LR8101
LR8102

Instruction Manual

DATA LOGGER

Check for the latest edition and other language versions.

Read carefully before use.
Keep for future reference.

Safety Information ▶ p.11
Part Names and Functions ▶ p.32
Settings and Operations ▶ p.101
Maintenance and Service ▶ p.455
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Introduction

Thank you for choosing the HIOKI LR8101/LR8102 Data Logger. To obtain maximum performance from this instrument over the long term, please read this manual carefully and keep it available for future reference.
The LR8102 Data Logger is a model based on the LR8101 with additional functions as follows.

- Function to synchronize sampling between instruments
- Function to output measured values from LAN2 port
- Function to output measured values from CAN port

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/

The following instruction manuals are provided. Refer to the appropriate manual for your specific application.
Before using the instrument, make sure to carefully read the separate document titled "Operating Precautions".

Type	Description	Printed version	DVD version
Operating Precautions	Information for using the instrument safely	✓	–
Startup guide	Operating precautions, connection method, and basic operations	✓	✓
Instruction Manual (this manual)	Detailed descriptions, specifications, and information about communications commands for controlling the instrument, functions, and operations	–	✓
Logger Utility*1 Instruction Manual	How to install and operate the PC application software	–	✓

*1. For how to install and operate the PC application software, "Logger Utility", refer to "Logger Utility Instruction Manual" found on the provided DVD (Application Disc).

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

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Symbols and Abbreviations

Safety

In this manual, the risk 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 could result in minor or moderate injury, or potential risks of damage to the supported product (or to other property), if not avoided.
IMPORTANT	Indicates information related to the operation of the instrument or maintenance tasks with which the operators must be fully familiar.
	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 prohibited actions.
!	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 “Usage Notes” (p. 13) of the Instruction Manual, warning messages listed at the beginning of each set of operating instructions, and the accompanying document entitled “Operating Precautions”.
⧈	Indicates that the entire device is protected with double or reinforced insulation.
⏻	Indicates the power push-button switch that toggles the instrument between on and off.
⏚	Indicates a grounding terminal.
⎓	Indicates DC (Direct Current).
∼	Indicates alternating current (AC).

Symbols for various standards

CE	Indicates that the product complies with standards imposed by EU directives.
	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.

Others

Tips	Indicates convenient functions and advice that are useful to know.
*	Indicates additional information is provided below.
☑	Indicates the default setting value. Initialization resets the setting to this value.
(p.)	Indicates the page number to refer to.
Bold letters	Indicates the names of the elements and the keys on the screen.
[ ]	Indicates the names of user interface elements on the screen.
Windows	Unless otherwise noted, the term “Windows” is used generically to refer to Windows 7, Windows 8, Windows 10, and Windows 11.
S/s	For this instrument, 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.

Accuracy labeling

The instrument accuracy is expressed by defining a limit value for errors in terms of the same unit as the unit of reading, range, full scale, digits, and measured value.

% 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 (“% of reading” or “% rdg”).
% of range	**Range** Indicates the measurement range of the instrument. Limit values for range errors are expressed as a percentage of the range (“% of range” or “% rng”).
f.s.	**Full scale (rated value)** This instrument mainly indicates the rated value of the current sensor. Limit values for full-scale errors are expressed as a percentage of full scale (“% of full scale” or “% 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 (“dgt”).

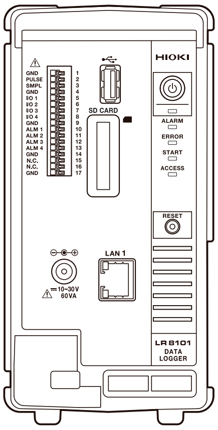
Checking Package Contents

When you receive the instrument, inspect it to ensure that no damage occurred during shipment. 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.

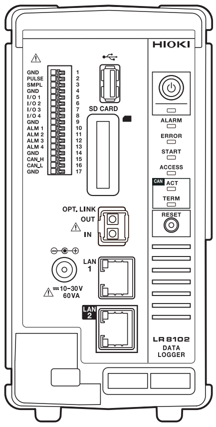
Check the package contents as follows.

Instrument

☐ LR8101 Data Logger

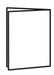


☐ LR8102 Data Logger

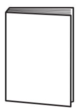


Included accessories

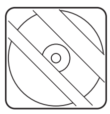
☐ Operating Precautions (0990A903)



☐ Startup Guide



☐ Logger Application Disc (DVD) *1
- Startup Guide
- Instruction Manual
- Logger Utility
- Logger Utility Instruction Manual
- CAN Editor
- CAN Editor Instruction Manual
- GENNECT One



*1. The latest edition can be downloaded from the Hioki website.

Options (sold separately)

The options listed below are available for the instrument. See “1.3 Options” (p. 35).
To place orders, contact your authorized Hioki distributor or reseller.
Options are subject to change. Check Hioki’s website for the latest information.

M7100	Voltage/Temp Module (15 channels)
M7102	Voltage/Temp Module (30 channels)
M7103	Power Measurement Module (3 channels)
M1100	AC Power Module
Z1016	AC Adapter (2-pole grounding power cord included)
L1012	Power Cable (with unprocessed ends)
Z4001	SD Memory Card (2 GB)
Z4003	SD Memory Card (8 GB)
Z4006	USB Drive (16 GB)
9642	LAN cable
L6101	Optical Connection Cable (1 m)
L6102	Optical Connection Cable (10 m)

Safety Information

The instrument and measurement modules are designed in accordance with IEC 61010 International Standards, and have been thoroughly tested for safety prior to shipment. However, failure to follow the guidelines outlined in this manual may compromise the safety of the instrument. Before using the instrument and measurement modules, make sure to read the following safety precautions carefully.

⚠DANGER

■ **Read the Instruction 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.

⚠WARNING

■ **When using the electric measuring instrument for the first time, perform the measurement under supervision of experienced personnel.**

Failure to do so could cause the operator to experience an electric shock.
In addition, heat generation, fire, arc discharge due to short circuit, or other problems could occur.

■ **Wear insulating protective equipment.**

This instrument measures live lines. Failure to wear the protective equipment could cause the operator to experience an electric shock. It is stipulated in the law that insulating protective equipment must be worn.

Measurement categories

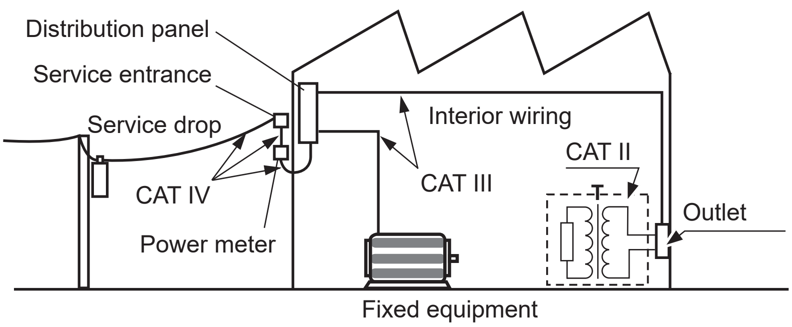
IEC 61010 defines measurement categories to facilitate safe use of measuring instruments. Test and measurement circuits designed to be connected to a main power supply are classified into three categories depending on the type of main power supply circuit.

⚠DANGER

- **Do not use the measuring instrument to measure a main power supply circuit that exceeds the instrument's specified measurement category.**
- **Do not use a measuring instrument without a specified 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.

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.



Usage Notes

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.

Check before use

⚠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 malfunction or damage, contact your authorized Hioki distributor or reseller.
See "2.1 Inspection Before Use" (p. 45) for information about inspections.

Installing the instrument

⚠WARNING

■ **Do not install the instrument in the following types of locations:**

- **Locations exposed to direct sunlight or high temperatures**
- **Areas where corrosive or explosive gases are present**
- **Near sources of strong electromagnetic fields or electrostatic charges**
- **Close to induction heating systems (such as high-frequency induction heaters or IH cookers)**
- **Locations subject to mechanical vibrations**
- **Places where the instrument could be exposed to water, oil, chemicals, or solvents**
- **High-humidity areas or places where condensation occurs**
- **Dusty environments**

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

■ **Leave sufficient space around the instrument, so that the power cord can be unplugged.**

Without sufficient space around the instrument, the power supply cannot be shut down immediately in emergency situations. Failure to do so may result in bodily injury, fire, or damage to the instrument.

⚠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.

■ **Do not bend or pull the cables in environments below 0°C.**

The cables become stiff in such an conditions. Bending or pulling the cables may result in cable breakage or damaged insulation, posing a risk of electric shock to the operator.

⚠CAUTION

■ **Do not unplug the communication cable while the instrument is sending or receiving data.**

Doing so could damage the instrument.

■ **Turn OFF the instrument and PC before connecting or disconnecting the communication cable.**

Failure to do so could damage the instrument being connected or cause it to malfunction.

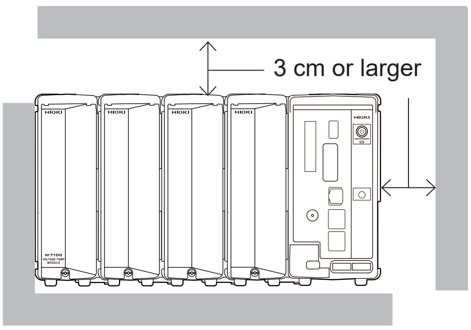
■ **Use the same ground for the instrument and the PC.**

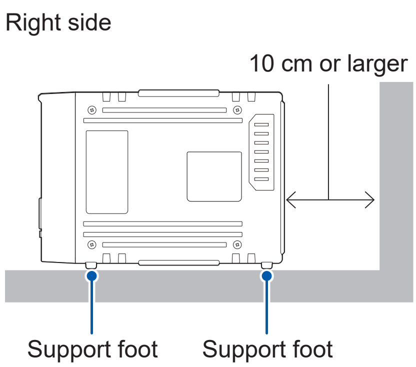
When a communication cable is connected to the instrument with a potential difference between the ground circuits of the instrument and the PC, the instrument may be damaged or malfunction.

IMPORTANT

- Take appropriate measures to prevent the ambient temperature near the terminal block of the measurement module from changing. If the terminal block is exposed to air from a ventilation fan, air conditioner, etc., a measurement error can occur during temperature measurement using a thermocouple.
- When the environment temperature has changed significantly, wait for at least 60 minutes before starting the measurement after the temperature is stabilized.

- Do not block the vents. (Leave at least 3 cm of space on the top and the right, and at least 10 cm on the rear to keep the instrument's temperature from rising.)
- Do not stack the instruments.
- Be sure to orient the feet so that they support the weight of the instrument as shown below.





Handling the instrument

⚠CAUTION

- **Do not subject the instrument to vibration or mechanical shock while transporting or handling it.**
- **Do not drop the instrument on the floor or other surfaces.**

  Doing so could damage the instrument.

- **Precautions when transporting the instrument**

  The instrument will become heavy if numerous modules are connected. Failure to observe occupational safety rules could lead to bodily injury or instrument damage.
  Reference weights:

  • LR8102, M7103 × 4, M7100 × 6, M1100: approx. 17.4 kg
  • LR8102, M7100 × 10: approx. 14.5 kg

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. In such cases, the operator should take appropriate measures to address the issue.

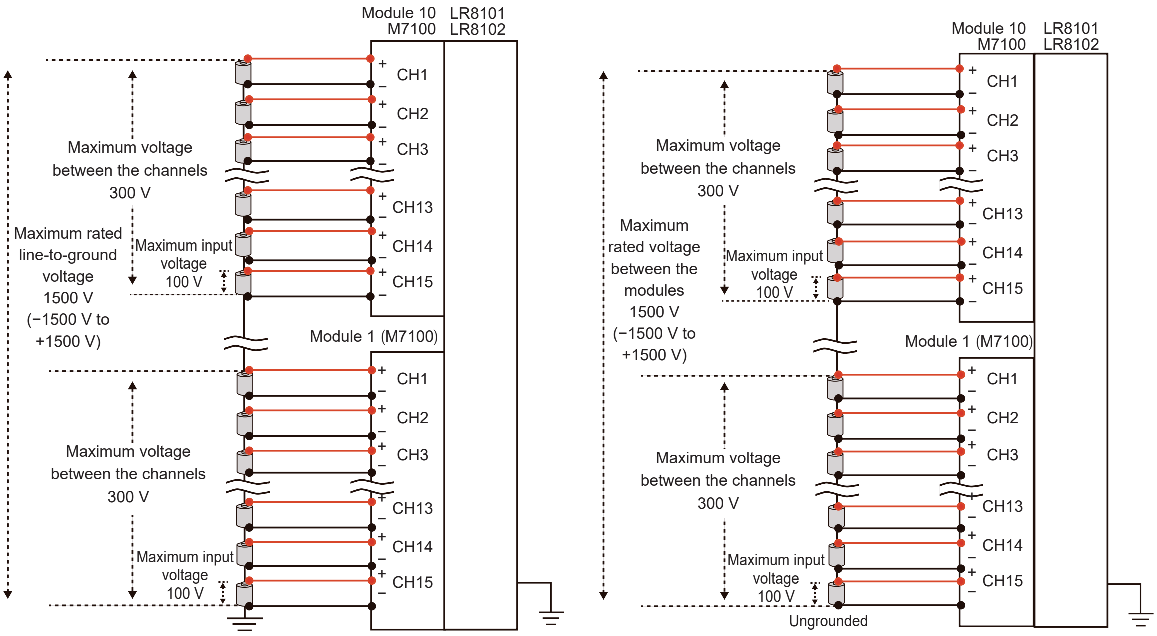
Precautions for measurement

⚠DANGER

■ **Do not input voltage between the channels that exceeds the maximum input voltage of the measurement modules, the maximum rated line-to-ground voltage, the maximum rated voltage between channels, or the maximum rated voltage between modules.**

- **Maximum input voltage: Between the + and − inputs**
- **Maximum voltage between the channels: Between any channels of the same module**
- **Maximum rated line-to-ground voltage: Between ground potential and the input terminals**
- **Maximum rated voltage between the modules: Between channels of different modules**

Doing so could result in serious bodily injury or damage to the instrument. These rated voltages vary depending on the measurement modules. See "13 Specifications" (p.355) for these values.



If you use modules with differing maximum rated voltages between modules for a measurement target connected in series, such as a battery pack, the specifications of the module with the lower maximum rated voltage between modules will apply.

Example: Mixing the M7100, M7103, and M7102 to measure a battery pack
This combination cannot be used to measure a battery pack over 600 V, because the maximum input voltage between the modules is limited to 600 V DC.

Tips **Supplementary explanation about maximum voltage between the channels**

When the maximum voltage between the channels is 300 V, make sure that the potential difference between the adjacent channels, as well as among all the channels, is within 300 V. For example, the potential difference should be within 300 V between CH1 and CH2, and also between CH1 and CH15.

⚠DANGER

- **Do not touch any input terminals on the VT (PT), CT, or instrument when they are in operation.**

  Doing so could result in serious bodily injury.

- **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.

- **Do not use the instrument and measurement modules to measure a main power supply circuit.**

  The voltages to earth of the M7100 and M7102 measurement modules are compatible with CAT II. However, these modules cannot be used for a measurement in CAT II, CAT III, or CAT IV.
  Never input a voltage in CAT II, CAT III, or CAT IV between the measurement terminals.
  Failure to do so could cause the operator to experience an electric shock or damage the instrument.

- **Do not short-circuit the two wires of the measurement line using the metallic tips of the sensors.**

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

⚠WARNING

- **Do not allow the instrument to become wet.**

- **Do not operate the instrument with wet hands.**

  Doing so could cause the operator to experience an electric shock.

- **Securely connect the measurement cables to the input terminals.**

  Loose terminals could result in increased contact resistance, causing the product to become hot or burn up or resulting in bodily injury or fire.

- **When no measurement module is connected, install the connector cover.**

  Failure to do so could cause the operator to experience an electric shock or damage the instrument and measurement modules.

Tips

Effect of induced voltage
Due to induced voltage, the displayed value may become unstable when there is no input; however, this is not a malfunction.

A physical phenomenon called short range ordering occurs in K and T thermocouples. This phenomenon may prevent accurate measurement between 250°C and 600°C.
Select the sensor while referring to the manufacturer of the thermocouples to be used.

Shipping Precautions

- Store the packing materials after unpacking. When shipping the instrument, use the original packing materials that were used when the instrument was delivered.
- To ship the instrument safely, use the box and cushioning material in which it was originally shipped. However, do not use the original box or cushioning material if the box is torn or deformed or the material is crushed. If you are unable to use the original box and cushioning material, contact your authorized Hioki distributor or reseller.
- Before packing the instrument, be sure to disconnect the power cords.
- 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.
- We are not responsible for any issues that may arise in your computer system due to the use of this disc.

About This Manual

The command is required for the setting.
Sending the command as shown in the example will update the settings on the instrument.

The command is required for inquiring about the setting.
Sending the command as shown in the example allows you to acquire the setting and measured value in the (Response) format.

Setting item and description
The configurable item and its description.

5 **Set whether or not to repeat the recording operation.**

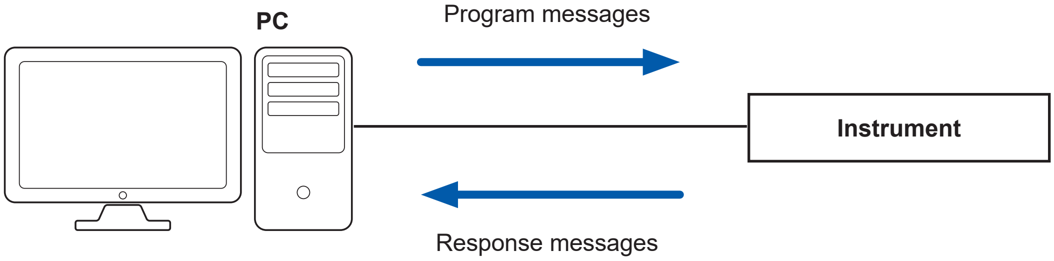
Settings		
Syntax	Command	`:TRIGger:MODE A$`
Example	`:TRIGger:MODE REPEat`	
Query		
Syntax	Query	`:TRIGger:MODE?`
	Response	`A$`
Example	`:TRIGger:MODE?` (Response) `:TRIGGER:MODE REPEAT` (When the header is ON)	
Parameter		
`A$` = SINGle, REPEat		

`SINGle`☑	Repetitive recording OFF The measurement is completed with one recording.
`REPEat`	Repetitive recording ON The recording is repeated. Executing the `STOP` command ends the measurement.

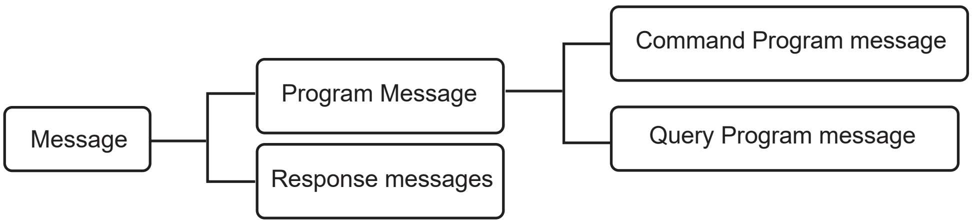
Communication Method

Command

Various communication commands are available to control the instrument via the interface.
The communication commands include the program messages, which are sent from a PC to the instrument, and the response messages, which are sent from the instrument to a PC.



The data sent and received between communication devices is referred to as a message.
The messages are categorized as shown in the figure below.



Program messages	These messages are sent from the controller to the instrument.
Response messages	These messages are sent from the instrument to the controller. The message is created after a query program message is received and its syntax is checked.
Command program messages	These messages are the commands to control the instrument, such as setting or resetting the instrument.
Query program messages	These messages are the commands to query the results of operations, measurements, and the setting status of the instrument.

The command program messages and the query program messages are collectively referred to as the commands. (The commands are written in Hioki's proprietary SCPI language.)

Message format

Program messages

The program messages can be categorized into command program messages and query program messages.

(1) Command program messages

Commands to control the instrument, such as setting or resetting the instrument

Example: Command to set the header

```
:HEADer ON
```

Header part Space Data part

(2) Query program messages

Commands to query the results of operations, measurements, and the setting status of the instrument

Example: Command to query the current header settings

```
:HEADer?
```

Header part Question mark

See “Header” (p. 22), “Separator” (p. 23), and “Data part” (p. 24).

Response messages

The response message is created after a query message is received and its syntax is checked. If any error occurs when a query message is received, no response message is created for the query message.

Command syntax

There are two command description formats as follows:
- Long form that can be associated with functions
- Abbreviated short form

In this manual, the short-form part is written in uppercase, while the remaining part is written in lowercase. Commands with both uppercase and lowercase letters are accepted.

`:SYSTem:COMMunicate:LAN:IPADdress`	Description in this manual
`:SYSTEM:COMMUNICATE:LAN:IPADDRESS`	OK (long form)
`:SYST:COMM:LAN:IPAD`	OK (short form)
`:SYST:COMM:LAN:IPADD`	Results in a command error.
`:SYST:COMM:LAN:IPA`	Results in a command error.

The response messages from the instrument are returned in the long form with uppercase letters.

Header

The program messages require a header.

(1) Command program headers

There are the following three types:

Command type	Example	Description
Single command header	`:HEADer ON`	Header that consists of a single word starting with an alphabetical character
Combined command header	`:SYSTem:DATE 24,1,2`	Header that consists of multiple single command headers separated with colons (`:`)
Standard command header	`*RST`	Header that starts with an asterisk (`*`) indicating the standard command header (as specified in IEEE 488.2)

(2) Query program header

This header is used to query the setting status of the instrument or query the measured values.
As shown in an example below, a program header ending with a question mark (`?`) is recognized as a query.

Command type	Example	Description
Single command header	`:HEADer?`	Header that consists of a single word starting with an alphabetical character
Combined command header	`:SYSTem:DATE?`	Header that consists of multiple single command headers separated with colons (`:`)
Standard command header	`*IDN?`	Header that starts with an asterisk (`*`) indicating the standard command header (as specified in IEEE 488.2)

Message terminator

The instrument can accept the following as a message terminator.

LAN1	LF, CR+LF

The terminator for response messages is fixed to CR+LF.

Separator

(1) Message unit separator

Multiple message can be described in a single line by connecting them using semicolons (;).

Example: `:HEADer ON;*OPC?`

Semicolon

If a series of messages is described continuously and an error occurs in the sentence, the messages after the error and before the terminator are not executed.

(2) Header separator

A message with a header and data can be separated into the header and data parts by using a space (blank).

Example: `:HEADer ON`

Space

(3) Data separator

A message with multiple data sets requires commas (,) between the data sets.

Example: `:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,1`

Comma

Data part

The instrument uses the character data or the decimal numerical value data for the data part depending on the commands.

The data field is expressed as follows.

Symbol	Meaning	Example
A$	Character string data	OFF, ON
module$	Module data	MODULE1 to MODULE10 PLS&ALM, CALC, CALC1, CALC2[*4]
ch$	Channel data	CH1_1 to CH10_30[*1] PLS1 LOG ALM1 to ALM4 ALARM[*2] W1 to W30 M1URMS1 to M4HST3[*3]
pls$	Pulse channel data	PLS1
alm$	Alarm channel data	ALM1 to ALM4
w$	Waveform calculation channel data	W1 to W30
A, B, C,…	Numerical value data	10, -20, 1.5E+05, 0.1
A<NR1>	Integral number data	+15, -20, 25
A<NR2>	Fixed-point data	+1.23, -4.57, 7.89
A<NR3>	Floating-point data	+10.0E-03, -2.3E+03, 5E+03

For the settings of numerical values, all of the <NR1 to 3> formats are accepted.
*1. Channel data of M7100 and M7102
*2. The alarm function itself is the target.
*3. Channel data of M7103 (p. 145)
*4. CALC1 groups together W1 through W15, while CALC2 groups together W16 through W30.

(1) Character data

The data always starts with an alphabetical character and consists of alphabetical and numerical characters. For the character data, both uppercase and lowercase letters are accepted. However, the response messages from the instrument are always returned with uppercase letters.
As with the command syntax, the long and short forms are available and both are accepted.

Example: `:TRIGger:MODE SINGle`

(2) Decimal numerical value data

For the numerical value data, the NR1, NR2, and NR3 formats are available. Each format can accept numerical values with and without a sign. Numerical values without a sign are treated as positive numerical values.
In addition, if a numerical value is described to a decimal place that cannot be processed by the instrument, the value is rounded off to the next higher decimal place.

- NR1 integral number data (example: +12, −23, 34)
- NR2 decimal fraction data (example: +1.23, −23.45, 3.456)
- NR3 floating-point exponential notation data (example: +1.0E-2, −2.3E+4)

The format including all of the three formats above is referred to as the “NRf” format.

The instrument can accept numerical values in the NRf format.
The response data are sent in the format specified for each command.

Example of NR1 format:	`:SYSTem:THINOut 10`
Example of NR2 format:	`:CONFigure:SAMPle 0.1`
Example of NR3 format:	`:ALARm:ANALog:LEVEl ALM1,CH1_1,+1.0E-3`

(3) Character string data

- The character string data are placed between quotation marks.
- The data consists of 8-bit ASCII characters. However, some commands including the comment setting are sent and received in Shift_JIS.
- A character that cannot be processed with the instrument is replaced with an underscore (_).
- As quotation marks, only double quotations (") can be sent. However, both double and single quotations (') can be received.
- In the commands, a single quotation (') can be used instead of a double quotation (").

The special characters can be entered as follows.

PC	^2	^3	~u	~o	~e	~c	~+	~,	~;	^^	~~
LR8101, LR8102	2	3	μ	Ω	ε	°	±	'	"	^	~

Example:
```
:COMMent:TITLe 'HIOKI'
:COMMent:TITLe "HIOKI"
:COMMent:TITLe "~o"
```

Abbreviation of combined command header

When the commands with a common leading part are combined, the repeated part can be omitted as long as the commands are described continuously.
This common part is referred to as a “current path”. Until the current path is cleared, the subsequent commands are analyzed assuming that the current path is omitted.

An example of using the current path is shown below.

Normal notation `:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,1;:SYSTem:COMMunicate:LAN:SMASk 255,255,255,0`
Abbreviated notation `:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,1;SMASk 255,255,255,0` This part defines a current path, which can be omitted in the subsequent commands.

The current path is cleared under the following situations.
- When the power is turned ON
- When a command starting with a colon (`:`) or an asterisk (`*`) is sent
- When a message terminator is detected

The single and combined command headers require no colon (`:`) at the beginning. However, it is recommended to place a colon (`:`) at the beginning of a command in order to prevent confusion with abbreviated forms and avoid malfunction.

Output queue and input buffer

(1) Output queue

The size of an output queue is 200 kilobytes.
The response messages are stored here and read out from the controller.
A response message exceeding 200 kilobytes results in a query error.

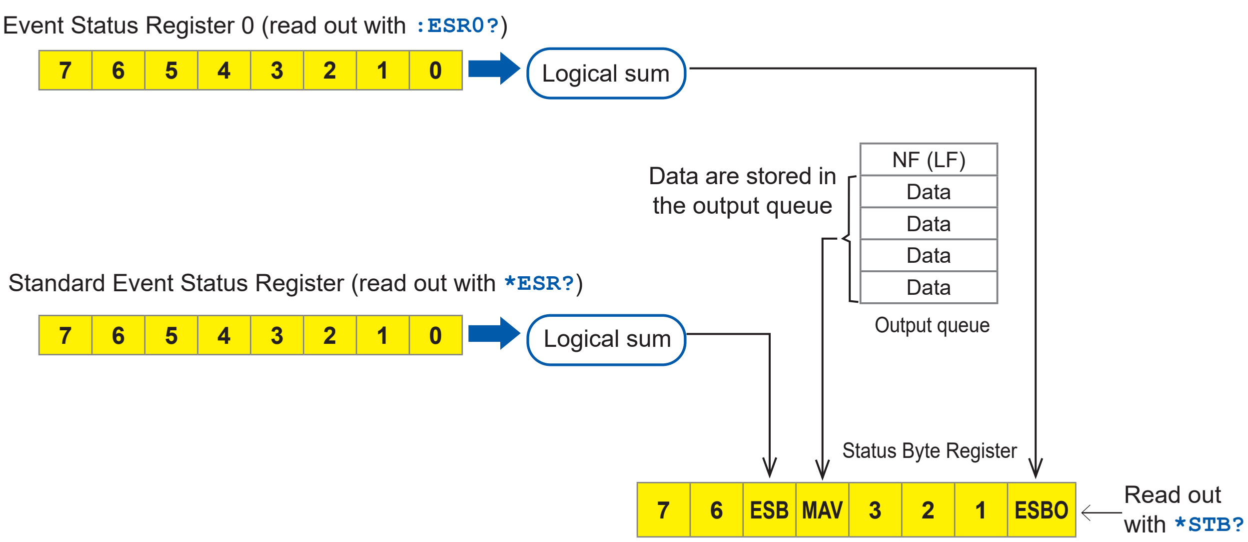
The output queue is cleared under the following situations.
- When the controller has read out a response message
- When the power is turned ON again
- When the instrument has received a message about the next target for processing.

(2) Input buffer

The size of an input buffer is 200 kilobytes.
Received messages are input in this buffer and executed sequentially.
However, the `:ABORT` command is executed immediately when received.

Register

The instrument is equipped with the following registers specified in IEEE 488.2 as shown in the figure below.
- Standard Event Status Register
- Status Byte Register
- Event Status Register 0



(1) Status byte

Each bit of the status byte is a summary (logical sum) of the event register corresponding to the bit.

Status Bar	Description
Bit 7	Unused: 0
Bit 6	Unused: 0
Bit 5 (ESB)	Event summery bit Represents a summary of the Standard Event Status Register.
Bit 4 (MAV)	Message available Indicates that there is a message in the output queue.
Bit 3	Unused: 0
Bit 2	Unused: 0
Bit 1	Unused: 0
Bit 0 (ESB0)	Event summery bit 0 Represents a summary of Event Status Register 0

To read out the status byte, use the following command.

Reading out the status byte	`*STB?`

(2) Standard Event Status Register (SESR)

The summary of this register is set on bit 5 of the status byte.
The contents of the Standard Event Status Register is cleared under the following situations.

- When the `*CLS` command is received
- When the content has been read out with the `*ESR?` query
- When the power is turned ON again

Standard Event Status Register (SESR)	Description
Bit 7 (PON)	The power is turned ON again. The power has been shut down after this register was read out for the last time. 1 when the power is turned ON.
Bit 6 (URQ)	User request Unused (0)
Bit 5 (CME)	Command error The received command contains an error. Syntax error, semantic error.
Bit 4 (EXE)	Execution error The command being executed by the instrument contains an error. Range error, mode error.
Bit 3 (DDE)	Device dependent error
Bit 2 (QYE)	Query error Empty queue, lost data (queue overflow)
Bit 1 (RQC)	Request of controller privilege (unused) Unused (0)
Bit 0 (OPC)	Operation completed Set only for the `*OPC` command.

To read out the Standard Event Status Register, use the following command.

Standard Event Status Register	`*ESR?`

(3) Event Status Register 0 (ESR0)

The summary of this register is set on bit 0 of the status byte.
The contents of the Event Status Register is cleared under the following situations.

- When the `*CLS` command is received
- When the content has been read out with the `:ESR0?` query
- When the power is turned ON again

Event Status Register 0 (SESR0)	Description
Bit 7	Unused: 0
Bit 6	Unused: 0
Bit 5	Unused: 0
Bit 4	Unused: 0
Bit 3	Unused: 0
Bit 2	Trigger standby end (set when the trigger is activated)
Bit 1	START process end (set when STOP is executed)
Bit 0	Error or warning occurred

To read out the status byte, use the following command.

Reading out Event Status Register	`:ESR0?`

Items to be initialized to the default status

The following items are initialized to the default status when the instrument is initialized.
For the initialization of the device-specific functions, see “14.8 Settings After Initialization (System Reset)” (p. 419).

✓: Initialized, –: Not initialized

Register	When the power is turned ON	`*RST` Command	`*CLS` Command
Device-specific functions (measurement conditions, compensation value, etc.)	–	✓	–
Output queue	✓	–	–
Input buffer	✓	–	–
Status byte register	✓	–	✓ *1
Event register	✓ *2	–	✓
Enable register	✓	–	–
Current path	✓	–	–

*1. Other than the MAV bit are cleared.
*2. The PON bit (bit 7) is excluded.

1 Overview

1.1 Product Overview and Features

The instrument is a multichannel data logger that combines individual measuring modules. It is used for recording physical readings, including temperatures and voltages.

Both LR8101 and LR8102

Choice of measurement modules according to applications

Features	Modules
Maximum rated line-to-ground voltage is 1500 V and voltage recording at intervals of 5 ms.	M7100 Voltage/Temp Module
Temperature recording in 30 channels	M7102 Voltage/Temp Module
High precision power recording	M7103 Power Measurement Module (Requires instrument firmware V1.50 or later)

Up to ten measurement modules can be connected

Up to 10 measurement modules can be connected to a single instrument.
However, a single instrument can accommodate a maximum of four M7103 modules.
Each instrument can accommodate a single power supply module.

LR8102 only

Data output based on UDP

Measurement data are output for every sampling in real time. The fastest speed is achieved with intervals of 5 ms.
This is useful when realtime processing is required, such as HILS.

Multiple instruments synchronized for measurement

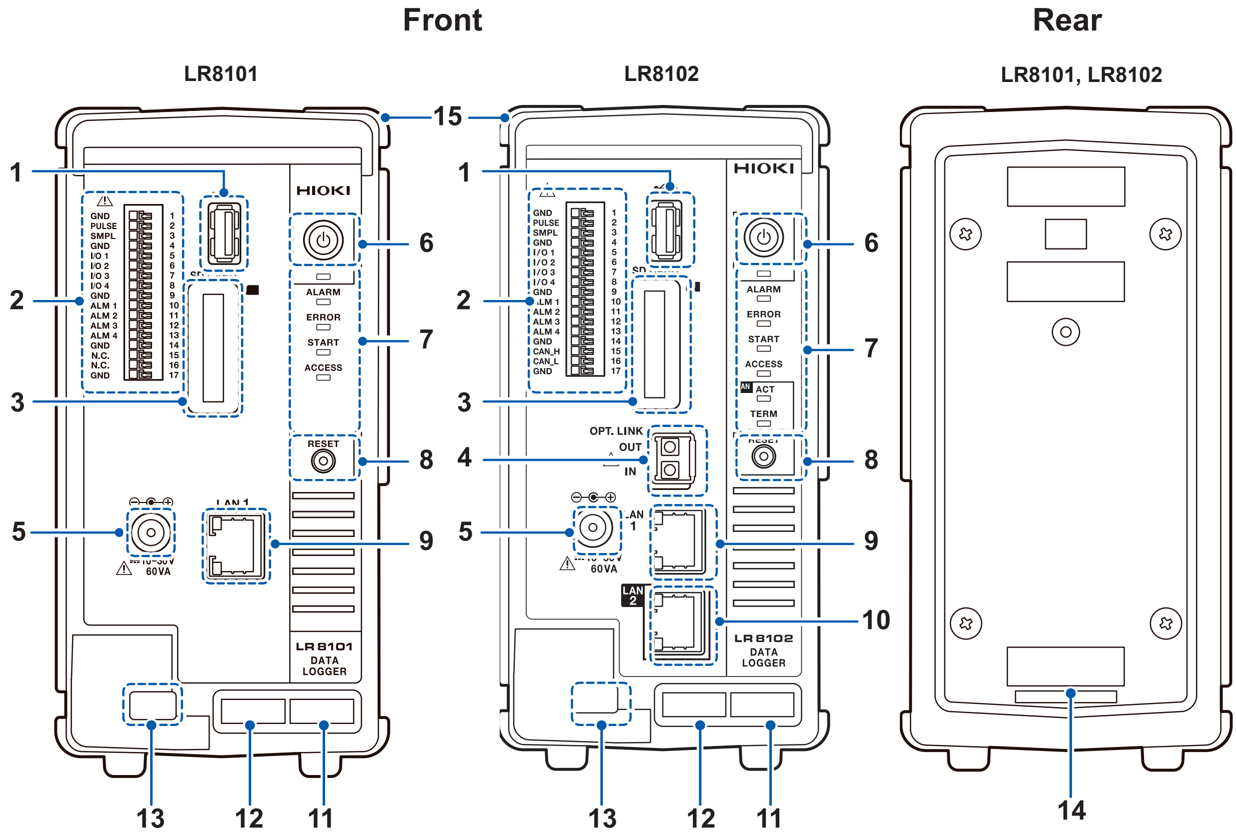
Synchronized measurement is enabled with an optional L6101 Optical Connection Cable (1 m) or L6102 Optical Connection Cable (10 m).
The measurement data from all of the synchronized instruments can be output from LAN2 of the primary instrument.

Data output via CAN

The measured value can be output via a Controller Area Network (CAN).
The value can be used for data integration with the information of an in-vehicle device, such as the battery management system (BMS).

1.2 Part Names and Functions

LR8101 and LR8102 Data Loggers



No.	Name	Function	Reference
1	**USB connector**	Optional USB drive can be connected.	p.75
2	**External control terminal**	Allows you to control the instrument with external signals. Alarm signal can be output.	p.61
3	**SD card slot**	Optional SD memory card can be inserted.	p.74
4	**Optical synchronization connector***1	Optional optical connection cable can be connected.	p.65
5	**Power supply terminal**	Optional Z1016 AC Adapter can be connected. External power supply can be connected (10 V to 30 V DC).	p.48
6	**POWER key**	Allows you to turn ON and OFF the power.	p.71
7	**LED**	See the next page	p.33
8	**RESET key**	Allows you to initialize the settings. Allows you to cancel the warning status.	p.34
9	**LAN1 port**	LAN cable can be connected. (100BASE-TX/1000BASE-T)	p.85
10	**LAN2 port***1	LAN cable can be connected. (100BASE-TX/1000BASE-T)	
11	**MAC address (LAN1)**	Indicates the MAC address assigned to LAN1. Do not remove it as the number is required for management.	–

*1. LR8102 only

No.	Name	Function	Reference
12	**Serial number**	For the latest information, check Hioki's website. Do not remove it as the number is required for management. Share this number when contacting your reseller.	–
13	**Cable hook**	To prevent the AC adapter from coming off, pass the AC adapter cable through this hook.	p.46
14	**MAC address (LAN2)*1**	Indicates the MAC address assigned to LAN2. Do not remove it as the number is required for management.	–
15	**Connecting cover**	When using the instrument without connecting a module, install the cover.	p.46

*1. LR8102 only

LED

LED	Name	Function	Reference
	POWER	Lights up when the power is ON.	p.71
ALARM	**ALARM**	Lights up when an alarm is issued.	p.247
ERROR	**ERROR**	Blinks when an error occurs. Lights up when a warning occurs.	p.458
START	**START**	Lights up while measurement is performed.	p.171
ACCESS	**ACCESS**	Lights up when the SD memory card or USB drive is accessed.	p.72
CAN ACT	**ACT *1**	Blinks when the CAN output is activated.	p.63
TERM	**TERM *1**	Lights up when the CAN terminator is ON.	

*1. LR8102 only

- The LEDs light up in sequence until the startup is completed.
  ALARM → ERROR → START → ACCESS
- When the instrument is updated, the LEDs blink in sequence according to the progress.
  ALARM → ERROR → START → ACCESS
- When the ROM and RAM of the instrument are checked, the LEDs blink in sequence according to the progress.
  ALARM → ERROR → START → ACCESS

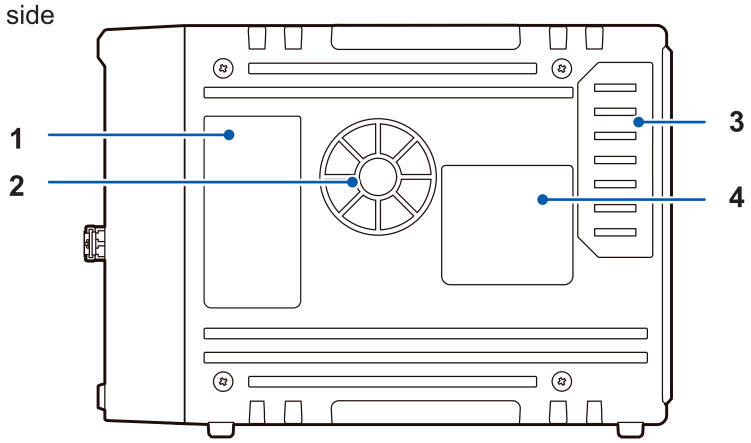
Key operation on the instrument

Key	Function	Operation	Reference
POWER key	Shutdown	When the key is pressed once, the LED starts blinking (approx. 5 seconds). Pressing the key again while the LED is blinking turns OFF the power.	–
RESET key	Initialization (full reset)	Holding down the key during startup fully resets the instrument. Keep holding down the key until the LED blinks and a buzzer sounds.	p.296
	Warning status clear	Pressing the key once in the warning status (ERROR LED is lit) cancels the warning status.	p.461
	Alarm hold clear	Pressing the key once during alarm hold cancels the hold status.	p.247

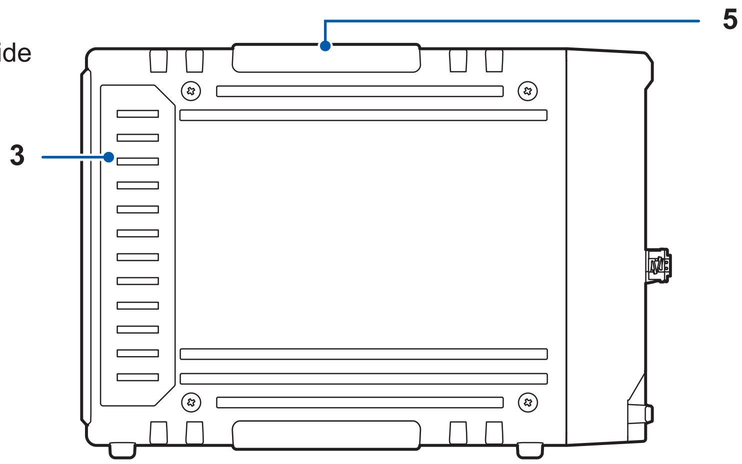
Side

LR8101, LR8102

Right side



Left side



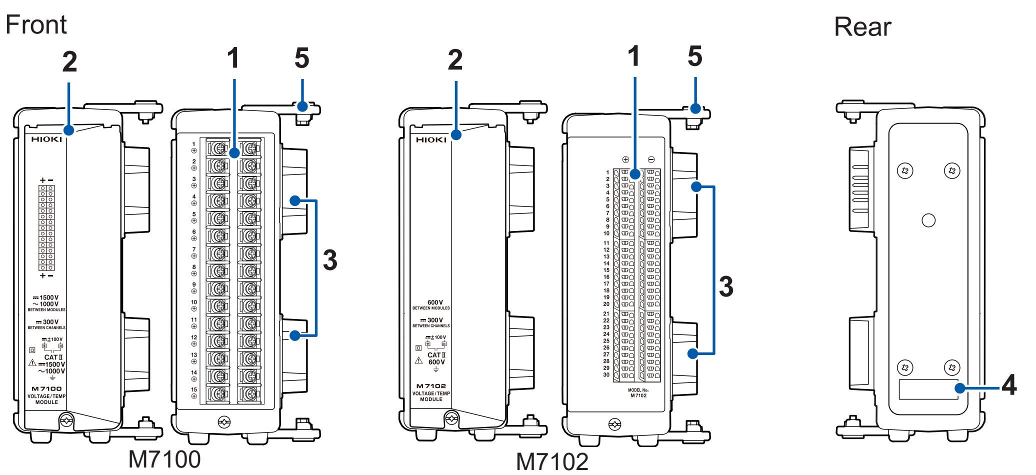
No.	Name	Function	Reference
1	**Description of the LED**	Indicates the operation of the LED located at the front of the instrument.	p.33
2	**Air vent**	Ventilates the instrument to prevent the temperature of the inside from going up excessively.	p.13
3	**Connector cover**	Under the cover, there is a connector to connect a module. When using the instrument without connecting a module, install the connector cover.	p.46
4	**Warning**	Provides the important information of the instrument.	–

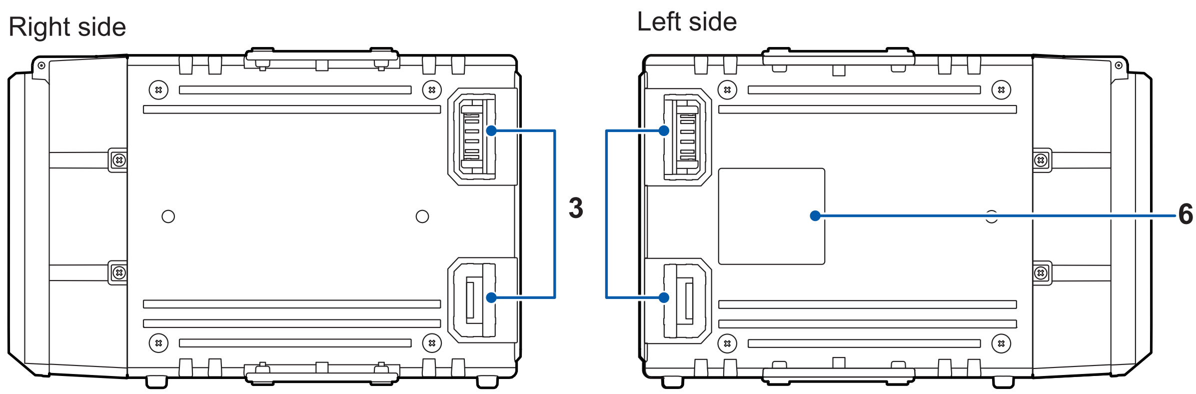
1.3 Options

Product name		Measurement target	Number of channels	Shortest sampling interval
M7100	Voltage/Temp Module	Voltage, temperature (thermocouple)	15	5 ms*1
M7102	Voltage/Temp Module	Voltage, temperature (thermocouple)	30	10 ms*2
M7103	Power Measurement Module	Power (voltage, current)	3	5 ms*3

*1. Only when the number of channels used in a module is eight or less and the voltage range is used.
*2. The number of channels used in a module is 15 or less.
*3. The harmonic calculation is excluded.

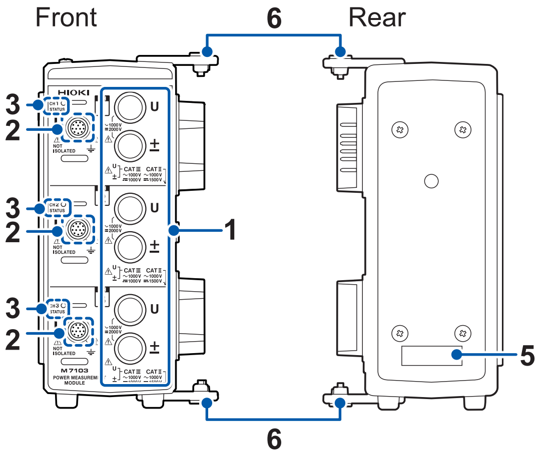
M7100, M7102 Voltage/Temp Module

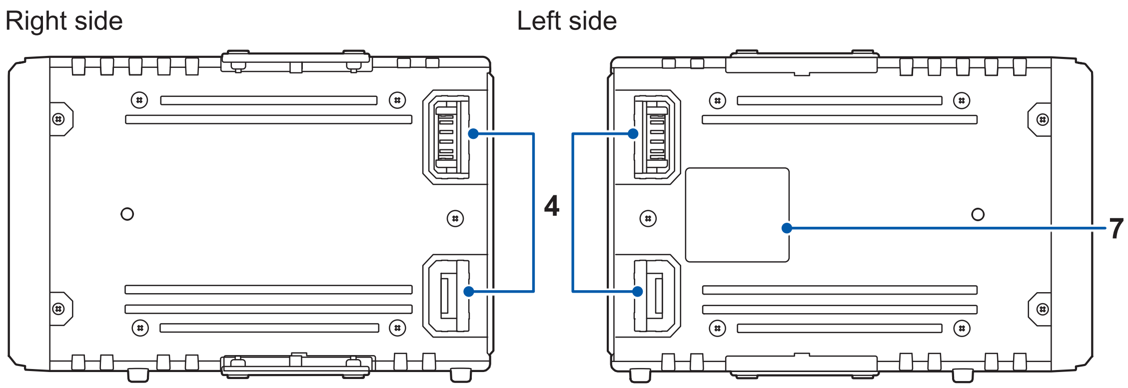




No.	Name	Function
1	**Input terminal**	The input terminal for each channel. The number represents the channel number.
2	**Terminal block cover**	The cover protects the terminal block. Close the cover during the measurement.
3	**Connector**	The connector for measurement module extension. Install the connector cover on the connector when it is not used.
4	**Serial number**	For the latest information, check Hioki's website. Do not remove it as the number is required for management. Share this number when contacting your reseller.
5	**Connecting plate**	The plate for connecting the measurement modules. After connecting the modules, fix the plate using screws.
6	**Warning label**	Provides the important information of the instrument.

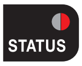
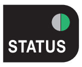
M7103 Power Measurement Module





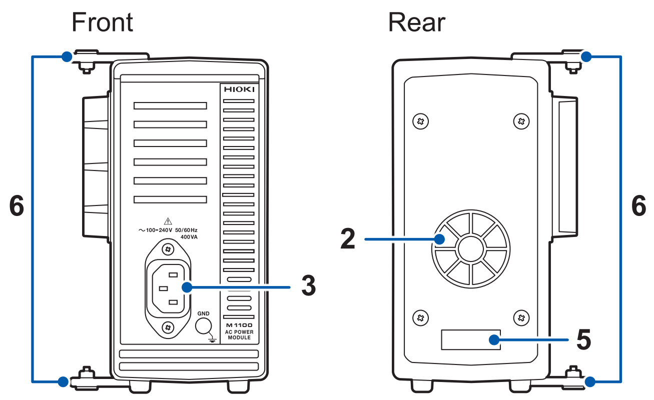
No.	Name	Function
1	**Voltage input terminal**	The optional voltage cords from Hioki can be connected.
2	**Current sensor terminal**	A voltage output type sensor, such as the current probe and CT, can be connected.
3	**Status LED**	Indicates the operation status of the instrument. (p.37)
4	**Connector**	The connector for measurement module extension. Install the connector cover on the connector when it is not used.
5	**Serial number**	For the latest information, check Hioki’s website. Do not remove it as the number is required for management. Share this number when contacting your reseller.
6	**Connecting plate**	The plate for connecting the measurement modules. After connecting the modules, fix the plate using screws.
7	**Warning label**	Provides the important information of the instrument.

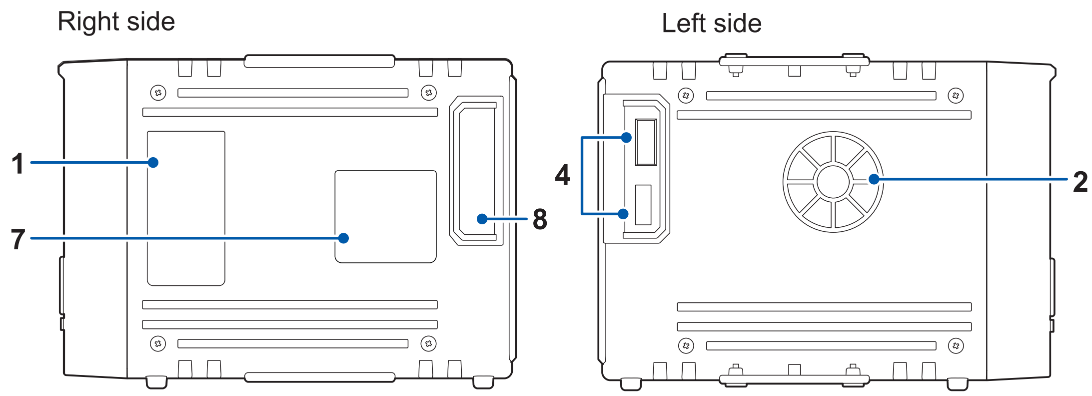
Status LED

LED status	Target	Notification summary	Action
 Red, flashing rapidly*1	All channels	FAN error	Check the error message and warning message. Reference: p.460, p.461
 Red, flashing slowly*2	Relevant channel	Current sensor error	
 Red lamp lit	Relevant channel	• Current/voltage over-peak • Current/voltage overload • Power overload	
 Green, flashing rapidly*1	Relevant channel	Harmonic measurement items cannot be measured accurately. • Harmonic synchronization unlock • Outside of harmonic frequency range	Check if the input signal frequency falls within the spec range.
 Green, flashing slowly*1	Relevant channel	Synchronization unlock	• Check the synchronous source setting. • Check the voltage range and current range settings • Check the zero-cross filter setting • Check the LPF setting
 Green lamp lit	Relevant channel	Normal	–

*1. Repeatedly flashes 5 times per second.
*2. Repeatedly flashes 2 times per second.

M1100 AC Power Module





No.	Name	Function
1	Description of the LED	Indicates the operation of the LED located at the front of the LR8101 or LR8102.
2	Air vent	Ventilates the instrument to prevent the temperature of the inside from going up excessively.
3	Power inlet	The provided power cord can be connected.
4	Connector	The connector for the instrument.
5	Serial number	For the latest information, check Hioki's website. Do not remove it as the number is required for management. Share this number when contacting your reseller.
6	Connecting plate	The plate for connecting the measurement modules. After connecting the modules, fix the plate using screws.
7	Warning label	Provides the important information of the instrument.
8	Opening	Affix the LR8101 or LR8102 connector cover.

Other options

Z1016 AC Adapter

Allows you to drive the instrument using a commercial power supply (AC driven).

- Rated supply voltage (100 V to 240 V AC)
- Rated power-supply frequency (50 Hz/60 Hz)

L1012 Power Cable

Allows you to drive the instrument using DC power supply.

Z4001 SD Memory Card (2 GB)
Z4003 SD Memory Card (8 GB)
Z4006 USB Drive (16 GB)

The measurement data and the setting conditions can be stored in SD memory cards and USB drives. The operation cannot be guaranteed if an SD memory card or USB drive other than the optional one is used.

L6101 Optical Connection Cable (1 m)
L6102 Optical Connection Cable (10 m)

The optical connection cable is required for synchronizing multiple units of LR8102.

9713-01 CAN Cable

Option for LR8102.
The CAN Cable is used for CAN output.
Length: 2.0 m

Voltage measurement options

A ø4 mm safety banana plug can be connected to the voltage input terminal of this instrument. Prepare the appropriate voltage cords according to their intended usage.

Product name		Maximum rated voltage Maximum rated current	Cable length (Approx.)	Remarks
L1025	Voltage Cord	CAT II DC 1500 V, AC 1000 V, 1 A CAT III 1000 V, 1 A	3 m	Banana - banana (red and black ×1 each) Alligator clip included 
L9438-50	Voltage Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	3 m	Banana - banana (red and black ×1 each) Alligator clip included 
L1000	Voltage Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	3 m	Banana - banana (red, yellow, blue, gray ×1 each, black ×4) Alligator clip included 
L1021-01	Patch Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	0.5 m	For voltage input branch Branch-banana - banana (red ×1) 
L1021-02	Patch Cord	CAT III 1000 V, 10 A CAT IV 600 V, 10 A	0.5 m	For voltage input branch Branch-banana - banana (black ×1) 
L9243	Grabber Clip	CAT II 1000 V, 1 A	–	Red and black ×1 each 
PW9000	Wiring Adapter	CAT III 1000 V, 1 A CAT IV 600 V, 1 A	–	For 3P3W 
PW9001	Wiring Adapter	CAT III 1000 V, 1 A CAT IV 600 V, 1 A	–	For 3P4W 
VT1005	AC/DC High Voltage Divider	5000 V, ±7100 V peak CAT III 1500 V CAT II 2000 V	–	For voltage measurement of 1000 V or above. 

Current measurement options (ME15W connector)

For more details, see the instruction manual supplied with the current sensor.

✓: Yes -: No

Current sensor Type	Automatic detection function	Product model	Rated current rms	Frequency characteristics	Basic accuracy (Amplitude)	Measurable conductor diameter	Number of channels Cable length (Approx.)	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 terminal M6 screw	3 channel	0°C to 40°C
	✓	PW9100A-4					4 channel	
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
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.			-40°C to 85°C
	✓	CT6873-01					10 m	
	✓	CT6875A	500 A	DC to 2 MHz	±0.04% rdg ±0.008% f.s.	ø 36 mm	3 m	
	✓	CT6875A-1		DC to 1.5 MHz			10 m	
	✓	CT6876A	1000 A				3 m	
	✓	CT6876A-1		DC to 1.2 MHz			10 m	
	✓	CT6877A	2000 A	DC to 1 MHz		ø 80 mm	3 m	
	✓	CT6877A-1					10 m	
High accuracy clamp 	✓	CT6830	2 A	DC to 100 kHz	±0.3% rdg ±0.05% f.s.	ø 5 mm	Approx. 4 m (Between sensor and relay box) Approx. 0.2 m (Between relay box and output connector)	Sensor: -40°C to 85°C Relay box: -25°C to 50°C
	✓	CT6831	20 A		±0.3% rdg ±0.01% f.s.			
High accuracy clamp 	✓	CT6833	200 A	DC to 50 kHz	±0.07% rdg ±0.007% f.s.	ø 20 mm	5 m	Sensor and cable: -40°C to 85°C Relay box: -25°C to 50°C
	✓	CT6833-01					10 m	
	✓	CT6834	500 A				5 m	
	✓	CT6834-01					10 m	

Current sensor Type	Automatic detection function	Product model	Rated current rms	Frequency characteristics	Basic accuracy (Amplitude)	Measurable conductor diameter	Number of channels Cable length (Approx.)	Operating temperature range
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
	✓	CT6843A	200 A	DC to 700 kHz				
	✓	CT6844A	500 A	DC to 500 kHz		ø 50 mm		
	✓	CT6845A		DC to 200 kHz				
	✓	CT6846A	1000 A	DC to 100 kHz				
General-purpose clamp *1 	–	9272-05	20 A 200 A	1 Hz to 100 kHz	±0.3% rdg ±0.01% f.s.	ø 46 mm		0°C to 50°C

*1. For measurement of commercial frequency band

Current measurement options (PL14 connector)

For more details, see the instruction manual supplied with the current sensor.
To connect M7103, the CT9920 Conversion Cable is required.

✓: Yes -: No

Current sensor Type	Automatic detection function	Model	Rated current rms	Frequency characteristics	Basic accuracy (Amplitude)	Measurable conductor diameter	Cable length (Approx.)	Operating temperature range
Current sensor suitable for large currents 	–	CT7742	2000 A	DC to 5 kHz	±1.5% rdg ±0.5% f.s.	ø 55 mm	2.5 m	-25°C to 65°C
	–	CT7642		DC to 10 kHz				
Flexible current sensor 	–	CT7044	6000 A	10 Hz to 50 kHz	±1.5% rdg ±0.25% f.s	ø 100 mm	2.3 m	
	–	CT7045				ø 180 mm		
	–	CT7046				ø 254 mm		

Current measurement options (others)

Product name			Remarks
	CT9557	Sensor Unit	4-channel specification, addition function, power supply with RMS output
	CT9904	Connection Cable	ME15W (12 pins) - ME15W (12 pins) 1 m For CT9557 connection
	CT9920	Conversion Cable	For conversion from current sensor connector PL14 to ME15W (12 pins)

The following are the made-to-order products.

	Product name		Remarks
	PW9100A-3	AC/DC Current Box	3-channel 5 A rated specification
	PW9100A-4	AC/DC Current Box	4-channel 5 A rated specification

1.4 Measurement Workflow

The measurement procedure with the instrument is as follows.
For steps 4 to 6, the method for sending commands from a PC is explained in this manual.
For details about the command operations as well as other operations not related to the commands, see “12 Communication with PC (Computer)” (p.311).

1. Preparation of the instrument

See “2 Connection (Preparation for Measurements)” (p.45).

- Install the measurement modules on the instrument.
- Connect the AC adapter.

2. Preparation of the instrument

See “2.6 Connecting Cables” (p. 54).

- Connect the LAN cable on the instrument.
- Connect the cables for the thermocouples, etc. to the terminal block of the measurement modules.

3. Turn ON the power

See “2.7 Turning ON and OFF the Power” (p. 71).

- Pressing the POWER key turns ON the instrument.

4. Set and connect the LAN

See “2.10 Setting and Connecting the LAN” (p. 85)

5. Set the instrument

See “3.3 Setting Measurement Conditions” (p. 106).

- Before starting the measurement, set the measurement conditions using communication commands.
  See “3.1 Controlling the Instrument Using Communication Commands” (p. 101).
- Set the recording interval (sampling interval) and the recording time.

See “3.4 Setting the Voltage/Temp Module” (p. 120).

- Set the input types and ranges for the voltage, thermocouple, etc.

6. Start and stop the measurement

See “3.10 Starting and Stopping Measurement” (p. 171).

- Send the `STARt` command to start the measurement.
- Send the `STOP` command to stop the measurement.

7. Acquire the waveform data

See “4 Acquiring Measurement Data” (p.175).

See “4.2 Acquiring Realtime Data” (p. 180).

Tips

Select an appropriate data acquisition method according to the application.

See “4.7 Comparison of Realtime Data Acquisition” (p. 189).

2 Connection (Preparation for Measurements)

This chapter explains preparation prior to starting a measurement.
For the power supply, use the AC adapter, an external power supply or M1100 AC Power Module.
Install and wire the modules and cables according to the measurement target.
An SD memory card or USB drive can be selected as a storage medium.

2.1 Inspection Before Use

⚠DANGER

- **Before using the instrument, check the measurement cables to confirm that the insulation is not worn and no metal parts are exposed.**
- **Inspect the instrument and verify proper operation before use.**

  Using a damaged cable or instrument could result in serious bodily injury. Replace with those specified by our company if you find any damage.

Inspect the instrument before turning ON the power, and ensure that no damage occurred during storage or shipping.
If you find any damage, contact your authorized Hioki distributor or reseller.

Inspecting the peripheral devices

Inspect the measurement cables to confirm that the insulation is not worn and no metal parts are exposed.
Do not use a measurement cable if you find any damage. Failure to do so could cause the operator to experience an electric shock. Replace with those specified by our company.

Inspecting the instrument

- Confirm that the instrument is not damaged.
  If you find any damage, request repair.
- Turn ON the instrument and confirm that the POWER LED lights up.
  If the LED does not light up, the power cord may be broken or the instrument may be damaged. Request repair.

2.2 Connecting the Measurement Modules

Up to ten optional measurement modules can be connected to one instrument.
Up to a total of ten M7100 or M7102 modules can be connected to a single instrument.
Up to four M7103 modules can be connected to a single instrument.
When using M7103, AC power supply module M1100 is required. (p.51).
Determine the number of measurement modules to be connected according to the number of channels required for the measurement.

⚠WARNING

■ **When no measurement module is connected, do not remove the connector cover.**

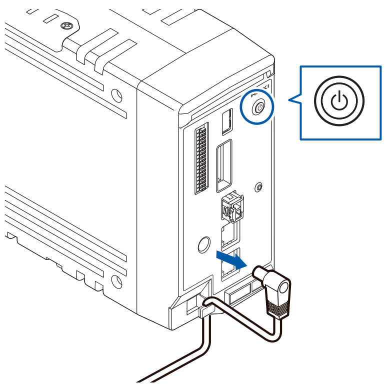
Doing so could cause the operator to experience an electric shock or damage the instrument and measurement modules.

■ **Before connecting or disconnecting the measurement modules, turn OFF the instrument and remove the cables.**

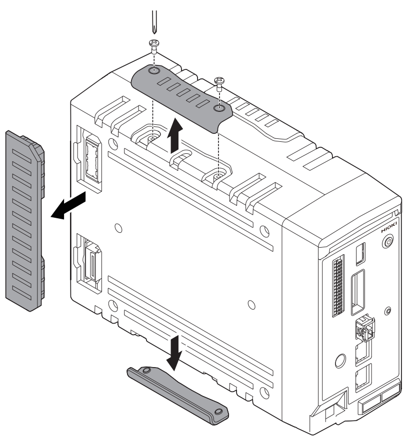
Failure to do so could cause the operator to experience an electric shock or damage the instrument and measurement modules.

Connecting the Measurement Modules to the Instrument

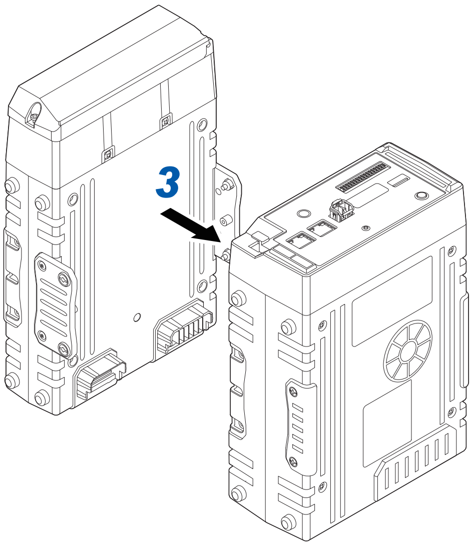
Applicable modules: M7100, M7102 or M7103
Required items: Phillips screwdriver (No. 2)



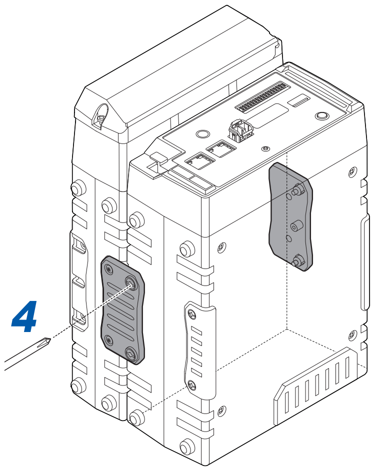
1 **Turn OFF the instrument and remove the AC adapter.**



2 **Remove the connector covers.**

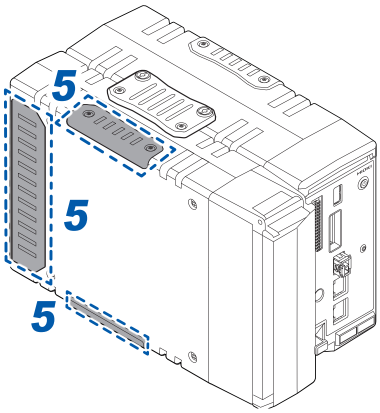


3 **Connect a measurement module to the connector of the instrument.**



4 **Tighten the captive screws (4 locations).**

Tighten the screws at 0.6 N•m.



5 **Reattach the connector covers removed in 2.**

Tighten the screws at 0.6 N•m.

Connecting an additional measurement module

An additional measurement module can be installed on the left side of the first measurement module.
Connect the additional measurement module in the same way as you connected the first measurement module to the instrument.
Neither M7100 nor M7102 can be connected between M7103 and the instrument.

IMPORTANT
Channel settings may be initialized when there is a change in connected modules. Please check settings.

2.3 Connecting the AC adapter

Connect the power cord to the AC adapter, and then connect the AC adapter to an outlet.
Make sure to use the optional Z1016 AC Adapter (2-pole grounding power cord included).
Before connecting, make sure to read “Handling of cords and cables” (p. 54).
In addition, turn OFF the instrument before connecting or disconnecting the AC adapter.

⚠WARNING

- **When supplying the power from a commercial power supply to the instrument, use the optional Z1016 AC Adapter (2-pole grounding power cord included).**
- **Use the AC adapter at the rated supply voltage and the rated power-supply frequency.**

  Rated supply voltage: 100 V AC to 240 V AC (voltage fluctuation within ±10%)
  Rated power-supply frequency: 50/60 Hz
- **Turn OFF the instrument before connecting the AC adapter to the instrument and the commercial power supply.**

  Failure to do so could cause the operator to experience an electric shock.
- **Connect the power cord of the AC adapter to a 2-pole grounding outlet.**

  Connecting the power cord to an ungroundable outlet could cause the operator to experience an electric shock.

⚠CAUTION

- **When using the AC power supply module, do not use the AC adapter or external power supply.**

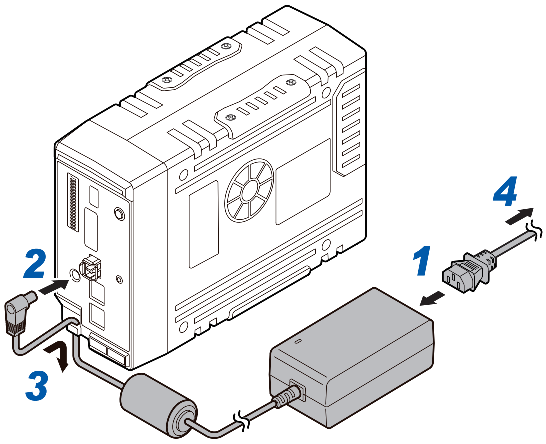
  The instrument can be damaged.

- **Before connecting the plug to the outlet, connect the output plug of the AC adapter to the instrument.**

  Failure to do so could damage the instrument.
- **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.

Supply the power to the instrument using the AC adapter (AC driven)



1. **Connect the power cord to the Z1016 AC Adapter.**

2. **Connect the output plug of the AC adapter to the power supply terminal of the instrument.**

3. **To prevent the plug from coming off, press the output cord of the AC adapter cable into the cable hook of the instrument.**

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

2.4 Connecting an External Power Supply

A DC power supply can be used as an external power supply for the instrument.
Be sure to use the optional L1012 Power Cable.
Before connecting, make sure to read “Handling of cords and cables” (p. 54).
In addition, turn OFF the instrument before connecting or disconnecting the power cable.

⚠CAUTION

- **When using the AC power supply module, do not use the AC adapter or external power supply.**

  The instrument can be damaged.

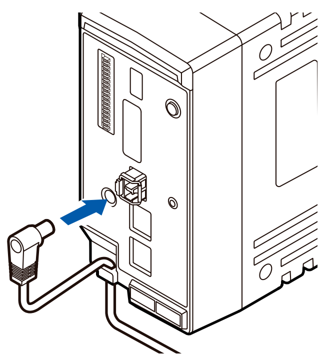
- **Use the external power supply at the rated supply voltage.**

  Rated supply voltage: 10 V DC to 30 V DC

- **Turn OFF the instrument before connecting the power cord.**
- **Pay attention to the polarity and correctly connect the terminals of the power cord.**

  Failure to do so could damage the instrument.

Supply the power to the instrument from an external power supply (DC driven)



1. **Connect the plug of the power cord to the power supply terminal of the instrument.**
2. **To prevent the plug from coming off, press the power cord into the cable hook of the instrument.**
3. **Pay attention to the polarity and connect the terminals of the power cord to the DC power supply.**

IMPORTANT

When a power cord that is 3 m or longer is connected, the instrument may be affected by factors in the EMC environment, such as exogenous noise.

2.5 Connecting the AC Power Supply Module

Install the optional AC power supply module M1100 onto the instrument.
The AC power supply module is required only when using the M7103 Power Measurement Module.
Before connecting, make sure to read “Handling of cords and cables” (p. 54).
Also, turn OFF the instrument before connecting the AC power supply module.

⚠WARNING

- **Use the AC power supply module at the rated supply voltage and the rated power-supply frequency.**

  Rated supply voltage: 100 V to 240 V AC (voltage fluctuation within ±10%)
  Rated power-supply frequency: 50 Hz/60 Hz

- **Turn OFF the instrument before connecting the AC power supply module to the instrument and the commercial power supply.**

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

- **Connect the power cord of the AC power supply module to a 3-prong grounded-type (2-pole) power outlet.**

  Connecting the power cord to an ungroundable outlet could cause the operator to experience an electric shock.

⚠CAUTION

- **When using the AC power supply module, do not use the AC adapter or external power supply.**

  The instrument can be damaged.

- **Before connecting the plug to the outlet, connect the output plug of the AC power supply module to the instrument.**

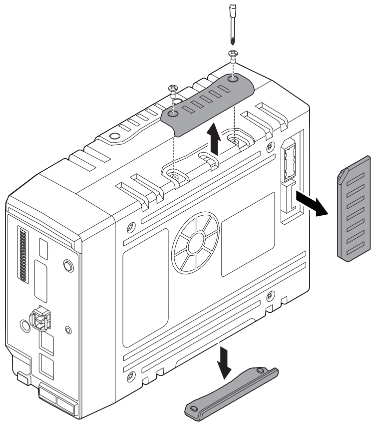
  Failure to do so could damage the instrument.

- **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.

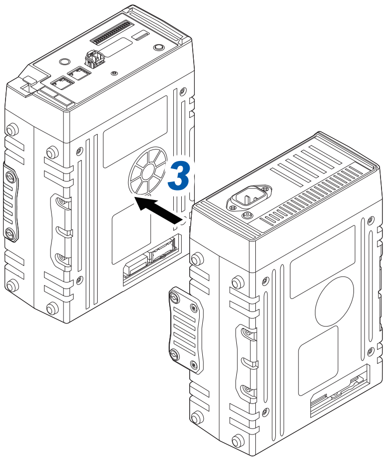
Connecting the AC power supply module to the instrument

Applicable module: M1100
Required items: Phillips screwdriver (No. 2)

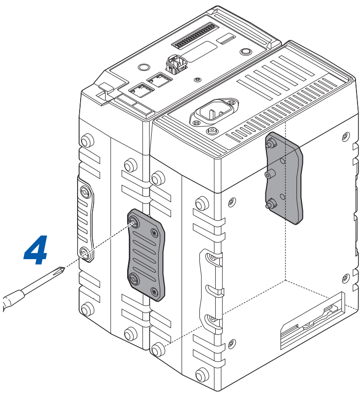


1 **Remove the connector cover.**

2 **Loosen the captive screws. (4 locations)**

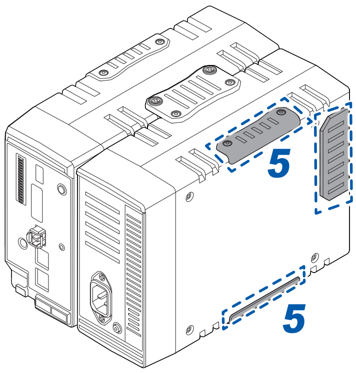


3 **Connect the AC power supply module to the connector of the instrument.**



4 **Tighten the captive screws. (4 locations)**

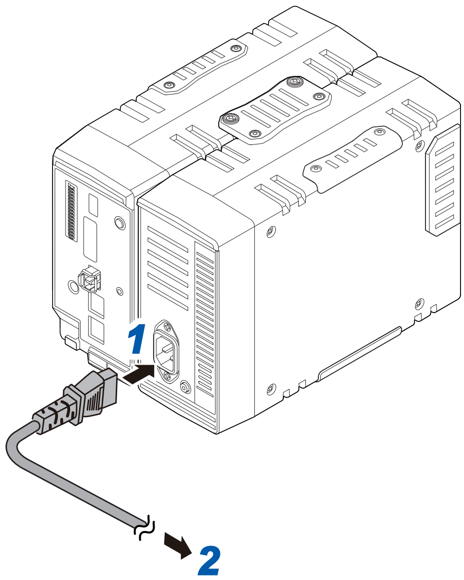
Tighten the screws at 0.6 N•m.



5 **Reattach the connector cover removed in step 1.**

Tighten the screws at 0.6 N•m.

Supplying the power to the instrument using the M1100 AC power supply module (AC driven)



1 **Connect the provided power cord to the power inlet of the AC power supply module.**

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

2.6 Connecting Cables

Handling of cords and cables

⚠WARNING

- **Hang the measurement cables lower than the instrument.**

  Otherwise, water or liquid could enter the instrument along the measurement cables, damaging the instrument and causing bodily injury.

- **Follow the procedure below before wiring the measurement terminals or turning ON the instrument.**

  1. Shut down the power of the measurement line.
  2. Turn OFF the instrument and other devices.
  3. Remove the measurement target.
  4. Close the terminal block cover.

- **Use the specified wiring materials. Alternatively, use wiring materials with sufficient dielectric strength and current capacity.**

  Otherwise, accidents due to electric shock or short circuit may occur.

- **Securely connect the measurement cables to the input terminals.**

  Loose terminals could result in increased contact resistance, causing the product to become hot or burn up or resulting in bodily injury or fire.

⚠CAUTION

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

  Doing so could damage the insulation and cause the operator to experience an electric shock.

- **Do not input voltage that exceeds the specified rating between the channels.**

  Semiconductor relays are used for the insulation between the channels of the measurement module. When any voltage that exceeds the specified rating is applied, such as lightning surges, the semiconductor relays can fail with a short-circuit.

IMPORTANT

- When a cable that is 3 m or longer is connected, measurement may be affected by factors in the EMC environment, such as exogenous noise. Position the cable away from the power line or ground cable.
- When the cable is connected in parallel to other equipment, measurement values may vary. If the measurement cable is to be connected in parallel, make sure to check the operation before use.

When connecting to the input terminal

⚠DANGER

- **Do not leave the input cables connected in an environment where there is a possibility of surges exceeding the dielectric strength.**

  Doing so may damage the instrument, resulting in serious bodily injury.

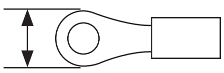
⚠WARNING

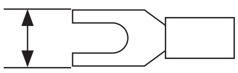
- **Follow the procedure below before wiring the input terminal.**

  1. Turn off the power of this instrument and the instrument to be connected.
  2. Discharge static electricity from your body.

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

When wiring with a crimped terminal, use an insulation coated terminal with the following size for M3 screws.


6 mm or less


6 mm or less

When wiring the external control terminal

⚠WARNING

- **Follow the procedure below before wiring the external control terminal.**

  1. Turn off the power of this instrument and the instrument to be connected.
  2. Discharge static electricity from your body.
  3. Check that the signal does not exceed the external input and output rating.
  4. Properly isolate this instrument and the instrument to be connected to the EXT. I/O connector terminal.

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

⚠CAUTION

- **Do not short or input any voltage to the output unit.**

  The instrument can be damaged.

- **Ensure that there is no potential difference between the ground of the external control terminal and the ground of the connection target.**

  Failure to do so could damage the connection target and the instrument.
  The ground of the external control terminal and the ground of the instrument are common and they are not isolated from each other.

When using a twisted pair wire for the measurement cable, take care not to allow the measurement cable to contact adjacent measurement cables or terminals.

Wiring the voltage cable and thermocouple

Connection to a screw type terminal block

⚠WARNING

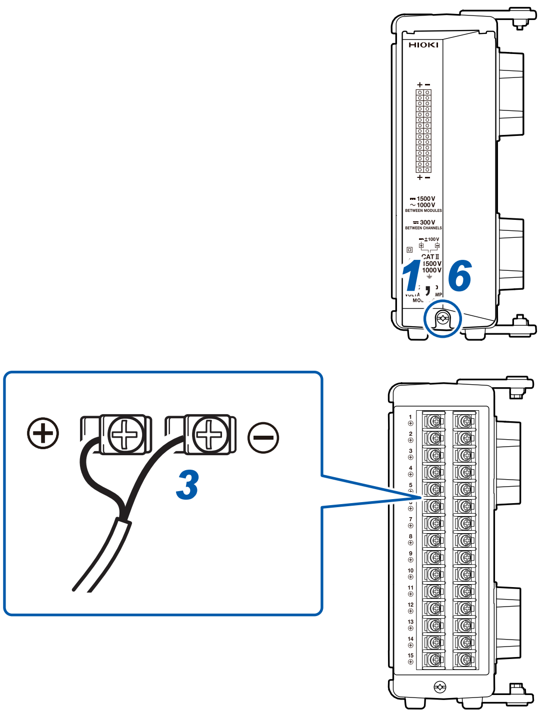
- **Use the dedicated screws to fix the wiring to a screw type terminal block.**

  Using screws other than the dedicated ones could cause the operator to experience an electric shock or damage the instrument.

Applicable module: M7100
Required items: Phillips screwdriver (No. 2), input cable or thermocouple

Recommended wire diameter

Solid	ø0.2 mm to ø1.29 mm (AWG32-16)
Stranded	0.03 mm^2 to 1.38 mm^2 (AWG32-16)
Standard stripped wire length	10 mm



1 **Remove the screw for the terminal block cover.**

2 **Open the terminal block cover.**

3 **Loosen the terminal block screws. Insert the wires of the cable as shown in the figure and tighten the screws.**

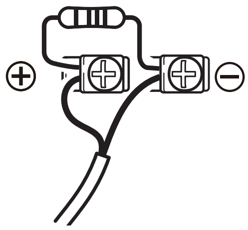
Tighten the terminal block screws at 0.5 N·m.
The color scheme for the cable sheath varies with different countries and manufacturers. Confirm the colors before connecting the cable.

4 **Connect the cable to the measurement target.**

5 **Close the terminal block cover.**

6 **Tighten the screw for the terminal block cover.**

When measuring an instrumentation device (inputting a current of 4-20 mA), connect a 250 Ω shunt resistor as shown in the figure below. For the measurement of instrumentation devices, see “When measuring the output from an instrumentation device” (p. 121).



IMPORTANT

Be sure to fix the **terminal block** cover using the screw.
If the **terminal block** cover is not closed, the measured values may be affected.

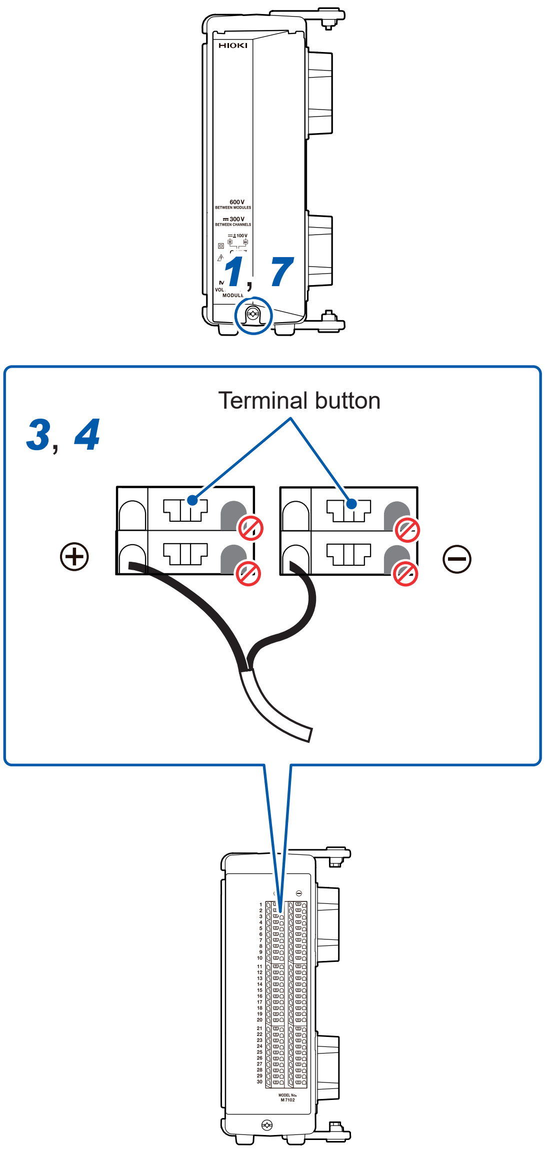
Connecting to a push-button type terminal block

Applicable module: M7102

Required items: Flat-head screwdriver (blade edge width 2.6 mm), input cable or thermocouple

Recommended wire diameter

Solid	ø0.32 mm to ø1.29 mm (AWG26-16)
Stranded	0.2 mm^2 to 0.52 mm^2 (AWG24-20)
Standard stripped wire length	9 mm



1 **Remove the screw for the terminal block cover.**

2 **Open the terminal block cover.**

3 **Press the terminal button with a flat-head screwdriver and insert the wire of the cable into the terminal hole.**

The color scheme for the cable sheath varies with different countries and manufacturers. Confirm the colors before connecting the cable.

4 **Remove the flat-head screwdriver from the button.**

The cable is locked. Pull the cable gently and confirm that the cable will not come out.

5 **Connect the cable to the measurement target.**

6 **Close the terminal block cover.**

7 **Tighten the screw for the terminal block cover.**

IMPORTANT

Be sure to fix the terminal block cover using the screw.

If the terminal block cover is not closed, the measured values may be affected.

Wiring for the pulse input

Connect a cable to the external control terminal.

Required items: Flat-head screwdriver (blade edge width 2.6 mm), input cable (pulse measurement)

Recommended wire diameter

Solid	ø0.32 mm to ø0.81 mm (AWG28-20)
Stranded	0.08 mm^2 to 0.32 mm^2 (AWG28-20)
Standard stripped wire length	10 mm

1 **Turn forward the external control terminal on the front of the instrument.**

2 **Press the button of the PULSE terminal with a flat-head screwdriver.**

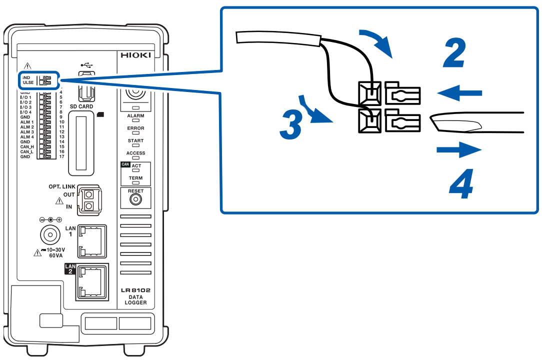
3 **While holding down the button, insert the plus (+) cable into the terminal hole.**

4 **Remove the flat-head screwdriver from the button.**
The cable is locked. Pull the cable gently and confirm that the cable will not come out.

5 **Press the button of the GND terminal with a flat-head screwdriver.**
Five ground terminals are available. The cable can be connected to any of the ground terminals.

6 **While holding down the button, insert the minus (-) cable into the terminal hole.**

7 **Remove the flat-head screwdriver from the button.**
The cable is locked. Pull the cable gently and confirm that the cable will not come out.



Wiring for the alarm output

Connect a cable to the external control terminal.

Required items: Flat-head screwdriver (blade edge width 2.6 mm), output cable (alarm output)

Recommended wire diameter

Solid	ø0.32 mm to ø0.81 mm (AWG28-20)
Stranded	0.08 mm^2 to 0.32 mm^2 (AWG28-20)
Standard stripped wire length	10 mm

1 **Turn forward the external control terminal on the front of the instrument.**

2 **Press the button of the ALM 1 (or ALM 2 to ALM 4) terminal with a flat-head screwdriver.**

3 **While holding down the button, insert the cable into the terminal hole.**

4 **Remove the flat-head screwdriver from the button.**

The cable is locked. Pull the cable gently and confirm that the cable will not come out.

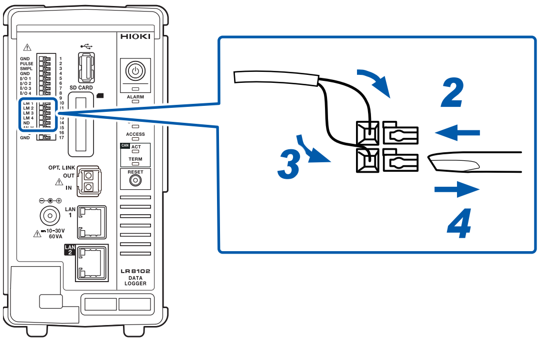
5 **Press the button of the GND terminal with a flat-head screwdriver.**

Five ground terminals are available. The cable can be connected to any of the ground terminals.

6 **While holding down the button, insert the cable into the terminal hole.**

7 **Remove the flat-head screwdriver from the button.**

The cable is locked. Pull the cable gently and confirm that the cable will not come out.



Wiring for external control

Connect a cable to the external control terminal.

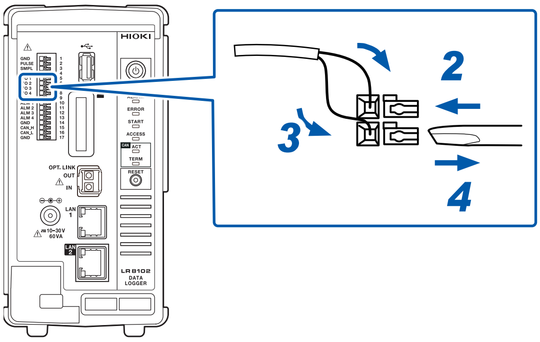
- External input: Allows you to control the start and stop of the measurement and input the trigger signals.
  See "5.6 Applying External Trigger" (p. 214) and
  "11.2 Setting the External Input and Output (I/O) Terminals" (p. 305).
- External output: Signals can be output when the trigger is activated.
  See "11.2 Setting the External Input and Output (I/O) Terminals" (p. 305).

Required items: Flat-head screwdriver (blade edge width 2.6 mm), input cable (pulse measurement)

Recommended wire diameter

Solid	ø0.32 mm to ø0.81 mm (AWG28-20)
Stranded	0.08 mm^2 to 0.32 mm^2 (AWG28-20)
Standard stripped wire length	10 mm

1. **Turn forward the external control terminal on the front of the instrument.**
2. **Press the button of the I/O 1 (or I/O 2 to I/O 4) terminal with a flat-head screwdriver.**
3. **While holding down the button, insert the cable into the terminal hole.**
4. **Remove the flat-head screwdriver from the button.**
   The cable is locked. Pull the cable gently and confirm that the cable will not come out.
5. **Press the button of the GND terminal with a flat-head screwdriver.**
   Five ground terminals are available. The cable can be connected to any of the ground terminals.
6. **While holding down the button, insert the cable into the terminal hole.**
7. **Remove the flat-head screwdriver from the button.**
   The cable is locked. Pull the cable gently and confirm that the cable will not come out.



Wiring for the external sampling

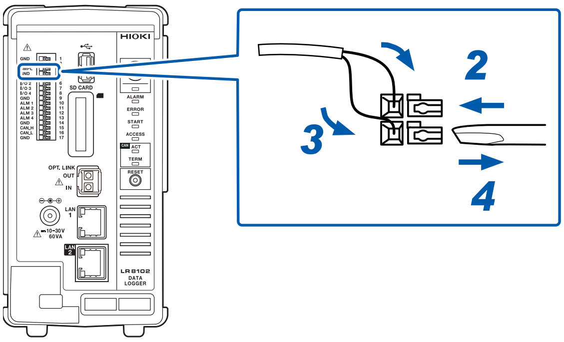
Connect a cable to the external control terminal.

Required items: Flat-head screwdriver (blade edge width 2.6 mm), input cable (pulse measurement)

Recommended wire diameter

Solid	ø0.32 mm to ø0.81 mm (AWG28-20)
Stranded	0.08 mm^2 to 0.32 mm^2 (AWG28-20)
Standard stripped wire length	10 mm

1. **Turn forward the external control terminal on the front of the instrument.**
2. **Press the button of the SMPL terminal with a flat-head screwdriver.**
3. **While holding down the button, insert the plus (+) cable into the terminal hole.**
4. **Remove the flat-head screwdriver from the button.**
   The cable is locked. Pull the cable gently and confirm that the cable will not come out.
5. **Press the button of the GND terminal with a flat-head screwdriver.**
   Five ground terminals are available. The cable can be connected to any of the ground terminals.
6. **While holding down the button, insert the minus (-) cable into the terminal hole.**
7. **Remove the flat-head screwdriver from the button.**
   The cable is locked. Pull the cable gently and confirm that the cable will not come out.



Wiring the CAN cable (LR8102 only)

Required items: Flat-head screwdriver (blade edge width 2.6 mm), 9713-01 CAN cable

⚠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 unplug the input cable while the instrument is sending or receiving data.**

Doing so could cause an unexpected error on the CAN bus.

1 **Turn forward the external control terminal on the front of the instrument.**

2 **Press the terminal button with a flat-head screwdriver and insert the wire of the cable into the terminal hole.**

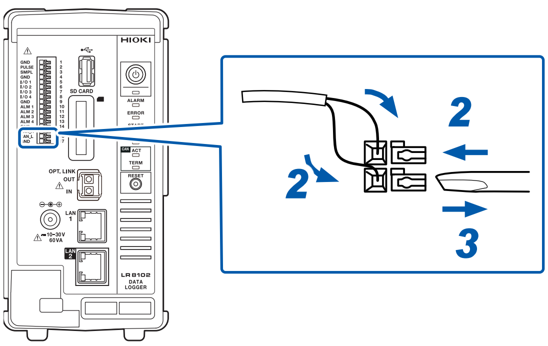
Terminal	Cable
CAN_H	CAN_H (red)
CAN_L	CAN_L (green)
GND	CAN_GND (black)

Five ground terminals are available. The cable can be connected to any of the ground terminals.

3 **Remove the flat-head screwdriver from the button.**

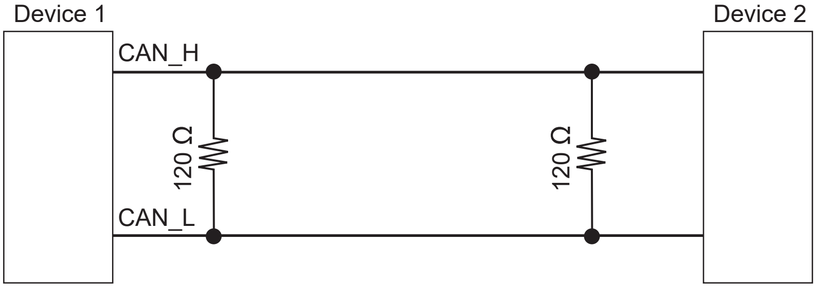
The cable is locked.

4 **Pull the cable gently and confirm that the cable will not come out.**



Terminator setting

- The CAN communication system requires 120 Ω terminators on both sides of the bus.



- If the terminator is set to ON, the 120 Ω resistors are inserted between the differential signals of the CAN bus inside the LR8102.
  See “14.11 Configuration of Input Circuit” (p. 426).

Description of the LED operations

The operation status of the CAN can be checked with the LEDs.

LED	Status
ACT LED	• Blinking: When the output signal is received properly*1 • Lamp OFF: When there is no output target*2
TERM LED	• Lit: When the terminator is ON • Lamp OFF: When the terminator is OFF

*1. The LED blinks if any one of the set CAN communications is performed in accordance with the conditions.
See CAN Editor Instruction Manual“6.3 Receive CAN Data”.

*2. The conditions for the CAN communication may not be satisfied or the CAN port may not be connected with the CAN bus correctly.
See CAN Editor Instruction Manual “5.4 Setting the Communication Method of the CAN Unit”.

Check that there is a channel for which the output is ON.
See CAN Editor Instruction Manual “7.5 Selecting the Channel to be Output”.

Wiring the optical connection cable (LR8102 only)

⚠CAUTION

- **Do not connect or disconnect connectors while the instrument is powered ON.**
  Doing so could damage the instrument.
- **Do not bend or pull the optical connection cables.**
  Bending or pulling the cables may result in cable breakage or damaged insulation, causing the instrument to malfunction.

Using the optional L6101 or L6102 Optical Connection Cable to connect instruments in a daisy chain enables synchronized measurement with up to 10 units.

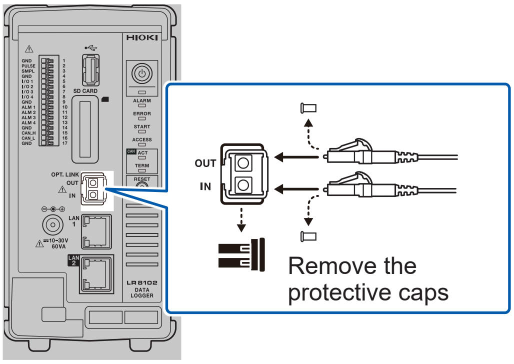
Since the units are synchronized using optic fiber without electrical signals, instruments with different ground potential can be connected without any problems.

IMPORTANT
- Up to 10 units can be synchronized. Eleven or more units cannot be synchronized.
- The cable can only be connected with the instrument. Connecting the cable with other devices may cause a malfunction.

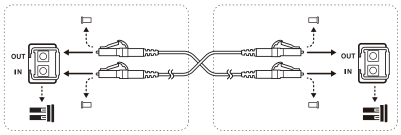
Required items: Instruments (2 to 10 units), L6101 or L6102 Optical Connection Cable (the same number of cables as the instruments)

1. **Make sure that the instruments are turned off.**
2. **Connect the OUT terminal of the optical synchronization connector of the primary unit and the IN terminal of the optical synchronization connector of the secondary unit using an optical connection cable.**
3. **For multiple secondary units**
   Connect the OUT terminal of the optical synchronization connector of the secondary unit and the IN terminal of the optical synchronization connector of another secondary unit using an optical connection cable.
   Repeat this step until all the IN terminals of the optical synchronization connectors of the secondary units are connected.

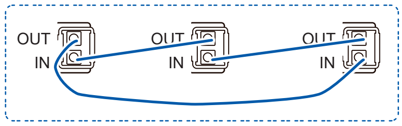
4 **There is a secondary unit for which the OUT terminal of the optical synchronization connector remains unconnected with an optical connection cable. Connect the unconnected OUT terminal and the IN terminal of the optical synchronization connector of the primary unit.**



When two units are connected



When three units are connected



IMPORTANT

- Never unplug the cable during the synchronization control. The synchronization may fail.
- A synchronization error occurs if either of the power supplies for the primary and secondary units is turned OFF.
- Use primary and secondary units with the same version. Using different versions results in a synchronization error.
- Even when connecting instruments with a synchronization cable, LAN cables must be connected to all instruments to allow configuration of their settings.

Connecting the voltage cords

Connect the voltage cords (option) to the voltage input terminals. Connect the necessary number of cords for the lines to be measured and their wiring.

⚠DANGER

- **Do not short-circuit the two wires of the measurement line using the metallic part at the tip of the voltage cord clip.**

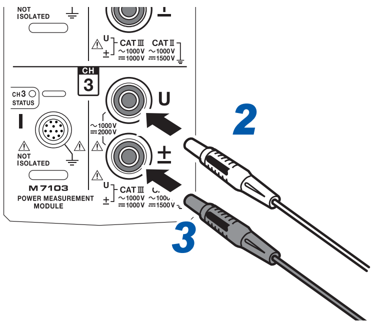
  Doing so can cause arc flash, resulting in serious bodily injury or damage to the device or other equipment.

⚠WARNING

- **When using the instrument, make sure to use the connection cord specified by our company.**

  Using any cords other than that specified could result in serious bodily injury or short circuit.
  Reference: “Voltage measurement options” (p. 40)

IMPORTANT
To ensure correct measurement, securely insert the voltage cords as far as they will go.



1 **Turn OFF the instrument.**

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

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

Connecting the current sensor (current input)

Connect the current sensor to the current sensor terminal.

⚠DANGER

- **Do not use the current sensor for measuring any circuits that exceed the maximum rated line-to-ground voltage *1.**
- **Do not use over bare conductors.**

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

*1. For the maximum rated line-to-ground voltage of the current sensor, see the instruction manual supplied with the current sensor.

⚠WARNING

- **Be sure to turn OFF each hardware before connecting the pass-through type current sensor, such as CT6875.**

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

⚠CAUTION

- **Do not connect or disconnect connectors while the instrument is powered ON.**

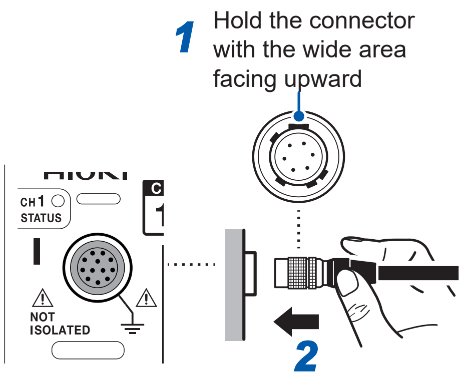
The sensor can be damaged.

- **When disconnecting the cable, be sure to release the lock first, and then pull on the connector end (not the cable).**

Failure to do so could cause damage to the BNC connector or joint section.

For metal connectors

Connectors of the 9709-05, CT6860-05 series, and CT6840-05 series can be directly connected to the current sensor terminal.
Connectors for current sensors with “-05” in the product model are mode of metal.

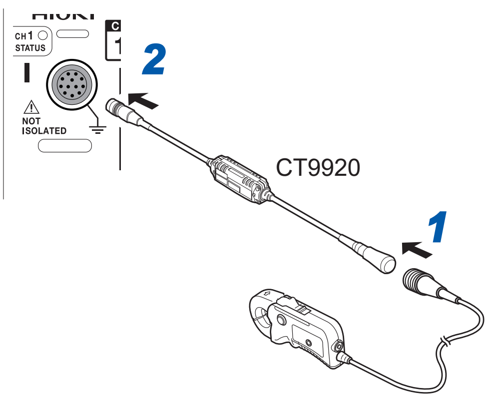


1 **After turning OFF the instrument, align it with the connector guide of the current sensor.**

2 **Hold the resin part of the connector and insert it straight into the terminal until it locks completely.**
The instrument automatically detects the type of current sensor.

For resin connectors

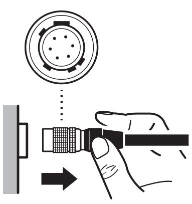
Connectors of the 9709, CT6860 series, and CT6840 series can be connected to the current sensor terminal only when the optional CT9920 Conversion Cable is used.



1 **After turning OFF the instrument, connect the CT9920 conversion cable by aligning it with the connector guide of the current sensor.**

2 **Insert the CT9920 connector straight into the terminal until it locks completely.**

How to detach the connector



1 **While holding the metal part of the connector, release the lock by sliding it to the cable side.**

2 **Pull out the connector.**

When a value exceeds the measurement range (VT/CT is used)

Use an externally installed converter VT (PT) and converter CT for the meter. Setting the VT and CT ratios in the instrument allows you to directly read the input value on the primary side.

Reference: “Scaling (when VT (PT) or CT is used)” (p. 134)

⚠DANGER

- **Do not touch any input terminals on the VT (PT), CT, or instrument when they are in operation.**

  Doing so could result in serious bodily injury.

⚠WARNING

- **Do not short-circuit the secondary side when an externally installed VT (PT) is used.**

  Applying voltage to the primary side while it is short-circuited will cause a large current to flow into the secondary side, potentially resulting in burning or fire.

- **Do not release the secondary side when an externally installed CT is used.**

  If current flows into the primary side while the secondary side is released, high voltage will be generated on the secondary side, which could cause the user to experience an electric shock.

IMPORTANT
The phase difference for externally installed VT (PT) and CT may result in a significant error during power measurement. To ensure more accurate power measurement, use the VT (PT) and CT that have less phase difference in the frequency band of the circuit to be used.

2.7 Turning ON and OFF the Power

For M1100, also use the POWER key for LR8101 and LR8102 to turn ON/OFF the power.

⚠WARNING

■ **Before turning ON the power, make sure that the supply voltage you plan to use falls within the specified supply voltage range.**

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

⚠CAUTION

■ **Do not input voltage to the input terminal while the instrument is powered OFF.**

Doing so could damage the instrument.

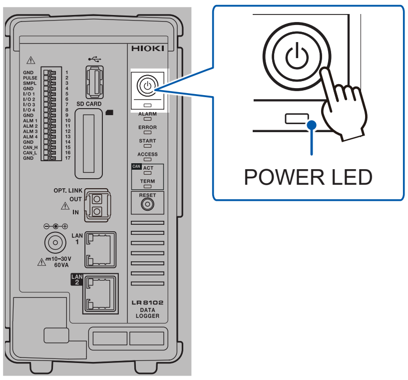
IMPORTANT
- Be sure to turn OFF the power after using the instrument.
- An instantaneous power failure longer than 40 ms could shut down the power supply, causing the instrument to malfunction. Check the status of the power supply.

Procedure to turn on the instrument

Pressing the POWER key turns ON the instrument. The POWER LED lights up in green.

Procedure to turn off the instrument

When the POWER key is pressed, the LEDs blink for 5 seconds.
Pressing the POWER key again while the LEDs are blinking turns OFF the power.
The POWER LED is turned OFF.



2.8 SD Memory Card and USB Drive

The measurement data and the setting conditions of the instrument can be stored in SD memory cards and USB drives.
In addition, the stored data can be loaded and reproduced on the instrument.

For the data storage, use the following options.
Z4001 SD Memory Card (2 GB), Z4003 SD Memory Card (8 GB),
Z4006 USB Drive (16 GB)

⚠WARNING

- **Do not modify, disassemble, or repair an SD memory card and USB drive.**

  Doing so could result in serious bodily injury or fire.

- **Keep these parts out of reach of children.**

  Children may accidentally swallow an SD memory card or USB drive.

⚠CAUTION

- **Do not attach a label and the like to an SD memory card.**

  Doing so could cause the SD memory card to overheat, exposing the operator to a risk of being burned or causing fire.

- **Do not allow water to drip on the terminal of an SD memory card or USB drive.**
- **Do not touch the terminal or contact surface of an SD memory card. Do not allow a metal object to contact these areas.**
- **Do not bend or drop an SD memory card. Do not subject an SD memory card to mechanical shock.**
- **While the instrument is accessing an SD memory card or USB drive, do not subject the instrument to vibration or mechanical shock. Do not turn OFF the instrument. Do not remove an SD memory card or USB drive from the instrument.**
- **Before formatting an SD memory card, make sure that no necessary information, such as files, is stored on the card.**

  The internal data could be damaged or lost.

- **Do not forcefully insert an SD memory card or USB drive with the wrong side up or in the wrong direction.**

  The SD memory card, the USB drive, or the instrument can be damaged.

