HIOKI

Instruction Manual

MR6000
MR6000-01

MEMORY HiCORDER

EN

Feb. 2018 Edition 1
MR6000A966-00 18-02H

600516590

Contents

Introduction

Thank you for purchasing the HIOKI MR6000, MR6000-01 Memory HiCorder. To obtain maximum performance from the instrument over the long term, be sure to read this manual carefully and keep it handy for future reference.
Model MR6000-01 Memory HiCorder is a model of Model MR6000 equipped with the following calculation functions (options):

- Digital filter calculation
- Real-time waveform calculation

Following manuals are provided along with these models. Refer to the relevant manual based on the usage.

Type	Contents	Print	PDF
Operating Precautions	Information on the instrument for safe operation	✓	–
Quick Start Manual	Basic instructions and instrument specifications	✓	–
Instruction Manual (this document)	Functions and instructions for the instrument	–	✓
Calculation Guide (Options)	Method to use the calculation functions, etc. available only with Model MR6000-01	–	✓

Notations

*	Additional information is presented below.
☑	Indicates the initial setting values of the items. Initialization sets the items to these values.
(p.)	Indicates the location of reference information.
START (Bold-faced)	Indicates the names and keys on the windows in boldface.
[ ]	Menus, dialogs, buttons in a dialog, and other names on the screen are indicated in brackets.
Windows	Unless otherwise specified, “Windows” represents Windows 7, Windows 8, and Windows 10.
Current sensor	Sensors measuring current are referred to as “current sensor.”
S/s	The number of times per second the analog input signals are digitized by the instrument is expressed in terms of “samples per second (S/s).” Example: “20 MS/s” (20 megasamples per second) indicates that the signal is digitized 20×10^6 times per second.

Accuracy

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

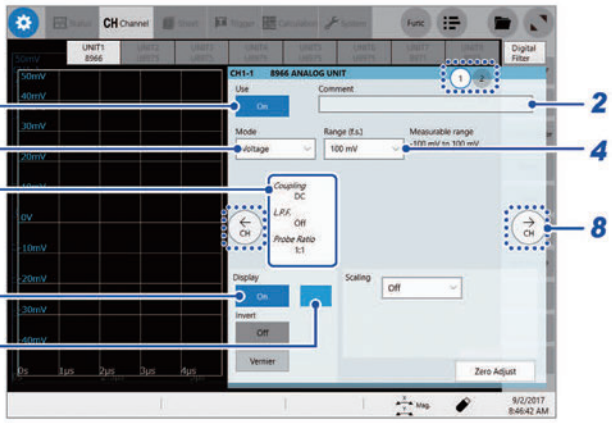
f.s.	(maximum display value or scale length) The maximum displayable value or scale length.
rdg.	(displayed value) The value presently being measured and indicated on the measuring instrument.

How to Refer to This Manual

How to open a screen
Indicates the order of tapping the screens.
The button  represents the setting key.

Sequence numbers
Numbered same as a corresponding step-by-step instruction.

Options and explanations
Describes selectable settings when an item is tapped.
The icon ☑ indicates the default setting of the item.



1 Set [Use] to On.

On☑	Measures a waveform through this module.
Off	Does not measure any waveform through this module. Since no data is acquired, nothing can be displayed or saved.

2 Enter text in [Comment].
Number of characters that can be entered: up to 40

3 Set [Mode].

Voltage☑	Measures a waveform in voltage mode.
Temperature	Measures a waveform in temperature mode.

The settings of these modes vary depending on the installed modules.
Refer to "3.6 Configuring Each Module-Specific Setting" of Instruction Manual.

4 Set [Range (f.s.)] for each channel.
The measurement ranges that can be set varies depending on modules.
If the input voltage exceeds the measurable range (overrange), change the measurement range to one having a lower sensitivity.

1 Measurement Method

1.1 Measurement Procedure

Inspecting the instrument before measurement

↓

Configuring the basic settings for measurement

- Set the sampling rate. (p. 5)
- Set the recording length. (p. 6)

Advanced settings:
- "Using the envelope" (p. 9)
- "3.1 Overlaying New Waveforms With Previously Acquired Waveforms" (p. 40)

Setting the input channels (p. 11)

- Set the analog channels. (p. 13)
- Set the logic channels. (p. 17)

Advanced settings:
- "3.2 Converting Input Values (Scaling Function)" (p. 42)
- "3.3 Fine-Adjusting Input Values (Vernier Function)" (p. 48)
- "3.4 Inverting the Waveform (Invert Function)" (p. 49)

Setting the sheets

- Set the display format of waveforms. (p. 18)

Setting the triggers (p. 81)

↓

Starting a measurement (p. 20)

↓

Finishing the measurement

Advanced operation:
- "2.2 Specifying the Waveform Range (Section Cursor)" (p. 26)
- "Scrolling waveforms" (p. 30)
- "2.5 Changing the Display Position and Display Magnification of the Waveforms" (p. 47)
- "4 Saving/Loading Data and Managing Files" (p. 65)
- "7 Numerical Calculation Function" (p. 119)

To perform the automatic setup

On the waveform screen, tap **[Auto range]** to set the sampling rate, measurement range, and zero position of input waveforms automatically, and then start a measurement.
Refer to “3.7 Measurement With the Auto-range Setting” in Quick Start Manual.

To load settings registered previously

Load the settings file on the file screen.
Refer to “4.3 Loading Data” (p. 77).

To load saved settings automatically at the time of startup

Configure the setting for the instrument so as to load the file containing the instrument settings at the time of startup.
Refer to “Loading the settings automatically (Auto-setup function)” (p. 78)

To initialize the instrument (restoring the basic settings)

Restore the instrument settings to the factory default by tapping **[Initialize]**, which is accessible by proceeding in the following order:

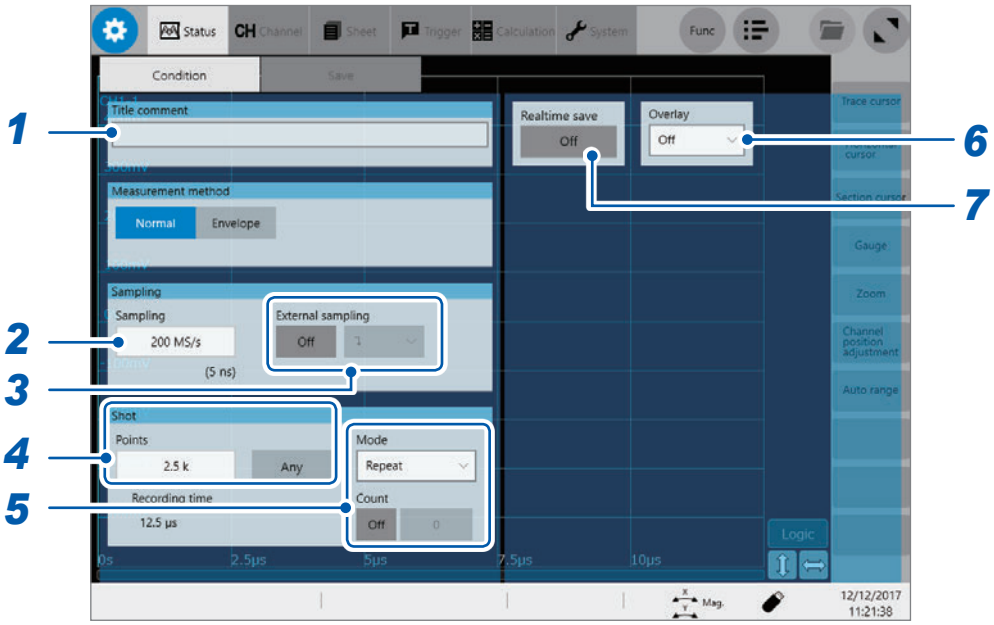
 > **[System]** > **[Initialize]**

The setting after the initialization is suitable for simple measurement.
If any unexpected or complicated behavior is observed, initialize the instrument.
Refer to “6.2 Initializing the Instrument” in Quick Start Manual.

1.2 Configuring Measurement Conditions

Configure conditions required for measurement including the sampling rate (**[Sampling]**) and recording length (**[Shot]**).

> [Status] > [Condition]



1 Type a comment in the [Title comment] box.

Number of characters: up to 40

2 Set [Sampling].

Refer to “Sampling rate setting guideline” (p. 7).

200 MS/s☑, 100 MS/s, 50 MS/s, 20 MS/s, 10 MS/s, 5 MS/s, 2 MS/s, 1 MS/s,
500 kS/s, 200 kS/s, 100 kS/s, 50 kS/s, 20 kS/s, 10 kS/s, 5 kS/s, 2 kS/s, 1 kS/s,
500 S/s, 200 S/s, 100 S/s, 50 S/s, 20 S/s, 10 S/s, 5 S/s, 2 S/s, 1 S/s

When the real-time waveform calculation (Model MR6000-01 only) is set to **[On]**, a sampling rate of 200 MS/s cannot be selected.
When the real-time save is set to **[On]**, due to the combination of the number of channels to be used and save destinations, the maximum sampling rate that can be set varies as follows:

Number of channels to be used	Maximum sampling rate that can be set		
	SSD	HDD	USB flash drive SD card FTP transmission
1 channel to 2 channels	20 MS/s	10 MS/s	5 MS/s
3 channels to 4 channels	10 MS/s	5 MS/s	2 MS/s
5 channels to 8 channels	5 MS/s	2 MS/s	1 MS/s
9 channels to 16 channels	2 MS/s	1 MS/s	500 kS/s
17 channels to 32 channels	1 MS/s	500 kS/s	200 kS/s

Only if the following Hioki-designated options are used, the real-time save operation with the instrument is guaranteed:
- Model U8332 SSD Unit
- Model U8333 HD Unit
- Model Z4006 USB Drive
- Model Z4001 and Model Z4003 SD Memory Card

3 Set [External sampling].

The external sampling is disabled when the envelope is used.

Off☑	Disables the external sampling function.
On	Select this option to sample data at a sampling rate defined by a signal input into the external sampling terminal (EXT.SMPL).

↑	Samples data at rising edges of the input signal.
↓☑	Samples data at falling edges of the input signal.

4 Set [Shot].

Tap **[Points]** to set the number of measurement points.

2.5 k☑**, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 2 M, 5 M, 10 M, 20 M, 50 M, 100 M, 200 M, 500 M, 1 G**

Enabling **[Any]** and tapping **[Points]** allows you to set the number of points in increments of 100.
When the real-time save is set to **[On]**, **[Shot]** cannot be set in terms of **[Points]**.
Set **[Recording time]** on the **[Save]** screen. (p. 73)
The maximum recording length that can be set varies depending on the number of channels to be measured.

5 Set [Mode].

Single	Measures waveforms only once. Pressing the **START** key starts recording waveforms, and then stops when the specified recording length of the waveforms have been acquired.
Repeat☑	Measures waveforms repeatedly. Pressing the **STOP** key stops the measurement in progress.

When **[Repeat]** mode is set and **[Count]** is set to **[On]**, the specified number of measurements are performed.
Only **[Single]** mode can be selected when **[Realtime save]** is set to **[On]**.

6 Set [Overlay].

Refer to “3.1 Overlaying New Waveforms With Previously Acquired Waveforms” (p. 40).

7 Set [Realtime save] to [On].

Data can be recorded in the optional storage device while measuring waveforms.
Refer to “Real-time save” (p. 72).

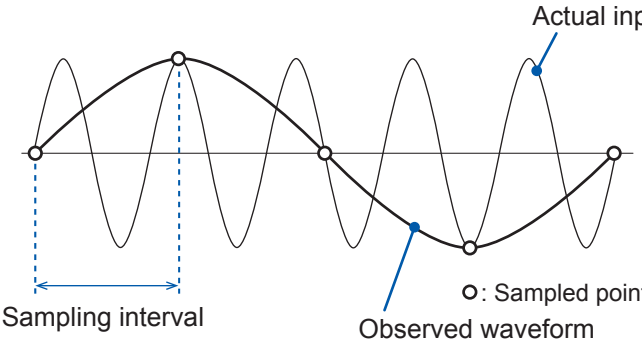
Sampling rate setting guideline

Select a sampling rate using the following table as a guideline.

Maximum display frequency	Sampling rate	Maximum display frequency	Sampling rate
8 MHz	200 MS/s	400 Hz	10 kS/s
4 MHz	100 MS/s	200 Hz	5 kS/s
2 MHz	50 MS/s	80 Hz	2 kS/s
800 kHz	20 MS/s	40 Hz	1 kS/s
400 kHz	10 MS/s	20 Hz	500 S/s
200 kHz	5 MS/s	8 Hz	200 S/s
80 kHz	2 MS/s	4 Hz	100 S/s
40 kHz	1 MS/s	2 Hz	50 S/s
20 kHz	500 kS/s	0.8 Hz	20 S/s
8 kHz	200 kS/s	0.4 Hz	10 S/s
4 kHz	100 kS/s	0.2 Hz	5 S/s
2 kHz	50 kS/s	0.08 Hz	2 S/s
800 Hz	20 kS/s	0.04 Hz	1 S/s

If the instrument plots non-existent waveforms (aliasing)

If a measured signal oscillates at a higher frequency compared to the specified sampling rate, the instrument may plot non-existent waveforms oscillating at a lower frequency than that of the actual signal when the signal frequency reaches a certain level. This phenomenon is called aliasing.



A sampling interval longer than the cycle of the input signal causes aliasing.

To plot a sign wave that allows you to observe the peaks of the sine wave on the LCD without any aliasing, the instrument needs to sample the waveform at a minimum of 25 points per cycle.

To set the sampling rate automatically

Refer to “3.7 Measurement With the Auto-range setting” in Quick Start Manual.

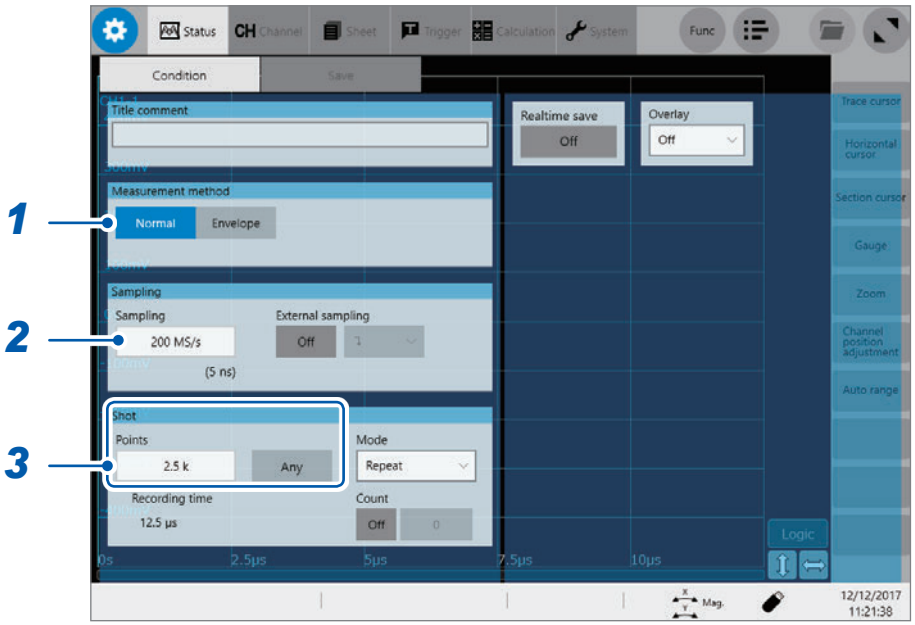
Update rate of each module

The data update rate is not allowed to exceed the maximum sampling rate of each module.
The same data are measured until they get updated, causing the instrument to plot a stair-step waveform.
In addition, even though the same signal is measured simultaneously, values may vary due to differences in the sampling rate, frequency range, and frequency characteristics of modules.

Module	Sampling rate of module	Reference
Model 8966 Analog Unit	20 MS/s (50 ns)	–
Model 8967 Temp Unit	Varies according to the data refresh setting.	p. 52
Model 8968 High Resolution Unit	1 MS/s (1 µs)	–
Model U8969 Strain Unit	200 kS/s (5 µs)	p. 54
Model 8970 Freq Unit	Varies according to the setting.	p. 56
Model 8971 Current Unit	1 MS/s (1 µs)	p. 59
Model 8972 DC/RMS Unit	Varies according to the response setting.	p. 61
Model 8973 Logic Unit	20 MS/s (50 ns)	–
MR8990 Digital Voltmeter Unit	Varies according to the NPLC setting.	p. 62
Model U8974 High Voltage Unit	1 MS/s (1 µs)	p. 64
Model U8975 4ch Analog Unit	5 MS/s (200 ns)	–
Model U8976 High Speed Analog Unit	200 MS/s (5 ns)	–

Using the envelope

> [Status] > [Condition]

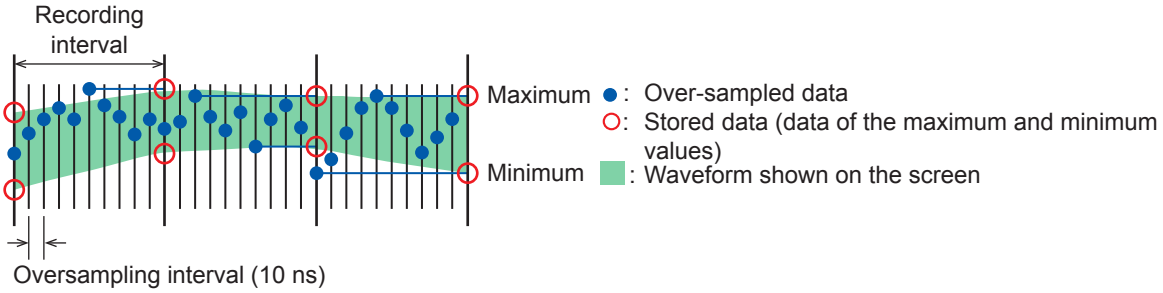


1 Set [Measurement method] to [Envelope].

Normal☑	Does not use the envelope.
Envelope	Uses the envelope.

- Normal:
  The instrument records data at the specified sampling rate.
- Envelope:
  At the specified recording interval, the instrument records the maximum and minimum values among data sampled within each specified recording interval at an over-sampling rate* of 100 MS/s. Hence, even though a relatively longer recording interval is set, peaks of fluctuations can be recorded without being missed.

  *: Over-sampled data (indicated by blue dots ● in the figure) are not saved.
- Values to be acquired using the envelope



A set of sampled data acquired using the envelope consists of two values: the maximum value and the minimum value. These values are taken from the measured values acquired at an over-sampling rate during the recording interval set in **[Sampling]**. When shown on the screen, they are displayed as if they range in amplitude. When saved in an external storage device, the data of the maximum and minimum values are stored for a single instance of measurement.

