Hioki Power Analyzer are shown below. You can download them from the PW8001 or the PW6001 introduction page.

Resources in Japanese

- High-Precision, Wideband, Highly Stable Current Sensing Technology
- Identification Method of PMSM Parameters with the PW6001 Power Analyzer
- Current Measurement Technologies That Deliver High-Precision Power Measurement in the Field of Power Electronics
- High-Precision Power Measurement of SiC Inverters
- Identification of PMSM Motor Parameters with a Power Analyzer (actual measurement)
- Measurement of Loss in High-Frequency Reactors
- Effectiveness of Phase Correction When Evaluating the Efficiency of High-Efficiency Motor Drives
- Temperature Measurement in Bench Testing
- Winding Method of Secondary Winding (Detecting Coil) for Measuring Iron Loss Using Two-Coil Method
- Introduction of Active Line Device Analysis System That Can Accurately Measure Impedance during Charge/Discharge Testing
- Measuring actual operating loss of low-loss inductors with high-precision-wideband power analyzer and current sensors
- Measurement of Large DC Current and Conversion Efficiency of Power Supply for Plating Equipment

Please visit the following Hioki PW8001's website (in Japanese) at the URLs below:

PW8001	PW6001 (relevant product)
https://www.hioki.co.jp/jp/products/detail/?product_key=1907#docs	https://www.hioki.co.jp/jp/products/detail/?product_key=649#docs

Resources in English

- Effectiveness of Current Sensor Phase Shift When Evaluating the Efficiency of High-efficiency Motor Drives
- Measurement of Loss in High-Frequency Reactors
- High-precision Power Measurement of SiC Inverters
- Current Measurement Methods that Deliver High Precision Power Analysis in the Field of Power Electronics
- Identification of PMSM Motor Parameters with a Power Analyzer
- Identification of PMSM Parameters with the Power Analyzer PW6001
- Real Operating Loss Measurement of Low-Loss Inductors Using High-Precision Wideband Power Analyzer and Current Sensor
- High-precision, Wideband, Highly Stable Current Sensing Technology

Please visit the following Hioki PW8001's website (in English) at the URLs below:

PW8001	PW6001 (relevant product)
https://www.hioki.com/global/products/power-meters/power-analyzer/id_412384#downloads	https://www.hioki.com/global/products/power-meters/power-analyzer/id_6029#downloads

11.9 Block Diagram

U7005 15MS/s input circuit

Voltage input circuit

4 MΩ — Range — LPF (Off, 2 MHz) — A/D — Isolator

U

±

Isolation

Current sensor input circuit

1 MΩ — Range — LPF (Off, 2 MHz) — A/D

I

±

U7001 2.5MS/s Input circuit

Voltage input circuit

1 MΩ — Range — LPF (Off, 500 kHz) — A/D — Isolator

U

±

1 MΩ

Isolation

Current sensor input circuit

1 MΩ — Range — LPF (Off, 500 kHz) — A/D

I1

±

1 MΩ

I2

±

BNC

Motor analysis input circuit (optional)

Ch. A, C, E, G input circuit

1 MΩ — Range — LPF (1 kHz, 20 kHz) — A/D — Isolator

BNC

Zero-crossing detection

Each channel isolated

Ch. B, D, F, H input circuit

1 MΩ — Zero-crossing detection — Isolator

BNC

Each channel isolated

D/A output circuit (optional)

100 Ω — D/A

Ch. 1 to Ch. 20

High-speed power analyzing engine III

CPU

10.1″ WXGA LCD (touchscreen)

Keys

USB port (flash drive)

RS-232C

LAN

GP-IB

Synchronization control BNC

CAN/CAN FD (optional)

Sync control Optical link (optional)