- **Do not transport the instrument while it is connected to a USB drive.**

  The USB drive or the instrument can be damaged.

⚠CAUTION

- **Take measures to prevent static electricity from being applied to an SD memory card or USB drive.**

  Failure to do so could damage the SD memory card or USB drive and cause the instrument to malfunction.

- **Use a USB drive within the specified ranges of temperature and humidity.**

  The USB drive can be damaged.

- **Back up important data and store it in a safe place.**

  SD memory cards and USB drives have a service life because flash memory is used. They lose the ability to store and load data after extended or frequent use. If you encounter this issue, purchase a new drive. Hioki is not liable for data stored on SD memory cards or USB drives, regardless of the nature or cause of the accident or damage involved.

- **When formatting an SD memory card or USB drive with a PC, select the FAT/FAT32.**

  The media formatted to other formats (NTFS, etc.) cannot be recognized with the instrument.

- **Discharge static electricity from your body before handling an SD memory card or USB drive.**

- **Turn ON the instrument before inserting an SD memory card or USB drive.**

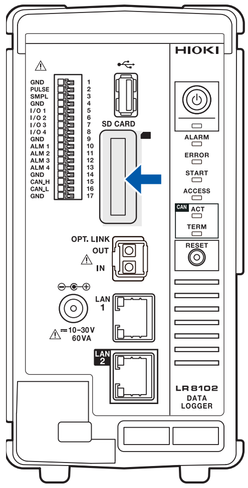
  Failure to do so could damage the SD memory card or USB drive, or cause the instrument to malfunction. The instrument may fail to start up if it is turned on while a USB drive is inserted.

IMPORTANT

- The operation is guaranteed only for the optional SD memory cards and USB drives. The operation of storage media other than the options is not guaranteed.
- Use the instrument to format a new SD memory card or USB drive. If the media are formatted with a PC, the realtime saving may not be completed in time.
- Check that the write protect (write inhibit) of the SD memory card is disabled.
- Follow the procedure below to remove an SD memory card and USB drive from the instrument.

Installing and removing an SD memory card

Installing an SD memory card



1 **Turn an SD memory card with the surface marked with "▲" facing left, and insert the card into the SD card slot.**

2 **Insert the SD memory card until the card is locked with a click.**

Removing the SD memory card

1 **Make sure that the instrument is not accessing (saving, loading, etc.) the SD memory card.**

Confirm that the ACCESS LED is turned OFF.

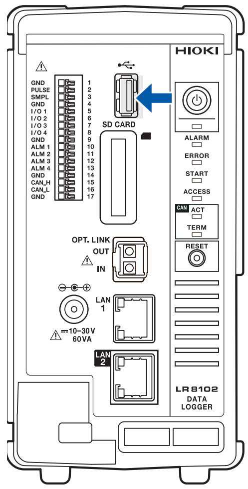
2 **Press and release the SD memory card. When the card is partially pushed out, pinch the card and pull it out.**

Installing and removing a USB drive

Installing a USB drive

1 **Check the connection between the USB drive and the USB connector.**

2 **Insert the USB drive completely.**



Removing the USB drive

1 **Make sure that the instrument is not accessing (saving, loading, etc.) the USB drive.**

Confirm that the ACCESS LED is turned OFF.

2 **Pull out the USB drive.**

2.9 Wiring the Power Measurement Module to the Measurement Line

Setting the wiring mode and current sensor

Set the wiring mode according to the measurement line.
When combining multiple channels for measurements (as in measuring a multi-phase system), connect the same current sensor to all the channels involved.
Wiring setting is only available for those channels in the same module.
Select the wiring mode for each module.

1P2W (Single-phase 2-wire)	When measuring the DC line, also select this wiring. Measurement can be performed on both the source and ground connection sides of the current sensor. The connection diagram shows both of these two patterns. Reference: "Connection diagram" (p. 83)
1P3W (Single-phase 3-wire)	–
3P3W2M (3-phase 3-wire)	This method uses two channels of the three-phase delta connection line to measure power using the two-wattmeter method. It accurately measures the active power of unbalanced and distorted waveforms. The apparent, reactive power, and power factor values of an unbalanced line may vary compared to other measuring instruments. In such a case, use 3V3A or 3P3W3M.
3V3A (3-phase 3-wire)	This method uses three channels of the three-phase delta connection line for measurement with the two-wattmeter method. It is preferred when compatibility with Hioki's conventional power meters like the 3193 model is important. It correctly measures not only the active power but also the apparent and reactive power, and power factor, even on unbalanced lines.
3P3W3M (3-phase 3-wire)	This method uses three channels of the three-phase delta connection line to measure power using the three-wattmeter method. This method is suitable for measuring motor power in PWM inverter assessments, where high-frequency component leakage currents are significant. It ensures accuracy even when using the 3V3A method, which might otherwise introduce errors.
3P4W (3-phase 4-wire)	This method involves using three channels of the three-phase Y (star) connection line to measure using the three-wattmeter method.

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:WIRing A$`
Example	`:POWer:MODule1:WIRing TYPE5`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:WIRing?`
	Response	`A$`
Example	`:POWer:MODule1:WIRing?` (Response)`:POWER:MODULE1:WIRING TYPE5 (When the header is ON)`	
Parameter		

`A$` = TYPE1,TYPE2,TYPE3,TYPE4,TYPE5,TYPE6

TYPE1☑	1P2W × 3
TYPE2	1P3W+1P2W
TYPE3	3P3W2M+1P2W
TYPE4	3V3A
TYPE5	3P3W3M
TYPE6	3P4W

Power channel settings included in measurement line combinations
• The TYPE2 and TYPE3 settings configured for CH1 are applied to CH2.
• The TYPE4, TYPE5, and TYPE6 settings configured for CH1 are applied to CH2 and CH3.

Current sensor automatic detection function

The M7103 Power Measurement Module automatically acquires the rated current and phase compensation value of the connected current sensor.
It drastically reduces the time required for pre-measurement settings, and also enables power measurement based on the accurate sensor information.
(Current sensor with memory only)

M7103 only detects the rated current of the connected current sensor in the following cases.
- When a current sensor without memory is connected to M7103
- When M7103 cannot read the phase compensation value, etc., of the current sensor
- When the current sensor is connected using the CT9920 conversion cable

Optional current sensors

Reference: “Current measurement options” (p. 374)

1 **Acquire the sensor type, rating, and serial No.**

Query			
Syntax	Query		`:POWer:MODule[n:1 to 4]:SENSor[ch:1~3]:ID?`
	Response		<Sensor type>, <Sensor rating>, Sensor serial No.>
Example	:POWer:MODule1:SENSor1:ID?		
	(Response)	`:POWER:MODULE1:SENSOR1:ID CT6872,50A_ACDC,123456789` (When the header is ON)	
		`:POWER:MODULE1:SENSOR1:ID Probe1,50A_ACDC,-` (When the header is ON)	
		`:POWER:MODULE1:SENSOR1:ID Probe2,1mV/A,-` (When the header is ON)	

Parameter

<Sensor type> = Sensor model, Probe1, Probe2

Sensor model	ME15W connector: Current sensor with memory
Probe1	ME15W connector: Current sensor without memory
Probe2	PL14 connector: When the PL14 connector’s current sensor is connected with the CT9920 conversion cable

<Sensor rating>

Sensor model, For Probe 1	(AC sensor) 1A_AC, 2A_AC, 5A_AC, 10A_AC, 20A_AC, 50A_AC,100A_AC, 200A_AC, 500A_AC, 1kA_AC, 2kA_AC, 5kA_AC, (ACDC sensor) 1A_ACDC, 2A_ACDC, 5A_ACDC, 10A_ACDC, 20A_ACDC,50A_ACDC, 100A_ACDC, 200A_ACDC, 500A_ACDC, 1kA_ACDC, 2kA_ACDC, 5kA_ACDC
For Probe 2	Current output rate (0.1 mV/A, 1 mV/A, 10 mV/A, 100 mV/A, 1 V/A)

<Sensor serial No.> = 9-digit NR1 numerical value

Note

If the serial No. cannot be acquired for the sensor, a hyphen (−) is returned.
If the Probe1 sensor is not connected, the sensor rating will be “50A ACDC”.
When Probe 2 is selected, the specified output rate is acquired, regardless of the sensor connection status.
The current sensor is automatically detected when the power is turned ON and measurement starts.
If the current sensor should be detected manually, execute “`:POWer:SENSor:CHECk`”.

2 Acquire the sensor adjustment date.

Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:SENSor[ch:1 to 3]:ADATE?`
	Response	`YYYY,MM,DD`
Example	`:POWer:MODule1:SENSor1:ADATE?` (Response)`:POWER:MODULE1:CURRENT1:ADATE 2024,6,28` (When the header is ON)	
Parameter		
`YYYY<NR1>`	Year	2021 to 2037
`MM<NR1>`	Month	1 to 12
`DD<NR1>`	Day	1 to 31
Note		
The current sensor is automatically detected when the power is turned ON and measurement starts. If the current sensor should be detected manually, execute "`:POWer:SENSor:CHECk`".		

3 Acquire the sensor calibration date.

Query		
Syntax	Query	`:POWer:MODule[n:1~4]:SENSor[ch:1~3]:CDATE?`
	Response	`YYYY,MM,DD`
Example	`:POWer:MODule1:SENSor1:CDATE?` (Response)`:POWER:MODULE1:CURRENT1:CDATE 2024,6,28` (When the header is ON)	
Parameter		
`YYYY<NR1>`	Year	2021 to 2037
`MM<NR1>`	Month	1 to 12
`DD<NR1>`	Day	1 to 31
Note		
The current sensor is automatically detected when the power is turned ON and measurement starts. If the current sensor should be detected manually, execute "`:POWer:SENSor:CHECk`".		

Current sensor detection

This command detects the types of current sensors connected to the M7103 Power Measurement Module.
Use it when you wish to detect current sensors manually. Current sensors are detected automatically when the instrument is powered on and at the start of measurement.

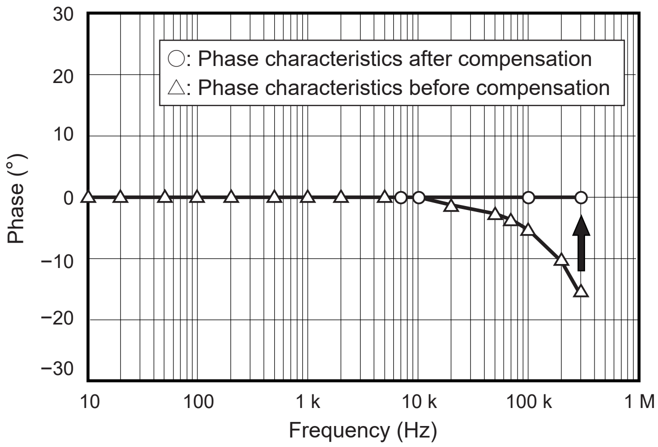
Settings		
Syntax	Command	`:POWer:SENSor:CHECk`

Example	`:POWer:SENSor:CHECk`
	`:POWer:MODule1:SENSor1:ID?`
	`:POWer:MODule1:SENSor2:ID?`
	`:POWer:MODule1:SENSor3:ID?`	

Current sensor phase compensation

In general, current sensor phase errors are more likely to increase gradually in the high-frequency area within the frequency band. It is possible to reduce power measurement errors in the high-frequency domain by correcting the measurement values using the phase characteristics information specific to the sensor.

Image view



> **Tips** **Phase compensation of current sensor with memory**
> When the current sensor with memory is used, the phase of the current sensor is automatically corrected.

How to check the phase compensation value

Acquiring the current sensor phase compensation frequency

Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:FREQuency?`
	Response	`A<NR2>`
Example	`:POWer:MODule1:CURRent1:FREQuency?` (Response) `:POWER:MODULE1:CURRENT1:FREQUENCY 100000` (When the header is ON)	
Parameter		
`A` = 0.1 and above		
Note		
The current sensor is automatically detected when the power is turned ON and measurement starts. If the current sensor should be detected manually, execute “`:POWer:SENSor:CHECK`”.		

Acquiring the phase difference for current sensor phase compensation

Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:DEGRee?`
	Response	`A<NR2>`
Example	`:POWer:MODule1:CURRent1:DEGRee?` (Response)`:POWER:MODULE1:CURRENT1:DEGREE -1.41` (When the header is ON)	
Parameter		
`A` = −180.0 to 180.0		
Note		
The current sensor is automatically detected when the power is turned ON and measurement starts. If the current sensor should be detected manually, execute “`:POWer:SENSor:CHECK`”.		

Setting the output rate

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:RATE A$`
Example	`:POWer:MODule1:CURRent1:RATE 1mV/A`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:RATE?`
	Response	`A$`
Example	`:POWer:MODule1:CURRent1:RATE?` (Response)`:POWER:MODULE1:CURRENT1:RATE 1mV/A` (When the header is ON)	
Parameter		
`A$` = 0.1mV/A, 1mV/A, 10mV/A, 100mV/A, 1V/A		

`0.1mV/A`☑	400 A, 800 A, 2 kA, 4 kA, 8 kA, 20 kA range configuration
`1mV/A`	40 A, 80 A, 200 A, 400 A, 800 A, 2 kA range configuration
`10mV/A`	4 A, 8 A, 20 A, 40 A, 80 , 200 A range configuration
`100mV/A`	0.4 A, 0.8 A, 2 A, 4 A, 8 A, 20 A range configuration
`1V/A`	0.04 A, 0.08 A, 0.2 A, 0.4 A, 0.8 A, 2 A range configuration

Note
Changing the settings will also affect the settings of other channels included in the measurement line combination.

Zero adjustment and degaussing (DMAG)

Before wiring, execute zero adjustment while no voltage and current are input. Zero adjustment is executed for all ranges of all input channels simultaneously. Also, when the current sensor available for AC/DC measurement is connected to the M7103 Power Measurement Module, degaussing (DMAG) of the current sensor is also executed at the same time.

1 **When the power is ON, allow at least 30 minutes for the instrument to warm up.**

2 **Connect the current sensor and voltage cords to M7103.**

When the current measurement value is corrected, the current sensor should be included.

3 **When the current sensor connected to the instrument is available for zero adjustment, perform zero adjustment on the current sensor side.**

There are some current sensor models that allow you to perform zero adjustment using a knob.

4 **Set the wiring mode and current sensor.**

5 **Execute zero adjustment.**

Settings		
Syntax	Command	`:POWer:DEMAg`
Example	`:POWer:DEMAg`	
Query		
Syntax	Query	`:POWer:DEMAg?`
	Response	`A$`
Example	`:POWer:DEMAg?` (Response)`:POWER:DEMAG OK` (When the header is ON)	
Parameter		

`A$` = NONE, BUSY, OK, ERROR

`NONE`	After startup before execution of zero adjustment
`BUSY`	Zero adjustment is being executed
`OK`	Normal end
`ERROR`	Zero adjustment failed

It takes approximately 15 seconds to complete the execution of zero adjustment.
Once the "OK" or "ERROR" response for [:POWer:DEMAg?] is returned, send the next command.

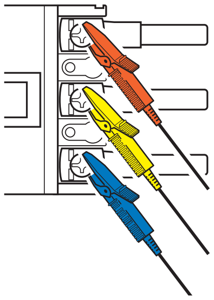
When the beep sound is enabled, a beep sound is issued once in the case of a success, or it is issued twice in the case of a failure.
Reference: "Beep sound" (p. 289)

6 **Perform wiring to the measurement line.**

Wiring to the measurement line

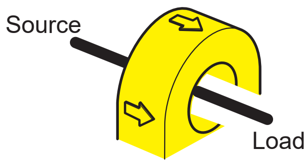
After executing zero adjustment, connect the voltage cords and current sensor to the measurement line according to the connection diagram.
To ensure correct measurement, perform wiring as indicated in the connection diagram (p.83).

Voltage cords

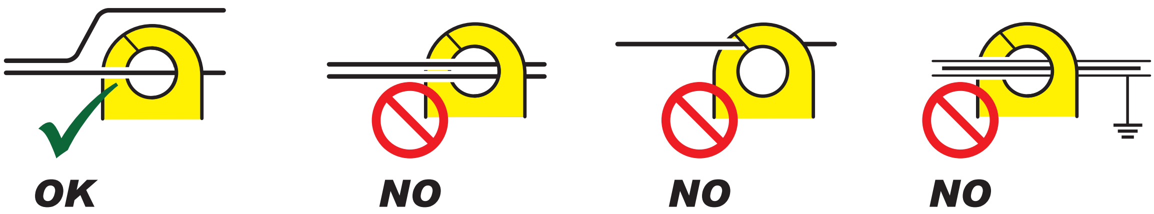


Securely clip the voltage cords to the relevant metal part, such as the screw and wiring bar on the power supply side.

Current sensor



Clamp the current sensor onto the wire with the current direction arrow pointing towards the load side.



No clamping on 2 or more lines

No pinching of line

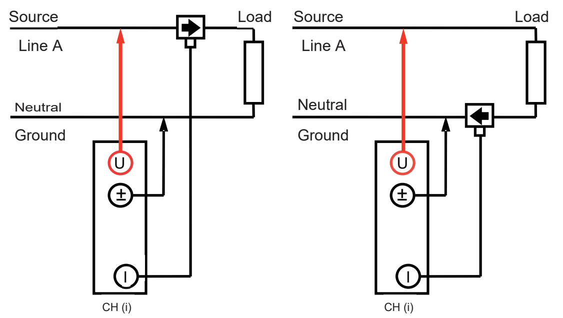
No clamping on shielded line

IMPORTANT

- In the connection diagram, the phase names are indicated as “A, B, C”. When wiring, use the appropriate labels such as “R, S, T” or “U, V, W”, etc., according to the designated names.
- Clamp the sensor around only one conductor. The current cannot be measured if the clamp encompasses two or more wires together, whether in a single-phase or three-phase setup.

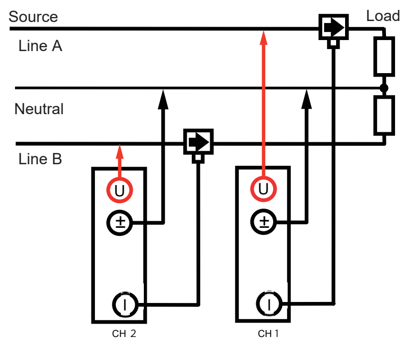
Connection diagram

Single-phase 2-wire (1P2W)

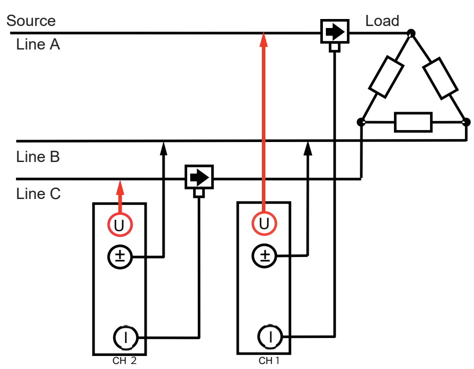


(i): Measurement power channel

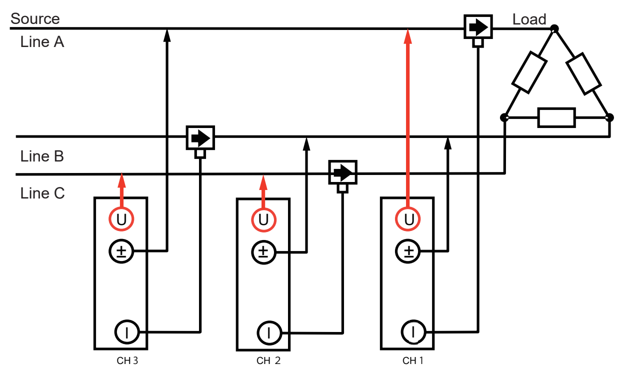
Single-phase 3-wire (1P3W)



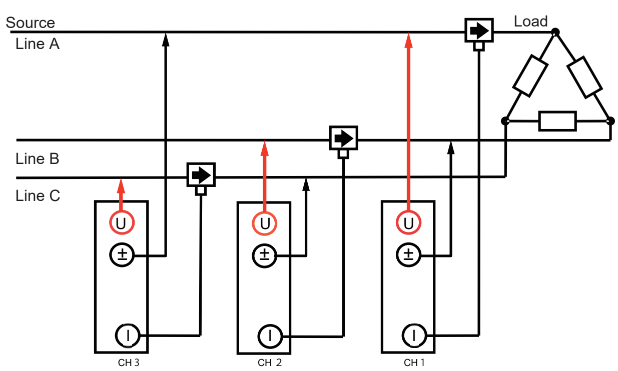
3-phase 3-wire (3P3W2M)



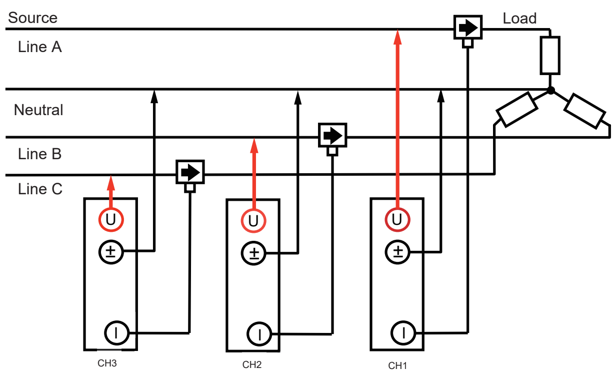
3-phase 3-wire (3V3A)



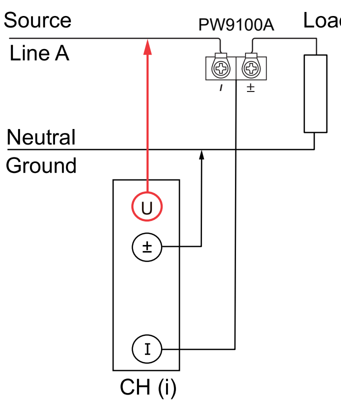
3-phase 3-wire (3P3W3M)



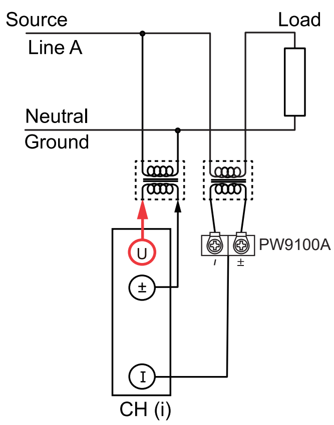
3-phase 4-wire (3P4W)



Normal connections when using the PW9100A



When using the PW9100A with a PT and CT



2

Connection (Preparation for Measurements)

Checking connection

Check the measured values to confirm that the voltage cords and current sensor are connected appropriately.
In the 3P3W2M and 3V3A configurations, the measured active power P for each channel may sometimes be negative.

Situation	Cause
The measured voltage value is too high. **The measured voltage value is too low.**	• The voltage cords are not securely inserted into the voltage input terminal on the instrument. • The voltage cords are not connected properly.
The measured current value is not valid.	• The current sensor is not securely inserted into the current input terminal on the instrument. • The current sensor is not connected properly.
The active power measurement value is a negative value.	• The voltage cords are not connected properly. • When wiring, the arrow that indicates the current flow direction of the current sensor does not point to the load side.

Reference: “Wiring to the measurement line” (p. 82)

2.10 Setting and Connecting the LAN

The instrument and a PC can be connected using a LAN cable.

You can perform the following with LAN1

- Record and observe the settings of the instrument and the measurement data with Logger Utility. (p. 311)
- Remotely operate the instrument (setting, data acquisition, screen monitoring, etc.) using a standard browser, such as Microsoft Edge (HTTP server). (p. 313)
- Download files from the media (SD memory card and USB drive) to the PC (FTP server). (p. 324)
- Automatically send waveform data saved in the media of the instrument to the network or the FTP server of the remote PC (FTP client). (p. 326)
- Control the instrument using communication commands. (p. 101)
- Control the instrument using XCP on Ethernet (TCP). (p. 339)

You can perform the following with LAN2 (LR8102 only)

- Output the measurement data based on the UDP. (p. 347)
- Control the instrument using XCP on Ethernet (UDP). (p. 339)

IMPORTANT
Be sure to configure the LAN settings before connecting the instrument to the network. If you change the 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.

Checking before connection

The settings are different when connecting the instrument to an existing network and when connecting one instrument to one PC.

When connecting the instrument to an existing network

You must first have the network system administrator (department) allocate the following parameters. Ensure that the instrument uses a unique IP address that is not being used by any other device on the network.

DHCP server	DHCP server: Used/not used
Host name **IP address** **Subnet mask**	Host name IP address Subnet mask: ___.___.___.___ (IP address and subnet mask are not required when using DHCP server)
Port	**LAN1** TCP/IP port number to be used: ___X (default 880x) Specify at least the first 3 digits of the 4 or 5 digits. The last digit is used and reserved for the instrument (The last digit: 0 for Logger Utility, 2 for the communication commands, 5 for XCP on Ethernet) Specify when the default setting (8800 to 8809) is not available **Example of port number (with 880x default setting)** Communication command: 8802 (Use this port for command control) Logger Utility: 8800 XCP on Ethernet: 8805 **LAN2** UDP/IP port number to be used: ___X (default 880X) Specify at least the first 3 digits of the 4 or 5 digits. The last digit is used and reserved for the instrument (The last digit: 1 for the measurement data output, 5 for XCP on Ethernet) Specify when the default setting (8800 to 8809) is not available **Example of port number (with 880x default setting)** Measurement data output: 8801 XCP on Ethernet: 8805
Gateway	Gateway: Used/not used IP address (when used): ___.___.___.___ (Setting is not required when using DHCP server, because the address is obtained from the server.)
DNS	DNS: used/not used IP address (when used): ___.___.___.___ (Setting is not required when using DHCP server, because the address is obtained from the server.)

When connecting one instrument and one PC (local network without external connection)

The following address is recommended if there is no administrator or the setting is discretionary.
Setting example

DHCP server		OFF
Host name		Discretionary setting (must be a unique name)
IP address	PC	192.168.1.1
	Logger 1	192.168.1.2
	Logger 2	192.168.1.3 (numbered consecutively)
	↓	↓
Subnet mask		255.255.255.0
Port		880X
Gateway		OFF
DNS		OFF

Parameter

DHCP server (Dynamic Host Configuration Protocol) is used	DHCP is a method by which devices can automatically acquire and configure themselves with an IP address and other information. When the DHCP server is enabled and the server is operating on the same network as the instrument, the instrument can automatically acquire and configure the IP address, subnet mask, and gateway.
Host name	This name represents the instrument on the network. Ensure that the instrument uses a unique name that is not being used by any other device on the network. Since the instrument does not support dynamic DNS, the host name setting is not registered in the DNS.
IP address	The IP address is used to identify individual devices that are connected to the network. Ensure that the instrument uses a unique name that is not being used by any other device on the network. If the DHCP server is enabled, the setting will be configured automatically using the server.
Subnet mask	The subnet mask is used to separate the IP address into the portion that indicates the network and the portion that indicates the device. Ensure that the instrument uses the same subnet mask that is being used by other devices on the same network. If the DHCP server is enabled, the setting will be configured automatically using the server.
Gateway **IP address**	• When connecting the instrument to a network When the PC to be used (communicating device) is on a different network than the network with which the instrument is connected, set this parameter to **[ON]** and specify the device that serves as the gateway. When the PC is on the same network, generally use the same setting as the default gateway setting of the PC. • When connecting one instrument and one PC Set this parameter to **[OFF]** when they are connected to the same hub. If the DHCP server is enabled, the setting will be obtained from the server.
DNS (Domain Name System)	If the DNS is enabled, the communication partner can be specified with its name instead of the IP address. (The IP addresses are difficult to remember because they are a series of numbers. It is easier if devices can be specified with their names instead of the IP addresses.) If a server that allows you to obtain the IP addresses using the names is operating on the network, the IP address of the communication partner can be looked up from the name by querying the server. If the DHCP server is enabled, the setting will be obtained from the server.

Network settings on PC

The setting method is the same for the case when connecting one instrument and one PC and the case when connecting one PC and multiple instruments via a hub.

The following network is assumed here.

- IP address: 192.168.1.0/24 (network address)
  or 192.168.1.1 (private IP address*1)
- Subnet mask: 255.255.255.0

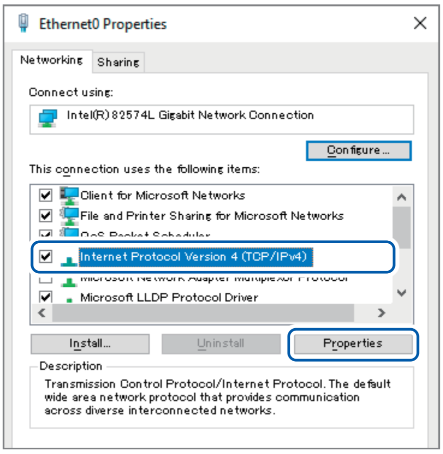
*1. You may set the IP address as desired. However, a private IP address is recommended.

For Windows 10 or Windows 11

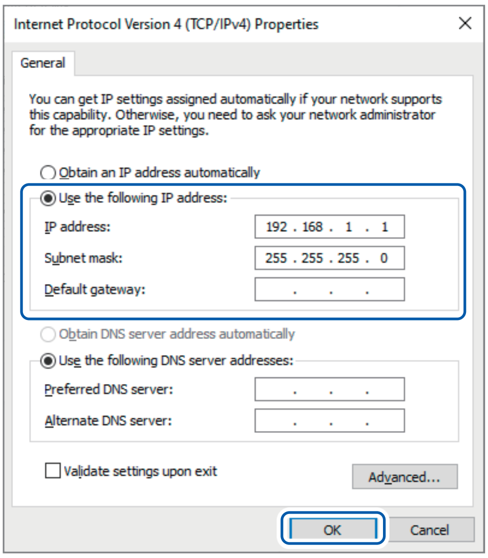
1 **Display the network connections from [Control Panel] > [Network and Sharing Center] > [Change adapter settings].**

2 **Right-click the icon of the adapter to be used for communications (named [Local Area Connection], [Ethernet], etc.), and then select [Properties].**

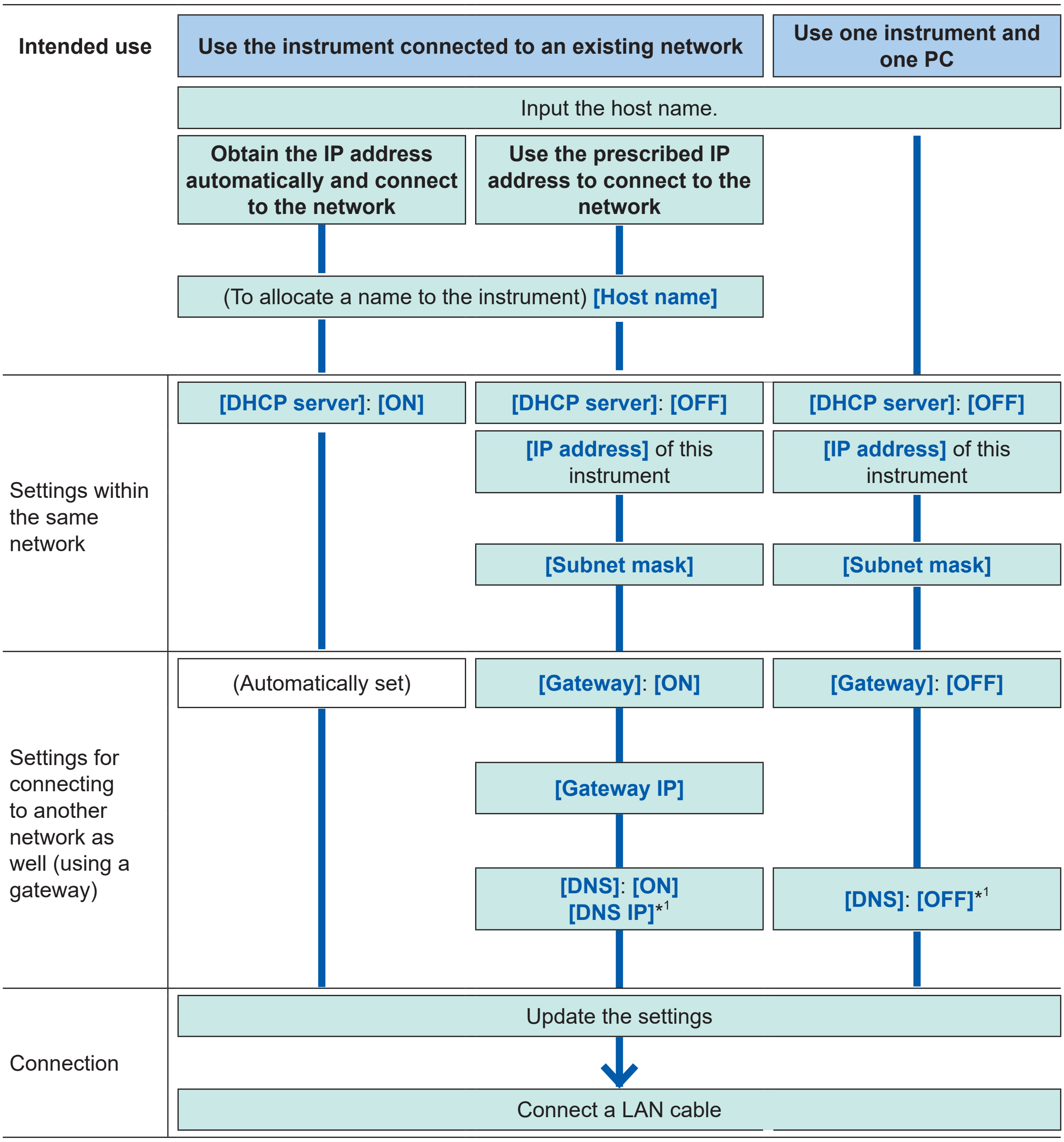
3 **Select [Internet Protocol Version 4 (TCP/IPv4)], and then click [Properties].**



4 **Enter [IP address] and [Subnet mask], then click [OK].**



Workflow for LAN settings



*1. LAN1 only

Configuring the settings for LAN1

Configure the following settings to perform the LAN communications. (p.101)

Update the LAN1 settings.

IMPORTANT
The LAN1 settings will not be updated until this command is executed.
Execute the command after completing the LAN1 settings.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:UPDate`
Example	`:SYSTem:COMMunicate:LAN:UPDate`	
Note		
The ongoing LAN communications are disconnected.		

DHCP server

When the DHCP server is set to ON, the IP address and the subnet mask can be obtained automatically.
For `PREParation?`, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:DHCP A$`
Example	`:SYSTem:COMMunicate:LAN:DHCP ON` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:DHCP?` `:SYSTem:COMMunicate:LAN:DHCP:PREParation?`
	Response	`A$`
Example	`:SYSTem:COMMunicate:LAN:DHCP?` (Response) `:SYSTEM:COMMUNICATE:LAN:DHCP ON` (When the header is ON)	
Parameter		
`A$` = OFF,ON		

`OFF`☑	Disables the DHCP function.
`ON`	Enables the DHCP function.

Host name

For `PREParation?`, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:HOSTname "A$"`
Example	`:SYSTem:COMMunicate:LAN:HOSTname "LOGGER"` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:HOSTname?` `:SYSTem:COMMunicate:LAN:HOSTname:PREParation?`
	Response	`"A$"`
Example	`:SYSTem:COMMunicate:LAN:HOSTname?` (Response) `:SYSTEM:COMMUNICATE:LAN:HOSTNAME "LOGGER"` (When the header is ON)	
Parameter		
`A$` = Character string of host name (up to 12 single-byte characters)		

IP address

The IP address is used to identify individual devices that are connected to the network. Ensure that the instrument uses a unique name that is not being used by any other device on the network. If the DHCP server is enabled, the setting will be configured automatically using the server.
For, `PREParation?`, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:IPADdress ip1,ip2,ip3,ip4`
Example	`:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,100` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:IPADdress?` `:SYSTem:COMMunicate:LAN:IPADdress:PREParation?`
	Response	`ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>`
Example	`:SYSTem:COMMunicate:LAN:IPADdress?` (Response) `:SYSTEM:COMMUNICATE:LAN:IPADDRESS 192,168,1,100` (When the header is ON)	
Parameter		

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

Subnet mask

The subnet mask is used to separate the IP address into the portion that indicates the network and the portion that indicates the device.
Ensure that the instrument uses the same subnet mask that is being used by other devices on the same network. If the DHCP server is enabled, the setting will be configured automatically using the server.
`PREParation?`, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:SMASk mask1,mask2,mask3,mask4`
Example	`:SYSTem:COMMunicate:LAN:SMASk 255,255,255,0` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:SMASk?` `:SYSTem:COMMunicate:LAN:SMASk:PREParation?`
	Response	`mask1<NR1>mask2<NR1>,mask3<NR1>,mask4<NR1>`
Example	`:SYSTem:COMMunicate:LAN:SMASk?` (Response) `:SYSTEM:COMMUNICATE:LAN:SMASK 255,255,255,0` (When the header is ON)	
Parameter		

`mask1`	0 to 255
`mask2`	0 to 255
`mask3`	0 to 255
`mask4`	0 to 255

Port

The last digit is used by the LAN1 system.
Example: No matter which number between 8800 and 8809 is specified, 8802 is the communication command port.
(The last digit: 0 for Logger Utility, 2 for the communication commands, 5 for XCP on Ethernet)
For PREParation?, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	:SYSTem:COMMunicate:LAN:CONTrol no
Example	:SYSTem:COMMunicate:LAN:CONTrol 8800 :SYSTem:COMMunicate:LAN:UPDate	
Query		
Syntax	Query	:SYSTem:COMMunicate:LAN:CONTrol? :SYSTem:COMMunicate:LAN:CONTrol:PREParation?
	Response	no
Example	:SYSTem:COMMunicate:LAN:CONTrol? (Response) :SYSTEM:COMMUNICATE:LAN:CONTROL 8800 (When the header is ON)	
Parameter		
no = 1020 to 65520		
Note		
For example, if a number between 8800 and 8809 is specified, the setting will always return 8800.		

Gateway IP

If the DHCP server is set to ON, the setting will be configured automatically.
Setting 0,0,0,0 disables the use of the Gateway.
For PREParation?, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	:SYSTem:COMMunicate:LAN:GATeway ip1,ip2,ip3,ip4
Example	:SYSTem:COMMunicate:LAN:GATeway 192,168,1,100 :SYSTem:COMMunicate:LAN:UPDate	
Query		
Syntax	Query	:SYSTem:COMMunicate:LAN:GATeway? :SYSTem:COMMunicate:LAN:GATeway:PREParation?
	Response	ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>
Example	:SYSTem:COMMunicate:LAN:GATeway? (Response) :SYSTEM:COMMUNICATE:LAN:GATEWAY 192,168,1,100 (When the header is ON)	
Parameter		

ip1	0 to 255
ip2	0 to 255
ip3	0 to 255
ip4	0 to 255

DNS

Setting 0,0,0,0 disables the use of the DNS.
For `PREParation?`, the setting made before the update of the LAN1 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:DNS ip1,ip2,ip3,ip4`
Example	`:SYSTem:COMMunicate:LAN:DNS 192,168,1,100` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:DNS?` `:SYSTem:COMMunicate:LAN:DNS:PREParation?`
	Response	`ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>`
Example	`:SYSTem:COMMunicate:LAN:DNS?` (Response) `:SYSTEM:COMMUNICATE:LAN:DNS 192,168,1,100` (When the header is ON)	
Parameter		

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

Setting example

- When connecting one instrument and one PC

Setting	Instrument	PC
DHCP server	OFF	OFF
Host name	LOGGER	PC
IP address	192.168.1.2	192.168.1.1
Subnet mask	255.255.255.0	255.255.255.0
Port	880X	*1
Gateway	OFF	192.168.1.200
DNS	OFF	OFF

*1. When the setting of the instrument is **[880X]**, set **[8802]** for the PC connection destination port.

- When connecting one PC and multiple instruments via a hub.
  A case of involving a local network without an external connection is explained here.
  A private IP address is recommended.
  Configure as follows to ensure that the instrument uses a unique host name and IP address that are not being used by any other device on the network.
  Instrument unit 1

Host name	LOGGER
IP address	192.168.1.2

Instrument unit 2

Host name	LOGGER2
IP address	192.168.1.3

Instrument unit 3

Host name	LOGGER3
IP address	192.168.1.4

Common settings

DHCP server	OFF
Subnet mask	255.255.255.0
Port	880X
Gateway	OFF

Connecting the instrument and a PC via LAN

Connect the instrument and a PC with a LAN cable.

⚠CAUTION

- **Do not unplug the LAN cable while the instrument is sending or receiving data.**

  Doing so could damage the instrument and the PC.

- **Turn OFF the instrument and PC before connecting or disconnecting a LAN cable.**

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

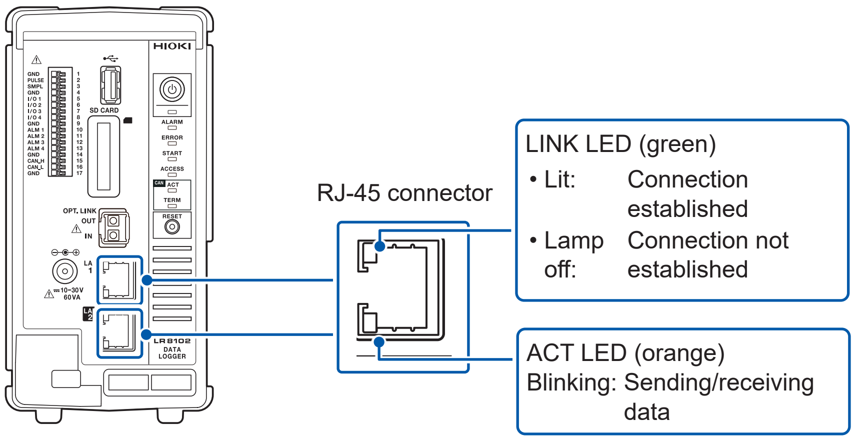
- **Use the same ground for the instrument and the PC.**

  When a LAN cable is connected to the instrument with a potential difference between the ground circuits of the instrument and the PC, the instrument and PC may be damaged or malfunction.

- **If routing a LAN cable outdoors or using a LAN cable longer 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.

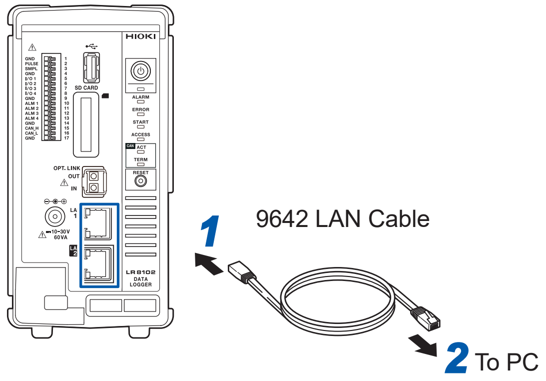
LAN port of the instrument



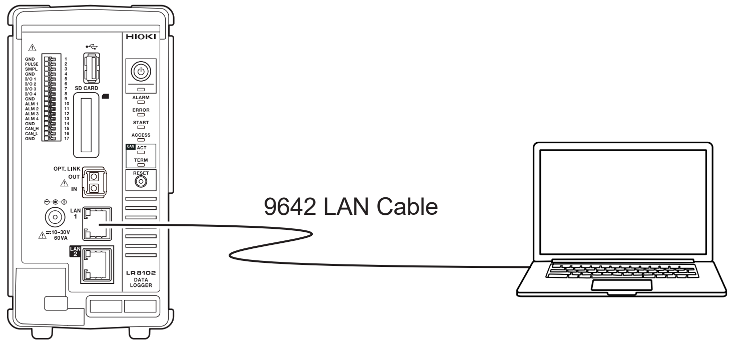
The LINK LED lights up when the instrument is properly connected to the network and available. If the LED does not light up, the instrument or connected devices may have a problem or the LAN cable may be broken.

When connecting one instrument and one PC

Required item: 9642 LAN Cable (1 piece)

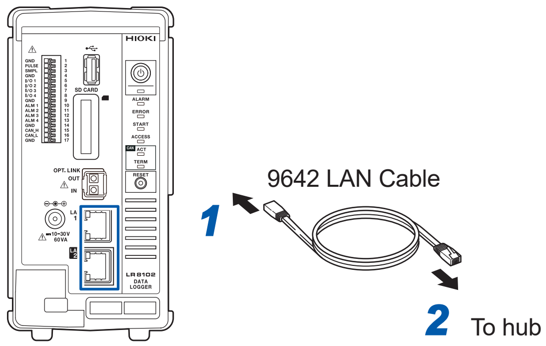


1. **Connect the 9642 LAN Cable to the LAN1 or LAN2 port of the instrument.**
2. **Connect the 9642 LAN Cable to the PC's LAN connector.**

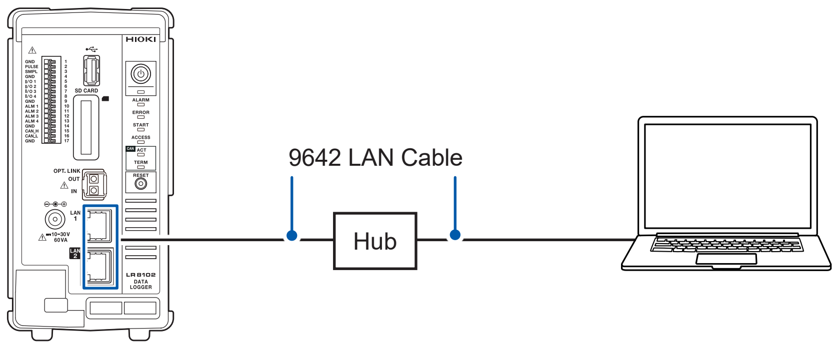


When connecting one PC and multiple instruments via a hub.

Required items: 9642 LAN Cable (2 pieces), hub



1. **Connect the 9642 LAN Cable to the LAN1 or LAN2 port of the instrument.**
2. **Connect the 9642 LAN Cable to the hub's LAN connector.**



Default connection settings for LAN1

The default IP address of the instrument on LAN1 is 192.168.1.2.
There are three methods to change the IP address on LAN1 and the communication settings of the instrument as follows.

- Use the HTTP server
- Use the communication commands.
- Use Logger Utility.

To change the settings using the HTTP server

See “12.2 Remotely Operating the Instrument through the HTTP Server” (p. 313).

To change the settings using the communication commands.

Example: Connecting one instrument and one PC with the minimum settings required

Required items: 9642 LAN Cable (1 piece), PC with configurable IP address

Change the IP address of the PC to 192.168.1.1
Send the following communication commands from the PC (communication command port 8802)

1 Set the IP address of the instrument.

The IP address is used to identify individual devices that are connected to the network. Ensure that the instrument uses a unique name that is not being used by any other device on the network. If the DHCP server is enabled, the setting will be configured automatically using the server.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:IPADdress ip1,ip2,ip3,ip4`
Example	`:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,100` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:IPADdress?`
	Response	`ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>`
Example	`:SYSTem:COMMunicate:LAN:IPADdress?` (Response) `:SYSTEM:COMMUNICATE:LAN:IPADDRESS 192,168,1,100` (When the header is ON)	
Parameter		

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

2 Set the subnet mask of LAN1.

The subnet mask is used to separate the IP address into the portion that indicates the network and the portion that indicates the device.
Ensure that the instrument uses the same subnet mask that is being used by other devices on the same network. If the DHCP server is enabled, the setting will be configured automatically using the server.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:SMASk mask1,mask2,mask3,mask4`
Example	`:SYSTem:COMMunicate:LAN:SMASk 255,255,255,0` `:SYSTem:COMMunicate:LAN:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN:SMASk?`
	Response	`mask1<NR1>,mask2<NR1>,mask3<NR1>,mask4<NR1>`
Example	`:SYSTem:COMMunicate:LAN:SMASk?` (Response) `:SYSTEM:COMMUNICATE:LAN:SMASK 255,255,255,0` (When the header is ON)	
Parameter		

`mask1`	0 to 255
`mask2`	0 to 255
`mask3`	0 to 255
`mask4`	0 to 255

3 Updates the settings of LAN1.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN:UPDate`
Example	`:SYSTem:COMMunicate:LAN:UPDate`	

4 Change the PC to be used or change the IP address of the PC (as needed).

- If the intended use of the PC is only to set the IP address of the instrument, replace the PC as needed.
- Change the IP address of the PC as well if it becomes necessary as a result of setting the IP address of the instrument.

Changing the settings using Logger Utility

Required items: 9642 LAN Cable (1 piece), PC on which Logger Utility can be installed

1 Install Logger Utility on the PC.

Refer to the “Logger Utility Instruction Manual” (PDF file) on the provided DVD.

2 Start up Logger Utility.

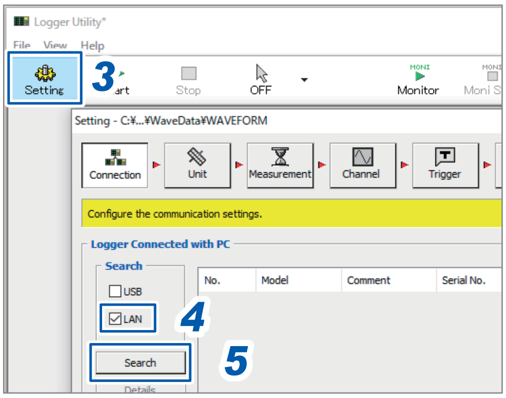
Click **[All Programs]** > **[HIOKI]** > **[Logger Utility]**.

3 **Click [Setting].**

The settings screen is displayed.

4 **Check the [LAN] checkbox.**

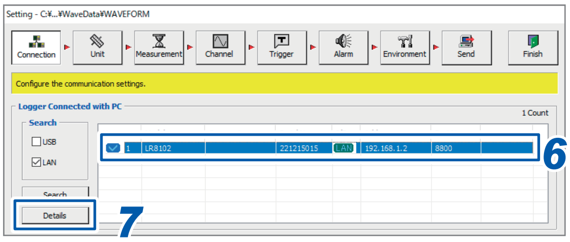
5 **Click [Search].**



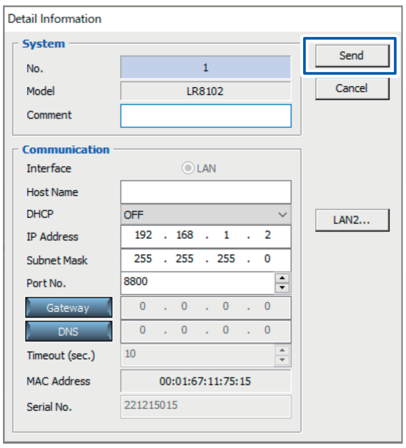
6 **Select the target instrument.**

7 **Click [Details].**

The **[Detail Information]** dialog box is displayed.



8 **Configure the network settings and click [Send].**



9 **Change the IP address of the PC. (as needed).**

> **IMPORTANT**
> If the DHCP setting for the instrument is set to ON in an environment where the DHCP server is not operating, the instrument cannot be searched for with Logger Utility. Connect the instrument in an environment with the DHCP server operating, or fully reset the instrument.

When the LAN communications cannot be established.

The cable is not connected properly

- There may be a contact failure in the connector. Disconnect and then connect the cable again.
- When the cable is connected properly, the LINK LED of the **LAN1 or LAN2 port** of the instrument lights up.

The IP address of the PC is not correct

The IP address, subnet mask, and gateway address of the network interface of the PC can be checked.

1. **Press the Windows and R keys simultaneously.**

   The **[Run]** dialog box is displayed.
2. **Enter “CMD” and press the Enter key.**

   The **[CMD.exe]** window will open.
3. **After the cursor starts blinking, enter [ipconfig/all] and press the Enter key.**

The communications between the instrument and the PC cannot be established

If the IP addresses of the instrument and the PC are set correctly, you can use the ping protocol to check whether the transmission from the PC reaches the instrument.

1. **Press the Windows and R keys simultaneously.**

   The **[Run]** dialog box is displayed.
2. **Enter “CMD” and press the Enter key.**

   The **[CMD.exe]** window will open.
3. **After the cursor starts blinking, enter [ping XXX.XXX.X.X] (IP address of the host to be checked) and press the Enter key.**

   The host name can also be used in an environment where the DNS is functioning normally.
   For example, enter **[ping 192.168.1.2]** if the IP address of the instrument is **[192.168.1.2]**.
4. **Check the contents displayed on the PC screen.**

   The communications are normal if the following is displayed on the PC screen. “Time” represents the time spent for the communications.
   Pinging 192.168.1.2 with 32 bytes of data:
   Reply from 192.168.1.2: bytes=32 time<10ms TTL=32
   Reply from 192.168.1.2: bytes=32 time<10ms TTL=32
   Reply from 192.168.1.2: bytes=32 time<10ms TTL=32
   Reply from 192.168.1.2: bytes=32 time=1ms TTL=32

   The communications are not normal if the following is displayed on the PC screen. Check the cable connection.
   Pinging 192.168.1.2 with 32 bytes of data:
   Reply from 192.168.1.2: Host is down.
   Reply from 192.168.1.2: Host is down.
   Reply from 192.168.1.2: Host is down.
   Reply from 192.168.1.2: Host is down.

3 Settings and Operations

3.1 Controlling the Instrument Using Communication Commands

Before starting the measurement, set the measurement conditions using the communication commands.
By sending the communication commands from a PC, you can control the instrument and acquire the status of the instrument.
See “Communication Method” (p. 20).

Use a LAN cable to connect the instrument and a PC.
See “Connecting the instrument and a PC via LAN” (p. 95) and See “2.10 Setting and Connecting the LAN” (p. 85).

The communication protocol is TCP/IP.
If connection from another PC is attempted while a connection is already established, the currently connected PC will be disconnected, and the new PC will be connected instead.

Standard commands specified by IEEE 488.2

1 Clear the status byte and related queues (excluding the output queue).

The event register corresponding to each bit of the Status Byte Register is cleared.
The Status Byte Register is also cleared.
Since the output queue is not cleared, MAV (bit 4) of the status byte is not affected.

Settings		
Syntax	Command	`*CLS`
Example	`*CLS`	

2 Read out and clear the Standard Event Status Register (SESR).

Query		
Syntax	Query	`*ESR?`
	Response	`A<NR1>`
Example	`*ESR?` (Response) `*ESR 0` (When the header is ON)	
Parameter		
`A` = 0 to 255 The content of the SESR is returned with NR1 and the SESR is cleared.		

3 Query the device ID (identification code).

Query		
Syntax	Query	`*IDN?`
	Response	`A$,B$,C$,D$`
Example	`*IDN?` (Response) `*IDN HIOKI,LR8101,123456789,V1.00` (When the header is ON)	
Parameter		
`A$` = Manufacturer name `B$` = Model name `C$` = Serial number `D$` = Software version		

4 Set LSB of the SESR after all operations are completed.

Set LSB (bit 0) of the SESR (Standard Event Status Register) once the commands before the `*OPC` command are processed, among the transmitted commands.
The following commands will wait for processing to be completed.

- Stop measurement (`:STOP`)
  To wait for the measurement to be stopped, the `:STOP` command needs to be sent 2 times.
- Load hold data (`:MEMory:GETReal`)
- Initialize instrument (`*RST`)

Settings		
Syntax	Command	`*OPC`
Example	`A$;*OPC` After the processing of command `A$` is completed, `*OPC` is executed.	

5 Return 1 in ASCII after all operations are completed.

Return 1 in ASCII once the commands before the `*OPC?` command are processed, among the transmitted commands.
The following commands will wait for processing to be completed.

- Stop measurement (`:STOP`)
  To wait for the measurement to be stopped, the `:STOP` command needs to be sent 2 times.
- Load hold data (`:MEMory:GETReal`)
- Initialize instrument (`*RST`)

Query		
Syntax	Query	`*OPC?`
	Response	`A<NR1>`
Example	`A$;*OPC?` After the processing of command `A$` is completed, 1 in ASCII is returned. (Response) `*OPC 1` (When the header is ON)	
Parameter		
`A` = 1		

6 Query the optional equipment of the instrument.

Return the type of the modules installed. The responses are returned starting from module 1 in order.

Query		
Syntax	Query	`*OPT?`
	Response	`A<NR1>`
Example	`A$;*OPT?` (Response) `*OPT 1,1,1,1,1,3,3,3,3,3` (When the header is ON)	
Parameter		
`Ax` = 0, 1, 3, 4		

`0`	No module
`1`	M7100 Voltage/Temp Module
`3`	M7102 Voltage/Temp Module
`4`	M7103 Power Measurement Module

7 Initialize the instrument.

Data related to the LAN communications will not be cleared.
(Event register, input buffer, output queue)
It takes time to process the `*RST` command.

Settings		
Syntax	Command	`*RST`
Example	`*RST`	

8 Read out the status byte.

Query		
Syntax	Query	`*STB?`
	Response	`A<NR1>`
Example	`*STB?` (Response) `*STB? 128` (When the header is ON)	
Parameter		
`A` = 0 to 255		

3
Settings and Operations

9 Execute a quick ROM/RAM check and query the check result.

Query		
Syntax	Query	`*TST?`
	Response	`A<NR1>`
Example	`*TST?` (Response) `*TST 0` (When the header is ON)	
Parameter		
`Ax` = 0, 1 The quick ROM/RAM check result of the instrument is returned with a numerical value in the NR1 format. `0` = Normal `1` = Error		

To check more details
See “Self-checks (Self-diagnosis)” (p. 297).

10 After the operation is completed, execute the subsequent commands.

Processing for the following commands will wait to be completed.

- Stop measurement (`:STOP`)
  To wait for the measurement to be stopped, the `:STOP` command needs to be sent 2 times.
- Load hold data (`:MEMory:GETReal`)
- Initialize instrument (`*RST`)

Settings		
Syntax	Command	`*WAI`
Example	`A$;*WAI;*IDN?`	

11 Read out and clear Event Status Register 0 (ESR0).

Query		
Syntax	Query	`:ESR0?`
	Response	`A<NR1>`
Example	`:ESR0?` (Response) `:ESR0? 0` (When the header is ON)	
Parameter		
`A` = 0 to 255 Event Status Register 0 (ESR0) is read out. The content of ESR0 is returned with NR1 and ESR0 is cleared.		

3.2 Basic Operations and Queries

1 **Query the status of the instrument.**

Query		
Syntax	Query	`:STATUS?`
	Response	`A<NR1>`
Example	`:STATUS?` (Response) `:STATUS 3` (When the header is ON)	
Parameter		

`A$` = 0 to 63

The status of the instrument is returned with a numerical value in the NR1 format. For example, a response with 3 indicates that the instrument is recording and starting.

`Bit0`	Starting
`Bit1`	Recording
`Bit2`	The instrument is in the trigger standby state.
`Bit3`	Waiting for pre-trigger
`Bit4`	(Reserved)
`Bit5`	Accessing file

2 **Query errors in the instrument.**

Query		
Syntax	Query	`:ERRor?`
	Response	`A$`
Example	`:ERRor?` (Response) `:ERROR ERR_SY01` (When the header is ON)	
Parameter		

`A$` = Error number

The number of the error or warning that has sent in the instrument is returned.
If the `:ERRor?` query is issued immediately after an error occurs, the information on the previous error may be returned. In such a case, send the `:ERRor?` query again.
See “Error messages” (p. 460).

3 **Set the header.**

Settings		
Syntax	Command	`:HEADer A$`
Example	`:HEADer ON`	
Query		
Syntax	Query	`:HEADer?`
	Response	`A$`
Example	`:HEADer?` (Response) `:HEADER ON` (When the header is ON)	
Parameter		

`A$` = OFF, ON

`OFF`☑	Do not attach any header to the response data for the queries and commands.
`ON`	Attach a header to the response data for the queries and commands.

3.3 Setting Measurement Conditions

Configure the basic settings of the measurement, including the recording interval and the recording time.
The details of the settings depend on the recording modes.

Normal sampling

The sampling is performed at a timing synchronized with the internal clock of the logger to record the data.

1 **Set the recording mode to NORMAL.**

Settings		
Syntax	Command	`:CONFigure:SAMPKind A$`
Example	`:CONFigure:SAMPKind NORMal`	
Query		
Syntax	Query	`:CONFigure:SAMPKind?`
	Response	`A$`
Example	`:CONFigure:SAMPKind?` (Response) `:CONFIGURE:SAMPKIND NORMAL` (When the header is ON)	
Parameter		
`A$` = NORMal, EXT		

`NORMal`☑	The data are recorded in synchronization with the internal clock.
`EXT`	The data are recorded in synchronization with an external clock.

2 **Set the interval to acquire the data.**

Example: If the value is set to 10 ms, the data are acquired at intervals of 10 ms (100 times per second).

Settings		
Syntax	Command	`:CONFigure:SAMPle A`
Example	`:CONFigure:SAMPle 1E-2`	
Query		
Syntax	Query	`:CONFigure:SAMPle?`
	Response	`A<NR3>` (1 digit after the decimal point)
Example	`:CONFigure:SAMPle?` (Response) `:CONFIGURE:SAMPLE 1.0E-02` (When the header is ON)	
Parameter		
`A` = 5.0E-3 to 3.6E+3 (sec)		

5 ms*1, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms,
1 s, 2 s, 5 s, 10 s, 20 s, 30 s,
1 min, 2 min, 5 min, 10 min, 20 min, 30 min,
1 h

*1. Can be set only when using M7100 or M7103

Note

If a value not listed in the setting is specified and if there are ranges higher than the specified value, the nearest range is applied.
When using external sampling, the response to the query will be at the fastest update interval of any module that has a channel with measurement ON.

3 **Set the recording time (max. 500 days).**

The maximum recording time varies with the number of channels and the recording interval to be used.
If the continuous recording is specified, the measurement is continued until the **STOP** command is executed.
You can also stop the measurement using the trigger.
See “Set the behavior when the trigger is activated.” (p. 193).
If the maximum capacity of the internal buffer memory is exceeded, the measurement is continued while deleting old data in the internal buffer memory. Since the deleted data cannot be recovered, the auto-save operation is recommended.
See “Auto save (Realtime save)” (p. 226).

Settings		
Syntax	Command	`:CONFigure:RECTime day,hour,min,sec`
Example	`:CONFigure:RECTime 0,0,0,10`	
Query		
Syntax	Query	`:CONFigure:RECTime?`
	Response	`day<NR1>,hour<NR1>,min<NR1>,sec<NR1>`
Example	`:CONFigure:RECTime?` (Response) `:CONFIGURE:RECTIME 0,0,0,10` (When the header is ON)	
Parameter		

`day`	0 to 500 (days)
`hour`	0 to 23 (hours)
`min`	0 to 59 (minutes)
`sec`	0 to 59 (seconds)

The current setting of the recording time is returned with a numerical value in the NR1 format.
See “Data part” (p. 24).
The continuous recording is specified if all of the parameters are 0.

4 **Configure the measurement stop setting.**

Measurement can be stopped at the specified date and time. The recording is stopped as soon as the measurement is stopped.
After the measurement is started and before it is stopped, the recording is started or stopped according to the trigger conditions.

Settings		
Syntax	Command	`:CONFigure:STOP A$`
Example	`:CONFigure:STOP MANUAL`	
Query		
Syntax	Query	`:CONFigure:STOP?`
	Response	`A$`
Example	`:CONFigure:STOP?` (Response) `:CONFIGURE:STOP MANUAL` (When the header is ON)	
Parameter		

`A$` = MANUAL, TIME

`MANUAL`☑	Measurement is stopped with the **STOP** command or EXT. I/O.
`TIME`	Measurement is stopped at the specified date and time. (p. 108) Year - Month - Day Hour:Minute Executing the **STOP** command during the measurement stops the measurement even if the stop time is specified.

When an external sampling is used, only MANUAL can be set.

5 Set the measurement stop time.

You cannot set a time earlier than the measurement start time.

Settings		
Syntax	Command	`:CONFigure:STOPTime year,month,day,hour,minute`
Example	`:CONFigure:STOPTime 24,1,2,12,34`	
Query		
Syntax	Query	`:CONFigure:STOPTime?`
	Response	`year<NR1>,month<NR1>,day<NR1>hour<NR1>,minute<NR1>`
Example	`:CONFigure:STOPTime?` (Response) `:CONFIGURE:STOPTIME 24,1,2,12,34` (When the header is ON)	
Parameter		

`year`	21 to 37 (year)
`month`	1 to 12 (month)
`day`	1 to 31 (days)
`hour`	0 to 23 (hours)
`minute`	0 to 59 (minutes)

External sampling

The sampling is performed at a timing synchronized with an external clock to record the data.
When an external sampling is used, the following functions are disabled or settings are fixed.

- Data refresh interval: 0 (auto) cannot be set
- Stop: MANUAL only
- Pulse, logic channel: Measurement disabled
- Synchronized operation: Setting disabled
- Auto save - Folder splitting: OFF (Disable) only
- Auto save - File splitting: Function disabled
- Horizontal (time) axis display: SCALE (Number of data) only
- Pre-trigger: Function disabled
- Alarm type: Level and Window only
- Numerical - Time split calculation: OFF (Disable) only
- Waveform calculation - Reset time: OFF (Disable) only
- CAN measured value output, CAN terminal output: No time output

1 **Set the recording mode.**

Settings		
Syntax	Command	`:CONFigure:SAMPKind A$`
Example	`:CONFigure:SAMPKind EXT`	
Query		
Syntax	Query	`:CONFigure:SAMPKind?`
	Response	`A$`
Example	`:CONFigure:SAMPKind?` (Response) `:CONFIGURE:SAMPKIND EXT` (When the header is ON)	
Parameter		
`A$` = NORMal, EXT		

`NORMal`☑	The data are recorded in synchronization with the internal clock.
`EXT`	The data are recorded in synchronization with an external clock.

2 **Set the number of samples.**

Settings		
Syntax	Command	`:CONFigure:EXTRECSamp A`
Example	`:CONFigure:EXTRECSamp 100`	
Query		
Syntax	Query	`:CONFigure:EXTRECSamp?`
	Response	`A<NR1>`
Example	`:CONFigure:EXTRECSamp?` (Response) `:CONFIGURE:EXTRECSAMP 100` (When the header is ON)	
Parameter		
`A` = 1 to 1000000000		

See“11.3 Setting the External Sampling (SMPL)” (p. 310).

Tips

When measurement is performed consecutively without specifying the number of samples for external sampling

Set the continuous recording using the following command.

```
:CONFigure:RECTime 0,0,0,0
```

The setting for the number of samples is ignored.

Common settings for the recording modes

1 **Enter the title comment (optional).**

See “Title comment” (p. 168) and “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:COMMent:TITLe "A$"`
Example	`:COMMent:TITLe "HIOKI"`	
Query		
Syntax	Query	`:COMMent:TITLe?`
	Response	`"A$"`
Example	`:COMMent:TITLe?` (Response) `:COMMENT:TITLE "HIOKI"` (When the header is ON)	
Parameter		
`A$` = Character string of comment (up to 20 double-byte characters or 40 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

2 **Set whether or not to repeat the recording operation.**

Settings		
Syntax	Command	`:TRIGger:MODE A$`
Example	`:TRIGger:MODE REPEat`	
Query		
Syntax	Query	`:TRIGger:MODE?`
	Response	`A$`
Example	`:TRIGger:MODE?` (Response) `:TRIGGER:MODE REPEAT` (When the header is ON)	
Parameter		
`A$` = SINGle, REPEat		
Note		
Changing these settings may also alter the interval trigger settings.		

`SINGle`☑	Repetitive recording OFF The measurement is completed with one recording.
`REPEat`	Repetitive recording ON The recording is repeated. Executing the `STOP` command ends the measurement.

3 Configure the measurement start setting.

Measurement can be started at the specified date and time. After the measurement is started, the recording is started according to the trigger settings.
After the measurement is started and before it is stopped, the recording is started or stopped according to the trigger conditions.

- Measurement start: The measurement is started and waiting for the trigger
- Recording started: The trigger is activated and the recording is started

Settings		
Syntax	Command	:CONFigure:STARt A$
Example	:CONFigure:STARt MANUAL	
Query		
Syntax	Query	:CONFigure:STARt?
	Response	A$
Example	:CONFigure:STARt? (Response) :CONFIGURE:START MANUAL (When the header is ON)	
Parameter		
A$ = MANUAL, TIME		

MANUAL☑	Measurement is started with the STARt command or EXT. I/O.
TIME	Measurement is started at the specified date and time. Year - Month - Day Hour:Minute The STARt command keeps the measurement start on standby until the specified date and time. If the STARt command is executed after the specified date and time, the measurement is started.

4 Set the measurement start time.

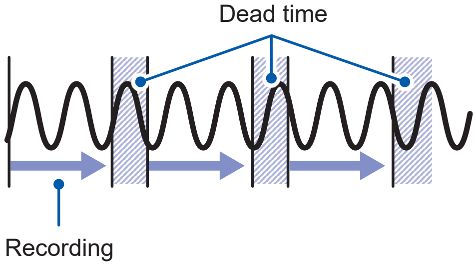
You cannot set a time later than the measurement stop time. (p.108)

Settings		
Syntax	Command	:CONFigure:STARTTime year,month,day,hour,minute
Example	:CONFigure:STARTTime 24,1,2,12,34	
Query		
Syntax	Query	:CONFigure:STARTTime?
	Response	year<NR1>,month<NR1>,day<NR1>,hour<NR1>,minute<NR1>
Example	:CONFigure:STARTTime? (Response) :CONFIGURE:STARTTIME 24,1,2,12,34 (When the header is ON)	
Parameter		

year	21 to 37 (year)
month	1 to 12 (month)
day	1 to 31 (days)
hour	0 to 23 (hours)
minute	0 to 59 (minutes)

When the repetitive recording is ON

After the data are recorded for the specified time, it takes time for the internal processing (dead time) before the next recording can be started. The data are not recorded during the dead time.



> **Tips** During normal sampling, the data can be recorded without any dead time by setting the recording time to continuous and enabling auto-save with file division. The data file to be saved can be divided at a specified time.

Set the synchronized terminal

Multiple units of the instrument can be operated synchronously.
To perform the synchronized operation, follow the procedure in “Wiring the optical connection cable (LR8102 only)” (p. 65).
The sampling clocks of the multiple instruments can be synchronized (the multiple units record the data at the same timing).
When an external sampling is used, synchronous operation cannot be set.

1 **Set the synchronized operation.**

Settings		
Syntax	Command	`:CONFigure:SYNC:SET A$`
Example	`:CONFigure:SYNC:SET PRIMary`	
Query		
Syntax	Query	`:CONFigure:SYNC:SET?`
	Response	`A$`
Example	`:CONFigure:SYNC:SET?` (Response) `:CONFIGURE:SYNC:SET PRIMARY` (When the header is ON)	
Parameter		

`A$` = OFF, PRIMary, CPRimary, SECondary

`OFF`☑	Synchronized operation disabled
`PRIMary`	Primary for sampling synchronization
`CPRimary`	Primary for power calculation synchronization
`SECondary`	Secondary

The following table shows the differences between PRIMary and CPRIMary.

Synchronized operation	PRIMary	CPRIMary
Synchronization of measurement start/stop between primary and secondary units	✓	✓
Synchronization of sampling between primary and secondary units	✓	✓
Data transfer from the primary unit to the secondary unit (Reference: p. 349)	✓	–
Synchronization of power calculation between primary and secondary units (Reference: p. 129)	–	✓

Note

- When multiple instruments are installed, only one instrument can be designated as the primary unit for sampling or power calculation synchronization.
  Designate the rest of the instruments as the secondary units.
- CPRimary can only be specified when a power measurement module is installed.
- When there’s an M7103 with the following settings that can serve as a calculation synchronization source, it is used as the overall synchronization source:
  1. The instrument is configured to serve as CPRIMary.
  2. An M7103 connected to the instrument in (1) above is configured to serve as PRIMary
  In this case, configure the second and subsequent M7103s to serve as SECondary units.

  Example: In the following example, the calculation synchronization source of the underlined M7103 is used, and M7103 modules not underlined are configured to serve as SECondary modules.
  LR8102 (CPRimary): M7103 (OFF*1), M7103*2 (PRIMary*1)
  LR8102 (SECondary): M7103 (SECondary*1), M7103 (PRIMary*1)
  *1. Configure synchronization source sharing for desired modules. (See:p. 130)

- The effects of synchronization error may cause the M7103 in the secondary instrument to have a different calculation interval than the primary instrument, possibly resulting in measurement errors.
- The secondary M7103 may exhibit a measurement error in the initial data after starting AC measurement.
- The conventional commands can also be used. (p. 452)

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2 Check the wiring of the optical connection cables.

Query		
Syntax	Query	`:CONFigure:SYNC:CHECk?`
	Response	`A<NR1>`
Example	`:CONFigure:SYNC:CHECk?` (Response) `:CONFIGURE:SYNC:CHECK 1` (When the header is ON)	

Parameter

`A$` = 0 to 255
The result of the following wiring checks is returned with a numerical value in the NR1 format.
For example, a returned value of 1 indicates that the instrument is not set to primary.

`Bit0`	The bit is set if the synchronized operation setting is not primary.
`Bit4`	The bit is set if the number of secondary units could be more than 9.
`Bit7`	The bit is set if the optical connection cables could be disconnected.

Other bits are fixed to 0.

IMPORTANT

- Use the primary unit to start and stop measurement. Measurement cannot be started or stopped from the secondary unit. Use the `:ABORT` command to stop measurement in the secondary unit.
- When using the start trigger, set the start trigger for all devices.
- If an error occurs in the synchronization signal during synchronized operation, the synchronized operation is automatically stopped.

Data refresh interval of the measurement modules

The data refresh interval of each measurement module can be set separately from the recording interval of the instrument.

Data refresh interval ▶	The intervals at which a measurement module updates the measurement data
Recording interval ▶	The intervals at which the instrument acquires the data from a measurement module (p. 106)

1 **Set the data refresh interval.**

The data refresh intervals are as follows according to the settings of the target module.

<table>
<tr><th>Module type</th><th colspan="2">M7100</th><th colspan="2">M7102</th></tr>
<tr><th>Number of measurement channels</th><th>1 to 8 CH</th><th>9 to 15 CH</th><th>1 to 15 CH</th><th>16 to 30 CH</th></tr>
<tr><td>• Voltage measurement only</td><td>5 ms or more</td><td rowspan="2">10 ms or more</td><td rowspan="2">10 ms or more</td><td rowspan="2">20 ms or more</td></tr>
<tr><td>• Thermocouple measurement included
• Wire break detection OFF</td><td>10 ms or more</td></tr>
<tr><td>• Thermocouple measurement included
• Wire break detection ON</td><td colspan="2">20 ms or more</td><td>20 ms or more</td><td>50 ms or more</td></tr>
</table>

Set the update interval for the M7103 Power Measurement Module using the following table as a reference. When connecting two or more power measurement modules to an instrument, all power measurement modules must use the same data refresh interval. During synchronized operation, all power measurement modules being synchronized must use the same data refresh interval.

5 ms	Select this setting to measure fluctuations of high-speed power. Even when 5 ms is selected, harmonic current analysis is operated at the interval of 50 ms.
50 ms	Normally, select 50 ms. With this setting, speed and accuracy are equally ensured.
200 ms	Select this option if there are significant fluctuations and the measurements do not stabilize at a 50 ms update interval. Also select this setting when the IEC mode is used for harmonic measurement.

Set the data refresh interval of the specified module with a numerical value (in seconds).
If A = 0, the data refresh interval is automatically set.

Settings		
Syntax	Command	:MODule:DATARate module$,A
Example	:MODule:DATARate MODULE1,1.0E+00	
Query		
Syntax	Query	:MODule:DATARate? module$
	Response	A
Example	:MODule:DATARate? MODULE1 (Response) :MODULE:DATARATE MODULE1,1.0E+00 (When the header is ON)	
Parameter		

module$ = MODULE1 to MODULE10
A = 0 (auto), 5.0E-3 to 1.0E+1 (sec)

0 (auto)☑, 5 ms, 10 ms, 20 ms, 50 ms*1, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s

*1. Default value for the power measurement module

Normally, select 0 (auto). If auto is selected, the shortest data refresh interval is set for each measurement module based on the recording interval.
When other than auto is selected: A value more than the recording interval can be set. If the recording interval is 10 s or more, the data refresh interval is fixed to 10 s.

Note

The possible data refresh interval setting varies with the modules to be used as well as the wire break detection settings.
If a value not listed in the settings is specified and if there are rates higher than the specified value, the nearest rate is applied.
When the power measurement module is used, 0 (auto) cannot be set.
When :MODule:DATARate is executed for a power measurement module, the data refresh intervals for all power measurement modules connected to the instrument will be changed.
When an external sampling is used, 0 (auto) cannot be set.

The filter cutoff frequency can be checked using the following command.

The filter cutoff frequency of the M7100 and M7102 depends on the data refresh interval setting.
The current value of the filter cutoff frequency of the specified module is returned with a numerical value.

Query		
Syntax	Query	:MODule:DFILter? module$
	Response	module$,A<NR3>
Example	:MODule:DFILter? MODULE1 (Response) :MODULE:DFILTER MODULE1,+7.4E+02 (When the header is ON)	
Parameter		
module$ = MODULE1 to MODULE10		

The power frequency filter can be set using the following command.

Set the filter for the M7100 and M7102 so that the effect of the digital filter is maximized.
It is recommended to set the value to the same frequency as the power-supply frequency of the region where the instrument is used (50 Hz or 60 Hz).

Settings		
Syntax	Command	`:MODule:FILTer A$`
Example	`:MODule:FILTer 50HZ`	
Query		
Syntax	Query	`:MODule:FILTer?`
	Response	`A$`
Example	`:MODule:FILTer?` (Response) `:MODULE:FILTER 50HZ` (When the header is ON)	
Parameter		
`A$` = 50HZ, 60HZ		

`50HZ`	Use the digital filter for the 50 Hz region.
`60HZ`☑	Use the digital filter for the 60 Hz region.

Tips

- It is recommended to use a longer time when the data refresh interval is not set to auto. Using a longer interval lowers the cutoff frequency of the digital filter as well as removes low frequency noise.
- The noise at the power-supply frequency can be removed by setting the data refresh interval so that the filter functions at 50 Hz or 60 Hz.

The following command allows you to obtain the module information at a specified position.

Query		
Syntax	Query	`:MODule:IDN? Module$`
	Response	`module$,A$,B$,C$,D$`
Example	`:MODule:IDN? MODULE1` (Response) `:MODULE:IDN MODULE1,M7100,100000000,V 100,V 100` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10 `A$` = Product model name `B$` = Serial number `C$` = Module version `D$` = Module FPGA version		
Note		
If a position where no module exist is specified, the response is UNKNOWN.		

Relationship of the data refresh interval and the recording interval

- The measurement module sends the data to the instrument at the data refresh intervals.
- The instrument receives the data from the measurement module at the recording intervals.
- If the recording interval of the instrument is long, the waveform peaks cannot be recorded even when the data refresh interval of the measurement module is short.

	Data refresh interval		Recording interval	
	Short	Long	Short	Long
Effect of power-supply frequency filter	Weak	Strong	–	–
Amount of data	–	–	Larger	Smaller
Waveform peaks	Easy to capture*1	Difficult to capture	Easy to capture*1	Difficult to capture

*1. When the data refresh interval and the recording interval are short

- For the M7100 or M7102 modules, the longer the data refresh interval, the lower the cutoff frequency of the digital filter. As a result, the effect of noise removal is increased. For the cutoff frequency, see the section for the digital filter of the modules in “Specifications of Modules” (p. 366).
- If the data refresh interval of the module is longer than the recording interval, the first two data sets become continuous and a delay occurs.

Setting example

Purpose	Data refresh interval	Recording interval
Record signals with fast variation (electrical signals, etc.)	Shorten	Shorten
Record signals with slow variation (temperature, etc.)	Extend	Extend
Record fast and slow signals simultaneously	Shorten for modules measuring fast signals Extend for modules measuring slow signals	Shorten

Since the data refresh interval can be set for each module, the following usage is possible.

- For module 1, in order to reduce influence of noise during temperature measurement using a thermocouple, set the data refresh interval to 2 s so that the power supply noise can be removed.
- For module 2, in order to record battery voltage fluctuation, set the data refresh interval to 10 ms.
- For module 3, in order to record variation in the control signals at the maximum speed, set the data refresh interval to 5 ms.
- Set the recording interval of the instrument to 5 ms, so that it matches the shortest data refresh interval.
  The instrument records the data from modules 1 to 3 at intervals of 5 ms.

If the recording interval of the instrument is shorter than the data refresh interval of a module, a constant value is recorded as the data from the module.
Example: When the recording interval is 10 ms and the data refresh interval is 1 s, the same data are recorded 100 times.

For the identification names of modules, see (p. 169).

Data refresh interval for pulses

The pulse data are updated at the data refresh intervals.
The data refresh interval for pulses is automatically set according to the input types.

Input type		Data refresh interval
Count		5 ms
Rotation speed	r/s or r/min (smoothing: 1 s)	10 ms
	r/min (smoothing: 2 s to 60 s)	50 ms

- Pulse counting is not affected by the data refresh interval.
- If the recording interval is shorter than the data refresh interval, the pulse data and the data from the measurement module are updated at different timings even when their data refresh intervals are the same.

3.4 Setting the Voltage/Temp Module

Set the input channel of the M7100 or M7102 Voltage/Temp Module for voltage measurement, temperature measurement, etc.

Channel	▶	Enable the measurement channel.
Input	▶	Set the measurement target type. Voltage, thermocouple, etc.
Range	▶	Set the magnitude of the input signal.

Set the scaling and comments as needed.

Voltage measurement

The setting method for measuring voltage is described here.

Setting method

1 **Enable the measurement channel.**

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe CH1_1,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? CH1_1` (Response) `:MODULE:STORE CH1_1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, , M1URMS1 to M4HST3 (pp.145) `A$` = OFF, ON		

2 **Set the input type to voltage.**

Settings		
Syntax	Command	`:MODule:INMOde ch$,A$`
Example	`:MODule:INMOde CH1_1,VOLTAGE`	
Query		
Syntax	Query	`:MODule:INMOde? ch$`
	Response	`ch$,A$`
Example	`:MODule:INMOde? CH1_1` (Response) `:MODULE:INMODE CH1_1,VOLTAGE` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `A$` = VOLTAGE, TC		

`VOLTAGE`☑	Voltage
`TC`	Thermocouples

3 **Set the measurement range according to the measurement target.**

(For M7100 or M7102)

Settings		
Syntax	Command	`:MODule:RANGe ch$,A`
Example	`:MODule:RANGe CH1_1,1E-1`	
Query		
Syntax	Query	`:MODule:RANGe? ch$`
	Response	`ch$,A<NR3>` (1 digit after the decimal point)
Example	`:MODule:RANGe? CH1_1` (Response) `:MODULE:RANGE CH1_1,+1.0E-01` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `A` = Vertical axis range		
10 mV ☑, 20 mV, 100 mV, 200 mV, 1 V, 2 V, 6 V, 10 V, 20 V, 60 V, 100 V, 1-5 V		
Note		
If a value not listed in the settings is specified and if there is a range right above the value, the range is applied. To set the voltage range to 1-5 V, set A = 15.		

When measuring the output from an instrumentation device

- To measure a 4-20 mA current, connect a 250 Ω resistor between the plus and minus terminals of the input terminal.
  See “Wiring the voltage cable and thermocouple” (p. 56).
- When measuring the output from a 4-20 mA instrumentation device, the 1-5 V range is useful.

> **Tips** With the scaling function, the measured voltage value can be converted to a value in a specified unit.
> See “3.7 Using the Scaling Function” (p. 161).

Temperature (thermocouple) measurement

The setting method for measuring temperature using a thermocouple is described here.
Applicable modules: M7100, M7102

1 **Enable the measurement channel.**

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe CH1_1,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? CH1_1` (Response) `:MODULE:STORE CH1_1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A$` = OFF, ON		

2 **Set the input type to thermocouple**

Settings		
Syntax	Command	`:MODule:INMOde ch$,A$`
Example	`:MODule:INMOde CH1_1,TC`	
Query		
Syntax	Query	`:MODule:INMOde? ch$`
	Response	`ch$,A$`
Example	`:MODule:INMOde? CH1_1` (Response) `:MODULE:INMODE CH1_1,TC` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `A$` = VOLTAGE, TC		

`VOLTAGE`☑	Voltage
`TC`	Thermocouples

3 Set the measurement range according to the measurement temperature.

Settings		
Syntax	Command	`:MODule:RANGe ch$,A`
Example	`:MODule:RANGe CH1_1,1E+2`	
Query		
Syntax	Query	`:MODule:RANGe? ch$`
	Response	`ch$,A<NR3>` (1 digit after the decimal point)
Example	`:MODule:RANGe? CH1_1` (Response) `:MODULE:RANGE CH1_1,1.0E+02` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `A` = Vertical axis range 100°C ☑, 500°C, 2000°C		
Note		
Thermocouple B cannot be selected for the 100°C range and the 500°C range. When using thermocouple B, set the range to the 2000°C range in advance. If a value not listed in the settings is specified and if there is a range right above the value, the range is applied.		

4 Set the thermocouple type to be used.

Settings		
Syntax	Command	`:MODule:SENSor ch$,A$`
Example	`:MODule:SENSor CH1_1,K`	
Query		
Syntax	Query	`:MODule:SENSor? ch$`
	Response	`ch$,A$`
Example	`:MODule:SENSor? CH1_1` (Response) `:MODULE:SENSOR CH1_1,K` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `A$` = K, J, E, T, N, R, S, B, C `K` ☑, `J`, `E`, `T`, `N`, `R`, `S`, `B`*1, `C` *1. B can be selected for the 2000°C range. See “Temperature measurement range” (p. 125).		

5 Set the wire break detection.

Settings		
Syntax	Command	`:MODule:WIRE module$,A$`
Example	`:MODule:WIRE MODULE1,ON`	
Query		
Syntax	Query	`:MODule:WIRE? module$`
	Response	`module$,A$`
Example	`:MODule:WIRE? MODULE1` (Response) `:MODULE:WIRE MODULE1,ON` (When the header is ON)	
Parameter		

`module$` = MODULE1 to MODULE10
`A$` = OFF, ON

`OFF`☑	Thermocouple wire break detection is not performed. When the thermocouple is disconnected, the value may fluctuate.
`ON`	Thermocouple wire break detection is performed during the thermocouple temperature measurement. The data during wire break are special values. See “14.12 Data Handling” (p. 428). There is a limit to the data refresh interval that can be set. See “Thermocouple wire break detection” (p. 125).

6 Set the method of reference junction compensation.

Settings		
Syntax	Command	`:MODule:RJC ch$,A$`
Example	`:MODule:RJC CH1_1,INT`	
Query		
Syntax	Query	`:MODule:RJC? ch$`
	Response	`ch$,A$`
Example	`:MODule:RJC? CH1_1` (Response) `:MODULE:RJC CH1_1,INT` (When the header is ON)	
Parameter		

`ch$` = CH1_1 to CH10_30
`A$` = INT, EXT

`INT`☑	The reference junction compensation is implemented inside the measurement module. This setting is made when a thermocouple (or compensating lead wire) is connected directly to the instrument. The measurement accuracy is the value obtained when the reference junction compensation accuracy are added to the temperature measurement accuracy.
`EXT`	The reference junction compensation is not implemented inside the measurement module. This setting is made when a zero junction compensator (0°C ice water, etc.) is externally connected. The measurement accuracy is specified only by the temperature measurement accuracy.

Temperature measurement range

The temperature measurement range depends on the thermocouple types.

Thermocouples	Temperature measurement range
K	−200°C to 1350°C
J	−200°C to 1200°C
E	−200°C to 1000°C
T	−200°C to 400°C
N	−200°C to 1300°C
R	0°C to 1700°C
S	0°C to 1700°C
B*1	400°C to 1800°C
C	0°C to 2000°C

*1. Can be selected for the 2000°C range. Temperature from 0°C to 400°C is recorded even if B is selected. However, the accuracy cannot be guaranteed.

Thermocouple wire break detection

- During temperature measurement using a thermocouple, wire break detection is performed by inputting a fine current at the data refresh intervals.
- Since a wire break is detected at a different timing to measurement, the measurement values are not affected.
- If the data refresh intervals are the same, the cutoff frequency is higher when the wire break detection is set to ON compared with the case where the wire break detection is set to OFF. Therefore, the effect of noise removal is decreased.
  See “digital filter” of the modules in “13.2 Specifications of Modules” (p. 366) to check the cutoff frequency.
- A resistance value of the thermocouple that approximately exceeds the following value is considered a wire break.

Thermocouples	Range		
	100°C f.s.	500°C f.s.	2000°C f.s.
K	3570 Ω	3430 Ω	8330 Ω
J	3350 Ω	5010 Ω	5680 Ω
E	3140 Ω	3280 Ω	4480 Ω
T	3530 Ω	3460 Ω	3460 Ω
N	510 Ω	4120 Ω	1570 Ω
R	920 Ω	580 Ω	3550 Ω
S	920 Ω	620 Ω	760 Ω
B	–	–	1133 Ω
C	770 Ω	390 Ω	1190 Ω

When using an extended thermocouple with the wire break detection set to ON, use a thermocouple with a large wire diameter to avoid false detection.

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3.5 Setting the Power Measurement Module

M7103 has the power channels and power calculation channels.
Configure the necessary settings before starting the measurement.

Power channel	One set of inputs from the U/I terminal is handled as one channel. (Power channels 1 to 3)
Power calculation channel	The calculation result of each measurement (e.g., Urms) is handled as one channel. (Power calculation channels Urms1 to HarmStatus3) (p. 145)

Set the power channels of the M7103 Power Measurement Module for tasks such as power measurement and harmonic measurement.

Setting the power measurement range

Set the appropriate voltage and current ranges according to the voltage and current of the measurement target. To ensure accurate measurement, select the minimum range above the input level for both the voltage and current.

AUTO range and MANUAL range

Select either the AUTO or MANUAL range. When wiring multiple channels other than 1P2W together, each of the combined channels is automatically set to the same range.

Setting the AUTO voltage range

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:AUTO A$`
Example	`:POWer:MODule1:VOLTage1:AUTO OFF`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:AUTO?`
	Response	`A$`
Example	`:POWer:MODule1:VOLTage1:AUTO?` (Response)`POWER:MODULE1:VOLTAGE1:AUTO OFF` (When the header is ON)	
Parameter		
`A$` = OFF, ON		
`OFF`☑	The voltage is measured according to the MANUAL range.	
`ON`	The voltage is measured according to the AUTO range.	
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

Setting the AUTO current range

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:AUTO A$`
Example	`:POWer:MODule1:CURRent1:AUTO OFF`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:AUTO?`
	Response	`A$`
Example	`:POWer:MODule1:CURRent1:AUTO?` (Response) `POWER:MODULE1:CURRENT1:AUTO OFF` (When the header is ON)	
Parameter		
A$ = OFF, ON		
`OFF`☑	The current is measured according to the MANUAL range.	
`ON`	The current is measured according to the AUTO range.	
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

AUTO range switching conditions

When the Δ-Y conversion function is set to ON, any changes in the voltage range is judged by multiplying the range by $1/\sqrt{3}$ (approximately by 0.57735).

Reference: "Δ-Y conversion" (p. 142)

Range up	When any of the following conditions is met for any wiring channel, the range goes up one level. • rms value ≥ 110% of range • |Peak value| ≥ 300% of range
Range down	When the following conditions are met for all wiring channels, the range goes down one level. • rms value ≤ 40% of range • |Peak value| ≤ 280% of the range immediately below

Tips

If the range does not switch immediately:

Confirm that the input is properly synchronous, and then set the lower limit frequency to 1 Hz or above. To check the synchronization of the input, confirm that the synchronization unlock indicator is not lit in yellow.

If the range switches frequently:

It is recommended that the manual range should be selected.

Reference: "Setting the power measurement range" (p. 126)

Setting the voltage range

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:RANGE A`
Example	`:POWer:MODule1:VOLTage1:RANGE 6`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:RANGE?`
	Response	`A<NR2>`
Example	`:POWer:MODule1:VOLTage1:RANGE?` (Response) `POWER:MODULE1:VOLTAGE1:RANGE 6` (When the header is ON)	
Parameter		
`A` = 6, 15, 30, 60, 150, 300, 600, 1500		
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

Setting the current range

Settings		
Syntax	Command	:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:RANGe A
Example	:POWer:MODule1:CURRent1:RANGe 1	
Query		
Syntax	Query	:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:RANGe?
	Response	A<NR2>
Example	:POWer:MODule1:CURRent1:RANGe? (Response) POWER:MODULE1:CURRENT1:RANGE 1 (When the header is ON)	
Parameter		

A = See below (it varies depending on the connected sensor)

0.04, 0.08, 0.2, 0.4, 0.8, 2	2 A sensor
0.4, 0.8, 2, 4, 8, 20	20 A sensor
4, 8, 20, 40, 80, 200	200 A sensor
40, 80, 200, 400, 800, 2000	2000 A sensor
0.1, 0.2, 0.5, 1, 2, 5	5 A sensor
1, 2, 5, 10, 20, 50	50 A sensor
10, 20, 50, 100, 200, 500	500 A sensor
20, 40, 100, 200, 400, 1000	1000 A sensor
400, 800, 2000, 4000, 8000, 20000	For 0.1 mV/A
40, 80, 200, 400, 800, 2000	For 1 mV/A
4, 8, 20, 40, 80, 200	For 10 mV/A
0.4, 0.8, 2, 4, 8, 20	For 100 mV/A
0.04, 0.08, 0.2, 0.4, 0.8, 2	For 1 V/A

Note

Changing the settings will also affect the settings of other channels included in the measurement line combination.

Synchronization source

Set the source for each wiring that determines the basic period (between zero crosses) for various calculations.
Typically, for channels measuring alternating current, select the voltage of the measurement channel; for channels measuring direct current, select DC.

Setting the synchronization source within the same module

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:SOURce[ch:1 to 3] A$`
Example	`:POWer:MODule1:SOURce1 U1`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:SOURce[ch:1 to 3]?`
	Response	`A$`
Example	`:POWer:MODule1:SOURce1?` (Response) `:POWER:MODULE1:SOURCE1 UI` (When the header is ON)	
Parameter		
`A$` = U1, I1, U2, I2, U3, I3, DC		
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination. When IEC measurement mode is selected, only U or I can be selected.		

- The same synchronization source is set for the voltage and current of each channel.
- The same synchronization source is also used for measuring harmonics of each channel.
- For channels measuring alternating current, please select an input that matches the frequency of the measurement channel as the synchronization source. If the frequency chosen as the synchronization source greatly differs from that of the measurement channel, the frequency displayed may not match the input, or the measurement values may become unstable.
- The section when DC is selected is consistent with the data refresh interval. (5 ms, 50 ms, 200 ms) Measuring alternating current input with a DC setting will cause the displayed values to fluctuate and lead to inaccurate measurements.
- If the synchronization source is not DC, and the input frequency is lower than the set minimum frequency or higher than the zero cross filter setting, the measurement values may become unstable.
- If the synchronization source for a channel inputting direct current is set to voltage or current, the zero cross period will not be obtained. In this case, approximately one period of the lower limit frequency will apply to the synchronization frequency.
- Near the lower limit frequency setting, synchronization may unlock, causing the measurement values to become unstable.

Setting the shared synchronization source between modules

The synchronization source can be shared among multiple M7103 units connected to the instrument as needed.

1 **Set the sharing status of the synchronization source for the desired modules.**

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:SYNC:CONTrol A$`
Example	`:POWer:MODule1:SYNC:CONTrol PRIMary`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:SYNC:CONTrol?`
	Response	`A$`
Example	`:POWer:MODule1:SYNC:CONTrol?` (Response) `:POWER:MODULE1:SYNC:CONTROL PRIMARY` (When the header is ON)	
Parameter		
`A$` = OFF, PRIMary, SECondary		

`OFF`☑	The synchronization source sharing function is turned OFF.
`PRIMary`	The specified module is designated as the primary unit.
`SECondary`	The specified module is designated as the secondary unit.

Note

Only one module can be designated as the primary unit.
Harmonic measurement will be disabled for modules designated as secondary units.

For the module designated as the secondary unit, the settings specified in "`:POWER:MODule[n:1 to 4]:SOURce[n:1 to 3] A$`" will be disabled.

2 **Set desired channels for the synchronization source.**

Set the synchronization source channel for the synchronization source sharing function. The synchronization source of the primary unit will be shared with the secondary devices.

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:SYNC:SOURce A$`
Example	`:POWer:MODule1:SYNC:SOURce CH1`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:SYNC:SOURce?`
	Response	`A$`
Example	`:POWer:MODule1:SYNC:SOURce?` (Response) `:POWER:MODULE1:SYNC:SOURce CH1` (When the header is ON)	
Parameter		
`A$` = CH1, CH2, CH3		

Tips

Use the LR8102's synchronization function to share a synchronization source between LR8102 instruments.
See "Set the synchronized terminal" (p. 113)

Synchronization unlock

Channels that cannot synchronize with the synchronization source will undergo synchronization unlock, preventing accurate measurements.
Check the input of the synchronization source.

Low-pass filter (LPF)

This instrument features a low-pass filter function that limits the frequency band.
Using this filter allows for the removal of high-frequency components exceeding the set frequency and any unwanted external noise, enabling more accurate measurements.
It is recommended that the low-pass filter function should be set to OFF during normal measurement.

Setting the LPF

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:LPF[ch:1 to 3] A$`
Example	`:POWer:MODule1:LPF1 OFF`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:LPF[ch:1 to 3]?`
	Response	`A$`
Example	`:POWer:MODule1:LPF1?` (Response) `:POWER:MODULE1:LPF1 OFF` (When the header is ON)	
Parameter		
`A$` = OFF, 500Hz, 5kHz		
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

Zero cross filter and measurement lower limit frequency (measurable frequency range setting)

This instrument can measure frequencies for multiple systems simultaneously. Frequency measurement settings include the measurement lower limit frequency and zero cross filter (with an adjustable LPF cutoff), allowing you to limit the frequencies measured for each wiring configuration. When measuring a waveform that contains multiple frequency components, such as the fundamental and carrier frequencies of a PWM waveform, adjust the settings according to the frequency of the input you wish to measure.

Setting the zero cross filter

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:FREQuency[ch:1 to 3]:UPPer A$`
Example	`:POWer:MODule1:FREQuency1:UPPer 100Hz`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:FREQuency[ch:1 to 3]:UPPer?`
	Response	`A$`
Example	`:POWer:MODule1:FREQuency1:UPPer?` (Response) `:POWER:MODULE1:FREQUENCY1:UPPER 100Hz` (When the header is ON)	
Parameter		
`A$` = 100Hz, 500Hz, 5kHz, 200kHz		

`100Hz`	Primarily, set this parameter for measurements of general alternating current power supply equipment (50 Hz, 60 Hz), and to use the fundamental wave (100 Hz or less) from the secondary side of the inverter as the synchronization signal.
`500Hz`☑	Primarily, set this parameter for measurements of general alternating current power supply equipment (50 Hz, 60 Hz, 400 Hz), and to use the fundamental wave from the secondary side of the inverter as the synchronization signal.
`5kHz`	Set this parameter to use an input frequency above 500 Hz as the synchronization signal.
`200kHz`	Set this parameter to use an input frequency above 5 kHz as the synchronization signal.

Note

Changing the settings will also affect the settings of other channels included in the measurement line combination.
The zero cross filter is linked with the frequency measurement range.
Also change the setting of the zero cross filter when the frequency cannot be measured.

Setting the measurement lower limit frequency

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:FREQuency[ch:1 to 3]:LOWer A$`
Example	`:POWer:MODule1:FREQuency1:LOWer 10Hz`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:FREQuency[ch:1 to 3]:LOWer?`
	Response	`A$`
Example	`:POWer:MODule1:FREQuency1:LOWer?` (Response) `:POWER:MODULE1:FREQUENCY1:LOWer 10Hz` (When the header is ON)	
Parameter		
`A$` = 0.1Hz, 1Hz, 10Hz		

Note

Changing the settings will also affect the settings of other channels included in the measurement line combination.

Rectification method

Select the rectification method for the voltage and current values used to calculate apparent power, reactive power, and power factor.
The rectification method can be selected individually for the voltage and current in each wiring configuration.

Setting the rectification method for voltage and current.

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:MEAN A$` (voltage) `:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:MEAN A$` (current)
Example	`:POWer:MODule1:VOLTage1:MEAN OFF`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:VOLTage[ch:1 to 3]:MEAN?` (voltage) `:POWer:MODule[n:1 to 4]:CURRent[ch:1 to 3]:MEAN?` (current)
	Response	`A$`
Example	`:POWer:MODule1:VOLTage1:MEAN?` (Response) `:POWER:MODULE1:VOLTAGE1:MEAN OFF` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	RMS	True effective value Normally, select this setting.
`ON`	MEAN	Conversion value for the RMS of average value rectification Typically, this setting is used only when measuring the line-to-line voltage of the PWM waveform on the secondary side of the inverter.

Note
Changing the settings will also affect the settings of other channels included in the measurement line combination.

3

Settings and Operations

Scaling (when VT (PT) or CT is used)

Set the ratio (VT ratio or CT ratio) when an externally installed VT (PT) or CT is used.

Setting the VT ratio

For the VT ratio, set a common value to all channels in the same wiring.

Settings		
Syntax	Command	:POWer:MODule[n:1 to 4]:SCALe[ch:1 to 3]:VT A
Example	:POWer:MODule1:SCALe1:VT 1.00	
Query		
Syntax	Query	:POWer:MODule[n:1 to 4]:SCALe[ch:1 to 3]:VT?
	Response	A<NR2>
Example	:POWer:MODule1:SCALe1:VT? (Response): POWER:MODULE1:SCALE1:VT 1.00 (When the header is ON)	
Parameter		
A = 0.01 to 9999.99		
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

Setting the CT ratio

For the CT ratio, set a value for each channel in the same wiring.

Settings		
Syntax	Command	:POWer:MODule[n:1 to 4]:SCALe[ch:1 to 3]:CT A
Example	:POWer:MODule1:SCALe1:CT 1.00	
Query		
Syntax	Query	:POWer:MODule[n:1 to 4]:SCALe[ch:1 to 3]:CT?
	Response	A<NR2>
Example	:POWer:MODule1:SCALe1:CT? (Response) :POWER:MODULE1:SCALE1:CT 1.00 (When the header is ON)	
Parameter		
A = 0.01 to 9999.99		
Note		
Changing the settings will also affect the settings of other channels included in the measurement line combination.		

If “VT × CT” exceeds “1.0E + 06”, the setting is not allowed.
Once the VT (Voltage Transformer) ratio is set, all voltage measurement items, including voltage peak values, harmonics, and waveforms, as well as power measurement items that use these voltage calculations, will be adjusted by multiplying them by the set ratio.
Once the CT (Current Transformer) ratio is set, all current measurement items, including current peak values, harmonics, and waveforms, as well as power measurement items that use these current calculations, will be adjusted by multiplying them by the set ratio.
Set the value to 1.00000 to turn the setting OFF.

Zero suppression

When this is set to ON, any values less than 0.5% of the range will be handled as zero.

Settings		
Syntax	Command	`:POWer:ZEROsp A$`
Example	:POWer:ZEROsp ON	
Query		
Syntax	Query	`:POWer:ZEROsp?`
	Response	`A$`
Example	`:POWer:ZEROsp?` (Response) `:POWER:ZEROSP ON` (When the header is ON)	
Parameter		
A$ = OFF, ON		

`OFF`☑	Zero suppression is disabled.
`ON`	Treats values within 0.5% of full scale (f.s.) as zero for the range.

Count mode for integration measurement

Set the count mode of each channel. The count modes available are DC mode and RMS mode. You can select the appropriate mode for each wiring configuration.

Setting the count mode

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:INTEGrate:MODE[ch:1 to 3] A$`
Example	`:POWer:MODule1:INTEGrate:MODE1 RMS`	
Query		
Syntax	Query	`:POWer:MODule[n:1 to 4]:INTEGrate:MODE[ch:1 to 3]?`
	Response	`A$`
Example	`:POWer:MODule1:INTEGrate:MODE1?` (Response) `:POWER:MODULE1:INTEGRATE:MODE1 RMS` (When the header is ON)	
Parameter		
A$ = DC, RMS		

`DC`	The instantaneous current values and instantaneous power values for each sampling are integrated based on their polarity. This can be selected only for the 1P2W connection. All the six items of the current integration (Ih+, Ih−, Ih) and active power integration (WP+, WP−, WP) are integrated simultaneously.
`RMS`☑	Current RMS values and active power values are integrated at each data refresh interval. Only the active power is integrated on a polarity basis.

3

Settings and Operations

Enabling the harmonic measurement

The setting method for measuring harmonics is described here.
The harmonic measurement procedure is as follows.

1. Enabling the harmonic measurement

Reference: Enabling the harmonic measurement (p.137)

- Select the target power channel and calculation items for the harmonic calculation.
- The valid harmonic measurement parameters will vary according to the selected target.