2 Set [Sampling].

The following are the sampling rates that can be selected when the envelope is used.

10 MS/s☑, 5 MS/s, 2 MS/s, 1 MS/s, 500 kS/s, 200 kS/s, 100 kS/s, 50 kS/s, 20 kS/s, 10 kS/s, 5 kS/s, 2 kS/s, 1 kS/s, 500 S/s, 200 S/s, 100 S/s, 50 S/s, 20 S/s, 10 S/s, 5 S/s, 2 S/s, 1 S/s, 30 S/min, 12 S/min, 6 S/min, 2 S/min, 1 S/min

3 Set [Shot].

Tap **[Points]** to set the number of measurement points.

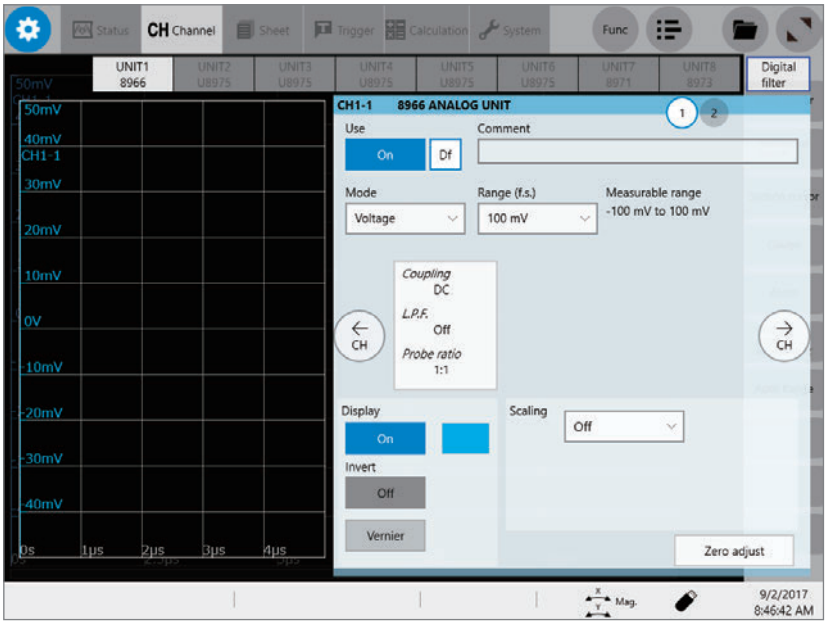
2.5 k☑, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 2 M, 5 M, 10 M, 20 M, 50 M, 100 M, 200 M, 500 M, 1 G

Enabling **[Any]** and tapping **[Points]** allows you to enter **[Points]** in increments of 100 points.
When the real-time save is set to **[On]**, **[Shot]** cannot be set in terms of **[Points]**.
Set **[Recording time]** on the **[Save]** screen. (p. 73)
The maximum recording length that can be set varies depending on the number of channels to be measured.

1.3 Setting Input Channels

Configure the settings of the analog and logic channels.

> [Channel]



Operation available on the [Channel] screen

- Adding a comment to a channel
- Setting measurement conditions for a channel
- Setting the display method of waveforms
- Converting measured values into physical quantities and displaying them

Channel setting procedure

Analog channels (CH1 through CH32) setting procedure

Configuring input settings

- Set the measurement mode. (p. 13)
- Select an appropriate range for measurement. (p. 14)
- Convert input values. (Scaling function) (p. 16)
- Set the input coupling. (p. 15)
- Set the low-pass filter (if noise is observed). (p. 15)

Configuring the display settings

- Set the display color of waveforms. (p. 16)
- Convert input values. (Scaling function) (p. 16)

Logic channels (Model 8973 Logic Unit) setting procedure

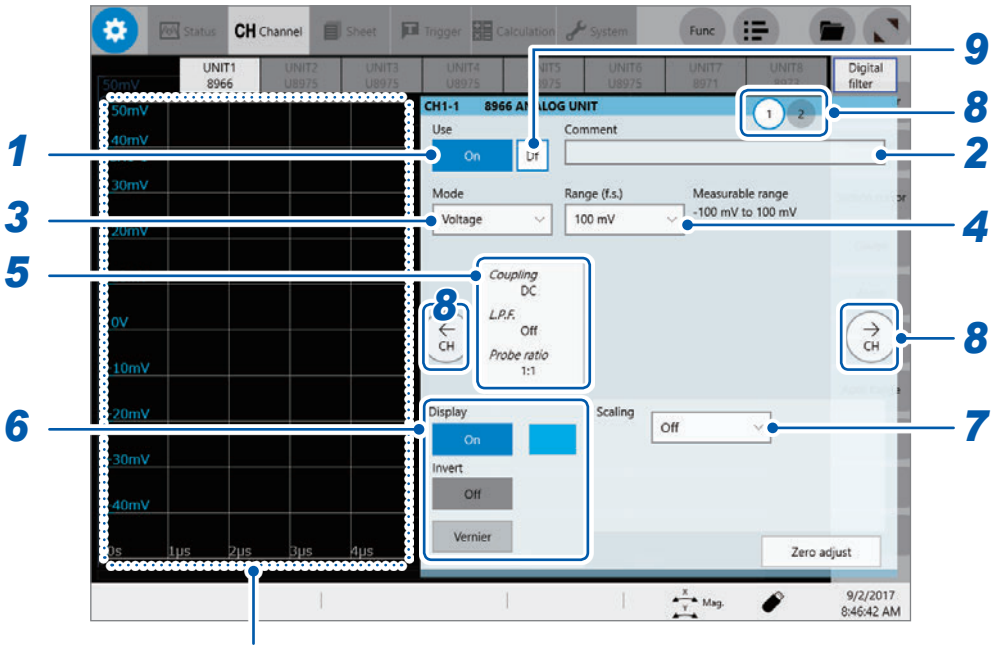
Configuring the display settings

- Set the logic recording width. (p. 17)
- Set the display positions of waveforms. (p. 17)
- Set the display colors of waveforms. (p. 17)

Analog channels

For details on setting each module, refer to “3.6 Configuring Module-Specific Settings” (p. 51).

> [Channel] > [UNIT]



The waveform screen is displayed during measurement.
When no measurement is not performed, the presently input waveforms are displayed on the monitor.

1 Set [Use] to [On] or [Off].

On☑	Sets the module as the measurement device.
Off	Does not set the module as the measurement device. Since no data is acquired, nothing can be displayed or saved.

2 Type a comment in the [Comment] box.

Number of characters: up to 40

3 Set [Mode].

Voltage☑	Measures a waveform in voltage mode.
Temperature	Measures a waveform in temperature mode.

Settings vary depending on the installed modules.
Refer to “3.6 Configuring Module-Specific Settings” (p. 51).

4 Set [Range (f.s.)].

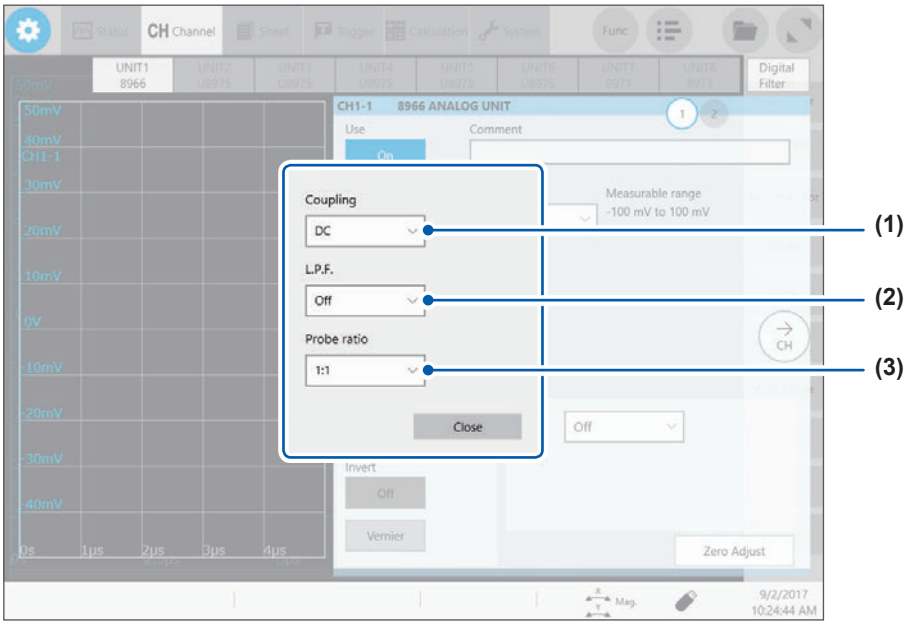
Set the measurement range for each channel. The value of the range represents its maximum displayable value (f.s.).
See the following table for the full-scale resolution of each module.
If the input voltage exceeds the measurable range (overrange occurs), change the measurement range to one having a lower sensitivity.
After changing **[Range (f.s.)]**, check the **[Level]**, **[Upper]**, **[Lower]**, and other values of the trigger, search, and numerical calculation functions.

Module	Resolution [LSB]
Model 8966 Analog Unit, Model 8971 Current Unit, Model 8972 DC/RMS Unit	2,000
Model 8967 Temp Unit	20,000
Model 8968 High Resolution Unit, Model U8974 High Voltage Unit, Model U8975 4ch Analog Unit	32,000
Model U8976 High Speed Analog Unit	1,600
Model U8969 Strain Unit	25,000
Model 8970 Freq Unit (Power frequency mode)	2,000
Model 8970 Freq Unit (Count mode)	40,000
Model 8970 Freq Unit (Frequency mode, rotation speed mode, duty ratio mode, pulse width mode)	10,000
Model MR8990 Digital Voltmeter Unit	1,000,000

*: For the Model 8967 Temp Unit, the valid range varies depending on the thermocouples. For more information about resolution, refer to “Model 8967 Temp Unit” in “5.2 Specifications for Options” in Quick Start Manual.

5 Set [Coupling], [L.P.F.], and [Probe ratio].

Tap the screen to open the settings dialog box.



(1) Set [Coupling].

The input signal coupling method can be specified. In general, use the DC coupling.

DC☑	Measures both DC and AC components of an input signal.
AC	Measures an AC component only of an input signal. A DC component can be eliminated.
GND	Connect the input terminal to the ground (Enables you to check the zero position).

(2) Set [L.P.F.] (low-pass filter).

Enabling the low-pass filter installed in the module allows elimination of unwanted high-frequency components. The filters that can be set varies depending on the type of modules. Select a filter according to the characteristics of the input signals.
Example: For Model 8966 Analog Unit

Off☑, **5 Hz**, **50 Hz**, **500 Hz**, **5 kHz**, **50 kHz**, **500 kHz**

(3) Set [Probe ratio].

Select this setting when the measurement is to be performed with a connection cable or probe.

1:1☑	Select this option when using Model L9197, Model L9198, Model L9790, or Model L9217 Connection Cord.
1:10	Select this option when using Model 9665 10:1 Probe.
1:100	Select this option when using Model 9666 100:1 Probe, Model P9000-01 Differential Probe, or Model P9000-02 Differential Probe.
1:1000	Select this option when using Model 9322 Differential Probe, Model P9000-01 Differential Probe, or Model P9000-02 Differential Probe.

6 Set [Display].

On☑	Displays the waveforms on the waveform screen.	
	Color	Allows you to select display colors of the waveforms. You can also select the same color as the lines acquired through other channels.
	Invert (**Off**☑, **On**)	When the signs of displayed waveforms are reversed, the waveforms can be inverted. Refer to “3.4 Inverting the Waveform (Invert Function)” (p. 49).
	Vernier	Allows you to fine-adjust the input voltage freely on the waveform screen (display adjustment only). When recording physical values such as noise, temperature, and acceleration with sensors, you can adjust those amplitudes, facilitating calibration. Refer to “3.3 Fine-Adjusting Input Values (Vernier Function)” (p. 48).
Off	Displays no waveforms.	

7 Set [Scaling].

Refer to “3.2 Converting Input Values (Scaling Function)” (p. 42).

8 Switch the channels.

Tap the corresponding location to switch the channels.

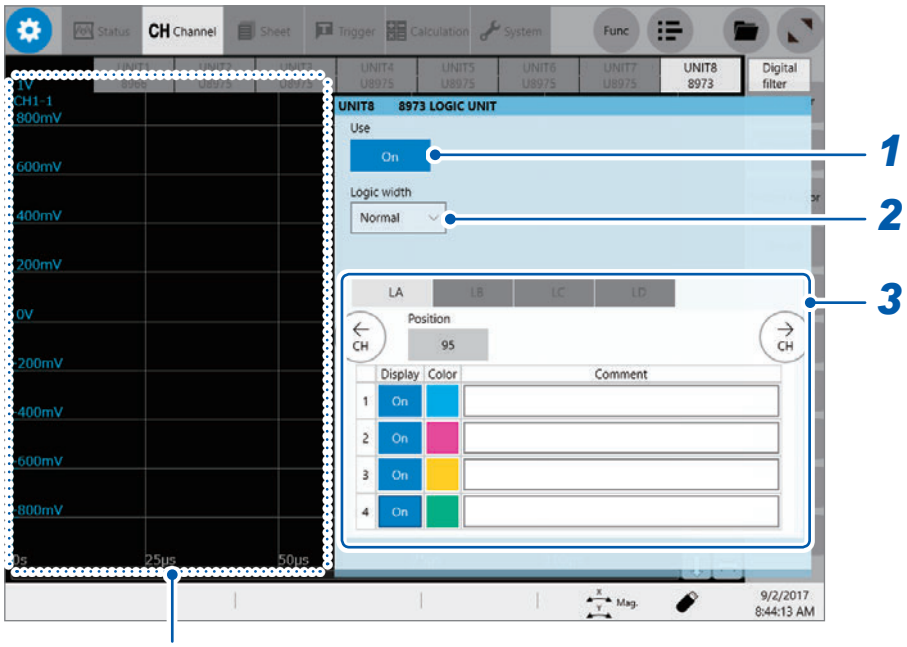
9 Set [Digital filter] for each channel. (Model MR6000-01 only)

The **[Df]** setting is displayed for only channels with **[Digital filter]** set to **[On]**, allowing you to set the digital filter for each channel.
For more information, refer to “Setting the Digital Filter Calculation” in Calculation Guide.

Logic channels

The logic sheet is displayed when the screen is in Single, Dual, Quad, Octa, or Hexadeca mode.

> [Channel]



The waveform screen is displayed when a logic channel is selected. Positions of the logic display can be checked.

1 Set [Use] to [On] or [Off].

On☑	Sets the module as the measurement device.
Off	Does not set the module as the measurement device. Since no data is acquired, nothing can be displayed or saved.

2 Set [Logic width].

You can change the display width of the logic waveforms. Making waveforms narrower can enhance the readability of a display that contains a large number of waveforms.
This setting is shared by all installed logic modules.

Wide	Increases the width of the waveforms.
Normal☑	Displays the waveforms in normal width.
Narrow	Reduces the width of the waveforms.

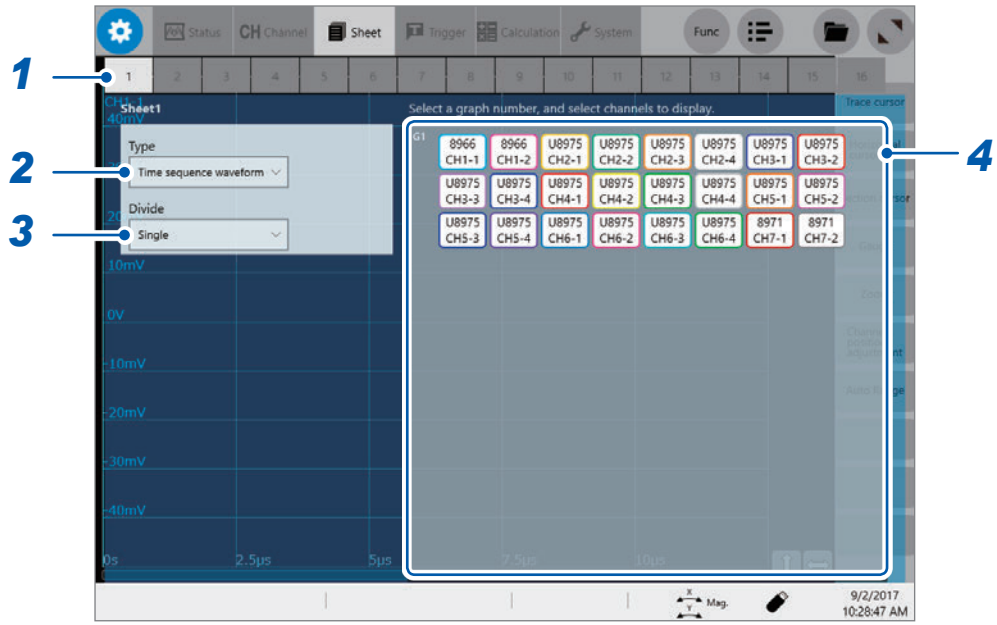
3 Select a display method for each probe (LA through LD).

Position	Allows you to set the position of the logic waveforms within the display range. The position of the waveforms can be set in increments of one percent point. This setting is shared by all probes (LA through LD). You can move the logic position freely within the screen limits.
Display	Sets whether to display each logic waveform.
Color	Allows you to select a display waveform of each waveform. You can also select the same color as the lines acquired through other channels.
Comment	Allows you to type a comment for each channel. Number of characters: up to 40

1.4 Setting the Sheets

You can define the display format of waveforms on the sheet. You can define different display formats for each of the 16 sheets. You can also switch the sheets to be displayed on the waveform screen.

> **[Sheet]**



1 Select a sheet.

2 Set [Type].

Time sequence waveform☑	Displays time-sequence waveforms.