Maintenance and Service

11

327

11.10 Updating the Firmaware

IMPORTANT
- Updating the firmware will take about five minutes. Do not turn off the instrument until updating is completed. Turning off the instrument during the process will cause it to malfunction. In such a case, contact your authorized Hioki distributor or reseller for repair.
- It is recommended that you save a backup copy of your configuration conditions before updating the firmware.
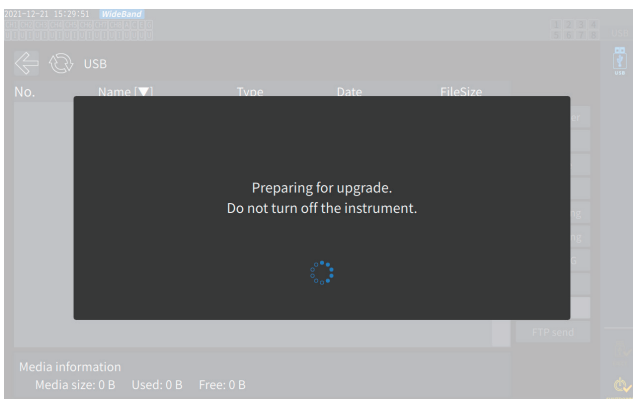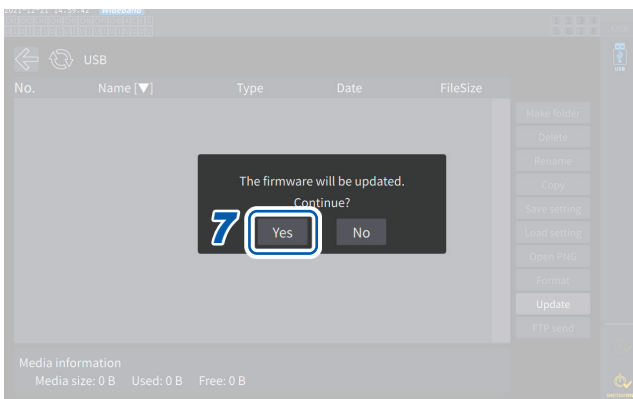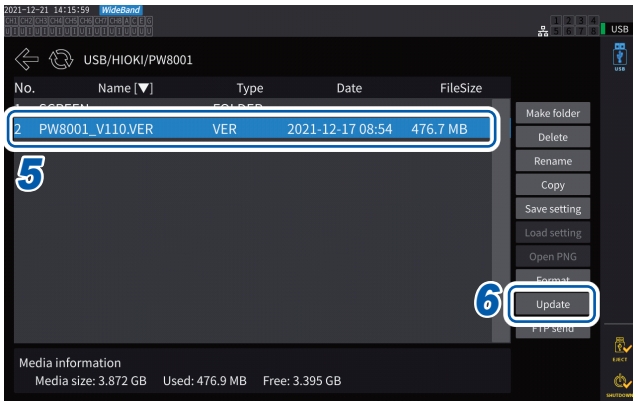
1 **Access our website and download the version-up file (PW8001_Vxxx.VER).**

The letters "xxx" represent the version number.
(e.g., 120 for Ver. 1.20)

2 **Save the version-up file to the HIOKI/PW8001/ directory on a USB flash drive.**

3 **Press the FILE key to move to the file operation screen.**

4 **Insert a USB flash drive into the instrument's USB connector.**

5 **Tap the version-up file to select it.**

6 **Tap [Update].**

The confirmation window is displayed.

7 **Tap [Yes].**

The window appears, indicating that an upgrade is being prepared.
After the window closes, the screen display disappears, and the firmware update begins.
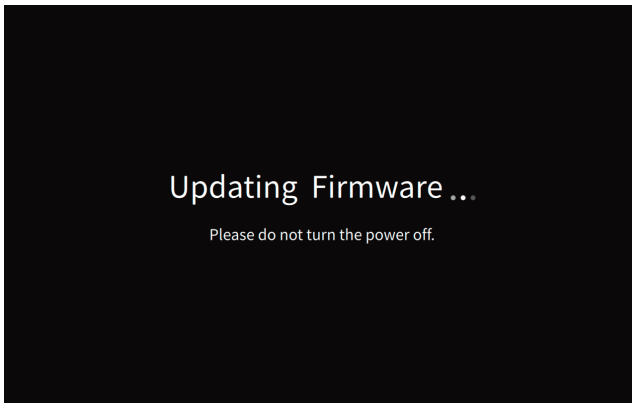
The message **[Updating Firmware...]** is displayed, and the instrument starts up.