2. Selecting the power calculation channel

Reference: "Power calculation channel list" (p. 145)

- Select the harmonic measurement for the power calculation channel.
- Only the harmonic measurement item parameters enabled in step 1. can be selected.
- To update the setting, send ":POWer:MODule[n]:HARMonic:U/I/P"after this setting. [1]

3. Setting the trigger, alarm, numerical calculation, and waveform calculation

Reference: "Select the target power channel and calculation items for the harmonic measurement." (p. 137)

- Specify the power calculation channel for the trigger, alarm, numerical calculation, and waveform calculation as necessary.
- Only the harmonic measurement item parameters enabled in step 2. can be selected.
- To update the setting, send ":POWer:MODule[n]:HARMonic:U/I/P"after this setting. [2]

4. Starting/stopping the measurement

See "3.10 Starting and Stopping Measurement" (p. 171).

- Send the STARt command to start the measurement.
- Send the STOP command to stop the measurement.

5. Acquiring the measurement data

See "4 Acquiring Measurement Data" (p.175).

See "4.2 Acquiring Realtime Data" (p. 180).

- Only the harmonic measurement item parameters enabled in step 2. can be selected.

IMPORTANT
Whenever "Enabling the harmonic measurement" in step 1. is executed, perform settings of step 2. and later.

*1. If the analysis target channel and selected item are changed after ":MODule:STORe" (:POWer:MODule[n]:HARMonic:U/I/P), the parameters are automatically replaced with the modified settings.
Example:

:POWer:MODule1:HARMonic:U CH2,CONTENT	(M1HU2D000 to M1HU2D050 can now be specified)
:MODule:STORe M1HU2D000,ON	M1HU2D000 measurement is set to ON
:POWer:MODule1:HARMonic:U CH1,RMS	(M1HU2D000 is replaced with M1HU1L000 = M1HU1L000 measurement is enabled)

*2. If the analysis target channel and selected item are changed after ":TRIGger:POWer:NO" (:POWer:MODule[n]:HARMonic:U/I/P), the parameters are automatically replaced with the modified settings.
Example:

:POWer:MODule1:HARMonic:U CH2,CONTENT	(M1HU2D000 to M1HU2D050 can now be specified)
:TRIGger:POWer:NO NO1, M1HU2D000	The power trigger NO1 target channel is set to M1HU2D000
:POWer:MODule1:HARMonic:U CH1,RMS	(M1HU2D000 is replaced with M1HU1L000 = The power trigger NO1 target channel is set to M1HU1L000)

Select the target power channel and calculation items for the harmonic measurement.

Settings			
Syntax	Command	:POWer:MODule[n:1 to 4]:HARMonic:U A$,B$	(Voltage)
		:POWer:MODule[n:1 to 4]:HARMonic:I A$,B$	(Current)
		:POWer:MODule[n:1 to 4]:HARMonic:P A$,B$	(Power)
Example	:POWer:MODule1:HARMonic:U CH1,RMS		
	:POWer:MODule1:HARMonic:I CH2,RMS		
	:POWer:MODule1:HARMonic:P SUM,RMS		
Query			
Syntax	Query	:POWer:MODule[n:1 to 4]:HARMonic:U?	(Voltage)
		:POWer:MODule[n:1 to 4]:HARMonic:I?	(Current)
		:POWer:MODule[n:1 to 4]:HARMonic:P?	(Power)
	Response	A$,B$	
Example	:POWer:MODule1:HARMonic:U? (Response) :POWER:MODULE1:HARMONIC:U CH1,RMS (When the header is ON)		
	:POWer:MODule1:HARMonic:I? (Response) :POWER:MODULE1:HARMONIC:I CH2,RMS (When the header is ON)		
	:POWer:MODule1:HARMonic:P? (Response) :POWER:MODULE1:HARMONIC:P SUM,RMS (When the header is ON)		

Parameter

A$ = CH1, CH2, CH3, SUM (P only)
B$ = RMS, CONTent, PHASe

RMS☑	Voltage RMS value, current RMS value, active power
CONTent	Voltage content, current content, power content
PHASe	Voltage phase angle, current phase angle, voltage and current phase angle

Note

You can select one power channel each for voltage, current, and power.
You can select one calculation item each for voltage, current, and power.
When the connecting setting is TYPE1 (1P2W×3), the SUM setting is not available.

Table 1. Harmonic parameters selectable for "`:POWer:MODule[n]:HARMonic:U A$, B$`".

		B$		
		RMS	**CONTent**	**PHASe**
A$	**CH1**	M1HU1L000 to M1HU1L050	M1HU1D000 to M1HU1D050	M1HU1P000 to M1HU1P050
	CH2	M1HU2L000 to M1HU2L050	M1HU2D000 to M1HU2D050	M1HU2P000 to M1HU2P050
	CH3	M1HU3L000 to M1HU3L050	M1HU3D000 to M1HU3D050	M1HU3P000 to M1HU3P050
Only one of the above nine types can be selected for the harmonic voltage. HU1L000 and HU2L000 cannot be measured in the same module simultaneously.				

Table 2. Harmonic parameters selectable for "`:POWer:MODule[n]:HARMonic:I A$, B$`".

		B$		
		RMS	**CONTent**	**PHASe**
A$	**CH1**	M1HI1L000 to M1HI1L050	M1HI1D000 to M1HI1D050	M1HI1P000 to M1HI1P050
	CH2	M1HI2L000 to M1HI2L050	M1HI2D000 to M1HI2D050	M1HI2P000 to M1HI2P050
	CH3	M1HI3L000 to M1HI3L050	M1HI3D000 to M1HI3D050	M1HI3P000 to M1HI3P050
Only one of the above nine types can be selected for the harmonic current. HI1L000 and HI2L000 cannot be measured in the same module simultaneously.				

Table 3. Harmonic parameters selectable for "`:POWer:MODule[n]:HARMonic:P A$, B$`".

		B$		
		RMS	**CONTent**	**PHASe**
A$	**CH1**	M1HP1L000 to M1HP1L050	M1HP1D000 to M1HP1D050	M1HP1P000 to M1HP1P050
	CH2	M1HP2L000 to M1HP2L050	M1HP2D000 to M1HP2D050	M1HP2P000 to M1HP2P050
	CH3	M1HP3L000 to M1HP3L050	M1HP3D000 to M1HP3D050	M1HP3P000 to M1HP3P050
	SUM	M1HP0L000 to M1HP0L050	M1HP0D000 to M1HP0D050	M1HP0P000 to M1HP0P050
Only one of the above nine types can be selected for the harmonic power. HP1L000 and HP2L000 cannot be measured in the same module simultaneously.				

Setting the details for harmonic measurement

1 **Set the harmonic measurement mode.**

Settings		
Syntax	Command	`:POWer:HARMonic:MODE A$`
Example	`:POWer:HARMonic:MODE WIDE`	
Query		
Syntax	Query	`:POWer:HARMonic:MODE?`
	Response	`A$`
Example	`:POWer:HARMonic:MODE?` (Response) `:POWER:HARMONIC:MODE WIDE` (When the header is ON)	
Parameter		
`A$` = IEC, WIDE		

`IEC`	This is the IEC standard mode. When the frequency of the measurement line is either 50 Hz or 60 Hz, harmonic measurement is performed in compliance with the IEC61000-4-7:2002+A1:2008 standard. Even if the data refresh interval is set to 5 ms or 50 ms, the harmonic measurement values are updated approximately every 200 ms. If the measured frequency falls outside the 45 Hz to 66 Hz range, the green LED will will flash rapidly to indicate it is out of the frequency range. Analysis can be performed up to the 50th order.
`WIDE`☑	This is the wide area mode. It can be used for a wide range of frequencies from 0.1 Hz to 30 kHz. The analysis order changes in accordance with the frequency to be measured. When the data refresh interval is set to 5 ms, the harmonic measurement values are updated every 50 ms.

2 **Set the grouping.**

Select the calculation method of the inter-harmonics for the harmonic measurement value.

Settings		
Syntax	Command	`:POWer:HARMonic:GROUp A$`
Example	`:POWer:HARMonic:GROUp TYPE1`	
Query		
Syntax	Query	`:POWer:HARMonic:GROUp?`
	Response	`A$`
Example	`:POWer:HARMonic:GROUp?` (Response) `:POWER:HARMONIC:GROUP TYPE1` (When the header is ON)	
Parameter		
A$ = OFF, TYPE1, TYPE2		

`OFF`	Only the integer multiples of the fundamental wave are considered as harmonics of that order.
`TYPE1`☑	The harmonic current sub-group is considered as harmonics of that order. This is compatible with harmonics of Hioki's PW3198.
`TYPE2`	The harmonic current group is considered as harmonics of that order.

3 **Set the THD calculation order.**

THD calculation order: This is the maximum order up to which total harmonic distortion is calculated.

- If the analysis order does not reach the set upper limit due to the harmonic measurement mode or fundamental frequency, the calculation will use the maximum available order as the upper limit.
- The harmonic measurement values displayed in lists or graphs, or those obtained through communication, are not restricted by the upper limit order set here.

Settings		
Syntax	Command	`:POWer:HARMonic:ORDer A`
Example	`:POWer:HARMonic:ORDer 50`	
Query		
Syntax	Query	`:POWer:HARMonic:ORDer?`
	Response	`A<NR1>`
Example	`:POWer:HARMonic:ORDer?` (Response) `:POWER:HARMONIC:ORDER 50` (When the header is ON)	
Parameter		
`A` = 2 to 50		

4 **Select the total harmonic distortion (THD) formula.**

This setting applies to the harmonic measurements of both voltage and current across all channels.

Settings		
Syntax	Command	`:POWer:HARMonic:THD A$`
Example	`:POWer:HARMonic:THD F`	
Query		
Syntax	Query	`:POWer:HARMonic:THD?`
	Response	`A$`
Example	`:POWer:HARMonic:THD?` (Response) `:POWER:HARMONIC:THD F` (When the header is ON)	
Parameter		
A$ = F, R		

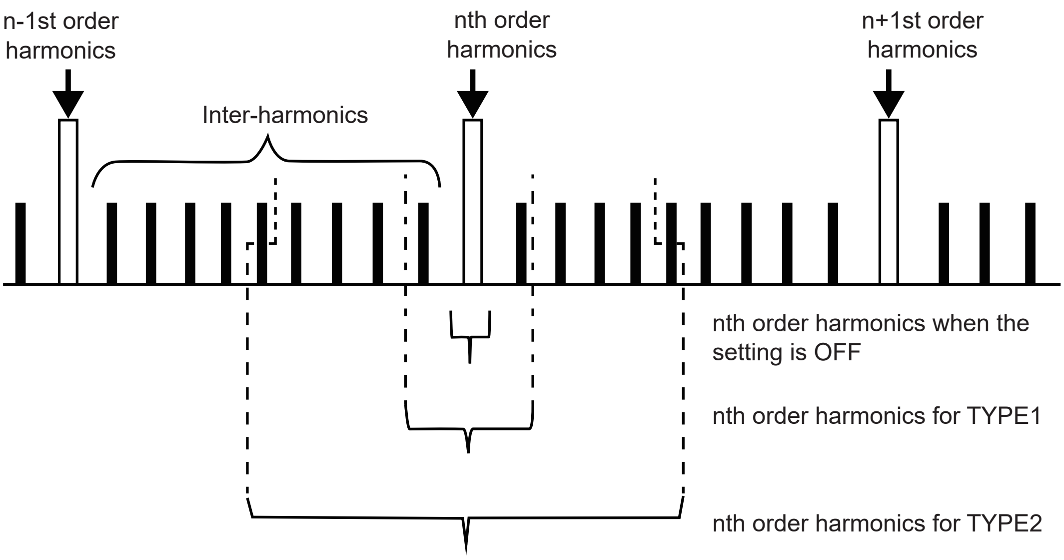
`F`☑	Total harmonic distortion percentage per fundamental wave This setting is commonly used for IEC standards, etc.
`R`	Total harmonic distortion percentage per total harmonic distortion including fundamental wave This value will be lower than the THD-F if the waveform is distorted significantly.

What is THD?

THD stands for “Total Harmonic Distortion”. It indicates the total harmonic distortion rate.

What is grouping?

For the harmonic measurement, the window wavenumber is determined according to the harmonic mode and fundamental wave frequency. If the window wavenumber is not 1, the number of spectral lines (output bins) (window wavenumber -1) in proportion to the window wavenumber can be obtained between the harmonic current components of the integer multiples (nth) for the fundamental wave. This is called the inter-harmonics.
During harmonic measurement, there will be some differences in the measurement values depending on how to handle the inter-harmonics. In order to eliminate such differences, grouping is defined in the IEC standard and the like.



Usually, TYPE1 range is called “harmonic sub-group”, and TYPE2 range is called “harmonic group”. Each range can be calculated by square-root of sum of squares of the output bins within the range. If there are no inter-harmonics or the window wavenumber is 1 in a wide area mode, the measurement values will be consistent regardless of which grouping method is selected. If inter-harmonics are present, the relationship of the harmonic measurement values will usually be “OFF < TYPE1 < TYPE2”.

Averaging function

This function averages the measurement values and displays the averaged value. When there are significant variations in the displayed values due to fluctuation of the measurement values, use this function to help you read the displayed stabilized values.

Setting the average

A moving average is calculated from the latest data, covering a span back through the number of specified averaging periods.

Settings		
Syntax	Command	`:POWer:AVEraging:TIMEs A`
Example	`:POWer:AVEraging:TIMEs 40`	
Query		
Syntax	Query	`:POWer:AVEraging:TIMEs?`
	Response	`A<NR1>`
Example	`:POWer:AVEraging:TIMEs?` (Response) `:POWER:AVERAGING:TIMES 40` (When the header is ON)	
Parameter		
`A` = 1, 10, 20, 40, 100 Averaging is turned OFF when `A` = 1.		

3

Settings and Operations

Delta conversion function

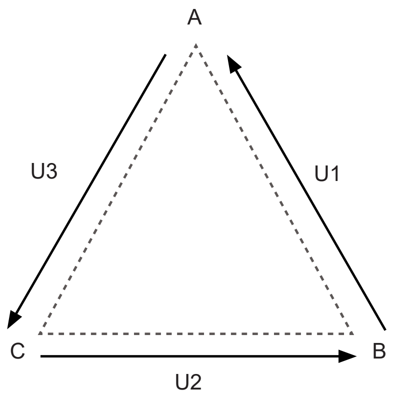
This function performs measurement by reciprocally converting the delta connection and Y connection (star connection) of the three-phase measurement line. The voltage waveform data obtained from the 500 kHz sampling between different channels are converted according to the formula.

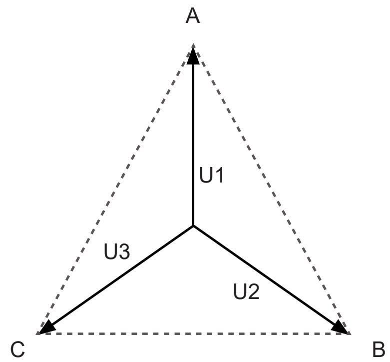
Δ-Y conversion

When the connection line is either 3P3W3M or 3V3A, this function can be set to ON.
Even if a motor with an internally Y-connected winding cannot have its midpoint accessed and is delta-connected, it is still possible to perform measurements using the phase voltage applied to the motor coils as if it were Y-connected.
Although the voltage waveform, various voltage measurements, and harmonic voltages are input as line-to-line voltages, they are processed as phase voltages.

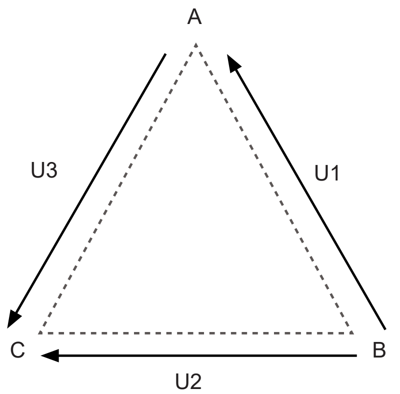
Image view of Δ-Y conversion

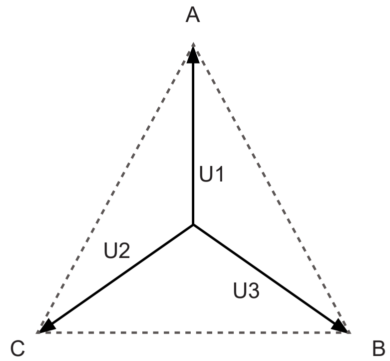
For 3P3W3M





For 3V3A





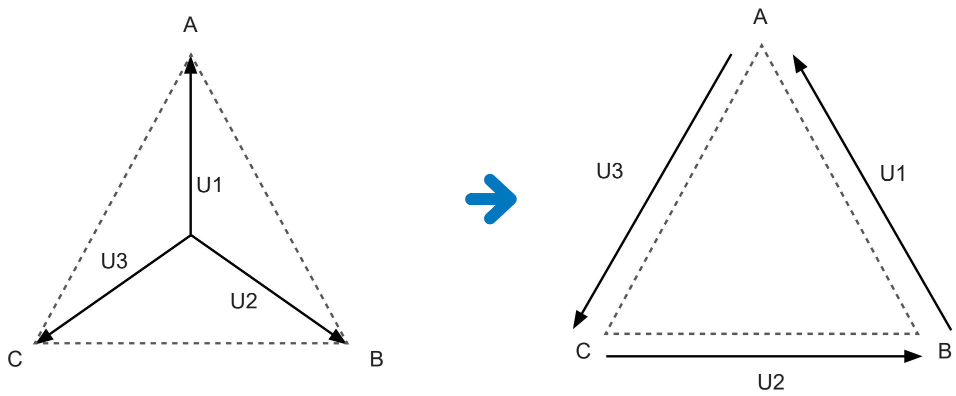
- For Δ-Y conversion, the voltage waveform is vector-transformed using a virtual neutral point before analysis.
- The actual phase voltage may differ.
- The vector diagram on the wiring screen is the same as that for a 3P4W configuration. For 3V3A, only the phase order is reversed.
- The active power in the 3V3A configuration is measured using the two wattmeter method; however, after conversion, it is measured using the three-wattmeter method.
- The over-peak is determined using the pre-conversion values.
- When the voltage range is set to AUTO, changes in the voltage range are determined by multiplying the range by 1/√3 (approximately 0.57735).

Y-Δ conversion

When the connection line is 3P4W, this function can be set to ON.
While the phase voltage is input for the Y connection, the voltage between lines can be measured.
Although the voltage waveform, various voltage measurements, and harmonic voltages are input as phase voltages, they are processed as line-to-line voltages.

Image view of Y-Δ conversion

For 3P4W



- The over-peak and the range for displaying voltage peak values are determined using the values before conversion.
- When the voltage range is AUTO, any changes in the voltage range are judged based on the measurement values after conversion.

Setting the conversion

The conversion setting is available for 3V3A, 3P3W3M, and 3P4W. It is automatically set to OFF for other wiring configurations.
3V3A, 3P3W3M: ON → Δ-Y conversion setting
3P4W: ON → Y-Δ conversion setting

Settings		
Syntax	Command	`:POWer:MODule[n:1 to 4]:DELTay A$`
Example	`:POWer:MODule1:DELTay ON`	
Query		
Syntax	Query	`:POWer:MODule1:DELTay1?`
	Response	`A$`
Example	`:POWer:MODule1:DELTay?` (Response) `:POWER:MODULE1:DELTAY ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Delta conversion is not performed.
`ON`	Delta conversion is performed.

Power formula

This function allows you to select the formulas for calculating reactive power, power factor, and power phase angle to align with Hioki's conventional models.
There is no standardized definition for the formulas of apparent power and reactive power for three-phase AC with harmonic distortion, resulting in different formulas being used across various measuring instruments. To enhance compatibility with conventional models, you can choose from three available options depending on the model.
Reference: “6. Formula specifications” (p. 395)

Settings		
Syntax	Command	`:POWer:MATH A`
Example	`:POWer:MATH 1`	
Query		
Syntax	Query	`:POWer:MATH?`
	Response	`A<NR1>`
Example	`:POWer:MATH?` (Response) `:POWER:MATH 1` (When the header is ON)	
Parameter		
`A$` = 1, 2, 3		

1☑	TYPE1 :	Compatible with TYPE1 of Hioki’s PW3390, 3390, and 3193. (When any connection lines other than 3V3A are selected) Compatible with TYPE2 of Hioki’s 3192 and 3193. (When 3V3A is selected)
2	TYPE2 :	Compatible with TYPE2 of Hioki’s 3192 and 3193.
3	TYPE3 :	The sign of active power is used for the sign of power factor.

IMPORTANT
TYPE1, TYPE2, and TYPE3 are compatible with the respective calculation formulas' TYPE for Hioki's PW8001 Power Analyzer.

If there is no target model or you are not sure which type should be selected, select TYPE1.
As the active power is directly obtained from the sampling values of the voltage and current waveforms, there will be no difference depending on the formula even when the waveform is distorted.

Selecting the power calculation channel

Enable the power calculation channel of the power measurement module.

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe CH1_1,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe CH1_1?` (Response) `:MODULE:STORE CH1_1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p.145) `A$` = OFF, ON		

Power calculation channel list

Basic measurement item parameters

The description of each basic measurement item parameter is as follows.

M1URMS1

$\underbrace{\text{M1}}_{1}\underbrace{\text{URMS}}_{2}\underbrace{\text{1}}_{3}$

1	Module number	Indicates the module number of M7103.
2	Calculation item	Indicates the measurement item.
3	Calculation target	1 to 3 indicates the target power channel, respectively. The value 0 indicates the total for power channels in a multi-phase connection.

This means that the parameter “M1URMS1” specifies the power calculation channel targeted by any given command.

Module No.: 1
Measurement item: Voltage RMS value:
Calculation target: Power channel 1

Measurement item	Instrument notation	Parameter list			
Voltage RMS value:	Urms	M1URMS1	M1URMS2	M1URMS3	M1URMS0
Conversion value of voltage average value to rectification RMS value	Umn	M1UMN1	M1UMN2	M1UMN3	M1UMN0
Simple voltage average value	Udc	M1UDC1	M1UDC2	M1UDC3	
Voltage alternating component RMS value	Uac	M1UAC1	M1UAC2	M1UAC3	
Voltage waveform peak value+	Upk+	M1UPKP1	M1UPKP2	M1UPKP3	
Voltage waveform peak value-	Upk-	M1UPKM1	M1UPKM2	M1UPKM3	
Voltage frequency	fU	M1UFREQ1	M1UFREQ2	M1UFREQ3	
Voltage ripple rate	Urf	M1URF1	M1URF2	M1URF3	
Fundamental wave voltage RMS value	Ufnd	M1UFND1	M1UFND2	M1UFND3	
Total harmonic voltage distortion rate	Uthd	M1UTHD1	M1UTHD2	M1UTHD3	
Voltage phase angle	θU	M1UDEG1	M1UDEG2	M1UDEG3	
Voltage unbalance factor	Uunb	M1UUNB			
Current RMS value	Irms	M1IRMS1	M1IRMS2	M1IRMS3	M1IRMS0
Conversion value of current average value rectification RMS value	Imn	M1IMN1	M1IMN2	M1IMN3	M1IMN0
Simple current average value	Idc	M1IDC1	M1IDC2	M1IDC3	
Current alternating component RMS value	Iac	M1IAC1	M1IAC2	M1IAC3	
Current waveform peak value+	Ipk+	M1IPKP1	M1IPKP2	M1IPKP3	
Current waveform peak value-	Ipk-	M1IPKM1	M1IPKM2	M1IPKM3	

Measurement item	Instrument notation	Parameter list			
Current frequency	fI	M1IFREQ1	M1IFREQ2	M1IFREQ3	
Current ripple rate	Irf	M1IRF1	M1IRF2	M1IRF3	
Fundamental wave current RMS value	Ifnd	M1IFND1	M1IFND2	M1IFND3	
Total harmonic current distortion rate	Ithd	M1ITHD1	M1ITHD2	M1ITHD3	
Current phase angle	θI	M1IDEG1	M1IDEG2	M1IDEG3	
Current unbalance factor	Iunb	M1IUNB			
Active power	P	M1P1	M1P2	M1P3	M1P0
Apparent power	S	M1S1	M1S2	M1S3	M1S0
Reactive power	Q	M1Q1	M1Q2	M1Q3	M1Q0
Power factor	λ	M1PF1	M1PF2	M1PF3	M1PF0
Power phase angle	ø	M1PDEG1	M1PDEG2	M1PDEG3	M1PDEG0
Fundamental wave active power	Pfnd	M1PFND1	M1PFND2	M1PFND3	M1PFND0
Fundamental wave apparent power	Sfnd	M1SFND1	M1SFND2	M1SFND3	M1SFND0
Fundamental wave reactive power	Qfnd	M1QFND1	M1QFND2	M1QFND3	M1QFND0
Fundamental wave power factor (PF)	λfnd	M1PFFND1	M1PFFND2	M1PFFND3	M1PFFND0
Current integration value+	Ih+	M1IHP1	M1IHP2	M1IHP3	
Current integration value-	Ih-	M1IHM1	M1IHM2	M1IHM3	
Summation of current integration value	Ih	M1IH1	M1IH2	M1IH3	
Active power integration value+	WP+	M1WPP1	M1WPP2	M1WPP3	M1WPP0
Active power integration value-	WP-	M1WPM1	M1WPM2	M1WPM3	M1WPM0
Summation of active power integration value	WP	M1WP1	M1WP2	M1WP3	M1WP0
Integrated elapse time (unit of hour)	Thour	M1THOUR			
Integrated elapse time (unit of minute)	Tmin	M1TMIN			
Integrated elapse time (unit of second)	Tsec	M1TSEC			
Integrated elapse time (unit of millisecond)	Tms	M1TMS			
Module status	StatusM	M1STATUS			
Basic measurement status	Status	M1ST1	M1ST2	M1ST3	

Harmonic measurement item parameters

The description of each harmonic measurement item parameter is as follows.

M1HU1L000

1 = M, 2 = 1HU, 3 = 1, 4 = L, 5 = 000

1	Module number	Indicates the module number of M7103.
2	Channel type	HU: Indicates the voltage harmonics. HI: Indicates the current harmonics. HP: Indicates the power harmonics.
3	Calculation target	1 to 3 indicates the target power channel, respectively. The value 0 indicates the total for power channels in a multi-phase connection.
4	Calculation item	L: RMS value D: Content P: Phase angle or phase difference
5	Order	The last three digits indicate an order from the 0th to 50th.

This means that the parameter of“M1HU1L000”specifies the following power calculation channel for the target of a desired command.

Module No.: 1
Channel type: Harmonics targeted for voltage
Calculation target: Power channel 1
Calculation item: RMS value
Order: 0th order

Measurement item		Instrument notation	Parameter list			
0th order	Voltage RMS value:	Uk	M1HU1L000	M1HU2L000	M1HU3L000	
	Voltage content	HDUk	M1HU1D000	M1HU2D000	M1HU3D000	
	Voltage phase angle	θUk	M1HU1P000	M1HU2P000	M1HU3P000	
	Current RMS value	Ik	M1HI1L000	M1HI2L000	M1HI3L000	
	Current content	HDIk	M1HI1D000	M1HI2D000	M1HI3D000	
	Current phase angle	θIk	M1HI1P000	M1HI2P000	M1HI3P000	
	Active power	Pk	M1HP1L000	M1HP2L000	M1HP3L000	M1HP0L000
	Power content	HDPk	M1HP1D000	M1HP2D000	M1HP3D000	M1HP0D000
	Voltage and current phase difference	θk	M1HP1P000	M1HP2P000	M1HP3P000	M1HP0P000
nth order	(omitted)					

Measurement item		Instrument notation	Parameter list			
50th order	Voltage RMS value:	Uk	M1HU1L050	M1HU2L050	M1HU3L050	
	Voltage content	HDUk	M1HU1D050	M1HU2D050	M1HU3D050	
	Voltage phase angle	θUk	M1HU1P050	M1HU2P050	M1HU3P050	
	Current RMS value	Ik	M1HI1L050	M1HI2L050	M1HI3L050	
	Current content	HDIk	M1HI1D050	M1HI2D050	M1HI3D050	
	Current phase angle	θIk	M1HI1P050	M1HI2P050	M1HI3P050	
	Active power	Pk	M1HP1L050	M1HP2L050	M1HP3L050	M1HP0L050
	Power content	HDPk	M1HP1D050	M1HP2D050	M1HP3D050	M1HP0D050
	Voltage and current phase difference	θk	M1HP1P050	M1HP2P050	M1HP3P050	M1HP0P050
Harmonic measurement status		HarmStatus	M1HST1*[1]	M1HST2*[1]	M1HST3*[1]	

*1. The same format as that for the basic measurement item parameters

Status

Each status indicates the measurement state of the measurement data. It is expressed with 32-bit hexadecimal numbers.

Module status	Indicates the status of the M7103 Power Measurement Module.
Basic measurement status	Indicates the measurement status of basic power calculation.
Harmonic measurement status	Indicates the measurement status of harmonic calculation.

Module status

Reference: “Basic measurement item parameters” (p. 145)

Example) Module 1: M1STATUS

Bit	Description
Bit 3 to 31	Unused: 0
Bit 2	Zero cross synchronization error
Bit 1	Fan status
Bit 0	Fan error

Basic measurement status

Reference: “Basic measurement item parameters” (p. 145)

Example) Module 1 and power channel 2: M1ST2

Bit	Description	
Bit 28 to 31	Current range	
Bit 24 to 27	Voltage range	
Bit 19 to 23	Unused: 0	
Bit 18	Fundamental wave invalid data	
Bit 17	Invalid data	Invalid measurement data immediately following a settings change and so on.
Bit 16	Power calculation	Synchronization unlock
Bit 15	Current frequency	Synchronization unlock
Bit 14	Voltage frequency	Synchronization unlock
Bit 13	Power calculation	No data update (copy of previous data)
Bit 12	Current frequency	No data update (copy of previous data)
Bit 11	Voltage frequency	No data update (copy of previous data)
Bit 8 to 10	Unused: 0	
Bit 7	Power	Overload (OR of voltage and current)
Bit 6	Current	Overload
Bit 5	Voltage	Overload
Bit 4	Current	Over-peak
Bit 3	Voltage	Over-peak
Bit 1 to 2	Unused: 0	
Bit 0	Current sensor combination error or read error	

Harmonic measurement status

Reference: "Harmonic measurement item parameters" (p. 147)

Example) Module 1, power channel 2: M1HST2

Bit	Description	
Bit 24 to 31	Harmonic range information	
Bit 16 to 23	Maximum harmonic analysis effective order	
Bit 7 to 15	Unused: 0	
Bit 6	Storage data error	
Bit 5	Storage data discard	
Bit 4	Frequency discrepancy	
Bit 3	Immediately after harmonic range update	
Bit 2	Outside of frequency range	
Bit 1	Invalid data	Immediately after setting change
Bit 0	Synchronization unlock	

Starting simple measurement (for the M7103 Power Measurement Module)

Starting measurement

If you want to use the auto range function or change the setting while acquiring the measurement values, use the following measurement start command to activate the function.

Settings		
Syntax	Command	`:STARt:PWCHeck`

Example	`:STARt:PWCHeck`
	`:POWer:MODule1:VOLTage1:RANGe 6`
	`:POWer:MODule1:CURRent1:RANGe 1`
	`:POWer:UPDate:SETTing`
		(Measurement start)
		(Voltage range change)
		(Current range change)
		(Setting update)

Note		
Only valid for the M7103 Power Measurement Module. To resume measurement, after sending the setting change command, issue the "`:POWer:UPDate:SETTing`" command. As the setting change is not permitted during integration, the integration function is disabled when measurement is started using this command. If you want to enable the integration function, use the `:START` command to start measurement. When measurement is started using "`:STARt:PWCHeck`",the following settings are disabled. • Auto-save: OFF • Trigger: OFF • Measurement start: Manual • Measurement stop: Manual • Recording time: Continuous recording Executable when the synchronized operation setting command `:CONFigure:SYNC:SET` has the parameter OFF.		

Updating the settings

This is effective when you want to update the settings by sending the setting command sent to the instrument to the M7103 Power Measurement Module.
This is effective when you want to update all settings at once after sending multiple setting commands, or to start measurement using "`:STARt:PWCHeck`".

Settings		
Syntax	Command	`:POWer:UPDate:SETTing`

Example	`:STARt:PWCHeck`
	`:POWer:MODule1:VOLTage1:RANGe 6`
	`:POWer:MODule1:CURRent1:RANGe 1`
	`:POWer:UPDate:SETTing`
		(Measurement start)
		(Voltage range change)
		(Current range change)
		(Setting update)

Note		
Only valid for the M7103 Power Measurement Module. To resume measurement, after sending the setting change command, issue the "`:POWer:UPDate:SETTing`" command. Invalid data may be returned immediately after `:POWer:UPDate:SETTing` depending on the setting that was changed. Use `:WAITNextsmpl?` after updating settings to verify that valid data exists.		

Tips

The LR8101/LR8102 sends settings to each module when receiving the `:STARt` command. The M7103 may generate inaccurate measurements or require stabilization time immediately after settings are changed. Sending the `:POWer:UPDate:SETTing` command before the `:STARt` command may improve this by updating M7103 settings before measurement starts.

3.6 Configuring the Pulse Channel and Logic Channel Settings

Pulse aggregation

The number of integrated pulses output from the integrated power meter or flow meter can be measured.
The setting method for performing aggregation measurement is described here.
External control terminal: Pulse input terminal (PULSE)
When an external sampling is used, the pulse channel cannot be used.

1 **Set the input type to Count.**

The range is fixed to 1000 Mc.

Settings		
Syntax	Command	`:MODule:PINMOde pls$,A$`
Example	`:MODule:PINMOde PLS1,COUNT`	
Query		
Syntax	Query	`:MODule:PINMOde? pls$`
	Response	`pls$,A$`
Example	`:MODule:PINMOde? PLS1` (Response) `:MODULE:PINMODE PLS1,COUNT` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = COUNT, REVOLVE, LOGIC		

`COUNT`☑	Aggregation
`REVOLVE`	Rotation speed
`LOGIC`	Logic

2 **Enable the measurement channel.**

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe PLS1,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? PLS1` (Response) `:MODULE:STORE PLS1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A$` = OFF, ON		
Note		
When the pulse input type is set to logic, measurement cannot be turned ON for the pulse channel.		

3 Set the counting method.

Settings		
Syntax	Command	`:MODule:PCOMOde pls$,A$`
Example	`:MODule:PCOMOde PLS1,ADD`	
Query		
Syntax	Query	`:MODule:PCOMOde? pls$`
	Response	`pls$,A$`
Example	`:MODule:PCOMOde? PLS1` (Response) `:MODULE:PCOMODE PLS1,ADD` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = ADD, INST

`ADD`☑	Addition Integrates the number of pulses input after the measurement is started.
`INST`	Instant value Integrates the number of pulses input to the instrument within the recording interval. The number of pulses is reset for each recording interval.

4 Set the slope for counting.

Settings		
Syntax	Command	`:MODule:PSLOPe pls$,A$`
Example	`:MODule:PSLOPe PLS1,UP`	
Query		
Syntax	Query	`:MODule:PSLOPe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PSLOPe? PLS1` (Response) `:MODULE:PSLOPE PLS1,UP` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = UP, DOWN

`UP`☑	Integrates the number of times the pulse changes from the Low to High level (rise).
`DOWN`	Integrates the number of times the pulse changes from the High to Low level (fall).

5 Set the level for counting.

Settings		
Syntax	Command	`:MODule:PTHRe pls$,A$`
Example	`:MODule:PTHRe PLS1,1V`	
Query		
Syntax	Query	`:MODule:PTHRe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PTHRe? PLS1` (Response) `:MODULE:PTHRE PLS1,1V` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = 1V, 4V

`1V`☑	Determines 1.0 V or higher to be the High level, 0 or higher and less than 0.5 V to be the Low level.
`4V`	Determines 4.0 V or higher to be the High level, 0 or higher and less than 1.5 V to be the Low level.

6 Set whether or not to use the chattering prevention filter.

When this setting is ON, a count error due to chattering can be prevented for the mechanical contact (relay) output.

Settings		
Syntax	Command	`:MODule:PFILTer pls$,A$`
Example	`:MODule:PFILTer PLS1,ON`	
Query		
Syntax	Query	`:MODule:PFILTer? pls$`
	Response	`pls$,A$`
Example	`:MODule:PFILTer? PLS1` (Response) `:MODULE:PFILTER PLS1,ON` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = OFF, ON		

7 Set the timing to reset the count.

Settings		
Syntax	Command	`:MODule:PCOSTart pls$,A$`
Example	`:MODule:PCOSTart PLS1,START`	
Query		
Syntax	Query	`:MODule:PCOSTart? pls$`
	Response	`pls$,A$`
Example	`:MODule:PCOSTart? PLS1` (Response) `:MODULE:PCOSTART PLS1,START` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = STARt, TRIGger		

`STARt` ☑	Start Resets the count to 0 when the measurement is started.
`TRIGger`	Trigger Resets the count to 0 when the measurement is started and when the trigger is activated. The value before being reset is recorded at the trigger point.

8 Set the operation to be performed when the integrated value overflows.

Settings		
Syntax	Command	`:MODule:PRESet pls$,A$`
Example	`:MODule:PRESet PLS1,ON`	
Query		
Syntax	Query	`:MODule:PRESet? pls$`
	Response	`pls$,A$`
Example	`:MODule:PRESet? PLS1` (Response) `:MODULE:PRESET PLS1,ON` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = OFF, ON		

`OFF` ☑	Stops counting.
`ON`	Resets the count value and restarts counting from 0.

Tips

- With the scaling function, the number of integrated pulses can be recorded as a value that is converted to a physical quantity (Wh, VA, etc.) for the measurement target.
  See "3.7 Using the Scaling Function" (p. 161).
- Up to 1,000,000,000 pulses can be measured. If there is a possibility that the number of pulses may exceed this value, it is recommended to perform measurement with the count mode set to the instant value and integrate the pulses later using Excel and the like.

Rotation speed measurement

The number of pulses output according to the rotation speed of the rotary encoder or speed recorder can be measured.
The number of pulses per second is counted to calculate the rotation speed.
External control terminal: Pulse input terminal (PULSE)
When an external sampling is used, the pulse channel cannot be used.

1 Set the input type to rotation speed.

Settings		
Syntax	Command	`:MODule:PINMOde pls$,A$`
Example	`:MODule:PINMOde PLS1,REVOLVE`	
Query		
Syntax	Query	`:MODule:PINMOde? pls$`
	Response	`pls$,A$`
Example	`:MODule:PINMOde? PLS1` (Response) `:MODULE:PINMODE PLS1,REVOLVE` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = COUNT, REVOLVE, LOGIC

`COUNT`☑	Aggregation
`REVOLVE`	Rotation speed
`LOGIC`	Logic

2 Enable the measurement channel.

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe PLS1,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? PLS1` (Response) `:MODULE:STORE PLS1,ON` (When the header is ON)	
Parameter		

`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p.145)
`A$` = OFF, ON

Note

When the pulse input type is set to logic, measurement cannot be turned ON for the pulse channel.

3 Settings and Operations

3 Set the reference time for counting.

Settings		
Syntax	Command	`:MODule:PRANGe pls$,A$`
Example	`:MODule:PRANGe PLS1,RPM`	
Query		
Syntax	Query	`:MODule:PRANGe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PRANGe? PLS1` (Response) `:MODULE:PRANGE PLS1,RPM` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = RPS, RPM		

`RPS`☑	r/s (number of rotations per second) The number of pulses per second is counted to calculate the rotation speed.
`RPM`	r/min (number of rotations per minute) The number of pulses for a specified smoothing time is counted to calculate the rotation speed. (p. 157)

Note
A command error occurs if the pulse input type (p. 155) is not set to the rotation speed.

4 Set the number of pulses per rotation output from the encoder or tachometer.

Settings		
Syntax	Command	`:MODule:PCOUnt pls$,A`
Example	`:MODule:PCOUnt PLS1,1`	
Query		
Syntax	Query	`:MODule:PCOUnt? pls$`
	Response	`pls$,A<NR1>`
Example	`:MODule:PCOUnt? PLS1` (Response) `:MODULE:PCOUNT PLS1,1` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A` = 1 to 1000		

5 Set the slope for counting.

Settings		
Syntax	Command	`:MODule:PSLOPe pls$,A$`
Example	`:MODule:PSLOPe PLS1,UP`	
Query		
Syntax	Query	`:MODule:PSLOPe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PSLOPe? PLS1` (Response) `:MODULE:PSLOPE PLS1,UP` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = UP, DOWN		

`UP`☑	Integrates the number of times the pulse changes from the Low to High level (rise).
`DOWN`	Integrates the number of times the pulse changes from the High to Low level (fall).

6 Set the level for counting.

Settings		
Syntax	Command	`:MODule:PTHRe pls$,A$`
Example	`:MODule:PTHRe PLS1,1V`	
Query		
Syntax	Query	`:MODule:PTHRe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PTHRe? PLS1` (Response) `:MODULE:PTHRE PLS1,1V` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = 1V, 4V

`1V`☑	Determines 1.0 V or higher to be the High level, 0 or higher and less than 0.5 V to be the Low level.
`4V`	Determines 4.0 V or higher to be the High level, 0 or higher and less than 1.5 V to be the Low level.

7 Set whether or not to use the chattering prevention filter.

When this setting is ON, a count error due to chattering can be prevented for the mechanical contact (relay) output.

Settings		
Syntax	Command	`:MODule:PFILTer pls$,A$`
Example	`:MODule:PFILTer PLS1,ON`	
Query		
Syntax	Query	`:MODule:PFILTer? pls$`
	Response	`pls$,A$`
Example	`:MODule:PFILTer? PLS1` (Response) `:MODULE:PFILTER PLS1,ON` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A$` = OFF, ON

8 Set the processing period for smoothing. {When the reference time for counting is in RPM (r/min)} (p.156)

Settings		
Syntax	Command	`:MODule:PSMooth pls$,A`
Example	`:MODule:PSMooth PLS1,1`	
Query		
Syntax	Query	`:MODule:PSMooth? pls$`
	Response	`pls$,A<NR1>`
Example	`:MODule:PSMooth? PLS1` (Response) `:MODULE:PSMOOTH PLS1,1` (When the header is ON)	
Parameter		

`pls$` = PLS1
`A` = 1 (OFF) to 60

1 s ☑ to 60 s

Smoothing is turned OFF when A = 1.

Principle of rotation speed measurement

In the following cases, the number of integrated pulses is internally updated at the data refresh intervals of 10 ms.

- When the range is RPS (r/s)
- When the range is RPM (r/min) and the smoothing is set to 1 s

Rotation speed r at time t [s] is calculated by dividing the number of pulses between (t – 1) and t [s] by the number of pulses per rotation.

$$r\text{ (r/s)} = \frac{\text{Number of integrated pulses of } t \text{ [s]} - \text{number of integrated pulses of } (t-1) \text{ [s]}}{\text{Number of pulses per rotation}}$$

r/s: Number of rotations per second

$$r\text{ (r/min)} = \frac{\text{Number of integrated pulses of } t \text{ [s]} - \text{number of integrated pulses of } (t-1) \text{ [s]}}{\text{Number of pulses per rotation}} \times 60$$

r/min: Rotation speed per 60 s (when the smoothing is set to **[1 s]**)

Example: When the number of pulses per rotation = 4,
the number of integrated pulses at 1 s (P1) = 1000 c,
and the number of integrated pulses at 2 s (P2) = 2000 c,
the rotation speed at t = 2 s ($r_{t=2}$) is calculated as follows.
$r_{t=2}$ = (2000 − 1000) /4 = 250 r/s

When the range is RPM (r/min) and the smoothing is set to t_0 [s], the number of integrated pulses is internally updated at the data refresh intervals of 50 ms.
Rotation speed r at time t [s] is calculated by dividing the number of pulses between ($t - t_0$) and t [s] by the number of pulses per rotation and the smoothing time and then multiplying the quotient by 60.

$$r\text{ (r/min)} = \frac{\text{Number of integrated pulses of } t \text{ [s]} - \text{number of integrated pulses of } (t-t_0) \text{ [s]}}{\text{Number of pulses per rotation}} \times \frac{60}{t_0}$$

When the range is RPM (r/min)

When time t [s] satisfies t < t_0 (t_0: The time set for smoothing), the value of the recorded rotation speed is smaller than the actual rotation speed due to smoothing (only when t_0 ≥ 2 s).
If an unintended trigger is activated, set the smoothing time to 1 s.

Example with t_0 = 5 s

The recorded value of rotation speed is increased for t_0 [s] after the measurement is started.
Even if a constant rotation speed is input, the recorded value appears to be increased since the start of measurement until t_0 [s] due to the smoothing process.

Logic signal measurement

The signals can be measured as logic data of 0 and 1.
When an external sampling is used, the logic channel cannot be used.

1 Set the measurement type to logic.

Settings		
Syntax	Command	`:MODule:PINMOde pls$,A$`
Example	`:MODule:PINMOde PLS1,LOGIC`	
Query		
Syntax	Query	`:MODule:PINMOde? pls$`
	Response	`pls$,A$`
Example	`:MODule:PINMOde? PLS1` (Response) `:MODULE:PINMODE PLS1,LOGIC` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = COUNT, REVOLVE, LOGIC		

`COUNT`☑	Aggregation
`REVOLVE`	Rotation speed
`LOGIC`	Logic

2 Enable the measurement channel.

Enable the pulse measurement channel.

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe LOG,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? LOG` (Response) `:MODULE:STORE LOG,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A$` = OFF, ON		
Note		
If there are no pulse channels set to the logic input type, the logic channel cannot be enabled for measurement.		

3 Set the level for counting.

Settings		
Syntax	Command	`:MODule:PTHRe pls$,A$`
Example	`:MODule:PTHRe PLS1,1V`	
Query		
Syntax	Query	`:MODule:PTHRe? pls$`
	Response	`pls$,A$`
Example	`:MODule:PTHRe? PLS1` (Response) `:MODULE:PTHRE PLS1,1V` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = 1V, 4V		

`1V`☑	Determines 1.0 V or higher to be the High level, 0 or higher and less than 0.5 V to be the Low level.
`4V`	Determines 4.0 V or higher to be the High level, 0 or higher and less than 1.5 V to be the Low level.

4 Set whether or not to use the chattering prevention filter.

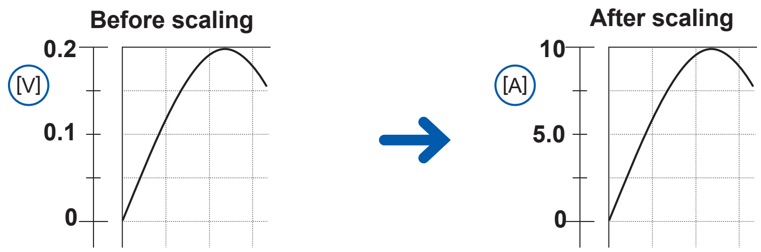
When this setting is ON, a count error due to chattering can be prevented for the mechanical contact (relay) output.

Settings		
Syntax	Command	`:MODule:PFILTer pls$,A$`
Example	`:MODule:PFILTer PLS1,ON`	
Query		
Syntax	Query	`:MODule:PFILTer? pls$`
	Response	`pls$,A$`
Example	`:MODule:PFILTer? PLS1` (Response) `:MODULE:PFILTER PLS1,ON` (When the header is ON)	
Parameter		
`pls$` = PLS1 `A$` = OFF, ON		

3.7 Using the Scaling Function

By using the scaling function, the voltage value measured with the instrument can be converted and recorded as a physical quantity (current, temperature, etc.) for the measurement target.
Using Logger Utility, the converted value can be displayed with a decimal fraction or exponential notation.
The scaling function is not applicable to the measurement values of the M7103 Power Measurement Module.

Example:Slope = 50,
Unit = A



1 **Set the display method for scaling.**

Settings		
Syntax	Command	`:SCALing:SET ch$,A$`
Example	`:SCALing:SET CH1_1,ENG`	
Query		
Syntax	Query	`:SCALing:SET? ch$`
	Response	`ch$,A$`
Example	`:SCALing:SET? CH1_1` (Response) `:SCALING:SET CH1_1,ENG` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A$` = OFF, ENG, SCI		

`OFF`☑	Disables the scaling function.
`ENG`	Enables the scaling function. When Logger Utility is used, a value is displayed with a decimal fraction.
`SCI`	Enables the scaling function. When Logger Utility is used, a value is displayed with exponential notation.

2 **Set the conversion method for scaling.**

Settings		
Syntax	Command	`:SCALing:KIND ch$,A$`
Example	`:SCALing:KIND CH1_1,POINT`	
Query		
Syntax	Query	`:SCALing:KIND? ch$`
	Response	`ch$,A$`
Example	`:SCALing:KIND? CH1_1` (Response) `:SCALING:KIND CH1_1,POINT` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A$` = RATIO, POINT, SENS		

`RATIO`☑	Uses the conversion ratio for scaling.
`POINT`	Specifies two points for scaling.
`SENS`	Uses the sensitivity for scaling.

Note
The setting method is restricted depending on the module type.

See “Scaling setting for integrated measurement.” (p. 166).

3 **Set the unit after conversion.**

See “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:SCALing:UNIT ch$,"A$"`
Example	`:SCALing:UNIT CH1_1,"mA"`	
Query		
Syntax	Query	`:SCALing:UNIT? ch$`
	Response	`ch$,"A$"`
Example	`:SCALing:UNIT? CH1_1` (Response) `:SCALING:UNIT CH1_1,"mA"` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A$` = Character string of unit (up to 3 double-byte characters or 7 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

4 **(When the conversion method for scaling is set to the conversion ratio method)**
Set the slope (scaling conversion value).

Settings		
Syntax	Command	`:SCALing:VOLT ch$,A`
Example	`:SCALing:VOLT CH1_1,1`	
Query		
Syntax	Query	`:SCALing:VOLT? ch$`
	Response	`ch$,A<NR3>` (4 digits after the decimal point)
Example	`:SCALing:VOLT? CH1_1` (Response) `:SCALING:VOLT CH1_1,+1.0000E+00` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A` = −9.9999E+09 to +9.9999E+09*1 (+1.0000E-09 to +9.9999E+09 for pulse integration) *1. 0 cannot be set.		
Note		
This setting may alter the following values. • Settings for the high and low points of actual measured values in scaling • Scaling sensitivity setting		

Set the offset.

Settings		
Syntax	Command	`:SCALing:OFFSet ch$,A`
Example	`:SCALing:OFFSet CH1_1,0`	
Querying the scaling offset		
Syntax	Query	`:SCALing:OFFSet? ch$`
	Response	`ch$,A<NR3>` (4 digits after the decimal point)
Example	`:SCALing:OFFSet? CH1_1` (Response) `:SCALING:OFFSET CH1_1,+0.0000E+00` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A` = -9.9999E+09 to 9.9999E+09		
Note		
This setting may alter the following values. • Settings for the high and low points of actual measured values in scaling • Numerical threshold setting		

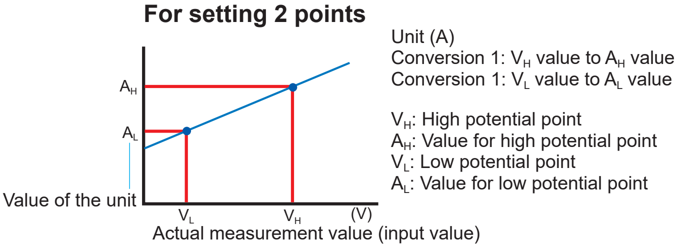
Setting example

Measurement is performed using a differential probe with division ratio of 1/100. The waveform data are recorded as a value represented in the voltage unit (V).

Unit	V
Slope	100
Offset	0

5 (When the conversion method for scaling is set to the two-point method)

For setting 2 points



Set the high point and low point of the unit to be converted.

Settings		
Syntax	Command	:SCALing:VOUPLOw ch$,A,B
Example	:SCALing:VOUPLOw CH1_1,0.05,-0.05	
Query		
Syntax	Query	:SCALing:VOUPLOw? ch$
	Response	ch$,A<NR3>,B<NR3> (4 digits after the decimal point)
Example	:SCALing:VOUPLOw? CH1_1 (Response) :SCALING:VOUPLOW CH1_1,+5.0000E-02,-5.0000E-02 (When the header is ON)	
Parameter		
ch$ = CH1_1 to CH10_30, PLS1 A,B = -9.9999E+29 to +9.9999E+29 A = B cannot be set.		
Note		
This setting may alter the following values. • Scaling offset setting • Scaling sensitivity setting • Scaling conversion value setting		

3 Settings and Operations

Set the high point and low point of the actual measured value.

Settings		
Syntax	Command	`:SCALing:SCUPLOw ch$,A,B`
Example	`:SCALing:SCUPLOw CH1_1,0.5,-0.5`	
Query		
Syntax	Query	`:SCALing:SCUPLOw? ch$`
	Response	`ch$,A<NR3>,B<NR3>` (4 digits after the decimal point)
Example	`:SCALing:SCUPLOw? CH1_1` (Response) `:SCALING:SCUPLOW CH1_1,+5.0000E-01,-5.0000E-01` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A,B` = -9.9999E+29 to +9.9999E+29 A = B cannot be set.		
Note		
This setting may cause alter the following values. • Scaling offset setting • Scaling sensitivity setting • Scaling conversion value setting		

Setting example

Convert a 4-20 mA output from the sensor to a value between 0 mm and 100 mm.
The 4-20 mA output is measured between 1 V and 5 V using a 250 Ω shunt resistor.
The range from 1 V to 5 V is converted to the range from 0 mm to 100 mm.

Unit	mm
A	1 *1 → 0 *2 (1 V → 0 mm)
B	5 *1 → 100 *2 (5 V → 100 mm)

*1. Set with `SCALing:VOUPLOw`
*2. Set with`SCALing:SCUPLOw`

6 **(When the conversion method for scaling is set to the sensitivity method)**
Set the sensitivity.

Settings		
Syntax	Command	`:SCALing:SENSE ch$,A`
Example	`:SCALing:SENSE CH1_1,1`	
Query		
Syntax	Query	`:SCALing:SENSE? ch$`
	Response	`ch$,A<NR3>` (4 digit after the decimal point)
Example	`:SCALing:SENSE? CH1_1` (Response) `:SCALING:SENSE CH1_1,+1.0000E+00` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A =` -1.0000E+09 to +1.0000E+09 *1. 0 cannot be set.		
Note		
This setting may alter the following values. • Settings for the high and low points of actual measured values in scaling • Scaling conversion value setting		

Setting example

Measurement is performed using a heat flow sensor with sensitivity constant of 0.02421 mV/W·m^{-2}.
The waveform data are recorded represented in the unit of W/m^2.

Unit	W/m^2
Sensitivity	0.02421 m
Offset	0

Tips

Checking the waveform before the scaling conversion

If the waveform data are saved in the binary format, the waveform before the scaling conversion and the scaling settings are recorded.

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Settings and Operations

Scaling setting for integrated measurement.

With the scaling function, the number of integrated pulses can be recorded as a value that is converted to a physical quantity (Wh, VA, etc.) for the measurement target.
For a pulse output instrument, the physical quantity per pulse or the number of pulses per basic unit (example: 1 kWh, 1 L, 1 m3) is defined.

1 Set the display method for scaling.

Settings		
Syntax	Command	`:SCALing:SET ch$,A$`
Example	`:SCALing:SET PLS1,ENG`	
Query		
Syntax	Query	`:SCALing:SET? ch$`
	Response	`ch$,A$`
Example	`:SCALing:SET? PLS1` (Response) `:SCALING:SET PLS1,ENG` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A$` = OFF, ENG, SCI		

`OFF`☑	Disables the scaling function.
`ENG`	Enables the scaling function. Displays a value with a decimal fraction.
`SCI`	Enables the scaling function. Displays a value with exponential notation.

2 Set the unit after change.

See “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:SCALing:UNIT ch$,"A$"`
Example	`:SCALing:UNIT PLS1,"kWh"`	
Query		
Syntax	Query	`:SCALing:UNIT? ch$`
	Response	`ch$,"A$"`
Example	`:SCALing:UNIT? PLS1` (Response) `:SCALING:UNIT PLS1,"kWh"` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A$` = Character string of unit (up to 3 double-byte characters or 7 single-byte characters)		

3 Set the physical quantity per pulse.

When you set the number of pulses per standard unit (example: 1 c = 1 pulse), set the reciprocal of the physical quantity per pulse for “A” .

Settings		
Syntax	Command	`:SCALing:VOLT ch$,A`
Example	`:SCALing:VOLT PLS1,1`	
Query		
Syntax	Query	`:SCALing:VOLT? ch$`
	Response	`ch$,A<NR3>` (4 digit after the decimal point)
Example	`:SCALing:VOLT? PLS1` (Response) `:SCALING:VOLT PLS1,+1.0000E+00` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1 `A` = -9.9999E+09 to +9.9999E+09 (+1.0000E-09 to +9.9999E+09 for pulse integration)		
Note		
This setting may alter the following values. • Settings for the high and low points of actual measured values in scaling • Scaling sensitivity setting		

Setting example

When integrating the number of pulses with a 50,000 pulse/kWh power meter connected

```
:SCALing:SET PLS1,ENG
:SCALing:UNIT PLS1,"kWh"
:SCALing:VOLT PLS1,+5.0E+4
```

When integrating the number of pulses with a 10 L/pulse flow meter connected

```
:SCALing:SET PLS1,ENG
:SCALing:UNIT PLS1,"L"
:SCALing:VOLT PLS1,+1.0E-1
```

3.8 Entering Comments

You can enter a title for measurement, comment for each channel, and identification name for the module.

Title comment

You can enter any character string as a title for measurement.
See "(3) Character string data" (p. 25).

Settings		
Syntax	Command	`:COMMent:TITLe "A$"`
Example	`:COMMent:TITLe "HIOKI"`	
Query		
Syntax	Query	`:COMMent:TITLe?`
	Response	`"A$"`
Example	`:COMMent:TITLe?` (Response) `:COMMENT:TITLE "HIOKI"` (When the header is ON)	
Parameter		
`A$` = Character string of comment (up to 20 double-byte characters or 40 single-byte characters)		

Channel comment

You can enter any character string for each channel.
See "(3) Character string data" (p. 25).

Settings		
Syntax	Command	`:COMMent:CH ch$,"A$"`
Example	`:COMMent:CH CH1_1,"ABCDEFG"`	
Query		
Syntax	Query	`:COMMent:CH? ch$`
	Response	`ch$,"A$"`
Example	`:COMMent:CH? CH1_1` (Response) `:COMMENT:CH CH1_1,"ABCDEFG"` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A$` = Character string of comment (up to 20 double-byte characters or 40 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

Module identification name

You can enter an identification name (any character string) for each module.
Use these names to identify modules when multiple modules are used.
See “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:COMMent:MODule module$,"A$"`
Example	`:COMMent:MODule MODULE1,"ABCDEFG"`	
Query		
Syntax	Query	`:COMMent:MODule? module$`
	Response	`module$,"A$"`
Example	`:COMMent:MODule? MODULE1` (Response) `:COMMENT:MODULE MODULE1,"ABCDEFG"` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10 `A$` = Character string of comment (up to 8 double-byte characters or 16 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

3

Settings and Operations

3.9 Performing Zero Adjustment

Deviation in the input part of M7100 or M7102 Voltage/Temp Module is corrected so that the reference potential of the instrument becomes 0 V.
Perform zero adjustment when there is no input. Zero adjustment may not be performed correctly if there is any input. It is not necessary to short circuit between the positive terminal and negative terminal of the measuring instrument.
For zero adjustment of the M7103 Power Measurement Module, refer to “2.9 Wiring the Power Measurement Module to the Measurement Line” (p. 75).

Query		
Syntax	Query	`:MODule:ADJUST?`
	Response	`A<NR1>`
Example	`:MODule:ADJUST?` (Response) `:MODULE:ADJUST 1` (When the header is ON)	
Parameter		
`A` = 1, 0		

`0`	Success
`1`	Failure

When the beep sound is enabled, a beep sound is issued once in the case of a success, or it is issued twice in the case of a failure.
See “Beep sound” (p. 289).

3.10 Starting and Stopping Measurement

Use the following command to start measurement.

Settings		
Syntax	Command	`:STARt`
Example	`:STARt`	

Use the following command to stop measurement.

Settings		
Syntax	Command	`:STOP`
Example	`:STOP`	
Note		
The operation depends on the recording time setting. First `:STOP` command When the recording time is set to continuous recording: The measurement is not stopped. When the recording time is set to time specification: The measurement is performed for the specified recording time and then stopped. Second `:STOP` command When the recording time is set to continuous recording: The measurement is stopped. When the recording time is set to time specification: The measurement is stopped. (The timing when processing the `:STOP` command is completed is the timing when the measurement is actually stopped.)		

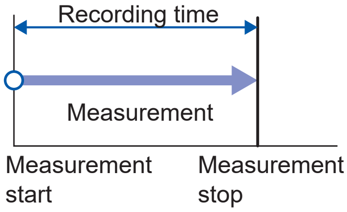
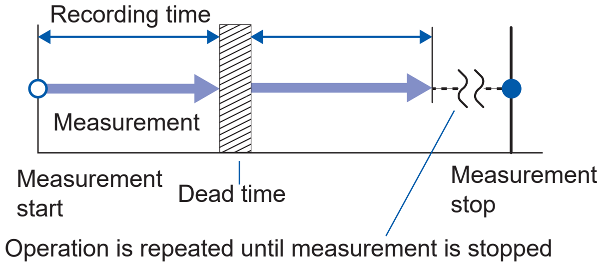
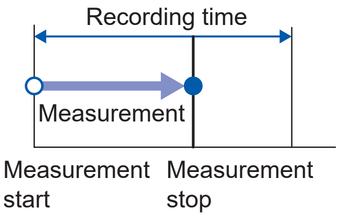
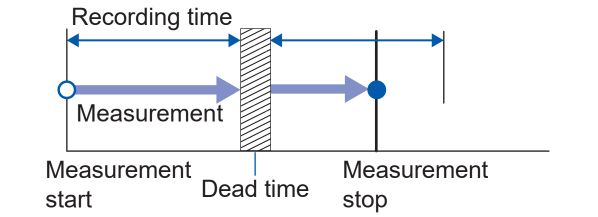
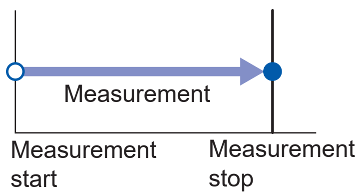
If the measurement is stopped and then started again, the measurement data in the internal buffer memory of the instrument is deleted. Save important data in an SD memory card or USB drive before starting the measurement again.

Tips
- Measurement can be automatically stopped at the specified time.
  See “3.3 Setting Measurement Conditions” (p. 106).
- The recording operation can be started under specific conditions. This function is useful for monitoring errors.
  See “5 Trigger Function” (p. 191).

Measurement operation

○ **START** command executed ● **STOP** command executed Dead time

Measurement ←→ Recording time setting

Recording time	Repetitive recording: OFF	Repetitive recording: ON
Time specification (**STOP** command is not executed)		
Time specification (**STOP** command is executed during the measurement)		
Continuous recording		(Same as Repetitive recording: OFF)

> **Tips**
> **When a power failure has occurred during the measurement**
> • Measurement cannot be performed during a power failure.
> • Measurement data before the power failure cannot be retained.
> However, if the auto-save operation is enabled, the data before the power failure is saved in the medium (SD memory card or USB drive).
> See “Preparations and settings in case of power failure” (p. 223).
> • The measurement is not restarted even if the power is restored.
> However, if the start status hold function (start backup) is enabled, the recording is restarted when the power is restored.

Forcing termination of measurement

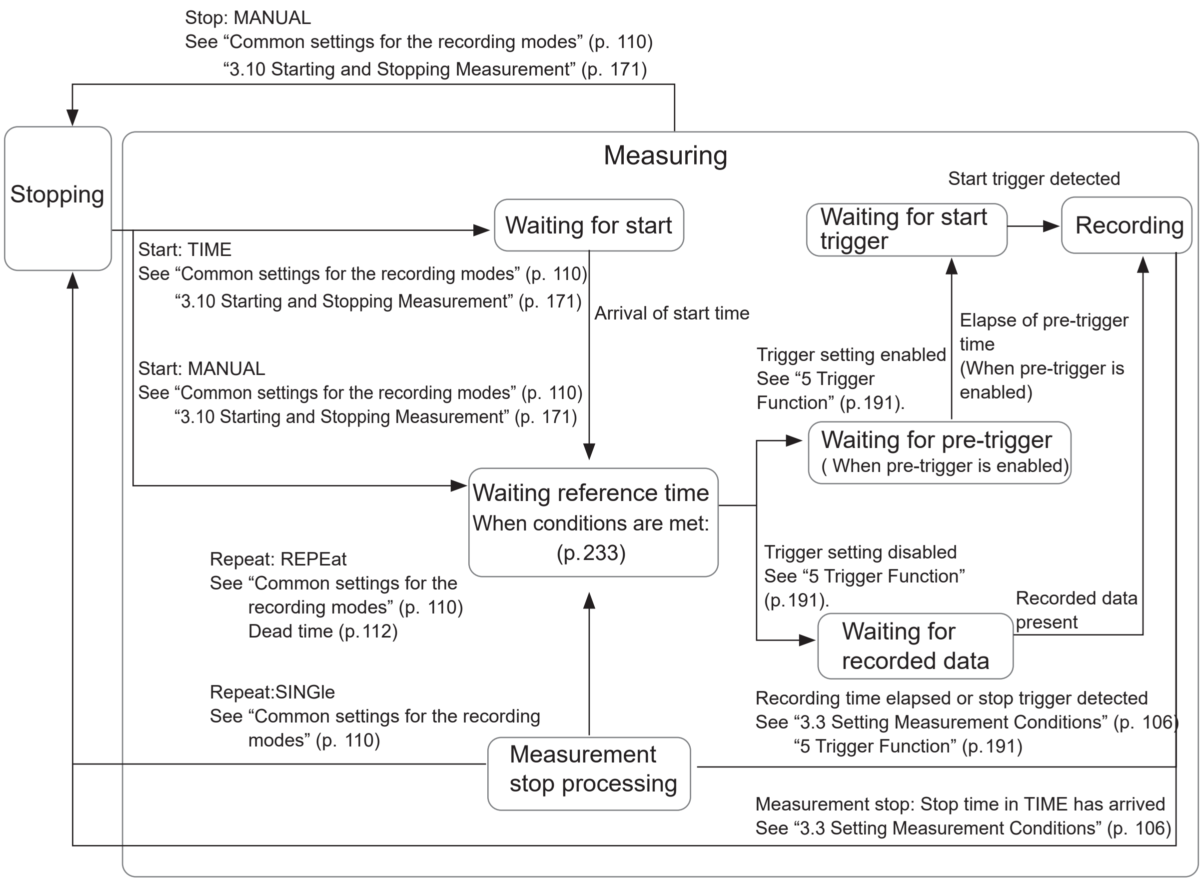
- The measurement is stopped even if the waveform capture operation is not completed.
- It is not possible to wait for the completion of measurement using a command in combination with `*OPC`, etc.
  Example of inoperable command: `:ABORT;*OPC?`
- If the instrument is set to a secondary unit of the synchronized operation, the measurement cannot be stopped.

Settings		
Syntax	Command	`:ABORT`
Example	`:ABORT`	

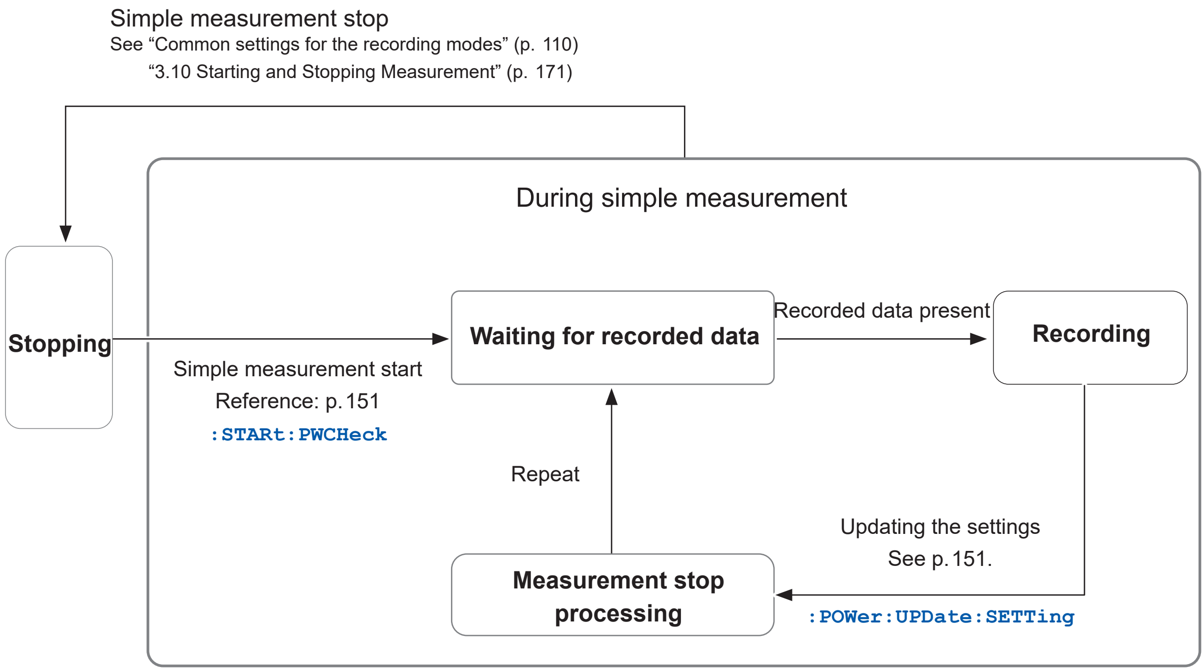
Handling of data exceeding the allowable measurement range

Regardless of the measurement target, the measured value exceeding the allowable measurement range is handled as an overrange value. The values listed in “14.12 Data Handling” (p. 428) are saved for the data and calculation result.

Measurement operation status change



When simple measurement is performed using the “`:STARt:PWCHeck`” command



3.11 Checking Measurement Start Time and Trigger Time

1 Query the start trigger detection date.

When the start trigger is set to OFF, the measurement start date is returned.

Query		
Syntax	Query	:TRIGger:DETECTDate?
	Response	year<NR1>,month<NR1>,day<NR1>
Example	:TRIGger:DETECTDate? (Response) :TRIGGER:DETECTDATE 19,12,26 (When the header is ON)	
Parameter		
If there is no storage data, “00,00,00” is returned.		

year	00 to 37 (year)
month	01 to 12 (month)
day	01 to 31 (days)

2 Query the start trigger detection time.

When the start trigger is set to OFF, the measurement start time is returned.

Query		
Syntax	Query	:TRIGger:DETECTTime?
	Response	hour<NR1>,min<NR1>,sec<NR1>,ms<NR1>
Example	:TRIGger:DETECTTime? (Response) :TRIGGER:DETECTTIME 01,02,03,004 (When the header is ON)	
Parameter		
If there is no storage data, “00,00,00,000” is returned.		

hour	00 to 23 (hours)
min	00 to 59 (minutes)
sec	00 to 59 (seconds)
ms	000 to 999 (millisecond)

4 Acquiring Measurement Data

IMPORTANT
Realtime acquisition of measurement data is limited during the measurement.
See “4.7 Comparison of Realtime Data Acquisition” (p. 189).

Before acquiring measurement data

- Complete the settings required for measurement. (p. 105)
- Confirm that the measurement on the target channel of acquisition is enabled, if needed.

Query		
Syntax	Query	`:MEMory:TARCH? module$` `:MEMory:TVRCH? module$`
	Response	`ch1$,ch2$,...`
Example	`:MEMory:TARCH? MODULE1` (Response) `:MEMORY:TARCH CH1_1,CH1_2,CH1_3,CH1_4,CH1_5` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 `ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145)		

List of data acquisition commands

By sending the following commands, the measurement results can be acquired in response.

Data acquired	Target	Command*1			Reference
		Acquired in text		Acquired in binary*2	
		Physical quantity	AD value		
Time series multiple data	1 channel	`:VDATa?`	`:ADATa?`	`:BDATa?`	“4.1 Acquiring Measurement Data on Internal Memory” (p. 176)
Latest data	1 channel	`:VREAL?`	`:AREAL?`	`:BREAL?`	“4.2 Acquiring Realtime Data” (p. 180)
	1 module	`:TVREAl?`	`:TAREAl?`	–	
Hold data	1 channel	`:VFETch?`	`:AFETch?`	`:BFETch?`	“4.3 Acquiring Hold Data” (p. 182)
	1 module	`:TVFETch?`	`:TAFETch?`	–	

*1. The command requires `:MEMory` at the beginning. (Example: `:MEMory:VDATA?`)

*2. Binary data may contain a newline (character code 0A or 0D). If the PC software being used interprets a newline as the end of the data, the data cannot be processed correctly. Therefore, be sure to read the number of data specified with A. No newline (LF or CR+LF) is attached to the end of data.

When acquiring text, it becomes more difficult to acquire all data in real time as the instrument configuration is scaled up.
The waveform data of the instrument can be acquired with various methods other than text. Select an appropriate method according to the application.
See “Comparison of Realtime Data Acquisition” (p. 189).

4.1 Acquiring Measurement Data on Internal Memory

1 **Start measurement.**

When the measurement has been stopped, the measurement data on the internal memory can be acquired in the same way.

Settings		
Syntax	Command	:START
Example	:START	

The measurement data can also be acquired using ":START:PWCHeck" as long as measurement is being performed. (p. 151)

2 **Check the number of measurement data.**

Confirm that the number of measurement data units is 1 or more and acquire the data.

Query		
Syntax	Query	:MEMory:AMAXPoint? (Number saved on the internal memory after measurement) :MEMory:MAXPoint? (Number saved on the internal memory)
	Response	A<NR1>
Example	:MEMory:AMAXPoint? (Response) :MEMORY:AMAXPOINT 800 (When the header is ON)	
Parameter		
A = Number of measurement data (0 = not saved)		

3 **Confirm that the measurement data on the target channel exists.**

Confirm that the measurement on the target channel exists, if needed.
Check the measurement data of the target channel.

Query		
Syntax	Query	:MEMory:CHSTore? ch$
	Response	ch$,A$
Example	:MEMory:CHSTore? CH1_1 (Response) :MEMORY:CHSTORE CH1_1,ON (When the header is ON)	
Parameter		
ch$ = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) A$ = OFF, ON		

Check the measurement data of the target module.

Query		
Syntax	Query	:MEMory:TCHSTore? module$
	Response	ch1$,ch2$,... If the specified module is not installed, the response is MODULE_NONE. If the measurement of all channels in the specified module is set to OFF, the response is NO DATA.
Example	:MEMory:TCHSTore? MODULE1 (Response) :MEMORY:TCHSTORE CH1_1,CH1_2,CH1_3,CH1_4,CH1_5 (When the header is ON)	
Parameter		
module$ = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 ch$ = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145)		

4 Check the leading data number on the internal memory.

The data located within the internal memory can be acquired.
If needed, acquire the leading data number on the internal memory to check the data range.

Query		
Syntax	Query	`:MEMory:TOPPoint?`
	Response	`A<NR1>`
Example	`:MEMory:TOPPoint?` (Response) `:MEMORY:TOPPOINT 10` (When the header is ON)	
Parameter		
`A` = Leading data number (0 = not saved)		

5 Set the channel for acquisition and the output position.

Specify a position within the number of measurement data from the leading number on the internal memory.

Settings		

Syntax	Command	`:MEMory:APOINt ch$,A`
		The data number beyond the internal memory can be specified.
		`:MEMory:POINt ch$,A`
		The data number beyond the internal memory cannot be specified.*[1]

Example	`:MEMory:APOINt CH1_1,100`	
Query		
Syntax	Query	`:MEMory:APOINt?` `:MEMory:POINt?`
	Response	`ch$,A<NR1>`
Example	`:MEMory:APOINt?` (Response) `:MEMORY:APOINT CH1_1,100` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = 0 to (Number of data in storage − 1)		
Note		
If there is no storage data, the output point cannot be set.		

*1. If the measurement data with continuous recording could go beyond the internal memory, use `APOINt`.
See “3.3 Setting Measurement Conditions” (p. 106).

4 Acquiring Measurement Data

6 Acquire the measurement data.

A specified number of data points are acquired starting from the data specified with the channel for acquisition and the output position.
In addition, the output position is increased by the number of data points. (p.179)
When there is no recorded data in the specified channel or output point, a value indicating “NO DATA” is returned.
See “14.12 Data Handling” (p. 428)

When acquiring in text (physical value)

Query		
Syntax	Query	`:MEMory:VDATa? A`
	Response	`B1,B2,...<NR3>`
Example	`:MEMory:VDATa? 2` (Response) `:MEMORY:VDATA +5.000000E-03,+4.000000E-03` (When the header is ON)	
Parameter		
`A` = 1 to 1000 `Bi` = Measured value Measured value of each channel See “4.6 Text (Physical Value)” (p. 188)		

When acquiring in text (AD value)

Query		
Syntax	Query	`:MEMory:ADATa? A`
	Response	`B1,B2,…<NR1>` (`<NR3>` for waveform calculation results only)
Example	`:MEMory:ADATa? 5` (Response) `:MEMORY:ADATA 3176,3176,3176,3186,3186` (When the header is ON)	
Parameter		
`A` = 1 to 2000 (Number of outputs) `Bi` = -2147483648 to 2147483647 (Analog) `Bi` = 0 to 2147483647 (aggregation, rotations) `Bi` = 0 to 1 (Logic) `Bi` = 0 to 15 (Alarm) `Bi` = Waveform calculation result (Wave calc) `Bi` = Power calculation result (power calculation channel) Method for converting the AD value to a physical value See “4.4 Conversion of Measurement Data” (p. 186).		

When acquiring in binary

Query		
Syntax	Query	`:MEMory:BDATa? A`
	Response	`#0`<The following binary data>
Example	`:MEMory:BDATa? 10` (Response) `:MEMORY:BDATA #0...`<Binary data> (When the header is ON)	
Parameter		
`A` = 1 to 5000 (Number of outputs) `#0` (representing the binary format) is attached to the beginning of the output data. Following `#0`, the storage data are sent in the binary format for the number of data points specified with A. Method for converting the AD value to a physical value See “4.5 About Binary Data” (p. 187).		

> **Tips**
> **Movement of the acquisition position**
> The acquisition position is increased when the measurement data are acquired. Therefore, a value without data is acquired at a position where no data exists.

Example:

Channel	CH1_2
Recording interval	1 (s)
Recording length	2 (s)
Number of measurement data	3

✓: Data present

1. Immediately after execution of `:MEMory:POINT CH1_2,0`

Storage number	0	1	2	3
Data present or absent	✓	✓	✓	–
Data acquisition position	↑			

The data acquisition position is set to storage number 0 of CH1_2.

2. Immediately after execution of `:MEMory:VDATa?2`

Storage number	0	1	2	3
Data present or absent	✓	✓	✓	–
Data acquisition position			↑	

The data in storage numbers 0 and 1 of CH1_2 are output. The data acquisition position is moved to storage number 2.

3. Immediately after execution of `:MEMory:ADATa?2`

Storage number	0	1	2	3
Data present or absent	✓	✓	✓	–
Data acquisition position				↑

The data in storage numbers 2 and 3 of CH1_2 are output. The data in storage number 3 is null.

The data acquisition position is moved to storage number 3.

If first `MEMory:ADATa?2` and then `:MEMory:VDATa?2` are executed, the same result is obtained.

4 Acquiring Measurement Data

4.2 Acquiring Realtime Data

1 **Acquire the relevant data.**

The realtime data for each data unit can be acquired. Regardless of whether or not this command is used, while the instrument is performing the measurement, the latest data acquired in the measurement are used as the realtime data.

Settings		
Syntax	Command	`:MEMory:GETReal`
Example	`:MEMory:GETReal`	
Note		
If the "`:MEMory:GETReal`" command is executed again during the operation of the "`:MEMory:GETReal`" command, a command execution error will occur.		

If data is acquired without loading data, a value indicating "NO DATA" is returned.
See "14.12 Data Handling" (p. 428)

2 **Acquire the measurement data.**

Acquire data from each channel.

- When acquiring in text (physical value)

Query		
Syntax	Query	`:MEMory:VREAL? ch$`
	Response	`A<NR3>`
Example	`:MEMory:VREAL? CH1_1` (Response) `:MEMORY:VREAL +1.230000E-03` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = measured value Measured value of each channel See "4.6 Text (Physical Value)" (p. 188)		

- When acquiring in text (AD value)

Query		
Syntax	Query	`:MEMory:AREAL? ch$`
	Response	`A<NR1>` (`<NR3>` for waveform calculation results only) If the specified target does not exist, `NO_STORAGE` is returned.
Example	`:MEMory:AREAL? CH1_1` (Response) `:MEMORY:AREAL 3176` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = -2147483648 to 2147483647 (Analog) `A` = 0 to 2147483647 (aggregation, rotations) `A` = 0 to 1 (Logic) `A` = 0 to 15 (Alarm) `A` = Waveform calculation result (Wave calc) `A` = Power calculation result (power calculation channel) Method for converting the AD value to a physical value See "4.4 Conversion of Measurement Data" (p. 186).		

- When acquiring in binary

Query		
Syntax	Query	:MEMory:BREAL? ch$
	Response	A
Example	:MEMory:BREAL? CH1_1 (Response) :MEMORY:BREAL (When the header is ON)	
Parameter		
ch$ = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) A = Binary data See “4.5 About Binary Data” (p. 187).		

Acquire data from each module.

Data can be acquired from the channel for which the measurement is set to ON in the target module.

- When acquiring in text (physical value)

Query		
Syntax	Query	:MEMory:TVREAl? module$
	Response	A1,A2,...<NR3> If the specified target does not exist, NO_STORAGE is returned.
Example	:MEMory:TVREAl? MODULE1 (Response) :MEMORY:TVREAL +1.000000E-03,+2.000000E-03,+3.000000E-03 (When the header is ON)	
Parameter		
module$ = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 Ax = measured value Measured value of each channel See “4.6 Text (Physical Value)” (p. 188)		

- When acquiring in text (AD value)

Query		
Syntax	Query	:MEMory:TAREAl? module$
	Response	A1,A2,...<NR1> (<NR3>) for waveform calculation results only) If the specified target does not exist, NO_STORAGE is returned.
Example	:MEMory:TAREAl? MODULE1 (Response) :MEMORY:TAREAL 3176,3176,3176 (When the header is ON)	
Parameter		
module$ = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 A = -2147483648 to 2147483647 (Analog) A = 0 to 2147483647 (aggregation, rotations) A = 0 to 1 (Logic) A = 0 to 15 (Alarm) A = Waveform calculation result (Wave calc) A = Power calculation result (power calculation channel) Method for converting the AD value to a physical value See “4.4 Conversion of Measurement Data” (p. 186).		

4.3 Acquiring Hold Data

1 **Acquire the relevant data.**

The hold data for each data unit can be acquired. While the instrument is performing the measurement, the latest data at the timing when the command is received is acquired as the hold data.

Settings		
Syntax	Command	`:MEMory:GETReal`
Example	`:MEMory:GETReal`	
Note		
If the “`:MEMory:GETReal`” command is executed again during the operation of the “`:MEMory:GETReal`” command, a command execution error will occur.		

As it takes time to load data, be sure to proceed to the next step only after it has been confirmed that the data have been completely loaded using a command such as `*OPC?` and `*WAI`.
While measurement is underway, new data can also be loaded when the measurement data are updated.
See “Acquire data at the timing when the measurement data are refreshed.” (p. 184)
If data is acquired without loading data, a value indicating “NO DATA” is returned.
See “14.12 Data Handling” (p. 428)

2 **Confirm that the hold data exists in the target channel.**

Confirm that the data exists in the target channel, if needed.
This confirmation is not necessary if it has been already confirmed before starting the hold that the measurement channel is ON.
Check the hold data in the target channel.

Query		
Syntax	Query	`:MEMory:FCHSTore? ch$`
	Response	`ch$,A$`
Example	`:MEMory:FCHSTore? CH1_1` (Response) `:MEMORY:FCHSTORE CH1_1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A$` = OFF, ON		

Check the hold data in the target module.

Query		
Syntax	Query	`:MEMory:TFCHSTore? module$`
	Response	`ch1$,ch2$,…` If the specified module is not installed, the response is `MODULE_NONE`. If the measurement of all channels in the specified module is set to OFF, the response is `NO DATA`.
Example	`:MEMory:TFCHSTore? MODULE1` (Response) `:MEMORY:TFCHSTORE CH1_1,CH1_2,CH1_3,CH1_4,CH1_5` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 `ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145)		

3 Acquire the measurement data.

Acquire data from each channel.

• When acquiring in text (physical value)

Query		
Syntax	Query	`:MEMory:VFETch? ch$`
	Response	`A<NR3>`
Example	`:MEMory:VFETch? CH1_1` (Response) `:MEMORY:VFETCH +1.230000E-03` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = measured value Measured value of each channel See "4.6 Text (Physical Value)" (p. 188)		

• When acquiring in text (AD value)

Query		
Syntax	Query	`:MEMory:AFETch? ch$`
	Response	`A<NR1>` (`<NR3>` for waveform calculation results only)
Example	`:MEMory:AFETch? CH1_1` (Response) `:MEMORY:AFETCH 3176` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = -2147483648 to 2147483647 (Analog) `A` = 0 to 2147483647 (aggregation, rotations) `A` = 0 to 1 (Logic) `A` = 0 to 15 (Alarm) `A` = Waveform calculation result (Wave calc) `A` = Power calculation result (power calculation channel) Method for converting the AD value to a physical value See "4.4 Conversion of Measurement Data" (p. 186).		

• When acquiring in binary

Query		
Syntax	Query	`:MEMory:BFETch? ch$`
	Response	`A`
Example	`:MEMory:BFETch? CH1_1` (Response) `:MEMORY:BFETCH` (Binary data) (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4HST3 (p. 145) `A` = Binary data • About binary data See "4.5 About Binary Data" (p. 187). • Method for converting the AD value to a physical value See "4.4 Conversion of Measurement Data" (p. 186).		

Acquire data from each module.

Data can be acquired from the channel for which the measurement is set to ON in the target module.
If the hold data has not been loaded before executing this command, a command error will occur.
If there is no channel with hold data in the specified module, a command error will occur.

- When acquiring in text (physical value)

Query		
Syntax	Query	`:MEMory:TVFETch? module$`
	Response	`A1,A2,...<NR3>`
Example	`:MEMory:TVFETch? MODULE1` (Response) `:MEMORY:TVFETCH +1.000000E-03,+2.000000E-03,+3.000000E-03` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 `Ax` = measured value Measured value of each channel See “4.6 Text (Physical Value)” (p. 188)		

- When acquiring in text (AD value)

Query		
Syntax	Query	`:MEMory:TAFETch? module$`
	Response	`A1,A2,...<NR1>` (`<NR3>`) for waveform calculation results only)
Example	`:MEMory:TAFETch? MODULE1` (Response) `:MEMORY:TAFETCH 3176,3176,3176` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10, PLS&ALM, CALC, CALC1, CALC2 `A` = -2147483648 to 2147483647 (Analog) `A` = 0 to 2147483647 (aggregation, rotations) `A` = 0 to 1 (Logic) `A` = 0 to 15 (Alarm) `A` = Waveform calculation result (Wave calc) `A` = Power calculation result (power calculation channel) Method for converting the AD value to a physical value See “4.4 Conversion of Measurement Data” (p. 186).		

Tips

Acquire data at the timing when the measurement data are refreshed.

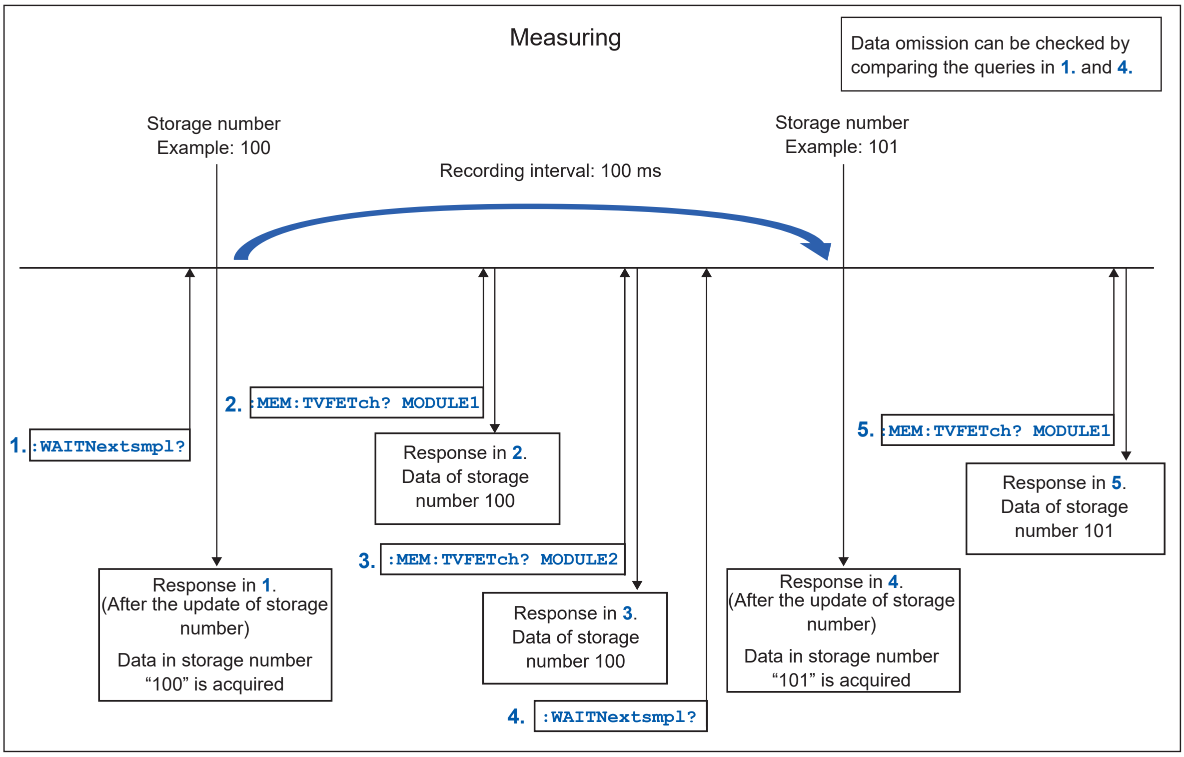
By combining the acquisition of the hold data and the issuing of the following command, the data can be acquired at the timing when the measurement data are refreshed during the measurement. This method is useful for acquiring data at a high speed without dropping it.

Wait for the measurement data to be refreshed.
It is not necessary to use **:MEMory:GETReal**, as all measurement channels are loaded and retained as hold data.

Query		
Syntax	Query	:WAITNextsmpl?
	Response	A<NR1>
Example	:WAITNextsmpl? (Response) :WAITNEXTSMPL 1000 (When the header is ON) :MEMory:TVFETch? MODULE1 (Response) :MEMORY:TVFETCH +1.000000E-03,+2.000000E-03,+3.000000E-03 (When the header is ON)	
Parameter		
A = 0 to (Latest storage number) A = -1 (While no measurement is being performed)		
Note		
If the recording interval is too long (10 s or longer), this parameter cannot be used.		

Possible command combinations to acquire the hold data
:MEMory:VFETch?
:MEMory:AFETch?
:MEMory:BFETch?
:MEMory:TVFETch?
:MEMory:TAFETch?

Hold data acquisition using the :WAITNextsmpl? command



4.4 Conversion of Measurement Data

Use the following formula to convert an analog data value to a physical quantity.
Physical quantity = Data value × Voltage axis range/Number of data points per range

When the scaling is set:
Converted value = Physical quantity × Scaling coefficient + Scaling offset

The number of data points per range is described as follows.

Modules	Mode	Number of data points per range (For the 1 V range, the number of data points from 0 V to 1 V)
M7100 **M7102**	Voltage (all ranges) The 1 V to 5 V range is equivalent to 6 V	100000
	Thermocouple (100°C range)	10000
	Thermocouple (500°C range)	10000
	Thermocouple (2000°C range)	20000

The measured value itself is returned as the data value of Aggregation, Waveform calculation, and power calculation channel.

To calculate the number of rotation, the data value needs to be divided by the number of pulses per rotation that is set with `:MODULE:PCOUnt`.
Number of rotation = Data value / Number of pulses per rotation
For the alarm channel, the integer representation of all channels (1/4 bit) is returned (starting from the lowest bit, output in order of alarm 1, alarm 2…).
When the alarm channel data value is 9, alarm 1 and alarm 4 are output.

Example:
Input type: Voltage
Range: 6 V
Scaling: Coefficient 2, offset 3
Data value: 12356

Physical quantity = 12356 × 6/100000 = 0.74136
Converted value = 0.74136 × 2 + 3 = 4.48272

Tips

If the scaling coefficient and offset for the target channel are unknown, use the queries of the following commands, regardless of the scaling conversion method.
`:SCALing:VOLT`
`:SCALing:OFFSet`

See “(When the conversion method for scaling is set to the conversion ratio method)” (p. 162).

4.5 About Binary Data

The storage data are output in the binary format (big endian).

The binary format for each channel type is as follows.

- Logic and alarm channels: Output with the 1-data and 2-byte unit
- Analog and pulse channels: Output with the 1-data and 4-byte unit
- Waveform calculation channel: Output with the 1-data and 8-byte unit
  The response of the waveform calculation channel is output in the double precision floating point format of IEEE 754.
- Power calculation channel: Output with the 1-data and 4-byte unit
  The response of the power calculation channel is output in the single precision floating point format of IEEE 754.
  The status channel is a 4-byte integer.

Method for converting data to physical quantity
See “4.4 Conversion of Measurement Data” (p. 186).

- When there is no data in the specified channel and output position
  The error value is output, which depends on the specified channels as shown in the table below.

Analog channel	0x7ffffffd	4 bytes
Pulse channel	0x00000000	4 bytes
Waveform calculation channel	0x7ff0000000000001	8 bytes
Power calculation channel	0x7ffffffd	4 bytes

- End of data
  Binary data may contain a newline (character code 0A or 0D).
  If the PC software being used interprets a newline as the end of the data, the data cannot be processed correctly. Therefore, make sure that the number of data specified with A are loaded.
  No newline (LF or CR+LF) is attached to the end of data.

4.6 Text (Physical Value)

When a text (physical value) is acquired, the number of decimal places varies depending on the specified channel.
When the scaling setting is enabled, the value after scaling is output.

Analog channel
7 significant figures *1
Example: +1.234567E+03

Pulse channel
10 significant figures *1
Example: +1.234567890E+03

Waveform calculation channel
12 significant figures *1
Example: +1.23456789012E+03

Power calculation channel
6 significant figures *1
Example: +1.23456E+03 *2

Power status
Example 8-digit hexadecimal value
Example: 0205F800

Logic
Bi = 0 to 1
Example: 1

Alarm
Bi = 0 to 15
Example: 9
For the alarm channel, the integers representing all channels (4 bit) are returned (starting from the lowest bit, output in order of alarm 1, alarm 2…).
When the alarm channel data value is 9, alarm 1 and alarm 4 are output.

*1. The decimal point position changes so that the exponential part is a multiple of 3.
Example: +1.234567E+03, +12.34567E+03, +123.4567E+03, +1.234567E+06
*2. See M7103 Power Measurement Module “-3. Power range configuration” (p. 392)

4.7 Comparison of Realtime Data Acquisition

		Logger Utility	GENNECT One	Communication command	UDP output	CAN output	XCP on Ethernet
Shortest sampling period		5 ms	1 s	100 ms	5 ms	5 ms	5 ms
Number of operable instruments (Number of instruments that can be synchronized for sampling)		5 units	10 units	10 units	10 units	10 units	10 units
Maximum number of operable channels (Number of channels synchronized for sampling)		600 channels (For M7103, up to 30 channels per module)	512 channels	1500 channel (100 ms) Up to 150 channels (5 modules) per unit 3000 channels (200 ms) Up to 300 channels (10 modules) per unit*4	5000 channels Up to 500 channels per unit if the synchronization setting is enabled while using the primary unit to generate output.	100 channels (5 ms) 450 channels (10 ms) 1000 channels (20 ms) (Reference value when data are received using the CAN FD port only)	500 channels (5 ms to 100 ms) (For LAN1) No limit on number of channels (For LAN 2)
Output port	**LAN1**	✓	✓	✓*3	–	–	✓
	LAN2	–	–	–	✓	–	✓
	CAN	–	–	–	–	✓	–
How to obtain sample program		• Included on the provided DVD • The latest version can be obtained from the Hioki website.*1		• Sample program is included in the Instruction Manual (included on the provided DVD) • Sequence Maker*2	Sample program is included on the provided DVD	–	–

*1. https://www.hioki.com/global/support/download/software/
*2. https://sequencemaker.hioki.com/en/
*3. The number of input channels that can be handled with the communication command has been confirmed under the following environment. The number of channels that can be acquired varies depending on the usage environment and conditions.
Communication commands used: `:WAITNextsmpl?,:MEMory:TVFETch? MODULE 1` (executed for the number of modules)
Instrument (LR8102): The setting changes from the default status only during the recording interval
PC used: OS: Microsoft Windows 10 Pro (Ver 22H2), CPU: Intel® Core™ i7-9700K 3.60 GHz, RAM: 32 GB
*4. The following channel counts are also supported if there is one or more M7103 modules (with up to 293 channels per module):
100 ms: Up to 293 channels (1 module) per instrument
500 ms: Up to 1352 channels (10 modules) per instrument

Reference: Data transfer time of each command

Command used	Count	PC used	Total number of acquired data units	Approximate time required for acquiring the total data (sec)
`:MEMory:VDATa? 1000`	1000	OS: Microsoft Windows 10 Pro (22H2) CPU: Intel® i7-9700F 3.00 GHz RAM: 16 GB	1,000,000 points	70
`:MEMory:ADATa? 2000`	500			26
`:MEMory:BDATa? 5000`	200			4

This value is given only as a guide. The communication speed is not guaranteed. The communication speed varies depending on the usage environment.

5 Trigger Function

The trigger function allows you to specify conditions and signals to determine the timing for starting and stopping the measurement.
When the specified condition (trigger condition) is satisfied, the trigger is said to have been activated.
The position at which the trigger is activated (the trigger condition is satisfied) is called the “trigger point”.
You can set the instrument so that it starts and stops the recording when the triggers are activated.
One of the following can be selected as the trigger source.

- Analog trigger (level, window)
- Pulse (level, window)
- Logic trigger (realization condition, pattern)
- Waveform calculation (level, window)
- Interval trigger
- External trigger

The following specific conditions can be set for the instrument.

Specific conditions	Description	Reference
Start trigger	The recording is started from the moment the trigger condition is satisfied. Example: Recording is started if the temperature rises to 50°C or higher	p. 193
Stop trigger	Recording is stopped at the moment the trigger condition is satisfied. Example: Recording is stopped if the signal falls below 1 V	p. 193
External trigger	The trigger is activated with an external signal. (I/O 3) Example: Recording is started in accordance with the operation of other devices	p. 214
Pre-trigger	Data before the trigger point is also recorded. Example: Phenomena before an error occurs are also recorded	p. 194
Interval trigger	The trigger can be activated at constant intervals. Example: Recording is performed hourly	p. 215
Trigger satisfaction condition	You can set the condition under which the trigger is satisfied. Select AND/OR between the triggers.	p. 195

IMPORTANT

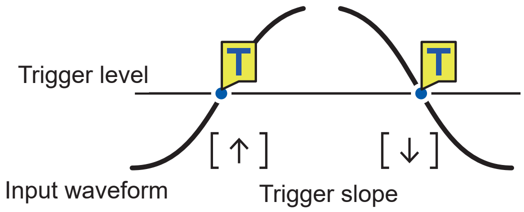
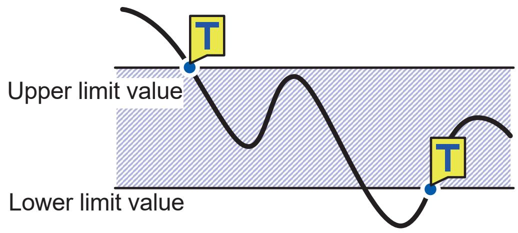
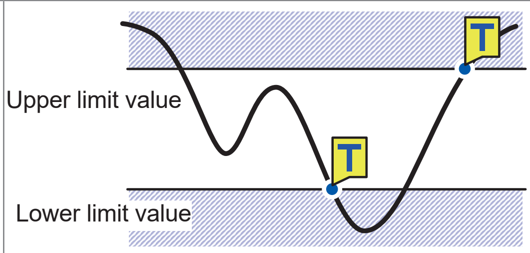
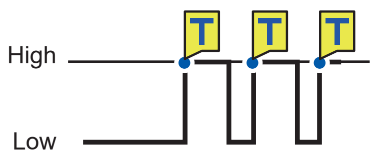
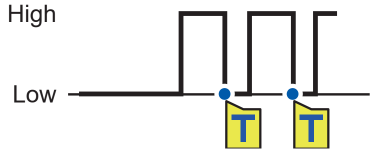
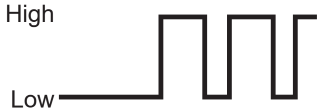
- If the trigger function is disabled, the recording is started when the **STARt** command is executed (free run).
- When the trigger function is enabled, the “trigger standby” is kept until the trigger condition is satisfied. The recording is started if the trigger condition is satisfied.
- When pre-trigger is used, the trigger is not activated with recovered data. In addition, the data during the pre-trigger standby is not recovered.
- The next trigger cannot be accepted while a trigger is being processed. The trigger output turns active while a trigger is being processed. For the trigger output, see (p. 309).

5.1 Trigger Contents

Set the conditions for starting or stopping the measurement.
Set the conditions with the trigger type (level, window, pattern) and slope (signal rise, fall).

Trigger type

There are the following three types.

Type		Operation	Description
Level trigger	↑		The trigger is activated when the waveform crosses above the level. The value equivalent to the level is included.
	↓		The trigger is activated when the waveform crosses below the specified level. However, the trigger is not activated if the waveform falls to become equal to the level value.*1
Window trigger	IN		The trigger is activated when the waveform enters the range between the upper and lower limit values. The value equivalent to the upper or lower limit value is included.
	OUT		The trigger is activated when the waveform exits the range between the upper and lower limit values. However, the trigger is not activated if the waveform rises to become equal to the upper limit value, or if the waveform falls to become equal to the lower limit value.*2
Pattern trigger	1		The trigger is activated when the logic signal turns into 1.
	0		The trigger is activated when the logic signal turns into 0.
	X		Ignores the signal. No trigger is activated.

*1. For the pulse channel, the trigger activates when the pulse decreases to zero, provided that the level value is set to zero.
*2. For the pulse channel, the trigger activates when the pulse decreases to zero, provided that the lower limit value is set to zero. Similarly, the trigger activates when the pulse increases to zero, provided that the upper limit value is set to zero.

5.2 Enabling the Trigger Function

Methods for starting and stopping the measurement using the trigger function are introduced here.

Common settings

1 **Set the trigger to ON.**

Settings		
Syntax	Command	:TRIGger:SET A$
Example	:TRIGger:SET ON	
Query		
Syntax	Query	:TRIGger:SET?
	Response	A$
Example	:TRIGger:SET? (Response) :TRIGGER:SET ON (When the header is ON)	
Parameter		
A$ = OFF, ON		

OFF☑	Trigger disabled
ON	Trigger enabled

Note
This setting may change the input type of external input terminal 3.

2 **Set the behavior when the trigger is activated.**

Settings		
Syntax	Command	:TRIGger:TIMIng A$
Example	:TRIGger:TIMIng START	
Query		
Syntax	Query	:TRIGger:TIMIng?
	Response	A$
Example	:TRIGger:TIMIng? (Response) :TRIGGER:TIMING START (When the header is ON)	
Parameter		
A$ = START, STOP, S_S		

START☑	Start trigger The recording begins when the trigger condition is satisfied (start trigger).
STOP	Stop trigger The recording stops when the trigger condition is satisfied (stop trigger).
S_S	Start and stop triggers The recording begins when the start trigger condition is satisfied, and the recording stops when the stop trigger condition is satisfied.

Note
This setting may change the input type of external input terminal 3.

3 Configure the amount of time or number of days to record before the trigger is activated.

Data before the trigger point (the moment the trigger is activated) can be recorded. This is useful for problem analyses, because the data before an abnormal phenomenon occurs can be recorded.
If the operation when the trigger is activated is set to STOP, the pre-trigger is disabled.

Pre-trigger

Settings		
Syntax	Command	:TRIGger:PRETrig day,hour,min,sec
Example	:TRIGger:PRETrig 0,0,0,10	
Query		
Syntax	Query	:TRIGger:PRETrig?
	Response	day<NR1>,hour<NR1>,min<NR1>,sec<NR1>
Example	:TRIGger:PRETrig? (Response) :TRIGGER:PRETRIG 0,0,0,10 (When the header is ON)	
Parameter		

day	0 to 99 (days)
hour	0 to 23 (hours)
min	0 to 59 (minutes)
sec	0 to 59 (seconds)

See “Data part” (p. 24).

Note

The recording interval setting may restrict the pre-trigger setting.
A time range for up to 100,000 samples can be set. However, the range cannot be set to 100 days or longer.
If a value exceeding the allowable setting range is specified, only the setting value allowed for each parameter should be set.
When an external sampling is used, this parameter cannot be set.