3 Set [Divide].

You can divide the screen into multiple screens (graphs).
The options when **[Type]** is set to **[Time sequence waveform]** are as follows:

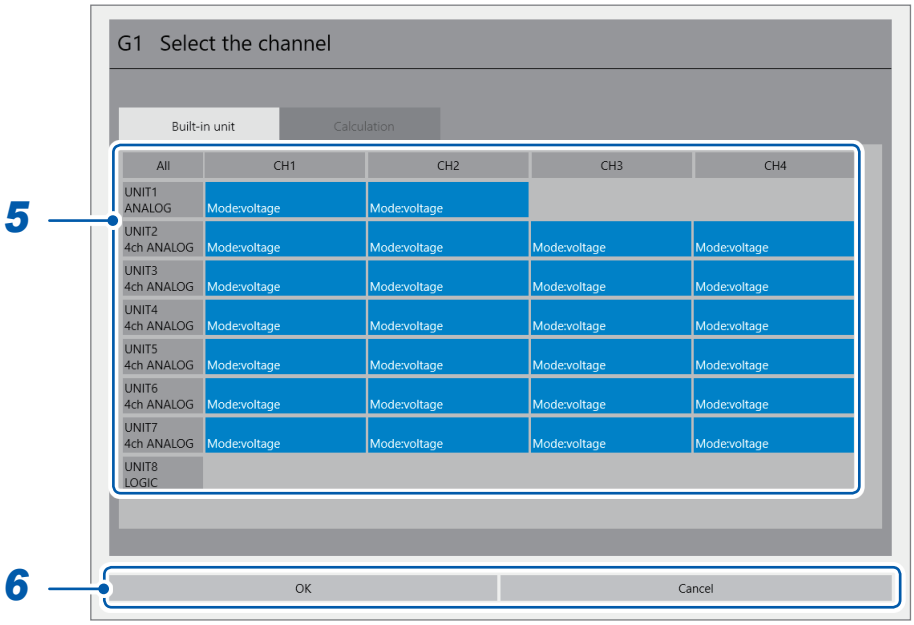
Single☑, **Dual**, **Quad**, **Octa**, **Hexadeca**

4 Assign channels to the graph.

Tap the display panel of each graph to open the **[Select the channel]** dialog box.

5 **Select the channels to be displayed on the graph.**

All channels are selected in the default setting. Tap a button to deselect a channel (Tap it again to select it).



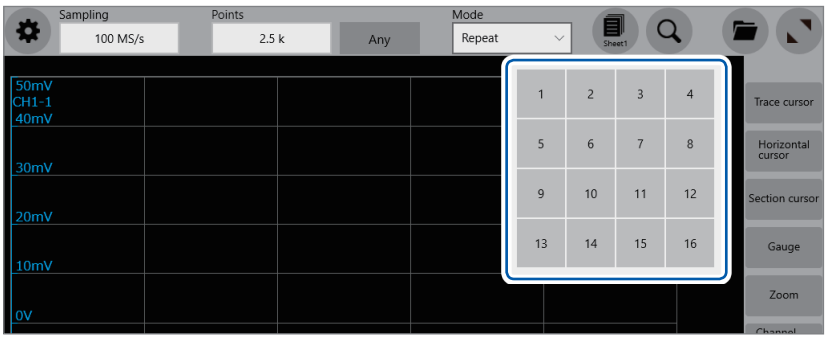
6 **Tap [OK].**

The selection is confirmed.

Tapping **[Cancel]** closes the dialog box without your selection confirmed.

Switching sheets on the waveform screen

> >



Select the sheet numbers to be displayed.

1.5 Starting/Stopping the Measurement

Starting a measurement

Pressing the **START** key starts a measurement.

- Waveform data displayed on the screen is cleared once the measurement starts.
- You can also start the measurement by inputting signal into the external control terminal.

  Refer to “10 Controlling the Instrument Externally” (p. 179).

Waveform display during measurement

In general, the waveforms are displayed after the specified recording length of data has been acquired. When the measurement is performed at a relatively slow speed, the waveforms are displayed while the data is being acquired.
However, even if a slow-speed range is set, the waveforms are displayed after the data of the whole waveform has been acquired, depending on the overlay or magnification setting.

To save data automatically during measurement

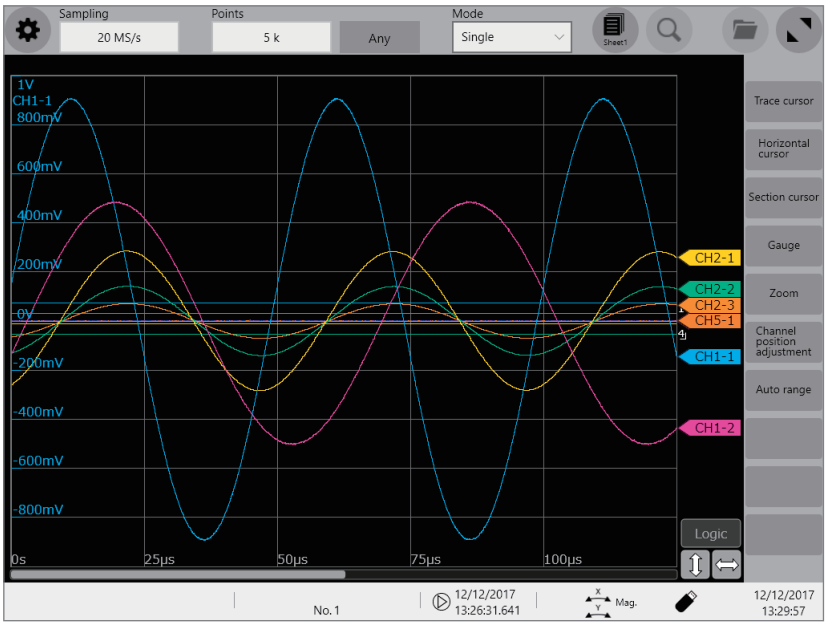
Refer to “Saving waveform data automatically” (p. 68).

Stopping the measurement

Pressing the **STOP** key once stops the measurement after the waveforms of the specified recording length have been acquired.
Pressing the **STOP** key twice stops the measurement immediately.

2 Operating the Waveform Screen and Analyzing Data

You can analyze measured data with various functions including trace cursor measurement and search of input waveforms on the waveform screen. You can also change measurement conditions or other configuration on this screen.



Operation available on the waveform screen

Use the trace cursors

- Reading measured values (p. 22)

Use the section cursors

- Specifying the waveform range (p. 26)

Moving the waveform display position

- Moving waveforms by dragging them
- Moving waveforms with the scroll bar

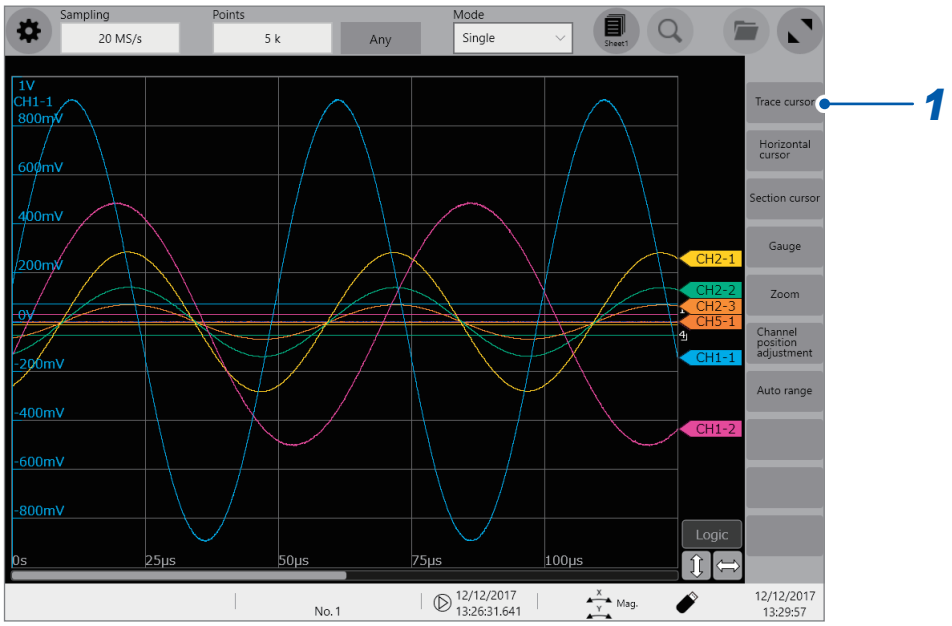
Changing the display magnification of waveforms

- Magnifying/demagnifying waveforms (p. 32)
- Magnifying a part of waveforms horizontally (p. 37)

2.1 Reading Measured Values (Trace Cursors)

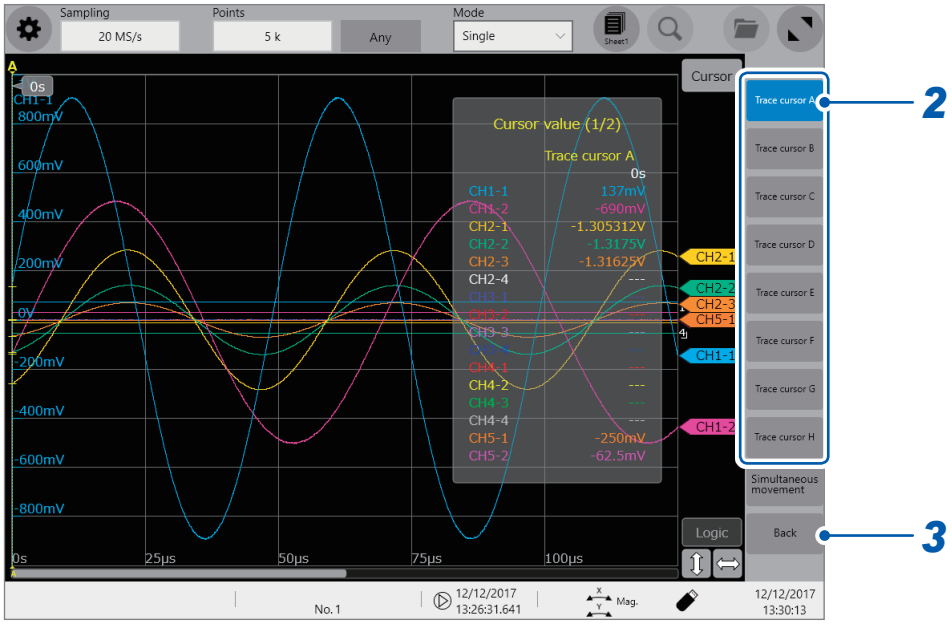
Using trace cursors on the waveform screen allows you to read measured values (scaled value when the scaling is used). Up to eight trace cursors can be displayed simultaneously. You can read differences in times and measured values at any two selected among them. The time lag, for example, shows the difference in time between Trace cursor A and Trace cursor B when they are enabled.

1 **Tap [Trace cursor].**



2 **Select one or more cursors from [Trace cursor A] through [Trace cursor H] by tapping them.**

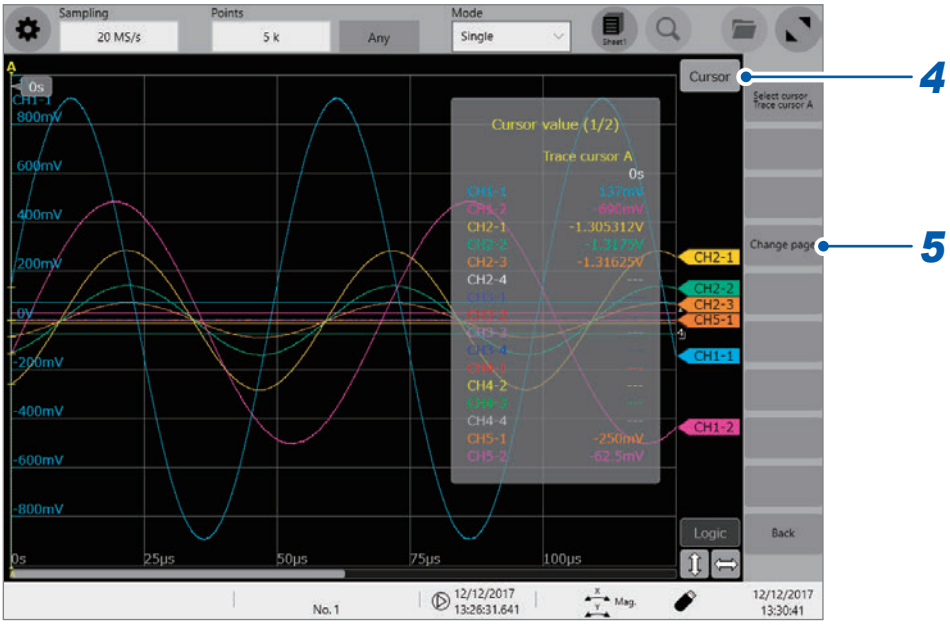
The selected trace cursors are displayed on the waveform screen.
Move the trace cursors by dragging them on the waveform screen.



3 **Tap [Back].**

4 Tap [Cursor].

The cursor value display can be switched between on and off every time [Cursor] is tapped.

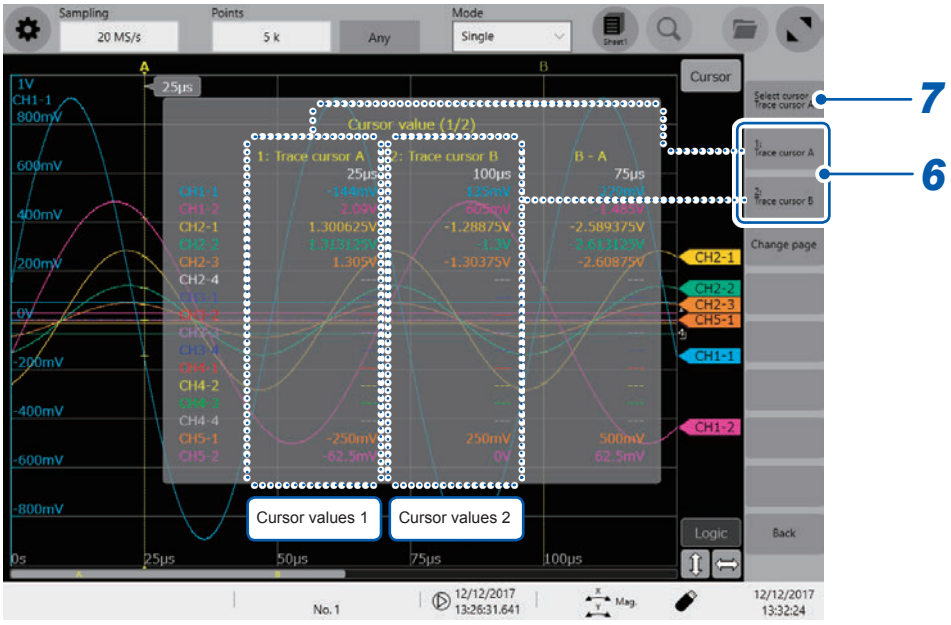


5 Tap [Change page].

If multiple channels are displayed, switch the pages to check the cursor values of each channel. Every time it is tapped, the pages are switched.

6 Tap [1: Trace cursor] or [2: Trace cursor].

When the multiple trace cursors are displayed, the cursor values acquired at the two trace cursors are displayed on the waveform screen (Cursor values 1 and 2).
Every time you tap [1: Trace cursor] (or [2: Trace cursor]), the values of Cursor values 1 (or Cursor values 2) switches from one to another.



7 **Tap [Select cursor].**

Every time you tap **[Select cursor]** when the multiple trace cursors are displayed, a cursor is activated one by one in sequence. In addition, you can activate any one of the cursors displayed on the screen by tapping it.

Changing the magnification of the waveform display while moving the trace cursor

Sliding your finger upward on the screen while dragging the trace cursor enlarges the waveform display centered around the trace cursor in proportion to the dragging distance. Sliding your finger downward compresses the waveform display.
Once you have adjusted the display to a suitable size, move the trace cursor along the horizontal axis to change the display position.
Releasing your finger from the screen reverts the display to the original magnification.

To move the trace cursor using the rotary knob X

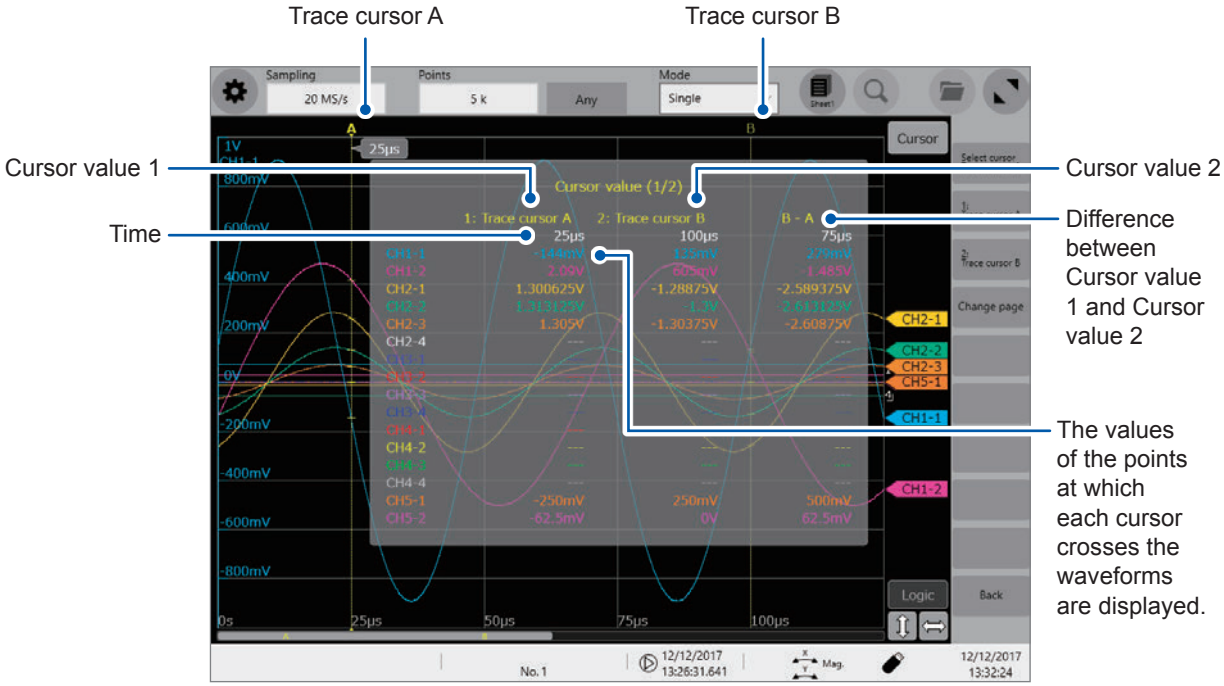
When **[Cursor]** is assigned to the rotary knob, you can move the active trace cursor with the rotary knob X.

If the trace cursor is not displayed on the screen even though it is enabled

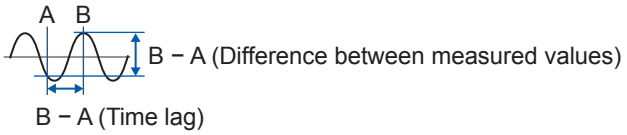
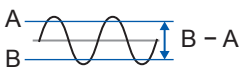
Check the position of the trace cursor on the scroll bar. (p. 31)

Reading measured values on the waveform screen

When the trace cursor is selected



The display of the cursor values vary depending on the selected cursor type.