8   **Press the SYSTEM key when the instrument starts up.**

Check that the version number is correct on the **[CONFIG]** screen.

11.11 Disposal of the Instrument (How to Remove the Lithium Battery)

When disposing of the instrument, remove the lithium battery and dispose of the battery in accordance with local regulations. Dispose of all optional accessories in accordance with applicable instructions.

⚠WARNING

- **Do not short-circuit the battery.**

- **Do not charge the battery.**

- **Do not disassemble the battery.**

- **Do not throw the battery in the fire or heat the battery.**

    Doing so can cause the battery to explode, resulting in bodily injury.

- **Before removing the lithium battery, turn off the instrument and remove the power cord and the measurement cables from the object under measurement.**

- **Keep the removed battery out of reach of children.**

CALIFORNIA, USA ONLY
Perchlorate Material - special handling may apply.
Visit www.dtsc.ca.gov/hazardouswaste/perchlorate.

Tools to be prepared

Phillips screwdriver (No. 2), hexagon wrench (width across flats: 2.5 mm), flat-head screwdriver (long shaft)
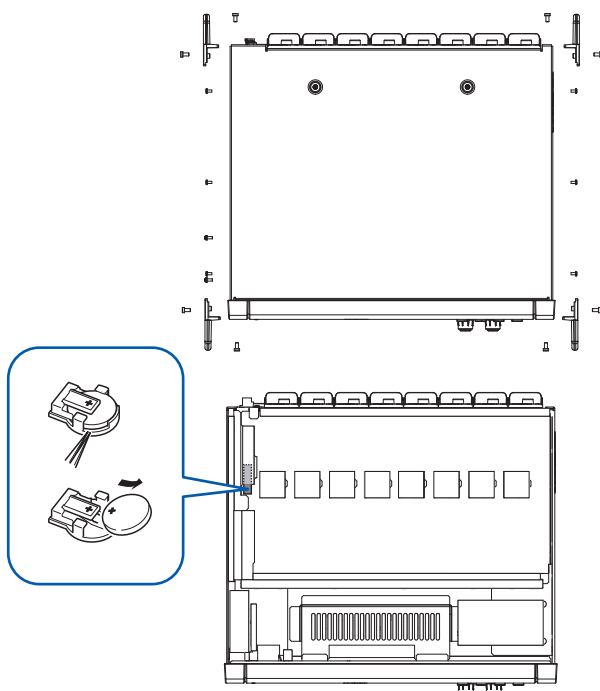
1 **Turn off the instrument.**

2 **Unplug current sensors, voltage cords, the power cord, and any other cords or cables.**

3 **Remove the 16 screws for the handles using the hexagon wrench.**

4 **Remove the four handles.**

5 **Remove the 10 screws securing the top cover using the Phillips screwdriver.**

6 **Lift up on the back securing the top cover to remove it.**

7 **Remove the USB cable from the printed circuit board.**

8 **Insert the tip of the flat-head screwdriver between the battery holder on the internal printed circuit board and the battery and lift up on the battery to remove it.**

11.12 Open-Source Software

This product includes the GNU General Public License (GPL), the GNU Lesser General Public License, and other licensed software. Customers who have purchased this product have the right to obtain, modify or redistribute the source code of the software in accordance with these licenses. For more information, visit the following website.

https://www.hioki.com/en/support/oss/

Please do not inquire about the contents of the source code.

Maintenance and Service

11

Index

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.

HIOKI E.E. CORPORATION
http://www.hioki.com   18-07 EN-3

HIOKI

www.hioki.com/

All regional
contact
information