Tips: To continue the recording of waveform after the trigger, set the recording time longer than the pre-trigger.

4 **Set the condition under which the trigger is satisfied.**

Set the conditions for activation between various types of triggers (analog, pulse, logic, waveform calculation, external, and interval) using logical AND or logical OR operations.
When all trigger sources are OFF (no trigger is set), the recording is started immediately (free run).
The trigger conditions need to be set separately for the start and stop triggers.

AND/OR between the start trigger sources

Settings		
Syntax	Command	`:TRIGger:SOURce A$`
Example	`:TRIGger:SOURce AND`	
Query		
Syntax	Query	`:TRIGger:SOURce?`
	Response	`A$`
Example	`:TRIGger:SOURce?` (Response) `:TRIGGER:SOURCE AND` (When the header is ON)	
Parameter		
`A$` = OR, AND		

`OR`☑	Logical sum The trigger is activated if any one of the trigger conditions is satisfied. Trigger satisfaction condition is judged with edge.
`AND`	Logical multiplication The trigger is activated if all of the trigger conditions are satisfied. Trigger satisfaction condition is judged with level.

AND/OR between the stop trigger sources

Settings		
Syntax	Command	`:TRIGger:SSOURce A$`
Example	`:TRIGger:SSOURce AND`	
Query		
Syntax	Query	`:TRIGger:SSOURce?`
	Response	`:A$`
Example	`:TRIGger:SSOURce?` (Response) `:TRIGGER:SSOURCE AND` (When the header is ON)	
Parameter		
`A$` = OR, AND		

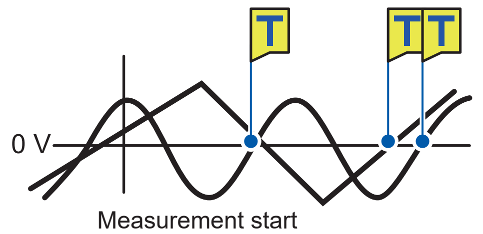
`OR`☑	Logical sum The trigger is activated if any one of the trigger conditions is satisfied. Trigger satisfaction condition is judged with edge.
`AND`	Logical multiplication The trigger is activated if all of the trigger conditions are satisfied. Trigger satisfaction condition is judged with level.

5
Trigger Function

If the trigger condition is satisfied at the moment the measurement begins, no trigger is activated. The trigger is activated if the trigger condition is changed from the unsatisfied to satisfied status.

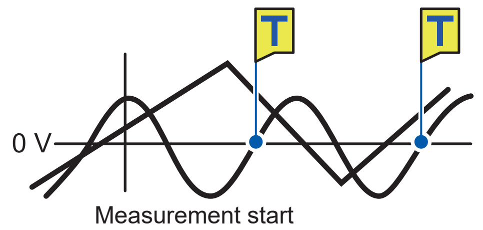
Example: The trigger is activated when the waveform crosses 0 V from below to above.
Type: Level trigger
Level: 0 V
Slope: ↑

[OR]



The trigger is activated when one crosses 0 V from below to above.

[AND]



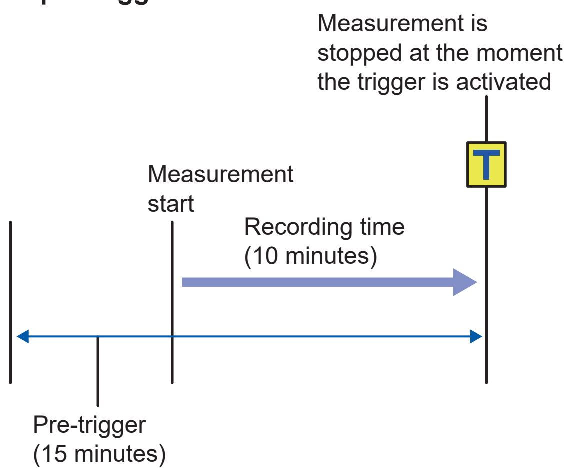
The trigger is activated when one is above 0 V and the other crosses 0 V from below to above.

Difference between the pre-trigger standby and trigger standby

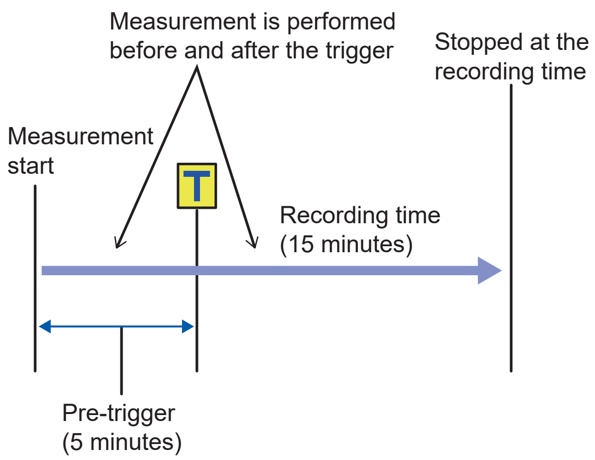
When measurement is started, the trigger acceptance is prohibited for the time specified for the pre-trigger. After the time for the pre-trigger elapses, establishment of the trigger condition is waited. The status during this period is trigger standby.
During the pre-trigger standby, the trigger is not activated even if the trigger condition is satisfied.

Relationship between the pre-trigger and recording time

When the recording time is shorter than the pre-trigger



When the recording time is longer than the pre-trigger

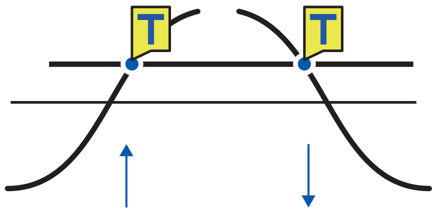


5.3 Analog Trigger, Pulse Trigger, and Waveform Calculation Trigger

The triggers can be set separately for the analog channel, pulse channel, and waveform calculation channel.
The following triggers can be set.
- Level trigger
- Window trigger

Level trigger

The trigger is activated when the waveform crosses the specified level (trigger level).
You can set the direction in which the waveform should cross the level (slope).



1 Set the trigger type to LEVEL.

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:KIND ch$,A$` (Start trigger) `:TRIGger:ANALog:STOP:KIND ch$,A$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:KIND w$,A$` (Start trigger) `:TRIGger:CALCulate:STOP:KIND w$,A$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:KIND pls$,A$` (Start trigger) `:TRIGger:PULSe:STOP:KIND pls$,A$` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:KIND CH1_1,LEVEL`	

Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:KIND? ch$` (Start trigger) `:TRIGger:ANALog:STOP:KIND? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:KIND? w$` (Start trigger) `:TRIGger:CALCulate:STOP:KIND? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:KIND? pls$` (Start trigger) `:TRIGger:PULSe:STOP:KIND? pls$` (Stop trigger)

	Response	Analog channel trigger
		`ch$,A$`
		Waveform calculation channel trigger
		`w$,A$`
		Pulse channel trigger
		`pls$,A$`

Example	`:TRIGger:ANALog:STARt:KIND? CH1_1` (Response) `:TRIGGER:ANALOG:START:KIND CH1_1,LEVEL` (When the header is ON)	

Parameter

`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`A$` = OFF, LEVEL, WINDOW

`OFF`☑	The trigger is not judged.
`LEVEL`	The trigger is judged with the specified level.
`WINDOW`	The trigger is judged with the range between the specified upper and lower limits (window).

Note

The conventional commands can also be used. (p.452)

2 **Set the slope.**

The trigger is activated when the waveform crosses the level in the specified direction.
When the trigger condition is set to AND, it is judged whether or not the waveform is above the specified level.

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:SLOPe ch$,A$` (Start trigger) `:TRIGger:ANALog:STOP:SLOPe ch$,A$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:SLOPe w$,A$` (Start trigger) `:TRIGger:CALCulate:STOP:SLOPe w$,A$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:SLOPe pls$,A$` (Start trigger) `:TRIGger:PULSe:STOP:SLOPe pls$,A$` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:SLOPe CH1_1,UP`	
Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:SLOPe? ch$` (Start trigger) `:TRIGger:ANALog:STOP:SLOPe? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:SLOPe? w$` (Start trigger) `:TRIGger:CALCulate:STOP:SLOPe? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:SLOPe? pls$` (Start trigger) `:TRIGger:PULSe:STOP:SLOPe? pls` (Stop trigger)

	Response	Analog channel trigger
		`ch$,A$`
		Waveform calculation channel trigger
		`w$,A$`
		Pulse channel trigger
		`pls$,A$`

Example	`:TRIGger:ANALog:STARt:SLOPe? CH1_1` (Response) `:TRIGGER:ANALOG:START:SLOPE CH1_1,UP` (When the header is ON)	
Parameter		

`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`A$` = UP, DOWN

`UP`☑	Rise The waveform crosses the specified level from below to above.
`DOWN`	Fall The waveform crosses below the specified level from above .

Note

The conventional commands can also be used. (p.452)

3 Set the trigger level.

The trigger is activated when the waveform crosses the specified level (temperature, voltage, etc.). When the scaling function is used, the value after scaling conversion can be used for setting the trigger level.

Settings		
Syntax	Command	Analog channel trigger :TRIGger:ANALog:STARt:LEVEl ch$,A (Start trigger) :TRIGger:ANALog:STOP:LEVEl ch$,A (Stop trigger) Waveform calculation channel trigger :TRIGger:CALCulate:STARt:LEVEl w$,A (Start trigger) :TRIGger:CALCulate:STOP:LEVEl w$,A (Stop trigger) Pulse channel trigger :TRIGger:PULSe:STARt:LEVEl pls$,A (Start trigger) :TRIGger:PULSe:STOP:LEVEl pls$,A (Stop trigger)
Example	:TRIGger:ANALog:STARt:LEVEl CH1_1,0.1	
Query		
Syntax	Query	Analog channel trigger :TRIGger:ANALog:STARt:LEVEl? ch$ (Start trigger) :TRIGger:ANALog:STOP:LEVEl? ch$ (Stop trigger) Waveform calculation channel trigger :TRIGger:CALCulate:STARt:LEVEl? w$ (Start trigger) :TRIGger:CALCulate:STOP:LEVEl? w$ (Stop trigger) Pulse channel trigger :TRIGger:PULSe:STARt:LEVEl? pls$ (Start trigger) :TRIGger:PULSe:STOP:LEVEl? pls$ (Stop trigger)
	Response	Analog channel trigger ch$,A<NR3> (3 digit after the decimal point) Waveform calculation channel trigger w$,A<NR3> (4 digits after the decimal point) Pulse channel trigger pls$,A<NR3> (9 digits after the decimal point)
Example	:TRIGger:ANALog:STARt:LEVEl? CH1_1 (Response) :TRIGGER:ANALOG:START:LEVEL CH1_1,+1.000E-01 (When the header is ON)	
Parameter		
ch$ = CH1_1 to CH10_30 w$ = W1 to W30 pls$ = PLS1 Analog channel trigger A = Allowable setting range: (Measurement range) × (±1.5), Maximum resolution: (Measurement range) × (1/1000)*1 Waveform calculation channel trigger A = -9.9999E+29 to 9.9999E+29 Pulse channel trigger A = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min) *1. When scaling is used, set the value after scaling. Example: For 1 V range A = Allowable setting range: +1.5 V to -1.5 V Maximum resolution: 1 mV When scaling is used with the 1 V range (1 V → 10 A) A = Allowable setting range: +15 A to -15 V Maximum resolution: 10 mV		

Note

If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.452)

Trigger level resolution

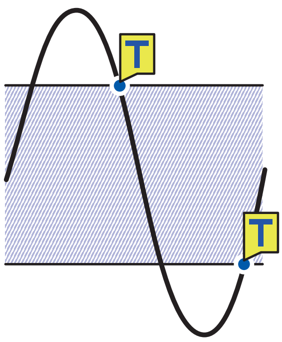
The trigger level resolution (minimum setting width) depends on the ranges.

Input	Range	Resolution
Voltage	1 mV f.s.	0.001 mV
	2 mV f.s.	0.002 mV
	5 mV f.s.	0.005 mV
	10 mV f.s.	0.01 mV
	20 mV f.s.	0.02 mV
	50 mV f.s.	0.05 mV
	100 mV f.s.	0.1 mV
	200 mV f.s.	0.2 mV
	1 V f.s.	0.001 V
	2 V f.s.	0.002 V
	6 V f.s.	0.006 V
	10 V f.s.	0.01 V
	20 V f.s.	0.02 V
	60 V f.s.	0.06 V
	100 V f.s.	0.1 V
	1-5 V f.s.	0.01 V
Temperature (thermocouple)	100°C f.s.	0.1°C
	500°C f.s.	0.5°C
	2000°C f.s.	2°C
Count	–	1 c
Rotation speed	5000 r/s	1 r/s
	300,000 r/min	1 r/min

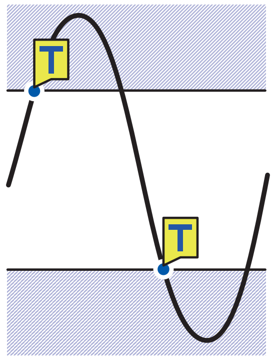
Window trigger

You can specify a range with upper and lower limit values (window), so that the trigger is activated when the waveform enters or exits the range.
The trigger can be activated when the waveform enters the range (window IN) as well as when the waveform exits the range (window OUT).

Window IN



Window OUT



1 **Set the trigger type to WINDOW.**

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:KIND ch$,A$` (Start trigger) `:TRIGger:ANALog:STOP:KIND ch$,A$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:KIND w$,A$` (Start trigger) `:TRIGger:CALCulate:STOP:KIND w$,A$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:KIND pls$,A$` (Start trigger) `:TRIGger:PULSe:STOP:KIND pls$,A$` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:KIND CH1_1,WINDOW`	
Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:KIND? ch$` (Start trigger) `:TRIGger:ANALog:STOP:KIND? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:KIND? w$` (Start trigger) `:TRIGger:CALCulate:STOP:KIND? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:KIND? pls$` (Start trigger) `:TRIGger:PULSe:STOP:KIND? pls$` (Stop trigger)

	Response	Analog channel trigger
		`ch$,A$`
		Waveform calculation channel trigger
		`w$,A$`
		Pulse channel trigger
		`pls$,A$`

Example	`:TRIGger:ANALog:STARt:KIND? CH1_1` (Response) `:TRIGGER:ANALOG:START:KIND CH1_1,WINDOW` (When the header is ON)	
Parameter		

`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`A$` = OFF, LEVEL, WINDOW

`OFF`☑	The trigger is not judged.
`LEVEL`	The trigger is judged with the specified level.
`WINDOW`	The trigger is judged with the range between the specified upper and lower limits (window).

2 Set IN/OUT of waveform.

When the trigger condition is set to AND, it is judged whether or not the waveform exists within the specified range.

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:SIDE ch$,A$` (Start trigger) `:TRIGger:ANALog:STOP:SIDE ch$,A$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:SIDE w$,A$` (Start trigger) `:TRIGger:CALCulate:STOP:SIDE w$,A$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:SIDE pls$,A$` (Start trigger) `:TRIGger:PULSe:STOP:SIDE pls$,A$` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:SIDE CH1_1,IN`	
Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:SIDE? ch$` (Start trigger) `:TRIGger:ANALog:STOP:SIDE? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:SIDE? w$` (Start trigger) `:TRIGger:CALCulate:STOP:SIDE? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:SIDE? pls$` (Start trigger) `:TRIGger:PULSe:STOP:SIDE? pls$` (Stop trigger)

	Response	Analog channel trigger
		`ch$,A$`
		Waveform calculation channel trigger
		`w$,A$`
		Pulse channel trigger
		`pls$,A$`

Example	`:TRIGger:ANALog:STARt:SIDE? CH1_1` (Response) `:TRIGGER:ANALOG:START:SIDE CH1_1,IN` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `w$` = W1 to W30 `pls$` = PLS1 `A$` = IN, OUT		

`IN`☑	Window IN The trigger is activated when the waveform enters the specified range.
`OUT`	Window OUT The trigger is activated when the waveform exits the specified range.

Note
The conventional command can also be used. (P. 434)

3 Set the upper and lower limit values.

The range between the upper and lower limit values is defined as the window.

Upper limit value

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:UPPEr ch$,A` (Start trigger) `:TRIGger:ANALog:STOP:UPPEr ch$,A` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:UPPEr w$,A` (Start trigger) `:TRIGger:CALCulate:STOP:UPPEr w$,A` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:UPPEr pls$,A` (Start trigger) `:TRIGger:PULSe:STOP:UPPEr pls$,A` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:UPPEr CH1_1,0.5`	
Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:UPPEr? ch$` (Start trigger) `:TRIGger:ANALog:STOP:UPPEr? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:UPPEr? w$` (Start trigger) `:TRIGger:CALCulate:STOP:UPPEr? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:UPPEr? pls$` (Start trigger) `:TRIGger:PULSe:STOP:UPPEr? pls$` (Stop trigger)
	Response	Analog channel trigger `ch$,A<NR3>` (3 digit after the decimal point) Waveform calculation channel trigger `w$,A<NR3>` (4 digits after the decimal point) Pulse channel trigger `pls$,A<NR3>` (9 digits after the decimal point)
Example	`:TRIGger:ANALog:STARt:UPPEr? CH1_1` (Response) `:TRIGGER:ANALOG:START:UPPER CH1_1,+5.000E-01` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30 `w$` = W1 to W30 `pls$` = PLS1 Analog channel trigger `A` = Allowable setting range: (Measurement range) × (±1.5), Maximum resolution: (Measurement range) × (1/1000) Waveform calculation channel trigger `A` = -9.9999E+29 to 9.9999E+29 Pulse channel trigger `A` = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min)		
Note		
You cannot input any values below the window trigger lower limit. If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input. If a value less than the lower limit of the allowable setting range is entered, the minimum value is input. The conventional commands can also be used. (p.452)		

Lower limit value

Settings		
Syntax	Command	Analog channel trigger `:TRIGger:ANALog:STARt:LOWEr ch$,A` (Start trigger) `:TRIGger:ANALog:STOP:LOWEr ch$,A` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:LOWEr w$,A` (Start trigger) `:TRIGger:CALCulate:STOP:LOWEr w$,A` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:LOWEr pls$,A` (Start trigger) `:TRIGger:PULSe:STOP:LOWEr pls$,A` (Stop trigger)
Example	`:TRIGger:ANALog:STARt:LOWEr CH1_1,-0.5`	
Query		
Syntax	Query	Analog channel trigger `:TRIGger:ANALog:STARt:LOWEr? ch$` (Start trigger) `:TRIGger:ANALog:STOP:LOWEr? ch$` (Stop trigger) Waveform calculation channel trigger `:TRIGger:CALCulate:STARt:LOWEr? w$` (Start trigger) `:TRIGger:CALCulate:STOP:LOWEr? w$` (Stop trigger) Pulse channel trigger `:TRIGger:PULSe:STARt:LOWEr? pls$` (Start trigger) `:TRIGger:PULSe:STOP:LOWEr? pls$` (Stop trigger)
	Response	Analog channel trigger `ch$,A<NR3>` (3 digit after the decimal point) Waveform calculation channel trigger `w$,A<NR3>` (4 digits after the decimal point) Pulse channel trigger `pls$,A<NR3>` (9 digits after the decimal point)
Example	`:TRIGger:ANALog:STARt:LOWEr? CH1_1` (Response) `:TRIGGER:ANALOG:START:LOWER CH1_1,-5.000E-01` (When the header is ON)	

Parameter

`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1

Analog channel trigger
`A` = Allowable setting range: (Measurement range) × (±1.5),
Maximum resolution: (Measurement range) × (1/1000)

Waveform calculation channel trigger
`A` = -9.9999E+29 to 9.9999E+29

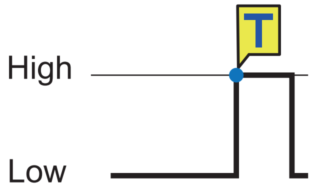
Pulse channel trigger
`A` = 0 to 1000000000 (count), 0 to 15000 (r/s),
0 to 900000 (r/min)

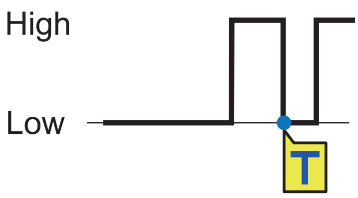
Note

You cannot input any values above the window trigger upper limit.
If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.452)

5.4 Logic Trigger (Pattern)

The trigger can be activated using the logic signal.
The trigger is activated when the logic signal value (1 and 0) matches the trigger pattern (1, 0, or X).
This setting is enabled when LOGIC is selected for the pulse (P1) input.
See “Logic signal measurement” (p. 159).





1 **Select the trigger pattern for P1.**

Enable the pulse measurement channel.

Settings		
Syntax	Command	`:TRIGger:LOGic:STARt:PATTern "A$"` (Start trigger) `:TRIGger:LOGic:STOP:PATTern "A$"` (Stop trigger)
Example	`:TRIGger:LOGic:STARt:PATTern "1"`	
Query		
Syntax	Query	`:TRIGger:LOGic:STARt:PATTern?` (Start trigger) `:TRIGger:LOGic:STOP:PATTern?` (Stop trigger)
	Response	`"A$"`
Example	`:TRIGger:LOGic:STARt:PATTern?` (Response) `:TRIGGER:LOGIC:START:PATTERN "1"` (When the header is ON)	
Parameter		
`A$` = 0, 1, X Trigger pattern		
`0`	The trigger is activated when the signal turns into 0 (Low).	
`1`	The trigger is activated when the signal turns into 1 (High).	
`X`☑	The trigger is not applicable. Ignores the signal.	
Note		
The conventional commands can also be used. (p.452)		

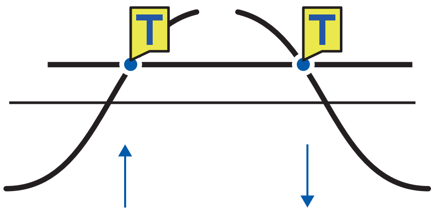
5.5 Power Trigger

Select the power channels for the trigger conditions. Up to 100 channels can be specified.
The following triggers can be set.

- Level trigger
- Window trigger

Level trigger

The trigger is activated when the waveform crosses the specified level (trigger level).
You can set the direction in which the waveform should cross the level (slope).



1 **Set the power channels to be used for the trigger.**

Settings		
Syntax	Command	:TRIGger:POWer:NO no$,ch$
Example	:TRIGger:POWer:NO NO1,M1URMS1	
Query		
Syntax	Query	:TRIGger:POWer:NO? no$
	Response	no$,ch$
Example	:TRIGger:POWer:NO? NO1 (Response) :TRIGGER:POWER:NO NO1,M1URMS1	
Parameter		
no$** = NO1 to NO100 **ch$ = M1URMS1 to M4TMS (p. 145)		
Note		
If the power channel has already been specified as another trigger condition number, it cannot be set.		

2 Set the trigger type to LEVEL.

Settings		
Syntax	Command	`:TRIGger:POWer:STARt:KIND no$,A$` `:TRIGger:POWer:STOP:KIND no$,A$`
Example	`:TRIGger:POWer:STARt:KIND NO1,LEVEL`	
Query		
Syntax	Query	`:TRIGger:POWer:STARt:KIND? no$` `:TRIGger:POWer:STOP:KIND? no$`
	Response	`no$,A$`
Example	`:TRIGger:POWer:STARt:KIND? NO1` (Response) `:TRIGGER:POWER:START:KIND NO1,LEVEL`	
Parameter		

no$ = NO1 to NO100

A = OFF, LEVEL, WINDOW

`OFF`☑	The trigger is not judged.
`LEVEL`	The trigger is judged with the specified level.
`WINDOW`	The trigger is judged with the range between the specified upper and lower limits (window).

3 Set the slope.

The trigger is activated when the waveform crosses the level in the specified direction.
When the trigger condition is set to AND, it is judged whether or not the waveform is above the specified level.

Settings		
Syntax	Command	`:TRIGger:POWer:STARt:SLOPe no$,A$` `:TRIGger:POWer:STOP:SLOPe no$,A$`
Example	`:TRIGger:POWer:STARt:SLOPe NO1,UP`	
Query		
Syntax	Query	`:TRIGger:POWer:STARt:SLOPe? no$` `:TRIGger:POWer:STOP:SLOPe? no$`
	Response	`no$,A$`
Example	`:TRIGger:POWer:STARt:SLOPe? NO1` (Response) `:TRIGGER:POWER:START:SLOPE NO1,UP`	
Parameter		

`no$` = NO1 to NO100

A`$` = UP, DOWN

`UP`☑	Rise The waveform crosses the specified level from below to above.
`DOWN`	Fall The waveform crosses below the specified level from above .

4 Set the trigger level.

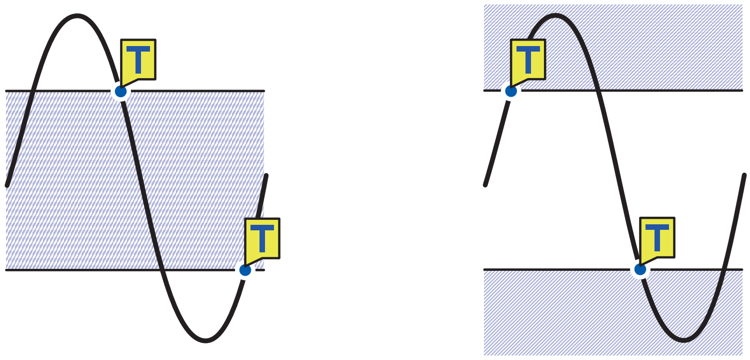
The trigger is activated when the waveform crosses the specified level.

Settings		
Syntax	Command	`:TRIGger:POWer:STARt:LEVEl no$,A` `:TRIGger:POWer:STOP:LEVEl no$,A`
Example	`:TRIGger:POWer:STARt:LEVEl NO1,0.1`	
Query		
Syntax	Query	`:TRIGger:POWer:STARt:LEVEl? no$` `:TRIGger:POWer:STOP:LEVEl? no$`
	Response	`no$,A`
Example	`:TRIGger:POWer:STARt:LEVEl? NO1` (Response) `:TRIGGER:POWER:START:LEVEL NO1,+1.000E-01`	
Parameter		
`no$` = NO1 to NO100 `A` = −9.9999E+29 to 9.9999E+29		
Note		
If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input. If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.		

Window trigger

You can specify a range with upper and lower limit values (window), so that the trigger is activated when the waveform enters or exits the range.
The trigger can be activated when the waveform enters the range (window IN) as well as when the waveform exits the range (window OUT).

Window IN **Window OUT**



1 **Set the power channels to be used for the 100 trigger conditions.**

Settings		
Syntax	Command	`:TRIGger:POWer:NO no$,ch$`
Example	`:TRIGger:POWer:NO NO1,M1URMS1`	
Query		
Syntax	Query	`:TRIGger:POWer:NO? no$`
	Response	`no$,ch$`
Example	`:TRIGger:POWer:NO? NO1` (Response) `:TRIGGER:POWER:NO NO1,M1URMS1`	
Parameter		
no$ = NO1 to NO100 ch$ = M1URMS1 to M4TMS (p. 145)		
Note		
If the channel has already been specified as another trigger condition number, it cannot be set.		

2 Set the trigger type to WINDOW.

Settings		
Syntax	Command	:TRIGger:POWer:STARt:KIND no$,A$:TRIGger:POWer:STOP:KIND no$,A$
Example	:TRIGger:POWer:STARt:KIND NO1,WINDOW	
Query		
Syntax	Query	:TRIGger:POWer:STARt:KIND? no$:TRIGger:POWer:STOP:KIND? no$
	Response	no$,A$
Example	:TRIGger:POWer:STARt:KIND? NO1 (Response) :TRIGGER:POWER:START:KIND NO1,WINDOW	
Parameter		

no$ = NO1 to NO100

A = OFF, LEVEL, WINDOW

OFF☑	The trigger is not judged.
LEVEL	The trigger is judged with the specified level.
WINDOW	The trigger is judged with the range between the specified upper and lower limits (window).

3 Set IN/OUT of waveform.

When the trigger condition is set to AND, it is judged whether or not the waveform exists within the specified range.

Settings		
Syntax	Command	:TRIGger:POWer:STARt:SIDE no$,A$:TRIGger:POWer:STOP:SIDE no$,A$
Example	:TRIGger:POWer:STARt:SIDE NO1,IN	
Query		
Syntax	Query	:TRIGger:POWer:STARt:SIDE? no$:TRIGger:POWer:STOP:SIDE? no$
	Response	no$,A$
Example	:TRIGger:POWer:STARt:SIDE? NO1 (Response) :TRIGGER:POWER:START:SIDE NO1,IN	
Parameter		

no$ = NO1 to NO100

A$ = IN, OUT

IN☑	Window IN The trigger is activated when the waveform enters the specified range.
OUT	Window OUT The trigger is activated when the waveform exits the specified range.

4 Set the upper and lower limit values.

The range between the upper and lower limit values is defined as the window.

Upper limit value

Settings		
Syntax	Command	`:TRIGger:POWer:STARt:UPPEr no$,A` `:TRIGger:POWer:STOP:UPPEr no$,A`
Example	`:TRIGger:POWer:STARt:UPPEr NO1,0.5`	
Query		
Syntax	Query	`:TRIGger:POWer:STARt:UPPEr? no$` `:TRIGger:POWer:STOP:UPPEr? no$`
	Response	`no$,A$`
Example	`:TRIGger:POWer:STARt:UPPEr? NO1` (Response) `:TRIGGER:POWER:START:UPPER NO1,+5.000E-01`	
Parameter		
`no$` = NO1 to NO100 `A` = −9.9999E+29 to 9.9999E+29		
Note		
You cannot input any values below the window trigger lower limit. If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input. If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.		

Lower limit value

Settings		
Syntax	Command	`:TRIGger:POWer:STARt:LOWEr no$,A` `:TRIGger:POWer:STOP:LOWEr no$,A`
Example	`:TRIGger:POWer:STARt:LOWEr NO1,-0.5`	
Query		
Syntax	Query	`:TRIGger:POWer:STARt:LOWEr? no$` `:TRIGger:POWer:STOP:LOWEr? no$`
	Response	`no$,A$`
Example	`:TRIGger:POWer:STARt:LOWEr? NO1` (Response) `:TRIGGER:POWER:START:LOWER NO1,-5.000E-01`	
Parameter		
`no$` = NO1 to NO100 `A` = −9.9999E+29 to 9.9999E+29		
Note		
You cannot input any values above the window trigger upper limit. If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input. If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.		

5.6 Applying External Trigger

The trigger can be activated with the input signal to the I/O 3 terminal of the external control terminal.

1 **Enable the external trigger function.**

<table>
<tr><th colspan="3">Settings</th></tr>
<tr><td>Syntax</td><td>Command</td><td><code>:TRIGger:EXTernal:STARt:KIND A$</code> (Start trigger)
<code>:TRIGger:EXTernal:STOP:KIND A$</code> (Stop trigger)</td></tr>
<tr><td>Example</td><td colspan="2"><code>:TRIGger:EXTernal:STARt:KIND ON</code></td></tr>
<tr><th colspan="3">Query</th></tr>
<tr><td rowspan="2">Syntax</td><td>Query</td><td><code>:TRIGger:EXTernal:STARt:KIND?</code> (Start trigger)
<code>:TRIGger:EXTernal:STOP:KIND?</code> (Stop trigger)</td></tr>
<tr><td>Response</td><td><code>A$</code></td></tr>
<tr><td>Example</td><td colspan="2"><code>:TRIGger:EXTernal:STARt:KIND?</code>
(Response) <code>:TRIGGER:EXTERNAL:START:KIND ON</code> (When the header is ON)</td></tr>
<tr><th colspan="3">Parameter</th></tr>
<tr><td colspan="3"><code>A$</code> = OFF, ON</td></tr>
<tr><td><code>OFF</code>☑</td><td colspan="2">Disabled</td></tr>
<tr><td><code>ON</code></td><td colspan="2">Activated</td></tr>
</table>

The external trigger function is enabled, allowing you to apply a trigger with the external input signal.
When the external trigger is enabled, the I/O 3 terminal is set to the trigger input.

5.7 Applying Triggers at Constant Intervals

The trigger can be activated at constant time intervals.
If the interval trigger is set to **OR** or **AND**, the repetitive recording is automatically set to ON.
The interval trigger is disabled when using Logger Utility.

1 Set the interval trigger condition.

To prioritize the interval trigger, set the parameter to **OR**.
To prioritize other triggers, set the parameter to **AND**.

Settings		
Syntax	Command	`:TRIGger:TIMEr A$`
Example	`:TRIGger:TIMEr OR`	
Query		
Syntax	Query	`:TRIGger:TIMEr?`
	Response	`A$`
Example	`:TRIGger:TIMEr?` (Response) `:TRIGGER:TIMER OR` (When the header is ON)	
Parameter		
`A$` = OFF, OR, AND		

`OFF`☑	Disabled The interval trigger is not used.
`OR`	Logical sum The interval trigger is used with the OR condition.
`AND`	Logical multiplication The interval trigger is used with the AND condition.

Note
Any changes to these settings may also change the repetitive recording settings.

2 Set the interval of the interval trigger.

The trigger condition is satisfied as soon as the measurement is started. After that, the trigger is activated at the intervals of the interval trigger.

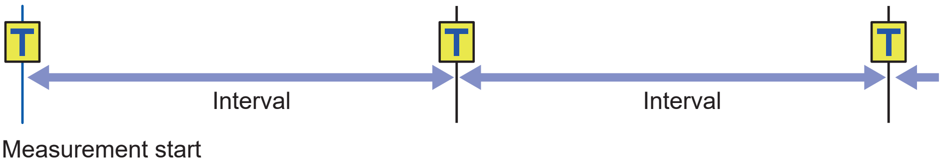
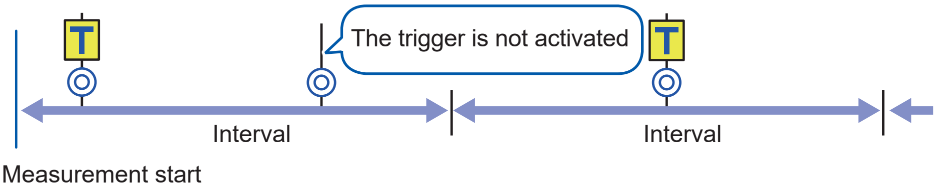
Settings		
Syntax	Command	`:TRIGger:TMINTvl day,hour,min,sec`
Example	`:TRIGger:TMINTvl 1,20,30,00`	
Query		
Syntax	Query	`:TRIGger:TMINTvl?`
	Response	`day<NR1>,hour<NR1>,min<NR1>,sec<NR1>`
Example	`:TRIGger:TMINTvl?` (Response) `:TRIGGER:TMINTVL 1,20,30,00` (When the header is ON)	
Parameter		

`day`	0 to 99 (days)
`hour`	0 to 23 (hours)
`min`	0 to 59 (minutes)
`sec`	0 to 59 (seconds)

The current setting of the recording time is returned with a numerical value in the NR1 format.
See “Data part” (p. 24).

Note
“`:TRIGger:TMINTvl 0,0,0,0`” cannot be set.

OR condition and AND condition

Trigger condition	T: Trigger point, ◎: Other trigger conditions
OR	
AND	One trigger is valid within one interval.  The trigger is not activated unless another trigger condition matches (if no other trigger condition is set, the operation is performed as with the OR condition).

5.8 Applying Trigger Forcibly

The trigger can be forcibly activated in the trigger standby state.
The forcible trigger can be activated regardless of the trigger source setting.

1 Activate the trigger forcibly.

Settings		
Syntax	Command	`:TRIGger:MANUal`
Example	`:TRIGger:MANUal`	

5.9 Trigger Setting Examples

The following are examples of the trigger settings.

Purpose	Reference (Table below)
Acquire data since the **START** command is executed until the **STOP** command is executed.	No. 1
Acquire 1-minute data one time after the **START** command is executed.	No. 2
Acquire a series of 1-minute data for 60 minutes after the **START** command is executed.	No. 3
Acquire data since the **START** command is executed until the measurement temperature in CH1 exceeds 500°C.	No. 4
Acquire data once the measurement temperature in CH1 exceeds 500°C until the **STOP** command is executed.	No. 5
Acquire data once the measurement temperature in CH1 exceeds 500°C until the temperature falls below 300°C.	No. 6
Acquire data repeatedly once the measurement temperature in CH1 exceeds 500°C until the temperature falls below 300°C.	No. 7
Acquire data for 1 minute after the measurement temperature in CH1 exceeds 500°C.	No. 8
Acquire data for 1 minute before and after the measurement temperature in CH1 exceeds 500°C.	No. 9
Acquire data from 2023-6-17 9:00 to 17:00.	No. 10
Acquire 24-hour data daily for 1 month starting from 2023-6-17 9:00.	No. 11
Acquire data from 9:00 to 17:00 daily for 1 month starting from 2023-6-17.	No. 12
Acquire 1-hour data at 9:00, 15:00, 21:00, and 3:00 for 1 month starting from 2023-6-17.	No. 13

No.	Measurement start	Measurement stop	Recording start	Recording stop	Others
1	Manual	Manual	–	–	–
2	Manual	Manual	–	Time specification: 1 minute	–
3	Manual	Manual	–	Time specification: 1 hour	File splitting: 1 minute
4	Manual	Manual	–	Stop trigger ↑500°C	–
5	Manual	Manual	Start trigger ↑500°C	–	–
6	Manual	Manual	Start trigger ↑500°C	Stop trigger ↓300°C	–
7	Manual	Manual	Same as above	Same as above	Repetitive recording
8	Manual	Manual	Start trigger ↑500°C	Time specification: 1 minute	–
9	Manual	Manual	Same as above	Same as above	Pre-trigger: 1 minute
10	Time 2023-6-17 9:00	Time 2023-6-17 17:00	–	–	–
11	Time 2023-6-17 9:00	Time 2023-7-17 9:00	–	–	File splitting: 1 day

No.	Measurement start	Measurement stop	Recording start	Recording stop	Others
12	Time 2023-6-17 9:00	Time 2023-7-17 9:00	Interval trigger: 1 day	Time specification: 8 hour	Repetitive recording
13	Time 2023-6-17 9:00	Time 2023-7-17 9:00	Interval trigger: 6 hours	Time specification: 1 hour	Repetitive recording

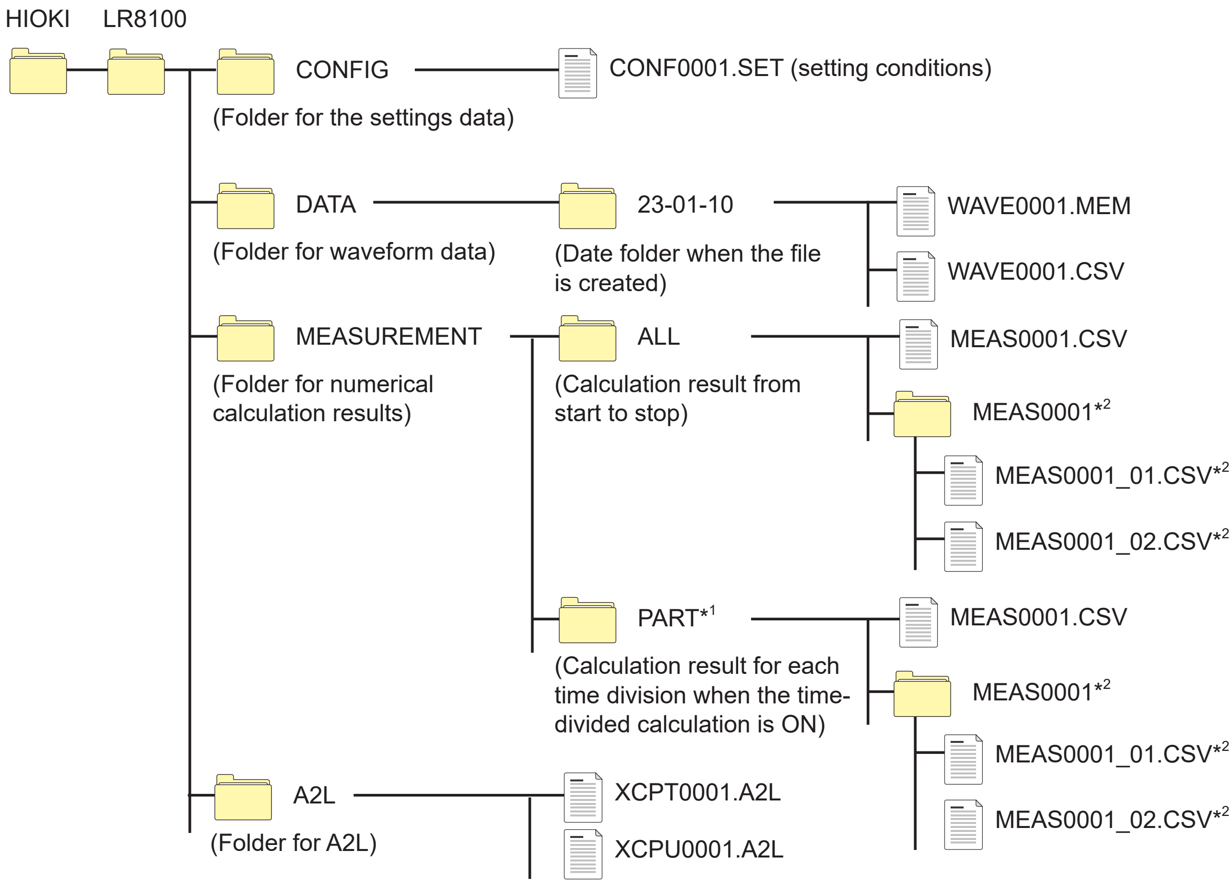
6 Saving and Loading Data

The measurement conditions of the instrument and the waveform data can be stored on SD memory cards and USB drives.

IMPORTANT
The operation is guaranteed only for the optional SD memory cards and USB drives. The operation of storage media other than the optional parts is not guaranteed.

6.1 Savable and Loadable Data

When data are saved on an SD memory card or USB drive, folders are created in **[HIOKI]** > **[LR8100]**.
The files are saved in the created folders as shown in the figure below.



*1: When the calculation period is set to divided or divided on time, the **[PART]** folder is added. The calculation result from start to stop is stored in **[ALL]**, while the calculation result for each division is stored in **[PART]**.
*2: Created if the saving settings are configured to Individual calc (separate file for each calculation).

When a file is saved without specifying a file name

The file is named as follows.

• Automatically saved waveform data: AUTO****.xxx
• Automatically saved numerical calculation result: AUTO****.xxx
• Manually saved setting data: CONF****.SET
• Manually saved waveform data: WAVE****.xxx
• Manually saved numerical calculation result: MEAS****.xxx
• Manually saved A2L data (for LAN1): XCPT****.A2L
• Manually saved A2L data (for LAN2): XCPU****.A2L

[****] represents a number (0001 to 9999).

[.xxx] represents an extension (.MEM, .CSV, .TXT).

✓: Possible, –: Impossible

Type	Format	Folder name	File name*4 (automatically numbered starting from 1)	Save		Load	
				Automatic	Manual	Instrument	PC
Setting condition	Binary	CONFIG	CONF0001.SET	–	✓	✓	–
Waveform data*1	Binary	DATA¥(Date)*3 Example: 23-01-10	AUTO0001.MEM WAVE0001.MEM	✓	✓	–	✓
	Text*2		AUTO0001.CSV WAVE0001.CSV *5	✓	✓	–	✓
	MDF		AUTO0001.MF4	✓	✓	–	✓*7
Numerical calculation results	Text*2	MEASUREMENT	AUTO0001.CSV MEAS0001.CSV *6	✓	✓	–	✓
CAN setting*8	Binary	–	****.CES	–	–	✓	✓*9
A2L file*10	–	A2L	XCPT0001.A2L XCPU0001.A2L	–	✓	–	✓*11

*1: To load the waveform data with the Logger Utility, save the data in the binary format. A part of the setting conditions during the measurement is saved with the waveform data.
When the waveform data after scaling conversion is saved in the binary format, the waveform before the scaling conversion and the scaling settings are recorded. When the waveform data are loaded, the waveform after scaling conversion is displayed. The waveform before the conversion can be displayed by setting the scaling to OFF.

*2: If the CSV data are loaded with a spreadsheet software, there is a limit to the number of lines that can be loaded at one time.

*3: Under the **[DATA]** folder, date folders (Year-Month-Day) are automatically created. If the number of files in a folder exceeds 1000, a new folder is created.
Example: 23-01-10_0000

*4: For the name of files saved manually, see “14.5 File Name” (p. 415).

*5: If the delimiter is other than **[COMMA]**, the extension is **[.TXT]**. (p.234)

*6: If the Individual calc (separate file for each calculation) is set, “_calculation number” is attached as **[MEAS0001_1.CSV]** and **[MEAS0001_2.CSV]**.

*7: Requires commercial software that can load MDF.

*8: This file is created with the PC application (CAN Editor) to be loaded with the instrument.

*9: Requires the PC application (CAN Editor).
*10: This file is saved with the instrument to be loaded with a third-party PC application.
*11: Requires measurement/compatible software for ECU.

> Tips
> **Number of files**
> It is recommended that the number of files saved in one folder should be 1000 or less.
> Although more than 1000 files can be saved, it takes a longer time for saving as the number of files increase.
> In the auto-save operation, if the number of the files in the folder exceeds 1000, a folder is created and the destination folder is switched automatically.

Preparations and settings in case of power failure

⚠CAUTION

■ **Do not use a damaged medium.**

The file completion processing may not end within the expected time, damaging the file.

If the power supply is shut down during the measurement, the measurement data cannot be retained. If measurement is performed for a long time, the following preparations and settings are recommended.

- Set the saving format for the waveform data in the auto-save operation.
  While the measurement is performed, the waveform data are saved on an SD memory card or USB drive.
  See “6.3 Saving Data” (p. 225).

> Tips
> It is recommended that you set **[BIN]** (binary format) for the auto-save operation.
> Files saved with the **[CSV]** (text format) setting cannot be loaded with the instrument or Logger Utility.
> Binary data (MEM file) saved with the **[BIN]** setting can be converted to the text format using Logger Utility.
> Data including M7103 Power Measurement Module cannot be opened using the Logger Utility.

6
Saving and Loading Data

6.2 Formatting Media

Format an SD memory card and USB drive before the first use.

Query		
Syntax	Query	`:MEDia:SD:FORMat?` `:MEDia:USB:FORMat?`
	Response	`A$`
Example	`:MEDia:SD:FORMat?` (Response) `:MEDIA:SD:FORMAT? SUCCESS` (When the header is ON)	
Parameter		
`A$` = FAIL, SUCCESS Formats media and returns the result.		

`FAIL`	Format has failed.
`SUCCESS`	Format has succeeded.

IMPORTANT
All data on the medium will be deleted.

⚠CAUTION

- **Back up important data and store it in a safe place.**

  SD memory cards and USB drives have a service life because flash memory is used. They lose the ability to store and load data after extended or frequent use. If you encounter this issue, purchase a new drive. Hioki is not liable for data stored on SD memory cards and USB drives, regardless of the nature or cause of the accident or damage involved.

- **When formatting an SD memory card or USB drive with a PC, select the FAT/FAT32.**

  The media formatted to other formats (NTFS, etc.) cannot be recognized with the instrument.

IMPORTANT
Use the instrument to format new SD memory cards and USB drive before use. If the media are formatted with a PC, the realtime saving may not be completed in time.

6.3 Saving Data

There are two ways to save data as follows.

To save data automatically during the measurement

↓

Auto-save operation

Configure the settings before starting the measurement.

The measurement data is saved as soon as the measurement is performed.
The calculation results are saved when the measurement is stopped.
(p.226)

Insert an SD memory card or USB drive

Execute the commands

Auto-save setting (p.226)

Set the contents to be saved

The following can be saved simultaneously.
- Waveform data
- Numerical calculation results

Measurement

↓

Saved automatically

To execute saving using the command

↓

Manual save operation

Set the contents to be saved in advance.

When the **SAVE** command is executed, the specified contents are saved.
(p.235)

Insert an SD memory card or USB drive

Execute the commands

Manual save setting (p.235)

Data that can be saved
- Waveform data
- Setting condition
- Numerical calculation results
- A2L file

SAVE command executed
(Data cannot be saved during the measurement) (p.236)

↓

Save

Auto save (Realtime save)

While the measurement is performed, the waveform data can be saved (realtime save) on a medium (SD memory card or USB drive).
The numerical calculation results can also be saved on the medium automatically.
It is also possible to automatically save both the waveform data and the numerical calculation results.
The following measurement data can be saved automatically.

Content to be saved	Parameter	File extension	Description
Waveform data	Binary format	.MEM	The waveform data are saved in the dedicated format (binary format) for the instrument. It is recommended that the binary format (MEM) is set normally.
	Text format	.CSV, .TXT*1	The waveform data are saved in the text format. The files can be loaded with spreadsheet software, but cannot be loaded with the Logger Utility.
	MDF format	.MF4	The waveform data are saved in the MDF (Ver. 4) format. The files can be loaded on a PC with a waveform viewer supporting the MDF format. The files cannot be loaded with the Logger Utility.
Numerical calculation results	Text format	.CSV, .TXT*1	The results of the numerical calculation are saved after measurement is stopped.

*1: If the delimiter in the text format is other than **[COMMA]**, the extension is **[.TXT]**.

Limitation of the auto-save operation for the binary and text formats.

The auto-save operation has the following limitations for the saving format, recording interval, and number of channels used.

Saving format	Recording interval	Channels used	
		Without power measurement module	With power measurement module
MEM, MDF	5 ms	No limit	Maximum of 300 channels
	10 ms		Maximum of 600 channels
	20 ms or more		No limit
CSV	5 ms	Cannot set the auto-save operation	
	10 ms	Maximum of 30 channels	Maximum of 30 channels
	20 ms	Maximum of 60 channels	Maximum of 60 channels
	50 ms	Maximum of 150 channels	Maximum of 150 channels
	100 ms	No limit	Maximum of 200 channels
	200 ms		Maximum of 500 channels
	500 ms or more		No limit

IMPORTANT
The operation is guaranteed only for the optional SD memory cards and USB drives. The operation of storage media other than the optional parts is not guaranteed.

1 Specify the file name when saving.

Number “0001” is attached to the end of the file name entered. The number is incremented by 1 starting from the next file name.
Example: If ABC is specified and the file is saved in the binary format
ABC0001.MEM, ABC0002.MEM, ABC0003.MEM, ...
Example: If ABC100 is specified and the file is saved in the binary format
ABC1000001.MEM, ABC1000002.MEM, ABC1000003.MEM, ...

If no file name is specified, the file is named automatically.
See “When a file is saved without specifying a file name” (p. 222).

Settings		
Syntax	Command	`:CONFigure:FILEName "A$"`
Example	`:CONFigure:FILEName "ABC"`	
Query		
Syntax	Query	`:CONFigure:FILEName?`
	Response	`A$`
Example	`:CONFigure:FILEName?` (Response) `:CONFIGURE:FILENAME "ABC"` (When the header is ON)	
Parameter		
`A$` = File name (up to 4 double-byte characters or 8 single-byte characters)		
Note		
This can also be set with parameter `B$` for the “`:CONFigure:ATSAve`” command. If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

2 Set whether or not to attach a title comment to the file name.

When the parameter is set to ON, the file is named as follows.
Set file name_title comment.MEM

Settings		
Syntax	Command	`:CONFigure:ADDComment A$`
Example	`:CONFigure:ADDComment ON`	
Query		
Syntax	Query	`:CONFigure:ADDComment?`
	Response	`A$`
Example	`:CONFigure:ADDComment?` (Response) `:CONFIGURE:ADDCOMMENT ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	No title comment is attached (serial number is attached automatically).
`ON`	A title comment is attached.

3 **Set whether or not to attach the date and time to the file name.**

When the parameter is set to ON, the file is named as follows.

Input file name_230324_235959_0001.MEM (when the trigger is activated at 2023/03/24 23:59:59)

Settings		
Syntax	Command	`:CONFigure:ADDDate A$`
Example	`:CONFigure:ADDDate ON`	
Query		
Syntax	Query	`:CONFigure:ADDDate?`
	Response	`A$`
Example	`:CONFigure:ADDDate?` (Response) `:CONFIGURE:ADDDATE ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	No trigger date is attached (serial number is attached automatically).
`ON`	The trigger date is attached.

4 **Set the medium to save files preferentially.**

When an SD memory card and USB drive are inserted, files are saved on the specified medium.
If the specified medium is not inserted, files are saved on the other medium.

Settings		
Syntax	Command	`:CONFigure:SAVEPri A$`
Example	`:CONFigure:SAVEPri SD`	
Query		
Syntax	Query	`:CONFigure:SAVEPri?`
	Response	`A$`
Example	`:CONFigure:SAVEPri?` (Response) `:CONFIGURE:SAVEPRI SD` (When the header is ON)	
Parameter		
`A$` = SD, USB		

`SD`☑	SD memory card
`USB`	USB drive

5 Set the saving format for the auto-save operation.

(1) Set all settings at once.

Settings		
Syntax	Command	`:CONFigure:ATSAve A$(,"B$")`
Example	`:CONFigure:ATSAve BIN,"AUTO"`	
Query		
Syntax	Query	`:CONFigure:ATSAve?`
	Response	`A$(,"B$")`
Example	`:CONFigure:ATSAve?` (Response) `:CONFIGURE:ATSAVE BIN,"AUTO"` (When the header is ON)	
Parameter		

`A$` = OFF, BIN, CSV, MF4, MEAS, BIN_MEAS, CSV_MEAS, MF4_MEAS
`B$` = File name (up to 4 double-byte characters or 8 single-byte characters, `A$` = Omitted when the setting is OFF)

	Waveform data	Numerical calculation results
`OFF`☑	Disables saving of data.	Disables saving of data.
`BIN`	Saves in the binary format.	Disables saving of data.
`CSV`	Saves in the text format.	Disables saving of data.
`MF4`	Saves in the MDF4 format.	Disables saving of data.
`MEAS`	Disables saving of data.	Saves in the text format.
`BIN_MEAS`	Saves in the binary format.	Saves in the text format.
`CSV_MEAS`	Saves in the text format.	Saves in the text format.
`MF4_MEAS`	Saves in the MDF4 format.	Saves in the text format.

Note

The waveform data saving format can also be set using the `:SAVEWave` command.
The saving format of the numerical calculation result can also be set using the `:SAVECalc` command.
The file name can also be set using the `:FILEName` command.

(2) Set the saving format for the waveform data.

Settings		
Syntax	Command	`:CONFigure:SAVEWave A$`
Example	`:CONFigure:SAVEWave BIN`	
Query		
Syntax	Query	`:CONFigure:SAVEWave?`
	Response	`A$`
Example	`:CONFigure:SAVEWave?` (Response) `:CONFIGURE:SAVEWAVE BIN` (When the header is ON)	
Parameter		

`A$` = OFF, BIN, CSV, MF4

`OFF`☑	Disables the auto-save operation.
`BIN`	Saves in the binary format. A file is created with extension .MEM.
`CSV`	Saves in the text format.
`MF4`	Saves in the MDF4 format.

Note

This can also be set with parameter `A$` for the "`:CONFigure:ATSAve`" command.

6 Saving and Loading Data

(When the saving format is set to CSV)

Set whether or not to perform the downsampling operation.

Settings		
Syntax	Command	`:CONFigure:THINOut A`
Example	`:CONFigure:THINOut 1000`	
Query		
Syntax	Query	`:CONFigure:THINOut?`
	Response	`A<NR1>`
Example	`:CONFigure:THINOut?` (Response) `:CONFIGURE:THINOUT 1000` (When the header is ON)	
Parameter		
`A` = 1 (OFF) to 100000*1		

`1`☑	Disables the downsampling operation.
`2` to `100000`	Decreases the data size to be saved. Example: If the parameter is set to `5`, 1 out of 5 data points is retained.

*1. Input in the format of A<NR1>.

See “Data part” (p. 24).

(When 2 or more is set for the downsampling)

Set the method to downsample the data.

Settings		
Syntax	Command	`:CONFigure:THINData A$`
Example	`:CONFigure:THINData INSTANT`	
Query		
Syntax	Query	`:CONFigure:THINData?`
	Response	`A$`
Example	`:CONFigure:THINData?` (Response) `:CONFIGURE:THINDATA INSTANT` (When the header is ON)	
Parameter		
`A$` = INSTANT, STATISTICS		

`INSTANT`☑	The first data is saved. Example: If the parameter is set to `5`, only the first data out of 5 is saved.
`STATISTICS`	The statistical data (maximum, minimum, average, and the first data) is saved. Example:If the parameter is set to `5`, the maximum, minimum, and average of 5 data sets and the first data are saved.

Set the processing method when the instrument runs out of free space on the media during the saving operation. (as needed).

Settings		
Syntax	Command	`:CONFigure:SAVEMode A$`
Example	`:CONFigure:SAVEMode FILEfull`	
Query		
Syntax	Query	`:CONFigure:SAVEMode?`
	Response	`A$`
Example	`:CONFigure:SAVEMode?` (Response) `:CONFIGURE:SAVEMODE FILEFULL` (When the header is ON)	
Parameter		
`A$` = FILEfull, REMove		

`FILEfull`☑	Deletion mode in the auto-save operation OFF When the instrument runs short of free space on the destination storage medium, the auto-save operation is stopped.
`REMove`	Deletion mode in the auto-save operation ON The oldest waveform file (binary, text) is deleted and the auto-save operation is continued. If no waveform file can be deleted, the save operation is stopped. The numerical calculation results are not deleted.

Set the timing to divide a folder. (as needed).

The save destination folder can be divided based on the specified period.

Example: If the parameter is set to WEEK
When measurement is started on 2023/03/26 (Sun), 2023/03/20 (Mon) is the starting point of the week.
In this case, the folder created automatically is named “23-03-20”.

Example: If the parameter is set to MONTH
When measurement is started on 2023/03/29, 2023/03/01 is the starting point of the month.

In this case, the folder created automatically is named “23-03-01”.

Settings		
Syntax	Command	`:CONFigure:AUTOFolder A$`
Example	`:CONFigure:AUTOFolder DAY`	
Query		
Syntax	Query	`:CONFigure:AUTOFolder?`
	Response	`A$`
Example	`:CONFigure:AUTOFolder?` (Response) `:CONFIGURE:AUTOFOLDER DAY` (When the header is ON)	
Parameter		
`A$` = OFF, DAY, WEEK, MONTH		

`OFF`☑	Division disabled
`DAY`	1 day
`WEEK`	1 week
`MONTH`	1 month

When an external sampling is used, only OFF (Disable) can be set.

Set the division method (as needed).

The save destination file can be divided based on the specified time.
When an external sampling is used, file splitting cannot be performed.

Settings		
Syntax	Command	:CONFigure:SAVEKind A$
Example	:CONFigure:SAVEKind NORMal	
Query		
Syntax	Query	:CONFigure:SAVEKind?
	Response	A$
Example	:CONFigure:SAVEKind? (Response) :CONFIGURE:SAVEKIND NORMAL (When the header is ON)	
Parameter		
A$ = NORMal, DIVide, REGUlarly		

NORMal☑	Division disabled One set of recorded data is saved in one file. However, the file is divided automatically if the file size has exceeded 1 GB.
DIVide	Division enabled The data is divided and the save destination file is switched to another file every time after the specified time elapses. However, if the file size has exceeded 1 GB, the file is divided even when the division time has not elapsed.
REGUlarly	Divided on time Set the reference time. The save destination file is switched to another file every time after the division time has elapsed starting from the reference time. When the recording is started, the measurement start is kept on standby until the recording interval is synchronized with the reference time.

(When DIVide is selected for the file splitting)
Set the period to execute the file splitting.

Settings		
Syntax	Command	:CONFigure:SAVELen day,hour,min
Example	:CONFigure:SAVELen 0,0,10	
Query		
Syntax	Query	:CONFigure:SAVELen?
	Response	day<NR1>,hour<NR1>,min<NR1>
Example	:CONFigure:SAVELen? (Response) :CONFIGURE:SAVELEN 0,0,10 (When the header is ON)	
Parameter		

day	0 to 30 (days)
hour	0 to 23 (hours)
min	0 to 59 (minutes)

Minimum of 1 minute

(When REGUlarly is selected for the file splitting)

Set the time that serves as a reference for dividing a file.

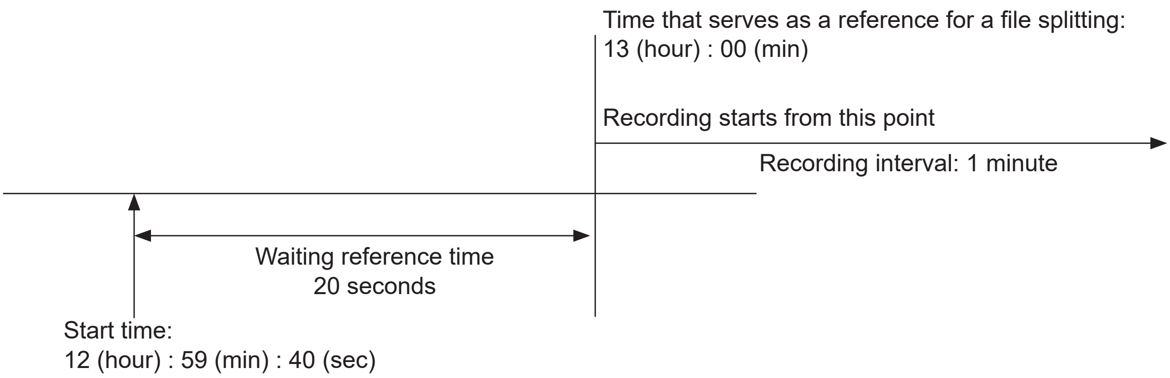
Settings		
Syntax	Command	`:CONFigure:SAVEReg hour,min`
Example	`:CONFigure:SAVEReg 0,0`	
Query		
Example	`:CONFigure:SAVEReg?` (Response) `:CONFIGURE:SAVEREG 0,0` (When the header is ON)	
Parameter		
`hour`	0 to 23 (hours)	
`min`	0 to 59 (minutes)	

Set the period to divide a file.

Settings		
Syntax	Command	`:CONFigure:SAVETime A`
Example	`:CONFigure:SAVETime 1`	
Query		
Syntax	Query	`:CONFigure:SAVETime?`
	Response	`A<NR1>`
Example	`:CONFigure:SAVETime?` (Response) `:CONFIGURE:SAVETIME 1` (When the header is ON)	
Parameter		
`A` = 1, 2, 5, 10, 15, 20, 30, 60 (1 hour), 120 (2 hours), 180 (3 hours), 240 (4 hours), 360 (6 hours), 480 (8 hours), 720 (12 hours), 1440 (1 day) (unit min)		
Note		
If a value not listed in the settings is specified, and if there are split times longer than the specified value, the nearest split time is applied.		

The instrument may be in the waiting status for the reference time, depending on the recording interval and start time. Recording starts when the reference time has arrived.

Example when the recording interval is 1 minute



6 **Set the saving format of numerical calculation results for the auto-save operation.**

Settings		
Syntax	Command	`:CONFigure:SAVECalc A$`
Example	`:CONFigure:SAVECalc CSV`	
Query		
Syntax	Query	`:CONFigure:SAVECalc?`
	Response	`A$`
Example	`:CONFigure:SAVECalc?` (Response) `:CONFIGURE:SAVECALC CSV` (When the header is ON)	
Parameter		
`A$` = OFF, CSV		
`OFF`☑	Disables the auto-save operation.	
`CSV`	Saves data in the text format.	
Note		
This can also be set with parameter `A$` for the "`:CONFigure:ATSAve`" command.		

Set whether or not to divide the file to be saved. (as needed).

Settings		
Syntax	Command	`:CALCulate:MEAS:FILE A$`
Example	`:CALCulate:MEAS:FILE ON`	
Query		
Syntax	Query	`:CALCulate:MEAS:FILE?`
	Response	`A$`
Example	`:CALCulate:MEAS:FILE?` (Response) `:CALCULATE:MEAS:FILE ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		
`OFF`☑	Single file (all calculations in one file) The results of all numerical calculations are saved in one file.	
`ON`	Individual calc (separate file for each calculation) In addition to a file summarizing all calculations, a separate file is created for each calculation item. For the file for each calculation item, the calculation number is attached to the end of the file name. Example: The file name for calculation No. 5 is "AUTO0001_05.CSV".	
Note		
The conventional commands can also be used. (p.451)		

Select whether or not to divide the numerical calculation.

This setting is the same as the time-divided calculation of the numerical calculation.
See "Setting the numerical calculations" (p. 272).

Manual save operation

Data can be saved using the communication commands.

IMPORTANT
- Data cannot be saved during the measurement.
- Only the data recorded on the internal buffer memory (final 512 MB) can be saved. To save data exceeding 512 MB, use the auto-save operation (realtime save). (p.226)

The following six types of data can be saved.
- Waveform data (binary format)
- Waveform data (text format)
- Waveform data (MDF format)
- Preset data
- A2L preset data (LAN1 or LAN2) *1
- Numerical calculation results

*1. Saves the setting conditions used by measurement/compatible software for ECU.
See “12.5 Sending Measurement Data Using XCP on Ethernet” (p. 339).

1 **Specify the file name when saving.**

If a value is not entered at the end of the file name, the number “0001” is attached to the end. The number is incremented by 1 starting from the next file name.
Example: If ABC is specified and the file is saved in the binary format
ABC0001.MEM, ABC0002.MEM, ABC0003.MEM, ...

If the file name has a number attached at its end, the number is incremented by 1.
Example: If ABC100 is specified and the file is saved in the binary format
ABC101.MEM, ABC102.MEM, ABC103.MEM, ...

Settings		
Syntax	Command	`:SYSTem:FILEName "A$"`
Example	`:SYSTem:FILEName "MANUAL"`	
Query		
Syntax	Query	`:SYSTem:FILEName?`
	Response	`:A$`
Example	`:SYSTem:FILEName?` (Response) `:SYSTEM:FILENAME "MANUAL"`	
Parameter		
`A$` = Character string of file name (up to 4 double-byte characters or 8 single-byte characters)		

If no file name is specified, the file is named automatically.
See “When a file is saved without specifying a file name” (p. 222).

6

Saving and Loading Data

(When the waveform data are saved)

Set whether or not to attach a title comment to the file name.

Settings		
Syntax	Command	:SYSTem:ADDComment A$
Example	:SYSTem:ADDComment ON	
Query		
Syntax	Query	:SYSTem:ADDComment?
	Response	A$
Example	:SYSTem:ADDComment? (Response) :SYSTEM:ADDCOMMENT ON	
Parameter		
A$ = OFF, ON		

OFF☑	No title comment is attached to the file name of waveform data.
ON	A title comment is attached to the file name of waveform data. When the title comment is LOGGER, the file is named as follows. File name specified with :SYSTem:FILEName_LOGGER_0001.MEM

Set whether or not to attach time to the file name.

When the parameter is set to ON, the file is named as follows.
Input file name_230324_235959_0001.MEM (when the trigger is activated at 2023/03/24 23:59:59)

Settings		
Syntax	Command	:SYSTem:ADDDate A$
Example	:SYSTem:ADDDate ON	
Query		
Syntax	Query	:SYSTem:ADDDate?
	Response	A$
Example	:SYSTem:ADDDate? (Response) :SYSTEM:ADDDATE ON (When the header is ON)	
Parameter		
A$ = OFF, ON		

OFF☑	No trigger date is attached.
ON	The trigger date is attached.

(When the waveform data are saved in the text format)

Set whether or not to perform the downsampling operation.

Settings		
Syntax	Command	:SYSTem:THINOut A
Example	:SYSTem:THINOut 5	
Query		
Syntax	Query	:SYSTem:THINOut?
	Response	A<NR1>
Example	:SYSTem:THINOut? (Response) :SYSTEM:THINOUT 5	
Parameter		
A = 1 (OFF) to 100000 If the parameter is set to 1, the downsampling is disabled. If the parameter is set to 5, 1 out of 5 data points is retained.		

(When other than OFF is set for the downsampling)

Set the method to downsample the data.

Settings		
Syntax	Command	`:SYSTem:THINData A$`
Example	`:SYSTem:THINData INSTANT`	
Query		
Syntax	Query	`:SYSTem:THINData?`
	Response	`A$`
Example	`:SYSTem:THINData?` (Response) `:SYSTEM:THINDATA INSTANT`	
Parameter		
`A$` = INSTANT, STATISTICS		

`INSTANT` ☑	The first data is saved. Example: If the parameter is set to 5, only the first data out of 5 is saved.
`STATISTICS`	The statistical data (maximum, minimum, average, and the first data) is saved. Example:If the parameter is set to 5, the maximum, minimum, and average of 5 data sets and the first data are saved.

(When the numerical calculation results are saved)

Configure the settings for dividing the file to be saved.

Settings		
Syntax	Command	`:SYSTem:CALCSplit A$`
Example	`:SYSTem:CALCSplit ON`	
Query		
Syntax	Query	`:SYSTem:CALCSplit?`
	Response	`A$`
Example	`:SYSTem:CALCSplit?` (Response) `:SYSTEM:CALCSPLIT ON`	
Parameter		
`A$` = OFF, ON		

`OFF` ☑	Saves the results of the numerical calculation in one file.
`ON`	Saves the results of each numerical calculation in a separate file.

6

Saving and Loading Data

2 **Execute the save operation.**

If the file size of waveform data exceeds 1 GB, the file is automatically divided and saved by approx. 1 GB.

See "14.5 File Name" (p. 415).

Settings		

Syntax	Command	When the waveform data (binary format) are saved
		`:MEDia:SD:SAVE:DATA:MEM`
		`:MEDia:USB:SAVE:DATA:MEM`
		
		When the waveform data (text format) are saved
		`:MEDia:SD:SAVE:DATA:CSV`
		`:MEDia:USB:SAVE:DATA:CSV`
		
		When the waveform data (MDF format) are saved
		`:MEDia:SD:SAVE:DATA:MF4`
		`:MEDia:USB:SAVE:DATA:MF4`
		
		When the preset data are saved
		`:MEDia:SD:SAVE:SET`
		`:MEDia:USB:SAVE:SET`
		
		When the A2L preset data are saved (LAN1)
		`:MEDia:SD:SAVE:A2L:LAN1`
		`:MEDia:USB:SAVE:A2L:LAN1`
		
		When the A2L preset data are saved (LAN2)
		`:MEDia:SD:SAVE:A2L:LAN2`
		`:MEDia:USB:SAVE:A2L:LAN2`
		
		When the numerical calculation results are saved
		`:MEDia:SD:SAVE:CALC:CSV`
		`:MEDia:USB:SAVE:CALC:CSV`

Example	`:MEDia:SD:SAVE:DATA:MEM`	
Query		

Syntax	Query	When the waveform data (binary format) are saved
		`:MEDia:SD:SAVE:DATA:MEM?`
		`:MEDia:USB:SAVE:DATA:MEM?`
		
		When the waveform data (text format) are saved
		`:MEDia:SD:SAVE:DATA:CSV?`
		`:MEDia:USB:SAVE:DATA:CSV?`
		
		When the waveform data (MDF format) are saved
		`:MEDia:SD:SAVE:DATA:MF4?`
		`:MEDia:USB:SAVE:DATA:MF4?`
		
		When the preset data are saved
		`:MEDia:SD:SAVE:SET?`
		`:MEDia:USB:SAVE:SET?`
		
		When the A2L preset data are saved (LAN1)
		`:MEDia:SD:SAVE:A2L:LAN1?`
		`:MEDia:USB:SAVE:A2L:LAN1?`
		
		When the A2L preset data are saved (LAN2)
		`:MEDia:SD:SAVE:A2L:LAN2?`
		`:MEDia:USB:SAVE:A2L:LAN2?`
		
		When the numerical calculation results are saved
		`:MEDia:SD:SAVE:CALC:CSV?`
		`:MEDia:USB:SAVE:CALC:CSV?`

	Response	`A$`

Example	`:MEDia:SD:SAVE:DATA:MEM?` (Response) `:MEDIA:SD:SAVE:DATA:MEM? SUCCESS_TEST` (When the header is ON)

Parameter

A$ = NONE, EXECUTING, SUCCESS_(File name), FAIL

NONE	Saving has not yet been executed.
EXECUTING	Saving is currently in operation.
SUCCESS_(File name)	Saving has succeeded. The name of the saved file is attached at the end.
FAIL	Saving has failed.

IMPORTANT

When an SD memory card and USB flash drive are inserted, files are saved on the specified medium.
If the specified medium is not inserted, files are saved on the other medium.

Common saving settings

1 **Set the format of text.**

Set the symbol to be used as the decimal point.

This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:CONFigure:SAVEDeci A$`
Example	`:CONFigure:SAVEDeci PERIOD`	
Query		
Syntax	Query	`:CONFigure:SAVEDeci?`
	Response	`A$`
Example	`:CONFigure:SAVEDeci?` (Response) `:CONFIGURE:SAVEDECI PERIOD` (When the header is ON)	
Parameter		
`A$` = PERIOD, COMMA		
Note		
It is impossible to set the decimal point symbol and the delimiter to COMMA simultaneously.		

`PERIOD`	Set a period (.) as the decimal point of numerical values.
`COMMA`	Set a comma (,) as the decimal point of numerical values.

Set the symbol to be used for separation.

The delimiter determines the file extension.
This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:CONFigure:SAVESep A$`
Example	`:CONFigure:SAVESep COMMA`	
Query		
Syntax	Query	`:CONFigure:SAVESep?`
	Response	`A$`
Example	`:CONFigure:SAVESep?` (Response) `:CONFIGURE:SAVESEP COMMA` (When the header is ON)	
Parameter		
`A$` = COMMA, SPACE, TAB, SEMI		
Note		
It is impossible to set the decimal point symbol and the delimiter to COMMA simultaneously.		

`COMMA`	Set a comma (,) as the delimiter. (extension: .CSV)
`SPACE`	Set a space as the delimiter. (extension: .TXT)
`TAB`	Set a tab as the delimiter. (extension: .TXT)
`SEMI`	Set a semicolon (;) as the delimiter. (extension: .TXT)

Set the format to describe the date.

This is only enabled when the horizontal (time) axis display setting (p.290) is set to “DATE”.

Settings		
Syntax	Command	`:CONFigure:SAVEFormat A$`
Example	`:CONFigure:SAVEFormat COMMENT`	
Query		
Syntax	Query	`:CONFigure:SAVEFormat?`
	Response	`A$`
Example	`:CONFigure:SAVEFormat?` (Response) `:CONFIGURE:SAVEFORMAT COMMENT` (When the header is ON)	
Parameter		

`A$` = COMMENT, SPLITMS

`COMMENT`☑	Comment (yy-MM-dd hh:mm:ss.0) The date is output in the format of ' (apostrophe) Year-Month-Day Hour:Minute:Second.Millisecond. Spreadsheet software handles this output as a comment. Example: **20-12-01 23:59:59.999**
`SPLITMS`	Less than 1 second split (yyyy-MM-dd hh:mm:ss + ms) The date is output in the format of " (double quotation) Year-Month-Day Hour:Minute:Second", and the time data less than 1 second (unit: ms) is output separately. Spreadsheet software displays the time data less than 1 second in a separate column. This format is useful when integrating CSV data acquired with different devices using spreadsheet software. Example: **2023-03-01 23:59:59,999**

Depending on the date format and the date delimiter settings in “Language” (p. 288), the following formats can also be selected.

The same format as yy-MM-dd hh:mm:ss.0 above

yy/MM/dd, yy.MM.dd, MM-dd-yy, MM/dd/yy, MM.dd.yy, dd-MM-yy, dd/MM/yy, dd.MM.yy

The same format as yyyy-MM-dd hh:mm:ss + ms above

yyyy/MM/dd, yyyy.MM.dd, MM-dd-yyyy, MM/dd/yyyy, MM.dd.yyyy, dd-MM-yyyy, dd/MM/yyyy, dd.MM.yyyy

6.4 Loading Data

Setting data saved on the media (SD memory card, USB drive) can be loaded.
The following files can be loaded with the instrument: setting conditions saved with LR8101 or LR8102 and CAN setting file (CES) saved with the PC application (CAN Editor).
The auto-load function for the setting files is available.
See “Auto-setup function” (p. 244).

Tips
To acquire the preset data list saved on a medium
See “Display a list of the files in **[/HIOKI/LR8100/CONFIG]** for each medium.” (p. 245).

1 **Check that the setting conditions can be loaded.**
The settings cannot be loaded if the module configuration is different.

Query		
Syntax	Query	`:MEDia:SD:FINFo:SET? "fname$"` `:MEDia:USB:FINFo:SET? "fname$"`
	Response	`ans$, modules$`
Example	`:MEDia:SD:FINFo:SET? "CONF0001.SET"` (Response): `MEDIA:SD:FINFO:SET? OK,1300000000` (When the header is ON)	

Parameter

`fname$` = File name of the setting conditions to be loaded (xxxx.SET)
`ans$` = OK, NG_MODEL, NG_MODULE, BUSY
`modules$` = 0, 1, 3, 4 (module type)

`OK`	The settings can be loaded.
`NG_MODEL`	The settings cannot be loaded because the setting file is for a different model.*1
`NG_MODULE`	The settings cannot be loaded because the setting file is for a different module configuration.
`BUSY`	The information cannot be acquired because file processing is underway.*1

*1. In this case, all the digits for the module type are 0.

`module$ = 0`	No module
`module$ = 1`	M7100 Voltage/Temp Module
`module$ = 3`	M7102 Voltage/Temp Module
`module$ = 4`	M7103 Power Measurement Module

The module types are module 1, module 2, and so on, in this order from the left.
In the case of 1300000000, module 1 is M7100, module 2 is M7102, and there are no modules for the rest.

2 Load the setting conditions.

Settings		
Syntax	Command	`:MEDia:SD:LOAD:SET "fname$",option` `:MEDia:USB:LOAD:SET "fname$",option`
Example	`:MEDia:SD:LOAD:SET "CONF0001.SET",0`	
Query		
Syntax	Query	`:MEDia:SD:LOAD:SET?` `:MEDia:USB:LOAD:SET?`
	Response	`A$`
Example	`:MEDia:SD:LOAD:SET?` (Response) `:MEDIA:SD:LOAD:SET? SUCCESS_LOAD_CONF0001` (When the header is ON)	

Parameter

`fname$` = File name of the setting conditions to be loaded (xxxx.SET)
`option` = 0 to 3 (Load option)
`A$` = NONE, FILE_NONE, EXECUTING_LOAD_(File name), SUCCESS_LOAD_(File name), FAIL_LOAD_(File name)

`NONE`	Loading has not yet been executed.
`FILE_NONE`	The specified file for loading does not exist.
`EXECUTING_LOAD_`(File name)	Loading is currently in operation.
`SUCCESS_LOAD_`(File name)	Loading has succeeded. The name of the loaded file is attached at the end.
`FAIL_LOAD_`(File name)	Loading has failed.

The type of setting to be loaded varies with the specified setting load options.
Setting load option

`option` = `0`	Measurement settings
`option` = `1`	Measurement settings + External terminal
`option` = `2`	Measurement settings + Communication settings
`option` = `3`	Measurement settings + External terminal + Communication settings

Auto-setup function

The setting file can be automatically loaded when the power is turned ON.

If the setting data is saved with the file name **[STARTUP.SET]** in the folder **[HIOKI]** > **[LR8100]** > **[CONFIG]**, the setting file can be automatically loaded when the power is turned ON.
If both the SD memory card and USB drive contain **[STARTUP.SET]**, the setting conditions on the SD memory card is loaded preferentially.

IMPORTANT
The communication settings including the IP address are also loaded.
If the same **[STARTUP.SET]** is used for multiple LR8101 or LR8102, a network failure may occur.
Create **[STARTUP.SET]** for each instrument.

6.5 Organizing Data

You can organize the data on an SD memory card or USB drive inserted into the instrument.
The following operations can be performed.

- Formatting the SD memory card or USB drive (p.224)
- Loading files (p.242)

Querying the free space on the medium

Query		
Syntax	Query	:MEDia:SD:FREE? :MEDia:USB:FREE?
	Response	A<NR1>
Example	:MEDia:SD:FREE? (Response) :MEDIA:SD:FREE 511156224	
Parameter		
A<NR1>		

Display a list of the files in [/HIOKI/LR8100/CONFIG] for each medium.

Query		
Syntax	Query	:MEDia:SD:FLISt:SET? :MEDia:USB:FLISt:SET?
	Response	A1$,A2...
Example	:MEDia:SD:FLISt:SET? (Response) :MEDIA:SD:FLIST:SET CONF0002.SET,CONF0001.SET (When the header is ON)	
Parameter		
A$ = File name Up to 100 files can be acquired for the list.		

7 Alarm (Alarm Output)

Alarm conditions can be set for each measurement channel.
The instrument can be set to sound a buzzer and output alarm signals to external devices when the measurement data satisfies specified conditions.
For example, an alarm can be output if recorded temperature is increased.
The following channels can be set as alarm sources.
Analog, Pulse, Logic, Waveform calculation
The following alarm types can be set: level, window, pattern, slope, and amount of change.
Up to 100 alarm conditions can be set for power calculation channels.

Alarm signals can be output from the external control terminal to external devices.
See “11 External Control (EXT. I/O)” (p.303).
If an alarm condition is satisfied when measurement is started, the alarm is output immediately.

7.1 Setting Alarms

Alarm condition settings that apply to all channels

Set the alarm conditions that apply to all channels.

1 **Set the alarm function to ON.**

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe ALARM,ON`	
Query		
Syntax	Query	`:MODule:STORe? ch$`
	Response	`ch$,A$`
Example	`:MODule:STORe? ALARM` (Response) `:MODULE:STORE ALARM,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4TMS (p.145) `A$` = OFF, ON		

7 Alarm (Alarm Output)

2 Set the alarm output hold.

Settings		
Syntax	Command	`:ALARm:HOLD A$`
Example	`:ALARm:HOLD ON`	
Query		
Syntax	Query	`:ALARm:HOLD?`
	Response	`A$`
Example	`:ALARm:HOLD?` (Response) `:ALARM:HOLD ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON, CLEAR		

`OFF`☑	When the alarm condition is no longer satisfied, the alarm output is stopped. Select this setting to output the alarm only when the alarm condition is satisfied.
`ON`	Once an alarm is output, the alarm output is held until the alarm is canceled manually or the measurement is stopped. Select this setting to hold the alarm output even if the alarm condition is no longer satisfied (the normal condition is recovered). • If the alarm filter (p.251) is 0 (OFF) The alarm hold is applied to the judgment result for the alarm sources to be monitored. Example: For AND between U1-1 and U1-2 Once the alarm condition of U1-1 is satisfied, the realization of the alarm condition is held. After that, the realization of U1-1 is held even if the alarm condition is no longer satisfied. Therefore, if the alarm condition of U1-2 is satisfied, the alarm is output. • If the alarm filter (p.251) other than 2 to 1000 (excluding OFF) The alarm hold is applied to ALM1 to ALM4. Example: For AND between U1-1 and U1-2 The alarm output is held only when the conditions of U1-1 and U1-2 are satisfied at the same time.
`CLEAR`	Cancels the held alarm without stopping the recording.

3 Set whether or not to sound an alarm buzzer when outputting an alarm.

Settings		
Syntax	Command	`:ALARm:BEEP A$`
Example	`:ALARm:BEEP ON`	
Query		
Syntax	Query	`:ALARm:BEEP?`
	Response	`A$`
Example	`:ALARm:BEEP?` (Response) `:ALARM:BEEP ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

4 Set whether or not to place an event mark when an alarm is issued.

Settings		
Syntax	Command	`:SYSTem:MARK A$`
Example	`:SYSTem:MARK ON`	
Query		
Syntax	Query	`:SYSTem:MARK?`
	Response	`A$`
Example	`:SYSTem:MARK?` (Response) `:SYSTEM:MARK ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

See “8.3 Placing an Event Mark When an Alarm is Issued” (p. 269).

5 Set the alarm history.

The history of alarms issued during the measurement is saved.
When the trigger is used, the alarm history while the instrument is in the trigger standby state is also saved (it can include the alarm history before the recorded waveform data).

Settings		
Syntax	Command	`:ALARm:HISTory A$`
Example	`:ALARm:HISTory ON`	
Query		
Syntax	Query	`:ALARm:HISTory?`
	Response	`A$`
Example	`:ALARm:HISTory?` (Response) `:ALARM:HISTORY ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Alarm numbers 1 to 100 are kept in the history (No. 101 and later are not kept in the history).
`ON`	The latest 100 alarms are kept in the history (older alarms are not kept in the history). Alarm numbers up to 999,999 can be kept in the history.

6 Set the alarm realization condition for each alarm output (ALM1 to ALM4).

Settings		
Syntax	Command	`:ALARm:SOURce alm$,A$`
Example	`:ALARm:SOURce ALM1,AND`	
Query		
Syntax	Query	`:ALARm:SOURce? alm$`
	Response	`alm$,A$`
Example	`:ALARm:SOURce? ALM1` (Response) `:ALARM:SOURCE ALM1,AND` (When the header is ON)	
Parameter		
`alm$` = ALM1 to ALM4 `A$` = OR, AND		

`OR`☑	Logical sum Outputs an alarm when any one of the alarm conditions set for the channels is satisfied.
`AND`	Logical multiplication Outputs an alarm when all of the alarm conditions set for the channels are satisfied.

7 **For each alarm output (ALM1 to ALM4), set whether or not to output an alarm when a thermocouple wire break is detected.**

This setting is enabled if the wire break detection setting is set to ON in the input channel settings.
See "Temperature (thermocouple) measurement" (p. 122).
An alarm is triggered regardless of other alarm conditions (OR, AND).

Settings		
Syntax	Command	`:ALARm:BURN alm$,A$`
Example	`:ALARm:BURN ALM1,ON`	
Query		
Syntax	Query	`:ALARm:BURN? alm$`
	Response	`alm$,A$`
Example	`:ALARm:BURN? ALM1` (Response) `:ALARM:BURN ALM1,ON` (When the header is ON)	
Parameter		
`alm$` = ALM1 to ALM4 `A$` = OFF, ON		

Settings for each alarm channel

Configure the settings for each of the alarm channels from ALM1 to ALM4.

1 **Set the data points for the alarm filter.**

An alarm is triggered if the alarm status continues for the specified number of data points.

Settings		
Syntax	Command	`:ALARm:FILTer alm$,A`
Example	`:ALARm:FILTer ALM1,2`	
Query		
Syntax	Query	`:ALARm:FILTer? alm$`
	Response	`alm$,A<NR1>`
Example	`:ALARm:FILTer? ALM1` (Response) `:ALARM:FILTER ALM1,2` (When the header is ON)	
Parameter		
`alm$` = ALM1 to ALM4 `A` = 0 (OFF), 2 to 1000		

2 **Set the comment (as needed).**

See “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:COMMent:ALMCH alm$,"A$"`
Example	`:COMMent:ALMCH ALM1,"ABCDEFG"`	
Query		
Syntax	Query	`:COMMent:ALMCH? alm$`
	Response	`alm$,"A$"`
Example	`:COMMent:ALMCH? ALM1` (Response) `:COMMENT:ALMCH ALM1,"ABCDEFG"` (When the header is ON)	
Parameter		
`alm$` = ALM1 to ALM4 `A$` = Character string of comment (up to 20 double-byte characters or 40 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

Alarm settings for each channel

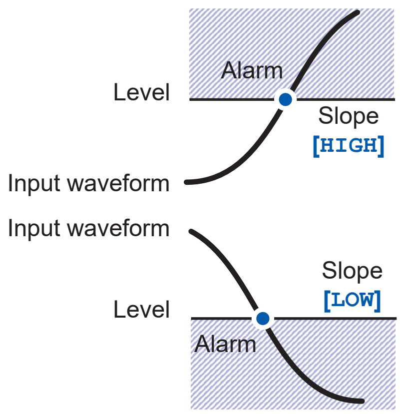
Set the alarm functions for each channel.
A total of 100 alarm conditions can be set for power calculation channels.

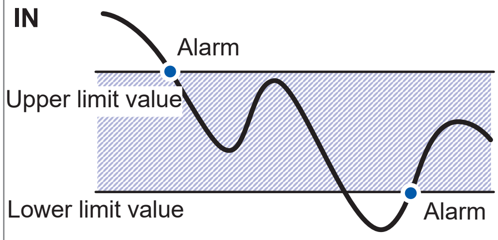
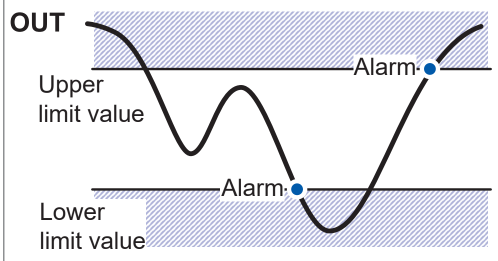
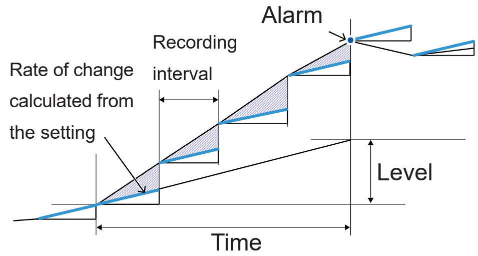
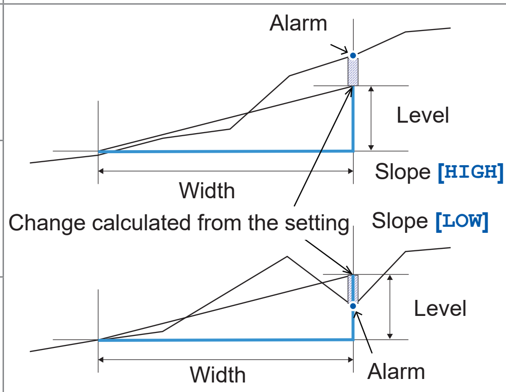
1 **Set the power calculation channel. (For power calculation channel alarms)**

Set power calculation channels that will be the alarm sources to alarm conditions from 1 to 100 for power calculation channels.
From 1 to 4 alarm conditions can be set per power calculation channel specified.

Settings		
Syntax	Command	`:ALARm:POWer:NO no$,ch$`
Example	`:ALARm:POWer:NO NO1,M1URMS1`	
Query		
Syntax	Query	`:ALARm:POWer:NO? no$`
	Response	`no$,ch$`
Example	`:ALARm:POWer:NO? NO1` (Response) `:ALARM:POWER:NO NO1,M1URMS1`	
Parameter		
`no$` = NO1 to NO100 `ch$` = M1URMS1 to M4TMS (p. 145)		

2 **Set the alarms for ALM1 to ALM4 of each channel to be monitored.**

Alarm type	Settings		Operation	Description
`OFF` ☑	–		–	The alarm function is disabled.
`LEVEl`	Slope	`HIGH` ☑ `LOW`		Outputs an alarm when the measurement data is equal to or greater than the specified level.
	Level	Enter a numerical value		Outputs an alarm when the measurement data is less than the specified level. However, in the case of the pulse channel, an alarm is also output when the measured value is 0, if the level is set to 0.

Alarm type	Settings		Operation	Description
WINDow	Direction	IN ☑ OUT		Outputs an alarm when the measurement data is equal to or greater than the lower limit value and is equal to or less than the upper limit value.
	Upper and lower limit values	Enter a numerical value		Outputs an alarm when the measurement data is less than the lower limit value or greater than the upper limit value. However, in the case of the pulse channel, an alarm is also output when the measured value is 0, if the upper or lower limit value is 0.
SLOPe	Level	Enter a numerical value		Outputs an alarm when the rate of change of the measurement data exceeds the rate of change (level/time) calculated from the setting for a specified time.*2
	Time	Set a time*1		
SLOPE2	Slope	HIGH ☑ LOW		Outputs an alarm when the amount of change within the specified width is equal to or greater or less than the specified level value.
	Level	Enter a numerical value		
	Width	Set a width in time		

*1. The time values that can be set are integer multiples of the module's data refresh interval.
*2. Example of slope
If the level is set to 5°C and the time is set to 5 seconds
1. If the recording interval is 5 seconds
An alarm is triggered if the difference from the previous measured value exceeds 5°C.
Data example: If the value is increased from 20°C to 25.1°C
2. If the recording interval is 1 second
An alarm is triggered if the difference from the previous measured value exceeds 1°C for 5 data points consecutively.
Data example: If the value is increased from 20°C to 21.1°C, 22.2°C, 23.3°C, 24.4°C, and then 25.5°C

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:KIND alm$,ch$,A$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:KIND alm$,w$,A$`
		Pulse channel alarm
		`:ALARm:PULSe:KIND alm$,pls$,A$`
		Power calculation channel alarm
		`:ALARm:POWer:KIND no$,alm$,A$`

Example	`:ALARm:ANALog:KIND ALM1,CH1_1,LEVEl`	

Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:KIND? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:KIND? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:KIND? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:KIND? no$,alm$`

	Response	Analog channel alarm
		`alm$,ch$,A$`
		Waveform calculation channel alarm
		`alm$,w$,A$`
		Pulse channel alarm
		`alm$,pls$,A$`
		Power calculation channel alarm
		`no$,alm$,A$`

Example	`:ALARm:ANALog:KIND? ALM1,CH1_1` (Response) `:ALARM:ANALOG:KIND ALM1,CH1_1,LEVEL` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100
`A$` = OFF, LEVEl, WINDow, SLOPe, SLOPE2

`OFF`☑	The alarm function is disabled.
`LEVEl`	Level
`WINDow`	Window
`SLOPe`	Slope
`SLOPE2`	Amount of change

When an external sampling is used, only “LEVEL” and “WINDow” can be set.

Note

The conventional commands can also be used. (p.450)

If the alarm type is LEVEl

(1) Set the slope.

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:SLOPe alm$,ch$,A$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:SLOPe alm$,w$,A$`
		Pulse channel alarm
		`:ALARm:PULSe:SLOPe alm$,pls$,A$`
		Power calculation channel alarm
		`:ALARm:POWer:SLOPe no$,alm$,A$`

Example	`:ALARm:ANALog:SLOPe ALM1,CH1_1,HIGH`	
Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:SLOPe? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:SLOPe? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:SLOPe? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:SLOPe? no$,alm$`

	Response	Analog channel alarm
		`alm$,ch$,A$`
		Waveform calculation channel alarm
		`alm$,w$,A$`
		Pulse channel alarm
		`alm$,pls$,A$`
		Power calculation channel alarm
		`no$,alm$,A$`

Example	`:ALARm:ANALog:SLOPe? ALM1,CH1_1` (Response) `:ALARM:ANALOG:SLOPE ALM1,CH1_1,HIGH` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100
`A$` = HIGH, LOW

`HIGH`☑	Outputs an alarm when the measurement data is equal to or greater than the specified level.
`LOW`	Outputs an alarm when the measurement data is less than the specified level.

Note

The conventional commands can also be used. (p.450)

7

Alarm (Alarm Output)

(2) Set the level.

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:LEVEl alm$,ch$,A`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:LEVEl alm$,w$,A`
		Pulse channel alarm
		`:ALARm:PULSe:LEVEl alm$,pls$,A`
		Power calculation channel alarm
		`:ALARm:POWer:LEVEl no$,alm$,A`

Example	`:ALARm:ANALog:LEVEl ALM1,CH1_1,0.1`	
Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:LEVEl? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:LEVEl? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:LEVEl? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:LEVEl? no$,alm$`

	Response	Analog channel alarm `alm$,ch$,A<NR3>` (3 digits after the decimal point) Waveform calculation channel alarm `alm$,w$,A<NR3>` (4 digits after the decimal point) Pulse channel alarm `alm$,pls$,A<NR3>` (9 digits after the decimal point) Power calculation channel alarm `no$,alm$,A<NR3>` (4 digits after the decimal point)
Example	`:ALARm:ANALog:LEVEl? ALM1,CH1_1` (Response) `:ALARM:ANALOG:LEVEL ALM1,CH1_1,+1.000E-01` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100

Analog channel alarm
`A` = Allowable setting range: (Measurement range) × (±1.5),
Maximum resolution: (Measurement range) × (1/1000)
Waveform calculation channel alarm
`A` = -9.9999E+29 to 9.9999E+29
Pulse channel alarm
`A` = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min)
Power calculation channel alarm
A = -9.9999E+29 to 9.9999E+29

If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.

Note

If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.450)

If the alarm type is WINDow

(1) Set the direction.

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:SIDE alm$,ch$,A$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:SIDE alm$,w$,A$`
		Pulse channel alarm
		`:ALARm:PULSe:SIDE alm$,pls$,A$`
		Power calculation channel alarm
		`:ALARm:POWer:SIDE no$,alm$,A$`

Example	`:ALARm:ANALog:SIDE ALM1,CH1_1,IN`	
Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:SIDE? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:SIDE? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:SIDE? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:SIDE? no$,alm$`

	Response	Analog channel alarm
		`alm$,ch$,A$`
		Waveform calculation channel alarm
		`alm$,w$,A$`
		Pulse channel alarm
		`alm$,pls$,A$`
		Power calculation channel alarm
		`no$,alm$,A$`

Example	`:ALARm:ANALog:SIDE? ALM1,CH1_1` (Response) `:ALARM:ANALOG:SIDE ALM1,CH1_1,IN` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100
`A$` = IN, OUT

`IN`☑	Outputs an alarm when the measurement data is equal to or greater than the lower limit value and is equal to or less than the upper limit value.
`OUT`	Outputs an alarm when the measurement data is less than the lower limit value or greater than the upper limit value. However, for the pulse channel, an alarm will also be output when the measured value is 0, if either the upper or lower limit value is set to 0.

Note

The conventional commands can also be used. (p.450)

(2) Set the upper and lower limit values.

The range between the upper and lower limit values is defined as the window.

Upper limit value

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:UPPEr alm$,ch$,A`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:UPPEr alm$,w$,A`
		Pulse channel alarm
		`:ALARm:PULSe:UPPEr alm$,pls$,A`
		Power calculation channel alarm
		`:ALARm:POWer:UPPEr no$,alm$,A`

Example	`:ALARm:ANALog:UPPEr ALM1,CH1_1,0.5`	
Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:UPPEr? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:UPPEr? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:UPPEr? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:UPPEr? no$,alm$`

	Response	Analog channel alarm `alm$,ch$,A<NR3>` (3 digits after the decimal point) Waveform calculation channel alarm `alm$,w$,A<NR3>` (4 digits after the decimal point) Pulse channel alarm `alm$,pls$,A<NR3>` (9 digits after the decimal point) Power calculation channel alarm `no$,alm$,A<NR3>` (4 digits after the decimal point)
Example	`:ALARm:ANALog:UPPEr? ALM1,CH1_1` (Response) `:ALARM:ANALOG:UPPER ALM1,CH1_1,+5.000E-01` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100

Analog channel alarm
`A` = Allowable setting range: (Measurement range) × (±1.5),
Maximum resolution: (Measurement range) × (1/1000)
Waveform calculation channel alarm
`A` = -9.9999E+29 to 9.9999E+29
Pulse channel alarm
`A` = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min)
Power calculation channel alarm
A = -9.9999E+29 to 9.9999E+29

Note

You cannot input any values below the window alarm lower limit.
If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.450)

Lower limit value

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:LOWEr alm$,ch$,A`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:LOWEr alm$,w$,A`
		Pulse channel alarm
		`:ALARm:PULSe:LOWEr alm$,pls$,A`
		Power calculation channel alarm
		`:ALARm:POWer:LOWEr no$,alm$,A`

Example	`:ALARm:ANALog:LOWEr ALM1,CH1_1,0.5`	

Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:LOWEr? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:LOWEr? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:LOWEr? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:LOWEr? no$,alm$`

	Response	Analog channel alarm `alm$,ch$,A<NR3>` (3 digits after the decimal point) Waveform calculation channel alarm `alm$,w$,A<NR3>` (4 digits after the decimal point) Pulse channel alarm `alm$,pls$,A<NR3>` (9 digits after the decimal point) Power calculation channel alarm `no$,alm$,A<NR3>` (4 digits after the decimal point)
Example	`:ALARm:ANALog:LOWEr? ALM1,CH1_1` (Response) `:ALARM:ANALOG:LOWER ALM1,CH1_1,+5.000E-01` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100

Analog channel alarm
`A` = Allowable setting range: (Measurement range) × (±1.5),
Maximum resolution: (Measurement range) × (1/1000)
Waveform calculation channel alarm
`A` = -9.9999E+29 to 9.9999E+29
Pulse channel alarm
`A` = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min)
Power calculation channel alarm
A = -9.9999E+29 to 9.9999E+29

Note

You cannot input any values above the window alarm upper limit level.
If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.450)

If the alarm type is SLOPe

(1) Set the level.

Settings		
Syntax	Command	Analog channel alarm :ALARm:ANALog:LEVEl alm$,ch$,A Waveform calculation channel alarm :ALARm:CALCulate:LEVEl alm$,w$,A Pulse channel alarm :ALARm:PULSe:LEVEl alm$,pls$,A Power calculation channel alarm :ALARm:POWer:LEVEl no$,alm$,A
Example	:ALARm:ANALog:LEVEl ALM1,CH1_1,0.1	
Query		
Syntax	Query	Analog channel alarm :ALARm:ANALog:LEVEl? alm$,ch$ Waveform calculation channel alarm :ALARm:CALCulate:LEVEl? alm$,w$ Pulse channel alarm :ALARm:PULSe:LEVEl? alm$,pls$ Power calculation channel alarm :ALARm:POWer:LEVEl? no$,alm$
	Response	Analog channel alarm alm$,ch$,A<NR3> (3 digits after the decimal point) Waveform calculation channel alarm alm$,w$,A<NR3> (4 digits after the decimal point) Pulse channel alarm alm$,pls$,A<NR3> (9 digits after the decimal point) Power calculation channel alarm no$,alm$,A<NR3> (4 digits after the decimal point)
Example	:ALARm:ANALog:LEVEl? ALM1,CH1_1 (Response) :ALARM:ANALOG:LEVEL ALM1,CH1_1,+1.000E-01 (When the header is ON)	
Parameter		
alm$ = ALM1 to ALM4 ch$ = CH1_1 to CH10_30 w$ = W1 to W30 pls$ = PLS1 no$ = NO1 to NO100 Analog channel alarm A = Allowable setting range: (Measurement range) × (±1.5), Maximum resolution: (Measurement range) × (1/1000) Waveform calculation channel alarm A = -9.9999E+29 to 9.9999E+29 Pulse channel alarm A = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min) Power calculation channel alarm A = -9.9999E+29 to 9.9999E+29		
Note		
If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input. If a value less than the lower limit of the allowable setting range is entered, the minimum value is input. The conventional commands can also be used. (p.450)		

(2) Set the time.

Settings		

Syntax	Command	Analog channel alarm
		`:ALARm:ANALog:STIMe alm$,ch$,hour,min,sec`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:STIMe alm$,w$,hour,min,sec`
		Pulse channel alarm
		`:ALARm:PULSe:STIMe alm$,pls$,hour,min,sec`
		Power calculation channel alarm
		`:ALARm:POWer:STIMe no$,alm$,hour,min,sec`

Example	`:ALARm:ANALog:STIMe ALM1,CH1_1,0,1,20`	
Query		

Syntax	Query	Analog channel alarm
		`:ALARm:ANALog:STIMe? alm$,ch$`
		Waveform calculation channel alarm
		`:ALARm:CALCulate:STIMe? alm$,w$`
		Pulse channel alarm
		`:ALARm:PULSe:STIMe? alm$,pls$`
		Power calculation channel alarm
		`:ALARm:POWer:STIMe? no$,alm$`

	Response	Analog channel alarm
		`alm$,ch$,hour<NR1>,min<NR1>,sec<NR1>`
		Waveform calculation channel alarm
		`alm$,w$,hour<NR1>,min<NR1>,sec<NR1>`
		Pulse channel alarm
		`alm$,pls$,hour<NR1>,min<NR1>,sec<NR1>`
		Power calculation channel alarm
		`no$,alm$,hour<NR1>,min<NR1>,sec<NR1>`

Example	`:ALARm:ANALog:STIMe? ALM1,CH1_1` (Response) `:ALARM:ANALOG:STIME ALM1,CH1_1,0,1,20` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`ch$` = CH1_1 to CH10_30
`w$` = W1 to W30
`pls$` = PLS1
`no$` = NO1 to NO100

`hour` = 0 to 6 (hour)*1
`min` = 0 to 59 (min)*1
`sec` = 0 to 59 (sec)*1

*1. Input in the format of A<NR1>.
See “Data part” (p. 24).

`0,0,0` cannot be entered.

If the alarm type is SLOPE2

(1) Set the slope.