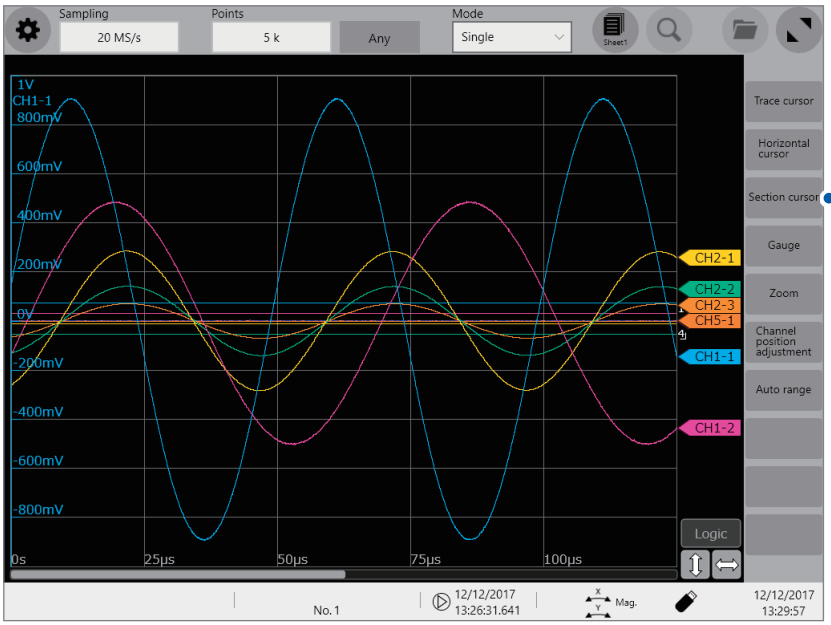
Cursor type	Cursor value
Trace cursor	When Trace cursor A is assigned to Cursor value 1; and Trace cursor B, to Cursor value 2. Time: A period of time from the trigger point or starting point of recording until the trace cursor selected for Cursor value 1 or Cursor value 2 B − A: Difference in measured values between Trace cursor A and Trace cursor B 
Horizontal cursor	When Horizontal cursor A is assigned to Cursor value 1; and Horizontal cursor B, to Cursor value 2 Cursor value 1 or Cursor value 2: Measured value of the specified cursor B − A: Difference in measured values between Horizontal cursor A and Horizontal cursor B 

When the external sampling is used, the time is replaced with the number of samples.

2.2 Specifying the Waveform Range (Section Cursor)

The range can be specified with section cursors.
The specified range is applicable for file saving, the numerical calculation, and search. The range selection remains to be common even when the waveform display format is changed.

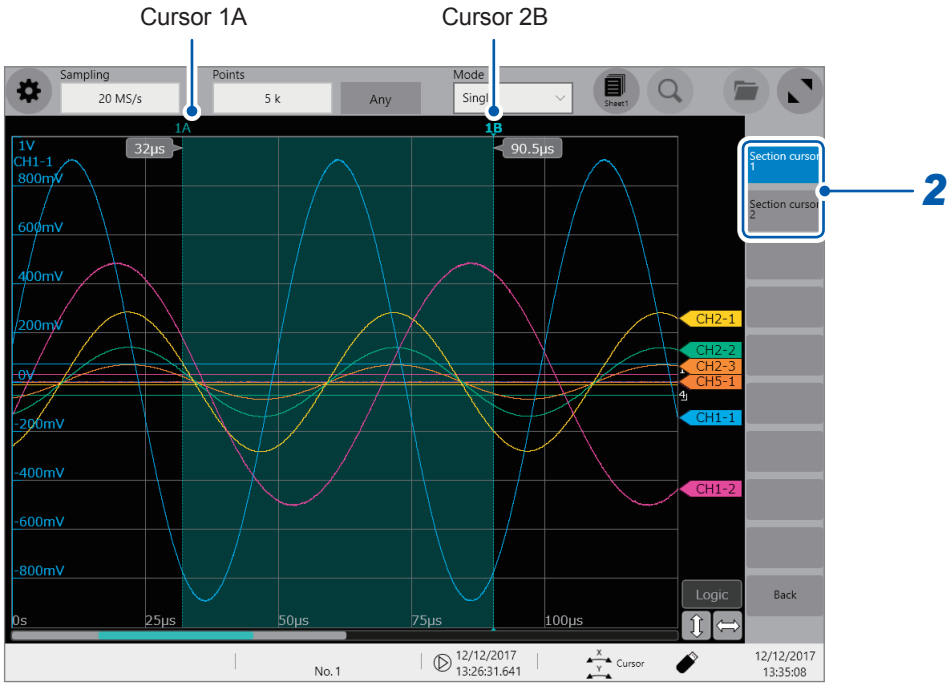
1 **Tap [Section cursor].**



2 **Tap [Section cursor 1] or [Section cursor 2].**

The cursor is displayed on the left side of the screen.
You can move the section cursors or each cursor on the waveform screen by dragging one of them.

Section cursor 1	Specifies the section with Cursor 1A and Cursor 1B.
Section cursor 2	Specifies the section with Cursor 2A and Cursor 2B.



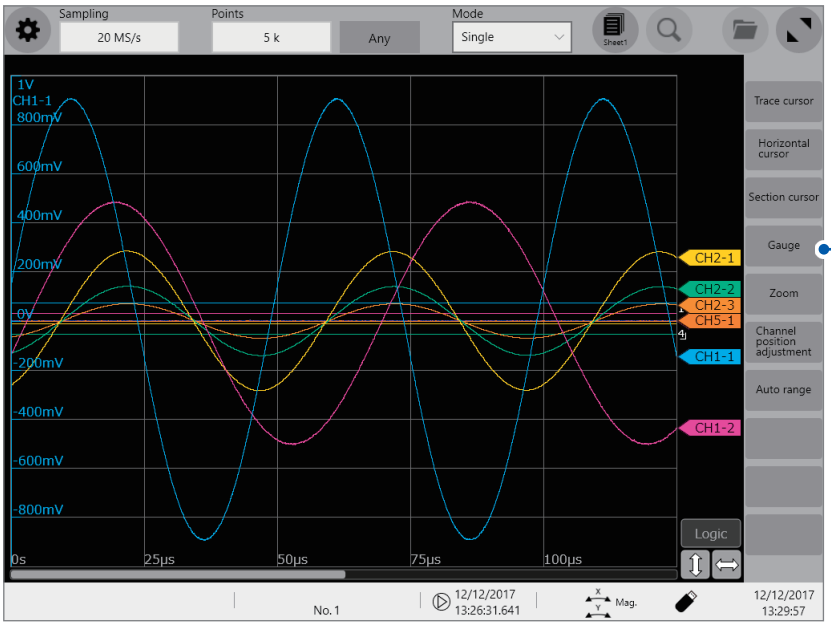
Changing the display magnification of the waveforms while moving the section cursor

Sliding your finger upward on the screen while dragging the section cursor enlarges the waveform display centered around the section cursor in proportion to the dragging distance (Sliding your finger downward compresses the waveform display.).
Once you have adjusted the display to a suitable size, move the section cursor along the horizontal axis to change the display position.
Releasing your finger from the screen reverts the display to the original magnification.

2.3 Displaying Vertical Scales (Gauge Function)

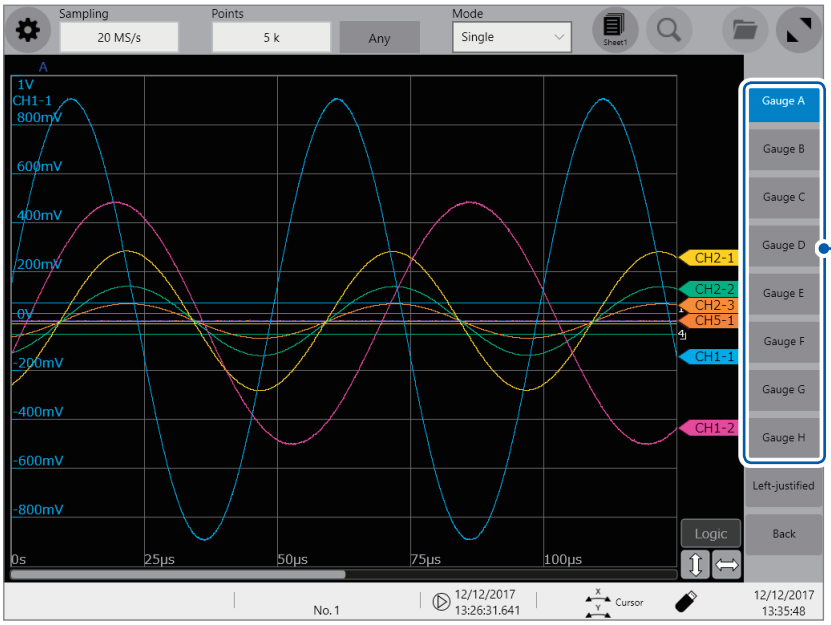
Using the gauge function enable the vertical scales (for convenience, hereafter referred to as “gauges”) to be displayed overlapping waveforms.

1 **Tap [Gauge].**



2 **Select gauges to be displayed from [Gauge A] through [Gauge H].**

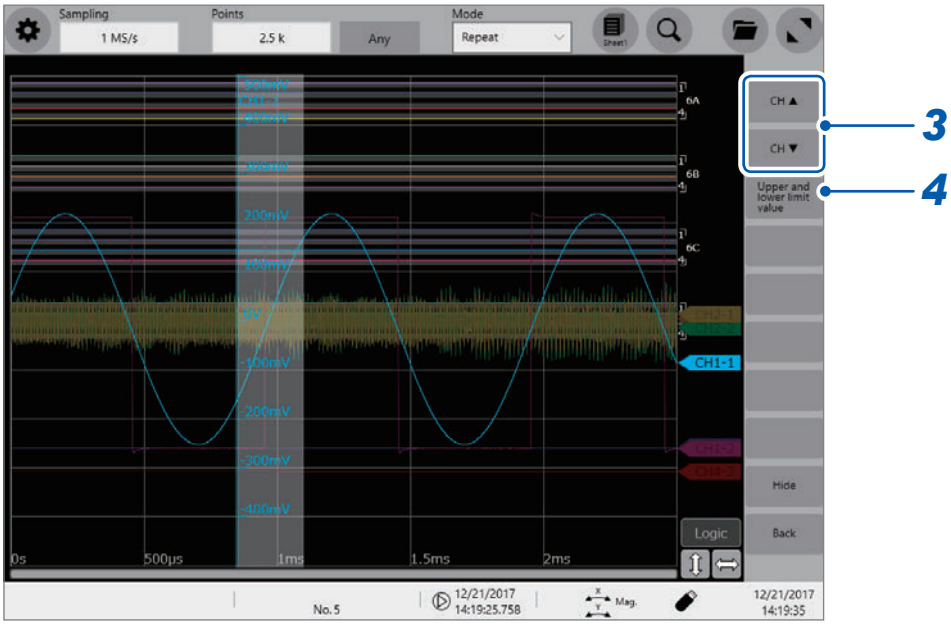
Gauges are displayed at the left of the screen.
To move a gauge, tap the gauge, thereby it is selected, and drag it.



Tapping **[Left-justified]** aligns the gauges to the left.

3 Tap [CH ▲] or [CH ▼].

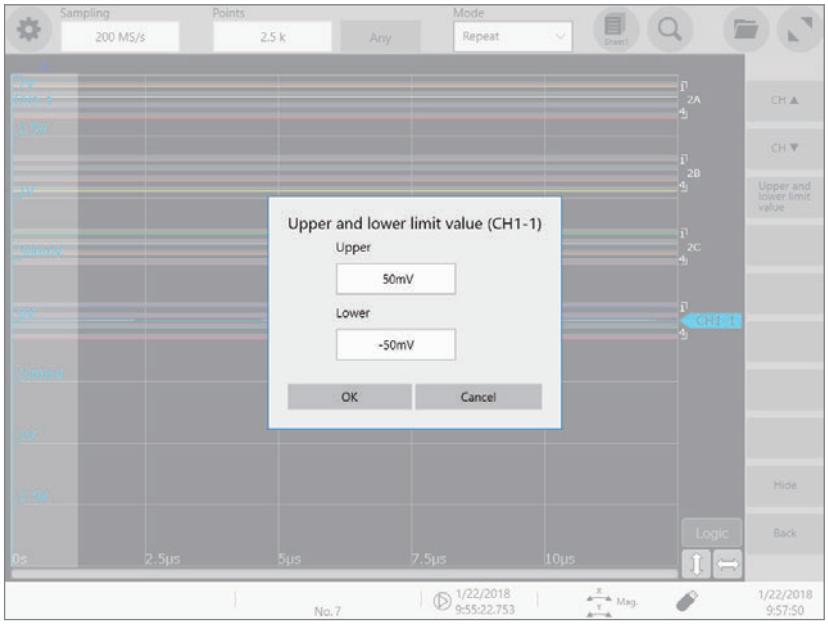
You can switch channels to be displayed along with the guage.



Tapping **[Hide]** hides the gauges.

4 Tap [Upper and lower limit value].

The setting dialog box is displayed, which allow you to set the channel display range numerically. Type the upper and lower values in the **[Upper]** and **[Lower]** boxes, respectively, and then tap **[OK]**.

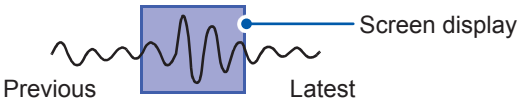


2.4 Scrolling Waveforms

Scrolling waveforms

Dragging the waveform screen scroll the waveforms that are being measured or existing waveforms.

Scrolling direction

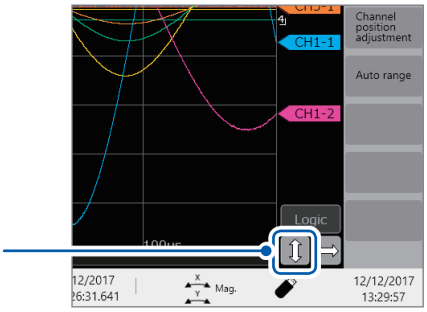


Dragging the waveform rightward:
Scrolls the waveform backward from the present.

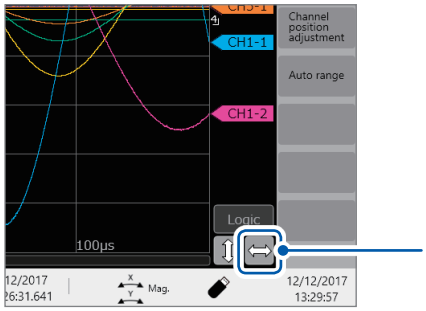
Dragging the waveform leftward:
Scrolls the waveform forward from the present.

To anchor the waveforms vertically

Tap the button to deselect it as the scroll direction.



To anchor the waveforms horizontally



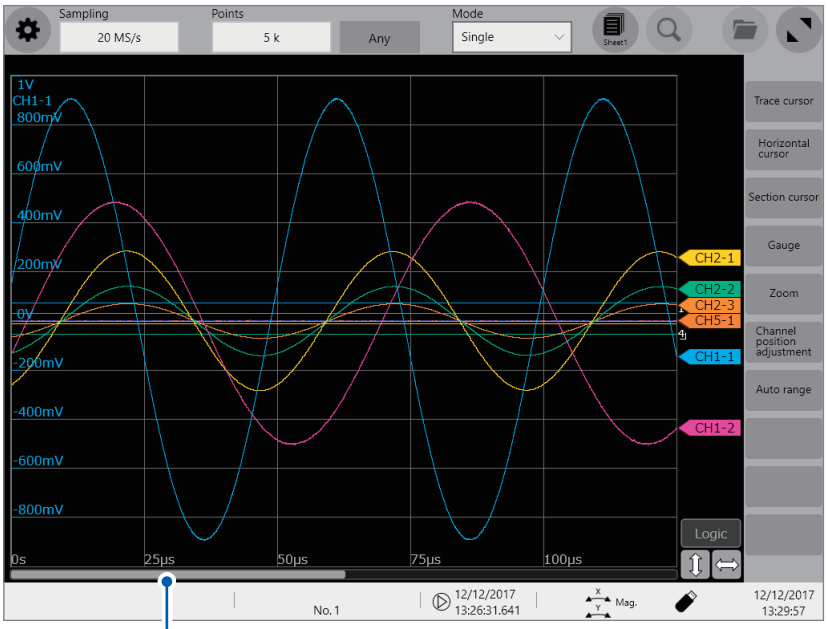
Tap the button to deselect it as the scroll direction.

To observe waveforms obtained previously during slow-speed measurement

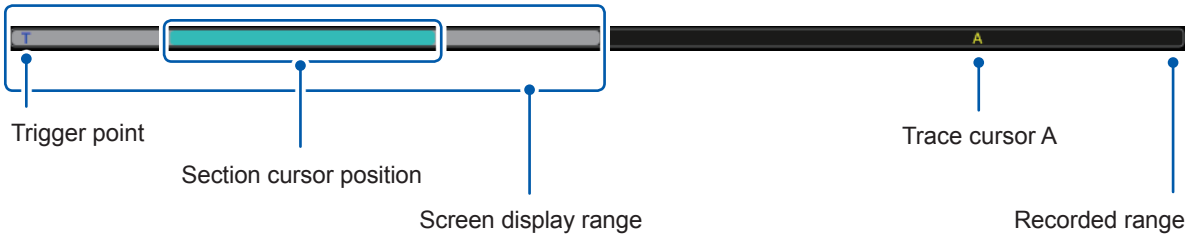
When the waveform is being displayed during a slow-speed measurement, dragging the waveform screen allows you to observe waveforms obtained previously. To observe the waveform being measured presently again, tap **[▶▶▶]** on the screen.

Checking a position of waveforms with the scroll bar

The scroll bar provides the position and size of the displayed part of the waveforms relative to the entire recording length of the waveforms. It also shows the positions of the trigger point, trace cursors, and section cursors.



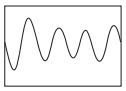
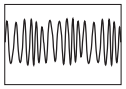
Verifying the position of the trigger point and cursors on the scroll bar



With the display zoomed in, the scroll bars are displayed at both the top and bottom.

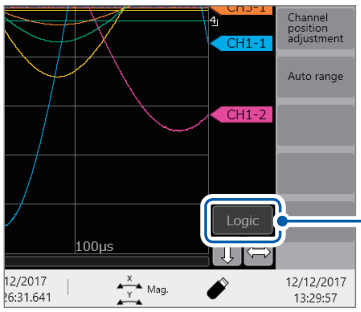
2.5 Changing the Display Position and Display Magnification of the Waveforms

Pinch in or out waveforms on the waveform screen to change the display magnification.

	**Pinch out**		Magnifies the waveforms.
	**Pinch in**		Demagnifies the waveforms.

To change the display position of logic channels in a batch

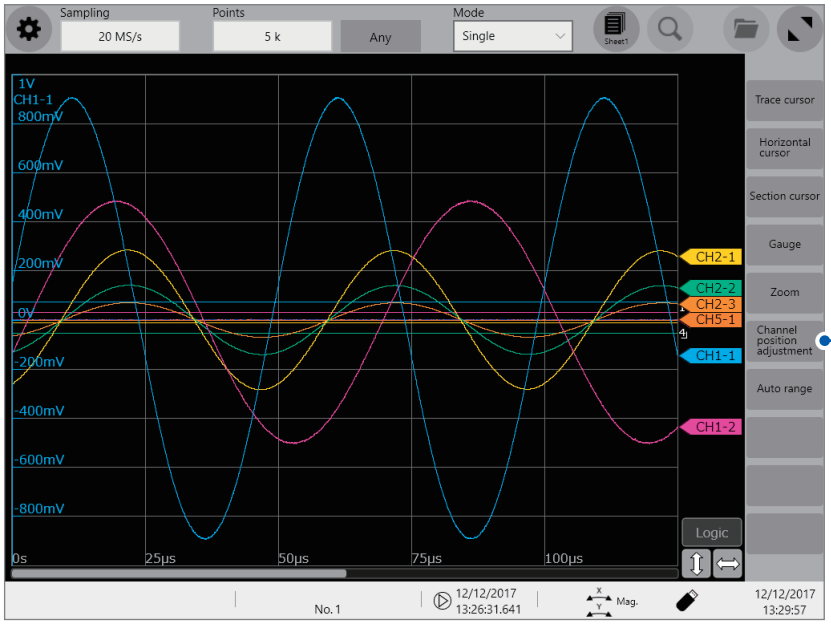
Select **[Logic]** and drag waveforms on the waveform screen to move logic channels only.
When **[Logic]** is not selected, only analog channels can be moved.



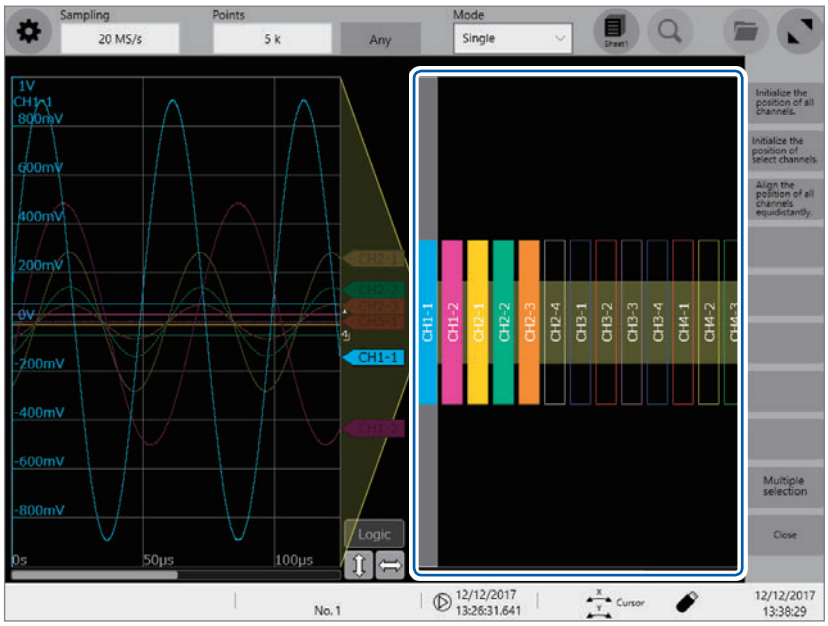
Tap the button to select or deselect it.

Differentiating the waveform display position and display magnification for each analog channel

1 Tap **[Channel position adjustment]**.



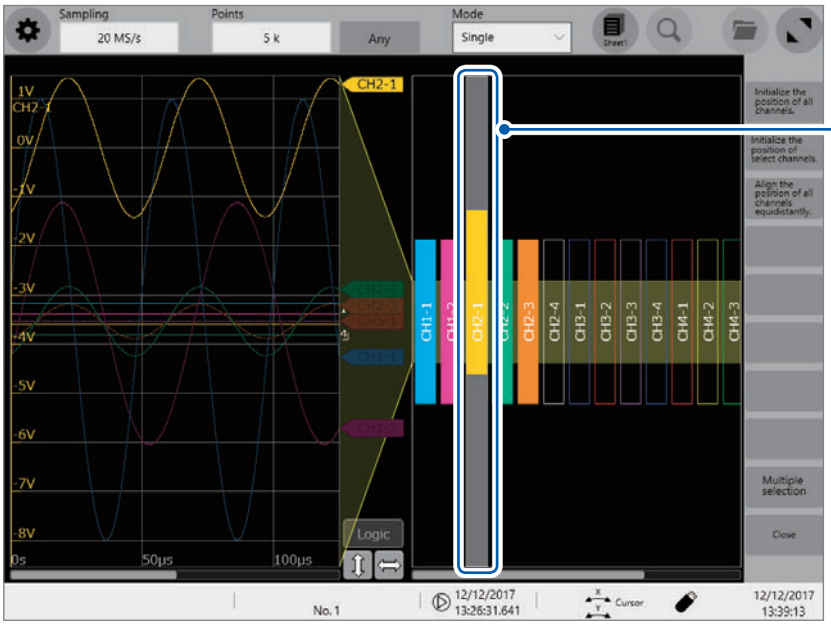
The channel position adjustment screen is displayed.



The yellow area shows the display range of the waveform screen.

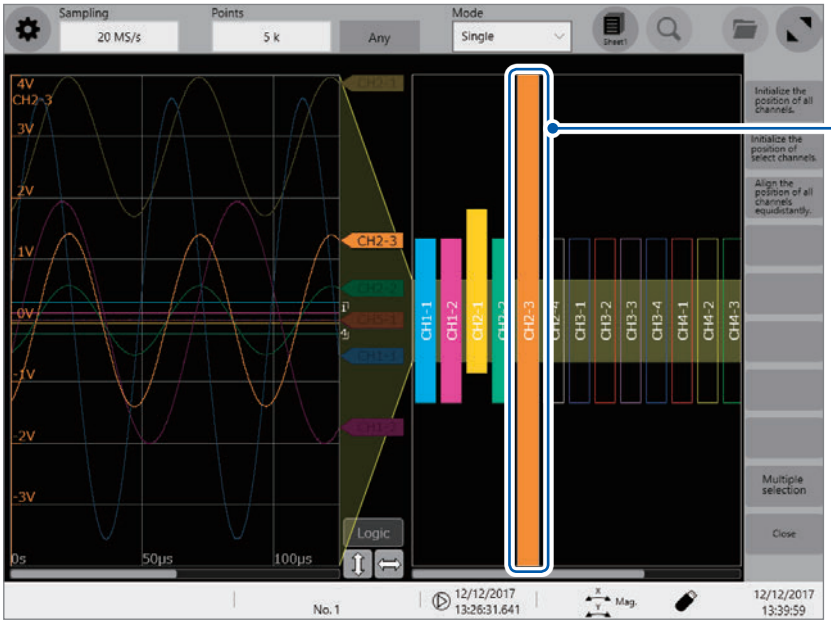
2 **Tap a channel number the display position of which is to be changed.**

Dragging and thereby moving the selected area changes the display position.



3 **Tap a channel number the display magnification of which is to be changed.**

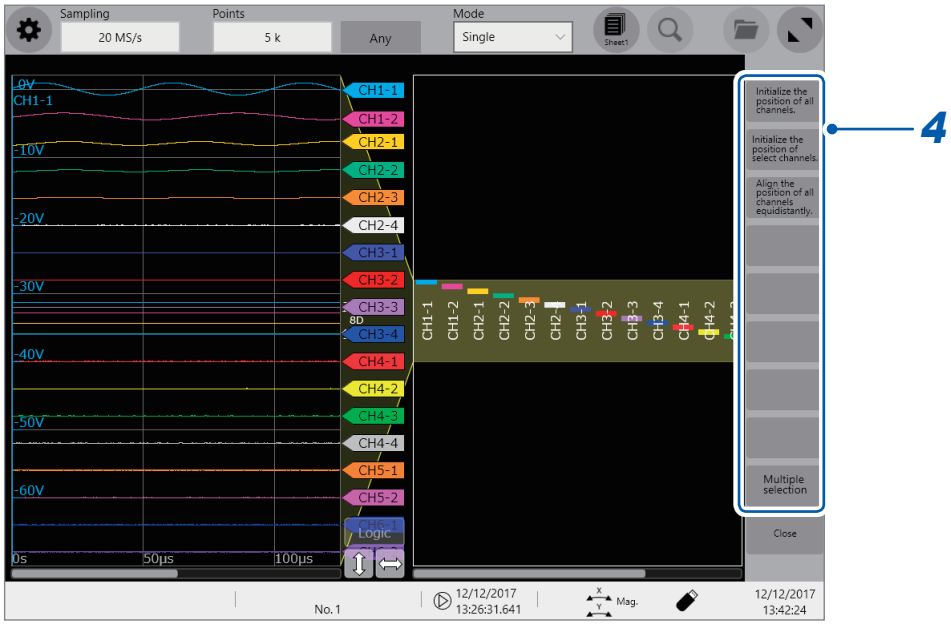
Pinching in or out the selected area changes the display magnification.



4 Adjust the display position and magnification.

The display can be adjusted as follows depending on the selected state.

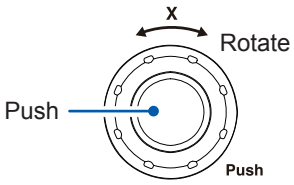
Initialize the position of all channels.	Restores all the channels to the initial positions and displays them at the default magnification.
Initialize the position of select channels.	Restores only selected channels to the initial positions and displays them at the default magnification.
Align the position of all channels equidistantly.	Adjusts the display positions and magnifications of all channels such that they are aligned at the same intervals.
Multiple selection	Allows you to select the channels the displays of which are to be adjusted.



2.6 Operating the Rotary Knob

Push the rotary knob to select an action and turn the knob to perform the action.

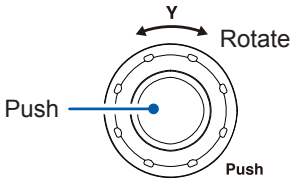
Operation of the rotary knob X



Pushing the rotary knob X selects one of the following actions in turn:

Magnification/ demagnification ratio	Changes the magnification/demagnification ratio of all channels in the horizontal axis direction.
Position	Changes the display position of all channels in the horizontal axis direction.
Cursor	Moves the selected cursor.
Setting	Changes the sampling rate. This operation can be used on the waveform screen only.

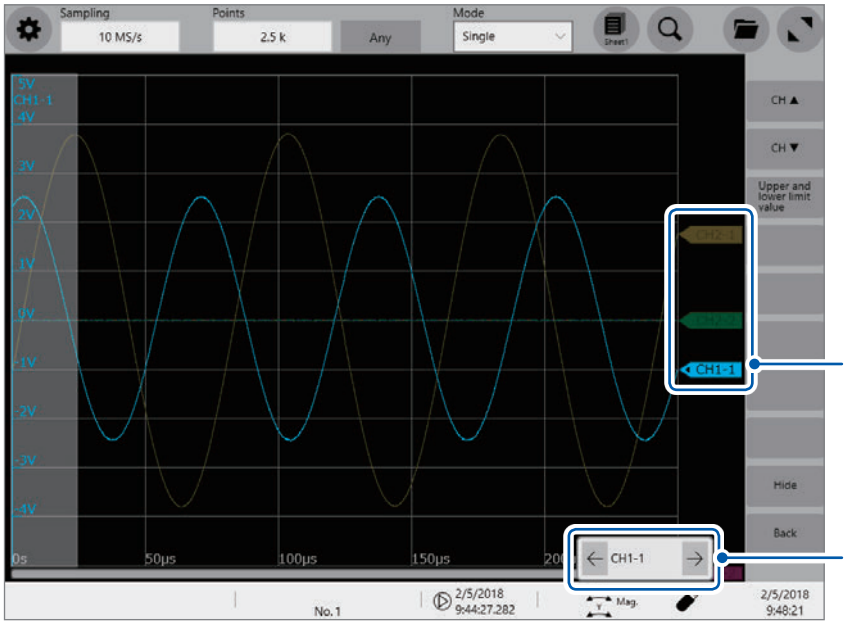
Operation of the rotary knob Y



Pushing the rotary knob Y selects one of the following actions in turn:

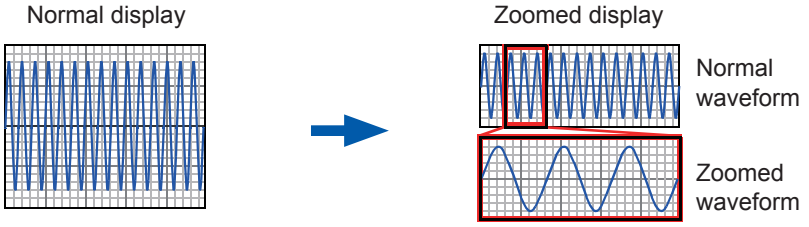
Magnification/ demagnification ratio	Changes the display magnification of the selected channel in the vertical axis direction.
Position	Changes the display position of the selected channel in the vertical axis direction.
Cursor	Moves the selected cursor.
Setting	Changes the measurement range. This operation can be used on the waveform screen only.

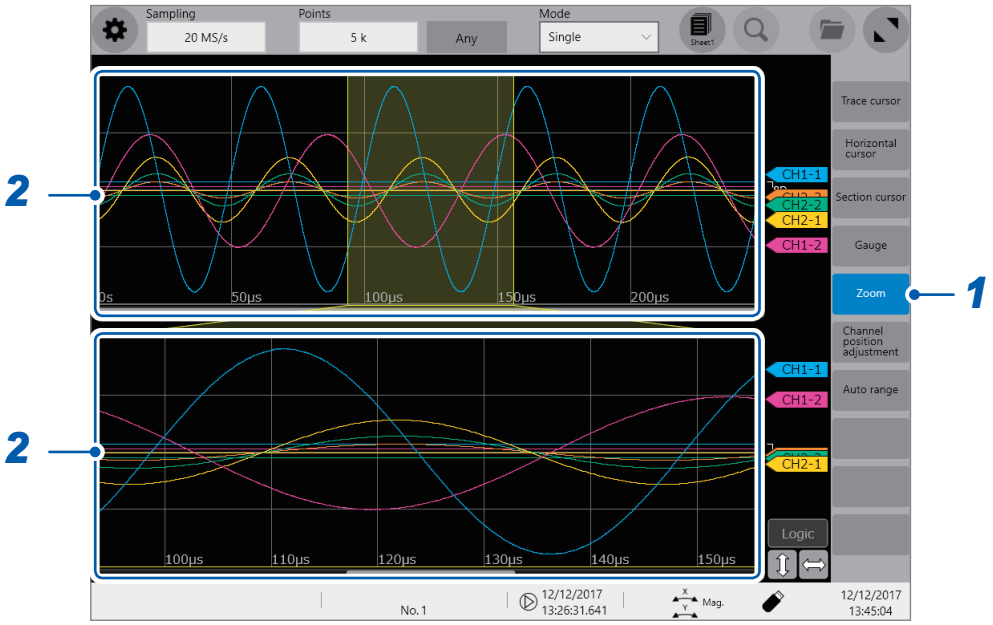
When a rotary knob is operated, the channel-selecting panel is displayed in some cases, which allows you to select an operational channel by tapping the **[←]** or **[→]** button. In addition, you can directly select an operational channel by tapping a channel marker.



2.7 Enlarging a Part of the Waveform (Zoom Function)

Using the zoom function allows you to enlarge a part of the waveform.





1 Set [Zoom].

When the zoom function is enabled, the screen is horizontally split into two: the upper and lower screens.

Upper screen: Displays the waveforms in the magnification specified before the zoom function was applied. The part of the waveforms enclosed by the yellow frame represents the zoomed display range shown in the lower screen.

Lower screen: Displays the zoomed-in waveform

2 Change the display magnification.

Pinch in or out each screen to change the display magnification of waveforms on each screen.

3 Scroll the waveform to be observed.

Drag and scroll waveforms on each screen.

To cancel the zoomed display

Tap **[Zoom]** on the screen to cancel the zoomed display. When you cancel the zoomed display, the display (the upper screen) restores that with the normal magnification.

3 Advanced Functions

Converting input values (scaling) (p. 42)

Fine-adjusting input values (p. 48)

Inverting waveforms (p. 49)

Copying a setting to another channel (p. 50)

Advanced measurements and settings

- Overlaying new waveforms with previously acquired waveforms (p. 40)

Detailed module settings (p. 51)

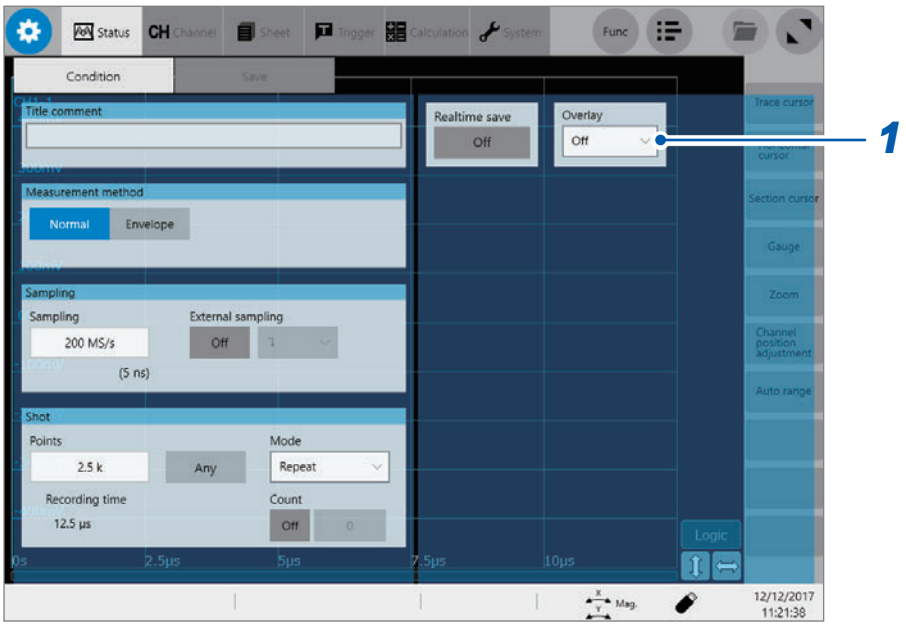
- Anti-aliasing filters
- Thermocouple types
- Reference junction compensation
- Detecting a burnout
- Updating data
- Executing the auto-balance
- Probe division ratio
- Response time
- Measurement mode

3.1 Overlaying New Waveforms With Previously Acquired Waveforms

The new waveform can be overlaid with the presently displayed waveforms.