<table>
<tr><th colspan="3">Settings</th></tr>
<tr><td>Syntax</td><td>Command</td><td>Analog channel alarm
<code>:ALARm:ANALog:SLOPe alm$,ch$,A$</code>
Waveform calculation channel
<code>:ALARm:CALCulate:SLOPe alm$,w$,A$</code>
Pulse channel
<code>:ALARm:PULSe:SLOPe alm$,pls$,A$</code>
Power calculation channel alarm
<code>:ALARm:POWer:SLOPe no$,alm$,A$</code></td></tr>
<tr><td>Example</td><td colspan="2"><code>:ALARm:ANALog:SLOPe ALM1,CH1_1,HIGH</code></td></tr>
<tr><th colspan="3">Query</th></tr>
<tr><td rowspan="2">Syntax</td><td>Query</td><td>Analog channel alarm
<code>:ALARm:ANALog:SLOPe? alm$,ch$</code>
Waveform calculation channel
<code>:ALARm:CALCulate:SLOPe? alm$,w$</code>
Pulse channel
<code>:ALARm:PULSe:SLOPe? alm$,pls$</code>
Power calculation channel alarm
<code>:ALARm:POWer:SLOPe? no$,alm$</code></td></tr>
<tr><td>Response</td><td>Analog channel alarm
<code>alm$,ch$,A$</code>
Waveform calculation channel alarm
<code>alm$,w$,A$</code>
Pulse channel alarm
<code>alm$,pls$,A$</code>
Power calculation channel alarm
<code>no$,alm$,A$</code></td></tr>
<tr><td>Example</td><td colspan="2"><code>:ALARm:ANALog:SLOPe? ALM1,CH1_1</code>
(Response) <code>:ALARM:ANALOG:SLOPE ALM1,CH1_1,HIGH</code> (When the header is ON)</td></tr>
<tr><th colspan="3">Parameter</th></tr>
<tr><td colspan="3"><code>alm$</code> = ALM1 to ALM4
<code>ch$</code> = CH1_1 to CH10_30
<code>w$</code> = W1 to W30
<code>pls$</code> = PLS1
<code>no$</code> = NO1 to NO100
<code>A$</code> = HIGH, LOW</td></tr>
</table>

`HIGH`☑	Outputs an alarm when the measurement data is equal to or greater than the specified level.
`LOW`	Outputs an alarm when the measurement data is less than the specified level.

Note

The conventional commands can also be used. (p.450)

(2) Set the level.

Settings		
Syntax	Command	Analog channel alarm :ALARm:ANALog:LEVEl alm$,ch$,A Waveform calculation channel alarm :ALARm:CALCulate:LEVEl alm$,w$,A Pulse channel alarm :ALARm:PULSe:LEVEl alm$,pls$,A Power calculation channel alarm :ALARm:POWer:LEVEl no$,alm$,A
Example	:ALARm:ANALog:LEVEl ALM1,CH1_1,0.1	
Query		
Syntax	Query	Analog channel alarm :ALARm:ANALog:LEVEl? alm$,ch$ Waveform calculation channel alarm :ALARm:CALCulate:LEVEl? alm$,w$ Pulse channel alarm :ALARm:PULSe:LEVEl? alm$,pls$ Power calculation channel alarm :ALARm:POWer:LEVEl? no$,alm$
	Response	Analog channel alarm alm$,ch$,A<NR3> (3 digits after the decimal point) Waveform calculation channel alarm alm$,w$,A<NR3> (4 digits after the decimal point) Pulse channel alarm alm$,pls$,A<NR3> (9 digits after the decimal point) Power calculation channel alarm no$,alm$,A<NR3> (4 digits after the decimal point)
Example	:ALARm:ANALog:LEVEl? ALM1,CH1_1 (Response) :ALARM:ANALOG:LEVEL ALM1,CH1_1,+1.000E-01 (When the header is ON)	

Parameter

alm$ = ALM1 to ALM4
ch$ = CH1_1 to CH10_30
w$ = W1 to W30
pls$ = PLS1
no$ = NO1 to NO100

Analog channel alarm
A = Allowable setting range: (Measurement range) × (±1.5),
Maximum resolution: (Measurement range) × (1/1000)
Waveform calculation channel alarm
A = -9.9999E+29 to 9.9999E+29
Pulse channel alarm
A = 0 to 1000000000 (count), 0 to 15000 (r/s), 0 to 900000 (r/min)
Power calculation channel alarm
A = -9.9999E+29 to 9.9999E+29

Note

If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The conventional commands can also be used. (p.450)

(3) Set the time.

Settings		
Syntax	Command	Analog channel alarm :ALARm:ANALog:SLP2:TIMe alm$,ch$,hour,min,sec,ms Waveform calculation channel alarm :ALARm:CALCulate:SLP2:TIMe alm$,w$,hour,min,sec,ms Pulse channel alarm :ALARm:PULSe:SLP2:TIMe alm$,pls$,hour,min,sec,ms Power calculation channel alarm :ALARm:POWer:SLP2:TIMe no$,alm$,hour,min,sec,ms
Example	:ALARm:ANALog:SLP2:TIMe ALM1,CH1_1,0,1,20,30	
Query		
Syntax	Query	Analog channel alarm :ALARm:ANALog:SLP2:TIMe? alm$,ch$ Waveform calculation channel alarm :ALARm:CALCulate:SLP2:TIMe? alm$,w$ Pulse channel alarm :ALARm:PULSe:SLP2:TIMe? alm$,pls$ Power calculation channel alarm :ALARm:POWer:SLP2:TIMe? no$,alm$
	Response	Analog channel alarm alm$,ch$,hour<NR1>,min<NR1>,sec<NR1>,ms<NR1> Waveform calculation channel alarm alm$,w$,hour<NR1>,min<NR1>,sec<NR1>,ms<NR1> Pulse channel alarm alm$,pls$,hour<NR1>,min<NR1>,sec<NR1>,ms<NR1> Power calculation channel alarm no$,alm$,hour<NR1>,min<NR1>,sec<NR1>,ms<NR1>
Example	:ALARm:ANALog:SLP2:TIMe? ALM1,CH1_1 (Response) :ALARM:ANALOG:SLP2:TIME ALM1,CH1_1,0,1,20,30 (When the header is ON)	

Parameter

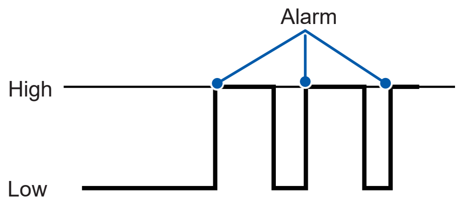
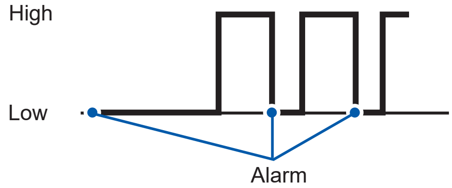
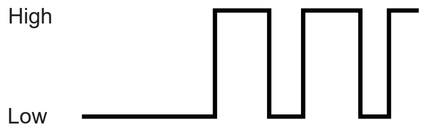
alm$ = ALM1 to ALM4
ch$ = CH1_1 to CH10_30
w$ = W1 to W30
pls$ = PLS1
no$ = NO1 to NO100

hour = 0 to 24 (hour)*1
min = 0 to 59 (min)*1
sec = 0 to 59 (sec)*1
ms = 0 to 999 (msec)*1

*1. Input in the format of A<NR1>.
See “Data part” (p. 24).

0,0,0,0 cannot be entered.
A time equal to or greater than “10000 × Recording interval” cannot be set.
A value can be set up to 24 hours.

3 When the input type for the logic channel (PLS1) is logic.

<table>
<tr><td rowspan="3">Pattern</td><td rowspan="3">Level</td><td rowspan="3">1, 0, X ☑</td><td>1
</td><td>Outputs an alarm when the logic signal is 1 (High).</td></tr>
<tr><td>0
</td><td>Outputs an alarm when the logic signal is 0 (Low).</td></tr>
<tr><td>X
</td><td>Not used for alarm judgment.
Ignores the signal.</td></tr>
</table>

Settings		
Syntax	Command	`:ALARm:LOGic:PATTern alm$,"A$"`
Example	`:ALARm:LOGic:PATTern ALM1,"1"`	
Query		
Syntax	Query	`:ALARm:LOGic:PATTern? alm$`
	Response	`"A$"`
Example	`:TRIGger:LOGic:STARt:PATTern?` (Response) `:ALARM:LOGIC:PATTERN ALM1,"1"` (When the header is ON)	

Parameter

`alm$` = ALM1 to ALM4
`A$` = 1, 0, X
Alarm pattern

`1`	An alarm is issued with the High level signal.
`0`	An alarm is issued with the Low level signal.
`X`☑	No alarm is applied. Ignores the signal.

Note

The conventional commands can also be used. (p.450)

7.2 Checking Alarm

1 **Check the alarm history.**

(1) Check the number of alarms.

Query		
Syntax	Query	:ALARm:ARCDNum?
	Response	A<NR1>
Example	:ALARm:ARCDNum? (Response) :ALARM:ARCDNUM 10 (When the header is ON)	
Parameter		
A = 0 to 999999 (0 = no alarm)		

(2) Check the details of the alarm history.

- Check the details of the target alarm history from the number obtained with the number of alarms.
- The formats of the issuance and cancellation times follow the settings for the horizontal (time) axis display. (p. 290)
- If the alarm is not canceled, the cancellation time is hyphen (-).
- When a thermocouple wire break occurs, the channel number is hyphen (-).
- The details can be checked for up to the latest 100 alarms in the alarm history.

Query		
Syntax	Query	:ALARm:ARCD? NO
	Response	NO<NR1>,ALM$,CH$,ERR$,STR$,END$
Example	:ALARm:ARCD? 1 (Response) :ALARM:ARCD 1,ALM1,CH1_1,-, 20ms, 60ms (When the header is ON)	
Parameter		
NO = Alarm history number (1 to 999999) ALM$ = ALM1 to ALM4 CH$ = CH1_1 to CH10_30, PLS1, W1 to W30, M1URMS1 to M4TMS ERR$ = -, BURN_OUT (thermocouple wire break) STR$ = Time of occurrence END$ = Time of cancellation		

2 **Cancel the alarm.**

When the alarm output hold is set to ON, the alarm can be canceled with the following command. The alarm cannot be canceled if the alarm condition is satisfied.

Settings		
Syntax	Command	:ALARm:HOLD A$
Example	:ALARm:HOLD CLEAR	

For the settings of the alarm function, alarm output hold, and alarm buzzer, see "7.1 Setting Alarms" (p. 247).

8 Marking Function

When Logger Utility is used, an event mark is displayed at the top of the screen.

8.1 Placing Event Marks During Measurement

It is useful for analysis if event marks are placed at the timing of operations during the measurement.
This feature allows you to see how the waveform changes when the object being measured performs a certain operation.
Up to 1000 event marks can be placed per measurement.
The event numbers are reset when the next measurement is started.

1 **Check the event mark setting and the number of event marks already set.**

Settings		
Syntax	Command	:DISPlay:MARK
Example	:DISPlay:MARK	
Query		
Syntax	Query	:DISPlay:MARK?
	Response	A<NR1>
Example	:DISPlay:MARK? (Response) :DISPLAY:MARK 10 (When the header is ON)	
Parameter		
A = 0 to1000		

2 **Check the data number of the event mark position.**

Query		
Syntax	Query	:DISPlay:MARKJump? A
	Response	A<NR1>,B<NR1>
Example	:DISPlay:MARKJump? 10 (Response) :DISPLAY:MARKJUMP 10,500 (When the header is ON)	
Parameter		
A = 1 to number of event marks B = Data number		

8.2 Placing Event Marks With External Signals

Event marks can be added using external signals.
The settings need to be configured before starting the measurement.

1 **Set the event input for external inputs 1 to 3.**

Settings		
Syntax	Command	:SYSTem:EXT:IO1:KIND A$ (External input 1) :SYSTem:EXT:IO2:KIND A$ (External input 2) :SYSTem:EXT:IO3:KIND A$ (External input 3)
Example	:SYSTem:EXT:IO1:KIND EVENTIN	
Query		
Syntax	Query	:SYSTem:EXT:IO1:KIND? (External input 1) :SYSTem:EXT:IO2:KIND? (External input 2) :SYSTem:EXT:IO3:KIND? (External input 3)
	Response	A$
Example	:SYSTem:EXT:IO1:KIND? (Response) :SYSTEM:EXT:IO1:KIND EVENTIN (When the header is ON)	

Parameter

For external inputs 1 and 2
A$ = OFF, STARTIN, STOPIN, S_SIN, EVENTIN

OFF☑	Disables the terminal.
STARTIN	Start Starts measurement.
STOPIN	Stop Stops measurement.
S_SIN	Start/stop Starts or stops measurement based on changes in the signal level.
EVENTIN	Event input Places an event mark.

For external input 3
A$ = OFF, TRIGIN, EVENTIN

OFF☑	Disables the external input.
TRIGIN	Trigger input The trigger is activated.
EVENTIN	Event input Places an event mark.

Note

For IO 3, when the external trigger setting is enabled, only the trigger input setting can be changed.

8.3 Placing an Event Mark When an Alarm is Issued

An event mark can be placed when an alarm is issued.
The settings need to be configured before starting the measurement.

1 **Set whether or not to place an event mark when an alarm is issued.**

If the parameter is set to ON, an event mark and number are placed when an alarm is issued.
See “7 Alarm (Alarm Output)” (p.247).

Settings		
Syntax	Command	`:SYSTem:MARK A$`
Example	`:SYSTem:MARK ON`	
Query		
Syntax	Query	`:SYSTem:MARK?`
	Response	`A$`
Example	`:SYSTem:MARK?` (Response) `:SYSTEM:MARK ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	No event mark is placed when an alarm is issued.
`ON`	An event mark is placed when an alarm is issued.

8

Marking Function

8.4 Checking Events in CSV Data

When the waveform data are saved in text format (CSV) using the instrument, event numbers are inserted alongside the measurement data.
This allows you to verify which data is associated with which event.

Event number

File name	AUTO0003	V1.00									
Title comment											
Trigger Tir	'23-07-17 07:58:52.494										
CH	CH1-1	CH1-2	CH1-3	CH1-4	CH1-5	CH1-6	CH1-7	CH1-8	CH1-9	CH1-10	Event
Mode	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage	
Range	100mV	100mV	100mV	100mV	100mV	100mV	100mV	100mV	100mV	100mV	
ModuleID											
Comment											
Scaling	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
Ratio	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	
Offset	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Time	CH1-1[V]	CH1-2[V]	CH1-3[V]	CH1-4[V]	CH1-5[V]	CH1-6[V]	CH1-7[V]	CH1-8[V]	CH1-9[V]	CH1-10[V	Event
0.00E+00	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	0
1.00E+00	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	0
2.00E+00	-1.00E-02	-1.00E-02	-1.00E-02	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	0
3.00E+00	-1.00E-02	-1.00E-02	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	1
4.00E+00	-1.00E-02	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	0
5.00E+00	-1.00E-02	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	2
6.00E+00	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	0
7.00E+00	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	3
8.00E+00	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	0
9.00E+00	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	0
1.00E+01	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	4
1.10E+01	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	0
1.20E+01	-9.99E-03	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	0
1.30E+01	-9.99E-03	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	5
1.40E+01	-9.99E-03	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	0
1.50E+01	-9.99E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	0
1.60E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	6
1.70E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.97E-03	0
1.80E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.97E-03	-9.97E-03	0
1.90E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.97E-03	-9.97E-03	-9.97E-03	0
2.00E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.97E-03	-9.97E-03	-9.97E-03	-9.97E-03	0
2.10E+01	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.98E-03	-9.97E-03	-9.97E-03	-9.97E-03	-9.97E-03	-9.97E-03	0

9 Numerical and Waveform Calculation

The instrument can perform numerical calculations and waveform calculations.
The numerical calculations are calculations of maximum value, minimum value, etc. for the measured waveforms.
The waveform calculations are performed using waveforms, including addition and multiplication of waveforms between the channels.

9.1 Performing Numerical Calculation

Perform calculations during the measurement.
Set the numerical calculation before starting the measurement. Calculations are performed in real time during the measurement.

Set the numerical calculations before starting the measurement. (p. 272)
Calculations are performed in real time during the measurement.
- You can check the latest calculation values using the commands.
- In addition, the calculation values at regular intervals can be saved in the text format. (p. 226)

Set the numerical calculation function to ON and select the calculation type

To save the calculation results automatically

Auto-save setting (p. 226)

Measurement start

Observation

In the following cases, the calculated value and saved data are handled according to "14.12 Data Handling" (p. 428).
- When the waveform significantly exceeds the allowable measurement range of each range (+OVER, −OVER)
- When a thermocouple wire break is detected during temperature measurement (wire break detection)

Setting the numerical calculations

1 Set the numerical calculation function to ON.

Settings		
Syntax	Command	`:CALCulate:MEASure A$`
Example	`:CALCulate:MEASure ON`	
Query		
Syntax	Query	`:CALCulate:MEASure?`
	Response	`A$`
Example	`:CALCulate:MEASure?` (Response) `:CALCULATE:MEASURE ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Disabled
`ON`	Activated

2 Set the method to save the numerical calculation results in the auto-save operation.

If the parameter is set to DIVide (divided) or ONTIME (divided on time), the calculation results at regular intervals are saved.
If the format for the numerical calculation results in the auto-save operation is set to OFF (division disabled), the time-divided calculation cannot be set.
See “Auto save (Realtime save)” (p. 226).
Set the format for the numerical calculation results to CSV (text format).
When an external sampling is used, only OFF (Disable) can be set.

Settings		
Syntax	Command	`:CALCulate:MEAS:KIND A$`
Example	`:CALCulate:MEAS:KIND DIVide`	
Syntax	Query	`:CALCulate:MEAS:KIND?`
	Response	`A$`
Example	`:CALCulate:MEAS:KIND?` (Response) `:CALCULATE:MEAS:KIND DIVIDE` (When the header is ON)	
Parameter		
`A$` = OFF, DIVide, ONTIME		

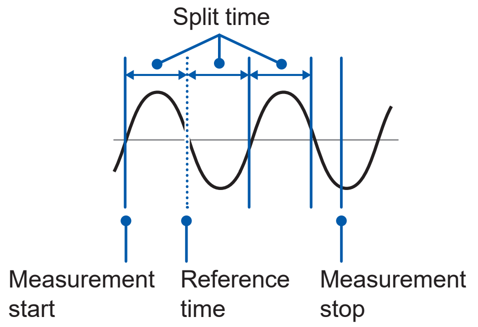
`OFF`☑	Division disabled The numerical calculations are performed for all data since measurement is started until it is stopped, and the calculation results are saved.
`DIVide`	Division enabled The numerical calculations are divided and performed at the specified intervals starting from the measurement start*1, and the calculation results for each interval are saved. *1. If the trigger is used, the numerical calculations are started from the start trigger.
`ONTIME`	Divided on time The length of the first section is automatically adjusted so that the calculation values at regular intervals (division time) can be saved based on the reference time (only the first section is shortened from the division time).

Note
The conventional commands can also be used. (p.450)

(When the time-divided calculation is set to DIVide)

Set the time interval to perform the calculation.

For example, if the division time is set to 10 minutes, the calculation is performed, and the calculation results are saved every 10 minutes.

	The calculation results are saved at the specified intervals after starting the measurement. The division time cannot be set to 0 days, 0 hours and 0 minutes. It is automatically updated to 0 days, 0 hours, and 1 minute.

Settings		
Syntax	Command	:CALCulate:MEAS:LEN day,hour,min
Example	:CALCulate:MEAS:LEN 0,1,30	
Query		
Syntax	Query	:CALCulate:MEAS:LEN?
	Response	day<NR1>,hour<NR1>,min<NR1>
Example	:CALCulate:MEAS:LEN? (Response) :CALCULATE:MEAS:LEN 0,1,30 (When the header is ON)	
Parameter		

day	0 to 30 (days)
hour	0 to 23 (hours)
min	0 to 59 (minutes)

See “Data part” (p. 24).

Note

The recording interval setting value may restrict the split length setting.
The conventional commands can also be used. (p.450)

(When the time-divided calculation is set to ONTIME)

Set the time that serves as a reference for dividing a file.

Settings		
Syntax	Command	:CALCulate:MEAS:REG hour,min
Example	:CALCulate:MEAS:REG 1,30	
Query		
Syntax	Query	:CALCulate:MEAS:REG?
	Response	hour<NR1>,min<NR1>
Example	:CALCulate:MEAS:REG? (Response) :CALCULATE:MEAS:REG 1,30 (When the header is ON)	
Parameter		

hour	0 to 23 (hours)
min	0 to 59 (minutes)

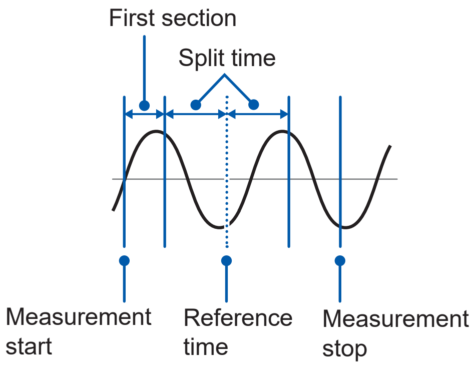
See “Data part” (p. 24).

Note

The conventional commands can also be used. (p.450)

Set the period to divide a file.

Settings		
Syntax	Command	`:CALCulate:MEAS:TIME A`
Example	`:CALCulate:MEAS:TIME 1`	
Query		
Syntax	Query	`:CALCulate:MEAS:TIME?`
	Response	`A<NR1>`
Example	`:CALCulate:MEAS:TIME?` (Response) `:CALCULATE:MEAS:TIME 1`	
Parameter		
`A` = 1, 2, 5, 10, 15, 20, 30, 60, 120, 180, 240, 360, 480, 720, 1440 (unit min)		
Note		
If a value not listed in the settings is specified, and if there are times longer than the specified value, the nearest time is applied. The conventional commands can also be used. (p.450)		



The calculation results are saved at the specified intervals based on the reference time.
The first section after starting the measurement is automatically adjusted to ensure that the calculated results are saved at intervals based on the division time, starting from the reference time.

3 **Set the numerical calculation type.**

Up to 10 numerical calculations can be set simultaneously.

Settings		
Syntax	Command	`:CALCulate:MEAS:SET no$,A$`
Example	`:CALCulate:MEAS:SET NO1,AVE`	
Query		
Syntax	Query	`:CALCulate:MEAS:SET? no$`
	Response	`no$,A$`
Example	`:CALCulate:MEAS:SET? NO1` (Response) `:CALCULATE:MEAS:SET NO1,AVE`	
Parameter		

`no$` = NO1 to NO10
`A$` = OFF, AVE, PP, MAX, MIN, MAXT, MINT, ACC, INT, OPE, ONT, OFFT, ONC, OFFC

`OFF`☑	No calculation
`AVE`	Average
`PP`	P-P value (difference between the maximum and the minimum)
`MAX`	Maximum
`MIN`	Minimum
`MAXT`	Time to reach the maximum since the start of recording*1
`MINT`	Time to reach the minimum since the start of recording*1
`ACC`	Integrated value
`INT`	Integral value
`OPE`	Operation rate (ratio when the measured value is equal to or greater than the threshold value)
`ONT`	ON time (total time when the measured value is equal to or greater than the threshold value)
`OFFT`	OFF time (total time when the measured value is less than the threshold value)
`ONC`	ON count (number of times when the measured value becomes equal to or greater than the threshold value)
`OFFC`	OFF count (number of times when the measured value becomes less than the threshold value)

*1. When the trigger is used, the time from the trigger point is calculated.
Only one threshold value can be set to each channel. If the same channel is specified for the ON and OFF times, the same threshold value is used.

Note

The conventional commands can also be used. (p.451)

4 Set the target channels to perform the numerical calculations.

Settings		
Syntax	Command	:CALCulate:MEAS:TARGet no$,ch$
Example	:CALCulate:MEAS:TARGet NO1,CH1_1	
Query		
Syntax	Query	:CALCulate:MEAS:TARGet? no$
	Response	no$,ch$
Example	:CALCulate:MEAS:TARGet? NO1 (Response) :CALCULATE:MEAS:TARGET NO1,CH1_1 (When the header is ON)	

Parameter

no$ = NO1 to NO10
ch$ = ALL, CH1_1 to CH10_30, PLS1, W1 to W30, M1URMS1 to M4TMS (p. 145)

ALL☑	Uses waveforms of all channels to perform the numerical calculations.
CH1_1 to CH10_30	Uses only waveforms of the specified channels to perform the numerical calculations. (n = 1, 2, ...)
PLS1	Performs the numerical calculations on pulse waveforms.
W1 to W30	Performs the numerical calculations on the waveforms on which the waveform calculations have been performed.
M1URMS1 to M4TMS	Uses only waveforms of the specified power calculation channels to perform the numerical calculations.

Note

Numerical calculation is not performed for the power calculation channel used as the status information. (p. 138)

5 (When the operation type is set to OPE [Usage ratio], ONT [ON time], OFFT [OFF time], ONC [ON count], or OFFC [OFF count])

Set the threshold value as a reference.

Settings		
Syntax	Command	:CALCulate:MEAS:LEVEl ch$,A
Example	:CALCulate:MEAS:LEVEl CH1_1,0.123	
Query		
Syntax	Query	:CALCulate:MEAS:LEVEl? ch$
	Response	ch$,A<NR3> (4 digit after the decimal point)
Example	:CALCulate:MEAS:LEVEl? CH1_1 (Response) :CALCULATE:MEAS:LEVEl CH1_1,+1.2340E-01 (When the header is ON)	

Parameter

ch$ = CH1_1 to CH10_30, PLS1, W1 to W30, M1URMS1 to M4TMS (p. 145)
A = −9.9999E+29 to 9.9999E+29

Note

If a value greater than the upper limit of the allowable setting range is entered, the maximum value is input.
If a value less than the lower limit of the allowable setting range is entered, the minimum value is input.
The power calculation channel used as the status information cannot be set. (p. 138)

6 **(When the operation type is set to ACC (integrated value) or INT (integral value)**
Select the calculation method.

For details about the calculation methods, see “Numerical calculation formula” (p. 278).

Settings		
Syntax	Command	`:CALCulate:MEAS:INTegra no$,A$`
Example	`:CALCulate:MEAS:INTegra NO1,TOTAL`	
Query		
Syntax	Query	`:CALCulate:MEAS:INTegra? no$`
	Response	`no$,A$`
Example	`:CALCulate:MEAS:INTegra? NO1` (Response) `:CALCULATE:MEAS:INTEGRA NO1,TOTAL` (When the header is ON)	
Parameter		
`no$` = NO1 to NO10 `A$` = TOTAL, POSitive, NEGative, ABSolute		

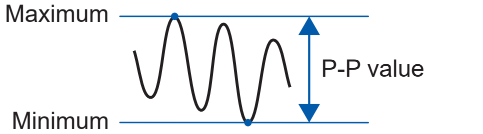
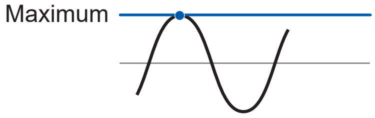
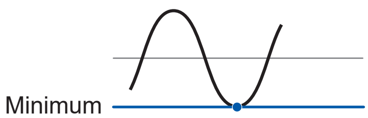
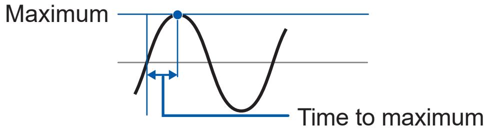
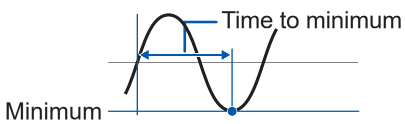
`TOTAL`☑	Total Calculates the difference between the integrated value or area enclosed with the zero position and sections of the signal waveform with a positive amplitude and the integrated value or area enclosed with the zero position and sections of the signal waveform with a negative amplitude.
`POSitive`	Positive Calculates the integrated value or area enclosed with the zero position and sections of the signal waveform with a positive amplitude.
`NEGative`	Negative Calculates the integrated value or area enclosed with the zero position and sections of the signal waveform with a negative amplitude.
`ABSolute`	Absolute value Calculates the integrated value or area enclosed with the zero position and the signal waveform.

7 **Check the numerical calculation results.**

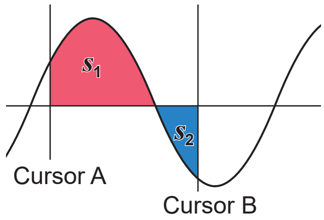
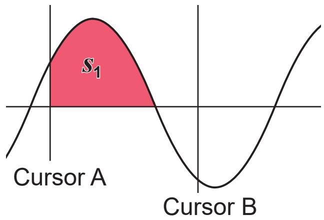
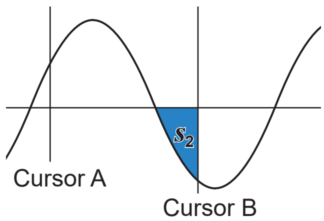
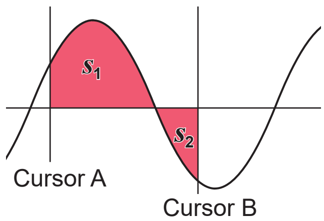
Query		
Syntax	Query	`:CALCulate:MEAS:ANSWer? no$,ch$`
	Response	`no$,ch$,A<NR3>` (11 digits after the decimal point)
Example	`:CALCulate:MEAS:ANSWer? NO1,CH1_1` (Response) `:CALCULATE:MEAS:ANSWER NO1,CH1_1,+1.23456789012E-03` (When the header is ON)	
Parameter		
`no$` = NO1 to NO10 `CH$` = CH1_1 to CH10_30, PLS1, W1 to W30, M1URMS1 to M4TMS (p. 145) `A` = Calculation result Under the following condition, `A` = NONE (character string) is returned. • When the numerical calculation is set to OFF • When the numerical calculation type of the specified calculation number is set to OFF • When no calculation result exists or can be acquired • When the power calculation channel is used as the status information (p. 138)		
Note		
The conventional commands can also be used. (p. 451)		

Numerical calculation formula

The details of the numerical calculations are described here.

Operation type	Description
Average	Calculates the average of waveform data. $AVE = \frac{1}{n}\sum_{i=1}^{n} di$ AVE: Average n: Number of data points di: ith data point in the channel
P-P value	Calculates the value between the maximum and minimum of waveform data (peak-to-peak value). 
Maximum	Calculates the maximum of waveform data. 
Minimum	Calculates the minimum of waveform data. 
Time to maximum	Calculates the time (s) to reach the maximum since the start of recording.*1 If 2 or more points have the maximum value, the first point in the target waveform of the operation is treated as the maximum. 
Time to minimum	Calculates the time (s) to reach the minimum since the start of recording.*1 If 2 or more points have the minimum value, the first point in the target waveform of the operation is treated as the minimum. 
Aggregation (total)	Calculates the summation of the measurement data. $SUM = \sum_{i=1}^{n} di$ SUM: Integrated value n: Total number of data di: ith data point in the channel
Aggregation (positive)	Calculates the summation of the positive measurement data. $SUM = \sum_{i=1,\ di>0}^{n} di$ SUM: Integrated value n: Total number of data di: ith data point in the channel
Aggregation (negative)	Calculates the summation of the negative measurement data. $SUM = \sum_{i=1,\ di<0}^{n} di$ SUM: Integrated value n: Total number of data di: ith data point in the channel
Aggregation (absolute value)	Calculates the summation of the absolute values of the measurement data. $SUM = \sum_{i=1}^{n} \lvert di \rvert$ SUM: Integrated value n: Total number of data di: ith data point in the channel

*1. When the trigger is used, the time from the trigger point is calculated.

Operation type	Description	
Integration (total)	Calculates the difference between the area (V·s) enclosed with the zero position (potential 0 V) and sections of the signal waveform with a positive amplitude and the area (V·s) enclosed with the zero position (potential 0 V) and sections of the signal waveform with a negative amplitude. If the operation is performed for a specified range (selected with A/B cursors), the aggregation between the cursors is calculated. $S = \sum_{i=1}^{n} di \times \Delta t$ S: Integral value n: Total number of data points di: ith data point in the channel Δt: Sampling period	 $S = S_1 - S_2$
Integration (positive)	Calculates the area (V·s) enclosed with the zero position (potential 0 V) and sections of the signal waveform with a positive amplitude. If the operation is performed for a specified range (selected with A/B cursors), the aggregation between the cursors is calculated. $S = \sum_{i=1,\, di>0}^{n} di \times \Delta t$ S: Integral value n: Total number of data di: ith data point in the channel Δt: Sampling period	Sections with a positive amplitude only  $S = S_1$
Integration (negative)	Calculates the area (V·s) enclosed with the zero position (potential 0 V) and sections of the signal waveform with a negative amplitude. If the operation is performed for a specified range (selected with A/B cursors), the aggregation between the cursors is calculated. $S = \sum_{i=1,\, di<0}^{n} di \times \Delta t$ S: Integral value n: Total number of data di: ith data point in the channel Δt: Sampling period	Sections with a negative amplitude only  $S = -S_2$
Integration (absolute value)	Calculates the area (V·s) enclosed with the zero position (potential 0 V) and the signal waveform. If the operation is performed for a specified range (selected with A/B cursors), the aggregation between the cursors is calculated. $S = \sum_{i=1}^{n} \lvert di \rvert \times \Delta t$ S: Integral value n: Total number of data di: ith data point in the channel Δt: Sampling period	 $S = S_1 + S_2$

9.2 Performing Waveform Calculations

The four arithmetic operations between the channels and other calculations including moving averaging can be performed (max. 30 calculations). The calculation types are the four arithmetic operations, aggregation, simple average, moving average, and integration. The calculations are performed in real time during the measurement, and the waveforms after the calculations are recorded. The waveform calculations cannot be performed after measurement. The waveform calculation results are recorded in calculation channel W1 to W30.

1 **Enable the waveform calculation channel.**

Settings		
Syntax	Command	`:MODule:STORe ch$,A$`
Example	`:MODule:STORe W1,ON`	
Query		
Syntax	Query	`:MODule:STORe?`
	Response	`ch$,A$`
Example	`MODule:STORe? W1` (Response) `:MODULE:STORE W1,ON` (When the header is ON)	
Parameter		
`ch$` = CH1_1 to CH10_30, PLS1, LOG, ALARM, W1 to W30, M1URMS1 to M4TMS (p. 145) `A$` = OFF, ON		
Note		
The power calculation channel used as the status information cannot be set for the waveform calculation. (p. 138)		

2 **Set the waveform calculation type.**

Settings		
Syntax	Command	`:CALCulate:WAVE:KIND w$,A$`
Example	`:CALCulate:WAVE:KIND W1,OPE`	
Query		
Syntax	Query	`:CALCulate:WAVE:KIND? w$`
	Response	`w$,A$`
Example	`:CALCulate:WAVE:KIND? W1` (Response) `:CALCULATE:WAVE:KIND W1,OPE` (When the header is ON)	

Parameter	
w$ = W1 to W30 A$ = OPE, SUM, AVE, MOV, INT	
OPE☑	Four arithmetic operations Performs addition, subtraction, multiplication, and division between the channels. Set the channels, coefficients, and constants. A constant can be set as an exponent. If division by zero occurs during the calculation, the value of the quotient is set to 1.797693e+308.
SUM	Aggregation Adds up the measurement data and records the summation. Set the channels, start reset, and reset time.
AVE	Simple average Calculates the arithmetic mean of all measurement data since measurement is started and records the result. Set the channels, start reset, and reset time.
MOV	Moving average Averages over the specified number of points while moving. The averaging is processed over the specified number of points in each sampling data, and the results are recorded. Set the channels and the number of points.
INT	Integration Adds up the values of the measurement data multiplied by the sampling period and records the summation. Set the channels, start reset, and reset time.

Note

The conventional commands can also be used. (p.451)

3 **(When the four arithmetic operations are selected for the waveform calculation type)**

Set the constants, target channels, and operators that form the following formula.

(Formula) = (A ∗ CHa□B ∗ CHb□C ∗ CHc□ D ∗ CHd) ■ E

(1) A, B, C, D, and E: Any constant (p.283)

(2) CHa, CHb, CHc, and CHd: Any measurement channels (max. 4 channels) (p.282)

(3) □: One of the OFF, PLUS, MINUS, MULTI, and DIV operators. When OFF is selected, operators within the brackets after OFF are disabled. (p.283)

(4) ■: One of the OFF, PLUS, MINUS, MULTI, DIV, and EXP operators. When OFF is selected, the constant E is disabled. (p.283)

Example:
```
:CALCulate:WAVE:ARIThmetic:COEF:A W1,5
:CALCulate:WAVE:ARIThmetic:COEF:E W1,2
:CALCulate:WAVE:SOURce:SR1 W1,CH1_1
:CALCulate:WAVE:ARIThmetic:OPERator:A W1,OFF
:CALCulate:WAVE:ARIThmetic:OPERator:D W1,EXP
```
In this case,
the formula is “$(5 \times CH\_1)^2$”.

The calculation channels can be selected as a target channel. However, the calculation channels with a larger number than the specified calculation channel cannot be selected. Example: For W5, W1 to W4 can be set as the calculation channels.

Waveform calculation source

Set CHa to CHd with the following commands.

<table>
<tr><th colspan="3">Settings</th></tr>
<tr><td>Syntax</td><td>Command</td><td>:CALCulate:WAVE:SOURce:SR1 w$,ch$ (Measurement CHa)
:CALCulate:WAVE:SOURce:SR2 w$,ch$ (Measurement CHb)
:CALCulate:WAVE:SOURce:SR3 w$,ch$ (Measurement CHc)
:CALCulate:WAVE:SOURce:SR4 w$,ch$ (Measurement CHd)</td></tr>
<tr><td>Example</td><td colspan="2">:CALCulate:WAVE:SOURce:SR1 W1,CH1_1</td></tr>
<tr><th colspan="3">Query</th></tr>
<tr><td rowspan="2">Syntax</td><td>Query</td><td>:CALCulate:WAVE:SOURce:SR1? w$ (Measurement CHa)
:CALCulate:WAVE:SOURce:SR2? w$ (Measurement CHb)
:CALCulate:WAVE:SOURce:SR3? w$ (Measurement CHc)
:CALCulate:WAVE:SOURce:SR4? w$ (Measurement CHd)</td></tr>
<tr><td>Response</td><td>w$,ch$</td></tr>
<tr><td>Example</td><td colspan="2">:CALCulate:WAVE:SOURce:SR1? W1
(Response) :CALCULATE:WAVE:SOURCE:SR1 W1,CH1_1 (When the header is ON)</td></tr>
<tr><th colspan="3">Parameter</th></tr>
<tr><td colspan="3">w$ = W1 to W30
ch$ = CH1_1 to CH10_30, PLS1, W1 to W29, M1URMS1 to M4TMS</td></tr>
<tr><th colspan="3">Note</th></tr>
<tr><td colspan="3">The conventional commands can also be used. (p.451)
The power calculation channel used as the status information cannot be set for the waveform calculation source. (p. 138)</td></tr>
</table>

Coefficients of the four arithmetic operations

Settings		
Syntax	Command	**:CALCulate:WAVE:ARIThmetic:COEF:A w$,A** (Coefficient A) **:CALCulate:WAVE:ARIThmetic:COEF:B w$,A** (Coefficient B) **:CALCulate:WAVE:ARIThmetic:COEF:C w$,A** (Coefficient C) **:CALCulate:WAVE:ARIThmetic:COEF:D w$,A** (Coefficient D) **:CALCulate:WAVE:ARIThmetic:COEF:E w$,A** (Coefficient E)
Example	**:CALCulate:WAVE:ARIThmetic:COEF:A W1,1**	
Query		
Syntax	Query	**:CALCulate:WAVE:ARIThmetic:COEF:A? w$** (Coefficient A) **:CALCulate:WAVE:ARIThmetic:COEF:B? w$** (Coefficient B) **:CALCulate:WAVE:ARIThmetic:COEF:C? w$** (Coefficient C) **:CALCulate:WAVE:ARIThmetic:COEF:D? w$** (Coefficient D) **:CALCulate:WAVE:ARIThmetic:COEF:E? w$** (Coefficient E)
	Response	**w$,A<NR3>** (4 digits after the decimal point)
Example	**:CALCulate:WAVE:ARIThmetic:COEF:A? W1** (Response) **:CALCULATE:WAVE:ARITHMETIC:COEF:A W1,+1.0000E+00** (When the header is ON)	
Parameter		
w$ = W1 to W30 **A** = -9.9999E+29 to 9.9999E+29		
Note		
The conventional commands can also be used. (p.451)		

Operators of the four arithmetic operations

Settings		
Syntax	Command	**:CALCulate:WAVE:ARIThmetic:OPERator:A w$,A$** (Operator A) **:CALCulate:WAVE:ARIThmetic:OPERator:B w$,A$** (Operator B) **:CALCulate:WAVE:ARIThmetic:OPERator:C w$,A$** (Operator C) **:CALCulate:WAVE:ARIThmetic:OPERator:D w$,A$** (Operator D)
Example	**:CALCulate:WAVE:ARIThmetic:OPERator:A W1,PLUS**	
Query		
Syntax	Query	**:CALCulate:WAVE:ARIThmetic:OPERator:A? w$** (Operator A) **:CALCulate:WAVE:ARIThmetic:OPERator:B? w$** (Operator B) **:CALCulate:WAVE:ARIThmetic:OPERator:C? w$** (Operator C) **:CALCulate:WAVE:ARIThmetic:OPERator:D? w$** (Operator D)
	Response	**w$,A$**
Example	**:CALCulate:WAVE:ARIThmetic:OPERator:A? W1** (Response) **:CALCULATE:WAVE:ARITHMETIC:OPERATOR:A W1,PLUS** (When the header is ON)	
Parameter		
w$** = W1 to W30 **A$ = OFF, PLUS, MINUS, MULTI, DIV (Operators A, B, C) **A$** = OFF, PLUS, MINUS, MULTI, DIV, EXP (Operator D)		

OFF	The subsequent operations are not performed.
PLUS	Addition
MINUS	Subtraction
MULTI	Multiplication
DIV	Division
EXP	Exponentiation

Note
The conventional commands can also be used. (p.451)

4 **(When the waveform calculation type is set to Aggregation, Simple average, or Integration) Set the reset operation when measurement is started.**

Settings		
Syntax	Command	`:CALCulate:WAVE:RESet:KIND w$,A$`
Example	`:CALCulate:WAVE:RESet:KIND W1,OFF`	
Query		
Syntax	Query	`:CALCulate:WAVE:RESet:KIND? w$`
	Response	`w$,A$`
Example	`:CALCulate:WAVE:RESet:KIND? W1` (Response) `:CALCULATE:WAVE:MOVE:KIND W1,OFF` (When the header is ON)	
Parameter		
`w$` = W1 to W30 `A$` = OFF, TRIG		

`OFF`☑	Does not reset the calculation results.
`TRIG`	Resets the calculation results when the trigger is activated.

Note
The conventional commands can also be used. (p.451)

5 **(When the waveform calculation type is set to Aggregation, Simple average, or Integration) Set the timing to perform the reset operation.**

Settings		
Syntax	Command	`:CALCulate:WAVE:RESet:TIME w$,A$`
Example	`:CALCulate:WAVE:RESet:TIME W1,OFF`	
Query		
Syntax	Query	`:CALCulate:WAVE:RESet:TIME? w$`
	Response	`w$,A$`
Example	`:CALCulate:WAVE:RESet:TIME? W1` (Response) `:CALCULATE:WAVE:MOVE:TIME W1,OFF` (When the header is ON)	
Parameter		
`w$` = W1 to W30 `A$` = OFF, ON, ONTIME		

`OFF`☑	Division disabled Does not reset the calculation results.
`ON`	Division enabled Resets the calculation results at the specified time intervals.
`ONTIME`	Divided on time Resets the calculation results at the specified intervals starting from the specified time.

When an external sampling is used, only OFF (Disable) can be set.

Note
The conventional commands can also be used. (p.451)

6 **Set the reference time and the reset interval.**
(When the reset time is set to "division enabled") Set the reset interval.

Settings		
Syntax	Command	`:CALCulate:WAVE:RESet:INT w$,day,hour,min`
Example	`:CALCulate:WAVE:RESet:INT W1,0,0,1`	
Query		
Syntax	Query	`:CALCulate:WAVE:RESet:INT? w$`
	Response	`w$,day<NR1>,hour<NR1>,min<NR1>`
Example	`CALCulate:WAVE:RESet:INT? W1` (Response) `:CALCULATE:WAVE:MOVE:INT W1,0,0,1` (When the header is ON)	
Parameter		
`w$` = W1 to W30		
`day`	0 to 30 (days)	
`hour`	0 to 23 (hours)	
`min`	0 to 59 (minutes)	
Minimum of 1 minute		
Note		
The conventional commands can also be used. (p.451)		

(When the reset time is set to divided on time) Set the reference time and the reset interval.

Settings		
Syntax	Command	`:CALCulate:WAVE:RESet:BASE w$,hour,min`
Example	`:CALCulate:WAVE:RESet:BASE W1,0,0`	
Query		
Syntax	Query	`:CALCulate:WAVE:RESet:BASE? w$`
	Response	`w$,hour<NR1>,min<NR1>`
Example	`:CALCulate:WAVE:RESet:BASE? W1` (Response) `:CALCULATE:WAVE:RESET:BASE W1,0,0` (When the header is ON)	
Parameter		
`w$` = W1 to W30		
`hour`	0 to 23 (hours)	
`min`	0 to 59 (minutes)	
Note		
The conventional commands can also be used. (p.451)		

7 **(When the waveform calculation type is set to moving average) Set the number of points.**

Settings		
Syntax	Command	`:CALCulate:WAVE:MOVe:POINt w$,A`
Example	`:CALCulate:WAVE:MOVe:POINt W1,10`	
Query		
Syntax	Query	`:CALCulate:WAVE:MOVe:POINt? w$`
	Response	`w$,A<NR1>`
Example	`:CALCulate:WAVE:MOVe:POINt? W11` (Response) `:CALCULATE:WAVE:MOVE:POINT W1,10` (When the header is ON)	
Parameter		
`w$` = W1 to W30 `A$` = 1 to 600 (Number of points)		
Note		
The conventional commands can also be used. (p.451)		

8 Set the unit for waveform calculation.

See “(3) Character string data” (p. 25).

Settings		
Syntax	Command	`:CALCulate:WAVE:STR w$,"A$"`
Example	`:CALCulate:WAVE:STR W1,"mA"`	
Query		
Syntax	Query	`:CALCulate:WAVE:STR? w$`
	Response	`w$,"A$"`
Example	`:CALCulate:WAVE:STR? W1` (Response) `:CALCULATE:WAVE:STR W1,"mA"` (When the header is ON)	
Parameter		
`w$` = W1 to W30 `A$` = Unit (up to 7 characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered. The conventional commands can also be used. (p.451)		

10 Setting System Environment

10.1 Setting the Environment

Set the various functions.

Start backup

Set the operation when the power supply is restored.
When the parameter is set to ON, recording can be automatically resumed when the power supply is restored after the power is lost due to a power outage or other reasons during recording operation.
If the trigger is used, the instrument enters the trigger standby state.
If the measurement is resumed in the start hold status, the measurement data before the power failure stored in the internal buffer memory of the instrument is deleted.

Settings		
Syntax	Command	`:SYSTem:STARt A$`
Example	`:SYSTem:STARt ON`	
Query		
Syntax	Query	`:SYSTem:STARt?`
	Response	`A$`
Example	`:SYSTem:STARt?` (Response) `:SYSTEM:START ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Disables the start backup function.
`ON`	Enables the start backup function.

Setting System Environment

10

Language

This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:SYSTem:LANGuage A$`
Example	`:SYSTem:LANGuage ENGlish`	
Query		
Syntax	Query	`:SYSTem:LANGuage?`
	Response	`A$`
Example	`:SYSTem:LANGuage?` (Response) `:SYSTEM:LANGUAGE ENGLISH` (When the header is ON)	
Parameter		
`A$` = JAPANese, ENGlish		

`JAPANese`	Japanese
`ENGlish`	English

Date format

This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:SYSTem:DFORmat A$`
Example	`:SYSTem:DFORmat YYYYMMDD`	
Query		
Syntax	Query	`:SYSTem:DFORmat?`
	Response	`A$`
Example	`:SYSTem:DFORmat?` (Response) `:SYSTEM:DFORMAT YYYYMMDD` (When the header is ON)	
Parameter		
`A$` = YYYYMMDD, MMDDYYYY, DDMMYYYY		

`YYYYMMDD`	yyyy MM dd
`MMDDYYYY`	MM dd yyyy
`DDMMYYYY`	dd MM yyyy

Date delimiter

This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:SYSTem:DSEParator A$`
Example	`:SYSTem:DSEParator HYPHEN`	
Query		
Syntax	Query	`:SYSTem:DSEParator?`
	Response	`A$`
Example	`:SYSTem:DSEParator?` (Response) `:SYSTEM:DSEPARATOR HYPHEN` (When the header is ON)	
Parameter		

`A$` = HYPHen, SLASh, PERiod

`HYPHen`	Hyphen (-)
`SLASh`	Slash (/)
`PERiod`	Period (.)

Beep sound

Set whether or not to issue a beep sound when a warning occurs or a specific operation is performed.

Settings		
Syntax	Command	`:SYSTem:BEEP A$`
Example	`:SYSTem:BEEP ON`	
Query		
Syntax	Query	`:SYSTem:BEEP?`
	Response	`A$`
Example	`:SYSTem:BEEP?` (Response) `:SYSTEM:BEEP ON` (When the header is ON)	
Parameter		

`A$` = OFF, ON

`OFF`	Does not issue a beep sound when a warning occurs or a specific operation is performed.
`ON`☑	Issues a beep sound when a warning occurs or a specific operation is performed.

A beep sound is issued if an error occurs under any condition.

Horizontal (time) axis display

Set the horizontal axis display. This display is only available for the text format saving.

Settings		
Syntax	Command	`:SYSTem:TMAXis A$`
Example	`:SYSTem:TMAXis TIME`	
Query		
Syntax	Query	`:SYSTem:TMAXis?`
	Response	`A$`
Example	`:SYSTem:TMAXis?` (Response) `:SYSTEM:TMAXIS TIME` (When the header is ON)	
Parameter		
`A$` = TIME, DATE, SCALe		

`TIME`	Time
`DATE`	Date
`SCALe`	Number of data points

When an external sampling is used, only SCALe (Number of data) can be set.

10.2 Operating the System

You can correct the time and initialize the instrument (system reset).
You can run self-diagnosis (self-checks) on the instrument.

Time setting

This instrument has a built-in auto-calendar, automatic leap year adjustment, and 24-hour clock.

The time is used for starting the measurement (start trigger time) and file information.

1 **Set the date and time of the instrument.**

Settings		
Syntax	Command	`:SYSTem:DATETime year,month,day,hour,minute,second`
Example	`:SYSTem:DATETime 23,1,2,12,34,56`	
Query on the date and time of the instrument		
Syntax	Query	`:SYSTem:DATETime?`
	Response	year<NR1>,month<NR1>,day<NR1>hour<NR1>, minute<NR1>,second<NR1>
Example	`:SYSTem:DATETime?` (Response) `:SYSTEM:DATETIME 23,01,02,12,34,56` (When the header is ON)	
Parameter		
`year`	0 to 37 (year)	
`month`	1 to 12 (month)	
`day`	1 to 31 (days)	
`hour`	0 to 23 (hours)	
`minute`	0 to 59 (minutes)	
`second`	0 to 59 (seconds)	
Note		
It takes approx. 1 second to set the date and time of the instrument.		

2 **Set the date (year, month, day) of the instrument (if you wish to set the date without setting the time).**

Settings		
Syntax	Command	`:SYSTem:DATE year,month,day`
Example	`:SYSTem:DATE 20,1,2`	
Query		
Syntax	Query	`:SYSTem:DATE?`
	Response	year<NR1>,month<NR1>,day<NR1>
Example	`:SYSTem:DATE?` (Response) `:SYSTEM:DATE 20,01,02` (When the header is ON)	
Parameter		
`year`	0 to 37 (year)	
`month`	1 to 12 (month)	
`day`	1 to 31 (days)	
Note		
It takes approx. 1 second to set the date and time of the instrument.		

3 Set the time of the instrument (if you wish to set the time without setting the date: year, month, day).

Settings		
Syntax	Command	`:SYSTem:TIME h,m,s`
Example	`:SYSTem:TIME 12,34,56`	
Query		
Syntax	Query	`:SYSTem:TIME?`
	Response	`h<NR1>,m<NR1>,s<NR1>`
Example	`:SYSTem:TIME?` (Response) `:SYSTEM:TIME 12,34,56` (When the header is ON)	
Parameter		
`h`	0 to 23 (hours)	
`m`	0 to 59 (minutes)	
`s`	0 to 59 (seconds)	
Note		
It takes approx. 1 second to set the date and time of the instrument.		

4 Set the time zone.

This setting is not initialized. The default value varies depending on the shipping destination.

Settings		
Syntax	Command	`:SYSTem:TIMEZone hour`(`,min`)
Example	`:SYSTem:TIMEZone 9`	
Query		
Syntax	Query	`:SYSTem:TIMEZone?`
	Response	`hour<NR1>`(`,min<NR1>`)
Example	`:SYSTem:TIMEZone?` (Response) `:SYSTEM:TIMEZone +9` (When the header is ON)	
Parameter		
`hour`	−12 to +14 (hours)	
`min`	30, 45 (min) (0 min when omitted)	

If the time zone is changed, the time of the clock is also changed accordingly.
If the combination of hour and min cannot be set, an error will occur.

List of time zone

GMT+14, GMT+13, GMT+12:45, GMT+12, GMT+11, GMT+10:30, GMT+10, GMT+9:30, GMT+9, GMT+8:45, GMT+8, GMT+7, GMT+6:30, GMT+6, GMT+5:45, GMT+5:30, GMT+5, GMT+4:30, GMT+4, GMT+3:30, GMT+3, GMT+2, GMT+1, GMT, GMT-1, GMT-2, GMT-3, GMT-3:30, GMT-4, GMT-5, GMT-6, GMT-7, GMT-8, GMT-9, GMT-9:30, GMT-10, GMT-11, GMT-12

Tips

Time zone

Set the time zone according to the region in which the instrument will be used.
GMT stands for Greenwich Mean Time.

Country (capital)	Difference from standard time (Daylight-saving time)
New Zealand (Wellington)	GMT+12:00 (+13:00)
Australia (Canberra)	GMT+10:00 (+11:00)
Japan (Tokyo)	GMT+9:00
South Korea (Seoul)	GMT+9:00
China (Beijing)	GMT+8:00
Taiwan (Taipei)	GMT+8:00
Singapore (Singapore)	GMT+8:00
Mongol (Ulan Bator)	GMT+8:00
Indonesia (Jakarta)	GMT+7:00
Thailand (Bangkok)	GMT+7:00
India (New Delhi)	GMT+5:30
Pakistan (Islamabad)	GMT+5:00
United Arab Emirates (Abu Dhabi)	GMT+4:00
Oman (Muscat)	GMT+4:00
Iran (Tehran)	GMT+2:30 (+3:30)
Romania (Bucharest)	GMT+2:00 (+3:00)
Finland (Helsinki)	GMT+2:00 (+3:00)
Qatar (Doha)	GMT+3:00
Turkey (Ankara)	GMT+3:00
Russia (Moscow)	GMT+3:00
Israel (Jerusalem)	GMT+3:00
Ukraine (Kyiv)	GMT+2:00 (+3:00)

Country (capital)	Difference from standard time (Daylight-saving time)
Greece (Athens)	GMT+2:00 (+3:00)
Germany (Berlin)	GMT+1:00 (+2:00)
France (Paris)	GMT+1:00 (+2:00)
The Netherlands (Amsterdam)	GMT+1:00 (+2:00)
Italy (Rome)	GMT+1:00 (+2:00)
Poland (Warsaw)	GMT+1:00 (+2:00)
Switzerland (Bern)	GMT+1:00 (+2:00)
Czech Republic (Prague)	GMT+1:00 (+2:00)
Belgium (Brussels)	GMT+1:00 (+2:00)
Sweden (Stockholm)	GMT+1:00 (+2:00)
Denmark (Copenhagen)	GMT+1:00 (+2:00)
Norway (Oslo)	GMT+1:00 (+2:00)
Spain (Madrid)	GMT+1:00 (+2:00)
Hungary (Budapest)	GMT+1:00 (+2:00)
Austria (Vienna)	GMT+1:00 (+2:00)
Slovenia (Ljubljana)	GMT+1:00 (+2:00)
Egypt (Cairo)	GMT+2:00
South Africa (Pretoria)	GMT+2:00
U.K. (London)	GMT(+1:00)
Portugal (Lisbon)	GMT(+1:00)
U.S.A. (Washington D.C.)	GMT-5:00 (-4:00)

As of October 2021

Time synchronization

The clock of the instrument can be synchronized with an NTP server.
It is necessary to configure the LAN setting in advance. (p.85)

1 **Set the NTP client function.**

Settings		
Syntax	Command	`:SYSTem:NTP:KIND A$`
Example	`:SYSTem:NTP:KIND ON`	
Query		
Syntax	Query	`:SYSTem:NTP:KIND?`
	Response	`A$`
Example	`:SYSTem:NTP:KIND?` (Response) `:SYSTEM:NTP:KIND ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Disables the NTP client function
`ON`	Enables the NTP client function

2 **Set the synchronization timing.**

Settings		
Syntax	Command	`:SYSTem:NTP:SYNC A$`
Example	`:SYSTem:NTP:SYNC HOUR`	
Query		
Syntax	Query	`:SYSTem:NTP:SYNC?`
	Response	`A$`
Example	`:SYSTem:NTP:SYNC?` (Response) `:SYSTEM:NTP:SYNC HOUR` (When the header is ON)	
Parameter		
`A$` = OFF, HOUR, DAY		

`OFF`☑	Synchronization OFF
`HOUR`	Synchronization hourly
`DAY`	Synchronization daily

3 Set the time synchronization before starting the measurement.

Settings		
Syntax	Command	:SYSTem:NTP:STARt A$
Example	:SYSTem:NTP:STARt ON	
Query		
Syntax	Query	:SYSTem:NTP:STARt?
	Response	A$
Example	:SYSTem:NTP:STARt? (Response) :SYSTEM:NTP:START ON (When the header is ON)	
Parameter		
A$ = OFF, ON		

OFF☑	Disables the time synchronization before starting the measurement
ON	Enables the time synchronization before starting the measurement

4 Set the destination server address.

Settings		
Syntax	Command	:SYSTem:NTP:ADDRess "A$"
Example	:SYSTem:NTP:ADDRess "abcdef.com"	
Query		
Syntax	Query	:SYSTem:NTP:ADDRess?
	Response	"A$"
Example	:SYSTem:NTP:ADDRess? (Response) :SYSTEM:NTP:ADDRESS "abcdef.com" (When the header is ON)	
Parameter		
A$ = Destination server address (up to 64 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, a command error will occur.		

5 Execute the time synchronization and check the result.

Query		
Syntax	Query	:SYSTem:NTP:CHECk?
	Response	A
Example	:SYSTem:NTP:CHECk? (Response) :SYSTEM:NTP:CHECK 0 (When the header is ON)	
Parameter		
A$ = 0 (success), 1 (failure)		

Initialization

Initialize the settings of the instrument. There are the following types of initialization.

Type	Description
Measurement data reset	Initializes the measurement data stored internally.
System reset	Initializes the settings other than the communication settings. The measurement data is also initialized.
Full reset	Restores the instrument to its factory default settings.

Measurement data reset

Clears the measurement data.

Settings		
Syntax	Command	`:SYSTem:DATAClear`
Example	`:SYSTem:DATAClear`	
Note		
It takes a few seconds to clear the waveform data.		

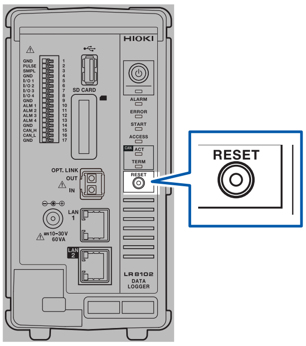
System reset

Initializes the settings other than the communication settings. The measurement data is also initialized.

Settings		
Syntax	Command	`*RST`
Example	`*RST`	
Note		
It takes time to process the `*RST` command.		

Full reset

Restores the factory default settings when the instrument is started up.
During startup, hold down the **RESET** key until the LED blinks and the buzzer sounds.



Self-checks (Self-diagnosis)

You can perform self-checks (self-diagnosis) on the instrument. If an error is detected, contact your authorized Hioki distributor or reseller for repair.

ROMRAM check

Settings		
Syntax	Command	:SYSTem:CHECk:ROMRam :SYSTem:CHECk
Example	:SYSTem:CHECk:ROMRam :SYSTem:CHECk	
Query		
Syntax	Query	:SYSTem:CHECk:ROMRam? :SYSTem:CHECk?
	Response	A$
Example	:SYSTem:CHECk:ROMRam? (Response) :SYSTEM:CHECK:ROMRAM PASS (When the header is ON)	
Parameter		
A$ = NONE, RUN, PASS, FAIL		

NONE	Not performed
RUN	Running
PASS	Normal
FAIL	Error

Note

It takes approx. 20 minutes to complete the ROMRAM check. Do not turn off the power during execution.
During the ROMRAM check, the LEDs blink in sequence according to the progress.

Module check

Settings		
Syntax	Command	:SYSTem:CHECk:MODule
Example	:SYSTem:CHECk:MODule	
Query		
Syntax	Query	:SYSTem:CHECk:MODule?
	Response	m1m2m3m4m5m6m7m8m9m10
Example	:SYSTem:CHECk:MODule? (Response) :SYSTEM:CHECK:MODULE 010101**** (When the header is ON)	
Parameter		
m1 to m10 = 0, 1, *, −, R		

0	Success
1	Failure
*	No module
-	No result
R	Running

Media check

Settings		
Syntax	Command	`:SYSTem:CHECk:MEDia:SD` `:SYSTem:CHECk:MEDia:USB`
Example	`:SYSTem:CHECk:MEDia:SD`	
Query		
Syntax	Query	`:SYSTem:CHECk:MEDia:SD?` `:SYSTem:CHECk:MEDia:USB?`
	Response	`A$`
Example	`:SYSTem:CHECk:MEDia:SD?` (Response) `:SYSTEM:CHECK:MEDIA:SD? 0` (When the header is ON)	
Parameter		

`A$` = NONE, RUN, PASS, FAIL

`NONE`	Not performed
`RUN`	Running
`PASS`	Normal
`FAIL`	Error

LAN1 check

Settings		
Syntax	Command	`:SYSTem:CHECk:IF:LAN1 ip1,ip2,ip3,ip4`
Example	`:SYSTem:CHECk:IF:LAN1 192,168,1,1`	
Query		
Syntax	Query	`:SYSTem:CHECk:IF:LAN1?`
	Response	`A$`
Example	`:SYSTem:CHECk:IF:LAN1?` (Response) `:SYSTEM:CHECK:IF:LAN1? PASS` (When the header is ON)	
Parameter		

`A$` = NONE, RUN, PASS, FAIL

`NONE`	Not performed
`RUN`	Running
`PASS`	Normal
`FAIL`	Error

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to255

As the instrument sends the PING command for checking the LAN, specify the IP of the LAN to which the PING command is to be sent.
Specify the IP of the target LAN to which the PING command can be returned.

LAN2 check (only LR8102)

Settings		
Syntax	Command	`:SYSTem:CHECk:IF:LAN2 ip1,ip2,ip3,ip4`
Example	`:SYSTem:CHECk:IF:LAN2 192,168,1,1`	
Query		
Syntax	Query	`:SYSTem:CHECk:IF:LAN2?`
	Response	`A$`
Example	`:SYSTem:CHECk:IF:LAN2?` (Response) `:SYSTEM:CHECK:IF:LAN2? PASS` (When the header is ON)	
Parameter		

`A$` = NONE, RUN, PASS, FAIL

`NONE`	Not performed
`RUN`	Running
`PASS`	Normal
`FAIL`	Error

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

As the instrument sends the PING command for checking the LAN, specify the IP of the LAN to which the PING command is to be sent.
Specify the IP of the target LAN to which the PING command can be returned.

Operation clock checks

Check the operation clock.

IMPORTANT
The clock signal is output from the SMPL terminal.

As the operation clock setting is not backed up, the setting is turned OFF whenever the power is restored.
Checking the waveform of the output clock allows you to check for a time lag of the operation clock.

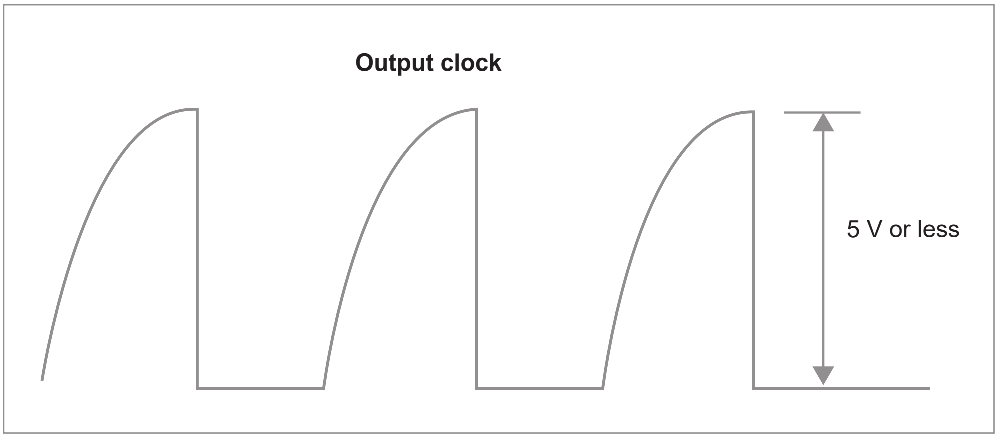
Settings		
Syntax	Command	`:SYSTem:CLOCk:OUT A$`
Example	`:SYSTem:CLOCk:OUT ON`	
Query		
Syntax	Query	`:SYSTem:CLOCk:OUT?`
	Response	`A$`
Example	`:SYSTem:CLOCk:OUT?` (Response) `:SYSTEM:CLOCK:OUT? ON` (When the header is ON)	
Parameter		

`A$` = OFF, ON, PRECISION

`OFF`	Does not output the clock signal for checking from the SMPL terminal.
`ON`	Outputs the clock signal for checking the clock accuracy from the SMPL terminal.
`PRECISION`	Outputs the clock signal for checking the time axis accuracy from the SMPL terminal.

Note

Check that the clock frequency output from the SMPL terminal is within the following range.
When ON is set: 32.768 kHz ±0.000379 kHz
When PRECISION is set: 10.000 kHz ±0.0000231 kHz



Adjustment/calibration date checks

Check the adjustment date.

Query		
Syntax	Query	`:SYSTem:ADJDate? A$`
	Response	`Y<NR1>,M<NR1>,D<NR1>`
Example	`:SYSTem:ADJDate? MODULE1` (Response) `:SYSTem:ADJDATE 23,12,22` (When the header is ON)	
Parameter		

`A$` = MAIN, MODULE1 to MODULE10

`MAIN`	Acquires the latest date (year, month, day) on which the instrument has been adjusted.
`MODULE1` to `MODULE10`	Acquires the latest date (year, month, day) on which the target module has been adjusted.

`Y`	year
`M`	month
`D`	days

If the target module does not exist, Y, M, and D are represented as `0,0,0`, respectively.

Check the calibration date.

Query		
Syntax	Query	`:SYSTem:CLBDate? A$`
	Response	`Y<NR1>,M<NR1>,D<NR1>`
Example	`:SYSTem:CLBDate? MODULE1` (Response) `:SYSTEM:CLBDATE 23,12,22` (When the header is ON)	
Parameter		

`A$` = MAIN, MODULE1 to MODULE10

`MAIN`	Acquires the latest date (year, month, day) on which the instrument has been calibrated.
`MODULE1` to `MODULE10`	Acquires the latest date (year, month, day) on which the target module has been calibrated.

`Y`	year
`M`	month
`D`	days

If the target module does not exist, Y, M, and D are represented as `0,0,0`, respectively.

11 External Control (EXT. I/O)

You can input signals to the external control terminal to control the instrument.
The signals according to the instrument operations are output from the external control terminal.
The external control terminal is not isolated (the ground is shared with the instrument).
For connection to the external control terminal, see “Wiring for external control” (p. 61).

11.1 Setting the Alarm Output (ALARM)

Set the voltage level of the signal that is output when an alarm condition is met. For the alarms, see “7 Alarm (Alarm Output)” (p.247).

Set the voltage level when an alarm is output.

Settings		
Syntax	Command	`:ALARm:ACTive alm$,A$`
Example	`:ALARm:ACTive ALM1,LOW`	
Query		
Syntax	Query	`:ALARm:ACTive? alm$`
	Response	`alm$,A$`
Example	`:ALARm:ACTive? ALM1` (Response) `:TRIGGER:ACTIVE ALM1,LOW` (When the header is ON)	
Parameter		
`alm$` = ALM1 to ALM4 `A$` = LOW, HIGH		

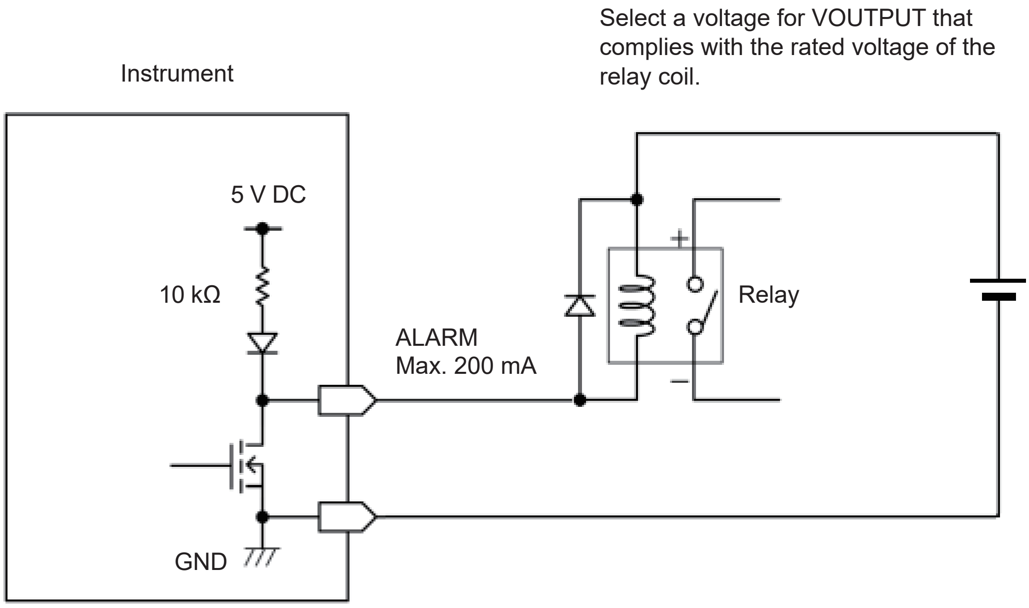
`LOW`☑	Outputs an alarm at a low level (0 V to 0.5 V).
`HIGH`	Outputs an alarm at a high level (4.0 V to 5.0 V).

Specifications of the alarm output terminal

Output type	Open drain output (with 5 V voltage output)
Output voltage	High level: 4.0 V to 5.0 V, Low level: 0 V to 0.5 V High and Low levels can be switched
Output response time	Data refresh interval × 3 + 5 ms
Maximum switching capacity	5 V to 10 V DC, 200 mA
Output pulse width	10 ms or greater

Circuit configuration diagram of an alarm output terminal and an example of connection with a relay

Select a relay with a contact configuration that enables the desired operations.
This connection example is a circuit configuration in which the relay is driven when the alarm output is Low.



11.2 Setting the External Input and Output (I/O) Terminals

Set the functions of the external I/O terminals.
There are 4 external I/O terminals: I/O 1 to I/O 4.
You can control the measurement, such as starting and stopping the measurement and inputting the trigger signals.
I/O 1 to I/O 3 are the input terminals and I/O 4 is the output terminal.

1 Set the external input terminals.

Settings		

Syntax	Command	`:SYSTem:EXT:IO1:KIND A$`
		`:SYSTem:EXT:IO2:KIND A$`
		`:SYSTem:EXT:IO3:KIND A$`

Example	`:SYSTem:EXT:IO1:KIND STARTIN`	
Query		

Syntax	Query	`:SYSTem:EXT:IO1:KIND?`
		`:SYSTem:EXT:IO2:KIND?`
		`:SYSTem:EXT:IO3:KIND?`

	Response	`A$`
Example	`:SYSTem:EXT:IO1:KIND?` (Response) `:SYSTEM:EXT:IO1:KIND STARTIN` (When the header is ON)	

Parameter

For external inputs 1 and 2
`A$` = OFF, STARTIN, STOPIN, S_SIN, EVENTIN

`OFF`☑	Disables the terminal.
`STARTIN`	Start Starts measurement.
`STOPIN`	Stop Stops measurement.
`S_SIN`	Start/stop Starts or stops measurement based on changes in the signal level.
`EVENTIN`	Event input Places an event mark.

For external input 3
`A$` = OFF, TRIGIN, EVENTIN

`OFF`☑	Disables the external input.
`TRIGIN`	Trigger input The trigger is activated.
`EVENTIN`	Event input Places an event mark.

Note

For IO 3, when the external trigger setting is enabled, only the trigger input setting can be changed.

2 Set the edge.

(1) Start slope

Set the slope to be used if the external input terminal is set to STARTIN, S_SIN, TRIGIN, or EVENTIN.

Settings		

Syntax	Command	`:SYSTem:EXT:IO1:SLOPe:STARt A$`
		`:SYSTem:EXT:IO2:SLOPe:STARt A$`
		`:SYSTem:EXT:IO3:SLOPe:STARt A$`

Example	`:SYSTem:EXT:IO1:SLOPe:STARt UP`	
Query		

Syntax	Query	`:SYSTem:EXT:IO1:SLOPe:STARt?`
		`:SYSTem:EXT:IO2:SLOPe:STARt?`
		`:SYSTem:EXT:IO3:SLOPe:STARt?`

	Response	`A$`
Example	`:SYSTem:EXT:IO1:SLOPe:STARt?` (Response) `:SYSTEM:EXT:IO1:SLOPE:START UP` (When the header is ON)	
Parameter		
`A$` = UP, DOWN		

`UP`	Operates at a rising edge from the Low to High level.
`DOWN`☑	Operates at a falling edge from the High to Low level.

(2) Stop slope

Set the slope to be used when the external input terminal is set to STOPIN or S_SIN.

Settings		

Syntax	Command	`:SYSTem:EXT:IO1:SLOPe:STOP A$`
		`:SYSTem:EXT:IO2:SLOPe:STOP A$`
		`:SYSTem:EXT:IO3:SLOPe:STOP A$`

Example	`:SYSTem:EXT:IO1:SLOPe:STOP UP`	
Query		

Syntax	Query	`:SYSTem:EXT:IO1:SLOPe:STOP?`
		`:SYSTem:EXT:IO2:SLOPe:STOP?`
		`:SYSTem:EXT:IO3:SLOPe:STOP?`

	Response	`A$`
Example	`:SYSTem:EXT:IO1:SLOPe:STOP?` (Response) `:SYSTEM:EXT:IO1:SLOPE:STOP UP` (When the header is ON)	
Parameter		
`A$` = UP, DOWN		

`UP`	Operates at a rising edge from the Low to High level.
`DOWN`☑	Operates at a falling edge from the High to Low level.

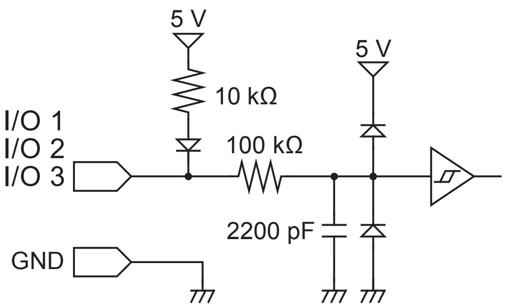
3 Set the functions of the external output terminal.

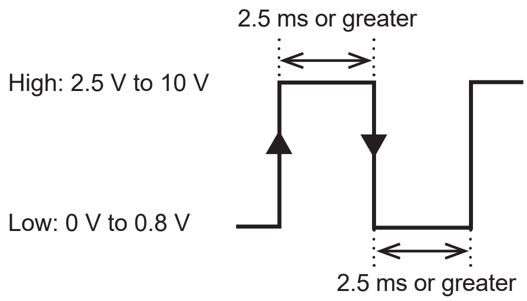
Settings		
Syntax	Command	`:SYSTem:EXT:IO4:KIND A$`
Example	`:SYSTem:EXT:IO4:KIND TRIGOUT`	
Query		
Syntax	Query	`:SYSTem:EXT:IO4:KIND?`
	Response	`A$`
Example	`:SYSTem:EXT:IO4:KIND?` (Response) `:SYSTEM:EXT:IO4:KIND TRIGOUT` (When the header is ON)	
Parameter		
`A$` = OFF, TRIGOUT		

`OFF`☑	Disables the terminal.
`TRIGOUT`	Outputs a Low level signal when the trigger is activated.

Input specifications of external input terminals (I/O 1, I/O 2, and I/O 3)

Input voltage	0 V to 10 V DC High level: 2.5 V to 10 V, Low level: 0 V to 0.8 V
Slope	Rise or fall can be selected
Response pulse width	High period 2.5 ms or greater, Low period 2.5 ms or greater

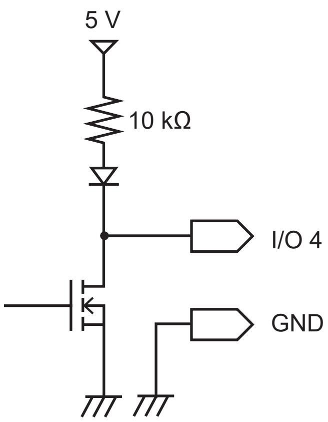


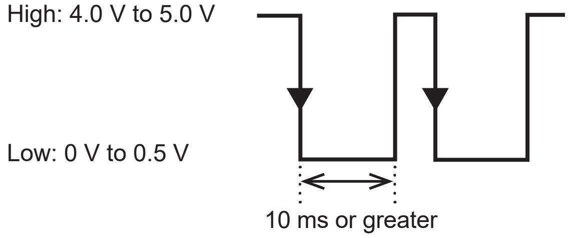


Operates at a rising edge or falling edge.
(depending on the edge setting)

Output specifications of external output terminal (I/O 4)

Output type	Open drain output (with 5 V voltage output)
Output voltage	High level: 4.0 V to 5.0 V, Low level: 0 V to 0.5 V
Maximum switching capacity	5 V to 10 V DC, 200 mA
Output pulse width	10 ms or greater (trigger output)





Starting multiple measurements simultaneously using the external trigger

The start time of measurements on multiple units can be synchronized using the trigger input and output.
Since the sampling clock operates on each device, performing the measurement for a long time causes variation in the data acquisition time.
Use the synchronized input and output terminals to synchronize the sampling clocks as well.
See "Set the synchronized terminal" (p. 113).
Methods for synchronizing the measurement start times are the daisy chain operation and parallel synchronized operation.

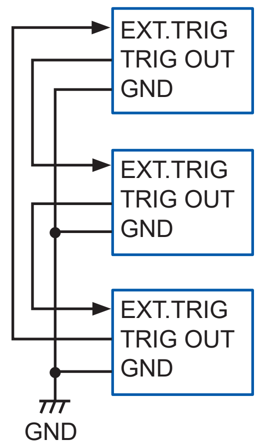
Daisy chain operation

When the trigger is activated to any one of the devices, other devices are also triggered.
As the number of connected devices increases, variation in the trigger time among devices is increased.

Connection method
Connect the "trigger output (I/O 4)" on one device with the "trigger input (I/O 3)" on the next device.
Repeat this connection in turn until all devices are connected.

Setting method
- Enable the trigger function on all devices (p. 193)
- Enable the external trigger function on all devices (p. 214)
- Set I/O 3 to the trigger input on all devices, and set the edge to **DOWN** (p. 306)
- Set the external output to **TRIGOUT** on all devices (p. 307)

Connection method



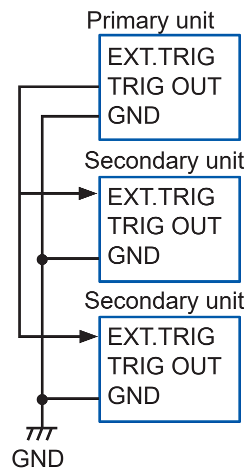
Parallel synchronized operation

Set one device as the primary unit (for trigger monitoring) and set other devices as the secondary units.
If the trigger is activated to the primary unit, the secondary units are also triggered.
Even if the number of connected devices increases, variation in the trigger time among devices is minimal.

Connection method
Connect the "trigger output (I/O 4)" on the primary unit with the "trigger input (I/O 3)" on all secondary units.

Setting method
- Enable the trigger function on all devices (p. 193)
- Enable the external trigger function on all secondary units (p. 214)
- Set I/O 3 to the trigger input on the secondary units, and set the edge to **DOWN** (p. 306)
- Set the external output to **TRIGOUT** on the primary unit (p. 307)

Connection method



11.3 Setting the External Sampling (SMPL)

Noise immunity can be improved by setting a filter on the external sampling terminal.
See “External sampling” (p. 109).

1 **Set the filter.**

Settings		
Syntax	Command	`:SYSTem:EXTFILTer A$`
Example	`:SYSTem:EXTFILTer ON`	
Query		
Syntax	Query	`:SYSTem:EXTFILTer?`
	Response	`A$`
Example	`:SYSTem:EXTFILTer?` (Response) `:SYSTEM:EXTFILTER ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`	Disables the filter.
`ON`☑	Enables the filter.

2 **Set the slope.**

Settings		
Syntax	Command	`:SYSTem:EXTSLOPe A$`
Example	`:SYSTem:EXTSLOPe UP`	
Query		
Syntax	Query	`:SYSTem:EXTSLOPe?`
	Response	`A$`
Example	`:SYSTem:EXTSLOPe?` (Response) `:SYSTEM:EXTSLOPE UP` (When the header is ON)	
Parameter		
`A$` = UP, DOWN		

`UP`	Operates at a rising edge from the Low to High level.
`DOWN`☑	Operates at a falling edge from the High to Low level.

12 Communication with PC (Computer)

Communication functions with a PC that cannot be used concurrently (LAN1)

There are the following restrictions concerning the communication function with a PC.

Description	Communication functions that cannot be used concurrently	See
Realtime data acquisition with communication commands*1 (measurement with a program in Visual Basic, etc.)	• Realtime measurement with Logger Utility	–
Realtime measurement with Logger Utility	• Realtime data acquisition using a communication command • Auto data sending using the FTP client function	p.311
Simple remote operation using the HTTP server function	• Realtime data acquisition using a communication command • Realtime measurement with Logger Utility	p.313
Data acquisition using the FTP server function	–	p.324
Auto data sending using the FTP client function	• Realtime measurement with Logger Utility	p.326

*1. There are restrictions when acquiring realtime data using a communication command.
See “4.7 Comparison of Realtime Data Acquisition” (p. 189).

The instrument can simultaneously output measured values from LAN2 and CAN while using LAN1 to communicate with a PC.

12.1 Using Logger Utility

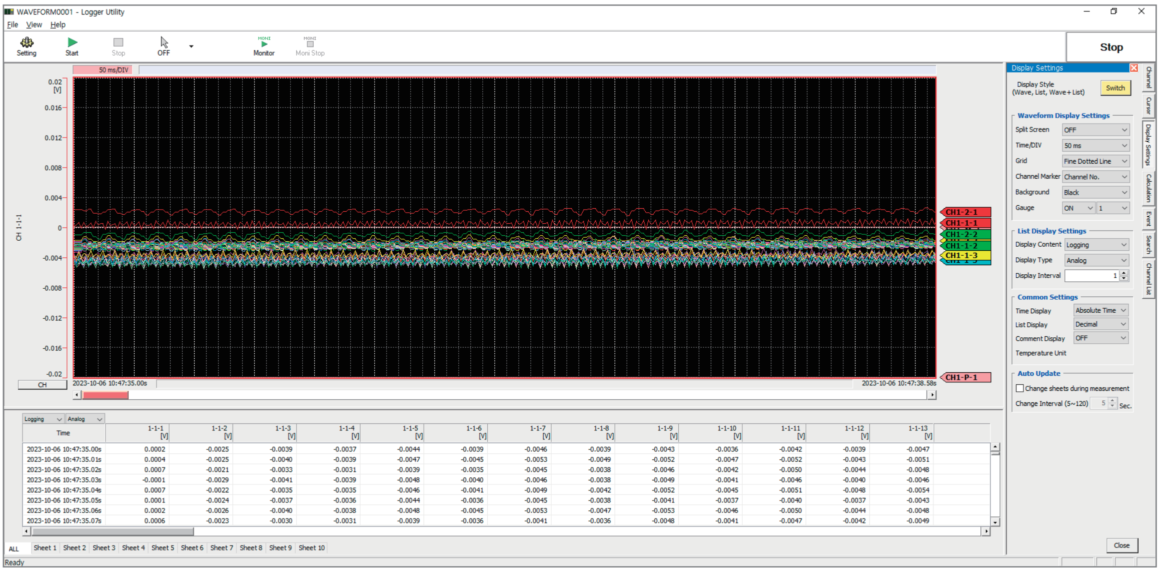
Application software “Logger Utility” is provided with the instrument.
Using a PC installed with Logger Utility, you can perform the settings and operations of the instrument and waveform observation.
The PC is connected with the instrument using LAN1.

The advantages are as follows:
- Data can be collected in real time on the PC and waveforms and numerical values can be checked immediately.
- The measurement data can be analyzed.
- The measurement data can be converted (from the binary format to the CSV format).
- Waveform data can be transferred in real time to an Excel file running on the PC.
- Not only the instrument, but also up to 5 units and 600 channels can be operated including existing loggers.

Models supporting Logger Utility

LR8101, LR8102, LR8450, LR8450-01, LR8400, LR8401, LR8402, LR8410, LR8416, LR8431, LR8432, 8423

For how to install and operate the PC application software, “Logger Utility”, refer to “Logger Utility Instruction Manual” found on the provided DVD (Application Disc).



When the number of analog channels for measurement ON is 601 or more, realtime data cannot be collected.

As values are handled differently between the instrument and Logger Utility, the numerical calculation result and waveform calculation result may differ in the following cases.
- When the result significantly exceeds the allowable measurement range (+OVER, −OVER)
- When a thermocouple wire break is detected during temperature measurement (burnout detection)
- When no measurement data exists (NO DATA)

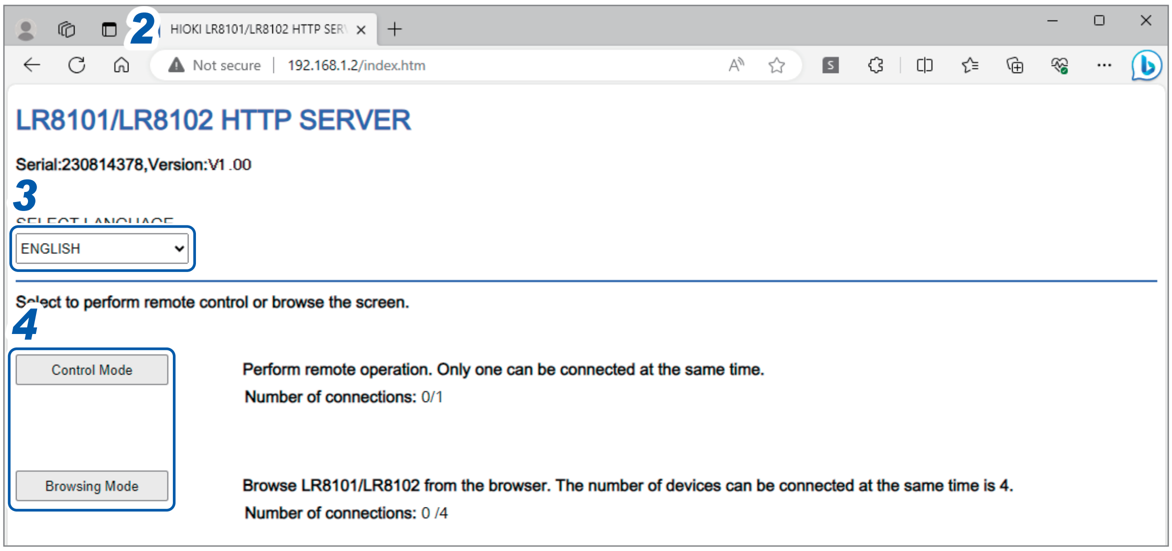
The following restrictions are applied to the M7103 Power Measurement Module.
- Up to 30 power calculation channels can be recorded per module.
- It is not possible to read any MEM files that include the power measurement module.

12.2 Remotely Operating the Instrument through the HTTP Server

The instrument can be remotely operated with a PC using the HTTP server function.
You can set the instrument, check the measurement data, etc., using a standard browser, such as Microsoft Edge.
The LAN setting and connection are required to remotely operate the instrument through the HTTP server.
When the HTTP server is accessed, the header is set to OFF in the communication command setting. During measurement with Logger Utility or a program in Visual Basic, etc., the remote operations through the HTTP server are disabled.
After the instrument is upgraded, the page of the previous version may open and the operations may not be performed properly. In this case, clear the browser's cache and connect to the HTTP server again.
When you set the clock of the instrument while connecting the HTTP server, the communication may be cut off.

Connecting to the HTTP server

Connect a PC to the HTTP server.



1 **Open a browser on the PC.**

2 **Enter the instrument's address in the address bar. (Example: http://192.168.1.2)**

Microsoft Edge is a recommended browser.

3 **Set the language (as needed).**

JAPANESE, **ENGLISH**

4 **Select the mode.**

Control Mode	Allows you to control and set the instrument from a browser. Only one unit can be connected at the same time.
View Mode	Allows you to only view the screen and status from a browser. Up to four units can be connected at the same time.

When the HTTP screen displays nothing

Perform the following operations and then check whether the LAN communications can be established.
See “When the LAN communications cannot be established.” (p. 100).

Windows 7 or Windows 8

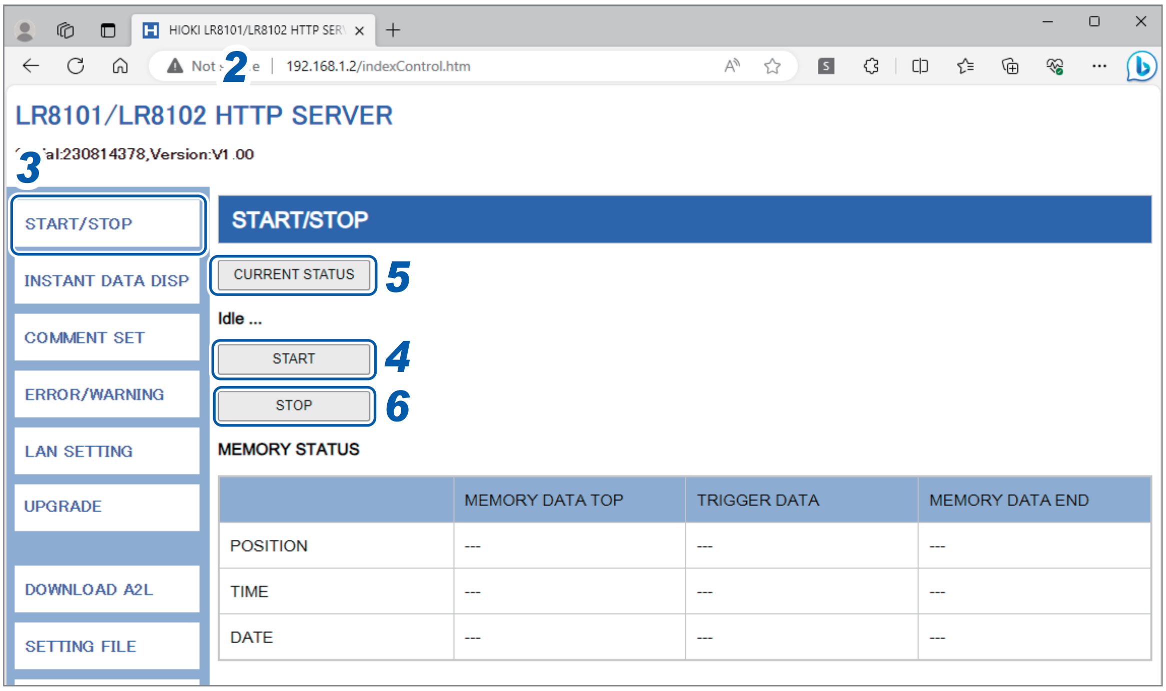
1. **Open [Control Panel] and click [Network and Internet] > [Internet Options].**
2. **In the [Advanced] tab, enable [Use HTTP 1.1] and disable [Use HTTP 1.1 through proxy connections].**
3. **In [LAN settings] in the [Connections] tab, disable the [Proxy server] setting.**

Windows 10 or Windows 11

1. **Open [Settings] in Windows and click [Network & internet] > [Proxy].**
2. **If [Manual proxy setup] > [Use a proxy server] is [On], turn it [Off].**
   If this is [On], the communications may not be established properly.

Starting and stopping measurement

You can use a browser to start and stop measurement.



1 **Open a browser on the PC.**

2 **Enter the instrument's address in the address bar. (Example: http://192.168.1.2)**

3 **Click [START/STOP].**
The [START/STOP] screen is displayed.

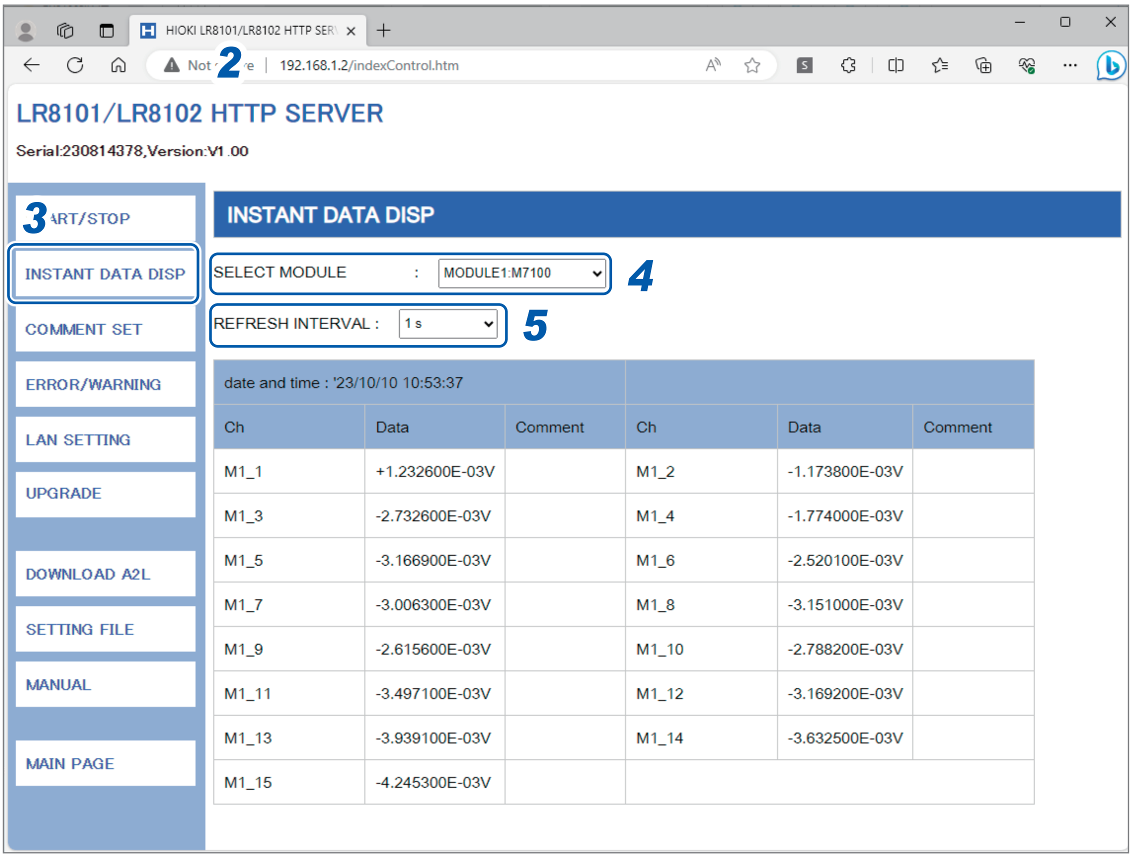
4 **Click [START].**
Starts measurement.

5 **Click [CURRENT STATUS] (as needed).**
Displays the measurement status of the instrument.

6 **Click [STOP].**
Stops measurement.

Displaying the measured value

You can use a browser to check the current measured value.



1 **Open a browser on the PC.**

2 **Enter the instrument's address in the address bar. (Example: http://192.168.1.2)**

3 **Click [INSTANT DATA DISP].**

Displays the current measured value.

4 **Set the module to display the value with [SELECT MODULE].**

Displays the measured value in each channel of the selected module.

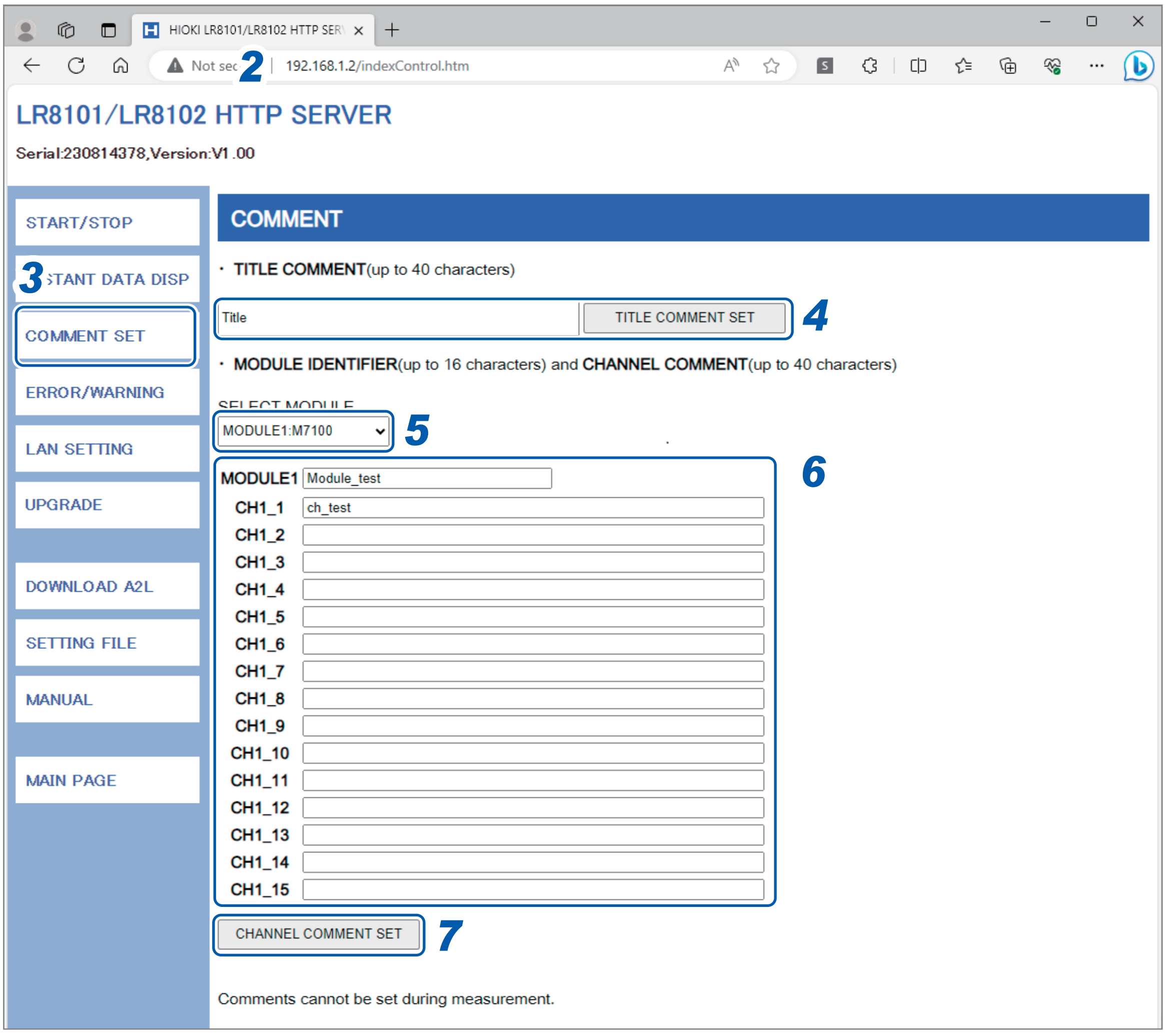
- It can take 2 or 3 seconds to acquire data depending on the communication status.
- If the display is set to OFF for a channel, its value is not displayed.
- While measurement is stopped, the instant data that is input to each channel is displayed.

5 **Set the screen refresh time with [REFRESH INTERVAL].**

OFF ☑, **1 s**, **5 s**, **10 s**, **30 s**

Comment entry

You can use a browser to enter a title comment and channel comments.



1 **Open a browser on the PC.**

2 **Enter the instrument's address in the address bar. (Example: http://192.168.1.2)**

3 **Click [COMMENT SET].**

Displays the comments that have been input to the instrument.

4 **Enter a title comment and then click [TITLE COMMENT SET].**

The title comment on the instrument is updated with the entry.

5 **Set the module to display the comment.**

Displays the module identification name and channel comment for the selected module.

6 **Enter a module identification name and comment for each channel.**

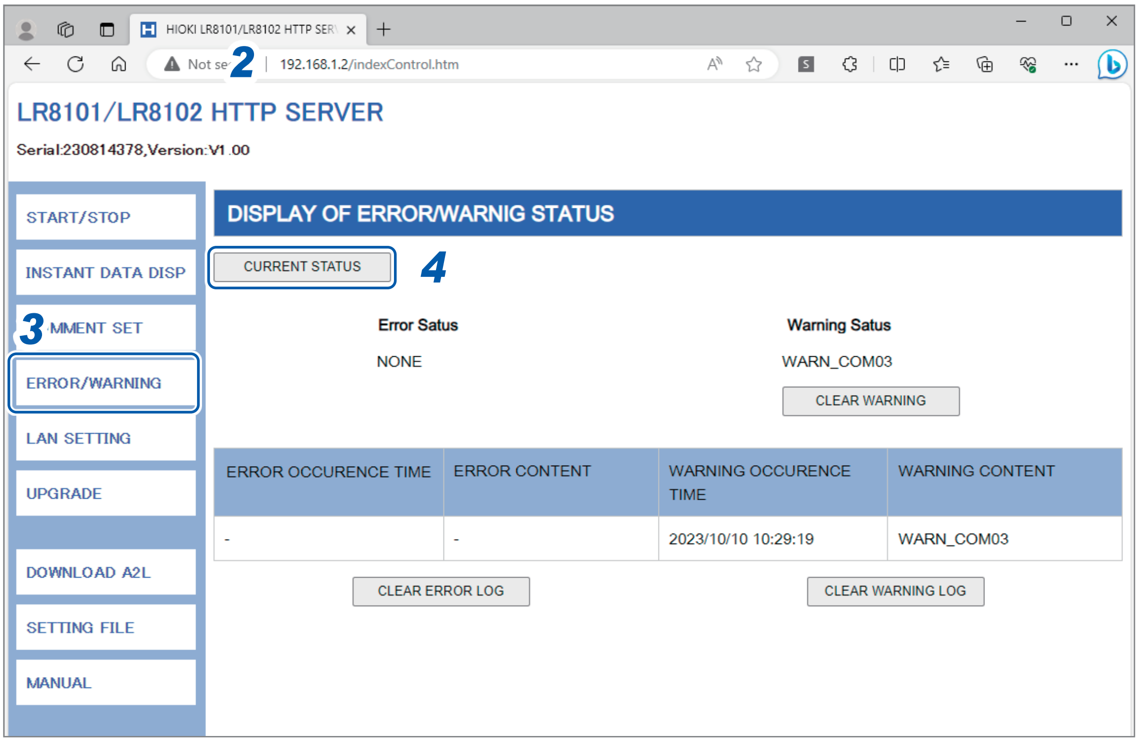
7 **Click [CHANNEL COMMENT SET].**

The module identification names and channel comments on the instrument are updated with the entries.

The comments on the instrument cannot be changed during the measurement.

Error/warning display

You can use a browser to check the errors and warnings.



1 **Open a browser on the PC.**

2 **Enter the instrument' s address in the address bar. (Example: http://192.168.1.2)**

3 **Click [ERROR/WARNING].**

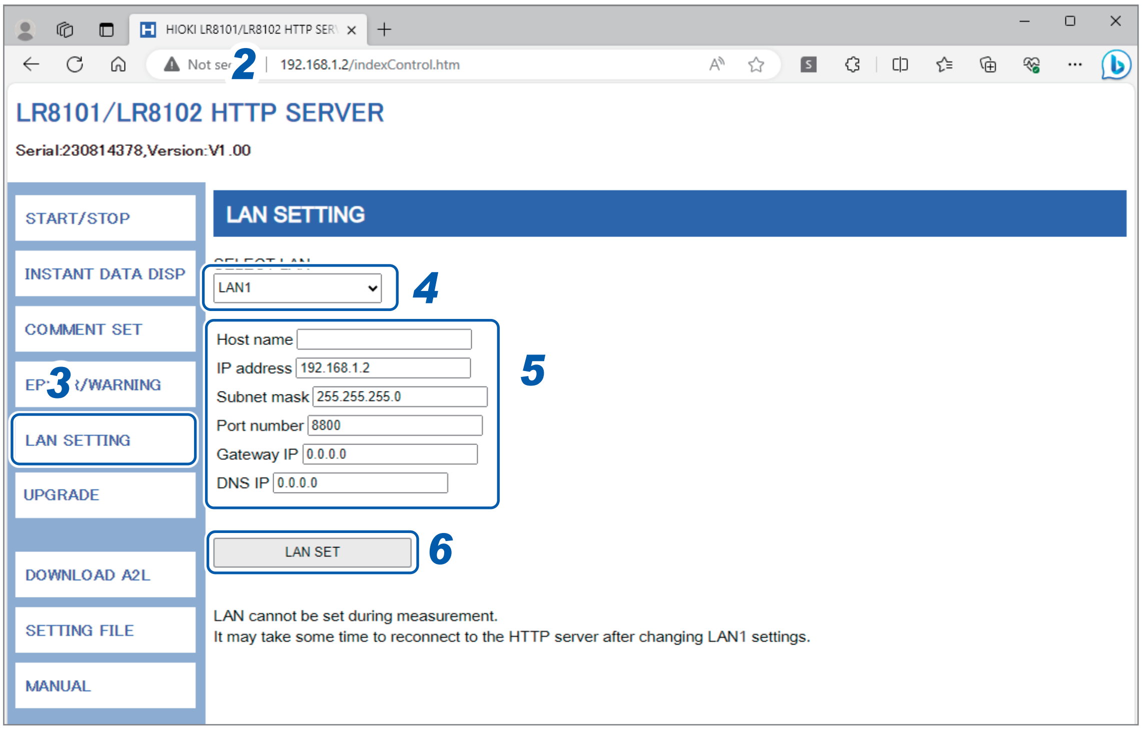
4 **Click [CURRENT STATUS].**

The displayed error and warning information is updated.

Display	Description	See
Error Status	Current error status of the instrument	p.460
Warning Status	Current warning status of the instrument Clicking **[CLEAR WARNING]** clears the description of the log.	p.461
ERROR OCCURENCE TIME ERROR CONTENT	50 latest error logs Clicking **[CLEAR ERROR LOG]** clears the description of the log.	–
WARNING OCCURENCE TIME WARNING CONTENT	50 latest warning logs Clicking **[CLEAR WARNING LOG]** clears the description of the log.	–

LAN settings

You can use a browser to set a LAN.



1 **Open a browser on the PC.**

2 **Enter the instrument' s address in the address bar. (Example: http://192.168.1.2)**

3 **Click [LAN SETTING].**

4 **Select the type of LAN for which the settings are to be changed.**

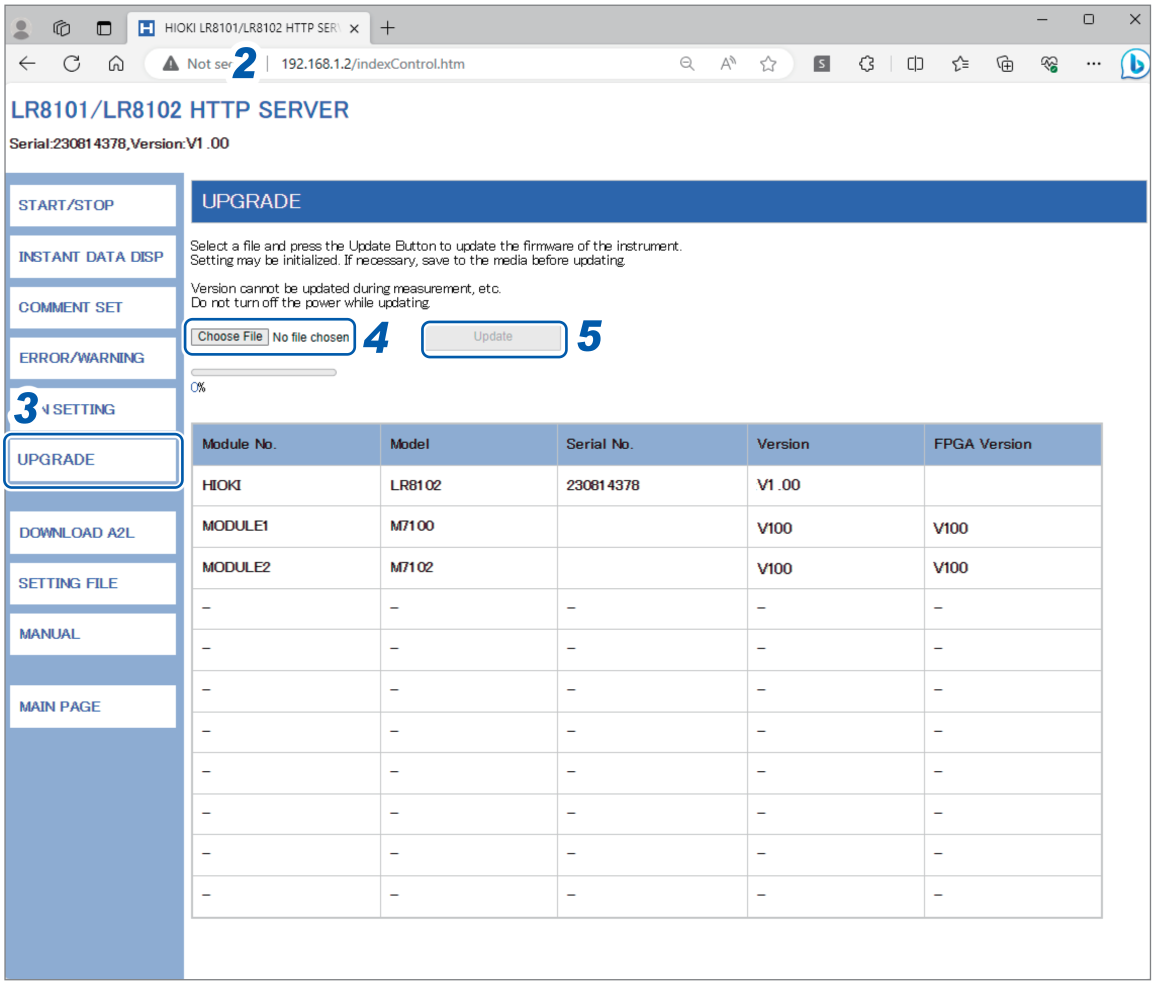
5 **Enter the LAN settings.**

6 **Click [LAN SET].**

After the LAN1 settings have been changed, the HTTP server is disconnected. Wait for a while, and then reconnect to the server.

Remote upgrade

You can use a browser to upgrade the instrument and modules.
You can also check the models, serial numbers, and versions of the instrument and modules, as well as the FPGA versions of the modules.
When an upgrade is required, the upgrader file and procedures are released on the Hioki website.
When performing remote upgrade, download the file from the Hioki website and extract it in advance. (Be sure not to change the file name.)
No SD memory card or USB drive is required.



1 **Open a browser on the PC.**

2 **Enter the instrument's address in the address bar. (Example: http://192.168.1.2)**

3 **Click [UPDATE].**

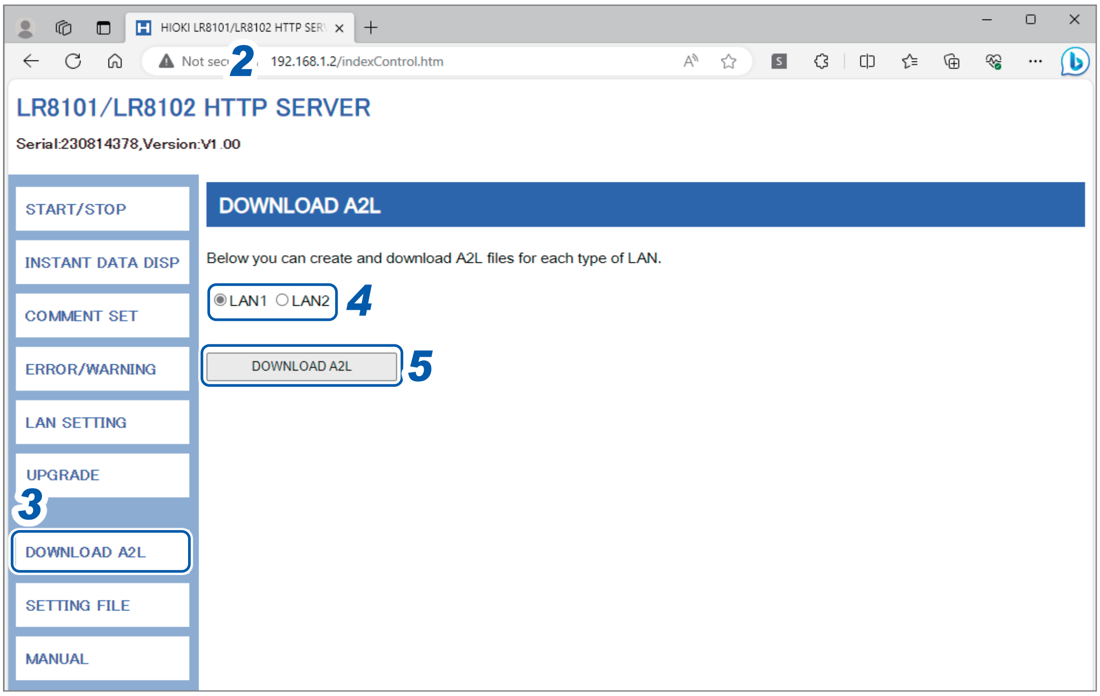
4 **Click [Choose File] and select the downloaded upgrader file (extensions: [UPG] for the instrument, [PRG] for the modules).**

5 **Click [UPDATE].**

The instrument is automatically restarted after the upgrade. The communications are shut down at that time.
For other precautions and checks after the upgrade, refer to the procedures.

Downloading A2L file

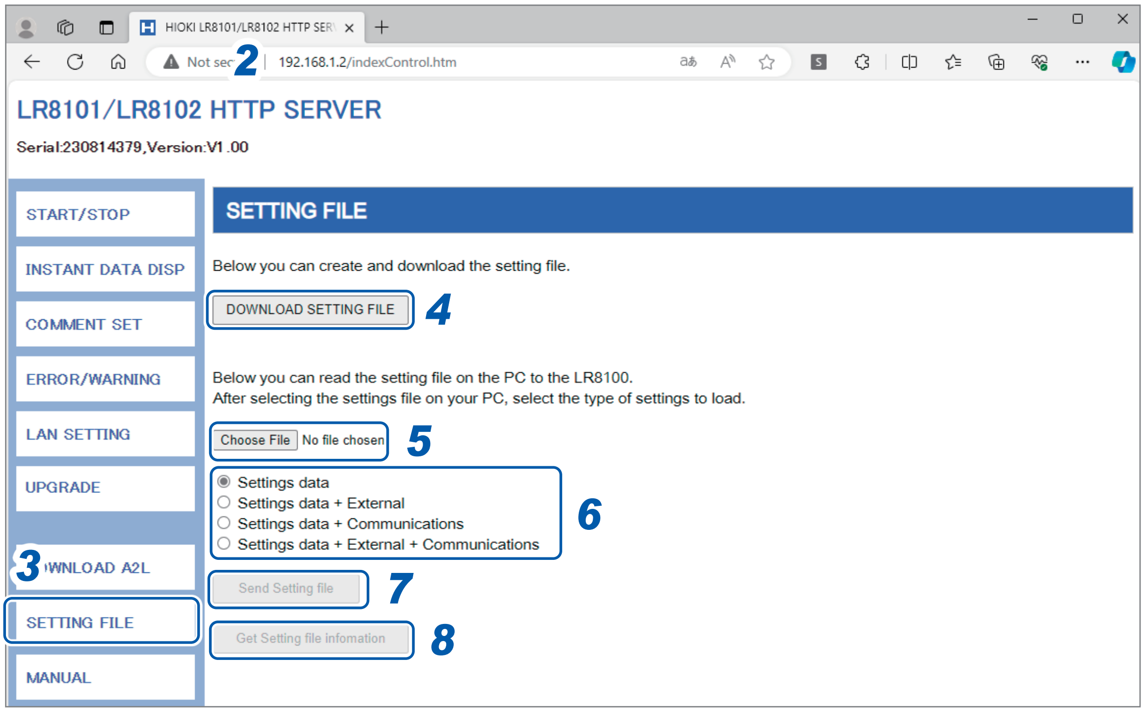
You can use a browser to download the A2L file.



1. **Open a browser on the PC.**
2. **Enter the instrument' s address in the address bar. (Example:** http://192.168.1.2 **)**
3. **Click [DOWNLOAD A2L].**
4. **Select the LAN to be connected to the XCP.**
5. **Click [DOWNLOAD A2L].**

Acquisition of setting file information

You can use a browser to acquire the setting file information.



1 **Open a browser on the PC.**

2 **Enter the instrument' s address in the address bar. (Example: http://192.168.1.2)**

3 **Click [SETTING FILE].**

4 **Click [DOWNLOAD SETTING FILE].**
Download the current settings of the instrument.

5 **Click [Choose File], and then select the setting file on the PC you want to load into the instrument.**

6 **Select the settings to be loaded into the instrument.**

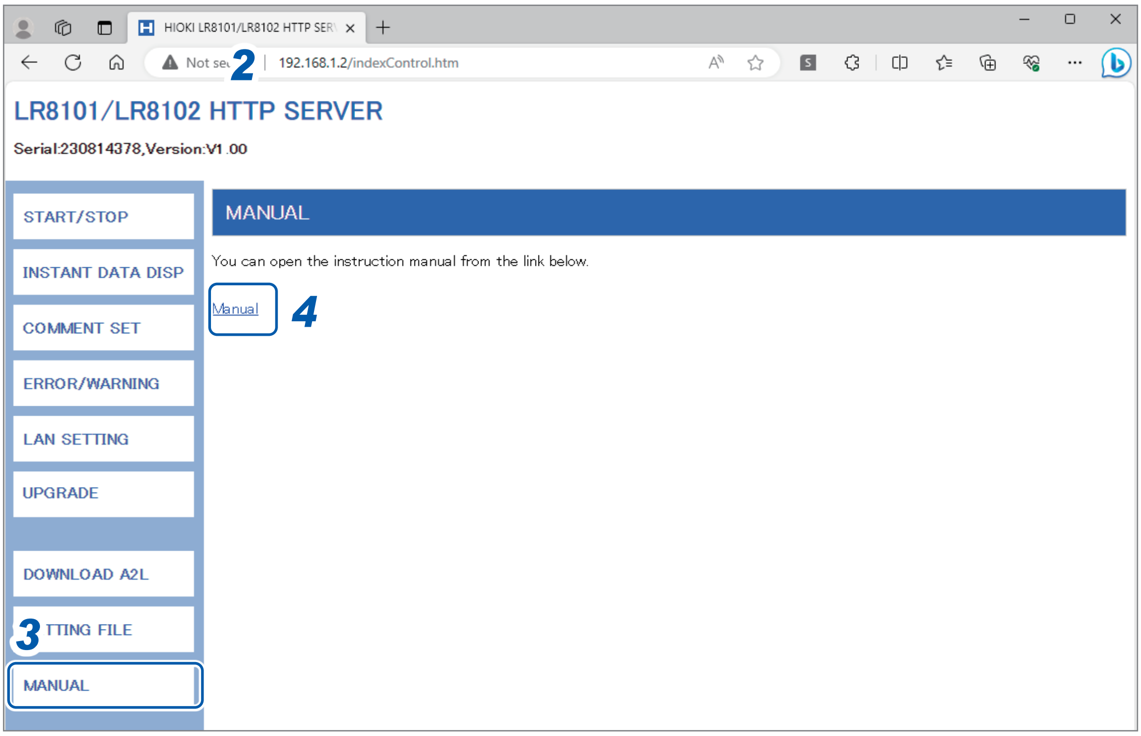
Setting data, Settings data + External, Settings data + Communications, Settings data + External+ Communications

7 **Click [Send Setting file].**
The current settings are updated with the setting selected in step 6.

8 **Click [Get Setting file information].**
The module configuration of the setting file is acquired.

Downloading Instruction Manual

You can use a browser to download the Instruction Manual for the instrument.



1 **Open a browser on the PC.**

2 **Enter the instrument' s address in the address bar. (Example: http://192.168.1.2)**

3 **Click [MANUAL].**

Download the Instruction Manual for the instrument.

4 **Click [Manual].**

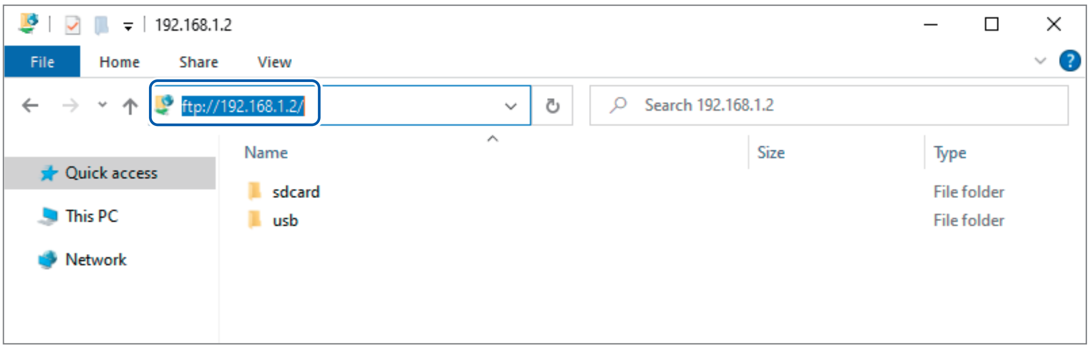
The Instruction Manual in PDF format is displayed.

12.3 Acquiring Data with the FTP Server

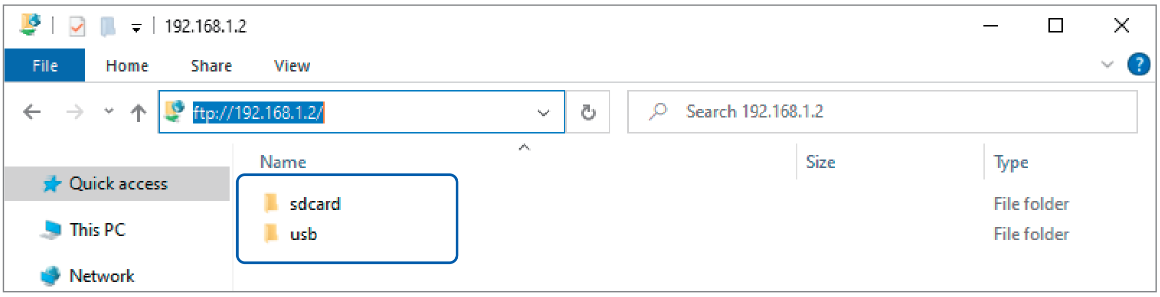
With the FTP server function, files stored on the instrument can be acquired on a PC.
The File Transfer Protocol (FTP) is a protocol to transfer files within a network.
By running an FTP client on a PC, files stored on the SD memory card or USB drive can be acquired on the PC.

1 **Enter the instrument's address in the address bar of the explorer. (Example: ftp://192.168.1.2)**

The "sdcard" and "usb" folders are displayed.



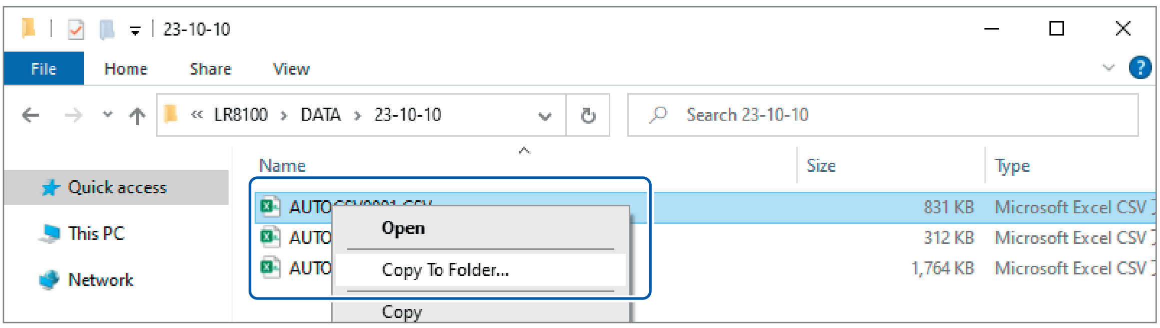
2 **Double-click the item to acquire data.**



sdcard	SD memory card
usb	USB drive

Opens the folder.

3 **Right-click the file name and click [Copy To Folder].**



Executes the file copy.

IMPORTANT
Some PC's FTP client software delete selected files and folders being moved if the move operation is canceled. Exercise caution when moving files and folders.
Instead of moving the data, it is recommend to copy and acquire the data and then delete the data.

- The instrument's FTP server supports only one connection. It is not possible to access it simultaneously from multiple PCs.
- The FTP connection may be disconnected if 1 minute or more passes without a command being sent after the connection is initiated. In this case, connect to the FTP server again.
- Reconnection to the FTP server may not be possible immediately after the FTP connection is disconnected. In this case, wait for approx. 1 minute and then connect to the FTP server again.
- Disconnect the FTP connection before exchanging the SD memory cards or USB drives.
- Do not use the communication commands related to the file operations and FTP simultaneously. Doing so may result in an unexpected operation.
- Free software, such as FFFTP, is also available.
- If the file operation or transfer is executed during the auto-save operation, the saving speed of the auto-save operation is slowed down.

12.4 Sending Data Using the FTP Client

Any files automatically saved in the media (SD memory card and USB drive) of the instrument can be automatically sent to the FTP server on the PC.
Specify the IP address of the PC with the FTP server operating.
It is necessary to register the user name and password of the instrument in the FTP server. For details, see HELP of Windows FTP server.
A Windows FTP server, etc. may be used.
In addition to a Windows FTP server, free software FILEZILLA (Third-party company's trademark) Server, etc. may be used.

- Set `A$` under `:CONFigure:ATSAve` to anything other than OFF.
- To send data periodically, set `A$` under `:CONFigure:SAVEKind` to anything other than `NORMal`.
- To send data continuously even when the SD card or USB drive runs low on free space, perform settings so that auto saving can be continued by deleting the oldest waveform file (binary or text) under `:CONFigure:SAVEMode REMove`.

See "Auto save (Realtime save)" (p. 226).

1 **Set and connect the LAN. (p.322)**

2 **Set the FTP server on the PC. (p.327)**

3 **Run FTP auto send on the instrument. (p.332)**

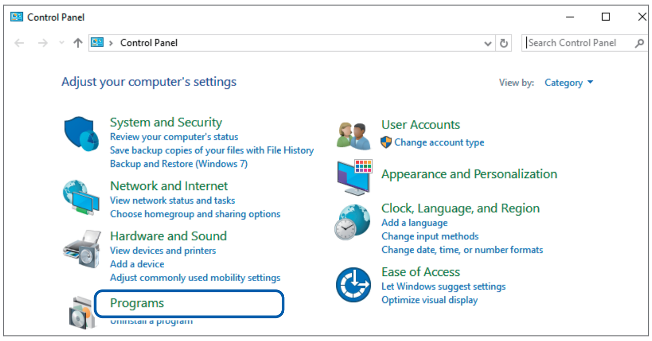
4 **Configure the auto-save settings on the instrument. (p.226)**

5 **Start measurement on the instrument.**

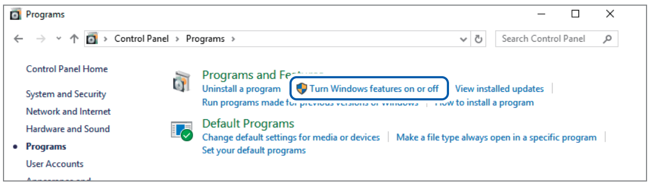
When the auto-save operation is executed on the instrument, the files are automatically sent to the FTP server on the PC.

6 **Check the communication status. (p.338)**

Enable FTP (for Windows 10)

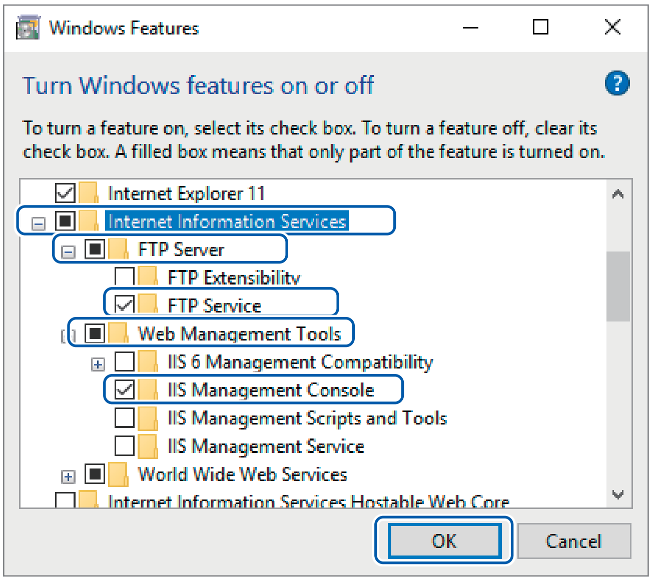


1 **Click [Control Panel] > [Program].**



2 **Click [Turn Windows features on or off].**

The [Windows Features] dialog box is displayed.



3 **Click [+] on the left of [Internet Information Services] to expand it.**

Click [+] on the left of [FTP server] to expand it. Select [FTP Service].

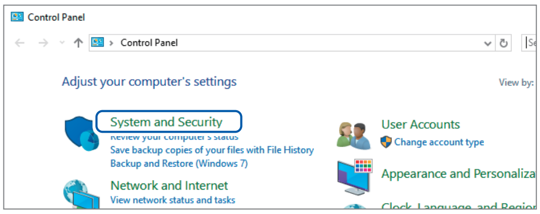
Click [+] on the left of [Web Management Tools] to expand it. Select [IIS Management Console].

Click [OK].

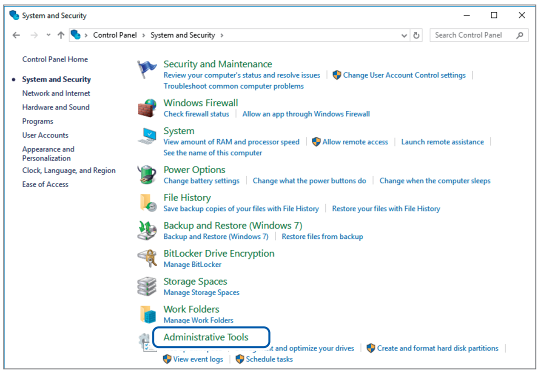
This completes the installation of FTP.
When the installation is completed, the [inetpub] folder is created in the root of drive C.

Set FTP (for Windows 10)

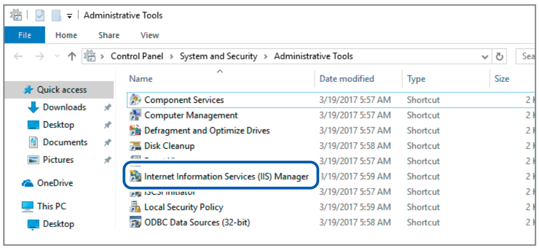
1 **Click [Control Panel] > [System and Security].**



2 **Click [Administrative Tools].**

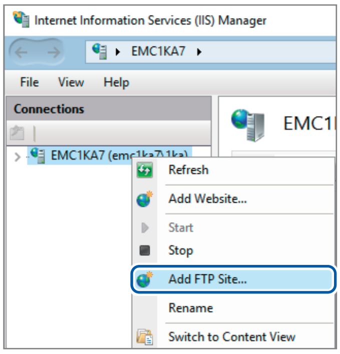


3 **Double-click [Internet Information Services (IIS) Manager].**



4 **Right-click the item displayed in the [Connections] field on the left of the screen. Click [Add FTP Site...] in the shortcut menu.**

Communication may be blocked based on the settings of your PC's security software, such as a firewall.



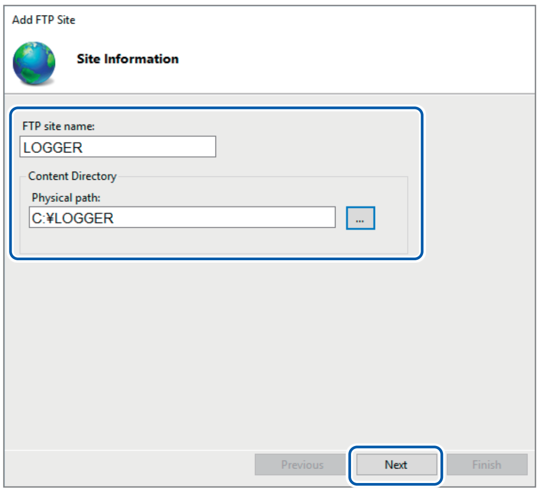
5 **Enter [Site Information].**

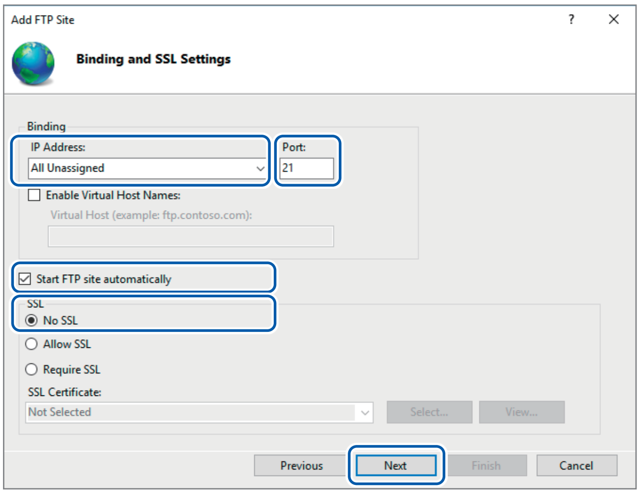
Example:

[FTP site name]: LOGGER

Specify a location to save the data from the FTP client in **[Physical path]** of **[Content Directory]**.

Click [Next].

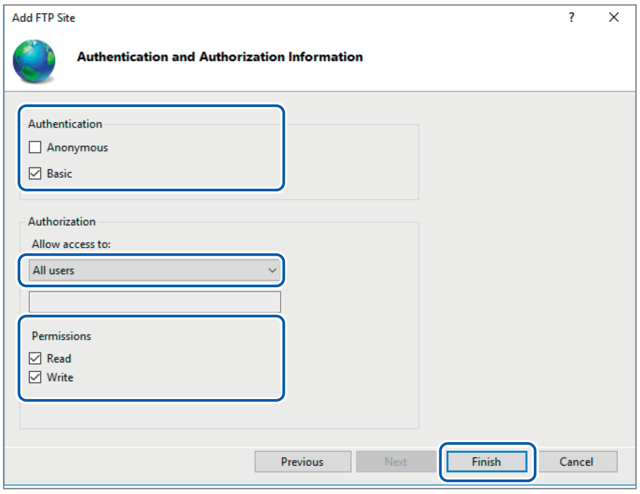




6 **Set [Binding] and [SSL] as follows.**

[IP address]	**[All Unassigned]**
[Port]	**[21]**
[Start FTP site automatically]	Select
[SSL]	**[No SSL]**

Click **[Next]**.



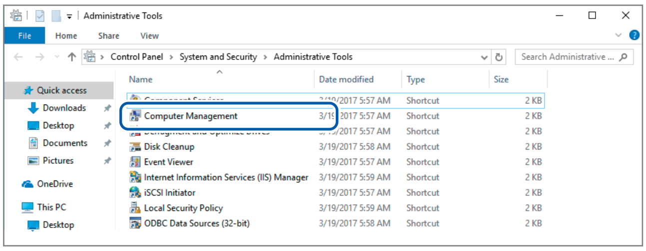
7 **Set [Authentication and Authorization Information] as follows.**

[Authentication]	Select **[Basic]**
[Authorization]	**[All users]**
[Permissions]	Select both **[Read]** and **[Write]**

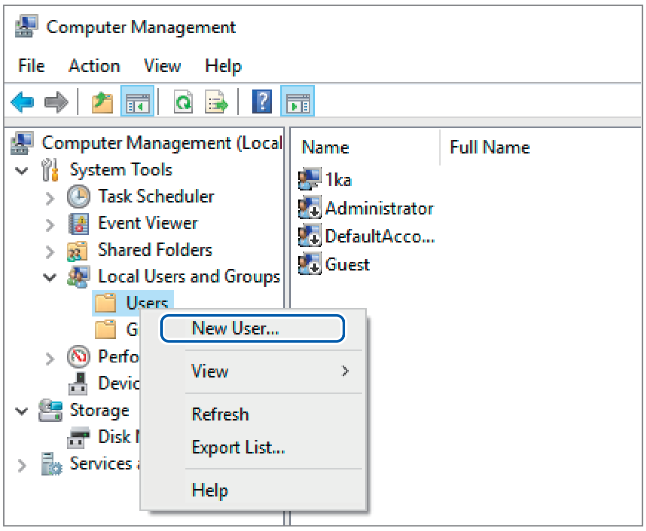
Click [Finish].

Set users accessing FTP (for Windows 10)

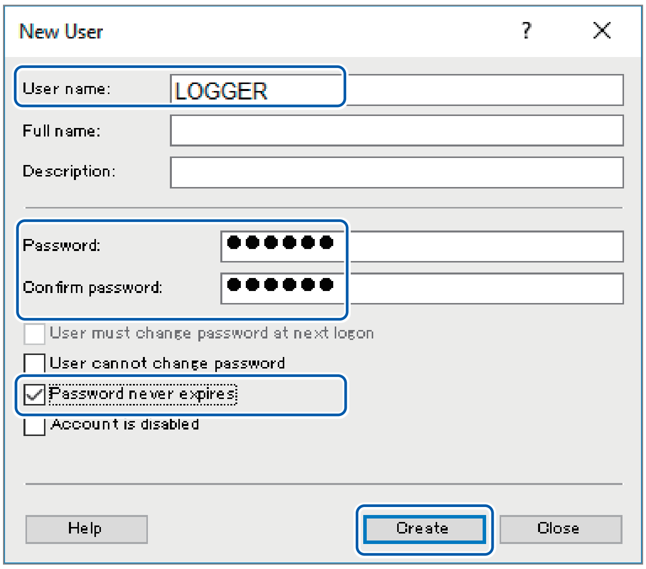
Enter the username and password to access the FTP.
Enter **[User name]** and **[Password]** specified here in the **[User name]** and **[Password]** boxes on the FTP auto send setting screen on the instrument.
See "2 Set each item" (page 273).



1 **From [Administrative Tools] in step *2* (p.328), select [Computer Management].**



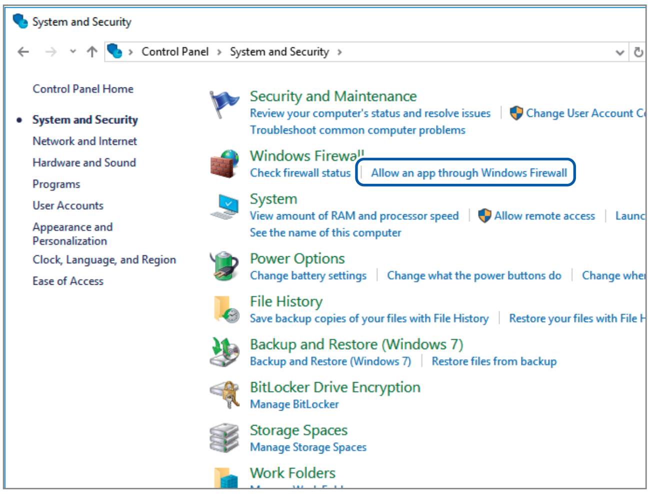
2 **Right-click [Users] in [Local Users and Groups]. Select [New User] in the shortcut menu.**



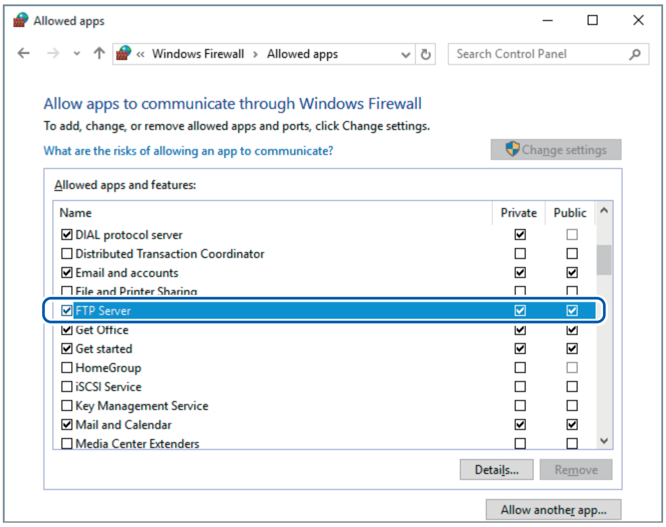
3 **Enter the user name in the [User name] box and the password in the [Password] and [Confirm password] boxes. Select the [Password never expires] check box.**

Click [Create].

Set the firewall (for Windows 10)



4 **From [System and Security] in step 1 ("1 Click [Control Panel] > [System and Security]." (p. 328), click [Allow an app through Windows Firewall].**



5 **Select [FTP server].**

Select Private or Public, whichever is connected with the instrument.

Restart the FTP server

Restart Microsoft FTP Service in **[Control Panel]** > **[System and Security]** > **[Administrative Tools]** > **[Services]**.

This completes the FTP settings for Windows 10.

> **Tips** There is a possibility that the connection with the Logger may be blocked by security software or other types of software. Confirm that the connection with the target Logger is not blocked by software.

Setting auto send

Any files automatically saved in the media of the instrument can be sent to the FTP server on the PC automatically.

Operation method

The following shows an example of sending data to FTP server 192.168.1.1.

Instrument
(Example: 192.168.1.2)

FTP server PC
(Example: 192.168.1.1)

1 **Set the FTP data auto send function.**

Settings		
Syntax	Command	`:SYSTem:FTP:USE A$`
Example	`:SYSTem:FTP:USE ON`	
Query		
Syntax	Query	`:SYSTem:FTP:USE?`
	Response	`A$`
Example	`:SYSTem:FTP:USE?` (Response) `:SYSTEM:FTP:USE ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Disables the FTP data auto send.
`ON`	Enables the FTP data auto send.

2 **Set the FTP server name.**

Sets the host name or IP address of the FTP server.
See “Network settings on PC” (p. 88).

Settings		
Syntax	Command	`:SYSTem:FTP:ADDRess "A$"`
Example	`:SYSTem:FTP:ADDRess "HIOKI_FTP"`	
Query		
Syntax	Query	`:SYSTem:FTP:ADDRess?`
	Response	`"A$"`
Example	`:SYSTem:FTP:ADDRess?` (Response) `:SYSTEM:FTP:ADDRESS "HIOKI_FTP"` (When the header is ON)	
Parameter		
`A$` = Destination FTP server address (up to 45 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, a command error will occur.		

3 Set the connection security.

Configure the settings according to the security method supported by the FTP server.

Settings		
Syntax	Command	`:SYSTem:FTP:SECUrity A$`
Example	`:SYSTem:FTP:SECUrity EXPLICIT`	
Query		
Syntax	Query	`:SYSTem:FTP:SECUrity?`
	Response	`A$`
Example	`:SYSTem:FTP:SECUrity?` (Response) `:SYSTEM:FTP:SECURITY EXPLICIT` (When the header is ON)	
Parameter		

`A$` = OFF, EXPLICIT, IMPLICIT

`OFF`☑	Communications are not secure.
`EXPLICIT`	Explicit FTP over TLS
`IMPLICIT`	Implicit FTP over TLS

4 Set the server certificate confirmation.

Settings		
Syntax	Command	`:SYSTem:FTP:CERTificate A$`
Example	`:SYSTem:FTP:CERTificate ON`	
Query		
Syntax	Query	`:SYSTem:FTP:CERTificate?`
	Response	`A$`
Example	`:SYSTem:FTP:CERTificate?` (Response) `:SYSTEM:FTP:CERTIFICATE ON` (When the header is ON)	
Parameter		

`A$` = OFF, ON

`OFF`	Files are transferred via encrypted communications. However, the certificate presented by the server is not validated.
`ON`☑	The certificate presented by the server is validated. If the validity is not confirmed, no file is transferred.

5 Set the port number of the FTP server.

Settings		

Syntax	Command	`:SYSTem:FTP:PORT A`
		
		(When the connection security is set to IMPLICIT)
		`:SYSTem:FTP:PORT:IMPLicit A`

Example	`:SYSTem:FTP:PORT 1234`	
Query		

Syntax	Query	`:SYSTem:FTP:PORT?`
		
		(When the connection security is set to IMPLICIT)
		`:SYSTem:FTP:PORT:IMPLicit?`

	Response	`A$`
Example	`:SYSTem:FTP:PORT?` (Response) `:SYSTEM:FTP:PORT 1234` (When the header is ON)	
Parameter		

`A$` = 1 to 21☑ to 65535
When the connection security is set to `IMPLICIT`, the default setting is 990.

6 Set the user name.

Sets the user name for logging on to the FTP server.
Set the username for the instrument registered with the FTP server on the PC.

Settings		
Syntax	Command	`:SYSTem:FTP:USER "A$" "`
Example	`:SYSTem:FTP:USER "LOGGER"`	
Query		
Syntax	Query	`:SYSTem:FTP:USER?`
	Response	`"A$"`
Example	`:SYSTem:FTP:USER?` (Response) `:SYSTEM:FTP:USER "LOGGER"` (When the header is ON)	
Parameter		
`A$` = User name (up to 32 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, a command error will occur.		

7 Set the password.

Sets the password for logging on to the FTP server.
Set the password for the instrument registered with the FTP server on the PC.
For the query, the entered password is checked against the current password setting and the result is returned.

Settings		
Syntax	Command	`:SYSTem:FTP:PASSword "A$"`
Example	`:SYSTem:FTP:PASSword "abcd"`	
Query		
Syntax	Query	`:SYSTem:FTP:PASSword? "A$"`
	Response	`B$`
Example	`:SYSTem:FTP:PASSword? "abcd"` (Response) `:SYSTEM:FTP:PASSWORD PASS` (When the header is ON)	
Parameter		
`A$` = Password (up to 32 single-byte characters) `B$` = PASS, FAIL		
`PASS`	The entered password is correct.	
`FAIL`	The entered password is incorrect.	
Note		
If the entered string exceeds the maximum number of characters, a command error will occur.		

8 Set the saving destination directory.

Specifies the director on the FTP server for saving data. (Default: Serial number of the instrument)

Settings		
Syntax	Command	`:SYSTem:FTP:DIR "A$"`
Example	`:SYSTem:FTP:DIR "/abc/def/"`	
Query		
Syntax	Query	`:SYSTem:FTP:DIR?`
	Response	`"A$"`
Example	`:SYSTem:FTP:DIR?` (Response) `:SYSTEM:FTP:DIR "/abc/def/"` (When the header is ON)	
Parameter		
`A$` = Destination directory (up to 45 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, a command error will occur.		

9 Set the PASV mode.

Settings		
Syntax	Command	`:SYSTem:FTP:PASV A$`
Example	`:SYSTem:FTP:PASV ON`	
Query		
Syntax	Query	`:SYSTem:FTP:PASV?`
	Response	`A$`
Example	`:SYSTem:FTP:PASV?` (Response) `:SYSTEM:FTP:PASV ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Does not use the PASV mode during communication.
`ON`	Uses the PASV mode during communication.

10 Specify the deletion of sent files.

Settings		
Syntax	Command	`:SYSTem:FTP:AUTODel A$`
Example	`:SYSTem:FTP:AUTODel ON`	
Query		
Syntax	Query	`:SYSTem:FTP:AUTODel?`
	Response	`A$`
Example	`:SYSTem:FTP:AUTODel?` (Response) `:SYSTEM:FTP:AUTODEL ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	Does not delete sent files.
`ON`	Deletes sent files.

11 Set the file name identifier.

Settings		
Syntax	Command	`:SYSTem:FTP:FILE:HOST A$` (Host name) `:SYSTem:FTP:FILE:IP A$` (IP address) `:SYSTem:FTP:FILE:TIME A$` (Time)
Example	`:SYSTem:FTP:FILE:HOST ON`	
Query		
Syntax	Query	`:SYSTem:FTP:FILE:HOST?` (Host name) `:SYSTem:FTP:FILE:IP?` (IP address) `:SYSTem:FTP:FILE:TIME?` (Time)
	Response	`A$`
Example	`:SYSTem:FTP:FILE:HOST?` (Response) `:SYSTEM:FTP:FILE:HOST ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`	Does not attach the target to file names.
`ON`☑	Attaches the target to file names.

Example:

Host name	LOGGER
IP address	192.168.1.2
Time	‘23-01-10 08:30:05
Auto-save file name	AUTO0001.MEM

With the settings above, the file is named as follows when the file name identifier is set to ON for the host name, IP address, and time.
[LOGGER_192-168-1-2_230110-083005_AUTO0001.MEM]
Files can be identified when multiple loggers are used.

12 Perform the upload test.

See “File upload test” (p. 337).

File upload test

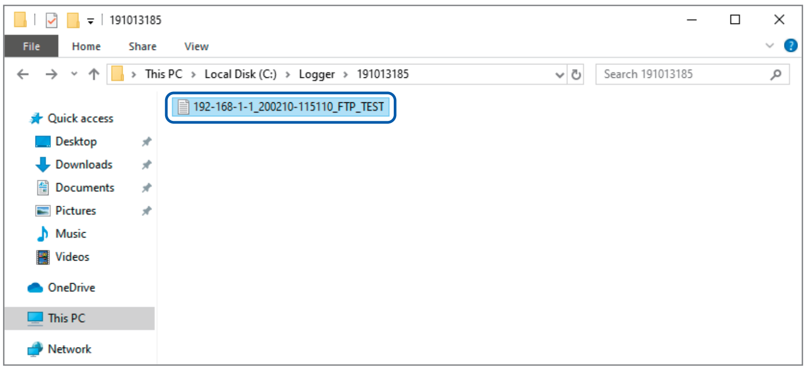
Check whether files can be sent using the FTP client.

1 Execute the upload test.

Query		
Syntax	Query	`:SYSTem:FTP:CHECk?`
	Response	`A`
Example	`:SYSTem:FTP:CHECk?` (Response) `:SYSTEM:FTP:CHECK 0` (When the header is ON)	
Parameter		
`A` = 0 (Success), 1 (Fail)		

Test file **[FTP_TEST.TXT]** is sent to the specified folder*1.

*1: The folder specified with **[Physical path]** in “Enter **[Site Information]**.” (p. 328) and “Set the saving destination directory.” (p. 335) (example: C:\LOGGER\data)



When the test file cannot be sent, check the auto send settings of the instrument and the FTP settings of the PC.
If the send test is successful, start measurement.
The measured waveform data are automatically sent to the FTP server on the PC.

Data send time

Transfer time (sec.) = File size (KB)/Transfer speed (KB/sec.) + Transfer preparation time (sec.)
For details about the file size, see “14.7 File Size” (p. 418).
For reference, the transfer speed is 4 MB/sec. and the transfer preparation time is 3 seconds.
Example: If the file size is 40 MB

Transfer time = 40 MB/4 (MB/sec) + 3 (sec)
= 10 + 3 (sec) = 13 (sec)

12
Communication with PC (Computer)

FTP communication status check

You can check the numbers of files that have been sent successfully, have failed to be sent, etc. using the FTP client.

1 **Check the numbers of files under the FTP communication status.**

Query		
Syntax	Query	`:SYSTem:FTP:STATe?`
	Response	`A<NR1>, B<NR1>, C<NR1>, D<NR1>`
Example	`:SYSTem:FTP:STATe?` (Response) `:SYSTEM:FTP:STATE 10,1,5,4` (When the header is ON)	
Parameter		
`A` = Total number of files `B` = Numbers of files that have been sent successfully `C` = Numbers of files that have failed to be sent `D` = Number of files that have not been sent		

2 **Check whether or not there is a file under the FTP communication status that has not been sent.**

Query		
Syntax	Query	`:SYSTem:FTP:PROGress?`
	Response	`A$`
Example	`:SYSTem:FTP:PROGress?` (Response) `:SYSTEM:FTP:PROGRESS YES` (When the header is ON)	
Parameter		
`A$` = YES, NO		

`YES`	There is a file that has not been sent.
`NO`	There are no unsent files.

12.5 Sending Measurement Data Using XCP on Ethernet

The instrument supports only the measurement mode of XCP on Ethernet and can be connected with higher level tools complying with the ASAM standards.
The LAN setting and connection are required to send the measurement data using XCP on Ethernet.
For the XCP connection, use LR8101 or LR8102 to create the setting file (A2L) specific to the instrument.
If the instrument settings have been changed after creating the A2L file, recreate the A2L file and use the latest A2L file.
The instrument does not support asynchronous upload of the measurement data with polling from ECU measurement/compatible software.
The XCP output of LAN2 can be performed at the recording intervals in real time.
The XCP output from LAN1 does not support the output in real time. The timing for LAN1 to send the measurement data to ECU measurement/compatible software is only when the command is sent from the software to the instrument.

Setting the input channel

See “3.4 Setting the Voltage/Temp Module” (p. 120).
See “3.5 Setting the Power Measurement Module” (p. 126).

Creating the A2L file

1 **Specify the file name when saving.**

Settings		
Syntax	Command	:SYSTem:FILEName "A$"
Example	:SYSTem:FILEName "MANUAL"	
Query		
Syntax	Query	:SYSTem:FILEName?
	Response	"A$"
Example	:SYSTem:FILEName? (Response) :SYSTEM:FILENAME "MANUAL"	
Parameter		
A$ = Character string of file name (up to 4 double-byte characters or 8 single-byte characters)		
Note		
If the entered string exceeds the maximum number of characters, any characters beyond the maximum will not be entered.		

If no file name is specified, the file is named automatically.
See “When a file is saved without specifying a file name” (p. 222).

2 **Save the A2L file.**

When the file is saved using LAN1: Communication takes place via the LAN1 port. The communication protocol is TCP.
When the file is saved using LAN2: Communication takes place using the LAN2 port. The communication protocol is UDP.
The A2L file contains only the information of channels in which the measurement are set to ON on the instrument.

Settings		
Syntax	Command	When LAN1 is used :MEDia:SD:SAVE:A2L:LAN1 :MEDia:USB:SAVE:A2L:LAN1 When LAN2 is used :MEDia:SD:SAVE:A2L:LAN2 :MEDia:USB:SAVE:A2L:LAN2
Example	:MEDia:SD:SAVE:A2L:LAN1	
Query		
Syntax	Query	When LAN1 is used :MEDia:SD:SAVE:A2L:LAN1? :MEDia:USB:SAVE:A2L:LAN1? When LAN2 is used :MEDia:SD:SAVE:A2L:LAN2? :MEDia:USB:SAVE:A2L:LAN2?
	Response	A$
Example	:MEDIA:SD:SAVE:A2L:LAN1? (Response) :MEDIA:SD:SAVE:A2L:LAN1? SUCCESS_TEST (When the header is ON)	
Parameter		
A$ = NONE, EXECUTING, SUCCESS_(File name), FAIL		

NONE	Saving has not yet been executed.
EXECUTING	Saving is currently in operation.
SUCCESS	Saving has succeeded. The name of the saved file is attached at the end.
FAIL	Saving has failed.

Settings on ECU control software

Setting the measurement channels

Before measurement, initialize and create the DAQ list using ECU control software and set the information of measurement channels on the ODT entry.
The DAQ list cannot be initialized or created while the instrument is performing the measurement.

12.6 Outputting the Measured Value Using CAN

Output the measured value of the instrument to the CAN bus.
The CAN-H and CAN-L terminals are used for the CAN measured value output.
For the method of connecting the CAN cable, see “Wiring the CAN cable (LR8102 only)” (p. 63).
For the setting method, see “CAN Editor Instruction Manual”.

1 Set the measured value output function.

You can choose whether to output the measurement data using the settings configured in the CAN Editor.

Settings		
Syntax	Command	`:SYSTem:RTOut A$`
Example	`:SYSTem:RTOut CAN`	
Query		
Syntax	Query	`:SYSTem:RTOut?`
	Response	`A$`
Example	`:SYSTem:RTOut?` (Response) `:SYSTEM:RTOUT CAN` (When the header is ON)	
Parameter		

`A$` = OFF, CAN, LAN2udp

`OFF`☑	Does not output the data from CAN or LAN2.
`CAN`	Outputs the data from the CAN terminal. When an external sampling is used, the time is not output.
`LAN2udp`	Outputs the data from LAN2.

If the instrument is controlled with XCP on Ethernet UDP, the data are not output regardless of the settings.
The parameter can also be set to CAN when setting the instrument from CAN Editor.

12.7 Setting and Connecting LAN2

The instrument and a PC can be connected using a LAN cable.
Connect the LAN cable to the LAN2 port. The measured value can be output in real time.
The default IP address of the instrument is 192.168.1.102. The port number is 8801 and the output destination port number is 8800.

Send the following communication commands from the PC to LAN1 (communication command port: 8802).
LAN2 does not support the communication commands. Set LAN2 from LAN1.

Updates the settings of LAN2.

IMPORTANT
The LAN2 settings will not be updated until this command is executed.
Execute the command after completing the LAN2 settings.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:UPDate`
Example	`:SYSTem:COMMunicate:LAN2:UPDate`	

DHCP server

When the DHCP server is set to ON, the IP address and the subnet mask can be obtained automatically.
For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:DHCP A$`
Example	`:SYSTem:COMMunicate:LAN2:DHCP ON` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:DHCP?` `:SYSTem:COMMunicate:LAN2:DHCP:PREParation?`
	Response	`A$`
Example	`:SYSTem:COMMunicate:LAN2:DHCP?` (Response) `:SYSTEM:COMMUNICATE:LAN2:DHCP ON` (When the header is ON)	
Parameter		
`A$` = OFF,ON		

`OFF`☑	Disables the DHCP function.
`ON`	Enables the DHCP function.

Host name

For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:HOSTname "A$"`
Example	`:SYSTem:COMMunicate:LAN2:HOSTname "LOGGER"` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:HOSTname?` `:SYSTem:COMMunicate:LAN2:HOSTname:PREParation?`
	Response	`"A$"`
Example	`:SYSTem:COMMunicate:LAN2:HOSTname?` (Response) `:SYSTEM:COMMUNICATE:LAN2:HOSTNAME "LOGGER"` (When the header is ON)	
Parameter		
`A$` = Character string of host name (up to 12 single-byte characters)		

Set the IP address of the instrument.

The IP address is used to identify individual devices that are connected to the network. Ensure that the instrument uses a unique name that is not being used by any other device on the network.
For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:IPADdress ip1,ip2,ip3,ip4`
Example	`:SYSTem:COMMunicate:LAN2:IPADdress 192,168,1,200` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:IPADdress?` `:SYSTem:COMMunicate:LAN2:IPADdress:PREParation?`
	Response	`ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>`
Example	`:SYSTem:COMMunicate:LAN2:IPADdress?` (Response) `:SYSTEM:COMMUNICATE:LAN2:IPADDRESS 192,168,1,200` (When the header is ON)	
Parameter		

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

Set the subnet mask of LAN2.

The subnet mask is used to separate the IP address into the portion that indicates the network and the portion that indicates the device.
Ensure that the instrument uses the same subnet mask that is being used by other devices on the same network. If the DHCP server is enabled, the setting will be automatically configured using the server.
For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:SMASk mask1,mask2,mask3,mask4`
Example	`:SYSTem:COMMunicate:LAN2:SMASk 255,255,255,0` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:SMASk?` `:SYSTem:COMMunicate:LAN2:SMASk:PREParation?`
	Response	`mask1<NR1>,mask2<NR1>,mask3<NR1>,mask4<NR1>`
Example	`:SYSTem:COMMunicate:LAN2:SMASk?` (Response) `:SYSTEM:COMMUNICATE:LAN2:SMASK 255,255,255,0` (When the header is ON)	
Parameter		

`mask1`	0 to 255
`mask2`	0 to 255
`mask3`	0 to 255
`mask4`	0 to 255

Set the port number of the instrument.

The last digit is used by the LAN2 system.
Example: No matter which number between 8800 and 8809 is specified, the parameter is set to 8800. 8801 is used for the UDP output.
(The last digit: 1 for the UDP output, 5 for XCP on Ethernet)
For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:CONTrol no`
Example	`:SYSTem:COMMunicate:LAN2:CONTrol 8800` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:CONTrol?` `:SYSTem:COMMunicate:LAN2:CONTrol:PREParation?`
	Response	`no<NR1>`
Example	`:SYSTem:COMMunicate:LAN2:CONTrol?` (Response) `:SYSTEM:COMMUNICATE:LAN2:CONTROL 8800` (When the header is ON)	
Parameter		
`no` = 1020 to 65520		
Note		
For example, no matter which number between 8800 and 8809 is specified, 8800 is returned for the setting.		

Gateway IP

Setting 0.0.0.0 disables the use of the Gateway.
If the DHCP server is set to `ON`, the setting will be configured automatically.
For `PREParation?`, the setting made before the update of the LAN2 settings is returned.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:GATeway ip1,ip2,ip3,ip4`
Example	`:SYSTem:COMMunicate:LAN2:GATeway 192,168,1,100` `:SYSTem:COMMunicate:LAN2:UPDate`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:GATeway?` `:SYSTem:COMMunicate:LAN2:GATeway:PREParation?`
	Response	`ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>`
Example	`:SYSTem:COMMunicate:LAN2:GATeway?` (Response) `:SYSTEM:COMMUNICATE:LAN2:GATEWAY 192,168,1,100` (When the header is ON)	
Parameter		

`ip1`	0 to 255
`ip2`	0 to 255
`ip3`	0 to 255
`ip4`	0 to 255

Change the PC to be used or change the IP address of the PC (as needed).

- If the intended use of the PC is only to set the IP address of the instrument, replace the PC as needed.
- Change the IP address of the PC as well if it becomes necessary as a result of setting the IP address of the instrument.

12.8 Outputting the Measured Value Using LAN2

The measured value of the instrument is output in real time.
The communication protocol is UDP.
All measured values of the measurement ON channels are output at the recording intervals.
Using the primary unit for the sampling synchronization with the appropriate settings, you can output the measured values of the synchronized LR8102 units. (p.113) (p.349)
There may be a delay depending on the performance or operating system of the receiving device.
As the protocol is UDP, receiving of all packets is not guaranteed.
To improve real-time performance, turn off the numerical calculation, alarm, and stop trigger functions.

1 **Enable the measured value output function.**

Settings		
Syntax	Command	:SYSTem:RTOut A$
Example	:SYSTem:RTOut LAN2udp	
Query		
Syntax	Query	:SYSTem:RTOut?
	Response	A$
Example	:SYSTem:RTOut? (Response) :SYSTEM:RTOUT LAN2UDP (When the header is ON)	
Parameter		
A$ = OFF, CAN, LAN2udp		

OFF☑	Does not output the data from CAN or LAN2.
CAN	Outputs the data from the CAN terminal.
LAN2udp	Outputs the data from LAN2.

If the instrument is controlled with XCP on Ethernet UDP, the data are not output regardless of the setting.

2 **Set the IP address of the output destination.**

The multicast communication is enabled by specifying the IP address for multicasting (224.0.0.0 to 239.255.255.255).

Settings		
Syntax	Command	:SYSTem:COMMunicate:LAN2:SEND:IPADdress ip1,ip2,ip3,ip4
Example	:SYSTem:COMMunicate:LAN2:SEND:IPADdress 192,168,1,100	
Query		
Syntax	Query	:SYSTem:COMMunicate:LAN2:SEND:IPADdress?
	Response	ip1<NR1>,ip2<NR1>,ip3<NR1>,ip4<NR1>
Example	:SYSTem:COMMunicate:LAN2:SEND:IPADdress? (Response) :SYSTEM:COMMUNICATE:LAN2:SEND:IPADDRESS 192,168,1,100 (When the header is ON)	
Parameter		

ip1	0 to 255
ip2	0 to 255
ip3	0 to 255
ip4	0 to 255

3 Set the port number of the output destination.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:SEND:PORT no$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:PORT 10000`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:SEND:PORT?`
	Response	`no$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:PORT?` (Response) `:SYSTEM:COMMUNICATE:LAN2:SEND:PORT 10000` (When the header is ON)	
Parameter		
`no$` = 1020 to 65535		

4 Set the endianness.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:SEND:ENDIAN A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:ENDIAN LITTle`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:SEND:ENDIAN?`
	Response	`A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:ENDIAN?` (Response) `:SYSTEM:COMMUNICATE:LAN2:SEND:ENDIAN LITTLE` (When the header is ON)	
Parameter		
`A$` = LITTle, BIG		

`LITTle`	The format to send the lower-order byte first (little endian).
`BIG`☑	The format to send the higher-order byte first (big endian).

5 Set the data format of the measured value to be output.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:SEND:FORMat A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:FORMat INT32`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:SEND:FORMat?`
	Response	`A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:FORMat?` (Response) `:SYSTEM:COMMUNICATE:LAN2:SEND:FORMAT INT32` (When the header is ON)	
Parameter		
`A$` = INT32, FLOAT, INDex		

`INT32`☑	Signed, 32 bits, INT format
`FLOAT`	Single precision floating point number format
`INDex`	Exponential notation (ASCII code)

The exponential notation is output with a character string. The data size per channel is increased and the number of measurement channels that can be output is decreased for the recording interval. Also, the exponential notation is output with a value rounded off to the number of display digits. If you want to acquire a value including a digit after the display digits, convert the value acquired by specifying the INT32 format into a physical quantity.
See “Conversion method from data in the INT32 format to physical quantities.” (p. 352).

6 **(For primary unit)**
Set whether or not to output the data in all secondary units.

Settings		
Syntax	Command	`:SYSTem:COMMunicate:LAN2:SEND:SYNC A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:SYNC ON`	
Query		
Syntax	Query	`:SYSTem:COMMunicate:LAN2:SEND:SYNC?`
	Response	`A$`
Example	`:SYSTem:COMMunicate:LAN2:SEND:SYNC?` (Response) `:SYSTEM:COMMUNICATE:LAN2:SEND:SYNC ON` (When the header is ON)	
Parameter		
`A$` = OFF, ON		

`OFF`☑	When this instrument is the primary unit, no data from any secondary unit are output from LAN2 of this instrument.
`ON`	When this instrument is the primary unit, the data of all secondary units are output from LAN2 of this instrument. The output setting depends on the primary unit. The data are output when the measured value output function of the primary unit is set to LAN2udp.

Note

Up to 500 channels can be output from each secondary unit.
If there are more than 500 channels, the data up to the 500th channel will be output according to the output order.
Reference: “Data format” (p. 343)
Example: If the number of measurement channels for the secondary unit is as follows, output will not be made from the primary unit after the pulse channel.

Power calculation channel: 400
Analog channel: 100
Pulse: 1
Waveform calculation: 5

12
Communication with PC (Computer)

Data format

About the UDP data frame

1 byte	1 byte	1 byte	1 byte	8 bytes	4 bytes	Variable length	1 byte	1 byte
Header (0xFE)	Synchronization number (0 or more)	Number of fragments (0 or more)	Fragment number (0 or more)	Data number (0 or more)	Data size	Measurement data	Checksum*1	Footer (0xFF)

*1. Calculation range: Synchronization number to measurement data part
Method: Lower-order 8 bits of the value calculated by simple addition of every 8 bits.

The data size of each channel type is as follows.

When the data format of the measured value is INT32 or FLOAT

Channel type	Data size
Power calculation	4 bytes (Float fixed)
Analog	4 bytes
Pulse	4 bytes
Logic	2 bytes (INT16 fixed)
Alarm*2	2 bytes (INT16 fixed)
Waveform calculation	8 bytes (Double fixed)

When the data format of the measured value is INDEX

Channel type	Data size
Power calculation	12 bytes
Analog	12 bytes
Pulse	12 bytes
Logic	2 bytes
Alarm*2	2 bytes
Waveform calculation	12 bytes

1 byte is added to the number of data points for all channels except for the last one, because a comma (,) is added between channels.

*2. The alarm channel represents all channels (4 bit) by integers (starting from the lowest bit, output in order of alarm 1, alarm 2…). When the alarm channel data value is 9, alarm 1 and alarm 4 are output.

Example:

When the data format of the measured value is INT32 (when endian is set to BIG)
See “Conversion method from data in the INT32 format to physical quantities.” (p. 352).

Channel type	Example of output data	Decimal value
Power calculation	be 4c cc cd	−0.2
Analog	ff ff 8c f1	−29455
Pulse	00 00 00 01	1
Logic	00 01	1
Alarm	00 01	1 (Alarm 1 is output)
Waveform calculation	bf 94 57 ce 1d 2e e4 f0	−0.0198662

When the data format of the measured value is FLOAT (when endian is set to BIG)

Channel type	Example of output data	Decimal value
Power calculation	be 4c cc cd	−0.2
Analog	3d 38 51 ec	0.045
Pulse	45 48 30 00	3203
Logic	00 01	1
Alarm	00 09	9 (Alarm 1 and alarm 4 are output)
Waveform calculation	bf 94 57 ce 1d 2e e4 f0	−0.0198662

When the data format of the measured value is INDEX

Channel type	Example of output data	ASCII code character
Power calculation	2d 31 2e 30 32 32 37 35 65 2d 30 32	−1.02275e−02
Analog	2d 31 2e 30 32 32 37 35 65 2d 30 32	−1.02275e−02
Pulse	2b 32 2e 33 30 30 30 30 65 2b 30 31	+2.30000e+01
Logic	30 31	01
Alarm	31 35	15
Waveform calculation	2d 31 2e 37 36 32 30 32 65 2d 30 32	−1.76202e−02

- The measurement data are output in the following order:
  Power calculation, analog, pulse, logic, alarm, and waveform calculation.
- For the same data size, the data are sorted by the module number in ascending order.
- For the same module number, the modules are sorted by the channel number in ascending order.

Example:
If the measurement ON channels are CH1_1, CH1_2, CH2_1, PLS1, ALM, and W1, the data are sorted and output in the following order.
CH1_1 → CH1_2 → CH2_1 → PLS1 → ALM → W1
The maximum packet size of the measurement data is 1454 byte per packet. If the size exceeds this value, the divided data are sent.

See “14.12 Data Handling” (p. 428).

Power measurement module data format

The power measurement module format follows the order shown in the tables under “Basic measurement item parameters” (p. 145) and “Harmonic measurement item parameters” (p. 147). Data populates each row from left to right to create a series of rows of parameters. Once all basic measurement parameters have been included, harmonic measurement parameters follow.
See below for a specific example.
M1URMS1, M1URMS2, M1URMS3, M1URMS0, M1UMN1, …, M1HST1, M1HST2, M1HST3

Disabling a measurement channel with `:MODule:STORe ch$, OFF` halts UDP output.
When a measurement channel is disabled, it is omitted, and the next parameter moves forward to take its place.
Example:
Data sequence if M1URMS2 is disabled
M1URMS1, M1URMS3, M1URMS0, …

Conversion method from data in the INT32 format to physical quantities.

Perform the following calculation using the coefficient (table below) determined by the input type and the range setting of each channel.
Physical quantity = Received measurement data × Coefficient
In addition, perform the following calculation if the scaling is set.
Measured value = Physical quantity × Scaling coefficient + Scaling offset value

Product name	Mode or sensor	Range (f.s.)	Coefficient
• M7100 Voltage/Temp Module (15 channels) • M7102 Voltage/Temp Module (30 channels)	Voltage	10 mV	1.0000E-07
		20 mV	2.0000E-07
		100 mV	1.0000E-06
		200 mV	2.0000E-06
		1 V	1.0000E-05
		2 V	2.0000E-05
		6 V	6.0000E-05
		10 V	1.0000E-04
		20 V	2.0000E-04
		60 V	6.0000E-04
		100 V	1.0000E-03
		1-5 V	6.0000E-05
	Thermocouples	100°C	1.0000E-02
		500°C	5.0000E-02
		2000°C	1.0000E-01

Measured value output function in synchronization

When multiple units are in synchronization, the primary unit can output the measured value of each secondary unit via UDP.
The output interval depends on each device.

Number of channels that can be output during each recording interval

When the measured value output function is ON, there is a limit on the number of channels to be output for each setting.
See the table below for the limit of each setting.
If the number of channels exceeds the output limit of the measurement data, blank data is output.

When the output format is INT32 or FLOAT

Synchronization	Data format	Limited
OFF	INT32	None
	FLOAT	None
	Exponent	*2
ON*1	INT32	500 channels per instrument
	FLOAT	500 channels per instrument
	Exponent	No output

*1. Synchronization is activated when the data of all secondary units are output from the primary units (`:SYSTem:COMMunicate:LAN2:SEND:SYNC ON`). When the data are output from each primary and secondary unit (`:SYSTem:COMMunicate:LAN2:SEND:SYNC OFF`), the synchronization is deactivated and the limit for “Synchronization: OFF” in the above table applies, even when the synchronous setting is set to ON.

*2. If the recording interval is set to 5 ms, no output will be generated when measurement turns on with a channel count of 700 or greater.

Tips **UDP receiving system**

A sample program of the system in which data are received using the measured-value output function is included on the provided DVD.
When the sample program is executed, the measured value of LR8102 is received with UDP, converted to a physical quantity for each output format, and then saved in a file.

13 Specifications

13.1 Specifications of Data Logger

General Specifications

Basic specifications

Product warranty duration	3 years
Accuracy warranty duration	1 year
Maximum number of module connections	Up to 1 power supply module unit + 10 measurement module units*[1] *1. Up to 4 M7103 units can be connected per instrument.
Modules that can be connected	
Measurement module	M7100 Voltage/Temp Module (15 channels) M7102 Voltage/Temp Module (30 channels) M7103 Power Measurement Module (Supported in instrument firmware V1.50 and later)
Power module	M1100 AC Power Module (Supported in instrument firmware V1.50 and later)
Internal buffer memory	Volatile memory 512 MB
Clock function	Auto calendar, automatic leap year adjustment, 24-hour clock
Clock accuracy (precision of start/stop times)	±1.0 s/day (at 23°C) By connecting to an NTP server, the time can be synchronized with the NTP server
Time axis accuracy	±0.2 s/day (at 23°C)
Backup battery life	10 years or more for clock use (reference value at 23°C)
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−20°C to 60°C (−4°F to 140°F), 80% RH or less (non-condensing)
Dimensions	No module Approx. 80W × 166H × 238D mm (3.2W × 6.5H × 9.4D in.) (excluding protruding parts) With one M7100 Voltage/Temp Module installed Approx. 134W × 166H × 263D mm (5.3W × 6.5H × 10.4D in.) (excluding protruding parts) With ten M7100 Voltage/Temp Module installed Approx. 620W × 166H × 263D mm (24.4W × 6.5H × 10.4D in.) (excluding protruding parts)
Weight	Approx. 1.5 kg (3.3 lb.)
Standards	Safety: EN 61010 EMC: EN 61326

Display area

Status LED	LR8101: POWER, ALARM, ERROR, START, ACCESS LR8102: POWER, ALARM, ERROR, START, ACCESS, ACT, TERM

Power

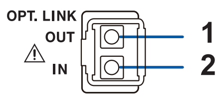
Power	
AC adapter	Z1016 AC Adapter (operates on 12 V DC ±10%) Rated supply voltage: 100 V AC to 240 V AC (assuming voltage fluctuations of ±10%) Rated power-supply frequency: 50 Hz/60 Hz
Power Module	M1100 AC Power Module Rated supply voltage: 100 V AC to 240 V AC (assuming voltage fluctuations of ±10%) Rated power-supply frequency: 50 Hz/60 Hz Anticipated transient overvoltage: 2500 V
External power supply	10 V DC to 30 V DC
Power consumption	
Normal power consumption	When Z1016 AC Adapter or 12 V DC external power supply is used, when one unit of M7100 or M7102 installed: 15 W (instrument only)
Maximum rated power	When Z1016 AC Adapter is used: 100 VA (including the AC adapter) When 30 V DC external power supply is used: 60 VA (instrument only)

Interface specifications

LAN interface	
LAN	IEEE802.3 Ethernet 100BASE-TX / 1000Base-T (automatic detection) Supporting Auto MDI-X, DHCP, and DNS (LAN1 only)
Connector	RJ-45
Number of LAN ports	1 (LR8101) 2 (LR8102)
LAN1 function	Collecting data and setting recording conditions using Logger Utility
	Setting the initial IP address using Logger Utility
	Setting and controlling recording using communication commands
	Manually acquiring data using an FTP Server Acquiring files on an SD memory card and USB drive Supported protocol: FTP
	FTP data auto send (FTP client) Transferring files saved on an SD memory card or USB drive During measurement: Waveform file (binary, text, MDF) After measurement: Waveform file (binary, text, MDF), numerical calculation result file Supported protocols: FTP, FTPS
	HTTP server function Control mode (max. 1 unit) Displaying the current measured value, starting and stopping the measurement, setting comments, upgrading, setting communications, displaying error information Browsing mode (max. 4 units) Displaying the current measured value, displaying the measurement status, displaying comments, displaying error information Language setting Japanese or English
	XCP on Ethernet (TCP) Supporting only measurement mode of ECU measurement/compatible software ASAM e.V. MCD-1 XCP v 1.5.0 compliant
	NTP client function Synchronizing time with NTP server Regular synchronization interval: 1 hour, 1 day Synchronization function before measurement available

LAN2 function (LR8102 only)	XCP on Ethernet (UDP) Supporting only measurement mode of ECU measurement/compatible software ASAM e.V. MCD-1 XCP v 1.5.0 compliant
	Measurement data output function Measurement data can be output based on the UDP Primary unit can output measurement data of all synchronized units, if the synchronization is ON Output period: Output at recording intervals
USB interface (host)	
Standard compliance	USB 2.0 compliant
Connector	Series A receptacle
Operation guaranteed options	Z4006 USB Drive (16 GB) Format type: FAT16, FAT32
Device that can be connected	USB drive
SD card slot	
Standard compliance	SD standards compliant × 1 (SD memory card/SDHC memory card supported)
Operation guaranteed option	Z4001 (2 GB), Z4003 (8 GB) Format type: FAT16, FAT32
Optical synchronization interface (LR8102 only)	
Connector	SFP optical transceiver, Duplex-LC (2-core LC)
Optical signal	850 nm VCSEL, 1 Gbps
Laser class	Class 1
Compatible fiber	50 μm/125 μm multi-mode fiber equivalent
Port	

Pin	Signal name	I/O	Function
1	OPT.LINK OUT	OUT	Optical signal output
2	OPT.LINK IN	IN	Optical signal input

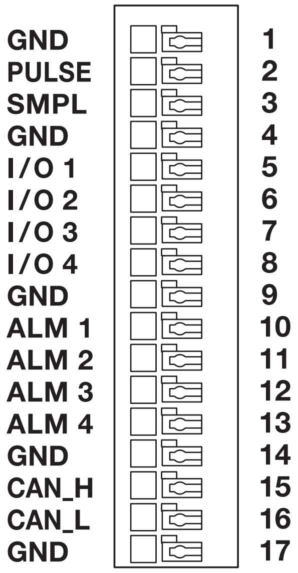


13

Specifications

External control terminal

Terminal block	Push-button type terminal block



Pin	Signal name	I/O	Function
1	GND	−	GND
2	PULSE	IN	Pulse/logic input
3	SMPL	IN	External sampling input
4	GND	−	GND
5	I/O 1	IN/OUT	External input and output 1
6	I/O 2	IN/OUT	External input and output 2
7	I/O 3	IN/OUT	External input and output 3
8	I/O 4	IN/OUT	External input and output 4
9	GND	−	GND
10	ALM1	OUT	Alarm output 1
11	ALM2	OUT	Alarm output 2
12	ALM3	OUT	Alarm output 3
13	ALM4	OUT	Alarm output 4
14	GND	−	GND
15	N.C. / CAN_H*1	−/OUT*1	Not connected / CAN_H communication line*1
16	N.C. / CAN_L*1	−/OUT*1	Not connected / CAN_L communication line*1
17	GND	−	GND

*1. Can be used as CAN terminal on LR8102 only

Pulse/logic input

Number of terminals	1 Not isolated (ground shared with instrument)
Function	Pulse/logic input
Applicable input form	No-voltage contact, open collector (PNP open collector requires an external resistor), or voltage input
Maximum input voltage	0 V DC to 42 V DC
Input resistance	1.1 MΩ ±5%
Detection level	Can be switched between 2 levels. High 1.0 V or more, Low 0 V to 0.5 V High 4.0 V or more, Low 0 V to 1.5 V

External sampling input

Number of terminals	1 Not isolated (ground shared with instrument)
Function	External sampling
Input voltage	0 V DC to 10 V DC High level 2.0 V to 10 V, Low level 0 V to 0.8 V
Slope	Rise or fall can be selected
Filter	Can be set to ON/OFF
Response pulse width	When filter is OFF: High period 100 μs or more, Low period 100 μs or more When filter is ON: High period 4 ms or more, Low period 4 ms or more
Max. external sampling period	5 ms

External input and output	
Number of terminals	4 Not isolated (ground shared with instrument)
For input	Function: Can be selected from OFF, START, STOP, START/STOP, trigger input, and event input
	Input voltage: 0 V DC to 10 V DC High level 2.5 V to 10 V, Low level 0 V to 0.8 V
	Slope: Rise or fall can be selected
	Response pulse width: High period 2.5 ms or more, Low period 2.5 ms or more
For output	Function: Can be selected from OFF and trigger output
	Output type: Open drain output (with 5 V voltage output)
	Output voltage: High level 4.0 V to 5.0 V Low level 0 V to 0.5 V
	Max. switching capacity: 5 V DC to 10 V DC, 200 mA
	Output pulse width (trigger output): 10 ms or more
Alarm output	
Number of terminals	4 Not isolated (ground shared with instrument)
Function	Alarm output
Output type	Open drain output (with 5 V voltage output)
Output voltage	High level: 4.0 V to 5.0 V, Low level: 0 V to 0.5 V High and Low levels can be switched
Maximum switching capacity	5 V DC to 30 V DC, 200 mA
Output pulse width	10 ms or more
CAN interface (LR8102 only)	
Number of ports	1 port
Function	Measured value output
Physical layer	ISO 11898 (High speed) Not isolated (ground shared with instrument)
Supported protocol	CAN/CAN FD (ISO 11898-1:2015 compliant)
Terminator	Can be set to ON/OFF Resistance: 120 Ω ±10 Ω
Baud rate	CAN/CAN FD (arbitration): 50 k, 62.5 k, 83.3 k, 100 k, 125 k, 250 k, 500 k, 800 k, 1000 k [Baud] CAN FD (data): 0.5 M, 1 M, 2 M, 2.5 M, 4 M, 5 M [Baud]
GND terminal	Number of terminals 5 (shared ground)

Recording

REC mode	Normal Ext. sampling
Recording interval	5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 20 min, 30 min, 1 h External
Data refresh interval	Can set a value for each module automatically or as desired Automatic: The best data refresh interval is automatically selected according to the recording interval settings Any value: Allowable settings must comply with module specifications
Repetitive recording	ON/OFF selection ON: Resume recording after recording is stopped (stopped under stop trigger condition or when measurement is completed for recording time). Recording is repeated until it is stopped. OFF: Recording one time until stopped.
Specified time/continuous	Specified time: Recording time is set with days, hours, minutes, and seconds. Can be set up to max. capacity of internal buffer memory (total 512 MB) Continuous: Recording is performed until stopped. Internal buffer memory is overwritten if max. capacity of internal buffer memory is exceeded. Number of samples : Set with number of samples when external sampling is performed.
Waveform storage	Final 512 MB (512 M / n data) is saved to internal buffer memory Calculation formula for data length (n) per sampling n = Number of analog channels*1 × 4 + Number of pulse channels × 4 + Number of logic channels × 2 + Number of waveform calculation channels × 8 + Alarm*2 × 2 *1. Applicable to measurement channels on M7100, M7102 or M7103 *2. Added only when alarm is used
Recorded data backup	None

File

Save

Saving destination	Select SD memory card or USB drive
File name to be saved	Up to 8 single-byte characters Selectable options include automatic serial numbering, date attachment, and comment attachment
Auto save	
Waveform data (Realtime save)	Selectable options include OFF, binary format, text format, and MDF format
Numerical calculation results (saving after recording)	Selectable from OFF and text format When text format is selected, “Single file” (all calculations in one file) or “Individual calc” (separate file for each calculation) can be selected.
Media (Preferred saving destination)	Select SD memory card or USB drive When both an SD memory card and a USB drive are inserted, you can select the preferred saving destination.
Deleting	ON/OFF selection OFF: Stops saving when the SD memory card or USB drive runs low on free space. ON: Continues saving by deleting the oldest waveform file (binary, text, MDF) if the SD memory card or USB drive runs low on free space. When both the SD memory card and USB drive are inserted, the deleting operation are performed only on the preferred saving destination medium.
Folder splitting	Select from disabled, 1 day, 1 week, and 1 month
File splitting	Select from division disabled, enabled, and divided on time. Disable: Saves one set of recorded data in one file. Enable: Divides data and switches to a new destination file for saving every time the specified time elapses after measurement starts. Split time: Specify with days, hours, and minutes Timed: Sets the reference time and switches to a new destination file for saving every time the division time elapses, starting from the reference time. Reference time: Specify with hours and minutes Split time:1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min, 1 h, 2 h, 3 h, 4 h, 6 h, 8 h, 12 h, 1 day
Data protection	If a power failure occurs while a file is being saved to the media, close the file before shutting down the power supply (enabled max. 30 minutes or more after the power is turned ON)
Manual save	Saves one of the following with the communication command. Settings data, Waveform data (binary format), Waveform data (text format), Waveform data (MDF format), A2L file, Numerical calculation results (Single file, Individual calc)
Downsampling (text format only)	
Downsampling	Select from OFF or 1/2 to 1/100,000
Save data	Selectable from instant value and statistical value When statistical value is selected: Saves the instant, maximum, minimum, and average values within the downsampling interval as data

Load

	Can load setting conditions using communication commands

Calculation

Numerical calculation	
Number of calculations	Up to 10 calculations can be performed simultaneously
Calculation details	Average, P-P, Maximum, Time to max, Minimum, Time to min, Integration*1, Aggregation*1, Usage ratio*2, ON time*2, OFF time*2, ON count*2, OFF count*2 *1. Selectable from Total, Positive, Negative, and ASB (absolute value) *2. Can set the threshold value for each channel
Calculation period	During recording: Performs calculation for all data being recorded
Time split calculation	Select from division disabled, enabled, and divided on time. Disable: Performs calculation for all data being recorded Enable: Performs calculation every time after division time elapses since measurement start time Split time: Specify with days, hours, and minutes Timed: Sets the reference time. Performs calculation every time after division time elapses starting from the reference time Reference time: Specify with hours and minutes Split time: 1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min, 1 h, 2 h, 3 h, 4 h, 6 h, 8 h, 12 h, 1 day
Waveform calculation	
Calculation details	The following calculations can be set: • The four arithmetic operations between channels*3 • Moving average, simple average, aggregation, and integration Calculation results are recorded as data in calculation channels (W1 to W30). (Calculations are performed simultaneously with measurement. Recalculation cannot be performed after measurement.) *3. Formula (A ∗ CHa □ B ∗ CHb □ C ∗ CHc □ D ∗ CHd) ■ E A, B, C, D, E: Any constant CHa, CHb, CHc, CHd: Any measurement channels □: One of +, −, ∗, and / ■: One of +, −, ∗, /, and ^

Trigger

Trigger method	Digital comparison method
Trigger timing	Start, Stop, Start & Stop
Trigger condition	AND or OR of trigger sources, Interval trigger, and External trigger Free run if trigger is OFF
Trigger source	Analog, Pulse, Logic, Wave calc
Trigger type	
Analog, Pulse, waveform calculation	Level trigger: Trigger is activated at a rise or fall across the specified level value Window trigger: Specifies upper and lower limit values of the trigger level Trigger is activated when entering or exiting the area
Logic	Trigger is activated when 1 or 0 is matched
External trigger	Trigger is activated at a rise or fall of external input signal Rise or fall can be selected
Trigger response time	Data refresh interval × 3 + 5 ms
Trigger level resolution	(Analog) 0.1% f.s. (Pulse) count 1 c, rotation speed 1/n (n is setting value for number of pulses per rotation)
Pre-trigger	Set days, hours, minutes, and seconds Can be set for realtime save as well

Alarm

Alarm condition	Separately set for ALM1 to ALM4 Alarm is triggered if one of the following conditions is met. • AND or OR of alarm sources • Tc Burn out (thermocouple wire break)
Alarm source	Analog, Pulse, Logic, Wave calc
Thermocouple wire break	An alarm is triggered when a thermocouple wire break occurs (if thermocouple wire break detection is set to ON)
Alarm type	
Analog, Pulse, waveform calculation	Level: An alarm is triggered at a rise or fall across the specified level value
	Window: Set the upper and lower limit values An alarm is triggered when the specified signal enters or exits the area
	Slope: Set the level and time An alarm is triggered when specified rate of change (level/time) is exceeded for a specified time.
	Amount of change: Set the level, time, and slope An alarm is triggered when the amount of change within the specified width is equal to or greater or less than the specified level value
Logic	An alarm is triggered when 1 or 0 is matched
Alarm filter	A filter is applied to the result of either the AND or OR operation among the alarm sources. Set with number of samples (OFF, 2 to 1000) An alarm is triggered if the alarm status continues for the specified number of samples
Alarm setting resolution	(Analog) 0.1% f.s. (Pulse) count 1 c, rotation speed 1/n (n is setting value for number of pulses per rotation)
Alarm hold	ON/OFF selection Alarm clear: Cancels the alarm without stopping the recording when the alarm hold is ON
Alarm buzzer	ON/OFF selection
Alarm output response time	Data refresh interval × 3 + 5 ms

Pulse input, logic input

Pulse input

Measurement range, maximum resolution, measuring range, measurement accuracy

Measurement target	Range	Maximum resolution	Measurement range	Measurement accuracy
Count	1000 M counts f.s.	1 count	0 count to 1000 M counts	±1 count
Rotation speed	5,000/n (r/s) f.s.	1/n (r/s)	0 (r/s) to 5000/n (r/s)	±1/n (r/s)
	300,000/n (r/min) f.s.	60/t0·n (r/min)	0 (r/min) to 300,000/n (r/min)	±60/t0·n (r/min)
	“n” is the number of pulses per one rotation between 1 and 1000 “t0” is the smoothing setting between 1 and 60 (s)			

Pulse input cycle	When filter is OFF: 200 μs or more (must be 100 μs or more in both H period and L period) When filter is ON: 100 ms or more (must be 50 ms or more in both H period and L period)
Slope	Can be set to rise or fall
Measurement mode	Count (addition, instant), rotation speed
Count	Addition: Counts the integrated value after the measurement is started Instant: Counts the instant value at recording intervals (integrated value is reset at recording intervals)
Rotation speed	r/s: The number of input pulses per second is counted to calculate the rotation speed. r/min: The number of input pulses per minute is counted to calculate the rotation speed.
Smoothing function	Can be selected between 1 s and 60 s (can be set when rotation speed is r/min only)
Chattering prevention filter	Can be set to ON/OFF
Logic input	
Measurement mode	Record 1 or 0 at recording intervals

Synchronous operation (LR8102 only)

Synchronization method	Multiple units of the instrument can be operated synchronously Assign one unit to the primary unit. Assign other units to the secondary units.
Max. number of units that can be synchronized	10 units
Allowable recording interval setting	5 ms or more
Synchronization error	• Standard mode 20 μs or less • Power calculation synchronization mode 30 μs or less
Synchronization mode	• Standard mode Aggregates secondary unit measurement results at the primary unit. • Power calculation synchronization mode If the synchronization source’s input frequency is 30 kHz or less, this mode allows the synchronization source for M7103 Power Measurement Module connected to the primary unit to be shared with secondary M7103 Power Measurement Modules.

Other functions

Event mark function	
Event mark input method	Event marks are input in the following events that have occurred during recording. The following operations are performed during recording. (1) Signal input to external input terminal (2) Input while an alarm has occurred (can be set to ON/OFF) (3) Using the corresponding communication commands
Number of inputs	Up to 1000 can be input per measurement
Scaling function	Scaling can be set for each channel (Analog*1) Options include setting by conversion ratio, setting with two points, or setting based on sensitivity. (Pulse count) Configurable either by the number of pulses or by the number of counts. (Pulse rotation speed) Configurable either by conversion ratio or by setting with two points. *1. Measurement channels on M7100 or M7102
Comment entry function	Can enter comments for title and each channel (numerical values, alphabetical characters, and symbols)
Start backup function	ON/OFF selection If this function is set to ON, the start status is automatically recovered and the recording is started (or the trigger standby state if the trigger is used) when the power is restored after shutdown during recording operation.
Beep sound	ON/OFF selection
Self-check function	Can check ROM/RAM, media, and modules
Horizontal (time) axis display	Horizontal (time) axis display can be selected from among the time, date, and number of data points. It takes effect during text format saving.
Measurement start and stop time specification function	Measurement start and stop conditions can be set. Specified date Start time and stop time can be set (year, month, day, hour, minute).
Power-supply frequency filter function	Select 50 Hz or 60 Hz

Included accessories, options

Included accessories	See p. 10.
Options	See p. 11.

13.2 Specifications of Modules

M7100 Voltage/Temp Module

General Specifications

Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−20°C to 60°C (−4°F to 140°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010 EMC: EN 61326 Class A
Standard compliance	Thermocouple JIS C1602:2015, IEC60584-1:2013
Withstand voltage	7.4 kV AC for 1 minute (sensitivity current 1 mA) Between input channels (+, −) and LR8101 or LR8102, between modules 350 V AC for 1 minute (sensitivity current 1 mA), between input channels (+, −)
Normal power consumption	2.9 W (during measurement, data refresh interval is 10 ms, all channels are 10 mV f.s. range, measurement of all channels is ON)
Dimensions	Approx. 53W × 166H × 263D mm (2.1W × 6.5H × 10.4D in.)
Weight	Approx. 1.3 kg (2.9 lb.)
Product warranty duration	3 year
Included accessory	Instruction Manual

Input specifications / Output specifications / Measurement specifications

-1. Basic specifications

Number of input channels	15 channels (voltage and thermocouple can be set for each channel)
Input terminal	M3 screw type terminal block (2 terminals per channel), equipped with terminal block cover
Measurement target	Voltage Thermocouple (K, J, E, T, N, R, S, B, C)
Input method	Scan method using semiconductor relays, floating unbalanced input All channels isolated
A/D resolution	18 bits
Maximum input voltage	±100 V DC
Maximum voltage between the channels	300 V DC
Maximum rated line-to-ground voltage	1500 V DC in measurement category II, anticipated transient overvoltage 8000 V 1000 V AC in measurement category II, anticipated transient overvoltage 6000 V
Maximum rated voltage between the modules	1500 V DC, 1000 V AC
Input resistance	100 MΩ or more (voltage 10 mV f.s. to 6 V f.s. range, 1-5 V f.s. range, thermocouple all ranges) 1 MΩ ±5% (voltage 10 V f.s. to 100 V f.s. range)
Allowable signal source resistance	1 kΩ or less
RJC (Reference junction compensation)	Can be switched between internal and external (for thermocouple measurement).

Thermocouple wire break detection	Wire break detection check for each data refresh interval during thermocouple measurement. ON/OFF setting can be switched (batch setting on module) Detection current 5 μA ±20%, no current while measurement data are acquired. (Cannot be set when data refresh interval is 5 ms or 10 ms)
Data refresh interval	5 ms*1, 10 ms*2, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s *1.Can be selected when all measurement channels on the module are set to the voltage range and the number of channels being used is 1 to 8 *2. Can be selected when thermocouple wire break detection is set to OFF
Digital filter	The cutoff frequency of the digital filter is automatically set according to the data refresh interval, wire break detection setting, and power-supply frequency filter setting as shown in the table below.

–: Cannot be set

Power-supply frequency filter setting	Wire break detection setting	Data refresh interval										
		5 ms*3	10 ms	20 ms	50 ms	100 ms	200 ms	500 ms	1 s	2 s	5 s	10 s
60 Hz	OFF	20.8 k	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60	60	60
	ON	–	–	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60	60
50 Hz	OFF	20.8 k	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50	50	50
	ON	–	–	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50	50

Unit: Hz

*3.Can be selected when all measurement channels are set to the voltage range and the number of channels being used is 1 to 8

-2. Accuracy specifications

Accuracy guarantee conditions	Accuracy guarantee duration: 1 year Accuracy guarantee temperature and humidity range: 23°C ±5°C (73°F ±9°F), 80% RH or less Warm-up time: 30 minutes or longer after the LR8101 or LR8102 Data Logger is connected and the power in turned ON (However, when 4 or more modules are connected, a 10-minute warm-up time is added for the other modules whenever a module is added) Determined for a setting that brings cutoff frequency to 50 Hz/60 Hz (see cutoff frequency table in “Digital filter” (p. 367)) after performing zero adjustment and also when the ambient temperature variation is within ±5°C after the execution of zero adjustment

Measurement range / maximum resolution / measuring range / measurement accuracy

Measurement target	Type	Range	Maximum resolution	Measuring range	Measurement accuracy
Voltage	–	10 mV f.s.	100 nV	−10 mV to 10 mV	±15 μV
		20 mV f.s.	200 nV	−20 mV to 20 mV	±20 μV
		100 mV f.s.	1 μV	−100 mV to 100 mV	±50 μV
		200 mV f.s.	2 μV	−200 mV to 200 mV	±100 μV
		1 V f.s.	10 μV	−1 V to 1 V	±500 μV
		2 V f.s.	20 μV	−2 V to 2 V	±1 mV
		6 V f.s.	60 μV	−6 V to 6 V	±3 mV
		10 V f.s.	100 μV	−10 V to 10 V	±5 mV
		20 V f.s.	200 μV	−20 V to 20 V	±10 mV
		60 V f.s.	600 μV	−60 V to 60 V	±30 mV
		100 V f.s.	1 mV	−100 V to 100 V	±50 mV
		1-5 V f.s.	60 μV	1 V to 5 V	±3 mV
Thermocouples (excluding reference junction compensation)	K	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.2°C
				−100°C to lower than 500°C	±0.5°C
				500°C to 1350°C	±0.8°C
	J	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 1200°C	±0.6°C
	E	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 1000°C	±0.5°C
	T	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 400°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 400°C	±0.5°C
	N	100°C f.s.	0.01°C	−100°C to lower than 0°C	±1.0°C
				0°C to 100°C	±0.8°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.6°C
				−100°C to lower than 0°C	±1.0°C
				0°C to 500°C	±0.8°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.6°C
				−100°C to lower than 0°C	±1.0°C
				0°C to 1300°C	±0.8°C
	R	100°C f.s.	0.01°C	0°C to 100°C	±3.5°C
		500°C f.s.	0.05°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 500°C	±2.1°C
		2000°C f.s.	0.1°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 1700°C	±2.1°C
	S	100°C f.s.	0.01°C	0°C to 100°C	±3.5°C
		500°C f.s.	0.05°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 500°C	±2.1°C
		2000°C f.s.	0.1°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 1700°C	±2.1°C
	B	2000°C f.s.	0.1°C	400°C to lower than 600°C	±4.3°C
				600°C to lower than 1000°C	±3.6°C
				1000°C to 1800°C	±2.3°C
	C	100°C f.s.	0.01°C	0°C to 100°C	±1.6°C
		500°C f.s.	0.05°C	0°C to 500°C	±1.6°C
		2000°C f.s.	0.1°C	0°C to 2000°C	±1.6°C

Reference junction compensation accuracy

±0.5°C (when input terminal temperature is equilibrated)
Reference junction compensation: Added to the thermocouple measurement accuracy when set to internal

Temperature characteristics	Add the following value to the measurement accuracy for operating temperature outside the accuracy guaranteed temperature range. ΔT × (measurement accuracy × 0.1) ΔT: Temperature difference between operating temperature and upper or lower limit value of accuracy guaranteed temperature range (°C) Add reference junction compensation accuracy to measurement accuracy when reference junction compensation is set to internal.
Normal mode removal ratio	50 dB or more (Power-supply frequency filter 50 Hz, data refresh interval 5 s, and thermocouple wire break detection OFF setting for 50 Hz input) (Power-supply frequency filter 60 Hz, data refresh interval 5 s, and thermocouple wire break detection OFF setting for 60 Hz input)
Common mode removal ratio	100 dB or more (signal source resistance of 100 Ω or less and data refresh interval of 10 ms for 50 Hz/60 Hz input) 140 dB or more (signal source resistance 100 Ω or less, power-supply frequency filter 50 Hz, data refresh interval 5 s, 10 mV f.s. range, and thermocouple wire break detection OFF setting for 50 Hz input) (signal source resistance 100 Ω or less, power-supply frequency filter 60 Hz, data refresh interval 5 s, 10 mV f.s. range, and thermocouple wire break detection OFF setting for 60 Hz input)
Effects of radiated radio-frequency electromagnetic field	±5% f.s. (80 MHz to 1 GHz: 10 V/m, 1 GHz to 6 GHz: 3 V/m, at voltage 10 V f.s. range)
Effects of conducted radio-frequency electromagnetic field	±5% f.s. at 10 V (voltage 10 V f.s. range)

M7102 Voltage/Temp Module

General Specifications

Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−20°C to 60°C (−4°F to 140°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010 EMC: EN 61326 Class A
Standard compliance	Thermocouple JIS C1602:2015, IEC60584-1:2013
Withstand voltage	3.6 kV AC for 1 minute (sensitivity current 1 mA) between input channels (+, −) and LR8101/LR8102, between modules 350 V AC for 1 minute (sensitivity current 1 mA) between input channels (+, −)
Normal power consumption	2.7 W (during measurement, data refresh interval is 20 ms, all channels are 10 mV f.s. range, measurement of all channels is ON)
Dimensions	Approx. 53W × 166H × 263D mm (2.1W × 6.5H × 10.4D in.)
Weight	Approx. 1.2 kg (2.6 lb.)
Product warranty duration	3 years
Included accessory	Instruction Manual

Input specifications / Output specifications / Measurement specifications
-1. Basic specifications

Number of input channels	30 channels (voltage and thermocouple can be set for each channel)
Input terminal	Push-button type terminal block (2 terminals per channel), equipped with terminal block cover
Measurement target	Voltage Thermocouple (K, J, E, T, N, R, S, B, C)
Input method	Scan method using semiconductor relays, floating unbalanced input All channels isolated
A/D resolution	18 bits
Maximum input voltage	±100 V DC
Maximum voltage between the channels	300 V DC
Maximum rated line-to-ground voltage	600 V AC, DC in measurement category II, anticipated transient overvoltage 4000 V
Maximum rated voltage between the modules	600 V AC, DC
Input resistance	100 MΩ or more (voltage 10 mV f.s. to 6 V f.s. range, 1-5 V f.s. range, thermocouple all ranges) 1 MΩ ±5% (voltage 10 V f.s. to 100 V f.s. range)
Allowable signal source resistance	1 kΩ or less
RJC (Reference junction compensation)	Can be switched between internal and external (for thermocouple measurement).
Thermocouple wire break detection	Wire break detection check for each data refresh interval during thermocouple measurement. ON/OFF setting can be switched (batch setting on module) Detection current 5 μA ±20%, no current while measurement data are acquired. (Cannot be set when data refresh interval is 10 ms)
Data refresh interval	10 ms*1, 20 ms*2, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s *1.Can be selected when thermocouple wire break detection is set to OFF and the number of channels being used is 1 to 15 *2.Can be selected when thermocouple wire break detection is set to OFF, or when thermocouple wire break detection is set to ON and the number of channels being used is 1 to 15
Digital filter	The cutoff frequency of the digital filter is automatically set according to the data refresh interval, wire break detection setting, and power-supply filter setting as shown in the following table.