- You can compare the new waveforms with those recorded before. (When **[Mode]** is set to **[Repeat]**) (p. 6)
- There are two methods for overlaying waveforms: the automatic overlaying during measurement and the manual overlaying.

> **[Status] > [Condition]**

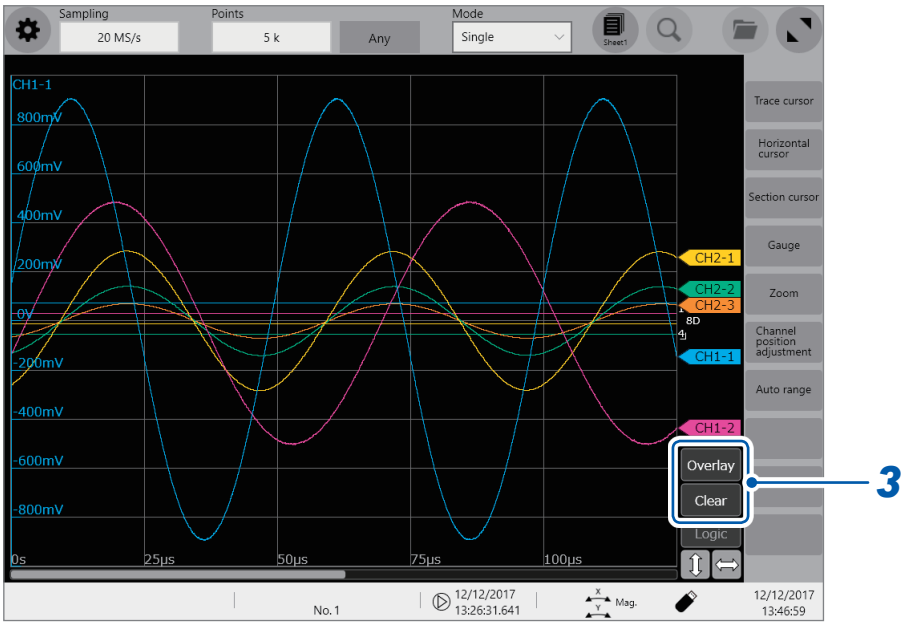


1 **Set [Overlay].**

Off☑	Does not overlay the waveforms.
Auto	Overlays the newly acquired waveforms with the presently displayed waveforms every time the new ones are acquired. When **[Mode]** is set to **[Repeat]**, the instrument overlays the new waveforms with the presently displayed waveforms beginning from the start until the stop of the measurement.
Manual	Overlays the new waveforms manually with the presently displayed waveforms. Refer to Step 3 “Overlay the waveforms manually (leaving any waveform to be displayed on the screen).” (p. 41).

Refer to “When the overlay function is enabled (When [Overlay] is set to [Auto] or [Manual])” (p. 41).

2 **Tap the button to display the waveform screen.**



3 **Overlay the waveforms manually (leaving any waveform to be displayed on the screen).**

Tap the button on the right side of the waveform screen.

Overlay	Leaves the acquired waveforms to be displayed on the screen. The overlay setting continues to be available until the waveforms are cleared.
Clear	Clears all the overlaid waveforms displayed on the screen. No cleared waveforms can be displayed again.

When the overlay function is enabled (When [Overlay] is set to [Auto] or [Manual])

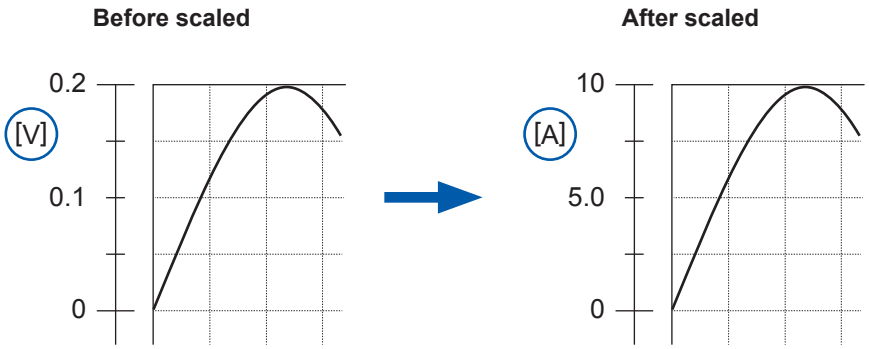
- The waveforms are always displayed after the data has been acquired.
- The trace cursors show the measured values of the waveforms acquired most recently.
- The following operation is not available on the waveform screen:
  Scrolling waveforms, switching the zoom function between on and off, changing the magnification, and changing the zero position.
- The instrument leaves only the waveforms most recently to be displayed and clears the others in the following cases:
  - After changing the **[Sheet]** setting, which is accessible by proceeding the following order:
    > **[Sheet]**
  - After changing the waveform display settings (switching the display between on and off, changing waveform color) in the **[Channel]** screen, which is accessible by proceeding in the following order:
    > **[Channel]**
  - After executing the search.

3.2 Converting Input Values (Scaling Function)

About the scaling function

The scaling function enables you to convert the measured voltage output from measuring devices such as sensors into physical quantities of measurement targets.
Hereafter, the term “scale” refers to converting numerical values using the scaling function.

Gauge scales, scaled values (upper and lower limits of the vertical axis or voltage axis), and measured values at trace cursors are expressed as scaled values in terms of the specified units.
You can scale the input values for each channel.

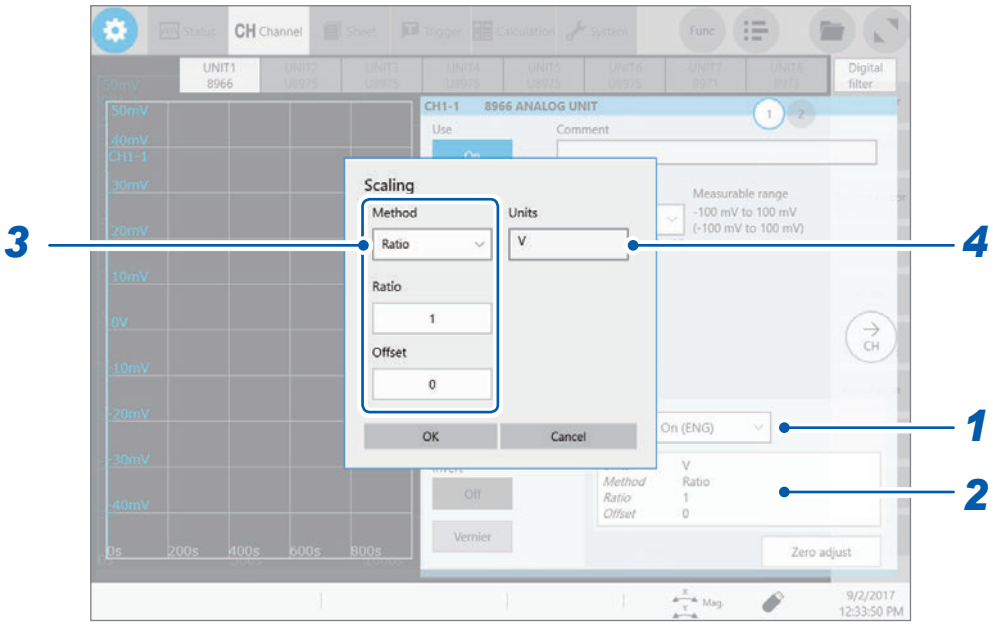


Scaling methods

The following six methods are available:

- Specifying a conversion ratio and offset
- Specifying two points
- Selecting a model name of a connected current sensor or differential probe
- Selecting an output rate
- Specifying an input value in decibels and value after scaled
- Specifying a rated capacity and rated output according to an inspection record of a strain gauge converter (for Model U8969 Strain Unit only)

> [Channel]



1 Set [Scaling].

Off☑	Does not scale any values.
On (ENG)	Displays values in decimal notation with a unit prefix (such as m and k).
On (SCI)	Displays values in scientific notation (as a power of 10).

2 Tap the setting item.

The settings dialog box is displayed.

3 Set [Method].

Ratio☑	Allows you to specify a conversion ratio and offset.
2-Point	Allows you to specify two scaling-reference points.
Sensor	Allows you to select a model name and measurement range of a connected current sensor or differential probe.
Output rate	Allows you to select an output rate (ratio) of a current sensor or a division ratio of a voltage dividing probe.
dB	Allows you to specify an input value in decibels and value after scaled.
Rating	Allows you to specify a rated capacity and rated output according to an inspection record of a strain gauge converter to be used. (For Model U8969 Strain Unit only)

When using [Ratio]: Specify [Ratio] and [Offset].

Type a numerical value in the **[Ratio]** box.

–9.9999E+9 to **9.9999E+9**

Type a numerical value in the **[Offset]** box.

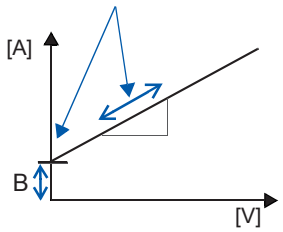
–9.9999E+19 to **9.9999E+19**

When converting the values in volts into those in amperes

Specify a physical quantity per volt (conversion ratio: [eu/V]), an offset value, and a measurement unit to be used. The instrument converts (scales) measured values acquired in terms of volts into values in the specified measurement unit. (eu: engineering unit)

Example:
Ratio: Change in terms of amperes per change in terms of volts; Offset value: B
Unit: A

Scaling using slope (conversion ratio) and offset value



When using [2-Point]: Specify two input values and those after scaling.

Type a value in each of the following fields: **[Input1]**, **[Input2]**, **[Scale1]**, **[Scale2]**.

–9.9999E+29 to **9.9999E+29**

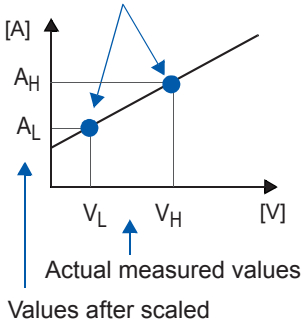
Set two points of the input signal in terms of volts, those after scaled, and a measurement unit to be used. The instrument converts (scales) measured values acquired in terms of volts into values in the specified measurement unit.

Example:

2 points of values in terms of volts	Values after scaled
V_H: Higher potential point	A_H: Value for higher potential point
V_L: Lower potential point	A_L: Value for lower potential point

Unit: A

Scaling using conversion ratio and offset value, both of which are calculated using two points



When the **[Ratio]** setting is changed, V_L and V_H set as two points do not change, whereas the values for A_L and A_H change.

When using [Sensor]: Select a connected current sensor or differential probe from the list.

Set a measurement range according to the current sensor.

Sensor	Range
3273-50	30 A
3274	150 A
3275	500 A
3276	30 A
3283☑	10 mA☑, 100 mA, 1 A, 10 A, 200 A
3284	20 A☑, 200 A
3285	200 A☑, 2000 A
9010-50	10 A☑, 20 A, 50 A, 100 A, 200 A, 500 A
9018-50	10 A☑, 20 A, 50 A, 100 A, 200 A, 500 A
9132-50	20 A☑, 50 A, 100 A, 200 A, 500 A, 1000 A
9322	–
9657-10	10 A
9675	10 A
CT6700	1 A
CT6701	1 A

Example of setting:

To display values measured with Model 9018-50 Clamp on Probe using the 10 A range as values in terms of amperes (A)

Sensor: 9018-50

Range: 10 A

When using [Output rate]: Select an output rate of a current sensor (ratio) or division ratio of a voltage dividing probe.

Select a scaled value for one volt.

10 mA☑, 100 mA, 1 A, 10 A, 20 A, 50 A, 100 A, 200 A, 250 A, 500 A, 1000 A, 2000 A, 2500 A, 5000 A, 1000 V

When using [dB]: Specify a physical quantity per input signal (ratio) in terms of decibels.

−200 to **+200**

A five-digit figures or less can be specified.

Setting example:

Converting (scaling) an input value of 40 dB into 60 dB

Input dB: 40

Output dB: 60

The conversion ratio corresponding to values entered in decibels is specified (The offset becomes zero.).

When using [Rating]: Specify a rated capacity and rated output of a strain gauge converter to be used.

(for Model U8969 Strain Unit only)

+1.0000E-9 to **+9.9999E+9**

A five-digit figures or less can be specified.

Set the parameters such that the rated capacity divided by two times the rated output is less than or equal to 9.9999E+9.

For the rated capacity and rated output, see an inspection record of a strain gauge converter to be used.

Setting example: To display the data measured with the strain gauge converter having a rated capacity of 20 G and rated output of 1000 μV/V as values in terms of gees (G)
Unit: G
Rated capacity: 20
Rated output: 1000

The upper and lower values of the waveforms also change automatically according to the changes made in the scaling settings.

4 Type a unit in the [Units] box.

Specify the unit into which you wish to convert the values. (Number of characters: up to 7)

To copy the scaling setting to another channel

Refer to “3.5 Copying Settings (Copy Function)” (p. 50).

When using Model U8969 Strain Unit

When an inspection record of a strain gauge converter provides a calibration factor

Example: To display data measured with the strain gauge converter having a calibration factor of 0.001442 G/1 × 10^{-6} strain* as values in terms of gees (G)

(*: 10^{-6} strain = με)

Scaling	On (ENG)
Method	Ratio
Units	G
Ratio	0.001442 [G] (Displayed as “1.4420 m”)

When an inspection record of a strain gauge converter provides the rated capacity and rated output

Refer to “When using **[Rating]**” in “3.2 Converting Input Values (Scaling Function)” (p. 46).

When using a strain gauge having a gauge factor of other than 2.0

Model U8969 Strain Unit measures outputs of the gauge supposing that the gauge factor stands at 2.0.
When a strain gauge having a gauge factor of other than 2.0 is used, the gauge factor needs to be set as the conversion ratio.
For example, if the gauge factor stands at 2.1, the conversion ratio will be 0.952 (≈ 2 / 2.1).

Example: To display data measured with a strain gauge (gauge factor: 2.1) as values in terms of gees (G)

This conversion requires calculations based on both a gauge factor and a conversion ratio that converts data into physical quantities. In this case, specify the product of the conversion ratios of the gauge factor and the scaling ratio as the conversion ratio.

Where the conversion ratio of the gauge factor is 0.952, and the conversion ratio to convert data into physical quantities is 0.001442*.
Conversion ratio = 0.952 × 0.001442 = 0.0013728

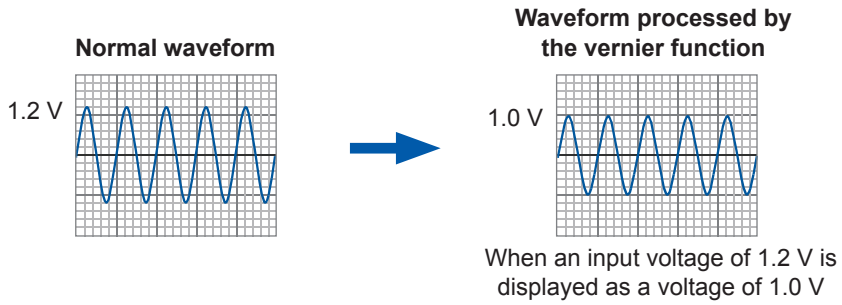
Type **[0.0013728]** as the conversion ratio.

*: To convert values measured with the strain gauge into physical quantities, calculate the conversion ratio based on Young’s modulus or Poisson’s ratio of a measurement object. The conversion method varies depending on the conditions in which the strain gauge is used.

Refer to “Scaling method for strain gauges” (p. 199).

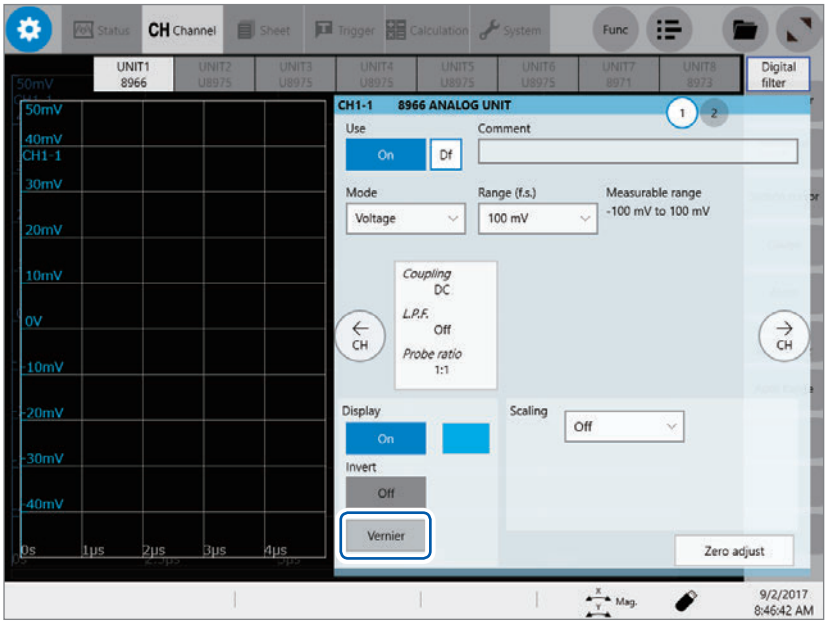
3.3 Fine-Adjusting Input Values (Vernier Function)

You can fine-adjust the input voltage freely on the waveform screen. When recording physical quantities such as noise, temperature, and acceleration with sensors, you can adjust those amplitudes, facilitating calibration.



When an input voltage of 1.2 V is displayed as a voltage of 1.0 V

> [Channel]



Adjust the set value in [Vernier].