• When the number of channels being used is 15 or less

–: Cannot be set

Power-supply frequency filter setting	Wire break detection setting	Data refresh interval									
		10 ms	20 ms	50 ms	100 ms	200 ms	500 ms	1 s	2 s	5 s	10 s
60 Hz	OFF	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60	60	60
	ON	–	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60	60
50 Hz	OFF	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50	50	50
	ON	–	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50	50

Unit: Hz

• When the number of channels being used is 16 to 30

–: Cannot be set

Power-supply frequency filter setting	Wire break detection setting	Data refresh interval									
		10 ms	20 ms	50 ms	100 ms	200 ms	500 ms	1 s	2 s	5 s	10 s
60 Hz	OFF	–	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60	60
	ON	–	–	20.8 k	6.94 k	2.98 k	2.42 k	739	60	60	60
50 Hz	OFF	–	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50	50
	ON	–	–	20.8 k	6.94 k	2.98 k	2.42 k	739	50	50	50

Unit: Hz

-2. Accuracy specifications

Accuracy guarantee conditions	Accuracy guarantee duration: 1 year Accuracy guarantee temperature and humidity range: 23°C ±5°C (73°F ±9°F), 80% RH or less Warm-up time: 30 minutes or longer after the LR8101 or LR8102 Data Logger is connected and the power in turned ON (However, when 4 or more modules are connected, a 10-minute warm-up time is added for the other modules whenever a module is added) Determined for a setting that brings cutoff frequency to 50 Hz/60 Hz (see cutoff frequency table in “Digital filter” (p. 370)) after performing zero adjustment and also when the ambient temperature variation is within ±5°C after the execution of zero adjustment

Measurement range / maximum resolution / measuring range / measurement accuracy

Measurement target	Type	Range	Maximum resolution	Measuring range	Measurement accuracy
Voltage	–	10 mV f.s.	100 nV	−10 mV to 10 mV	±15 μV
		20 mV f.s.	200 nV	−20 mV to 20 mV	±20 μV
		100 mV f.s.	1 μV	−100 mV to 100 mV	±50 μV
		200 mV f.s.	2 μV	−200 mV to 200 mV	±100 μV
		1 V f.s.	10 μV	−1 V to 1 V	±500 μV
		2 V f.s.	20 μV	−2 V to 2 V	±1 mV
		6 V f.s.	60 μV	−6 V to 6 V	±3 mV
		10 V f.s.	100 μV	−10 V to 10 V	±5 mV
		20 V f.s.	200 μV	−20 V to 20 V	±10 mV
		60 V f.s.	600 μV	−60 V to 60 V	±30 mV
		100 V f.s.	1 mV	−100 V to 100 V	±50 mV
		1-5 V f.s.	60 μV	1 V to 5 V	±3 mV
Thermocouples (excluding reference junction compensation)	K	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.2°C
				−100°C to lower than 500°C	±0.5°C
				500°C to 1350°C	±0.8°C
	J	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 1200°C	±0.6°C
	E	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 500°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±0.9°C
				−100°C to 1000°C	±0.5°C
	T	100°C f.s.	0.01°C	−100°C to 100°C	±0.5°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 400°C	±0.5°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.2°C
				−100°C to 400°C	±0.5°C
	N	100°C f.s.	0.01°C	−100°C to lower than 0°C	±1.0°C
				0°C to 100°C	±0.8°C
		500°C f.s.	0.05°C	−200°C to lower than −100°C	±1.6°C
				−100°C to lower than 0°C	±1.0°C
				0°C to 500°C	±0.8°C
		2000°C f.s.	0.1°C	−200°C to lower than −100°C	±1.6°C
				−100°C to lower than 0°C	±1.0°C
				0°C to 1300°C	±0.8°C
	R	100°C f.s.	0.01°C	0°C to 100°C	±3.5°C
		500°C f.s.	0.05°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 500°C	±2.1°C
		2000°C f.s.	0.1°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 1700°C	±2.1°C
	S	100°C f.s.	0.01°C	0°C to 100°C	±3.5°C
		500°C f.s.	0.05°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 500°C	±2.1°C
		2000°C f.s.	0.1°C	0°C to lower than 100°C	±3.5°C
				100°C to lower than 300°C	±2.8°C
				300°C to 1700°C	±2.1°C
	B	2000°C f.s.	0.1°C	400°C to lower than 600°C	±4.3°C
				600°C to lower than 1000°C	±3.6°C
				1000°C to 1800°C	±2.3°C
	C	100°C f.s.	0.01°C	0°C to 100°C	±1.6°C
		500°C f.s.	0.05°C	0°C to 500°C	±1.6°C
		2000°C f.s.	0.1°C	0°C to 2000°C	±1.6°C

Reference contact guaranteed accuracy

±0.5°C (when input terminal temperature is equilibrated)
Reference junction compensation: Added to the thermocouple measurement accuracy when set to internal

Temperature characteristics	Add the following value to the measurement accuracy for operating temperature outside the accuracy guaranteed temperature range. ∆T × (Measurement accuracy × 0.1) ∆T: Temperature difference between operating temperature and upper or lower limit value of accuracy guaranteed temperature range (°C) Add reference junction compensation accuracy to measurement accuracy when reference junction compensation is set to internal.
Normal mode removal ratio	50 dB or more (Power-supply frequency filter 50 Hz, data refresh interval 5 s, thermocouple wire break detection OFF setting, number of channels being used is 15 or less for 50 Hz input) (Power-supply frequency filter 60 Hz, data refresh interval 5 s, thermocouple wire break detection OFF setting, number of channels being used is 15 or less for 60 Hz input)
Common mode removal ratio	100 dB or more (data refresh interval 10 ms, signal source resistance 100 Ω or less, thermocouple wire break detection OFF setting, and number of channels being used is 15 or less for 50 Hz/60 Hz input) 140 dB or more (power-frequency filter 50 Hz, data refresh interval 5 s, 10 mV f.s. range, signal source resistance 100 Ω or less, thermocouple wire break detection OFF setting, and number of channels being used is 15 or less for 50 Hz input) (power-frequency filter 60 Hz, data refresh interval 5 s, 10 mV f.s. range, signal source resistance 100 Ω or less, thermocouple wire break detection OFF setting, and number of channels being used is 15 or less for 60 Hz input)
Effects of radiated radio-frequency electromagnetic field	±5% f.s. (80 MHz to 1 GHz: 10 V/m, 1 GHz to 6 GHz: 3 V/m, at voltage 10 V f.s. range)
Effects of conducted radio-frequency electromagnetic field	±5% f.s. at 10 V (voltage 10 V f.s. range)

M7103 Power Measurement Module

1. General specifications

Operating environment	Indoor use, pollution degree 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)
Standards	Safety: EN 61010 EMC: EN 61326 Class A
Applicable standards	Compliant with IEC 61000-4-7:2002+A1:2008 In IEC measurement mode
Dimensions	Approx. 65W × 170H × 255D mm (2.6W × 6.7H × 10.0D in.) (excluding protruding parts)
Weight	Approx. 1.5 kg (3.3 lb.)
Product warranty duration	3 years
Included accessory	Instruction Manual

Current measurement options	9272-05	Clamp on Sensor (20 A/200 A AC)
	CT6830	AC/DC Current Probe (2 A)
	CT6831	AC/DC Current Probe (20 A)
	CT6833	AC/DC Current Probe (200 A, cable length 5 m)
	CT6833-01	AC/DC Current Probe (200 A, cable length 10 m)
	CT6834	AC/DC Current Probe (500 A, cable length 5 m)
	CT6834-01	AC/DC Current Probe (500 A, cable length 10 m)
	CT6841A	AC/DC Current Probe (20 A)
	CT6843A	AC/DC Current Probe (200 A)
	CT6844A	AC/DC Current Probe (500 A, ϕ20 mm)
	CT6845A	AC/DC Current Probe (500 A, ϕ50 mm)
	CT6846A	AC/DC Current Probe (1000 A)
	PW9100A-3	AC/DC Current Box (50 A)
	PW9100A-4	AC/DC Current Box (50 A)
	CT6862-05	AC/DC Current Sensor (50 A)
	CT6872	AC/DC Current Sensor (50 A)
	CT6872-01	AC/DC Current Sensor (50 A, cable length 10 m)
	CT6863-05	AC/DC Current Sensor (200 A)
	CT6873	AC/DC Current Sensor (200 A)
	CT6873-01	AC/DC Current Sensor (200 A, cable length 10 m)
	CT6875A	AC/DC Current Sensor (500 A)
	CT6875A-1	AC/DC Current Sensor (500 A, cable length 10 m)
	CT6876A	AC/DC Current Sensor (1000 A)
	CT6876A-1	AC/DC Current Sensor (1000 A, cable length 10 m)
	CT6877A	AC/DC Current Sensor (2000 A)
	CT6877A-1	AC/DC Current Sensor (2000 A, cable length 10 m)
	CT6904A	AC/DC Current Sensor (500 A)
	CT9557	Sensor Unit (power supply with addition function)
	CT9904	Connection Cable (For CT9557 connection)
	CT7742	AC/DC Auto-Zero Current Sensor (2000 A)
	CT7642	AC/DC Current Sensor (2000 A)
	CT7044	AC Flexible Current Sensor (6000 A, ϕ100 mm)
	CT7045	AC Flexible Current Sensor (6000 A, ϕ180 mm)
	CT7046	AC Flexible Current Sensor (6000 A, ϕ254 mm)
	CT9920	Conversion Cable (PL14 receptacle - ME15W plug)

Voltage measurement options	L1025	Voltage Cord Banana - banana, red and black × 1 each, approx. 3 m length, with alligator clip CAT III 1000 V, 1 A CAT II 1500 VDC, 1000 VAC, 1 A
	L9438-50	Voltage Cord Banana - banana, red and black × 1 each, approx. 3 m length, with alligator clip CAT III 1000 V, 10 A CAT IV 600 V, 10 A
	L1000	Voltage Cord Banana - banana, red, yellow, blue, and gray × 1 each, black × 4, approx. 3 m length, with alligator clip CAT III 1000 V, 10 A CAT IV 600 V, 10 A
	L1021-01	Patch Cord Branch-banana - banana, red × 1, approx. 0.5 m length, for branching voltage input CAT III 1000 V, 10 A CAT IV 600 V, 10 A
	L1021-02	Patch Cord Branch-banana - banana, black × 1, approx. 0.5 m length, for branching voltage input CAT III 1000 V, 10 A CAT IV 600 V, 10 A
	L9243	Grabber Clip red and black × 1 each CAT II 1000 V, 1 A
	PW9000	Wiring Adapter (for 3-phase 3-wire) CAT III 1000 V, 1 A CAT IV 600 V, 1 A
	PW9001	Wiring Adapter (for 3-phase 4-wire) CAT III 1000 V, 1 A CAT IV 600 V, 1 A
	VT1005	AC/DC High Voltage Divider 5000 V, ±7100 V peak, CAT II 2000 V CAT III 1500 V

2. Basic specifications

-1. Power measurement input specifications

Measurement line

Single-phase 2-wire (1P2W)
Single-phase 3-wire (1P3W)
3-phase 3-wire (3P3W2M, 3V3A, 3P3W3M)
3-phase 4-wire (3P4W)

WIRING	CH1	CH2	CH3
1P2W × 3	1P2W	1P2W	1P2W
1P3W & 1P2W	1P3W		1P2W
3P3W2M	3P3W2M		1P2W
3V3A	3V3A		
3P3W3M	3P3W3M		
3P4W	3P4W		

Number of power channels

3 power channels
(Voltage terminals: U1, U2, and U3; current terminals: I1, I2, and I3)

Input terminal

Voltage: Plug-in terminal (safety terminal)
Current: Dedicated connector (ME15W)

Input method

Voltage: Isolated input, resistance division method
Current: Isolated input by current sensor (voltage output)

Voltage range

6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V

Current range

0.04 A, 0.08 A, 0.2 A, 0.4 A, 0.8 A, 2 A (2 A sensor)
0.4 A, 0.8 A, 2 A, 4 A , 8 A, 20 A (20 A sensor)
4 A, 8 A, 20 A, 40 A, 80 A, 200 A (200 A sensor)
40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (2000 A sensor)
0.1 A, 0.2 A, 0.5 A, 1 A, 2 A, 5 A (5 A sensor)
1 A, 2 A, 5 A, 10 A, 20 A, 50 A (50 A sensor)
10 A, 20 A, 50 A, 100 A, 200 A, 500 A (500 A sensor)
20 A, 40 A, 100 A, 200 A, 400 A, 1 kA (1000 A sensor)

When CT9920 Conversion Cable is used: Select the sensor output rate)
400 A, 800 A, 2 kA, 4 kA, 8 kA, 20 kA (100 μV/ A)
40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (1 mV/ A)
4 A, 8 A, 20 A, 40 A, 80 A, 200 A (10 mV/ A)
0.4 A, 0.8 A, 2 A, 4 A, 8 A, 20 A (100 mV/ A)
0.04 A, 0.08 A, 0.2 A, 0.4 A, 0.8 A, 2 A (1 V/ A)

Can be selected for each wiring (note, however, that a combination of different current sensors cannot be used for the same wiring)

Crest factor

3 (for ratings of the voltage and current ranges), 1.35 for the 1500 V range

Input resistance, input capacity

Voltage input section: 3 MΩ ±30 kΩ, 1.5 pH typical
Current sensor input section: 1 MΩ ±50 kΩ

Maximum input voltage

Voltage input section: 1000 V AC, 2000 V DC
Current sensor input section: 8 V, ±12 V peak

Maximum rated line-to-ground voltage

1000 V AC/DC measurement category III, anticipated transient overvoltage 8000 V
1000 V AC/1500 V DC in measurement category II, anticipated transient overvoltage 8000 V

Measurement method

Voltage and current simultaneous digital sampling, zero cross synchronous calculation method

Sampling

500 kHz, 16-bit

Frequency band

DC, 0.1 Hz to 100 kHz

Effective measurement range

1% of range to 110% of range

Effects of conducted radio-frequency electromagnetic field

At 10 V, current/active power 6% of full scale or below (when 9272-05 is used)
At 10 V, current/active power 30% of full scale or below (when CT9920 is used)
(Full scale conforms to sensor rating)

Effects of radiated radio-frequency electromagnetic field	At 10 V/m, current/active power 6% of full scale or below (Full scale conforms to sensor rating, only when 9272-05 is used)
Synchronous frequency range	0.1 Hz to 100 kHz Lower limit frequency setting provided (0.1 Hz, 1 Hz, 10 Hz)
Synchronization source	U1 to U3, I1 to I3, DC (depending on the data refresh interval) Can be set individually for each wiring When IEC measurement mode is selected, only U or I can be selected. Operation and accuracy are not defined if the synchronization source is less than 1% of range Operation and accuracy are not defined if synchronous detection is disabled For the modules set as the secondary units with the synchronization source sharing function, the synchronization source selected for the primary unit is used
LPF	Select from OFF, 500 Hz, or 5 kHz When OFF is not selected, ±0.05% of reading is added to the accuracy 500 Hz: Accuracy is defined for 60 Hz or less 5 kHz: Accuracy is defined for 500 Hz or less The peak value uses the value after passing the LPF Over-peak is judged according to the value before passing the digital LPF
Data refresh interval	Select from 5 ms, 50 ms, and 200 ms
Polarity judgment for lead and lag	Voltage/current zero cross timing comparison method Zero cross filter with digital low-pass filter is provided
Measurement item	Voltage (U), Current (I), Active power (P), Apparent power (S),Reactive power (Q),Power factor (λ), Phase angle (ø),Voltage frequency (fU), Current frequency (fI), Voltage ripple rate (Urf), Current ripple rate (Irf), Current integration (Ih) Power integration (WP), Voltage peak (Upk), Current peak (Ipk)

-2. Power measurement accuracy specifications

Accuracy warranty conditions	Accuracy warranty period: 1 year Accuracy guarantee for temperature and humidity: 23°C ±3°C, 80% RH or less Warm-up time: 30 minutes or more Input: Sine-wave input, power factor 1, or DC input, 0 V line-to-ground voltage, within effective measurement range, within the range for the fundamental wave to meet the synchronization source conditions, within ±1°C ambient temperature change from the zero adjustment point after zero adjustment

Accuracies of voltage, current, active power, and power phase angle

Frequency	±(% of reading +% of range)	
	Voltage (U)	Current (I)
DC	0.02% + 0.03%	0.02% + 0.03%
0.1 Hz ≤ f < 45 Hz	0.1% + 0.1%	0.1% + 0.1%
45 Hz ≤ f ≤ 440 Hz	0.02% + 0.03%	0.02% + 0.03%
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 ≤ 100 kHz	0.1 × f% + 0.1%	0.1 × f% + 0.1%

Frequency	± (% of reading +% of range)	Power phase angle (°)
	Active power (P)	
DC	0.02% + 0.05%	–
0.1 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%	±0.1
1 kHz < f ≤ 10 kHz	0.3% + 0.1%	±0.5
10 kHz < f ≤ 100 kHz	0.2 × f% + 0.1%	±(0.05 × f)

- The unit of “f” in the above table is kilohertz (kHz)
- DC for voltage and current is defined by Udc and Idc, while the frequencies other than DC are defined by Urms and Irms
- When either U or I is selected for the synchronization source, accuracy is defined when the input is over 5% of range
- For the power phase angle, accuracy is defined when the power factor is zero at the time of 100% input
- For the current, active power, and power phase angle, accuracy of the current sensor is added to each of the above accuracies
- Under the condition of “0.1 Hz ≤ f < 10 Hz”, the voltage, current, active power, and power phase angle should only be used as reference values
- Under the conditions of “10 Hz ≤ f < 16 Hz” and voltage of over 220 V, the voltage, active power, and power phase angle should only be used as reference values
- Under the conditions of “30 kHz < f ≤ 100 kHz” and voltage of over 750 V, the voltage, active power, and power phase angle should only be used as reference values
- Under the condition of “1000 V < DC voltage ≤ 1500 V”, 0.05% of reading is added to the voltage and active power (also when the input voltage falls below 1000 V, there will be some influence until the input resistance temperature has completely decreased)
- Outside the range from 45 Hz to 66 Hz, the power phase angle should only be used as a reference value
- If the voltage exceeds 600 V, the following are added to the accuracy of the power phase angle:
  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 ≤ 100 kHz: ±1°
- When the data refresh interval is set to 5 ms and the frequency is not set to DC, ±0.05% of reading is added to the voltage and current, ±0.1% of reading is added to the active power
- When the data refresh interval is set to 5 ms, ±0.05° is added to the power phase angle
- For the 6 V range of voltage, ±0.03% of range is added to the voltage and active power
- The effective measurement range for 9272-05 is 0.5% to 100% of full scale of the sensor
- Under the condition of “100% of range < input ≤ 110% of range”, range error is multiplied by 1.1
- If there is ±1°C or more change in the temperature after zero adjustment, ±0.01% of range/°C is added to the DC accuracies of voltage, current, and active power

Apparent power accuracy	Voltage accuracy + current accuracy ±10 digits
Reactive power accuracy	In any cases except for ø = 0°or ±180° $(\text{Accyracy of apparent power}) \pm \left\{1 - \frac{\sin[\phi + (\text{Accuracy of power phase angle})]}{\sin\phi}\right\} \times (100\%\text{ of reading})$ $\pm\left(\sqrt{1.001-\lambda^2}-\sqrt{1-\lambda^2}\right) \times (100\%\text{ of range})$ In the case of ø = 0°or ±180° $(\text{Accuracy of apparent power}) \pm \sin(\text{Accuracy of power phase angle}) \times (100\%\text{ of range}) \pm (3.16\%\text{ of range})$ λ is the measurement value of the power factor
Power factor measurement accuracy	In any cases except for ø = ±90° $\pm\left\{1 - \frac{\cos[\phi + (\text{Accuracy of power phase angle})]}{\cos\phi}\right\} \times (100\%\text{ of reading}) \pm (50\text{ digits})$ In the case of ø = ±90° $\pm\cos[\phi + (\text{Accuracy of power phase angle})] \times (100\%\text{ of range}) \pm (50\text{ digits})$ ø is the measurement value of the power phase angle Both are defined at the time of rated input of the voltage and current ranges
Waveform peak measurement accuracy	Voltage/current RMS value accuracy ±1% of range (300% of the range is applied as the peak range)
Effects of temperature	The following is added to the voltage, current, and active power accuracies within the range from 0°C to 20°C or from 26°C to 40°C: ±0.01% of reading/°C. For direct current, 0.01% of range/°C is also added.
Common-mode voltage rejection ratio (Effects of common-mode voltage)	100 dB or more at 50 Hz/60 Hz It is defined by CMRR when the maximum input voltage is applied between the voltage input terminal and enclosure for all measurement ranges
Effects of external magnetic field	±1% of range or less (400 A/m, DC, in 50 Hz/60 Hz magnetic field)
Effects of power factor on active power	In any cases except for ø = ±90° $\pm\left\{1 - \frac{\cos[\phi + (\text{Accuracy of power phase angle})]}{\cos\phi}\right\} \times (100\%\text{ of reading})$ In the case of ø = ±90° $\pm\cos[\phi + (\text{Accuracy of power phase angle})] \times (100\%\text{ of VA})$
Zero adjustment	Voltage: Zero correction for internal offset of ±20% of range or less Current: Zero correction for input offset of ±20% of range or less
Zero suppression	Select either ON or OFF (zero suppression is performed for 0.5% of range or less)

-3. Frequency measurement specifications

Measurement item	Voltage and current of power channels (fU1 to fU3, fI1 to fI3)
Measurement method	Reciprocal method + sampling value correction between each zero cross
Measurement range	0.1 Hz to 100 kHz within synchronous frequency range (0.0000 Hz when measurement is disabled) Measurement lower limit frequency can be set (0.1 Hz, 1 Hz, 10 Hz) When frequency is measured more often than the data refresh interval, the data refresh interval depends on the frequency

Accuracy	±0.005 Hz (When the data refresh interval is 50 ms or more, voltage is 15 V range or higher, and sine-wave input is 50% or more at the time of voltage frequency measurement, and also when frequency is measured at 45 Hz to 66 Hz) ±0.05% of reading under any conditions other than those above (for sine-wave of 30% or more for the measurement range of the measurement source)
Format	0.10000 Hz to 9.99999 Hz, 10.0000 Hz to 99.9999 Hz, 100.000 Hz to 999.999 Hz, 1.00000 kHz to 9.99999 kHz, 10.0000 kHz to 99.9999 kHz, 100.000 kHz
Effects of radiated radio-frequency electromagnetic field	Current frequency 6% of reading or less at 10 V/m (when using 9272-05 only)
Effects of conductive electromagnetic fields	6% of current frequency reading or less at 10 V (when using CT9920 only)

-4. Integration measurement specifications

Measurement mode	RMS, DC (DC can only be selected when the AC/DC sensor is used for 1P2W wiring)
Measurement item	Current integration (Ih+, Ih−, Ih), active power integration (WP+, WP−, WP) Ih+ and Ih- are measured only in the DC mode, and Ih is measured in the RMS mode
Measurement method	Digital calculation from each current and active power (When averaging, calculation is performed with the value before averaging) In DC mode: The current values and instantaneous power values for each sampling are integrated on a polarity basis In RMS mode: The current RMS value and active power value at each data refresh interval are integrated. Only the active power values are integrated on polarity basis (active power values are integrated on a polarity basis at each synchronization source period). For the active power integrated SUM value for multi-phase wiring, the active power SUM values are integrated at the measurement interval on a polarity basis
Measurement interval	Same as the data refresh interval
Measurement resolution	999999 (6 digits + decimal point) Start from the resolution that treats 1% of each range as 100% of range
Measurement range	0 to ±9999.99 TAh / Twh (however, the integration time should be within 9999 hour 59 min) If any integrated value or integration time exceeds these upper limits, integration stops
Integration time accuracy	±100 ppm ±1 digit
Integration accuracy	±(Accuracies of current and active power) ± integration time accuracy

-5. Harmonic measurement common specifications

Number of measurement power channels	3 power channels
Synchronization source	Same as the basic measurement specifications In accordance with the synchronization source for measurements of the voltage, current, and power selected for each wiring
Measurement mode	Select either IEC measurement mode or wide area measurement mode
Measurement item	Harmonic voltage RMS value, harmonic voltage content, harmonic voltage phase angle, harmonic current RMS value, harmonic current content, harmonic current phase angle, harmonic active power, harmonic power content, harmonic voltage and current phase difference, total harmonic voltage distortion rate, total harmonic current distortion rate, voltage unbalance factor, current unbalance factor

FFT processing word length	32 bits
Anti-aliasing	Digital filter (automatically set according to the synchronous frequency)
Window function	Rectangular
Grouping	OFF, TYPE1 (harmonic sub-group), TYPE2 (harmonic group)
THD calculation method	THD_F / THD_R Calculation order: Select from the 2nd to 50th order (up to the maximum analysis order of each mode)

-6. IEC measurement mode harmonic measurement specifications

Measurement method	Zero cross synchronous calculation method (same window for each synchronization source) Fixed sampling interpolation calculation method, uniform downsampling within the window Compliant with IEC61000-4-7:2002+A1:2008, with gap overlapping
Synchronous frequency range	45 Hz to 66 Hz (Disabled with DC synchronization source)
Data refresh interval	Fixed to approximately 200 ms (when 5 ms or 50 ms is set, update is performed at the 200 ms interval for harmonics only)
Maximum analysis order	50th order
Window wave number	10 waves for less than 56 Hz, 12 waves for 56 Hz or above
Number of FFT points	8192 points
Measurement accuracy	

Frequency	Voltage and current	Power	Phase difference
DC (0th order)	±0.1% rdg ±0.1% of range	±0.1% rdg ±0.2% of range	–
45 Hz ≤ f ≤ 66 Hz	±0.2% rdg ±0.04% of range	±0.4% rdg ±0.05% of range	±0.08°
66 Hz < f ≤ 440 Hz	±0.5% rdg ±0.05% of range	±1.0% rdg ±0.05% of range	±0.08°
440 Hz < f ≤ 1 kHz	±0.8% rdg ±0.05% of range	±1.5% rdg ±0.05% of range	±0.4°
1 kHz < f ≤ 2.5 kHz	±2.4% rdg ±0.05% of range	±4% rdg ±0.05% of range	±0.4°
2.5 kHz < f ≤ 3.3 kHz	±6% rdg ±0.05% of range	±10% rdg ±0.05% of range	±0.8°

-7. Wide area measurement mode harmonic measurement specifications

Measurement method	Zero cross synchronous calculation method (same window for each synchronization source), with gap Fixed sampling interpolation calculation method
Synchronous frequency range	0.1 Hz to 30 kHz
Data refresh interval	Fixed at 50 ms When set at 5 ms, data is updated at 50 ms intervals for harmonics only When set at 200 ms, values acquired 4 times every 50 ms are averaged and applied

Maximum analysis order and window wave number

Fundamental wave frequency	Window wave number	Maximum analysis order
0.1 Hz ≤ f ≤ 200 Hz	1	50th order
200 Hz < f ≤ 400 Hz	2	50th order
400 Hz < f ≤ 600 Hz	4	50th order
600 Hz < f ≤ 1 kHz	4	30th order
1 kHz < f ≤ 2 kHz	8	15th order
2 kHz < f ≤ 4 kHz	16	7th order
4 kHz < f ≤ 6 kHz	32	5th order
6 kHz < f ≤ 10 kHz	64	3rd order
10 kHz < f ≤ 30 kHz	128	1st order

Number of FFT points

Automatically selected from among 2048, 4096, and 8192 points

Measurement accuracy

The following are added to the accuracies of voltage, current, active power, and phase angle for each measurement module.
For fundamental waves of 2 kHz or more, however, 0.05% of reading is added.

Frequency	Voltage, current, and power ±(% of reading)	Phase ±(°)
DC	0.05%	–
0.1 Hz ≤ f ≤ 200 Hz	0.01%	0.1
200 Hz < f ≤ 1 kHz	0.03%	0.1
1 kHz < f ≤ 10 kHz	0.08%	0.6
10 kHz < f ≤ 30 kHz	0.15%	(0.020 × f) ±0.5

- The unit of “f” for the formula in the above table is kilohertz (kHz).
- When the fundamental wave is outside the range from 16 Hz to 850 Hz, the voltage, current, power, and phase difference for waves other than the fundamental wave should only be used as reference values.
- When the fundamental wave is within the range from 16 Hz to 850 Hz, the voltage, current, power, and phase difference for waves that exceed 6 kHz should only be used as reference values.
- The phase difference is defined when the inputs of the voltage and current of the same order are 10% of range or more.

3. Function specifications

-1. AUTO range function

Function

The ranges of voltage and current for individual wirings is automatically changed in accordance with the input.

Operation mode

OFF/ON (Can be selected for each wiring)

Range switching conditions

Switch to the range immediate above
When any of the following conditions is met for any wiring channel
- rms value ≥ 110% of range
- |Peak value| ≥ 300% of range

Switch to the range immediate below
When all of the following conditions are met for all wiring channels
- rms value ≤ 40% of range
- |Peak value| ≤ 280% of the range immediately below

When the Δ-Y conversion function is set to ON, any change in the voltage range is judged by multiplying the range by $1/\sqrt{3}$.

The rms value and peak value for judging the range are both instantaneous values (not averaged).
The peak value for judging the range uses the value before passing the LPF.

-2. Calculation function

(1) Rectification method

Function	Select the voltage and current values to be used for calculating the apparent power, reactive power, and power factor.
Method	RMS or MEAN (Can be selected for each voltage and current of individual wirings)

(2) Scaling

VT (PT) ratio	0.01 to 9999.99 The VT (PT) ratio cannot be set such that the product of VT and CT exceeds 1.0E+06.
CT ratio	0.01 to 9999.99 The CT ratio cannot be set such that the product of VT and CT exceeds 1.0E+06.

(3) Averaging function

	All the instantaneous measurement values, including harmonics, are averaged. (The peak value, integrated value, and harmonic data at 5 ms data updating are excluded) During averaging, average data are applied to all data, including the save data
Method	Moving average The output data are updated by averaging the number of data points equal to the moving average count at each data refresh interval. The data refresh interval is the same as when no averaging is performed. The voltage (U), current (I), and power (P) values are each averaged, and the calculation values are obtained from those values For harmonics, the RMS values and content are obtained by averaging the instantaneous values, and the phase angle is obtained by averaging the real part and imaginary part after FFT The phase difference, distortion rate, and unbalance factor are obtained according to the data after the above averaging The ripple rate is obtained according to the averaged data of the differences in the ±peak value
Moving average count	10, 20, 40, and 100 counts

(4) Delta conversion

Function	For Δ-Y 3P3W3M or 3V3A wiring, the line-to-line voltage waveform is converted into the phase voltage waveform using the virtual neutral point For Y-Δ 3P4W wiring, the phase voltage waveform is converted into the voltage waveform between lines All the voltage parameters, including harmonics, such as voltage RMS value, are calculated according to the converted voltage. However, over-peak is judged using the value before conversion.
Formula	Δ-Y 3P3W3M U(1)s = (u(1)s − u(3)s) / 3 U(2)s = (u(2)s − u(1)s) / 3 U(3)s = (u(3)s − u(2)s) / 3 Δ-Y 3V3A U(1)s = (u(1)s − u(3)s) / 3 U(2)s = (u(3)s + u(2)s) / 3 U(3)s = (-u(2)s − u(1)s) / 3 Y-Δ u(1)s = U(1)s − U(2)s u(2)s = U(2)s − U(3)s u(3)s = U(3)s − U(1)s u(x)s: Sampled line-to-line voltage value U(x)s: Sampled phase voltage value

(5) Formula selection

Function	The reactive power, power factor, and power phase angle formulas can be selected
Formula	TYPE1, TYPE2, TYPE3 TYPE1: Compatible with TYPE1 of PW3390, 3193, and 3390 TYPE2: Compatible with TYPE2 of 3192 and 3193 TYPE3: The sign of power factor uses the sign of active power (TYPE1, TYPE2, and TYPE3 are compatible with the TYPE of each formula for PW8001)

-3. Synchronization source sharing function

Function	The zero cross timing is shared between connected modules Select the power channels to be synchronized with each other from the module designated as the primary unit The zero cross timing of the selected power channel is shared with the power channels for all modules designated as the secondary units
Operation mode	OFF, primary, secondary (Only one module can be designated as the primary unit)
Synchronous power channel selection	CH1 to CH3 (select from the module designated as the primary unit)
Synchronous item	Zero cross timing

4. Setting specifications

-1. Input settings

Wiring	Single-phase 2-wire (1P2W) Single-phase 3-wire (1P3W) 3-phase 3-wire (3P3W2M, 3V3A, 3P3W3M) 3-phase 4-wire (3P4W)

<table>
<tr><th>WIRING</th><th>CH1</th><th>CH2</th><th>CH3</th></tr>
<tr><td>1P2W × 3</td><td colspan="3">1P2W</td></tr>
<tr><td>1P3W & 1P2W</td><td colspan="2">1P3W</td><td>1P2W</td></tr>
<tr><td>3P3W2M & 1P2W</td><td colspan="2">3P3W2M</td><td>1P2W</td></tr>
<tr><td>3V3A</td><td colspan="3">3V3A</td></tr>
<tr><td>3P3W3M</td><td colspan="3">3P3W3M</td></tr>
<tr><td>3P4W</td><td colspan="3">3P4W</td></tr>
</table>

Synchronization source	U1 to U3, I1 to I3, DC (5 ms, 50 ms, 200 ms) Can be selected for each wiring
Voltage range	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V Can be selected for each wiring

Current range	0.04 A, 0.08 A, 0.2 A, 0.4 A, 0.8 A, 2 A (2 A sensor) 0.4 A, 0.8 A, 2 A, 4 A, 8 A, 20 A (20 A sensor) 4 A, 8 A, 20 A, 40 A, 80 A, 200 A (200 A sensor) 40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (2000 A sensor) 0.1 A, 0.2 A, 0.5 A, 1 A, 2 A, 5 A (5 A sensor) 1 A, 2 A, 5 A, 10 A, 20 A, 50 A (50 A sensor) 10 A, 20 A, 50 A, 100 A, 200 A, 500 A (500 A sensor) 20 A, 40 A, 100 A, 200 A, 400 A, 1 kA (1000 A sensor) When CT9920 Conversion Cable is used: Select the sensor output rate) 400 A, 800 A, 2 kA, 4 kA, 8 kA, 20 kA (100 μV/ A) 40 A, 80 A, 200 A, 400 A, 800 A, 2 kA (1 mV/ A) 4 A, 8 A, 20 A, 40 A, 80 A, 200 A (10 mV/ A) 0.4 A, 0.8 A, 2 A, 4 A, 8 A, 20 A (100 mV/ A) 0.04 A, 0.08 A, 0.2 A, 0.4 A, 0.8 A, 2 A (1 V/ A) Can be selected for each wiring (However, a combination of different current sensors cannot be used for the same wiring)
LPF	OFF, 500 Hz, 5 kHz Can be selected for each wiring
Data refresh interval	5 ms, 50 ms, 200 ms
Zero cross filter	100 Hz, 500 Hz, 5 kHz, 200 kHz Can be selected for each wiring
Measurement lower limit frequency	0.1 Hz, 1 Hz, 10 Hz Can be selected for each wiring
Zero suppression	OFF/ON
Count mode	RMS, DC Can be selected for each wiring

-2. Function and calculation settings

AUTO range	OFF/ON (Both voltage and current can be selected for each wiring)
Voltage rectification method	RMS, MEAN (Voltage values used for calculating the apparent power, reactive power, and power factor) Can be selected for each wiring
Current rectification method	RMS, MEAN (Current values used for calculating the apparent power, reactive power, and power factor) Can be selected for each wiring
VT (PT) ratio	0.01 to 9999.99 The VT (PT) ratio cannot be set such that the product of VT and CT exceeds 1.0E+06. Can be selected for each wiring
CT ratio	0.01 to 9999.99 The CT ratio cannot be set such that the product of VT and CT exceeds 1.0E+06. Can be selected for each wiring
Average	OFF, 10, 20, 40, 100
Delta conversion	OFF/ON
Formula	TYPE1, TYPE2, TYPE3
Synchronization	OFF, primary, secondary (Select the power channels to be synchronized with each other from the instrument designated as the primary unit)

-3. Harmonic settings

Harmonic synchronization source	Shared with the synchronization source specified in the input settings In accordance with the synchronization source for measurements of the voltage, current, and power selected for each wiring
THD calculation method	THD-F / THD-R

THD calculation order	Select one from the 2nd to 50th order (up to the maximum analysis order of each mode)
Measurement mode	IEC measurement mode, wide area measurement mode
Grouping	OFF, TYPE1 (harmonic sub-group), TYPE2 (harmonic group)

5. Measurement item detailed specifications

-1. Basic measurement items

(1) Power measurement items

Measurement item		Notation	1P2W × 3	1P3W/ 3P3W2M+1P2W	3P3W3M/3V3A	3P4W
Voltage	RMS value	Urms	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
	Average value rectification RMS value conversion value	Umn	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
	Alternating-current component	Uac	1,2,3	1,2,3	1,2,3	1,2,3
	Simple average value	Udc	1,2,3	1,2,3	1,2,3	1,2,3
	Fundamental wave components	Ufnd	1,2,3	1,2,3	1,2,3	1,2,3
	Waveform peak+	Upk+	1,2,3	1,2,3	1,2,3	1,2,3
	Waveform peak-	Upk-	1,2,3	1,2,3	1,2,3	1,2,3
	Total harmonic distortion rate	Uthd	1,2,3	1,2,3	1,2,3	1,2,3
	Ripple rate	Urf	1,2,3	1,2,3	1,2,3	1,2,3
	Unbalance factor	Uunb	–	–	123	123
Current	RMS value	Irms	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
	Average value rectification RMS value conversion value	Imn	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
	Alternating-current component	Iac	1,2,3	1,2,3	1,2,3	1,2,3
	Simple average value	Idc	1,2,3	1,2,3	1,2,3	1,2,3
	Fundamental wave components	Ifnd	1,2,3	1,2,3	1,2,3	1,2,3
	Waveform peak+	Ipk+	1,2,3	1,2,3	1,2,3	1,2,3
	Waveform peak-	Ipk-	1,2,3	1,2,3	1,2,3	1,2,3
	Total harmonic distortion rate	Ithd	1,2,3	1,2,3	1,2,3	1,2,3
	Ripple rate	Irf	1,2,3	1,2,3	1,2,3	1,2,3
	Unbalance factor	Iunb	–	–	123	123
Active power		P	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123

Measurement item		Notation	1P2W × 3	1P3W/ 3P3W2M+1P2W	3P3W3M/3V3A	3P4W
Fundamental wave active power		Pfnd	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Apparent power		S	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Fundamental wave apparent power		Sfnd	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Reactive power		Q	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Fundamental wave reactive power		Qfnd	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Power factor		λ	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Fundamental wave power factor		λfnd	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Phase angle	Voltage phase angle	θU	1,2,3	1,2,3	1,2,3	1,2,3
	Current phase angle	θI	1,2,3	1,2,3	1,2,3	1,2,3
	Power phase angle	ø	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123

✓: With polarity, -: No polarity

Measurement item		Notation	Unit	Measurement range	Polarity (+/−)
Voltage	RMS value	Urms	V	0% to 150% of U range*1	−
	Conversion value for the RMS of average value rectification	Umn	V	0% to 150% of U range*1	−
	Alternating-current component	Uac	V	0% to 150% of U range*1	−
	Simple average value	Udc	V	0% to 150% of U range*1	✓
	Fundamental wave components	Ufnd	V	0% to 150% of U range*1	−
	Waveform peak+	Upk+	V	0% to 300% of U range*1	✓
	Waveform peak-	Upk-	V	0% to 300% of U range*1	✓
	Total harmonic distortion rate	Uthd	%	0.000 to 500.000	−
	Ripple rate	Urf	%	0.000 to 500.000	−
	Unbalance factor	Uunb	%	0.000 to 100.000	−
Current	RMS value	Irms	A	0% to 150% of I range	−
	Conversion value for the RMS of average value rectification	Imn	A	0% to 150% of I range	−
	Alternating-current component	Iac	A	0% to 150% of I range	−
	Simple average value	Idc	A	0% to 150% of I range	✓
	Fundamental wave components	Ifnd	A	0% to 150% of I range	−
	Waveform peak+	Ipk+	A	0% to 300% of I range	✓
	Waveform peak-	Ipk-	A	0% to 300% of I range	✓
	Total harmonic distortion rate	Ithd	%	0.000 to 500.000	−
	Ripple rate	Irf	%	0.000 to 500.000	−
	Unbalance factor	Iunb	%	0.000 to 100.000	−
Active power		P	W	0% to 150% of P range	✓

Measurement item		Notation	Unit	Measurement range	Polarity (+/−)
Fundamental wave active power		Pfnd	W	0% to 150% of P range	✓
Apparent power		S	VA	0% to 150% of P range	–
Fundamental wave apparent power		Sfnd	VA	0% to 150% of P range	–
Reactive power		Q	var	0% to 150% of P range	✓
Fundamental wave reactive power		Qfnd	var	0% to 150% of 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	°	0.000 to 180.000	✓
	Current phase angle	θI	°	0.000 to 180.000	✓
	Power phase angle	ø	°	0.000 to 180.000	✓

*1. 135% for the 1500 V range only
This range will not be changed for delta conversion function.

An over-peak is detected when either voltage waveform peak Upk+ or Upk-, or current waveform peak Ipk+ or Ipk-, exceeds the measurement range.

(2) Integration measurement items

Measurement item		Notation	1P2W × 3	1P3W/ 3P3W2M+1P2W	3P3W3M/3V3A	3P4W
Count	Positive current amount*1	Ih+	1,2,3	3	–	–
	Negative current amount*1	Ih-	1,2,3	3	–	–
	Sum of positive and negative current amounts	Ih	1,2,3	1,2,3	1,2,3	1,2,3
	Positive power amount	WP+	1,2,3	12,3	123	123
	Negative power amount	WP-	1,2,3	12,3	123	123
	Sum of positive and negative power amounts	WP	1,2,3	12,3	123	123

*1. Only for the power channels with the DC integration mode

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✓: With polarity, -: No polarity

Measurement item		Notation	Unit	Measurement range	Polarity (+/−)
Count	Positive current amount	Ih+	Ah	0 to 1% and above of I range*2	−
	Negative current amount	Ih-	Ah	0 to 1% and above of I range*2	Normally negative sign
	Sum of positive and negative current amounts	Ih	Ah	0 to 1% and above of I range*2	✓
	Positive power amount	WP+	Wh	0 to 1% and above of P range*2	−
	Negative power amount	WP-	Wh	0 to 1% and above of P range*2	Normally negative sign
	Sum of positive and negative power amounts	WP	Wh	0 to 1% and above of P range*2	✓

*2. The same range applies to the positive, negative, and positive/negative. The range is shown up to the number of digits needed to display the maximum values.

(3) Frequency measurement items

Measurement item	Notation	Unit	Power channel	Measurement range	Polarity (+/−)
Voltage frequency	fU	Hz	1,2,3	0.00000 Hz to 100.000 kHz	−
Current frequency	fI	Hz	1,2,3	0.00000 Hz to 100.000 kHz	−

-2. Harmonic measurement items

Measurement item	Notation	1P2W × 3	1P3W/ 3P3W2M+1P2W	3P3W3M/3V3A	3P4W
Harmonic voltage RMS value	Uk	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic voltage phase angle	θUk	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic current RMS value	Ik	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic current phase angle	θIk	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic active power	Pk	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Harmonic voltage and current phase difference	θk	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123
Harmonic voltage content	HDUk	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic current content	HDIk	1,2,3	1,2,3	1,2,3	1,2,3
Harmonic power content	HDPk	1,2,3	1,2,3,12	1,2,3,123	1,2,3,123

✓: With polarity

Measurement item	Notation	Unit	Measurement range	Polarity (+/−)
Harmonic voltage RMS value	Uk	V	0% to 150% of U range	*1
Harmonic voltage phase angle	θUk	°	0.000 to 180.000	✓
Harmonic current RMS value	Ik	A	0% to 150% of I range	*1
Harmonic current phase angle	θIk	°	0.000 to 180.000	✓
Harmonic active power	Pk	W	0% to 150% of P range	✓
Harmonic voltage and current phase difference	θk	°	0.000 to 180.000	✓
Harmonic voltage content	HDUk	%	0.000 to 100.000	*1
Harmonic current content	HDIk	%	0.000 to 100.000	*1
Harmonic power content	HDPk	%	0.000 to 100.000	✓

*1. Polarity (+/-) is only present for the 0th order components

13 Specifications

-3. Power range configuration

(1) For 20 A sensor

Voltage/wiring		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

Active power (P) is in units of “W”, apparent power (S) is in “VA”, and reactive power (Q) is in “var”
The range is 1/10 times the values in this table for the 2 A sensor, 10 times for the 200 A sensor, and 100 times for the 2 kA sensor

(2) For 50 A sensor

Voltage/wiring		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

Active power (P) is in units of “W”, apparent power (S) is in “VA”, and reactive power (Q) is in “var”
The range is 1/10 times the values in this table for the 5 A sensor, 10 times for the 500 A sensor, and 100 times for the 5 kA sensor

(3) For 1 kA sensor

Voltage/wiring		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

Voltage/wiring		Current					
		20.0000 A	40.0000 A	100.000 A	200.000 A	400.000 A	1.00000 kA
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

Active power (P) is in units of “W”, apparent power (S) is in “VA”, and reactive power (Q) is in “var”

6. Formula specifications

-1. Formulas of basic measurement items

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Voltage RMS value:	$U_{rms(i)} = \sqrt{\frac{1}{M}\sum_{s=0}^{M-1}\left(U_{(i)s}\right)^2}$	$U_{rms_{12}} = \frac{1}{2}\left(U_{rms_1} + U_{rms_2}\right)$		$U_{rms_{123}} = \frac{1}{3}\left(U_{rms_1} + U_{rms_2} + U_{rms_3}\right)$		
Voltage average value Rectification RMS value Conversion value	$U_{mn(i)} = \frac{\pi}{2\sqrt{2}}\frac{1}{M}\sum_{s=0}^{M-1}\left\|U_{(i)s}\right\|$	$U_{mn_{12}} = \frac{1}{2}\left(U_{mn_1} + U_{mn_2}\right)$		$U_{mn_{123}} = \frac{1}{3}\left(U_{mn_1} + U_{mn_2} + U_{mn_3}\right)$		
Voltage alternating-current components	$U_{ac(i)} = \sqrt{\left(U_{rms(i)}\right)^2 - \left(U_{dc(i)}\right)^2}$					
Simple voltage average value	$U_{dc(i)} = \frac{1}{M}\sum_{s=0}^{M-1} U_{(i)s}$					
Voltage fundamental wave components	Harmonic voltage $U_{1(i)}$ in harmonic equations					
Voltage peak	$U_{pk+(i)}$, the maximum of M measurements of U $U_{pk-(i)}$, the minimum of M measurements of U					
Voltage total harmonic distortion rate	$Uthd_{(i)}$ in harmonic equations					
Voltage ripple rate	$\frac{\left(U_{pk+(i)} - U_{pk-(i)}\right)}{\left(2 \times \left\|U_{dc(i)}\right\|\right)} \times 100$					
Voltage phase angle	$\theta U_{1(i)}$ in harmonic equations					
Voltage unbalance factor				$Uunb_{123} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ $\beta = \frac{U_{12}{}^4 + U_{23}{}^4 + U_{31}{}^4}{\left(U_{12}{}^2 + U_{23}{}^2 + U_{31}{}^2\right)^2}$ For U_{12}, U_{23}, and U_{31}, the fundamental wave voltage RMS value (voltage between lines) based on the result of the harmonic calculation is used. For 3P4W, the phase voltage is detected and then converted into the voltage between lines for calculation.		
(i): Measurement power channel, M: Number of samples between each synchronization timing, s: Sampling point number						

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Current RMS value	$I_{\mathrm{rms}(i)} = \sqrt{\frac{1}{M}\sum_{s=0}^{M-1}\left(I_{(i)s}\right)^2}$	$I_{\mathrm{rms}_{12}} = \frac{1}{2}(I_{\mathrm{rms}_1} + I_{\mathrm{rms}_2})$		$I_{\mathrm{rms}_{123}} = \frac{1}{3}(I_{\mathrm{rms}_1} + I_{\mathrm{rms}_2} + I_{\mathrm{rms}_3})$		
Current average value Rectification RMS value Conversion value	$I_{\mathrm{mn}(i)} = \frac{\pi}{2\sqrt{2}}\frac{1}{M}\sum_{s=0}^{M-1}\left\lvert I_{(i)s}\right\rvert$	$I_{\mathrm{mn}_{12}} = \frac{1}{2}(I_{\mathrm{mn}_1} + I_{\mathrm{mn}_2})$		$I_{\mathrm{mn}_{123}} = \frac{1}{3}(I_{\mathrm{mn}_1} + I_{\mathrm{mn}_2} + I_{\mathrm{mn}_3})$		
Current alternating-current components	$I_{\mathrm{ac}_{(i)}} = \sqrt{\left(I_{\mathrm{rms}_{(i)}}\right)^2 - \left(I_{\mathrm{dc}_{(i)}}\right)^2}$					
Simple current average value	$I_{\mathrm{dc}_{(i)}} = \frac{1}{M}\sum_{s=0}^{M-1} I_{(i)s}$					
Current fundamental wave components	Harmonic voltage $I_{1(i)}$ in harmonic equations					
Current peak	$I_{\mathrm{pk}+_{(i)}}$, the maximum of M measurements of $I_{(i)s}$ $I_{\mathrm{pk}-_{(i)}}$, the minimum of M measurements of $I_{(i)s}$					
Current total harmonic distortion rate	$Ithd_{(i)}$ in harmonic equations					
Current ripple rate	$\frac{\left(I_{\mathrm{pk}+_{(i)}} - I_{\mathrm{pk}-_{(i)}}\right)}{\left(2 \times \left\lvert I_{\mathrm{dc}_{(i)}}\right\rvert\right)} \times 100$					
Current phase angle	$\theta I_{1(i)}$ in harmonic equations					
Current unbalance factor				$Iunb_{123} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100$ $\beta = \frac{{I_{12}}^4 + {I_{23}}^4 + {I_{31}}^4}{\left({I_{12}}^2 + {I_{23}}^2 + {I_{31}}^2\right)^2}$ For I_{12}, I_{23}, and I_{31}, the fundamental wave current RMS value based on the result of the harmonic calculation is used.		
(i): Measurement power channel, M: Number of samples between each synchronization timing, s: Sampling point number						

<table>
<tr><th>Item \ Wiring setting</th><th>1P2W</th><th>1P3W</th><th>3P3W2M</th><th>3V3A</th><th>3P3W3M</th><th>3P4W</th></tr>
<tr><td rowspan="2">Active power</td><td>$P_{(i)} = \frac{1}{M}\sum_{s=0}^{M-1}(U_{(i)s} \times I_{(i)s})$</td><td colspan="2">$P_{12} = P_1 + P_2$</td><td>$P_{123} = P_1 + P_2$</td><td colspan="2">$P_{123} = P_1 + P_2 + P_3$</td></tr>
<tr><td colspan="6">• For 3P3W3M and 3P4W wiring, phase voltage is used for the voltage waveform $U_{(i)}$s.
For 3P3W3M wiring: The sampled voltage, which is the voltage between lines, is converted into the phase voltage.
$U_{1s} = \frac{u_{1s} - u_{3s}}{3},\ U_{2s} = \frac{u_{2s} - u_{1s}}{3},\ U_{3s} = \frac{u_{3s} - u_{2s}}{3}$
u_{1s}, u_{2s}, u_{3s}: Voltage sampling value between the lines of channels 1 to 3
U_{1s}, U_{2s}, U_{3s}: Phase voltage calculation value for channels 1 to 3
For 3P4W wiring: As the sampled voltage is the phase voltage, it can be used as it is.
• For 3V3A wiring, when Δ-Y conversion is set to ON, the 3P3W3M and 3P4W formulas are used.
• For 3V3A wiring, the voltage between lines is used for voltage $U(i)$ (the same calculation applies to 3P3W2M and 3V3A).
• The polarity sign of active power P indicates the current direction of power during consumption ($+P$) and regeneration (-P).</td></tr>
<tr><td rowspan="2">Apparent power</td><td>$S_{(i)} = U_{(i)} \times I_{(i)}$</td><td>$S_{12} = S_1 + S_2$</td><td>$S_{12} = \frac{\sqrt{3}}{2}(S_1 + S_2)$</td><td>$S_{123} = \frac{\sqrt{3}}{3}(S_1 + S_2 + S_3)$</td><td colspan="2">$S_{123} = S_1 + S_2 + S_3$</td></tr>
<tr><td colspan="6">• Select from the RMS and MEAN rectification methods for $U_{(i)}$ and $I_{(i)}$.
• For 3P3W3M and 3P4W wiring, phase voltage is used for voltage $U_{(i)}$.
• For 3V3A wiring, the voltage between lines is used for voltage $U_{(i)}$.
• Treated same as active power when Δ-Y conversion is enabled with 3V3A wiring.</td></tr>
<tr><td rowspan="5">Reactive power</td><td colspan="6">When formula TYPE1 or TYPE3 is selected</td></tr>
<tr><td>$Q_{(i)} = si_{(i)}\sqrt{{S_{(i)}}^2 - {P_{(i)}}^2}$</td><td colspan="2">$Q_{12} = Q_1 + Q_2$</td><td>$Q_{123} = Q_1 + Q_2$</td><td colspan="2">$Q_{123} = Q_1 + Q_2 + Q_3$</td></tr>
<tr><td colspan="6">When formula TYPE2 is selected</td></tr>
<tr><td>$Q_{(i)} = \sqrt{{S_{(i)}}^2 - {P_{(i)}}^2}$</td><td colspan="2">$Q_{12} = \sqrt{{S_{12}}^2 - {P_{12}}^2}$</td><td colspan="3">$Q_{123} = \sqrt{{S_{123}}^2 - {P_{123}}^2}$</td></tr>
<tr><td colspan="6">• Polarity sign si of reactive power Q for formula TYPE1 or TYPE3 indicates the polarity of lead/lag.
Sign “none” indicates lag (LAG), and sign “-” indicates lead (LEAD).
• Polarity sign $si_{(i)}$ is acquired from the lead/lag status of voltage waveform $U_{(i)}$s and current waveform $I_{(i)}$s for each measurement power channel (i).
• For 3P3W3M and 3P4W wiring, phase voltage is used for the voltage waveform $U_{(i)}$s.
For 3P3W3M wiring: The sampled voltage, which is the voltage between lines, is converted into the phase voltage.
$U_{1s} = \frac{u_{1s} - u_{3s}}{3},\ U_{2s} = \frac{u_{2s} - u_{1s}}{3},\ U_{3s} = \frac{u_{3s} - u_{2s}}{3}$
u_{1s}, u_{2s}, u_{3s}: Voltage sampling value between the lines of power channels 1 to 3
U_{1s}, U_{2s}, U_{3s}: Phase voltage calculation value for power channels 1 to 3
• For 3P4W wiring: As the sampled voltage is the phase voltage, it can be used as it is.
• When formula TYPE2 is selected, no polarity sign is assigned.
• Treated same as active power when Δ-Y conversion is enabled with 3V3A wiring.</td></tr>
</table>

<table>
<tr><th>Item \ Wiring setting</th><th>1P2W</th><th>1P3W</th><th>3P3W2M</th><th>3V3A</th><th>3P3W3M</th><th>3P4W</th></tr>
<tr><td rowspan="7">Power factor</td><td colspan="6">When formula TYPE1 is selected</td></tr>
<tr><td>$\lambda_{(i)} = si_{(i)} \left| \frac{P_{(i)}}{S_{(i)}} \right|$</td><td colspan="2">$\lambda_{12} = si_{12} \left| \frac{P_{12}}{S_{12}} \right|$</td><td colspan="3">$\lambda_{123} = si_{123} \left| \frac{P_{123}}{S_{123}} \right|$</td></tr>
<tr><td colspan="6">When formula TYPE2 is selected</td></tr>
<tr><td>$\lambda_{(i)} = \left| \frac{P_{(i)}}{S_{(i)}} \right|$</td><td colspan="2">$\lambda_{12} = \left| \frac{P_{12}}{S_{12}} \right|$</td><td colspan="3">$\lambda_{123} = \left| \frac{P_{123}}{S_{123}} \right|$</td></tr>
<tr><td colspan="6">When formula TYPE3 is selected</td></tr>
<tr><td>$\lambda_{(i)} = \frac{P_{(i)}}{S_{(i)}}$</td><td colspan="2">$\lambda_{12} = \frac{P_{12}}{S_{12}}$</td><td colspan="3">$\lambda_{123} = \frac{P_{123}}{S_{123}}$</td></tr>
<tr><td colspan="6">• Polarity sign si of power factor λ for formula TYPE1 indicates the polarity of lead/lag. Sign “none” indicates lag (LAG), and sign “-” indicates lead (LEAD).
• Polarity sign $si_{(i)}$ is acquired from the lead/lag status of voltage waveform $U_{(i)}$s and current waveform $I_{(i)}$s for each measurement channel (i).
si_{12} and si_{123} are acquired from the Q_{12} and Q_{123} signs, respectively.
• The polarity sign for formula TYPE3 uses the sign of active power P as it is.</td></tr>
<tr><td rowspan="7">Power phase angle</td><td colspan="6">When formula TYPE1is selected</td></tr>
<tr><td>$\phi_{(i)} =$
$si_{(i)} \cos^{-1}\left|\lambda_{(i)}\right|$</td><td colspan="2">$\phi_{12} = si_{12} \cos^{-1}\left|\lambda_{12}\right|$</td><td colspan="3">$\phi_{123} = si_{123} \cos^{-1}\left|\lambda_{123}\right|$</td></tr>
<tr><td colspan="6">When formula TYPE2 is selected</td></tr>
<tr><td>$\phi_{(i)} = \cos^{-1}\left|\lambda_{(i)}\right|$</td><td colspan="2">$\phi_{12} = \cos^{-1}\left|\lambda_{12}\right|$</td><td colspan="3">$\phi_{123} = \cos^{-1}\left|\lambda_{123}\right|$</td></tr>
<tr><td colspan="6">When formula TYPE3 is selected</td></tr>
<tr><td>$\phi_{(i)} = \cos^{-1}\lambda_{(i)}$</td><td colspan="2">$\phi_{12} = \cos^{-1}\lambda_{12}$</td><td colspan="3">$\phi_{123} = \cos^{-1}\lambda_{123}$</td></tr>
<tr><td colspan="6">• Polarity sign si for formula TYPE1 indicates the polarity of lead/lag. Sign “none” indicates lag (LAG), and sign “-” indicates lead (LEAD).
• Polarity sign $si_{(i)}$ is acquired from the lead/lag status of voltage waveform $U_{(i)}$s and current waveform $I_{(i)}$s for each measurement power channel (i).
si_{12} and si_{123} are acquired from signs Q_{12} and Q_{123}, respectively.
• $\cos^{-1}|\lambda|$ is used for $P \geq 0$, and $|180-\cos^{-1}|\lambda||$ is used for $P < 0$, in formulas TYPE1 and TYPE2.</td></tr>
<tr><td colspan="7">(i): Measurement power channel, M: Number of samples between each synchronization timing, s: Sampling point number
For Δ-Y conversion with 3V3A and 3P3W3M, the 3P4W formula is used.
For Y-Δ conversion with 3P4W, also, the 3P4W formula is used as it is.</td></tr>
</table>

<table>
<tr><th>Item \ Wiring setting</th><th>1P2W</th><th>1P3W</th><th>3P3W2M</th><th>3V3A</th><th>3P3W3M</th><th>3P4W</th></tr>
<tr><td>Fundamental wave active power</td><td>$P_{\text{fnd}(i)}$ for harmonic active power</td><td colspan="3">Harmonic power of $P_{\text{fnd}(12)}$</td><td colspan="2">Harmonic active power of $P_{\text{fnd}(123)}$</td></tr>
<tr><td>Fundamental wave apparent power</td><td>$S_{\text{fnd}(i)} =$
$\sqrt{\left(P_{\text{fnd}_{(i)}}\right)^2 + \left(Q_{\text{fnd}_{(i)}}\right)^2}$</td><td colspan="3">$S_{\text{fnd}_{12}} = \sqrt{\left(P_{\text{fnd}_{12}}\right)^2 + \left(Q_{\text{fnd}_{12}}\right)^2}$</td><td colspan="2">$S_{\text{fnd}_{123}} = \sqrt{\left(P_{\text{fnd}_{123}}\right)^2 + \left(Q_{\text{fnd}_{123}}\right)^2}$</td></tr>
<tr><td>Fundamental wave reactive power</td><td>$Q_{\text{fnd}_{(i)}} \times (-1)$ *1
for harmonic reactive power</td><td colspan="3">Harmonic reacrive power $Q_{\text{fnd}_{12}} \times (-1)$ *1</td><td colspan="2">Harmonic reacrive power $Q_{\text{fnd}_{123}} \times (-1)$ *1</td></tr>
</table>

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Fundamental wave power factor	$\lambda_{\mathrm{fnd(i)}} = si_{(i)} \left\|\cos\theta_{1(i)}\right\|$	$\lambda_{\mathrm{fnd}_{12}} = si_{12} \left\|\cos\theta_{\mathrm{fnd}_{12}}\right\|$			$\lambda_{\mathrm{fnd}_{123}} = si_{123} \left\|\cos\theta_{\mathrm{fnd}_{123}}\right\|$	

Polarity sign si is acquired from the sign of fundamental wave reactive power for formula TYPE1, and from the sign of the fundamental wave active power for formula TYPE3, respectively. No polarity sign is assigned for formula TYPE2.
*1. An absolute value is assigned for formula TYPE2.

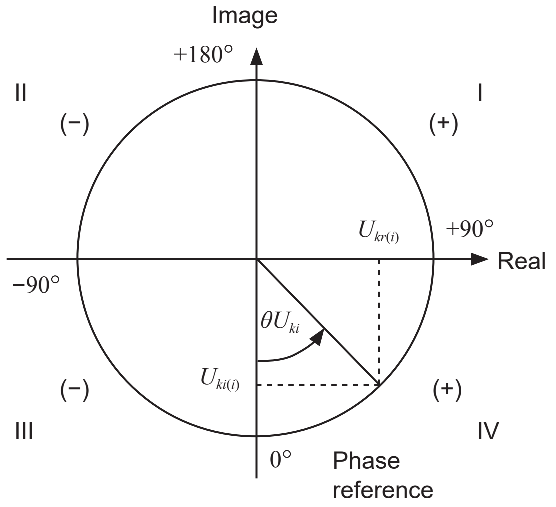
Formulas of harmonic measurement items

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Harmonic voltage	$U_{k(i)} = \sqrt{\left(U_{\mathrm{kr}(i)}\right)^2 + \left(U_{\mathrm{ki}(i)}\right)^2}$					
Harmonic voltage phase angle	$\theta U_{k(i)} = tan^{-1}\left(\dfrac{U_{kr(i)}}{-U_{ki(i)}}\right)$					
Harmonic current	$I_{k(i)} = \sqrt{\left(I_{\mathrm{kr}(i)}\right)^2 + \left(I_{\mathrm{ki}(i)}\right)^2}$					
Harmonic current phase angle	$\theta I_{k(i)} = tan^{-1}\left(\dfrac{I_{kr(i)}}{-I_{ki(i)}}\right)$					
Harmonic active power	$P_{k(i)} = U_{\mathrm{kr}(i)} \times I_{\mathrm{kr}(i)} + U_{\mathrm{ki}(i)} \times I_{\mathrm{ki}(i)}$				$P_{k_1} = \frac{1}{3}(U_{\mathrm{kr}_1} - U_{\mathrm{kr}_3}) \times I_{\mathrm{kr}_1} + \frac{1}{3}(U_{\mathrm{ki}_1} - U_{\mathrm{ki}_3}) \times I_{\mathrm{ki}_1}$ $P_{k_2} = \frac{1}{3}(U_{\mathrm{kr}_2} - U_{\mathrm{kr}_1}) \times I_{\mathrm{kr}_2} + \frac{1}{3}(U_{\mathrm{ki}_2} - U_{\mathrm{ki}_1}) \times I_{\mathrm{ki}_2}$ $P_{k_3} = \frac{1}{3}(U_{\mathrm{kr}_3} - U_{\mathrm{kr}_2}) \times I_{\mathrm{kr}_3} + \frac{1}{3}(U_{\mathrm{ki}_3} - U_{\mathrm{ki}_2}) \times I_{\mathrm{ki}_3}$	Same as 1P2W
	–	$P_{k_{12}} = P_{k_1} + P_{k_2}$			$P_{k_{123}} = P_{k_1} + P_{k_2} + P_{k_3}$	
Harmonic reactive power (Only used for internal calculation)	$Q_{k(i)} = U_{\mathrm{kr}(i)} \times I_{\mathrm{ki}(i)} - U_{\mathrm{ki}(i)} \times I_{\mathrm{kr}(i)}$				$Q_{k_1} = \frac{1}{3}(U_{\mathrm{kr}_1} - U_{\mathrm{kr}_3}) \times I_{\mathrm{ki}_1} + \frac{1}{3}(U_{\mathrm{ki}_1} - U_{\mathrm{ki}_3}) \times I_{\mathrm{kr}_1}$ $Q_{k_2} = \frac{1}{3}(U_{\mathrm{kr}_2} - U_{\mathrm{kr}_1}) \times I_{\mathrm{ki}_2} + \frac{1}{3}(U_{\mathrm{ki}_2} - U_{\mathrm{ki}_1}) \times I_{\mathrm{kr}_2}$ $Q_{k_3} = \frac{1}{3}(U_{\mathrm{kr}_3} - U_{\mathrm{kr}_2}) \times I_{\mathrm{ki}_3} + \frac{1}{3}(U_{\mathrm{ki}_3} - U_{\mathrm{ki}_2}) \times I_{\mathrm{kr}_3}$	Same as 1P2W
	–	$Q_{k_{12}} = Q_{k_1} + Q_{k_2}$			$Q_{k_{123}} = Q_{k_1} + Q_{k_2} + Q_{k_3}$	
Harmonic voltage and current phase difference	$\theta_{\mathrm{k(i)}} = \theta I_{k(i)} - \theta U_{k(i)}$					
	–	$\theta_{k_{12}} = \tan^{-1}\left(\dfrac{Q_{k_{12}}}{P_{k_{12}}}\right)$			$\theta_{k_{123}} = \tan^{-1}\left(\dfrac{Q_{k_{123}}}{P_{k_{123}}}\right)$	

- (i): Measurement power channel, k: Analysis order, r: Real part after FFT, i: imaginary part after FFT
- For the harmonic voltage phase angle and harmonic current phase angle, the fundamental wave of the harmonic synchronization source, which is the phase reference, is corrected to 0°. If the synchronization source is DC, the data refresh timing will be 0°.
- For the harmonic voltage and current phase difference, the phase difference between each phase for 3P3W3M and 3P4W is calculated with reference to the phase voltage, regardless of the delta conversion ON/OFF setting.

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
Harmonic voltage content	$Uhd_{k(i)} = \frac{U_k}{U_1} \times 100$					
Harmonic current content	$Ihd_{k(i)} = \frac{I_k}{I_1} \times 100$					
Harmonic power content	$Phd_{k(i)} = \frac{P_k}{P_1} \times 100$					
Total harmonic voltage distortion rate	$Uthd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K}(U_k)^2}}{U_1} \times 100$ (with THD-F setting) or $Uthd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K}(U_k)^2}}{\sqrt{\sum_{k=1}^{K}(U_k)^2}} \times 100$ (with THD-R setting)					
Total harmonic current distortion rate	$Ithd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K}(I_k)^2}}{I_1} \times 100$ (with THD-F setting) or $Ithd_{(i)} = \frac{\sqrt{\sum_{k=2}^{K}(I_k)^2}}{\sqrt{\sum_{k=1}^{K}(I_k)^2}} \times 100$ (with THD-R setting)					

(i): Measurement power channel, k: Harmonic order, K: Maximum analysis order



Example: For harmonic voltage

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

Formulas of integration measurements

Item \ Wiring setting	1P2W	1P3W	3P3W2M	3V3A	3P3W3M	3P4W
WP+	$WP_{i+} = k\sum_{1}^{h}(P_{i(+)})$	$WP_{\mathrm{sum}+} = k\sum_{1}^{h}(P_{\mathrm{sum}(+)})$				
WP−	$WP_{i-} = k\sum_{1}^{h}(P_{i(-)})$	$WP_{\mathrm{sum}-} = k\sum_{1}^{h}(P_{\mathrm{sum}(-)})$				
WP	$WP_{i} = (WP_{i+}) + (WP_{i-})$	$WP_{\mathrm{sum}} = (WP_{\mathrm{sum}+}) + (WP_{\mathrm{sum}-})$				
Ih+	$Ih_{i+} = k\sum_{1}^{h}(I_{i(+)})$	–				
Ih−	$Ih_{i-} = k\sum_{1}^{h}(I_{i(-)})$	–				
Ih	$Ih_{i} = (Ih_{i+}) + (Ih_{i-})$					

• h: Measurement period, k: Coefficient for conversion to 1 hour, i: Measurement power channel
• (+): Only positive values (for consumption) are used.
• (−): Only negative values (for regeneration) are used.

M1100 AC Power Module

General specifications

Operating environment	Indoor use, pollution degree 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)
Standards	Safety: EN 61010 EMC: EN 61326 Class A
Power supply	Commercial power supply Rated supply voltage: 100 V to 240 V AC (assuming voltage fluctuations of ±10%) Rated power-supply frequency: 50 Hz/60 Hz Anticipated transient overvoltage: 2500 V Maximum rated power: 400 VA (M1100 at the maximum rated current output) 300 VA (when four M7103 units and six M7100 units are connected) Normal power consumption: 55 W (When two M7103 units are connected, and 20 A AC is measured by connecting CT6872 to all current channels while 1000 V AC is input to all voltage channels)
Dimensions	Approx. 80W × 166H × 238D mm (3.2W × 6.5H × 9.4D in.)
Weight	Approx. 2.0 kg (4.4 lb.)
Product warranty duration	3 years
Included accessories	Instruction Manual, power cord
Supported models	LR8101, LR8102

14 Knowledge and Information

14.1 Measuring Temperature

Thermocouples are widely used for temperature measurement. This section describes precautions for using the thermocouples.

Select a thermocouple appropriate to the measurement target

The following thermocouples can be used with the instrument.

Thermocouples	Temperature range within which the limit deviation tolerance is specified in JIS C1602, IEC 60584-1 (°C)	Features
K	−40 to 1200	Linear relationship between temperature and thermo-electromotive force. Most widely used in industry.
J	−40 to 750	Electromotive force per 1°C is the second highest next to thermocouple E.
E	−40 to 900	Thermo-electromotive force per 1°C is the highest. As a result, the effect of noise can be reduced.
T	−40 to 350	Thermocouple with high electromotive force in a low temperature region between −40°C and 350°C. Used for high precis in low temperature regions.
N	−40 to 1200	The thermo-electromotive force is stable from low to high temperatures. Used to measure high temperature regions inexpensively.
R	0 to 1600	Used for measurement in high temperature regions. Although the oxidation resistance and chemical resistance are excellent, this thermocouple is expensive.
S		
B	600 to 1700	Used for measurement in higher temperature regions than R and S. Since the electromotive force is very low, this thermocouple cannot be used for measurement in low and intermediate temperature regions.
C	426 to 2315	This thermocouple can measure the highest temperature.

A physical phenomenon called short range ordering occurs in thermocouples K and E. Due to this phenomenon, the thermo-electromotive force is gradually increased from 250°C to 600°C, possibly causing a significant error in a relatively short time (within 1 hour). Since this phenomenon is originated with physical properties, it is unavoidable. Once the thermo-electromotive force of thermocouple is increased, the normal value cannot be recovered even if the temperature is decreased. To recover the original thermo-electromotive force curve, it is necessary to increase the temperature to 650°C or higher.
Select the thermocouples while referring to the manufacturer of the thermocouples to be used.

Error due to heat dissipation on a thermocouple

By attaching a thermocouple, heat is dissipated (transferred) from the measurement target via the thermocouple. If the amount of heat dissipation to the thermocouple is large, the measurement result can deviate from the actual temperature.
When thermocouples K and T are compared, the heat dissipation on thermocouple T is larger because the heat conduction is higher.
In addition, the larger the thermocouple diameter, the larger the heat dissipation on the thermocouple.
For temperature measurement of smaller parts, thermocouple K with a small diameter is recommended.

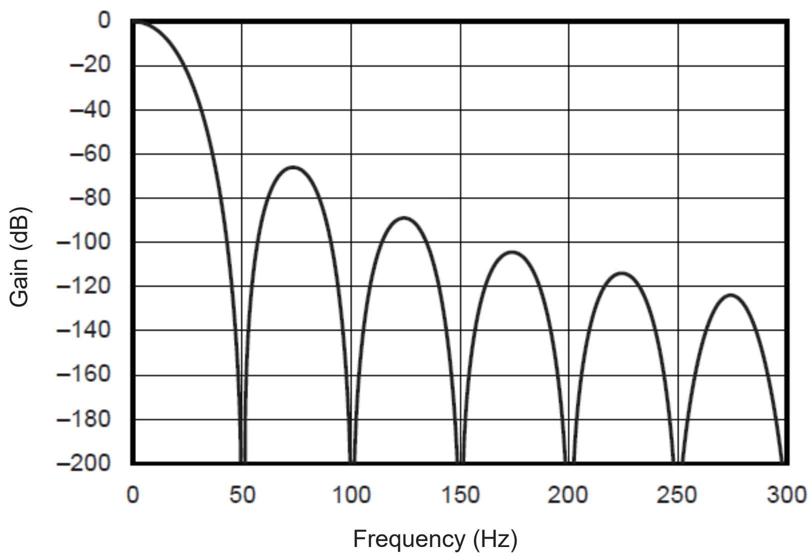
Closely attach a thermocouple to the measurement target

To measure the temperature with high precision, closely attach the thermocouple tip to the measurement target.
If the contact between the thermocouple and the measurement target is small, the heat transfer to the thermocouple is reduced and the measurement result can deviate from the actual temperature.
For a large measurement target, the heat dissipation from the thermocouple can be reduced by placing the part of the thermocouple adjacent to the tip in contact with the measurement target.

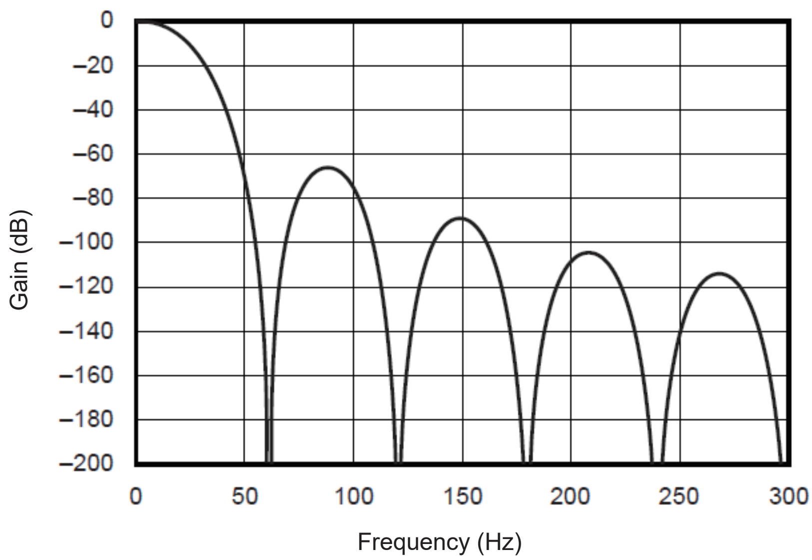
14.2 Digital Filter Characteristics

M7100 and M7102 Voltage/Temp Module are equipped with a digital filter. The cutoff frequency is automatically set according to the type of measurement module, number of channels being used, data refresh interval, power-supply frequency filter, and wire break detection setting.
If it is necessary to remove the power-supply line frequency, a high noise removing performance can be achieved by configuring the settings so that the cutoff frequency matches the power-supply line frequency. For the cutoff frequency, see the section for the digital filter of the modules in “13.2 Specifications of Modules” (p. 366).
The figures below show a typical example of the digital filter characteristics when the data refresh interval is 10 s in the M7100 and M7102.

Cutoff frequency: 50 Hz



Cutoff frequency: 60 Hz



14.3 Noise Countermeasures

This section describes countermeasures in a noise environment.

Mechanism of noise mixing

Noise source

In factories, a large current at 50 Hz/60 Hz is passed as the power source. The main loads include many inductive loads, such as motors and solenoids. For inverters and high frequency induction furnace, etc., a large amount of pulse current is passed in capacitor input type switching power supplies. Leakage current of the fundamental wave component, harmonic current, etc. are passed from the respective earths into the earth line including the ground.

Noise transmission path

- Leakage route to the input signal when the common mode voltage is activated between the grounds of the measurement target and the measuring Instrument
- Route in which the AC magnetic field is coupled with the loop section of the input signal line by the power supply line current
- Route in which capacitance between the input signal line and the power supply line is coupled

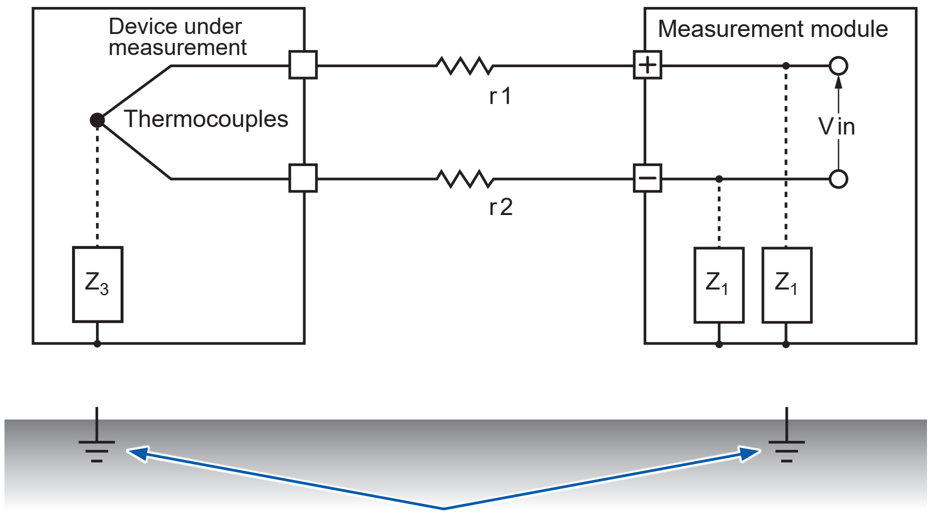
Common mode noise

Noise occurring between the input +/− terminals on the measuring Instrument and the ground

Normal mode noise

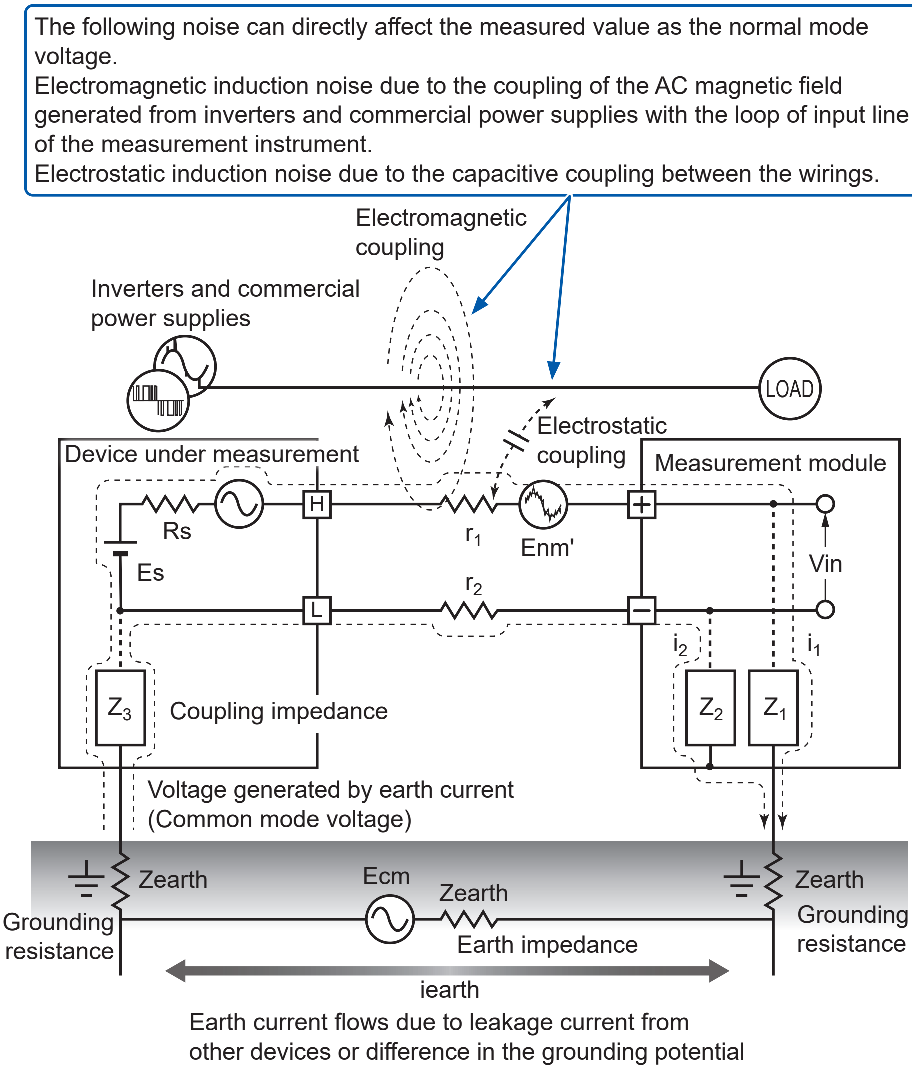
Noise between lines occurring between the input +/− terminals on the measuring Instrument

Example of connection susceptible to noise



Temperature measurement using a thermocouple is affected by noise unless both the instrument to be measured and the measurement module are connected to the ground. Be sure to ground the AC adapter when using it.

Equivalent circuit of noise transmission path



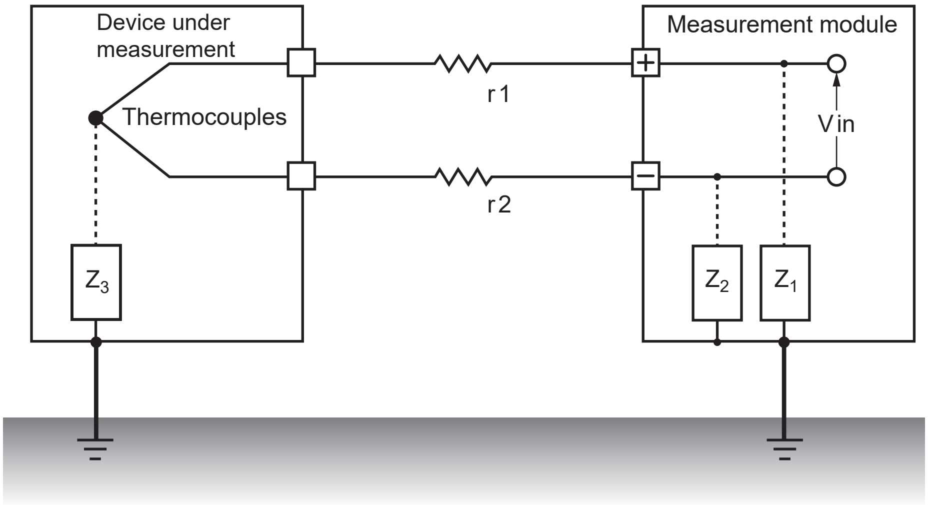
Common mode noise occurs when the earth impedance intervenes between the grounding point of the device under measurement and the grounding point of the measurement module, or if the earth line is coupled capacitively with a noise source.
The common mode noise is converted to normal mode voltage (Enm) applied across each +/− input terminals of the measuring instrument, when the noise currents (i_1, i_2) are passed through the coupling impedances (Z_1, Z_2) between the +/− input terminals of the measurement module and the ground. Since this voltage occurs between the input terminals, the measured value is directly affected.

Examples of noise countermeasures

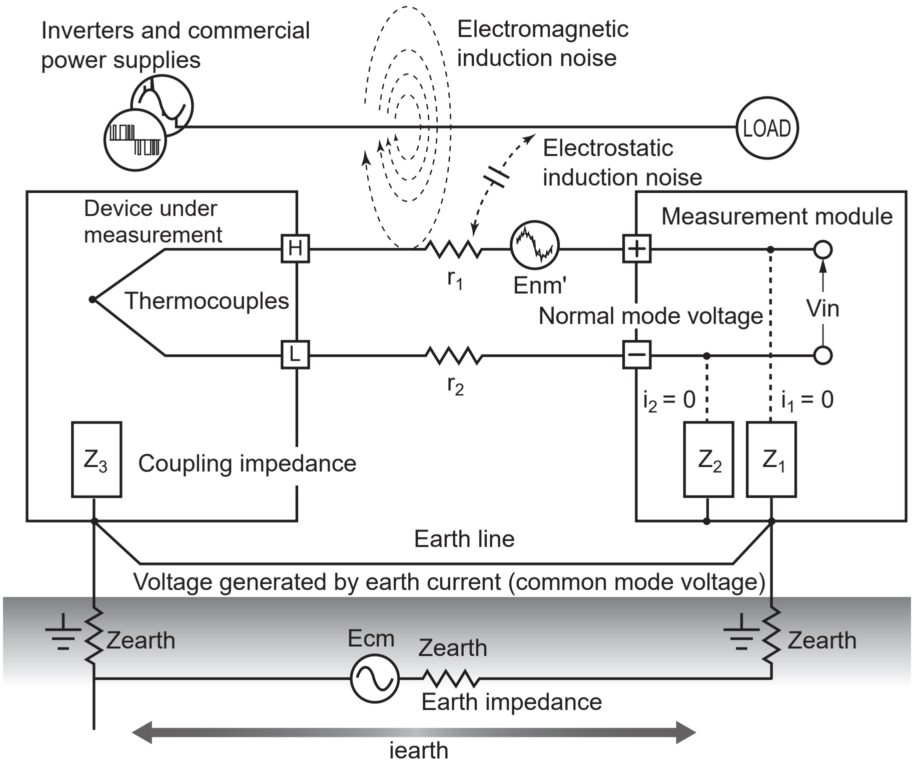
Ground securely

- Ground the instrument securely
  The chassis GND can be grounded by connecting the 2-pole grounding power cord of the AC adapter to an outlet with the grounding electrode.

- Ground the chassis GND of the measurement target securely
  Ground the chassis GND of the measurement target to a good earth securely



Countermeasures against common mode noise



Ground the chassis GND on the signal side to a good earth with a sufficiently low grounding resistance.

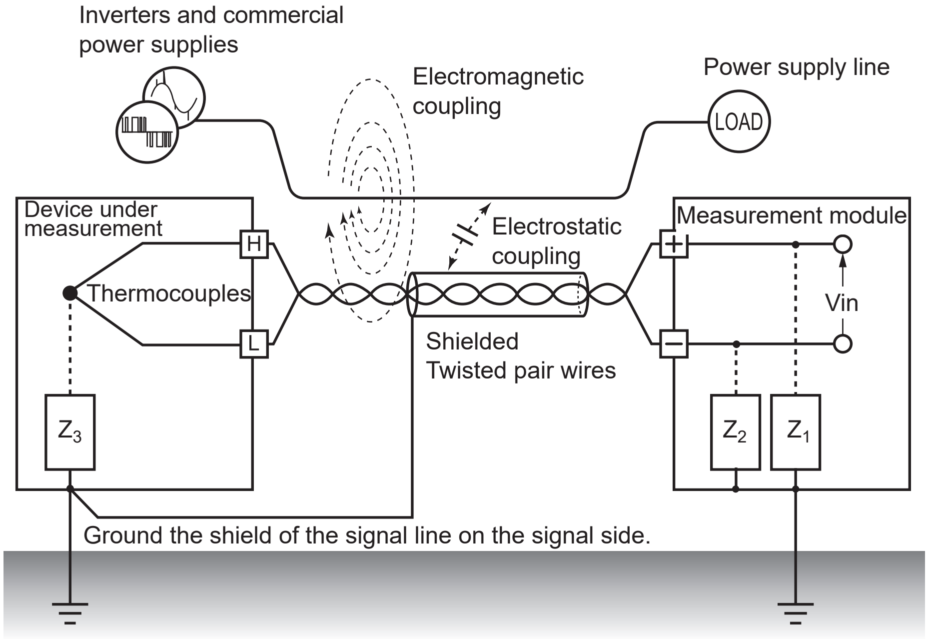
Connect to an earth line with a low resistance or bypass between the grounding electrodes. This can reduce the common mode voltage, decreasing the noise currents (i_1, i_2). As a result, the generation of normal mode voltage can be suppressed, reducing the effect on the measured value.

Block external noise

- Keep signal lines away from noise sources
  Keep the input signal lines (thermocouples) away from the wiring that can be noise sources (power lines, etc.).
  Alternatively, separate the signal lines and the wiring as far as possible, for example, by installing them in separate ducts.

- Use shielded and twisted pair wires.
  Shielded and twisted pair wires are effective for the input signal lines (thermocouples).
  The twisted pair wires are effective for preventing electromagnetic induction, while the shielded wires are effective for preventing electrostatic induction.
  Ground the shielded wire on the signal source side.
  For thermocouples with shielded and twisted pair wires, contact the manufacturers of thermocouples.

Countermeasures against normal mode noise



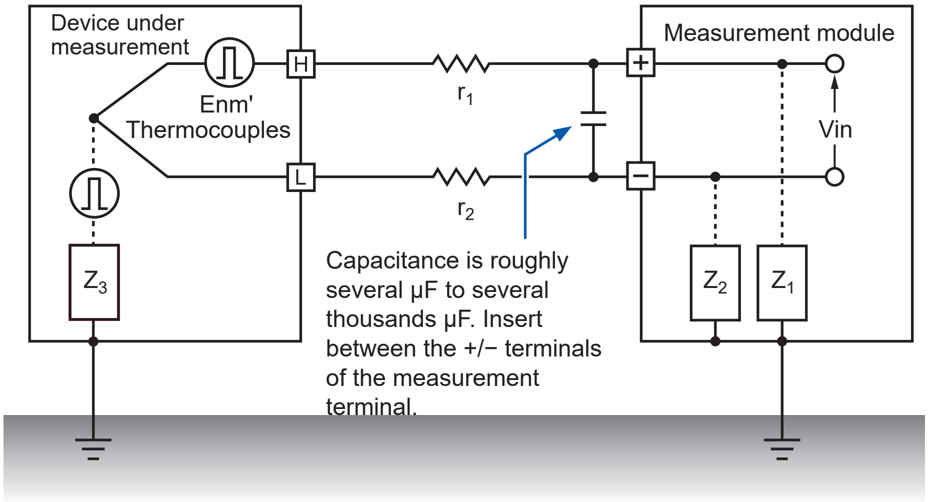
Keep away and separate the signal lines (thermocouples) from the wiring that can be noise sources (power lines, etc.). Furthermore, electrostatic coupling can be blocked by shielding and grounding the signal lines.

- Isolation from noise sources (temperature measurement using a thermocouple)
  Isolation is achieved between the input channels and housing as well as between the input channels. Measurement can be performed using a thermocouple directly attached to a conductor with a potential up to maximum rated line-to-ground voltage.
  If the measurement is affected by noise, it is effective to isolate the thermocouple by wrapping it with high temperature resistant tape, or use a non-grounding thermocouple and isolate the input lines.

- Use a filter
  Noise mixed with the input signals can be removed with a power-supply frequency filter.
  It is recommended to set the value to the same frequency as the power-supply frequency of the region where the instrument is used (50 Hz or 60 Hz).
  See “10.1 Setting the Environment” (p. 287).

Insert a capacitor into the signal line

For noise from overlapped signal sources and high frequency pulses, it is effective to insert a capacitor between the input +/− terminals. This capacitor can prevent the noise from entering inside the instrument.
Use a capacitor with a rated voltage higher than the voltage to be input.
Since the filter is applied before the channel scan, there is no limitation of the data refresh interval.



14.4 Timing of Scan

The following modules perform scans by switching the input channels with relays to acquire data.
- M7100 Voltage/Temp Module
- M7102 Voltage/Temp Module

All input channels are scanned within the specified time of the data refresh interval.
The measurement ON channels are scanned sequentially starting from CH1 as CH1→CH2→CH3 and so on. The sampling is performed again starting from CH1 at the next data refresh interval.
The scan time width necessary for 1 channel depends on the type of measurement module, number of channels being used, data refresh interval, power-supply frequency filter, and wire break detection setting.

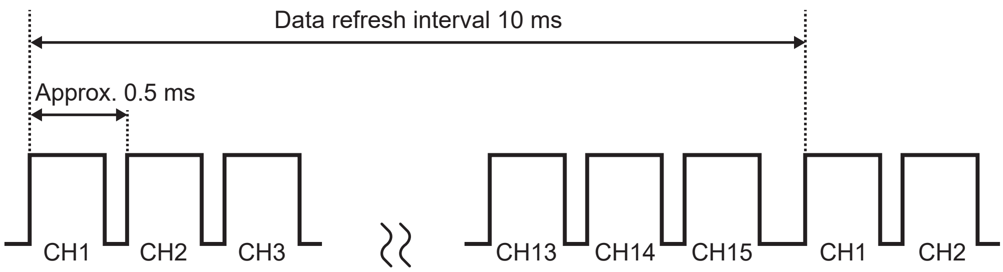
The M7103 Power Measurement Module performs power calculations continuously, without regard to the instrument's measurement state.
During measurement, the most recent power calculated value is recorded as the measured value when acquisition of instrument data is requested.

For M7100

The figures below show typical examples of scan timing in M7100.

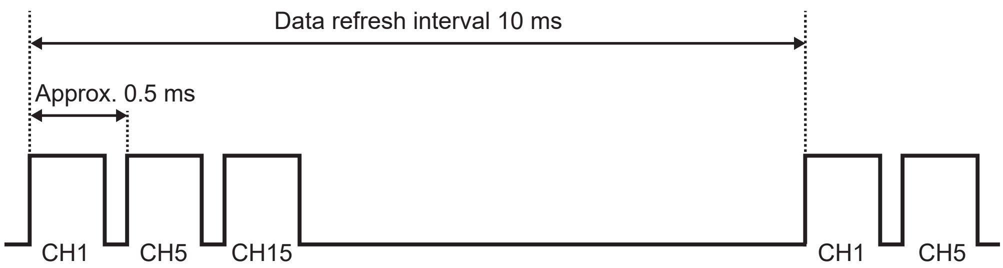
Example: Data refresh interval 10 ms, measurement ON in all 15 channels, wire break detection OFF

CH1 to CH 15 are scanned with the time width of approx. 0.5 ms per channel.
The scan is performed again starting from CH1 after 10 ms (data refresh interval) has elapsed.



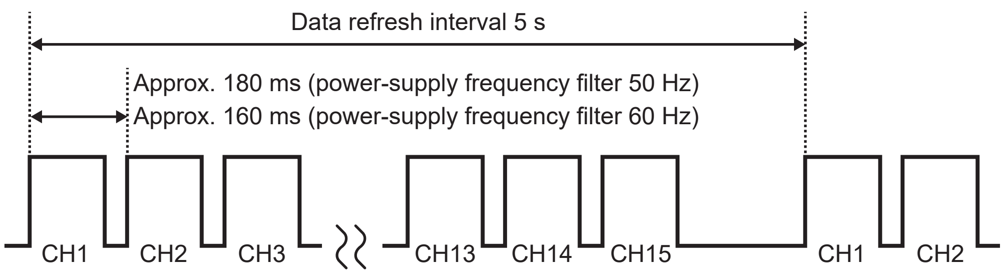
Example: Data refresh interval 10 ms, measurement ON in CH1, CH5, and CH15, wire break detection OFF

Only the measurement ON channels are scanned without scanning the measurement OFF channels.



Example: Data refresh interval 5 s, measurement ON in all 15 channels, wire break detection OFF

Depending on the setting of the power-supply frequency filter, CH1 to CH15 are scanned with the time width of approx. 160 ms or approx. 180 ms.



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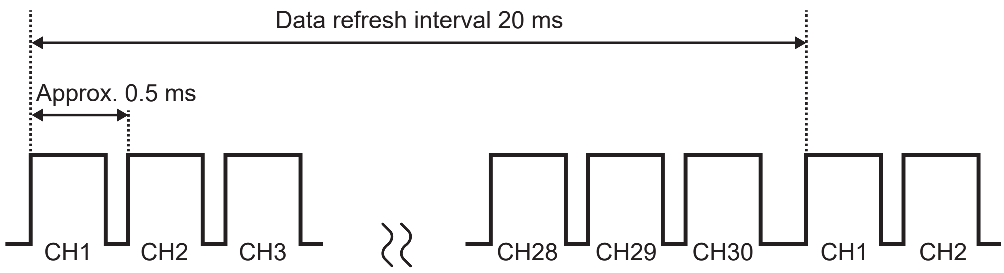
For M7102

The figures below show typical examples of scan timing in M7200 when the number of channels being used is 16 to 30. When the number of channels being used is 15 or less, the scan timing is the same as M7100.

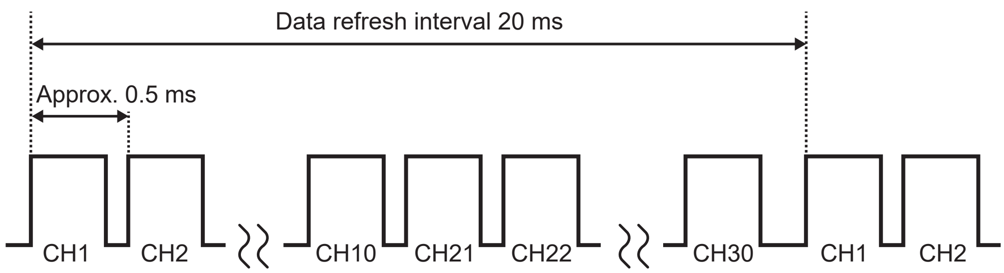
Example: Data refresh interval 20 ms, measurement ON in all 30 channels, wire break detection OFF

CH1 to CH 30 are scanned with the time width of approx. 0.5 ms per channel.



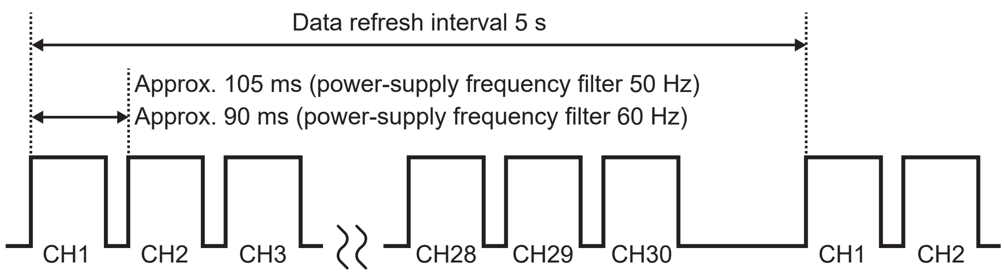
Example: Data refresh interval 20 ms, measurement ON in CH1 to CH10 and CH21 to CH30, wire break detection OFF

Only the measurement ON channels are scanned without scanning the measurement OFF channels.



Example: Data refresh interval 5 s, measurement ON in all 30 channels, wire break detection OFF

Depending on the setting of the power-supply frequency filter, CH1 to CH30 are scanned with the time width of approx. 90 ms or approx. 105 ms.



14.5 File Name

The file name is organized as follows.

WAVE0001.MEM
1 2 3

No.	Item
1	**File type**
2	**Automatic number**
3	**Extension**

Data name	Folder	File type	Automatic number	Extension
Setting condition	CONFIG	CONF	0001 or more	.SET
Waveform data	DATA *1	WAVE *2 AUTO *3	0001 or more	.MEM .CSV *4 .MF4
Numerical calculation results Not divided	MEASUREMENT /ALL	MEAS *2 AUTO *3	0001 or more*5	.CSV *4
Numerical calculation results Divided	MEASUREMENT /PART	MEAS *2 AUTO *3	0001 or more*5	.CSV *4
A2L	A2L	XCPT XCPU	0001 or more	.A2L

*1. The date folders are automatically created. The deleting operation deletes the older waveform file first. If all waveform files in the date folder are deleted, the folder name is automatically updated.
Example: Before update 23-03-26 → After update 23_03_26_230330_101113 (Date_Update date_time)
Hyphens (-) are replaced with underscores (_), and the date and time when the folder name is changed are placed at the end.
(Changed at 2023-3-30 10:11:13)

*2. When the file is saved manually.

*3. When the file is saved automatically. When a file name is specified, the specified name is used.

*4. If the delimiter is set to other than **[COMMA]**, the extension is **[.TXT]**.

*5. If the file splitting for numerical calculation result is ON, an underscore (_) and the calculation number is attached to the numbers starting from 0001.

14.6 File Configuration for Text Format

A file in the text format is composed of the header part and the data part.
The header part contains the following information.

(1) File: Name and version number
(2) Title comment
(3) Trigger time
(4) Channel number for each column*1
(5) Contents of measurement*2
(6) Range
(7) Module identification name
(8) Comment
(9) Scaling setting
(10) Conversion ratio for scaling
(11) Offset for scaling
(12) Channel number*1 and unit for each row
(13) Data*3

```
"File name","AUTO0001.CSV","V 1.00" ............................................ (1)
"Title comment" ................................................................. (2)
"Trigger Time","23-03-26 10:15:32" .............................................. (3)
"CH","CH1-1","ALM1","ALM2","W1","Event", ........................................ (4)
"Mode","Voltage","Alarm","Alarm","Calculation", ................................. (5)
"Range","1V","","","", .......................................................... (6)
"ModuleID","","","","", ......................................................... (7)
"Comment","","","","", .......................................................... (8)
"Scaling","OFF", ................................................................ (9)
"Ratio","+1.00000E+00", ......................................................... (10)
"Offset","+0.00000E+00", ........................................................ (11)
"Time","CH1-1[V]","ALM1","ALM2","W1[]",
"Event",......................................................................... (12)
+0.000000000E+00,-3.325000000E-02,0,0,-6.650000000E-02,0, ....................... (13)
+1.000000000E-01,+2.850000000E-02,1,0,+5.700000000E-02,0,
+2.000000000E-01,+9.600000000E-03,0,0,+1.920000000E-02,0,
+3.000000000E-01,-2.560000000E-02,0,0,-5.120000000E-02,0,
+4.000000000E-01,+4.560000000E-02,1,1,+9.120000000E-02,0,
```

*1. The channel numbers are output based on the data types as follows.
Analog direct connection (CHxa-xx), pulse (Py), logic (Ly), alarm (ALMz), waveform calculation (Wxx), power calculation (Mzooo) (xa: 1 to 10, xx: 1 to 30, y: 1, z: 1 to 4 , ooo: Parameter strings for corresponding power calculation)
If the statistical value is selected for saving data, the columns for average (ave), maximum (max), and minimum (min) are added to each item.

*2.The following are output according to the measurement target.
Voltage (Voltage), thermocouple (Tc), aggregation (Count), rotation speed (Revolve), logic (Logic), alarm (Alarm), waveform calculation (Calculation), power calculation (Power)

*3.The following are output according to the types of measurement data.

Data type	Output type
Analog, Pulse, waveform calculation, power calculation	Exponential notation (10 significant figures)
Logic	0: Low, 1: High
Alarm	0: Not issued, 1: Issued
Event mark	0: No mark, 1: Place marks

14.7 File Size

The calculation formula for the size of the binary waveform file (MEM) is described below.
Unit: byte

File size

Header size + data size

Header size

Shared header size + text header size + binary header size

Shared header size

1000 + Number of channels on the measurement module × 680 + Number of pulse channels × 650 + Number of logic channels × 240 + Number of waveform calculation channels × 450 + Number of alarm channels × 256

(This value is given only as a guide, because it can vary depending on the settings)

Text header size

512 × (10 + Number of channels on the measurement module × 4 + Number of pulse channels × 4 + Number of logic channels × 3 + Number of waveform calculation channels × 6 + Number of alarm headers*1)

*1. When the alarm is ON, then 8.
When the alarm is OFF, then 0.

Binary header size

512 × 17

Data size

(Number of channels on the measurement module × 4 + Number of pulse channels × 4 + Number of waveform calculation channels × 8 + logic data size*2 + alarm data size*3) × Number of data points

*2. If any one of the logic is ON, then 2. If no logic is ON, then 0.
*3. When the alarm is ON, then 2.
When the alarm is OFF, then 0.

14.8 Settings After Initialization (System Reset)

At the time of shipping and after the instrument is initialized (system reset), the following settings are applied (for M7100).
See "Initialization" (p. 296).

Category		Settings		
Main	**Sub**	**Parameter**	**Default setting**	
Measurement	Recording	Measurement start	Manual	
		Measurement stop	Manual	
		REC mode	Normal	
		Recording interval	10 ms	
		Repetitive recording	OFF	
		Recording time	Continuous recording	
		Synchronous operation	OFF	
	Auto save	File name to be saved	–	
			Add title comment	OFF
			Add trigger date/time	OFF
		Media (preferred saving destination)	SD memory card	
		Waveform data	Format	OFF
			Downsampling	OFF
			Deleting	OFF
			Folder splitting	Division disabled
			File splitting	Division disabled
		Numerical calculation results	Format	OFF
			File splitting	Single file (all calculations in one file)
		Text format	Decimal symbol*1	Period
			Delimiter*1	Comma
			Date format	yy-MM-dd hh:mm:ss.0
	Manual save	File name to be saved	–	
			Add trigger date/time	OFF
		Downsampling	OFF	
	Display	Display horizontal axis	Time	
	Settings	Auto setup*1	OFF	
Channel	Voltage and temperature individual settings	Channel	Measurement	ON
		Input	Input type	Voltage
			Range	10 mV
		Scaling	OFF	
		Comment	–	
		Numerical threshold	0	

*1. Excluded from initialization (factory setting).

Category		Settings		
Main	**Sub**	**Parameter**	**Default setting**	
Power	Common settings	Data refresh interval	50ms	
		Average	1 (OFF)	
		THD calculation method	THD-F	
		Power formula	TYPE1	
		Harmonic measurement mode	Wide area measurement mode	
		Harmonic grouping	TYPE1	
		Zero suppression	OFF	
		THD calculation order	50	
	Module setting	Wiring	TYPE1 (1P2W×3)	
		Delta conversion	OFF	
		Synchronization source sharing function	Module setting	OFF
			Synchronization source channel	CH1
		Harmonic result power channel settings	Voltage	CH1
			Current	CH1
			Power	CH1
		Harmonic result item settings	Voltage	Voltage RMS value:
			Current	Current RMS value
			Power	Active power
	Power channel settings CH1 to CH3	Synchronization source	U1	
		Voltage rectification method	RMS	
		Current rectification method	RMS	
		Count mode	RMS	
		Zero cross filter	500 Hz	
		Measurement lower limit frequency	10 Hz	
		LPF	OFF	
		Current sensor output rate	1 mV/A	
		Voltage auto range	OFF	
		Voltage range	300 V	
		Current auto range	OFF	
		Current range	50 A	
		VT ratio	1.00	
		CT ratio	1.00	

Category		Settings		
Main	**Sub**	**Parameter**	**Default setting**	
Trigger	Common	Trigger	OFF	
		Trigger timing	Start	
		Pre-trigger	Time	0 days and 00:00:00
		Trigger condition	Start	OR
		External trigger	OFF	
		Interval trigger	OFF	
		Trigger type	Start	OFF
			Stop	OFF
Alarm	Common	Alarm	OFF	
		Alarm hold	OFF	
		Alarm buzzer	OFF	
		Event mark	OFF	
		Alarm history	First 100	
	Alarm 1-4	ALM1 to ALM4	Filter	OFF
			Comment	–
Calculation	Numerical calculation	Numerical calculation	OFF	
	Waveform calculation	Waveform calculation	OFF	
System	Environment	Start backup	OFF	
		Language*1	English	
		Beep sound	ON	
		Power-supply frequency filter	60 Hz	
	External terminal	Alarm output 1 to 4	Low	
		External input 1 to 3	OFF	
		External output	OFF	

*1. Excluded from initialization (factory setting).

14.9 Maxi Recording Time

This section describes how to calculate the maximum time that can be recorded on the internal buffer memory or media on the instrument.
When data are saved in the binary format, the maximum recording time can be calculated with the following equation.

Maximum recording time = Storage capacity*1 × Recording interval (sec)/ Data size*2

*1. For the internal buffer memory of the instrument (512 MB), 512 × 1024 × 1024
*2. Data size in “14.7 File Size” (p. 418)

Maximum recording time (rough estimation)

Example: Measurement of 30 analog channels across 2 modules (no alarm output, no waveform calculations).
Since the size of the header part of the waveform file is not included, use approx. 90% of the values in the table below as a guide. The less the number of channels being recorded, the longer the maximum recording time.

Recording interval	Internal buffer memory (512 MB)	Z4001 (2 GB)
100 ms	5 days and 4 hours	19 days and 9 hours
200 ms	10 days and 8 hours	38 days and 18 hours
500 ms	25 days and 21 hours	96 days and 21 hours
1 s	51 days and 18 hours	193 days and 19 hours
5 s	258 day	581 days and 10 hours
10 s	500 day	1938 days and 4 hours

14.10 Applied Measurement

Recording of instrumentation signal (4-20 mA)

This section introduces a method for recording a current output (4-20 mA) from the instrumentation device.
Average every 1 minute is also recorded using the numerical calculation.

- Applicable modules: M7100, M7102
- Required item: Input cable, 250 Ω shunt resistor

Operation method

1 **Connect the input cable and 250 Ω shunt resistor to the channel to be measured.**

Connect the shunt resistor between the input +/− terminals.
See “Wiring the voltage cable and thermocouple” (p. 56).

2 **Connect the input cable to the current output (4-20 mA) terminal on the instrumentation device.**

3 **Set the data refresh interval to auto.**

See “Data refresh interval of the measurement modules” (p. 115).

4 **Configure the settings as follows.**

Recording interval	5 s
Recording time	Time specification, 1 hour (0 days and 01:00:00)

See “3.3 Setting Measurement Conditions” (p. 106).

5 **Configure the settings as follows.**

Media (Preferred saving destination)	SD memory card
Format (waveform data)	Binary format (MEM)
Format (numerical calculation results)	Text format (CSV)

See “Auto save (Realtime save)” (p. 226).