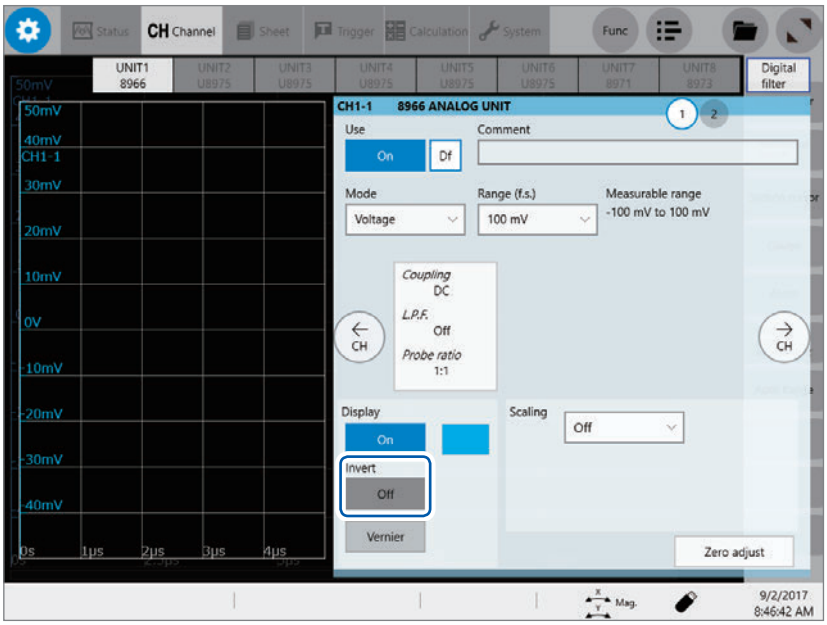
- The adjustable range is from 50% to 200% of an original waveform.
- You cannot check if waveforms are adjusted by the vernier function only by observing waveforms.
- The waveform data (data saved as files) is that adjusted by the vernier function.

3.4 Inverting the Waveform (Invert Function)

This function can be used for analog channels only. The positive and negative sides of the waveform get reversed.
The waveform data (saved as files) is that inverted by the invert function.

Example
- When the signal is input with spring-pulling force being negative and spring-compressing force being positive; however, you would like the results to be displayed with spring-pulling force being positive and spring-compressing force being negative
- If the current sensor is attached around the wire with its current direction mark mistakenly in the direction opposite to the current flow

> [Channel]



Set [Invert] to [On].

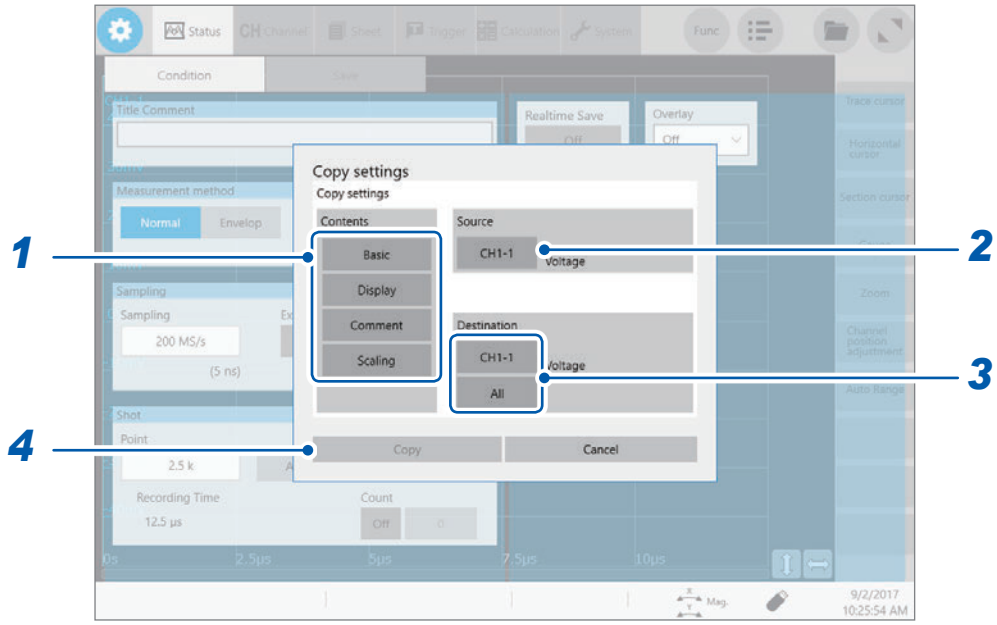
This setting is not available for Model 8967 Temp Unit, Model 8970 Freq Unit, and Model 8973 Logic Unit.

3.5 Copying Settings (Copy Function)

You can copy settings of other channels, as well as the trigger settings and the real-time waveform calculation settings (Model MR6000-01 only).

The following procedure explains how to copy settings of another channel.

> [Func] > [Copy] > [Channel]



1 Set [Contents].

Depending on the type of module, some items may not be able to be copied.

Basic	Copies the following settings: mode, measurement range, coupling, L.P.F., division ratio, and module-specific settings.
Display	Copies the display setting (excluding comments).
Comment	Copies a comment.
Scaling	Copies the scaling setting.

2 Set [Source].

Select the source channel to be copied.

3 Set [Destination].

CH1-1☑ (Channel selection)	Tap this option when you would like to copy the settings to any one of channels. Select a destination channel from the list.
All	Copies settings to UNIT 1 through UNIT 8.

4 Tap [Copy].

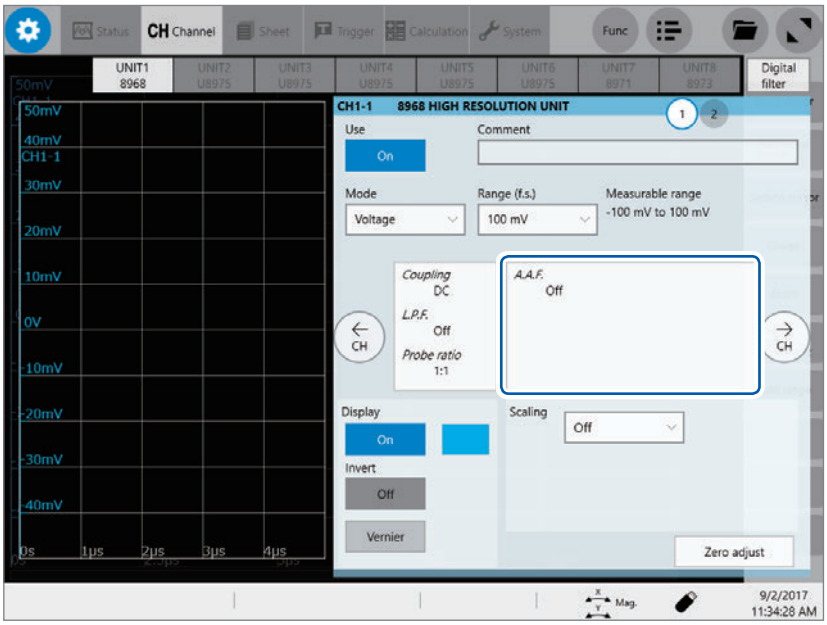
After copying the settings, check that the **[Range (f.s.)]** setting as well as values in the **[Level]**, **[Upper]**, **[Lower]** boxes of the numerical calculation function, the trigger function, and the search function are appropriate.

3.6 Configuring Module-Specific Settings

The advanced settings can be configured for each module.

Setting Model 8968 High Resolution Unit

> [Channel] > [8968]



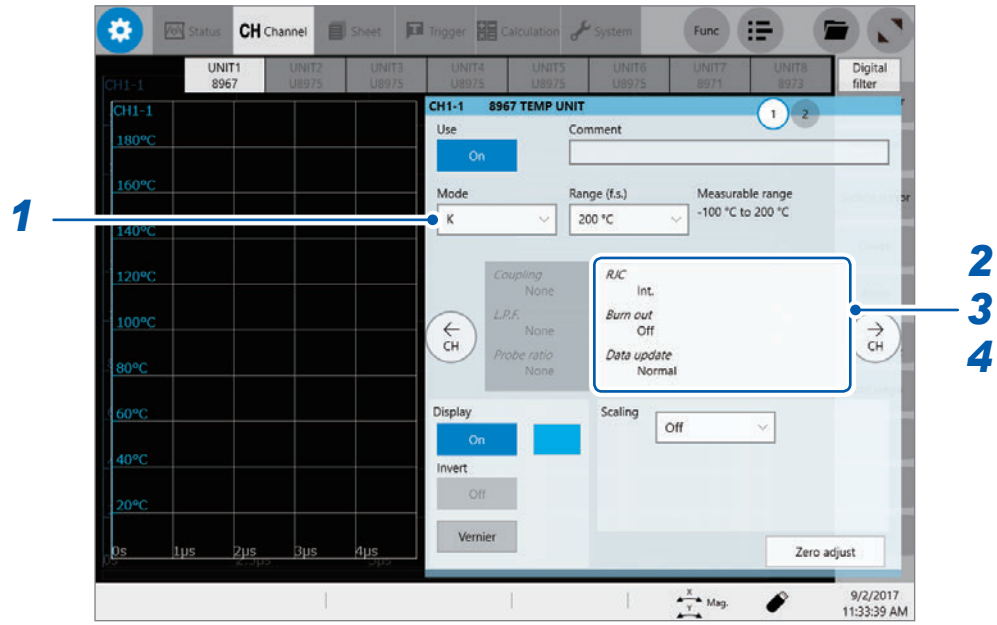
Set [A.A.F.] (anti-aliasing filter).

The anti-aliasing filter can prevent aliasing distortion when FFT calculations are performed. The cutoff frequency changes automatically according to the sampling rate setting.

Off☑	Disables the anti-aliasing filter.
On	Enables the anti-aliasing filter. (Disabled when the external sampling is used or the sampling rate is set at a rate of 100 kS/s or faster)

Setting Model 8967 Temp Unit

> [Channel] > [8967]



1 Set [Mode].

Choose an option depending on the type of thermocouple to be used.

Mode	Measurable range	Mode	Measurable range
K☑	−200°C to 1350°C	R	0°C to 1700°C
J	−200°C to 1100°C	S	0°C to 1700°C
E	−200°C to 800°C	B	400°C to 1800°C
T	−200°C to 400°C	W	0°C to 2000°C
N	−200°C to 1300°C		

2 Set [RJC].

Int.☑	Execute the reference junction compensation inside the module. (Measurement accuracy: The sum of the accuracy of the temperature measurement and that of the reference junction compensation)
Ext.	Does not execute the reference junction compensation inside the module. (Measurement accuracy: The accuracy of the temperature measurement only)

When connecting a thermocouple directly to the module, select [Int.].
When connecting a thermocouple via a reference junction device (e.g., zero-point bath), select [Ext.].

3 Set [Burn out].

You can detect a broken thermocouple wire during temperature measurement. If a thermocouple wire breaks, measured values will fluctuate.

Off☑	Does not check wires for breaks.
On	Check wires for breaks by flowing approximately 100 nA of minuscule current through the thermocouple.

If the thermocouple wires are long or have a relatively high resistance, set [Burn out] to [Off] to avoid measurement errors.

4 **Set [Data update].**

The data update rate has 3 options:

Fast	Updates data approximately every 1.2 ms. Select this option for a quicker response; however, selecting this option caused some increase in noise superimposed on input signals.
Normal☑	Updates data approximately every 100 ms. Selecting this option eliminates noise, leading to stable measurement.
Slow	Updates data approximately every 500 ms. Selecting this option leads to stabler measurement.

Setting Model U8969 Strain Unit

For Model U8969 Strain Unit, the auto-balance can be executed.
Executing the auto-balance regulates the reference output level of a transducer at the specified zero position. This function is available for Model U8969 Strain Unit only.

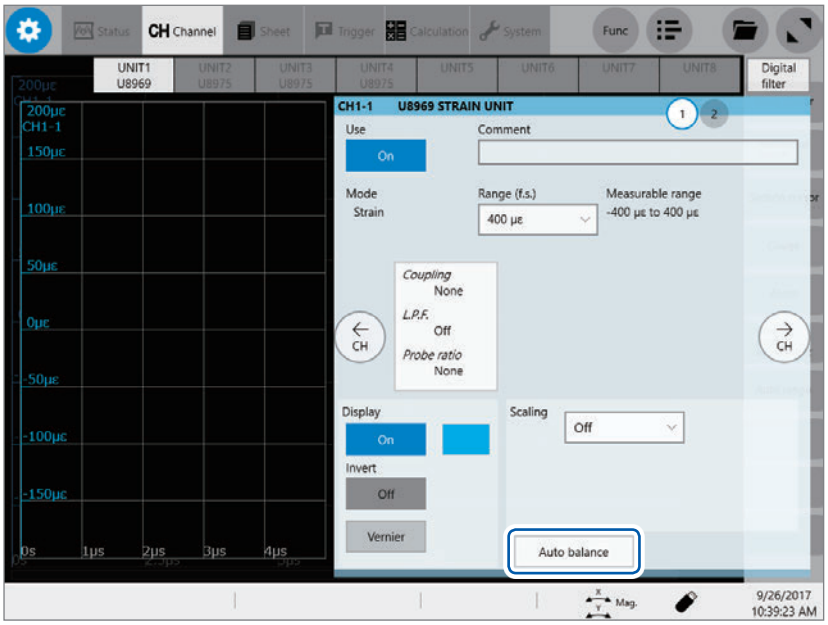
You can use Model 8969 Strain Unit you own with this instrument. The instrument displays the model name of Model 8969 Strain Unit as **[U8969]**.

Before executing the auto-balance

- Turn on the instrument and leave it for 30 minutes to allow the internal temperature of the module to stabilize.
- After connecting a strain gauge converter to the module, execute the auto-balance without any input including distortion.
- The auto-balance cannot be executed during measurement.
- No key operation is accepted during the execution of the auto-balance.

To execute the auto-balance on the channel screen of each channel

> **[Channel] > [U8969]**



Tap [Auto balance].

One channel only	Executes the auto-balance for only the channel displayed on the channel screen.
All channel	Executes the auto-balance for all of the channels in which Model U8969 is installed.

To execute the auto-balance on the list screen

 **> [Channel] >** **> [Operate] > [Auto balance]**

Executes the auto-balance for all of the channels in which Model Strain Unit is installed.

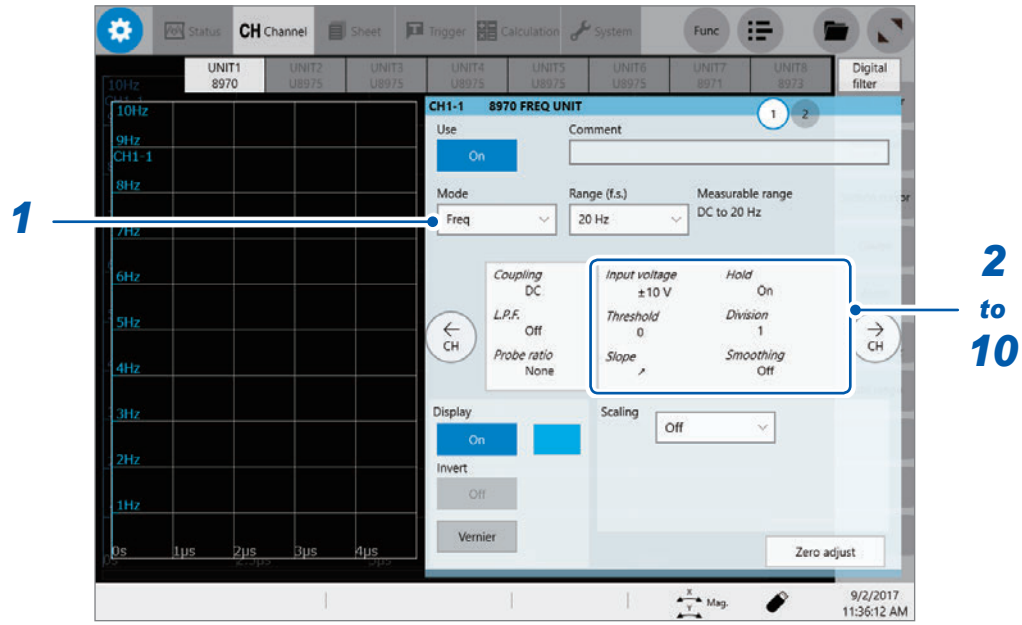
In the following cases, execute the auto-balance again.
- After changing the vertical axis (strain axis) range
- After replacing any of modules
- After replacing the strain gauge converter
- After cycling the instrument
- After initializing the instrument
- When the ambient temperature has changed significantly (The zero position may drift.)

If the auto-balance fails

Verify the following, and execute the auto-balance again.
- Is the strain gauge converter not subject to any load?
  (Make sure that the strain gauge converter is not subject to vibration, etc.)
- Is the strain gauge converter connected properly?

Setting Model 8970 Freq Unit

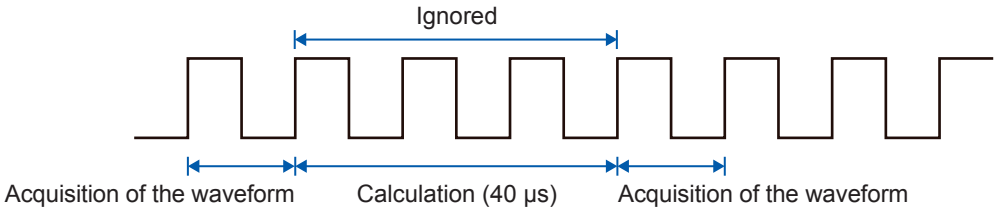
> [Channel] > [8970]



1 Set [Mode].

Freq☑	Measures the frequency of a waveform (in hertz [Hz]).
RPM	Measures the number of rotations of a measurement target (in rotations per minute [r/min]).
P-Freq	Measures power frequency fluctuation (in hertz [Hz]).
Count	Accumulates the number of input pulses.
Duty	Measures duty ratios of a measurement waveform (in percent [%]).
Pulse width	Measures pulse widths (in second [s]).

A pulse (having a frequency of 25 kHz or higher) that rises during the dead time (calculating period) cannot be measured.



2 Set [Input voltage].

Set the maximum level of an input signal.

±10 V☑, **±20 V**, **±50 V**, **±100 V**, **±200 V**, **±400 V**

3 Specify [Threshold].

- Measured values are acquired based on the following: the interval between the times when measured waveform exceeds or falls below the threshold value, and the number of times when the waveform exceeds or falls below the threshold value.
- The upper and lower limits of the threshold value and the increment in the threshold value vary depending on the input voltage setting.

To prevent measurement errors due to noise, the hysteresis width that is approximately 3% of the input voltage is tolerated for the threshold.
(When **[Input voltage]** is set to **[±10 V]**, it stands at approximately ±0.3 V.)
Specify a threshold allowing for tolerance exceeding the hysteresis width relative to a peak voltage.

4 Set [Slope].

The instrument detects the waveform when the waveform crosses the specified threshold in the direction specified here, which is used in each measurement mode.

↗☑	Detects the waveform when it exceeds the specified threshold value (in the positive direction).
↘	Detects the waveform when it falls below the specified threshold value (in the negative direction).

5 Specify [Division].

The instrument determines the frequency every time the specified number of pulses has been counted.

1☑ to **4,096**

Example: For the encoder that outputs 360 pulses per rotation, set **[Division]** to **[360]** to measure the frequency of each rotation. When **[Division]** is not used, set **[Division]** to **[1]**.