6 **Configure the settings as follows.**

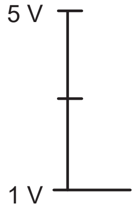
Numerical calculation	ON
Time split calculation	Division enabled
Split time	1 minute (0 days and 00:01)
Operation type	Average

See “Setting the numerical calculations” (p. 272).

7 **Configure the settings as follows. (p.120)**

Input type	Voltage
Range	1-5 V

Since the 250Ω resistor is connected to the input terminal, 4 mA and 20 mA are recorded as 1 V and 5 V, respectively.



8 **Execute the `START` command to start measurement.**

Data are recorded for 1 hour at intervals of 5 seconds.
In addition, the average is calculated every 1 minute using the numerical calculation and saved to the SD memory card.
The recording is stopped 1 hour after the recording is started.
To stop the recording halfway, execute the `STOP` command.
See “3.10 Starting and Stopping Measurement” (p. 171).

Measurement of power consumption using pulse output of watt-hour meter

This section describes a method for measuring pulses of watt-hour meter and converting them to the power consumption.
Measure the pulse output of watt-hour meter (50,000 pulses/kWh) and record the power consumption per 30 minutes and the power consumption per 1 month (30 days) to an SD memory card.

- Required item: Input cable

Operation method

1 **Connect the pulse output of the watt-hour meter to the pulse input terminal (PULSE) on the instrument.**

2 **Configure the settings as follows.**

Recording interval	30 min
Recording time	Time specification, 30 days (30 days and 00:00:00)

3 **Configure the settings as follows.**

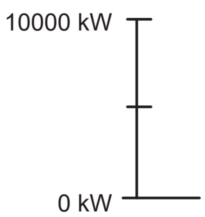
Media (Preferred saving destination)	SD memory card
Format	Binary format (MEM)

4 **Set as follows.**

Input type	Count
Count mode	Addition
Slope	↑ (according to the specifications of the watt-hour meter)
Threshold value	1 V (according to the specifications of the watt-hour meter)
Filter	ON *1
Scaling	Decimal fraction, 1 kWh = 5000 (5 k), Unit: kWh

*1. A count error due to chattering can be prevented.

With the scaling function, the number of pulses can be converted to the electric energy (kWh).



5 **Execute the `START` command to start measurement.**

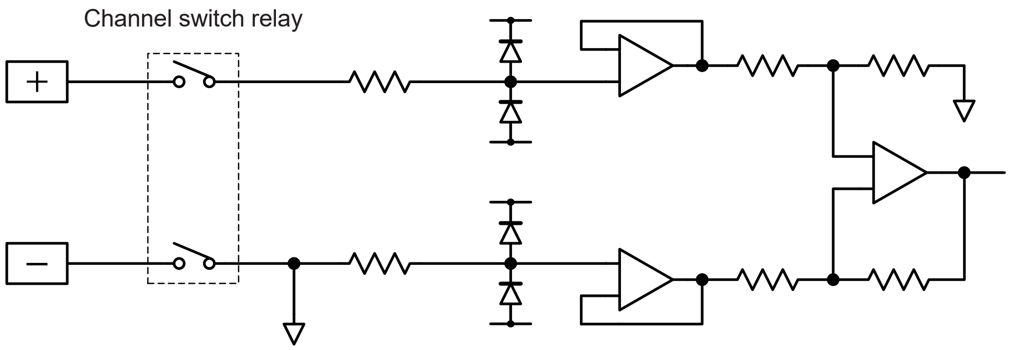
Data are recorded for 30 days at intervals of 30 minutes and waveform data is saved to an SD memory card.
The recording is stopped 30 days after the recording is started.
To stop the recording halfway, execute the `STOP` command.

14.11 Configuration of Input Circuit

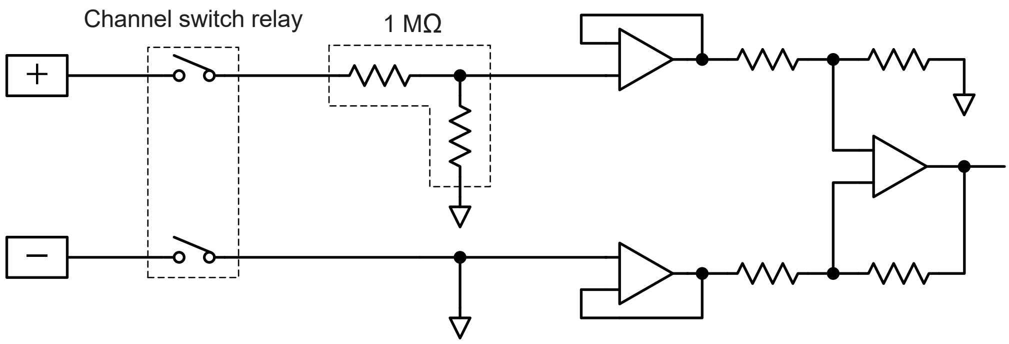
This section shows the configuration of the input circuit.

Input circuits for M7100 and M7102

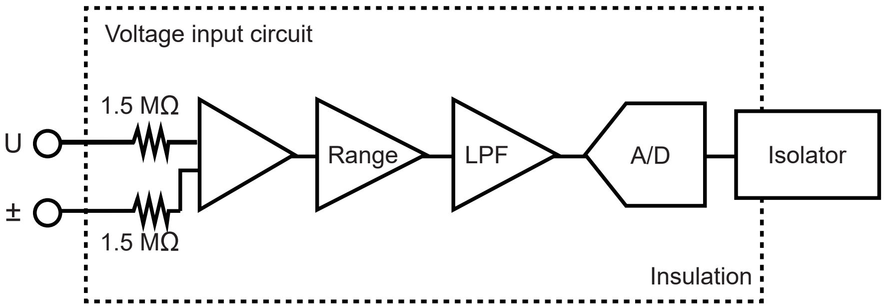
- Voltage (10 mV f.s. to 6 V f.s. range), thermocouple



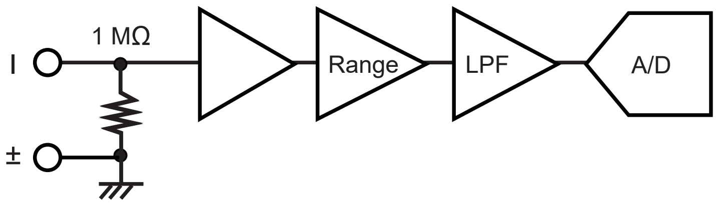
- Voltage (10 V f.s. to 100 V f.s., 1-5 V f.s. range)



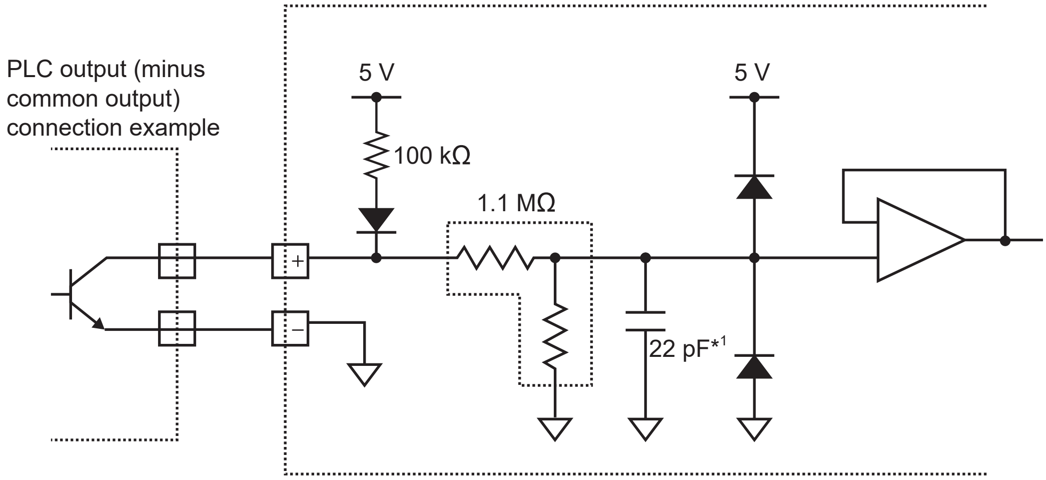
Input circuit for M7103



Current sensor input circuit



Pulse input circuit



*1. 0.047 μF when the chattering prevention filter is ON.

14.12 Data Handling

In the following cases, the values in the table below are used as the measured value and the calculated value.

- When the waveform significantly exceeds the allowable measurement range of each range (+OVER, −OVER)
- When a thermocouple wire break is detected during temperature measurement (wire break detection)
- When no data exists (NO DATA)

Measurement data special values

Communication commands and save data for acquiring a measured value in text (physical value)

See “4 Acquiring Measurement Data” (p. 175).

Input type	+OVER	−OVER	Burnout detection	NO DATA
Measurement channel for plug-in module (Other than the power measurement module)	+7.77777E+99	−7.77777E+99	+8.88888E+99	+9.99999E+99
Power measurement module measurement channel (Other than the status information)	+7.77777E+99	–	–	+9.99999E+99
Power measurement module measurement channel (Status information)	–	–	–	–
Pulse (count/rotation speed)	+7.77777E+99	–	–	+9.99999E+99
Waveform calculation	–	–	–	+9.99999E+99

Communication commands for acquiring a measured value in text (AD value)

See “4 Acquiring Measurement Data” (p. 175).

Input type	+OVER	−OVER	Burnout detection	NO DATA
Measurement channel for plug-in module (Other than the power measurement module)	2147483647	−2147483648	2147483646	2147483645
Power measurement module measurement channel (Other than the status information)	+7.77777E+34	–	–	+9.99999E+34
Power measurement module measurement channel (Status information)	–	–	–	–
Pulse (count/rotation speed)	2147483647	–	–	2147483645
Waveform calculation	–	–	–	+9.99999E+99

Communication commands for acquiring a measured value in binary

See “4 Acquiring Measurement Data” (p. 175).

Input type	+OVER	−OVER	Burnout detection	NO DATA
Measurement channel for plug-in module (Other than the power measurement module)	0x7FFFFFFF	0x80000000	0x7FFFFFFE	0x7FFFFFFD
Power measurement module measurement channel (Other than the status information)	0x796fabc9	–	–	0x799a1301
Power measurement module measurement channel (Status information)	–	–	–	–
Pulse (count/rotation speed)	0x7FFFFFFF	–	–	0x7FFFFFFD
Waveform calculation	–	–	–	0x7ff0000000000001

Calculation special values

Calculation is performed based on the values in the following table.

Input type	Input range	+OVER	−OVER	Burnout detection	NO DATA
Voltage	10 mV	214.7483647	−214.7483648	–	214.7483645
	20 mV	429.4967294	−429.4967296	–	429.496729
	100 mV	2147.483647	−2147.483648	–	2147.483645
	200 mV	4294.967294	−4294.967296	–	4294.96729
	1 V	21474.83647	−21474.83648	–	21474.83645
	2 V	42949.67294	−42949.67296	–	42949.6729
	6 V	128849.01882	−128849.01888	–	128849.0187
	10 V	214748.3647	−214748.3648	–	214748.3645
	20 V	429496.7294	−429496.7296	–	429496.729
	60 V	1288490.1882	−1288490.1888	–	1288490.187
	100 V	2147483.647	−2147483.648	–	2147483.645
	1-5 V	128849.01882	−128849.01888	–	128849.0187
Thermocouples	100°C	21474836.47	−21474836.48	21474836.46	21474836.45
	500°C	107374182.35	−107374182.4	107374182.3	107374182.25
	2000°C	214748364.7	−214748364.8	214748364.6	214748364.5
Count	1000 Mc	2147483647	–	–	2147483645
Rotation speed	5000 r/s	2147483647	–	–	2147483645
	300000 r/min	2147483647	–	–	2147483645
Waveform calculation	–	–	–	–	1.7976931348623157e+308
Power calculation (Other than the status information)	–	+7.77777E+34	–	–	+9.99999E+34
Power calculation (Status information)	–	–	–	–	–

Special value for measured value output using LAN2

See “12.8 Outputting the Measured Value Using LAN2” (p. 347).

When the data format of the measured value to be output is INT32 (when endian is set to BIG)

Input type	+OVER	−OVER	Burnout detection	NO DATA
Measurement channel for plug-in module (Other than the power measurement module)	0x7FFFFFFF	0x80000000	0x7FFFFFFE	–
Power measurement module measurement channel (Other than the status information)	+7.77777E+34	–	–	+9.99999E+34
Power measurement module measurement channel (Status information)	–	–	–	–
Pulse (count/rotation speed)	0x7FFFFFFF	–	–	–
Waveform calculation	–	–	–	–

When the data format of the measured value to be output is FLOAT or INDEX

- When the data format is FLOAT, binary data is output. The values in the following table can be obtained by converting the binary data.
- When the data format is INDEX, ASCII code data is output. The values in the following table can be obtained by converting the ASCII code.

Input type	Input range	+OVER	−OVER	Burnout detection	NO DATA
Voltage	10 mV	214.7483647	−214.7483648	–	–
	20 mV	429.4967294	−429.4967296	–	–
	100 mV	2147.483647	−2147.483648	–	–
	200 mV	4294.967294	−4294.967296	–	–
	1 V	21474.83647	−21474.83648	–	–
	2 V	42949.67294	−42949.67296	–	–
	6 V	128849.01882	−128849.01888	–	–
	10 V	214748.3647	−214748.3648	–	–
	20 V	429496.7294	−429496.7296	–	–
	60 V	1288490.1882	−1288490.1888	–	–
	100 V	2147483.647	−2147483.648	–	–
	1-5 V	128849.01882	−128849.01888	–	–
Thermocouple	100°C	21474836.47	−21474836.48	21474836.46	–
	500°C	107374182.35	−107374182.4	107374182.3	–
	2000°C	214748364.7	−214748364.8	214748364.6	–
Count	1000 Mc	2147483647	–	–	–
Rotation speed	5000 r/s	2147483647	–	–	–
	300000 r/min	2147483647	–	–	–
Waveform calculation	–	–	–	–	–
Power calculation (other than status information)	–	+7.77777E+34	–	–	+9.99999E+34
Power calculation (status information)	–	–	–	–	–

Special value for measured value output using CAN

See “12.6 Outputting the Measured Value Using CAN” (p. 342).

Input type	+OVER	−OVER	Burnout detection	NO DATA
Measurement channel for plug-in module (Other than the power measurement module)	0x7FFFFFFF	0x80000000	0x7FFFFFFE	0x7FFFFFFD
Power measurement module measurement channel (Other than the status information)	0x796fabc9	–	–	0x799a1301
Power measurement module measurement channel (Status information)	–	–	–	–
Pulse (count/rotation speed)	0x7FFFFFFF	–	–	0x7FFFFFFD
Waveform calculation	–	–	–	0x7ff0000000000001

The value converted using the settings of the DBC file is the same as the special value for calculation.

14.13 Module-related Commands

If both the header and data parts of a command are related to modules, the specification with UNIT can be accepted.

```
:MODule:DATARate module$,A
:MODule:DATARate? module$
```

In this case

`:MODule`	Can be replaced with `:UNIT`
`module$`	Can be replaced with `unit$`

> **Tips** If the header is ON, the header part is fixed to MODULE in the returned response.

Command example

Settings		
Syntax	Command	`:MODule:DATARate module$,A`
Example	`:MODule:DATARate MODULE1,1.0E+00`	
Query		
Syntax	Query	`:MODule:DATARate? module$`
	Response	`A`
Example	`:MODule:DATARate? MODULE1` (Response) `:MODULE:DATARATE MODULE1,1.0E+00` (When the header is ON)	
Parameter		
`module$` = MODULE1 to MODULE10		

For the command above, the next command results in the same operation.

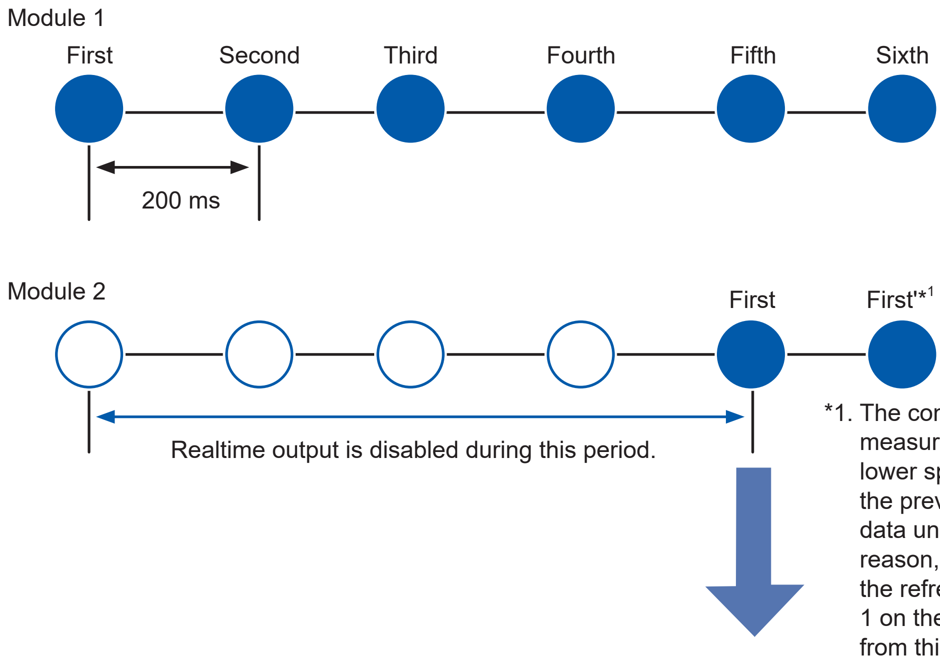
Settings		
Syntax	Command	`:UNIT:DATARate unit$,A`
Example	`:UNIT:DATARate UNIT1,1.0E+00`	
Query		
Syntax	Query	`:UNIT:DATARate? unit$`
	Response	`A`
Example	`:UNIT:DATARate? UNIT1` (Response) `:MODULE:DATARATE MODULE1,1.0E+00` (When the header is ON)	
Parameter		
`unit$` = UNIT1 to UNIT10		

14.14 The Measured Data Realtime Output

During realtime output, data are designed to be output every time the measurement data number increases. However, if the measurement data number increases by more than one due to the modules having different refresh intervals, the initial data is output.

When the measurement data can be integrated at the start of measurement

Example: When the recording interval is 200 ms, the refresh interval for module 1 is 200 ms, and the refresh interval for module 2 is 1 s



*1. The content of the measurement data for the lower speed is the same as the previous data until the next data unit is created. For this reason, the data are output at the refresh interval for module 1 on the higher speed side from this point on.

The measurement data do not progress until the lower speed data become ready. Once the lower speed data become ready, the data for both the higher speed and lower speed will progress.
At this point, the initial data of the summarized data is output.
(The first to fifth data units of module 1 and the first data unit of module 2 in the above drawing)

At this point, the data number used at the start of the output is assigned to the UDP data frame for outputting the measured value of LAN 2.
In the above case, for example, data are output from the sixth data unit for module 1, and the data number assigned to the UDP data frame starts from 5.

Tips

How to output the data numbers for the UDP data frame from 0 under the above condition

If you wish to output the data numbers from 0 under the above condition, use the trigger function. Enable the trigger function and external trigger*2, and also use the manual trigger command. The output will start from data number 0 when the manual trigger command is received.

*2. As long as the manual command can be received in a trigger standby state, a trigger other than the external trigger can also be used.

See "5.2 Enabling the Trigger Function" (p. 193),
"5.6 Applying External Trigger" (p. 214), and
"5.8 Applying Trigger Forcibly" (p. 217).

14.15 Command Samples

This section provides samples of the basic commands to perform measurement with the instrument.
The header setting is OFF in these examples.
The order of the command table is as follows.
Sending command → Response to query → Sending command

M7100 is connected to module 1 in these examples.

(1) Basic setting examples

See "3.3 Setting Measurement Conditions" (p. 106).

Sending command	Response to query command	Description
*ESR?	128	Check ESR first. The value of bit 8 is set after the power is turned ON.
:CONFigure:SAMPle 1E-2	–	Set the recording interval to 10 ms.
:CONFigure:RECTime 0,0,0,0	–	Set to the continuous measurement.
:MODule:INMOde CH1_1,VOLTAGE	–	Set CH1_1 to voltage measurement.
:MODule:RANGE CH1_1,1E-1	–	Set the voltage range of CH1_1 to 100 mV.
:MODule:INMOde CH1_2,TC	–	Set CH1_2 to thermocouple measurement.
:MODule:SENSor CH1_2,K	–	Set the type of thermocouple to be used in CH1_2 to K.
:MODule:RANGE CH1_2,1E+2	–	Set the range of thermocouple to be used in CH1_2 to 100°C.
:MODule:STORe CH1_3,OFF;STORe CH1_4,OFF	–	Set CH1_3 and CH1_4 to OFF. See "Abbreviation of combined command header" (p. 26).
*ESR?	0	Check whether or not the command contains any errors.

(2) Measurement and data acquisition (VREAL)

See "4.2 Acquiring Realtime Data" (p. 180).
Use the same settings as with (1) Basic setting examples.

Sending command	Response to query command	Description
*ESR?	128	Check ESR first. The value of bit 8 is set after the power is turned ON.
:START	–	Starts measurement.
:MEMory:AMAXPoint?	10	Check the number of measurement data. Repeat until a desired number of data are accumulated, as needed.
:MEMory:VREAL? CH1_1	1.230000E-02	Latest voltage value in CH1_1
:MEMory:VREAL? CH1_2	2.460000E+01	Latest temperature value in CH1_2
:STOP;:STOP	–	In the continuous measurement, send the STOP command 2 times to stop the measurement.
*ESR?	0	Check whether or not the command contains any errors.

(3) Measurement and data acquisition (VDATA)

See "4.1 Acquiring Measurement Data on Internal Memory" (p. 176).
Use the same settings as with (1) Basic setting examples.

Sending command	Response to query command	Description
*ESR?	128	Check ESR first. The value of bit 8 is set after the power is turned ON.
:START	–	Starts measurement.
:MEMory:AMAXPoint?	4	Check the number of measurement data. Repeat until a desired number of data are accumulated, as needed.
:MEMory:TOPPoint?	1	Check the leading data number on the internal memory.
:MEMory:APOINt CH1_2,0*1	–	Set the data acquisition position to number 0 in CH1_2.
:MEMory:VDATa? 2*2	+2.310000E+00, +2.320000E+00	Acquire 2 starting from data number 0 in CH1_2 as specified in *1.
:MEMory:VDATa? 2	+2.330000E+00, +2.340000E+00	Acquire 2 data continued from *2.
:STOP;:STOP	–	In the continuous measurement, send the STOP command 2 times to stop the measurement.
*ESR?	0	Check whether or not the command contains any errors.

14.16 String Input Rules

The following single-byte alphanumeric characters and symbols can be used in the file name.

0	1	2	3	4	5	6	7	8	9					
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W	X	Y	Z				
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
p	q	r	s	t	u	v	w	x	y	z				
#	$	%	&	'	(	)	-	~	@	^	_	{	}	

The following single-byte alphanumeric characters and symbols can be used in the destination directory name for FTP auto send.

0	1	2	3	4	5	6	7	8	9					
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W	X	Y	Z				
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
p	q	r	s	t	u	v	w	x	y	z				
#	$	%	(	)	/	=	[	]	@	_	{	}		

14.17 Calculation of Combination Accuracy

When the combination accuracy for LR8101/LR8102 (M7103) and sensor is not defined

For the measurement accuracy of active power and current, accuracy of the instrument and accuracy of the current sensor to be used are added together. For example, the measurement accuracy of the active power is calculated as follows:

Reading accuracy = Active power reading accuracy + Sensor reading accuracy
Range accuracy = Active power range accuracy + (Sensor rating/current range) × Sensor full-scale accuracy

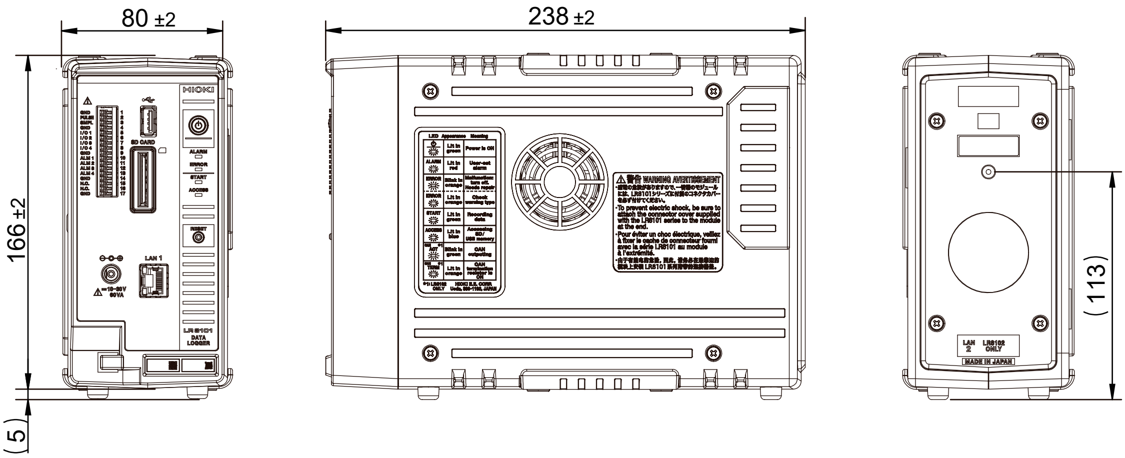
Sensor	CT6862 (50 A rating), accuracy ±0.05% of reading ± 0.01% of full scale
Instrument settings	Power range: 6.00000 kW, accuracy ±0.02% of reading ± 0.05% of range Wiring: 1P2W Voltage range: 600 V Current range: 10 A
Measurement target	400 V, 5 A, 2.00000 kW, 50 Hz

Reading accuracy = 0.02% of reading + 0.05% of reading = ±0.07% of reading
Range accuracy = 0.05% of range + (50 A/10 A) × 0.01% of full scale = ±0.10% of range
The active power accuracy is ±0.07% of reading ± 0.10% of range (6 kW power range).

14.18 External View

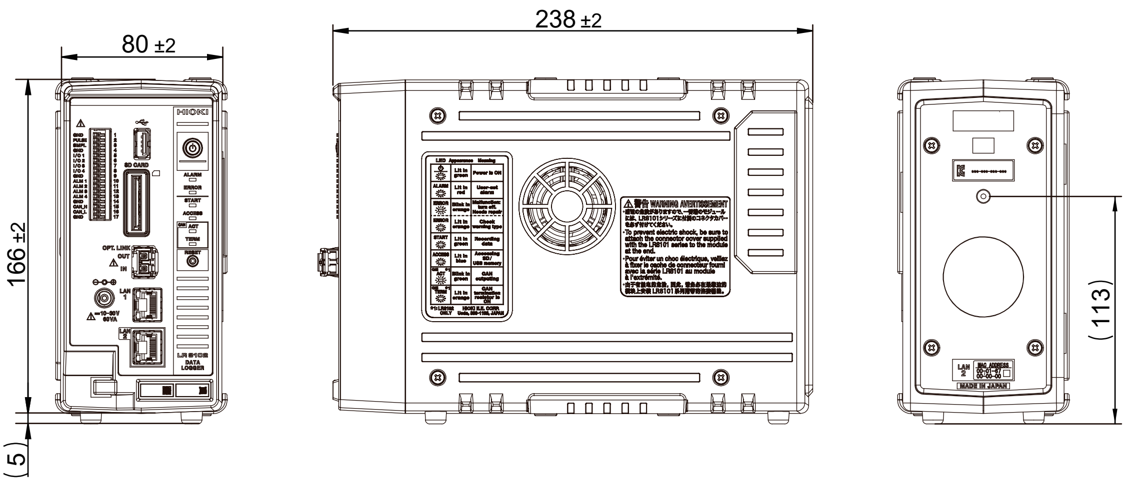
LR8101

Unit: mm



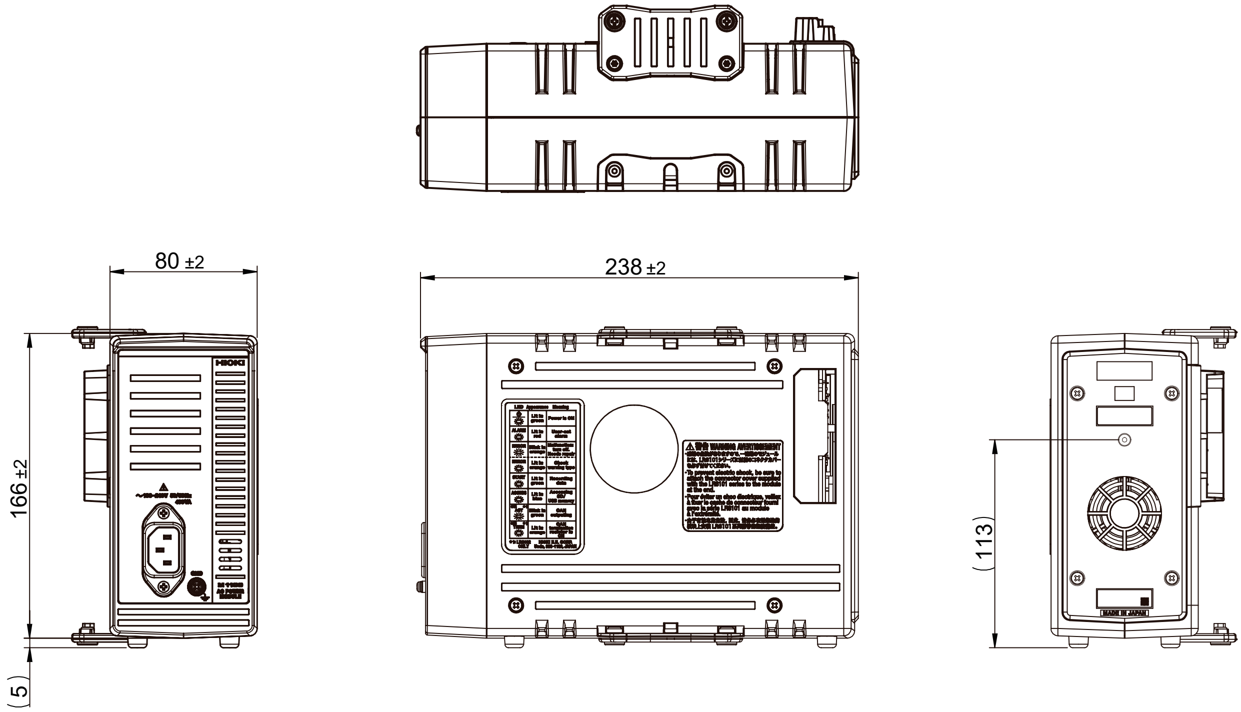
LR8102

Unit: mm



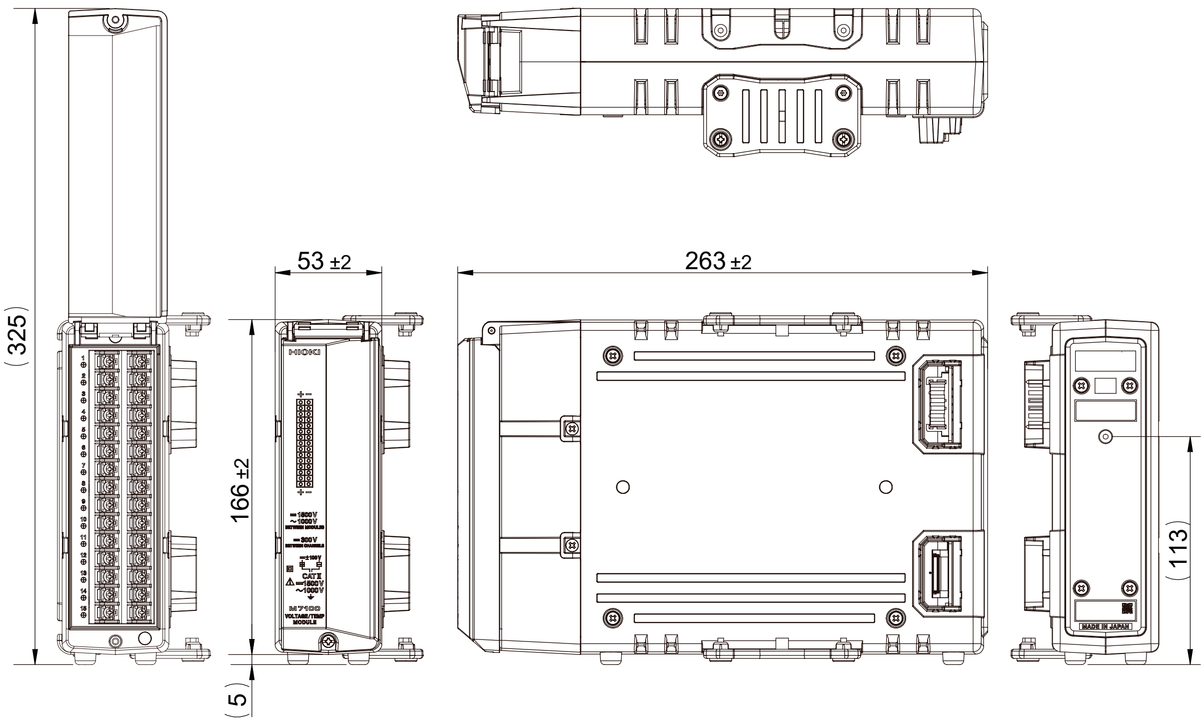
M1100

Unit: mm



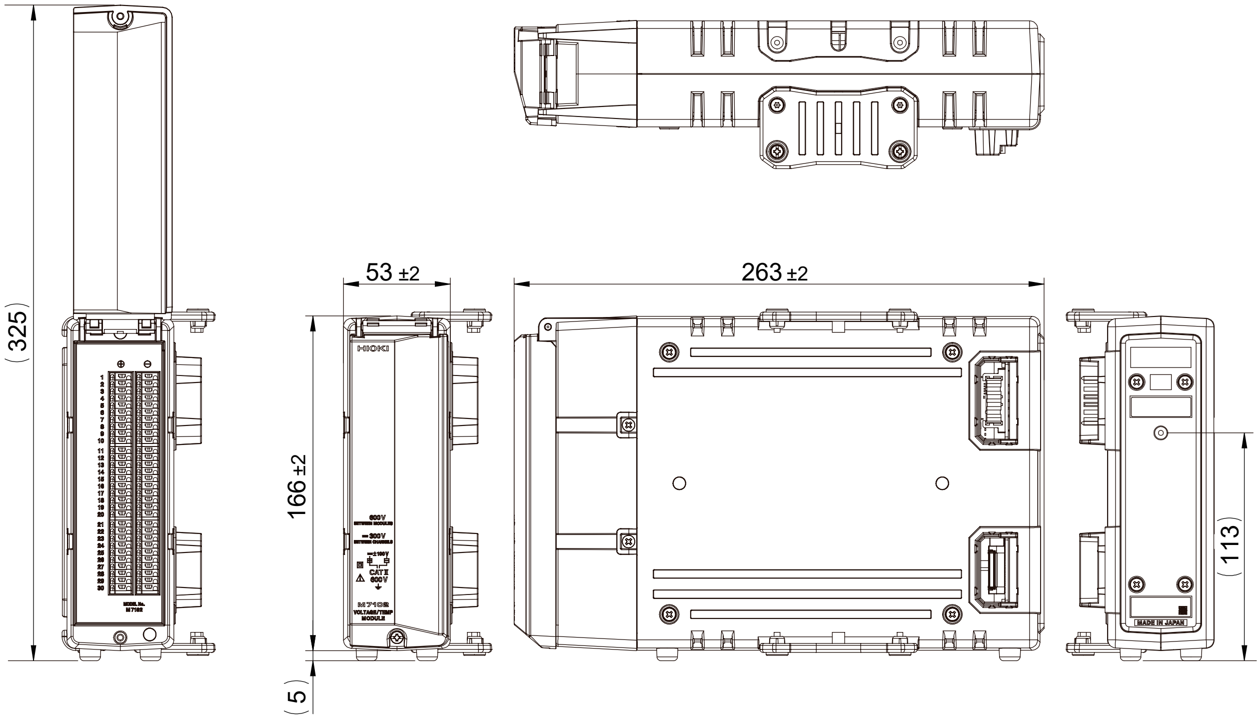
M7100

Unit: mm



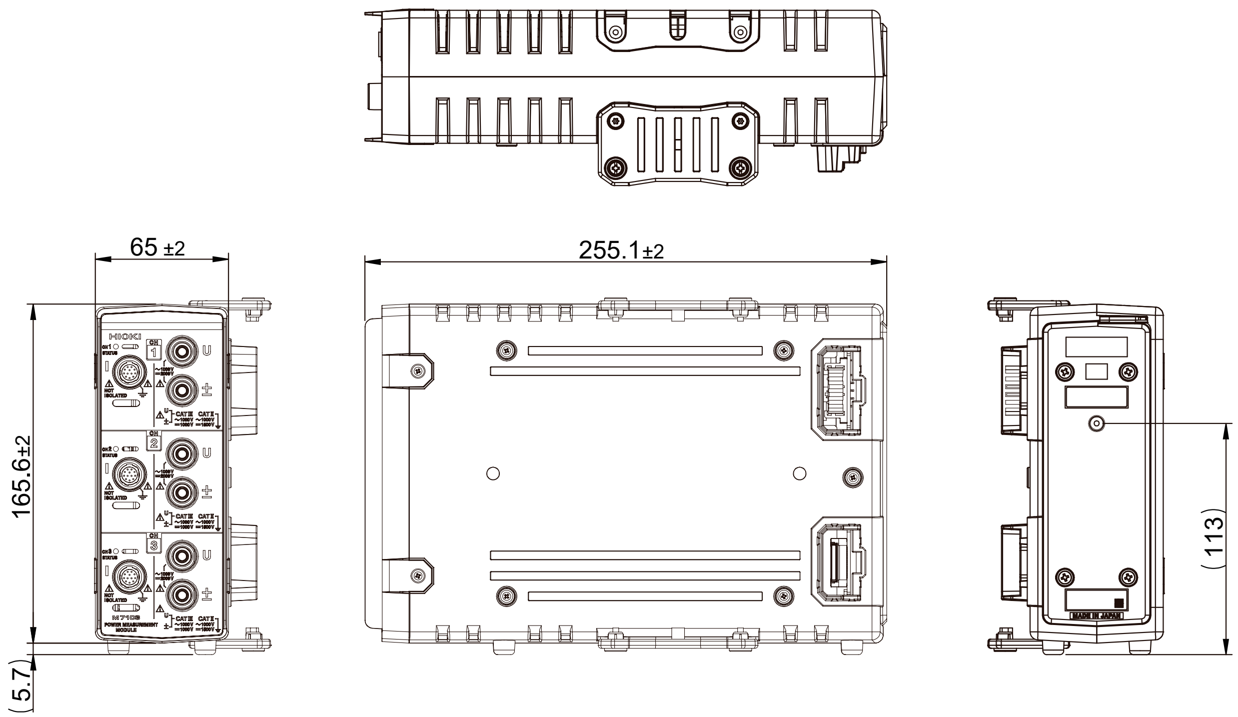
M7102

Unit: mm



M7103

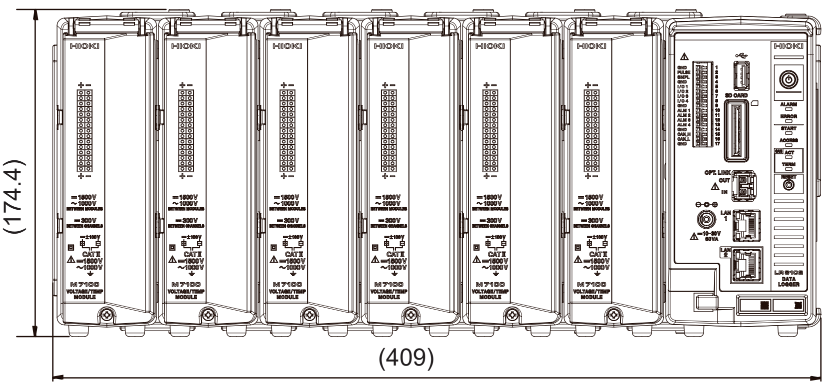
Unit: mm



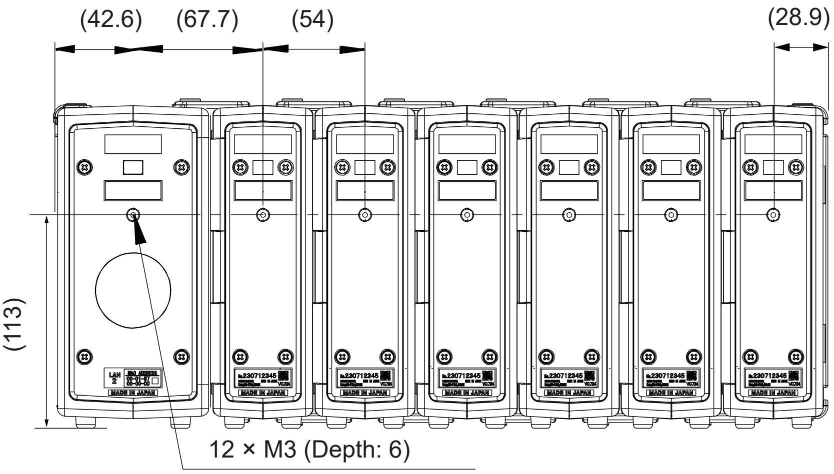
Six M7100 units are connected

Unit: mm

Front



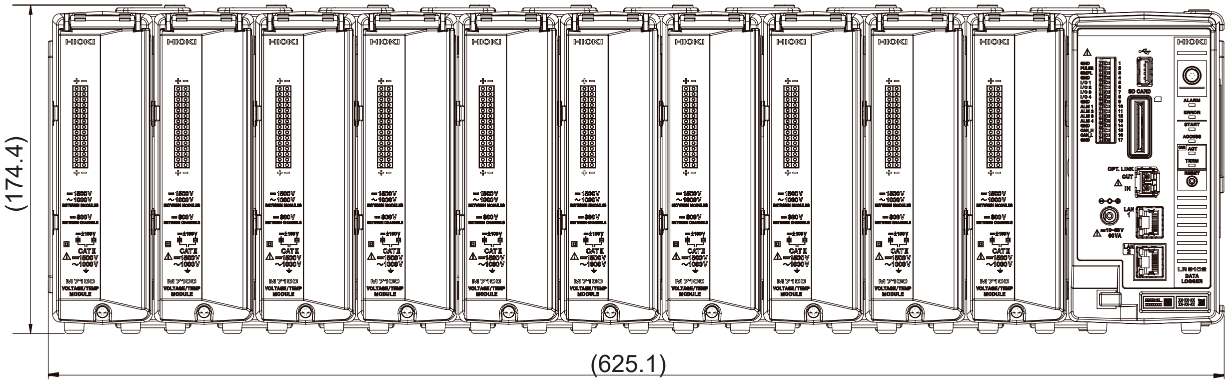
Rear



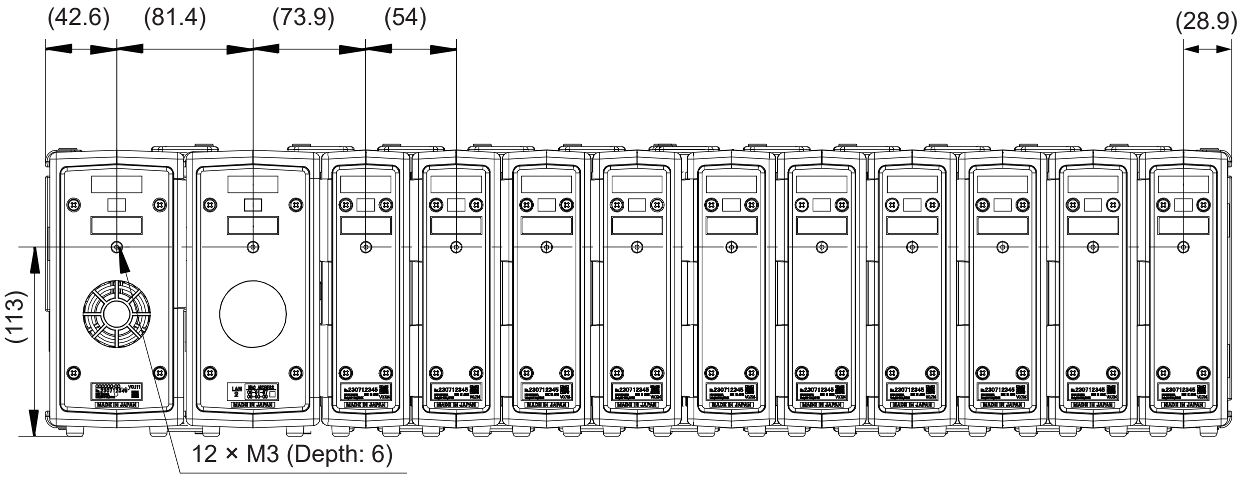
Ten M7100 units are connected

Unit: mm

Front



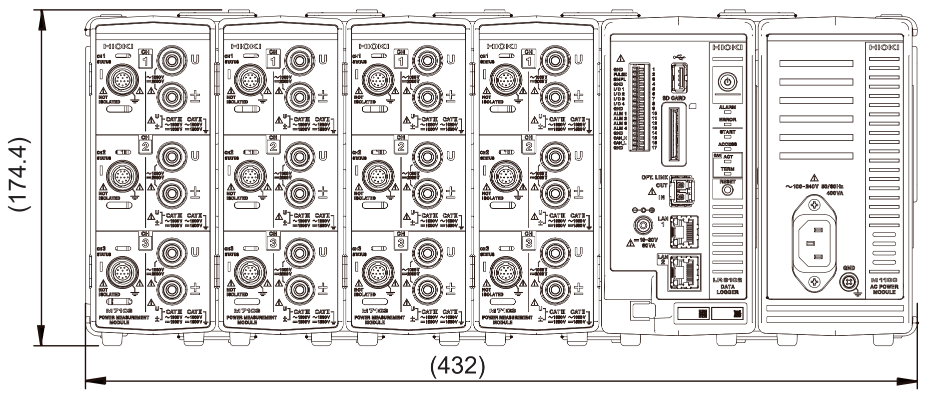
Rear



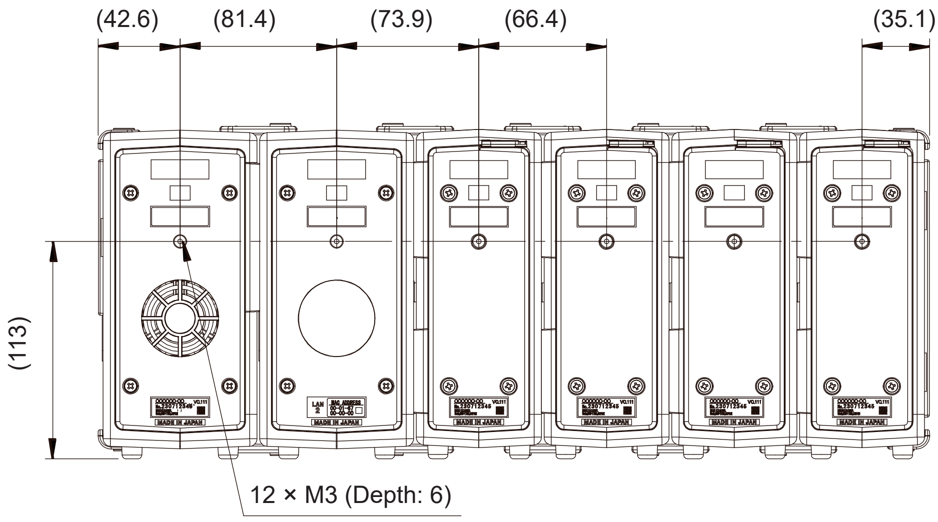
Four M7103 units are connected

Unit: mm

Front



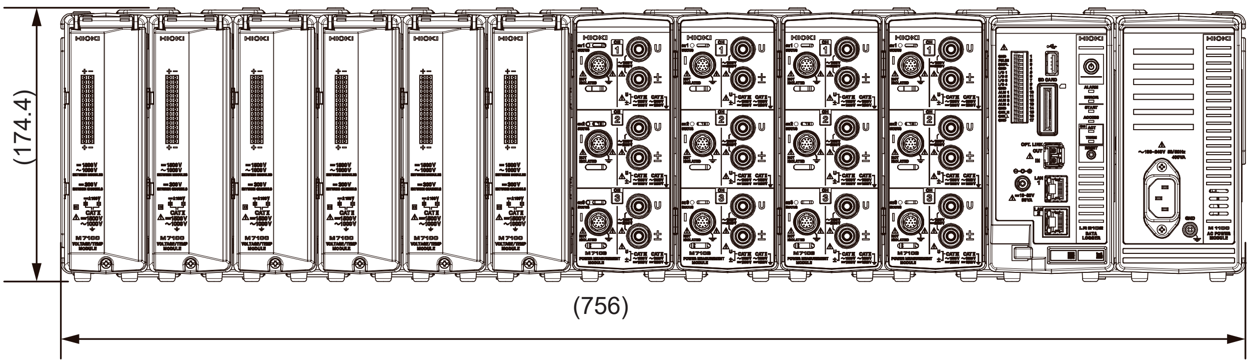
Rear



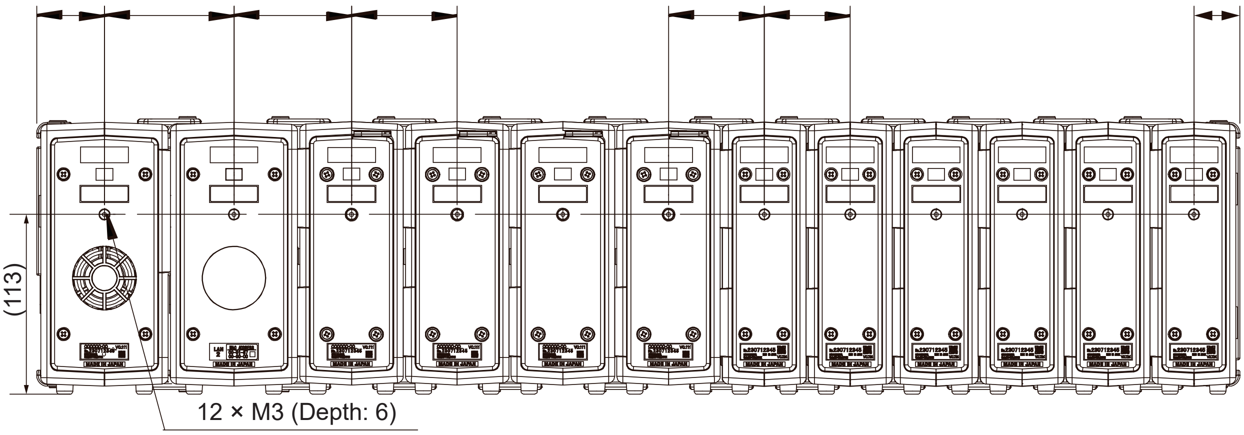
Six M7100 units + four M7103 units + M1100 are connected

Unit: mm

Front



Rear



14.19 Rack Mounting

This instrument can be rack mounted using the screw holes at the back.
The rack mounting hardware as shown in the reference drawing is available.
For more details, contact your authorized Hioki distributor or reseller.

⚠CAUTION

■ **Be sure to use appropriate screws and torque.**

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

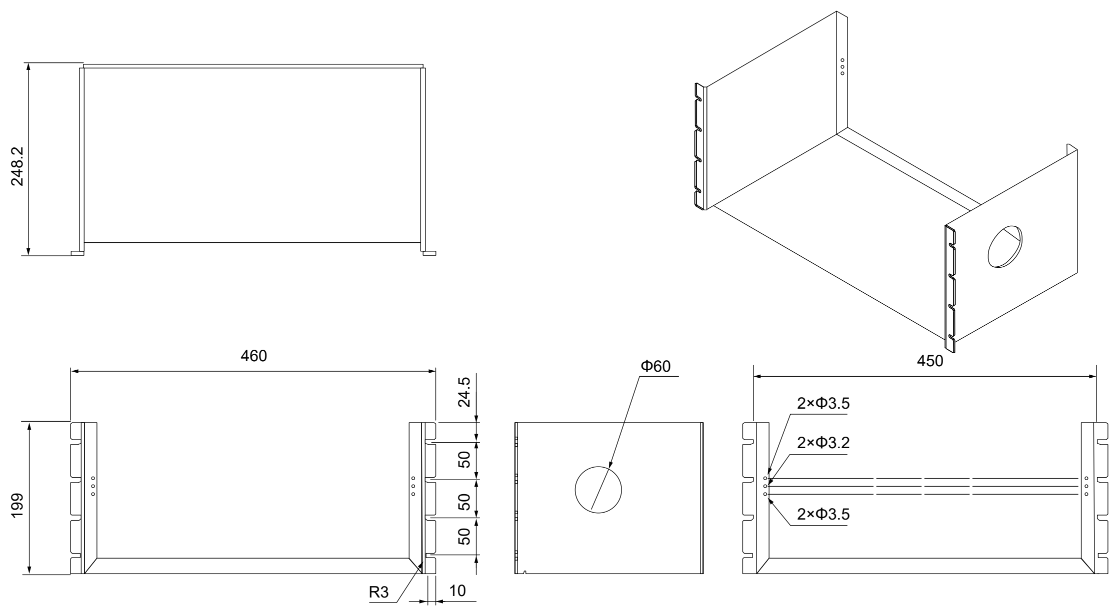
IMPORTANT

- The instrument cannot be completely secured to the rack by using only the screw holes at the back. When installing the instrument into the rack, be sure to support the bottom section of the instrument using a third-party platform or the like. In addition, use a third-party support angle or the like to reinforce the inside of the rack.
- Since the instrument may not fit within the horizontal width of a general rack, depending on the module configuration of the instrument, be sure to check the dimensions of the rack before assembly.
- Do not block the vents.

Reference drawing of rack mounting hardware

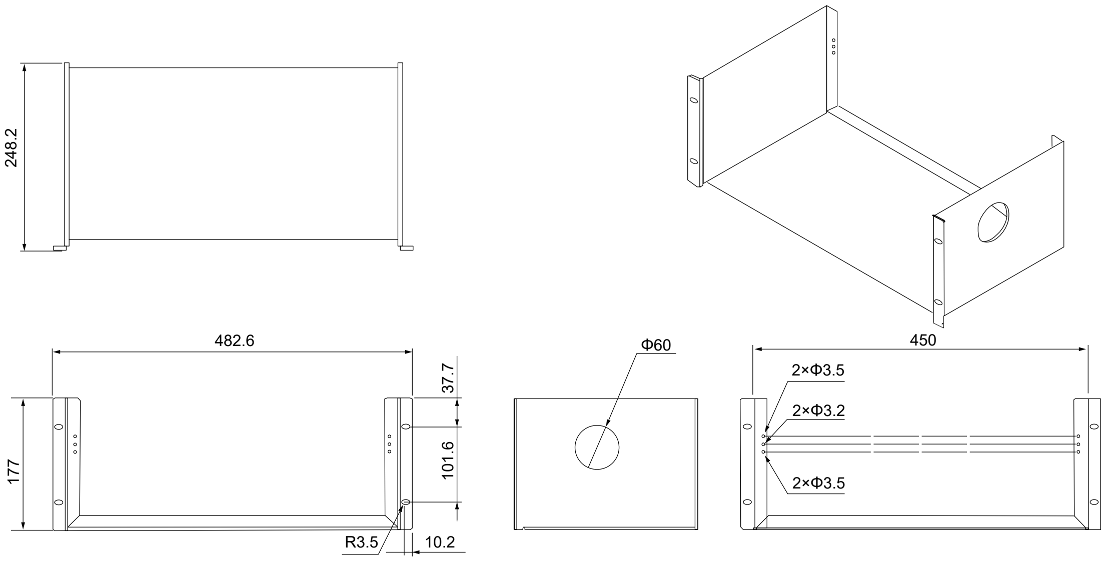
JIS hardware

Unit: mm



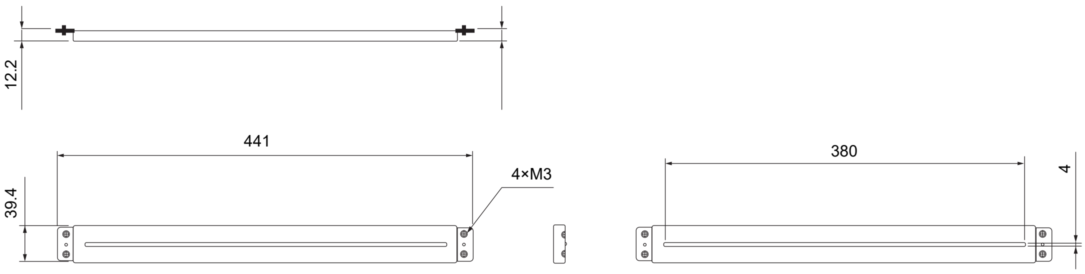
EIA hardware

Unit: mm

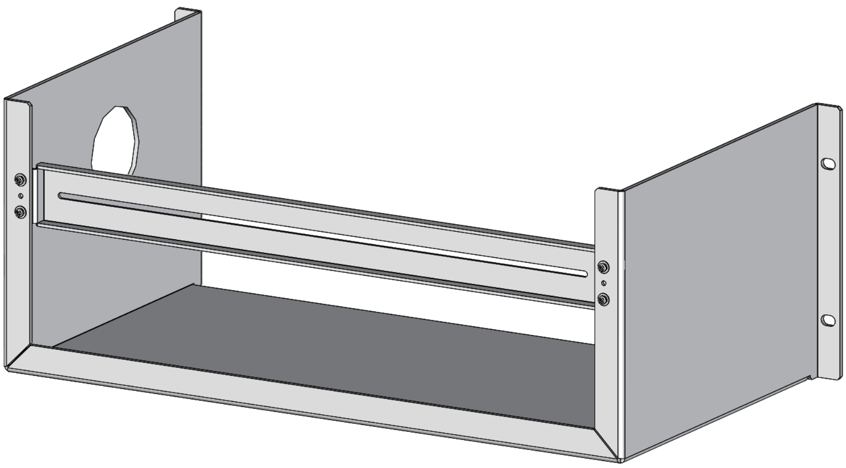


Bracket (common to JIS and EIA)

Unit: mm

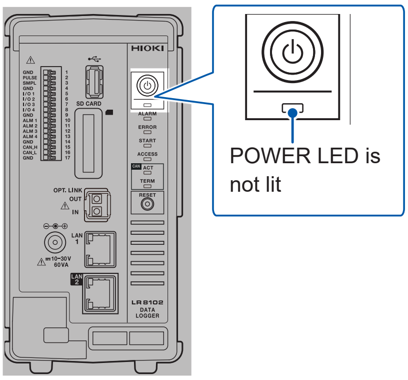


Assembled rack mounting hardware

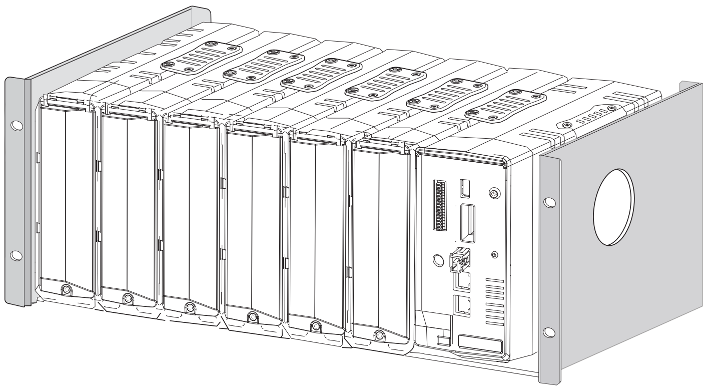


Installation example of rack mounting hardware

1 **Confirm that the instrument is turned OFF, and then remove the power cord and cables.**



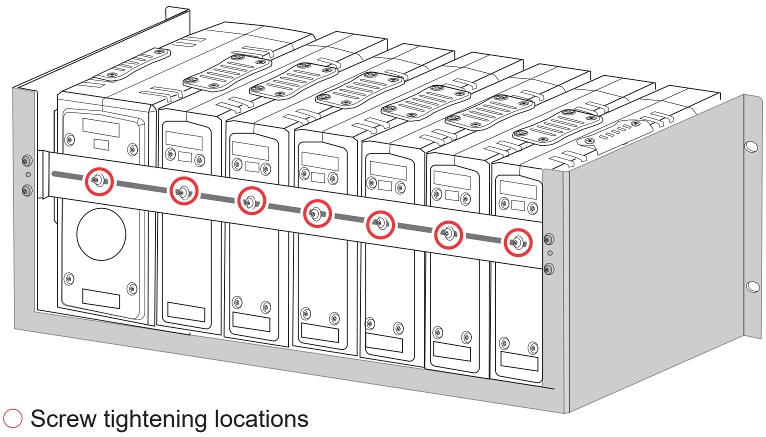
2 **Mount the instrument onto the rack mounting hardware.**



3 **Secure the instrument with the bracket with screws at the back.**

Secure the rear panels of the instrument and all modules to the bracket of the rack mounting hardware using screws.

- Screws to be used: Double-washer sems screw M3 × 8 mm
- Tightening torque: 0.6N•m

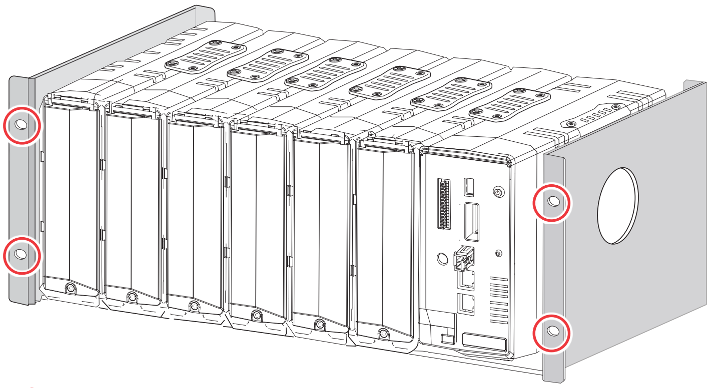


○ Screw tightening locations

4 **Secure the rack with screws (four locations).**

Check the required values on the rack side, and install the rack mounting hardware onto the rack.

- Screws to be used: Check the required value for the rack.
- Tightening torque: Check the required value for the rack.



○ Screw tightening locations

14.20 Conventional Command System

The command system used for the conventional models can also be used for this instrument.
The corresponding commands are listed in the table below.

1. :ALARm

Conventional command system	Corresponding command
:ALARm:KIND alm$,ch$,A$	:ALARm:ANALog:KIND alm$,ch$,A$
:ALARm:KIND? alm$,ch$	:ALARm:ANALog:KIND? alm$,ch$
:ALARm:LEVEl alm$,ch$,A$	:ALARm:ANALog:LEVEl alm$,ch$,A
:ALARm:LEVEl? alm$,ch$	:ALARm:ANALog:LEVEl? alm$,ch$
:ALARm:LOGPat alm$,"A$"	:ALARm:LOGic:PATTern alm$,"A$"
:ALARm:LOGPat? alm$	:ALARm:LOGic:PATTern? alm$
:ALARm:LOWEr alm$,ch$,A$	:ALARm:ANALog:LOWEr alm$,ch$,A
:ALARm:LOWEr? alm$,ch$	:ALARm:ANALog:LOWEr? alm$,ch$
:ALARm:PKIND alm$,pls$,A$	:ALARm:PULSe:KIND alm$,pls$,A$
:ALARm:PKIND? alm$,pls$	:ALARm:PULSe:KIND? alm$,pls$
:ALARm:PLEVEl alm$,pls$,A	:ALARm:PULSe:LEVEl alm$,pls$,A
:ALARm:PLEVEl? alm$,pls$	:ALARm:PULSe:LEVEl? alm$,pls$
:ALARm:PLOWEr alm$,pls$,A	:ALARm:PULSe:LOWEr alm$,pls$,A
:ALARm:PLOWEr? alm$,pls$	:ALARm:PULSe:LOWEr? alm$,pls$
:ALARm:PSIDE alm$,pls$,A$	:ALARm:PULSe:SIDE alm$,pls$,A$
:ALARm:PSIDE? alm$,pls$	:ALARm:PULSe:SIDE? alm$,pls$
:ALARm:PSLOPe alm$,pls$,A$	:ALARm:PULSe:SLOPe alm$,pls$,A$
:ALARm:PSLOPe? alm$,pls$	:ALARm:PULSe:SLOPe? alm$,pls$
:ALARm:PUPPEr alm$,pls$,A	:ALARm:PULSe:UPPEr alm$,pls$,A
:ALARm:PUPPEr? alm$,pls$	:ALARm:PULSe:UPPEr? alm$,pls$
:ALARm:SIDE alm$,ch$,A$	:ALARm:ANALog:SIDE alm$,ch$,A$
:ALARm:SIDE? alm$,ch$	:ALARm:ANALog:SIDE? alm$,ch$
:ALARm:SLOPe alm$,ch$,A$	:ALARm:ANALog:SLOPe alm$,ch$,A$
:ALARm:SLOPe? alm$,ch$	:ALARm:ANALog:SLOPe? alm$,ch$
:ALARm:UPPEr alm$,ch$,A$	:ALARm:ANALog:UPPEr alm$,ch$,A
:ALARm:UPPEr? alm$,ch$	:ALARm:ANALog:UPPEr? alm$,ch$
:ALARm:WKIND alm$,w$,A$	:ALARm:CALCulate:KIND alm$,w$,A$
:ALARm:WKIND? alm$,w$	:ALARm:CALCulate:KIND? alm$,w$
:ALARm:WLEVEl alm$,w$,A	:ALARm:CALCulate:LEVEl alm$,w$,A
:ALARm:WLEVEl? alm$,w$	:ALARm:CALCulate:LEVEl? alm$,w$
:ALARm:WLOWEr alm$,w$,A	:ALARm:CALCulate:LOWEr alm$,w$,A
:ALARm:WLOWEr? alm$,w$	:ALARm:CALCulate:LOWEr? alm$,w$
:ALARm:WSIDE alm$,w$,A$	:ALARm:CALCulate:SIDE alm$,w$,A$
:ALARm:WSIDE? alm$,w$	:ALARm:CALCulate:SIDE? alm$,w$
:ALARm:WSLOPe alm$,w$,A$	:ALARm:CALCulate:SLOPe alm$,w$,A$

Conventional command system	Corresponding command
:ALARm:WSLOPe? alm$,w$	:ALARm:CALCulate:SLOPe? alm$,w$
:ALARm:WUPPEr alm$,w$,A	:ALARm:CALCulate:UPPEr alm$,w$,A
:ALARm:WUPPEr? alm$,w$	:ALARm:CALCulate:UPPEr? alm$,w$

2. :CALCulate

Conventional command system	Corresponding command
:CALCulate:ANSWer? no$,ch$	:CALCulate:MEAS:ANSWer? no$,ch$
:CALCulate:HTBASE w$,hour,min	:CALCulate:WAVE:RESet:BASE w$,hour,min
:CALCulate:HTBASE? w$	:CALCulate:WAVE:RESet:BASE? w$
:CALCulate:HTINT w$,day,hour,min	:CALCulate:WAVE:RESet:INT w$,day,hour,min
:CALCulate:HTINT? w$	:CALCulate:WAVE:RESet:INT? w$
:CALCulate:HTKINd w$,A$	:CALCulate:WAVE:KIND w$,A$
:CALCulate:HTKINd? w$	:CALCulate:WAVE:KIND? w$
:CALCulate:HTMVPoint w$,A	:CALCulate:WAVE:MOVe:POINt w$,A
:CALCulate:HTMVPoint? w$	:CALCulate:WAVE:MOVe:POINt? w$
:CALCulate:HTRESet w$,A$	:CALCulate:WAVE:RESet:KIND w$,A$
:CALCulate:HTRESet? w$	:CALCulate:WAVE:RESet:KIND? w$
:CALCulate:HTRSTTime w$,A$	:CALCulate:WAVE:RESet:TIME w$,A$
:CALCulate:HTRSTTime? w$	:CALCulate:WAVE:RESet:TIME? w$
:CALCulate:MEASFile A$	:CALCulate:MEAS:FILE A$
:CALCulate:MEASFile?	:CALCulate:MEAS:FILE?
:CALCulate:MEASKind A$	:CALCulate:MEAS:KIND A$
:CALCulate:MEASKind?	:CALCulate:MEAS:KIND?
:CALCulate:MEASLen day,hour,min	:CALCulate:MEAS:LEN day,hour,min
:CALCulate:MEASLen?	:CALCulate:MEAS:LEN?
:CALCulate:MEASReg hour,min	:CALCulate:MEAS:REG hour,min
:CALCulate:MEASReg?	:CALCulate:MEAS:REG?
:CALCulate:MEASSet no$,A$	:CALCulate:MEAS:SET no$,A$
:CALCulate:MEASSet? no$	:CALCulate:MEAS:SET? no$
:CALCulate:MEASTime A	:CALCulate:MEAS:TIME A
:CALCulate:MEASTime? A	:CALCulate:MEAS:TIME?
:CALCulate:WVCOE1 w$,A	:CALCulate:WAVE:ARIThmetic:COEF:A w$,A
:CALCulate:WVCOE1? w$	:CALCulate:WAVE:ARIThmetic:COEF:A? w$
:CALCulate:WVCOE2 w$,A	:CALCulate:WAVE:ARIThmetic:COEF:B w$,B
:CALCulate:WVCOE2? w$	:CALCulate:WAVE:ARIThmetic:COEF:B? w$
:CALCulate:WVCOE3 w$,A	:CALCulate:WAVE:ARIThmetic:COEF:E w$,E
:CALCulate:WVCOE3? w$	:CALCulate:WAVE:ARIThmetic:COEF:E? w$
:CALCulate:WVKINd w$,A$	:CALCulate:WAVE:ARIThmetic:OPERator:A w$,A$
:CALCulate:WVKINd? w$	:CALCulate:WAVE:ARIThmetic:OPERator:A? w$
:CALCulate:WVSRC1 w$,ch$	:CALCulate:WAVE:SOURce:SR1 w$,ch$
:CALCulate:WVSRC1? w$	:CALCulate:WAVE:SOURce:SR1? w$

Conventional command system	Corresponding command
:CALCulate:WVSRC2 w$,ch$	:CALCulate:WAVE:SOURce:SR2 w$,ch$
:CALCulate:WVSRC2? w$	:CALCulate:WAVE:SOURce:SR2? w$
:CALCulate:WVSTR w$,"A$"	:CALCulate:WAVE:STR w$,"A$"
:CALCulate:WVSTR? w$	:CALCulate:WAVE:STR? w$

3. CONFigure

Conventional command system	Corresponding command
:CONFigure:SYNCSet A$	:CONFigure:SYNC:SET A$
:CONFigure:SYNCSet?	:CONFigure:SYNC:SET?

4. :TRIGger

Conventional command system	Corresponding command
:TRIGger:KIND ch$,A$	:TRIGger:ANALog:STARt:KIND ch$,A$
:TRIGger:KIND? ch$	:TRIGger:ANALog:STARt:KIND? ch$
:TRIGger:LEVEl ch$,A	:TRIGger:ANALog:STARt:LEVEl ch$,A
:TRIGger:LEVEl? ch$	:TRIGger:ANALog:STARt:LEVEl? ch$
:TRIGger:LOGPat "A$"	:TRIGger:LOGic:STARt:PATTern "A$"
:TRIGger:LOGPat?	:TRIGger:LOGic:STARt:PATTern?
:TRIGger:LOWEr ch$,A	:TRIGger:ANALog:STARt:LOWEr ch$,A
:TRIGger:LOWEr? ch$	:TRIGger:ANALog:STARt:LOWEr? ch$
:TRIGger:PKIND pls$,A$	:TRIGger:PULSe:STARt:KIND ch$,A$
:TRIGger:PKIND? pls$	:TRIGger:PULSe:STARt:KIND? ch$
:TRIGger:PLEVEl pls$,A	:TRIGger:PULSe:STARt:LEVEl pls$,A
:TRIGger:PLEVEl? pls$	:TRIGger:PULSe:STARt:LEVEl? pls$
:TRIGger:PLOWEr pls$,A	:TRIGger:PULSe:STARt:LOWEr pls$,A
:TRIGger:PLOWEr? pls$	:TRIGger:PULSe:STARt:LOWEr? pls$
:TRIGger:PSIDE pls$,A$	:TRIGger:PULSe:STARt:SIDE pls$,A$
:TRIGger:PSIDE? pls$	:TRIGger:PULSe:STARt:SIDE? pls$
:TRIGger:PSLOPe pls$,A$	:TRIGger:PULSe:STARt:SLOPe pls$,A$
:TRIGger:PSLOPe? pls$	:TRIGger:PULSe:STARt:SLOPe? pls$
:TRIGger:PUPPEr pls$,A	:TRIGger:PULSe:STARt:UPPEr pls$,A
:TRIGger:PUPPEr? pls$	:TRIGger:PULSe:STARt:UPPEr? pls$
:TRIGger:SIDE ch$,A$	:TRIGger:ANALog:STARt:SIDE ch$,A$
:TRIGger:SIDE? ch$	:TRIGger:ANALog:STARt:SIDE? ch$
:TRIGger:SKIND ch$,A$	:TRIGger:ANALog:STOP:KIND ch$,A$
:TRIGger:SKIND? ch$	:TRIGger:ANALog:STOP:KIND? ch$
:TRIGger:SLEVEl ch$,A	:TRIGger:ANALog:STOP:LEVEl ch$,A
:TRIGger:SLEVEl? ch$	:TRIGger:ANALog:STOP:LEVEl? ch$
:TRIGger:SLOGPat "A$"	:TRIGger:LOGic:STOP:PATTern "A$"
:TRIGger:SLOGPat?	:TRIGger:LOGic:STOP:PATTern?
:TRIGger:SLOPe ch$,A$	:TRIGger:ANALog:STARt:SLOPe ch$,A$

Conventional command system	Corresponding command
:TRIGger:SLOPe? ch$	:TRIGger:ANALog:STARt:SLOPe? ch$
:TRIGger:SLOWEr ch$,A	:TRIGger:ANALog:STOP:LOWEr ch$,A
:TRIGger:SLOWEr? ch$	:TRIGger:ANALog:STOP:LOWEr? ch$
:TRIGger:SPKIND pls$,A$	:TRIGger:PULSe:STOP:KIND ch$,A$
:TRIGger:SPKIND? pls$	:TRIGger:PULSe:STOP:KIND? ch$
:TRIGger:SPLEVEl pls$,A	:TRIGger:PULSe:STOP:LEVEl pls$,A
:TRIGger:SPLEVEl? pls$	:TRIGger:PULSe:STOP:LEVEl? pls$
:TRIGger:SPLOWEr pls$,A	:TRIGger:PULSe:STOP:LOWEr pls$,A
:TRIGger:SPLOWEr? pls$	:TRIGger:PULSe:STOP:LOWEr? pls$
:TRIGger:SPSIDE pls$,A$	:TRIGger:PULSe:STOP:SIDE pls$,A$
:TRIGger:SPSIDE? pls$	:TRIGger:PULSe:STOP:SIDE? pls$
:TRIGger:SPSLOPe pls$,A$	:TRIGger:PULSe:STOP:SLOPe pls$,A$
:TRIGger:SPSLOPe? pls$	:TRIGger:PULSe:STOP:SLOPe? pls$
:TRIGger:SPUPPEr pls$	:TRIGger:PULSe:STOP:UPPEr pls$,A
:TRIGger:SPUPPEr pls$,A	:TRIGger:PULSe:STOP:UPPEr? pls$
:TRIGger:SSIDE ch$,A$	:TRIGger:ANALog:STOP:SIDE ch$,A$
:TRIGger:SSIDE? ch$	:TRIGger:ANALog:STOP:SIDE? ch$
:TRIGger:SSLOPe ch$,A$	:TRIGger:ANALog:STOP:SLOPe ch$,A$
:TRIGger:SSLOPe? ch$	:TRIGger:ANALog:STOP:SLOPe? ch$
:TRIGger:SUPPEr ch$,A	:TRIGger:ANALog:STOP:UPPEr ch$,A
:TRIGger:SUPPEr? ch$	:TRIGger:ANALog:STOP:UPPEr? ch$
:TRIGger:SWKIND w$,A$	:TRIGger:CALCulate:STOP:KIND ch$,A$
:TRIGger:SWKIND? w$	:TRIGger:CALCulate:STOP:KIND? ch$
:TRIGger:SWLEVEl w$,A	:TRIGger:CALCulate:STOP:LEVEl w$,A
:TRIGger:SWLEVEl? w$	:TRIGger:CALCulate:STOP:LEVEl? w$
:TRIGger:SWLOWEr w$,A	:TRIGger:CALCulate:STOP:LOWEr w$,A
:TRIGger:SWLOWEr? w$	:TRIGger:CALCulate:STOP:LOWEr? w$
:TRIGger:SWSIDE w$,A$	:TRIGger:CALCulate:STOP:SIDE w$,A$
:TRIGger:SWSIDE? w$	:TRIGger:CALCulate:STOP:SIDE? w$
:TRIGger:SWSLOPe w$,A$	:TRIGger:CALCulate:STOP:SLOPe w$,A$
:TRIGger:SWSLOPe? w$	:TRIGger:CALCulate:STOP:SLOPe? w$
:TRIGger:SWUPPEr w$,A	:TRIGger:CALCulate:STOP:UPPEr w$,A
:TRIGger:SWUPPEr? w$	:TRIGger:CALCulate:STOP:UPPEr? w$
:TRIGger:UPPEr ch$,A	:TRIGger:ANALog:STARt:UPPEr ch$,A
:TRIGger:UPPEr? ch$	:TRIGger:ANALog:STARt:UPPEr? ch$
:TRIGger:WKIND w$,A$	:TRIGger:CALCulate:STARt:KIND ch$,A$
:TRIGger:WKIND? w$	:TRIGger:CALCulate:STARt:KIND? ch$
:TRIGger:WLEVEl w$,A	:TRIGger:CALCulate:STARt:LEVEl w$,A
:TRIGger:WLEVEl? w$	:TRIGger:CALCulate:STARt:LEVEl? w$
:TRIGger:WLOWEr w$,A	:TRIGger:CALCulate:STARt:LOWEr w$,A
:TRIGger:WLOWEr? w$	:TRIGger:CALCulate:STARt:LOWEr? w$

Conventional command system	Corresponding command
:TRIGger:WSIDE w$,A$	:TRIGger:CALCulate:STARt:SIDE w$,A$
:TRIGger:WSIDE? w$	:TRIGger:CALCulate:STARt:SIDE? w$
:TRIGger:WSLOPe w$,A$	:TRIGger:CALCulate:STARt:SLOPe w$,A$
:TRIGger:WSLOPe? w$	:TRIGger:CALCulate:STARt:SLOPe? w$
:TRIGger:WUPPEr w$,A	:TRIGger:CALCulate:STARt:UPPEr w$,A
:TRIGger:WUPPEr? w$	:TRIGger:CALCulate:STARt:UPPEr? w$

15 Maintenance and Service

15.1 Repair, Correction, and Cleaning

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 depending on the usage environment and frequency.
These parts are not guaranteed to operate throughout the period defined by the recommended replacement interval.

Parts	Recommended replacement cycle	Remarks
Electrical double layer capacitor	Approx 4 years	Requires replacement of the printed circuit boards on which such parts are mounted.
Electrolytic capacitor	Approx. 10 years	
Backup battery	Approx. 10 years	Requires replacement if the clock is significantly deviated when the instrument is turned ON.
Fan motor	Approx. 10 years	At 23°C

Fuse

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.

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 or update it to the latest software version. It is recommended to back up (save/write) data such as the settings and measurement data before requesting service.

Transporting the instrument

⚠CAUTION

When transporting the instrument, follow the precautions below.

- **Remove the measurement modules, storage media, accessories, and accessories from the instrument.**
- **When requesting repair, attach a note describing the details of the malfunction.**
- **Use the original packing materials that were provided when the instrument was delivered, and double-pack it.**

  Failure to do so could damage the instrument, etc., during transportation.

Cleaning

⚠CAUTION

- **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 benzine, alcohol, acetone, ether, ketones, thinners, or gasoline. Failure to follow this instructions can deform and discolor the instrument.
- **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.

15.2 Troubleshooting

If damage is suspected, read “Before returning for repair” (p. 457) to remedy the issue. If the issue cannot be resolved, contact your authorized Hioki distributor or reseller.

Before returning for repair

Issue	Cause	Countermeasures
The power supply does not turn on even when you press the power key.	• The power cord is disconnected.	Connect the power cord properly. (p.48)
	• The AC adapter is not outputting 12 V DC.	The AC adapter cannot be repaired by the customer. Contact your authorized Hioki distributor or reseller.
The measured value cannot be acquired even when the measurement has been started.	• The pre-trigger is set to be used. (When the pre-trigger is set, the trigger is not accepted until the waveform acquisition for the pre-trigger is completed.)	Disable the pre-trigger setting if the pre-trigger is not used. (p.194)
	• The trigger is set to be used.	Set the trigger function to OFF if the trigger is not used. (p.193)
The measured value does not change.	• The cables are disconnected or broken.	Connect the cables properly. (p.54)
	• The range setting is not appropriate.	Set an appropriate range. (p.120)
Cannot save data to the media (SD memory card, USB drive).	• A medium other than Hioki optional parts is used.	Make sure to use Hioki optional SD memory card or USB drive. The operation cannot be guaranteed if a medium other than Hioki optional parts is used.
	• The medium is not inserted securely.	Insert the medium securely. (p.72)
	• The medium is not formatted (initialized).	Format the media before the first use. (p.224)
	• Free space on the media is insufficient.	Format or replace the media.
	• The number of files in the folder is 1000 or more.	Keep the number of files save in one folder 1000 or less. Although more than 1000 files can be saved, it takes a longer time for saving as the number of files increase.
Communications cannot be established properly even with LAN connection.	• Connected equipment is turned OFF.	Turn ON the instrument and connected equipment.
	• LAN cable is disconnected.	Connect the LAN cable.
	• The IP address of the instrument is not correct.	Configure settings to enable the connection of the equipment to be connected. (p.85)
	• Equipment with the same IP address already exists on the network.	Set a unique IP address that is not being used by any other equipment.

If the cause of your problem remains unclear

Perform the system reset (initialization).
See “Initialization” (p. 296) and
“14.8 Settings After Initialization (System Reset)” (p. 419).

When the power cannot be turned OFF

Hold down the POWER key for 5 seconds. This will turn OFF the power forcibly.

Error messages

Error messages include "errors" and "warnings".
When an error or warning has occurred in the instrument, the issuance status can be checked using the communication commands.
Refer to the table and the command below for the details and countermeasures for the error.
Note that measurement stops if an error occurs.
Errors or warnings may not be included in the response immediately after they have occurred. Wait for a while, and then check the errors/warnings again.

1 **Query errors in the instrument.**

The number of the error or warning that has occurred in the instrument is returned.
If the `:ERRor?` query is sent immediately after an error occurs, the information on the previous error may be returned. In such a case, send the `:ERRor?` query again.

Query		
Syntax	Query	`:ERRor?`
	Response	`A$`
Example	`:ERRor?` (Response) `:ERROR ERR_SY01` (When the header is ON)	

2 **Read out the error bit.**

The status of the error that has occurred in the instrument is returned in bit format (as a hexadecimal character string).
The statuses of all errors occurred in the instrument can be acquired at once. Refer to the bit numbers in "Error messages" (p. 460).
Example: If ERR_SY02, ERR_SY06, ERR_SY07, and ERR_SY08 have occurred, the error status is "e2".

Query		
Syntax	Query	`:ERRor:BIT:ERRor?`
	Response	`A$`
Example	`:ERRor:BIT:ERRor?` (Response) `:ERROR:BIT:ERROR 0~ffffffffffffffffffffffffffffffff` (When the header is ON)	

3 **Read out the warning bit.**

The status of the warning occurred in the instrument is returned in bit format (in hexadecimal character strings).
The statuses of all warnings occurred in the instrument can be acquired at once. Refer to the bit numbers in "Warning messages" (p. 461).
Example: If WARN_SY03, WARN_SY06, and WARN_FL02have occurred, the warning status is "2000024".

Query		
Syntax	Query	`:ERRor:BIT:WARNing?`
	Response	`A$`
Example	`:ERRor:BIT:WARNing?` (Response) `:ERROR:BIT:WARNING 0~ffffffffffffffffffffffffffffffff` (When the header is ON)	

4 **Clear the warning bit.**

Clear the statuses of the warnings occurred in the instrument.

Settings		
Syntax	Query	`:ERRor:BIT:WARNing:CLEAr`
Example	`:ERRor:BIT:WARNing:CLEAr`	

5 **Read out the error log.**

Acquire the error log saved in the instrument. The latest 50 logs can be saved.
(no$ 1 to 50)
If there is no log, the response is “---”.

Query		
Syntax	Query	`:ERRor:LOG:ERRor? no$`
	Response	`A$`
Example	`:ERRor:LOG:ERRor? 1` (Response) `:ERROR 2023/01/23 12:34:56 – ERR_SY01` (When the header is ON)	

6 **Clear the error log.**

Clear the error log saved in the instrument.

Settings		
Syntax	Query	`:ERRor:LOG:ERRor:CLEAr`
Example	`:ERRor:LOG:ERRor:CLEAr`	

7 **Read out the warning log.**

Acquire the warning log saved in the instrument. The latest 50 logs can be saved.
(no$ 1 to 50)
If there is no log, the response is “---”.

Query		
Syntax	Query	`:ERRor:LOG:WARNing? no$`
	Response	`A$`
Example	`:ERRor:LOG:WARNing? 1` (Response) `:WARNING 2023/01/23 12:34:56 – WARN_SY01` (When the header is ON)	

8 **Clear the warning log.**

Clear the warning log saved in the instrument.

Settings		
Syntax	Query	`:ERRor:LOG:WARNing:CLEAr`
Example	`:ERRor:LOG:WARNing:CLEAr`	

Error messages

No.	Bit number	Description	Countermeasures
ERR_SY01	0	Program failure. Repair required.	Turn OFF the power and request repair.
ERR_SY03	2	Clock correction circuit error. Repair required.	Turn OFF the power and request repair.
ERR_SY04	3	Internal temperature of the instrument is abnormal.	Check the operating temperature environment and the status of the fan rotation. If this message is displayed even within the operating temperature range, request repair.
ERR_SY05	4	Hardware error detected.	Turn OFF the power and request repair.
ERR_SY06	5	Module error Module No.1	The module cannot be recognized normally. The module may be malfunctioning. Request repair.
ERR_SY07	6	Module error Module No.2	
ERR_SY08	7	Module error Module No.3	
ERR_SY09	8	Module error Module No.4	
ERR_SY10	9	Module error Module No.5	
ERR_SY11	10	Module error Module No.6	
ERR_SY12	11	Module error Module No.7	
ERR_SY13	12	Module error Module No.8	
ERR_SY14	13	Module error Module No.9	
ERR_SY15	14	Module error Module No.10	
ERR_SY16	15	CAN controller error	Turn OFF the power and request repair.
ERR_SY17	16	The status of the fan of the instrument is abnormal.	
ERR_PW01	32	The status of the fan of the M7103 Power Measurement Module is abnormal.	
ERR_PW02	33	The status of the fan of M1100 AC Power Supply Module is abnormal.	
ERR_PW04	35	Module error Module No.1	The M7103 Power Measurement Module cannot be detected normally. The module may be malfunctioning. Request repair.
ERR_PW05	36	Module error Module No.2	
ERR_PW06	37	Module error Module No.3	
ERR_PW07	38	Module error Module No.4	

Warning messages

No.	Bit number	Description	Countermeasures
WARN_SY01	0	Failed to upgrade.	Turn OFF the power and perform the upgrade again. If the upgrade fails again, request repair.
WARN_SY02	1	Internal temperature of the instrument has risen. Check the operating environment.	Check the state of the instrument's installation. See "Installing the instrument" (p. 13).
WARN_SY03	2	Internal temperature of the instrument has risen. Check the operating environment.	Check the state of the instrument's installation. See "Installing the instrument" (p. 13).
WARN_SY04	3	No channel selected for measurement.	Measurement is set to OFF in all channels. Set the measurement to ON in one or more channels and then start the measurement. While measurement is set to OFF for all channels, if measurement is started using a communication command, a "WARN_COM02" communication command error occurs.
WARN_SY05	4	Failed to initialize.	Perform the initialization again. This warning can occur due to a key operation during the initialization. Do not operate any keys during initialization.
WARN_SY06	5	System warning (SY06). Turn ON the instrument again.	Turn OFF the instrument and then turn it ON again.
WARN_SY07	6	The wiring is abnormal. Check the connection and settings of the primary and secondary units.	Check the connection and settings of the primary and secondary units. (p.65, p.113)
WARN_SY08	7	Measurement is stopped, because the synchronization signal is stopped.	Turn OFF the instrument and then turn it ON again.
WARN_SY09	8	Module connection error The current module configuration cannot be used. Review the connections.	Verify that the measurement modules are connected properly. • More than 10 modules are connected. • More than 5 M7103 are connected. • A different module is connected between the M7103 and the instrument. • One or more M7103 modules are connected, but no M1100 module is connected.
WARN_FL01	24	File processing error.	Unexpected abnormality has occurred while processing files on the SD memory card or USB drive. Replace with other media or turn ON the instrument again.
WARN_FL02	25	Waveform data not found	Acquire waveform data.
WARN_FL03	26	Numerical calculation data not found	Perform numerical calculation.
WARN_FL04	27	Cannot load this file	The selected file is created in the format that the instrument cannot load, or the selected file is corrupt. Load a suitable file.

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No.	Bit number	Description	Countermeasures
WARN_FL05	28	Insufficient storage memory	The file cannot be saved because the available space on the storage medium is low. Delete unnecessary files to secure a sufficient space or use a new medium.
WARN_FL06	29	Media is full or cannot delete oldest wave file	The file could not be saved, because free space on the SD memory card or USB drive is insufficient. Delete unnecessary files to secure a sufficient space or use a new medium.
WARN_FL07	30	This folder cannot be deleted or renamed on the instrument.	This message is displayed to prevent deletion of the data by an erroneous operation. Use a PC to delete or change the name of the folder.
WARN_FL08	31	File is damaged	The file cannot be loaded, because the information in the file is damaged. Load a suitable file.
WARN_FL10	33	This folder/file is protected.	The read-only folders and files cannot be deleted. Use a PC to delete these folders or files.
WARN_FL11	34	Data cannot be loaded, because the model configuration of the modules directly connected to the instrument does not match the model configuration in the file.	Data can be loaded in overwrite mode if the configuration of the plug-in modules is the same as the configuration of plug-in modules when the data are saved. Check the module configuration in the browsing mode.
WARN_FL12	35	Storage media not found.	Insert an SD memory card or USB drive.
WARN_FL13	36	Insert SD memory card or USB drive.	Insert an SD memory card or USB drive
WARN_FL14	37	Storage media is almost full	Free space on the media is insufficient. Replace with a new medium.
WARN_FL15	28	Unsaved data will be deleted shortly. Please insert storage media.	If the realtime save operation is started without inserting any media, this warning is displayed when the data on the internal buffer memory exceeds 50%. Insert an SD memory card or USB drive
WARN_FL16	39	Unsaved data present.	It is possible that no SD memory card or USB drive is inserted or free space is insufficient. Insert an SD memory card or USB drive and save the necessary data manually.
WARN_FL17	40	File name including the folder is too long - file operation unsuccessful.	The specified path name is too long. Use a PC to shorten the name of folders saved on the SD memory card or USB drive.
WARN_FL18	41	Busy	Wait for the process to be completed before proceeding with any operations.

No.	Bit number	Description	Countermeasures
WARN_SU04	59	Measurement cannot be started with the current settings. Please optimize the following settings. For details, see the instruction manual. • Recording interval • Number of measurement ON channels • Auto save format	The number of channels that can be used is limited depending on the recording interval and auto-save settings. • Recording interval (p.353) • Number of measurement ON channels (p.353) • Auto save format (p.226)
WARN_COM02	65	Communication command error	Check the content of the communication command.
WARN_COM03	66	No communication command is input.	Check the content of the communication command.
WARN_FTP01	72	Failed to connect to FTP server	Check the FTP data auto send setting and the connection.
WARN_FTP02	73	FTP data transfer failed. File not found.	Manually acquire the file that has not been sent from the instrument using FTP, or load the file from the recording destination media.
WARN_PW01	76	The connected sensor is not consistent with the settings.	When the measurement lines are connected to the same wiring, connect the current sensor with the same rating. Or, the current sensor reading has failed. Check the connection.
WARN_PW04	79	The current sensor has changed.	–
WARN_PW05	80	The sensor power supply voltage has decreased.	Turn off the instrument and check the operating environment.
WARN_PW06	81	The sensor power supply voltage has decreased for at least 1 s.	

Normalization process

When settings are changed or measurement is started, the settings may be automatically changed (normalized) according to various limitations of the settings. Check the status using the following command and the table below.

Read out the normalization bit.
The value is returned in hexadecimal character strings and the bit is cleared.

Query		
Syntax	Query	`:NRMFlag?`
	Response	`A$`
Example	`:NRMFlag?` (Response) `:NRMFLAG 3b` (when the header is ON and normalization of bit numbers 1, 2, 4, 5, and 6 has occurred)	
Parameter		
`A$` = 0 to ffffffff Example: In the case of 3b, it is 00111011 in a binary character string, and the contents of bit numbers 0, 1, 3, 4, and 5 are normalized.		

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Normalization bit and contents

Bit number	Target	Description
0	Others	Normalization of other than those described below.
1	Recording interval	Normalization of the recording interval
2	External input terminal (I/O 3)	If the external trigger setting is ON, changes the external input terminal (I/O 3) setting to the trigger input.
3	Recording time	Changes the recording time according to the number of channels to be used and the recording interval.
4	Waveform data division time in the auto-save operation	Changes the waveform data division time according to the recording interval.
5	Numerical calculation result split time in the auto-save operation	Changes the split time numerical calculation results according to the recording interval.
6	Pre-trigger time	Changes the pre-trigger time according to the recording interval.
7	Data refresh interval of module	Changes the data refresh interval of module according to the recording interval.
8	Waveform data saving format in the auto-save operation	Changes the waveform data saving format according to the number of channels to be used and the recording interval. See “Auto save (Realtime save)” (p. 226).
9	Repetitive recording	If the interval trigger is set to ON, changes the repetitive recording setting to ON. See “5.7 Applying Triggers at Constant Intervals” (p. 215).
10	Interval trigger	If the repetitive recording is set to OFF, changes the interval trigger setting to OFF. See “5.7 Applying Triggers at Constant Intervals” (p. 215).
12	Measurement start time and measurement stop time	Changes the measurement start time and measurement stop time. See “4 Set the measurement start time.” (p. 111) and “5 Set the measurement stop time.” (p. 108).
13	Burnout detection	Changes the burnout detection setting to OFF in accordance with the change in the data refresh interval. See “Data refresh interval of the measurement modules” (p. 115).
14	Wiring mode	Change the delta conversion settings and channel settings to suit the wiring mode. See “2.9 Wiring the Power Measurement Module to the Measurement Line” (p. 76) and “Setting the conversion” (p. 143)

15.3 Disposal

Backup lithium batteries are built into the instrument. When disposing of the instrument, remove the lithium batteries and handle and dispose of the instrument in accordance with local regulations.

⚠DANGER

- **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.

⚠WARNING

- **Before removing the lithium battery, turn OFF the instrument and remove the power cord and the cables.**

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

- **Keep the removed battery out of reach of children.**

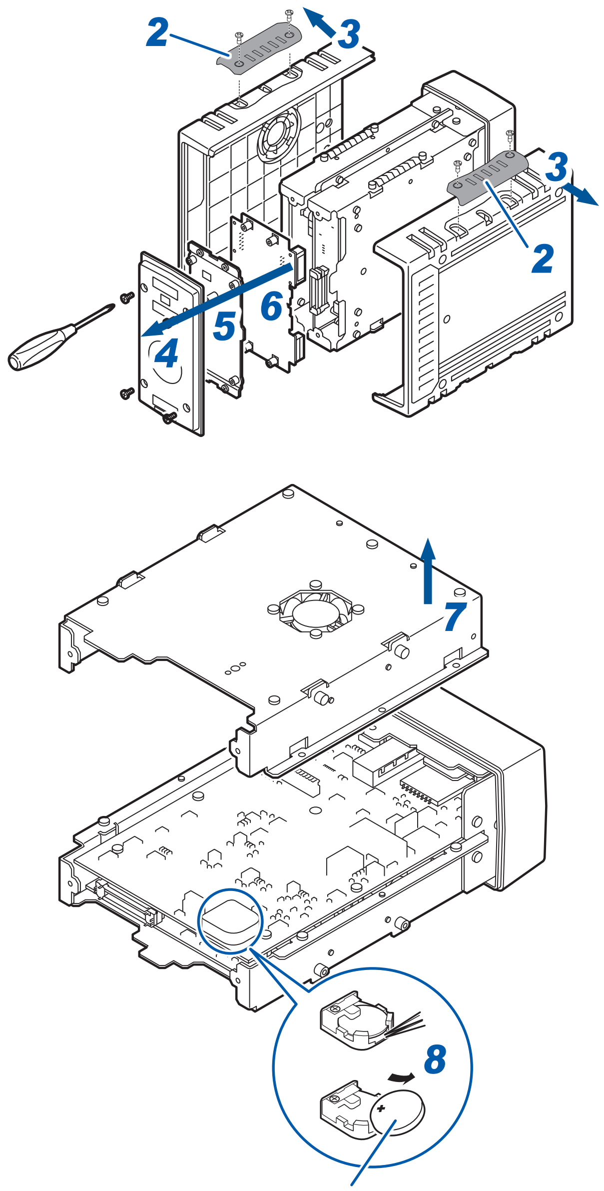
  Children may accidentally swallow the battery.

Dispose of the battery in accordance with local regulations.

CALIFORNIA, USA ONLY
Perchlorate Material - special handling may apply.
See https://dtsc.ca.gov/perchlorate/

How to remove lithium batteries

Required items: Phillips screwdriver (No. 2), tweezers



Lithium battery

1. **Confirm that the instrument is turned OFF. Remove the power cord and the cables.**
2. **Remove the cover. (4 locations)**
3. **Remove the side panels on both sides.**
4. **Remove the rear panel.**
5. **Remove the plate at the rear.**
6. **Remove the motherboard.**
7. **Remove the plate.**
8. **Insert a pair of tweezers between the battery and the battery holder, and then lift up the battery to remove it.**

15.4 FAQ (Frequently Asked Questions)

Installation and measurement operation

Query	Answer	Reference
What happens to the data if a power failure occurs during the measurement?	The measurement data cannot be retained.	“Preparations and settings in case of power failure” (p. 223), “Start backup” (p. 287)
What can I do to restart the recording after the power is restored?	The recording can be restarted after the power is restored by using the start backup function.	“10.1 Setting the Environment” (p. 287)
Why is the temperature error increased immediately after the instrument is moved to a location with a significantly different temperature?	For the temperature measurement using a thermocouple, the reference junction compensation is performed by measuring the terminal temperature using the internal temperature sensor. If the environment temperature changes drastically, the thermal equilibrium between the terminal block and the temperature sensor is disrupted, causing the error. When the instrument is moved to a location with a significantly different temperature, wait for at least 60 minutes before performing measurement.	“Installing the instrument” (p. 13)
What can I do to correct a deviation in the zero position of the input?	The deviation in the zero position can be corrected using the zero adjustment function.	“Performing Zero Adjustment” (p. 170)
What should I do if a measured value appears in an unconnected channel even when only CH1 is input?	When the input terminal is open, it may display a waveform affected by other channels. Set the input open channel to OFF or short the plus and minus terminals.	–
The measured value fluctuates even when there is no input. What should I do?	Due to induced voltage, the measured value may become unstable; however, this is not a malfunction.	–
Is it possible to place event marks during the measurement and search for them later?	Event marks can be placed on the measurement data. Use Logger Utility to jump to the display of the event mark.	“8.1 Placing Event Marks During Measurement” (p. 267)
The measured value cannot be acquired after the measurement has been started.	If the trigger is set, the recording is not started until the trigger is activated. You can activate the trigger forcibly.	“5 Trigger Function” (p. 191), “5.8 Applying Trigger Forcibly” (p. 217)
The measured data includes unusual values, such as +7.77777E+99 and +8.88888E+99. What does this mean?	The meaning indicated by special values varies depending on the data acquisition method.	“14 Data Handling” (p. 428)

MR7100 and MR7102

Query	Answer	Reference
Is it possible to measure the temperature of the part where voltage is applied?	The temperature can be measured if the voltage is not exceeding the maximum voltage between channels and the maximum voltage to the ground connection. If the voltage exceeds the maximum voltages, use an ungrounded thermocouple, for example, so that the voltage will not be applied to the input terminal.	"Precautions for measurement" (p. 16)
Which should I set for the reference junction compensation, **[EXT]** or **[INT]**? What is the accuracy in this case?	To connect a thermocouple to the terminal block of the module, set INT (internal). The measurement accuracy is the value obtained when the temperature measurement accuracy and reference junction compensation accuracy are added. Example: When measuring the temperature in the range between 0°C and 100°C using thermocouple K The measurement accuracy is ±1.0°C, which is the value obtained when the temperature measurement accuracy ±0.5°C and reference junction compensation accuracy ±0.5°C are added.	"Temperature (thermocouple) measurement" (p. 122)

MR7103

Query	Answer	Reference
The settings cannot be changed.	Settings can only be changed while measurement is stopped or simple measurement is being performed. In addition, instrument firmware V1.50 or later is required in order to use the M7103.	"Starting simple measurement (for the M7103 Power Measurement Module)" (p. 151)
The voltage/current measurement value is invalid.	Check the connections of the voltage cords and current sensor.	"Connecting the voltage cords" (p. 67), "Connecting the voltage cords" (p. 67)
The active power value is invalid.	Check the settings of the voltage range and current range.	"Setting the power measurement range" (p. 126)
The frequency cannot be measured. The measurement values are not stabilized.	Check the input frequency. If the input frequency is below the measurement lower limit frequency, the frequency cannot be measured. If a distorted waveform is input, such as PWM waveform, decrease the frequency of the zero cross filter.	"Zero cross filter and measurement lower limit frequency (measurable frequency range setting)" (p. 132)
	Check the synchronization source settings.	"Synchronization source" (p. 129)
The three-phase voltage is measured lower than it actually is.	When the phase voltage is measured using the Δ-Y conversion function, set the Δ-Y conversion function to OFF.	"Delta conversion function" (p. 142)

Query	Answer	Reference
The power measurement value is not correct.	Check the wiring.	“Checking connection” (p. 84)
	Check the rectification method settings.	“Rectification method” (p. 133)
The current is not zero even when there is no input.	If a low current range is used for the universal clamp-on CT, set the LPF to 100 kHz, and then execute zero adjustment.	“Low-pass filter (LPF)” (p. 131), “Wiring to the measurement line” (p. 82)
The apparent/reactive power and power factor values on the secondary side of the inverter differ from those of the other measuring instruments. The displayed voltage value is higher than it actually is.	Set the same rectification method as that for the other measuring instruments.	“Rectification method” (p. 133)
	Use the same formula as that for the other measuring instruments.	“Power formula” (p. 144)

Data saving

Query	Answer	Reference
Can I use a commercially available SD memory card or USB drive?	Make sure to use Hioki optional SD memory card or USB drive. The operation cannot be guaranteed for a commercially available SD memory card or USB drive.	“2.8 SD Memory Card and USB Drive” (p. 72)
	A USB drive with security functions, including fingerprint authentication, cannot be used.	
Can I replace the media during the auto-save operation?	You cannot replace the media during the auto-save operation. Try to select split saving, deleting, or FTP function.	“6.3 Saving Data” (p. 225) “12.3 Acquiring Data with the FTP Server” (p. 324) “12.4 Sending Data Using the FTP Client” (p. 326)
How many days can I record data?	The allowable recording length setting varies with the number of channels and the recording interval. Example: With the recording interval 1 s, 15 channels, and 1 GB media, a recording of approx. 200 days is possible.	“14.7 File Size” (p. 418)
Can I view the waveform data in Excel?	Automatically saved waveform data (binary format) can be converted to the text format (CSV) using Logger Utility. The CSV files can be read in Excel.	“12.1 Using Logger Utility” (p. 311)
I want to set the time (absolute time), instead of the elapsed time (relative time), for the time axis of the waveform data (CSV format). What should I do?	Set the horizontal (time) axis display to date. • Time: Elapsed time since the measurement is started • Date: Actual time (date and time) • Number of data: Number of data since the measurement is started.	“Horizontal (time) axis display” (p. 290)

15.5 Open-source Software

The product includes software under GNU General Public License, GNU Lesser General Public License, and other licenses.
Under these licenses, the customer has a right to obtain, modify, or redistribute the source codes of the software.
For more information, see the following website.
https://www.hioki.com/global/support/oss
Please understand that we cannot answer questions regarding the contents of the source codes.

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