6 Set [Timing].

Only when **[Mode]** is set to **[Count]**, this setting is available.
You can set when to start accumulating the number of pulses.

Start☑	Starts the accumulation when the **START** key is pressed.
Trigger	Starts the accumulation when the instrument is triggered.

- When **[Timing]** is set to **[Start]**, some internal processing time is required between the pressing of the **START** key and the start of measurement. Thus, the count value is not zero at the start point.
- When **[Timing]** is set to **[Start]**, the instrument does not trigger even when the input signal exceeds the specified trigger level while the pre-trigger length of data is being acquired. Furthermore, the time for internal processing at the start and the trigger priority setting may cause the instrument not to trigger even when the input signal exceeds the specified trigger level.

7 Set [Count over].

Only when **[Mode]** is set to **[Count]**, this setting is available.

Hold☑	Counts pulses and stops counting when the number of pulses reaches the upper limit (65535 for the 40 k range).
Back	Starts counting pulses and brings the count back to zero when the number of pulses reaches 25 times of the range (50000 for the 40 k range).

8 Set [Level].

Only when **[Mode]** is set to **[Pulse width]** or **[Duty ratio]**, this setting is available.
For the pulse width measurement and duty ratio measurement, you can select whether to detect the parts above the threshold level or those below the level.

HIGH☑	Measures the parts of waveforms above the threshold value.
LOW	Measures the parts of waveforms below the threshold value.

9 Set [Smoothing].

Only when **[Mode]** is set to **[Freq]** or **[Revolution]**, this setting is available.

Off☑	Records the measured data without smoothing (resulting in a stair-step waveform).
On	Interpolates the measured data to smooth the waveforms and outputs the waveforms. (Upper limit: 10 kHz, outputting data with this setting set to On lags behind than with this setting set to Off)

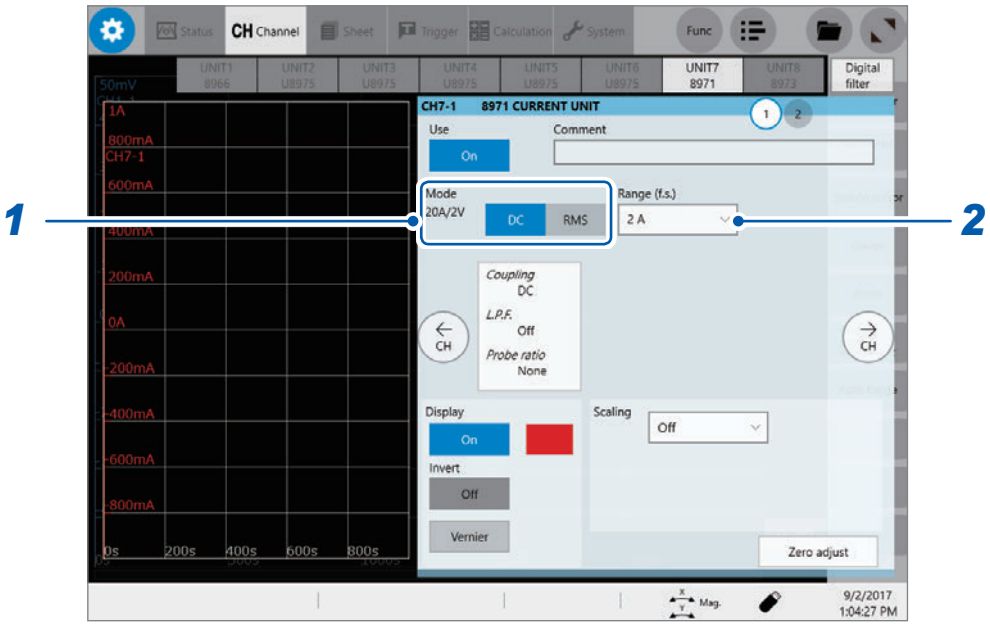
10 Set [Hold].

Only when **[Mode]** is set to **[Freq]** or **[Revolution]**, this setting is available.
The hold for frequencies and number of rotations can be set.

Off (1 Hz), **Off (0.5 Hz)**, **Off (0.2 Hz)**, **Off (0.1 Hz)**	When the instrument does not determine the measured value even when the frequency reaches one of the values in the brackets, the measurement is defined to stop and regards the measured value to be 0 Hz (0 rpm).
On☑	Retains the value settled last time.

Setting Model 8971 Current Unit

> [Channel] > [8971]



1 Set [Mode].

The instrument automatically recognizes the current sensor connected to Model 8971 Current Unit and displays it as follows:

20A/2V	When one of the following current sensors is connected: Model 9272-10 (20 A range) and Model CT6841.
200A/2V	When one of the following current sensors is connected: Model 9272-10 (200 A range), Model CT6843, and CT6863.
50A/2V	When the current sensor Model CT6862 is connected.
500A/2V	When one of the following current sensors is connected: Model 9709, Model CT6844, Model CT6845, Model CT6846*, and Model CT6865*.
None	When no current sensor is connected.

IMPORTANT

*: When Model CT6846 or Model CT6865 is connected to Model 8971 Current Unit via Model 9318 Conversion Cable, the instrument recognizes the sensor as a 500 A AC/DC sensor. Set the conversion ratio to 2.00 in the scaling setting.

Make sure to execute the zero adjustment after you change the setting. Execute the zero adjustment without any input.

DC☑	Current measurement
RMS	RMS measurement

2 Set [Range (f.s.)].

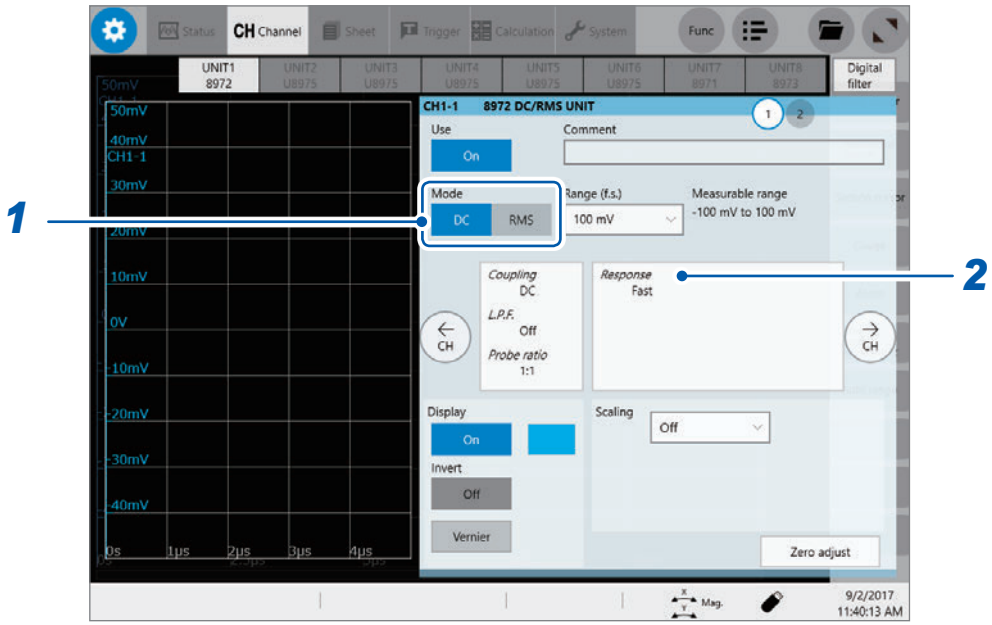
Select a measurement range from the scaled set values for the automatically recognized current sensor.

IMPORTANT

The values displayed under **[Range (f.s.)]** represent the maximum displayable values (f.s. or full-scale) of Model 8971. Currents that exceed the rated current of the connected current sensor cannot be measured. Check the specifications of the current sensor.

Setting Model 8972 DC/RMS Unit

> [Channel] > [8972]



1 Set [Mode].

Make sure to execute the zero adjustment after you change the setting. Execute the zero adjustment without any input.

DC☑	Voltage measurement
RMS	RMS measurement

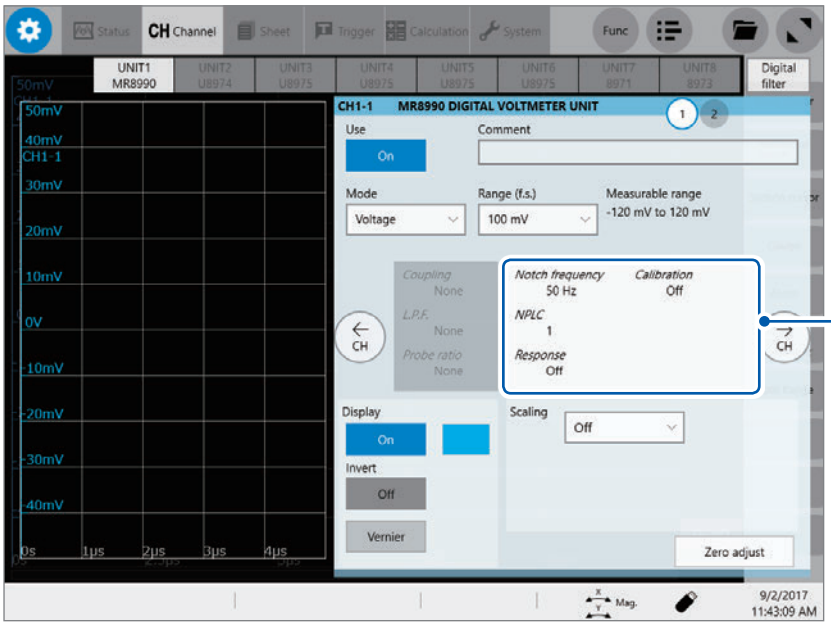
2 Set [Response].

Set the response time for RMS measurement.
Usually, use **[Fast]**. Setting the response time to **[Normal]** or **[Slow]** can stabilize the measured values if the frequency is relatively low or the voltage fluctuates severely.

Fast☑	Sets the response time to approximately 100 ms.
Normal	Sets the response time to approximately 800 ms.
Slow	Sets the response time to approximately 5 s.

Setting Model MR8990 Digital Voltmeter Unit

> [Channel] > [MR8990]



1 Set [Notch frequency].

Set the notch frequency according to the power frequency in your region.

50 Hz☑	Sets the period to 20 ms.
60 Hz	Sets the period to 16.67 ms.

If the power frequency is not set correctly, measured values will fluctuate.

2 Set [NPLC].

The power line cycle (PLC) is the time equivalent to one period of the power frequency.
Set the integration time based on 1 PLC.

0.1 to **0.9**, **1**☑ to **10**, **20**, **30**, **40**, **50**, **60**, **70**, **80**, **90**, **100**

Example: When the power frequency is 50 Hz and NPLC is set to 10, then 20 ms × 10 = 200 ms.
The measured data update rate is calculated to be 200 ms.

3 Set [Response].

Data can be updated at high speed.

Off☑	Updates data at intervals of the integration time specified under NPLC.
On	Calculates the moving average and thereby updates the data at high speed. • Updates data at intervals of 0.1 PLC when NPLC is set to 9 or less. • Updates data at intervals of 1 PLC when NPLC is set to 10 or more.

4 Set [Calibration].

Enabling this setting calibrates the module or synchronizes the channels automatically when measurement starts. The synchronization between the channels allows the integration calculations to synchronize with each other.

Off☑	Does not calibrate the module nor synchronize the channels.
On	Calibrates the instrument and synchronizes the channels.
Synchronization	Only synchronizes the channels.

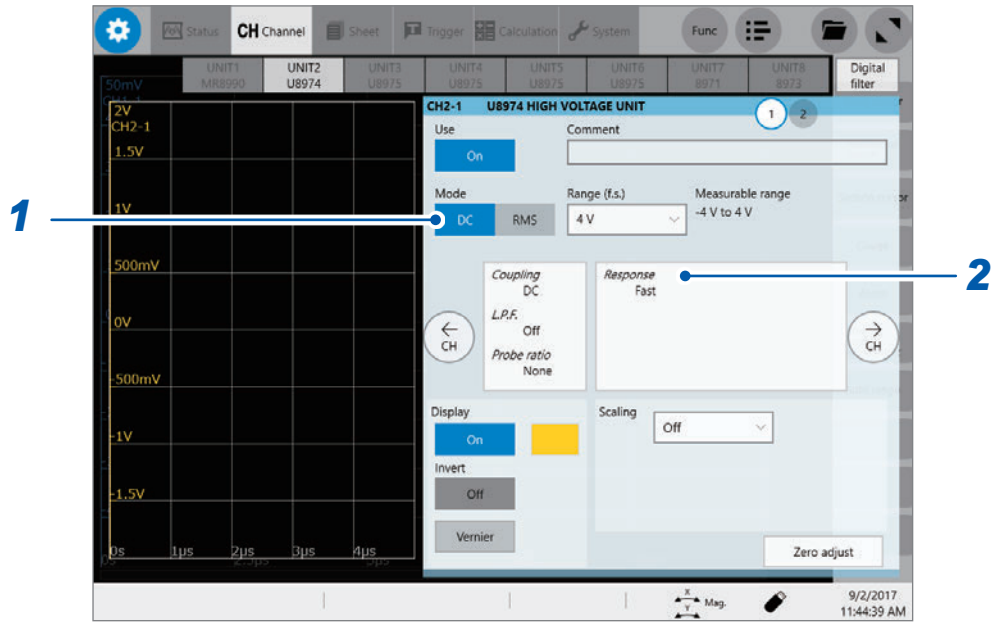
- It takes approximately 150 ms to calibrate the module. During this period of time, no measurement is performed.
- If the channels are synchronized, the signal that interrupts the integration is sent at the start of measurement; thus, the instrument has to wait until the first integration finishes.
  The wait time required for this process stands at the sum of 10 ms and integration time*.

  *: The integration time varies depending on the NPLC setting.

  Even when synchronization is not performed, the wait time described above is required for measurement performed immediately after the settings Model MR8990 Digital Voltmeter Unit has been changed. No wait time is required when the measurement is performed with the same settings.
- When **[Calibration]** is set to **[Off]** (default setting), execute calibration manually.
  Refer to “2.12 Executing Calibration (When Model MR8990 is Installed)” in Quick Start Manual.

Setting Model U8974 High Voltage Unit

> [Channel] > [U8974]



1 Set [Mode].

Make sure to execute the zero adjustment after you change the setting. Execute the zero adjustment without any input.

DC☑	Voltage measurement
RMS	RMS measurement

2 Set [Response].

Set the response time for RMS measurement.
Setting the response time to **[Slow]** can stabilize the measured values if the frequency is relatively low or the voltage fluctuates severely.

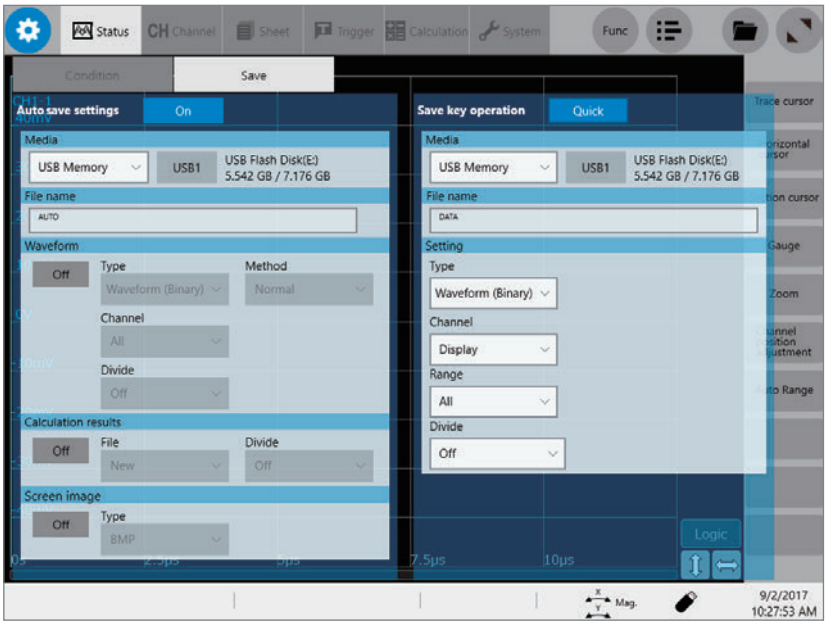
Fast☑	Sets the response time to 150 ms.
Normal	Sets the response time to 500 ms.
Slow	Sets the response time to 2.5 s.

4 Saving/Loading Data and Managing Files

This chapter explains how to save and load data and manage files.

Before saving data, configure the save setting on the **[Save]** screen, which is accessible by proceeding in the following order: **[Status] > [Save]**
The file screen allows you to load data.
The explorer allows you to manage files.
Refer to “4.4 Managing Files” (p. 79).

> [Status] > [Save]



Operation available on the [Save] screen

Auto-save

Setting the auto-save method of measured data (p. 68)

Real-time save

Setting the method of saving waveform data in real time (p. 72)

SAVE key operation

- Setting the operation implemented when the **SAVE** key is pressed (p. 74)
- Setting the contents to be saved when **[Quick]** is selected (p. 74)

4.1 Data That Can Be Saved and Loaded

Files that exceed 2 GB cannot be saved.
Data saved with another instrument cannot be loaded onto the instrument.

✓: Yes, –: No

File type	File format	File extension and description		Saving		Loading	Loading on a PC
				Auto.	Manual		
Setting data*1	Binary	SET	Setting data (measurement conditions)	–	✓	✓	–
Waveform data*2 The data of all waveforms or a part of waveforms within the range between the section cursors (acquired in the instrument)	Binary	MEM	Data measured normally	✓	✓	✓	– *3
		REC	Data measured using the envelope	✓	✓	✓	– *3
		FLT	Waveform data in floating-point format	–	✓	–	–
	Text	CSV, TXT*6	Text data	✓	✓	–	✓
Data managing data*4 (Division save)	(Index file)	IDX	Index data of the division save.	✓	✓	✓	–
Screen image, waveform image)	BMP*5	BMP	Image data	✓	✓	–	✓
	PNG*5	PNG	Image data (PNG format)	✓	✓	–	✓
	JPEG*5	JPG	Image data (JPEG format)	✓	✓	–	✓
Numerical calculation results	Text	CSV, TXT*6	Text data	✓	✓	–	✓

*1: The instrument loads the data automatically at the time of startup. (p. 78)

*2: To load data with the instrument: Save the data in binary format. Waveform data and a part of measurement settings data are saved.
To load data with a PC: Save the data in text format. (p. 67)
To save a part of waveforms: Specify the saving range with section cursors. (p. 22, p. 26)

*3: Files can be loaded with Wave Viewer (Wv).

*4: To load a divided waveform data: Load the index data (INX).

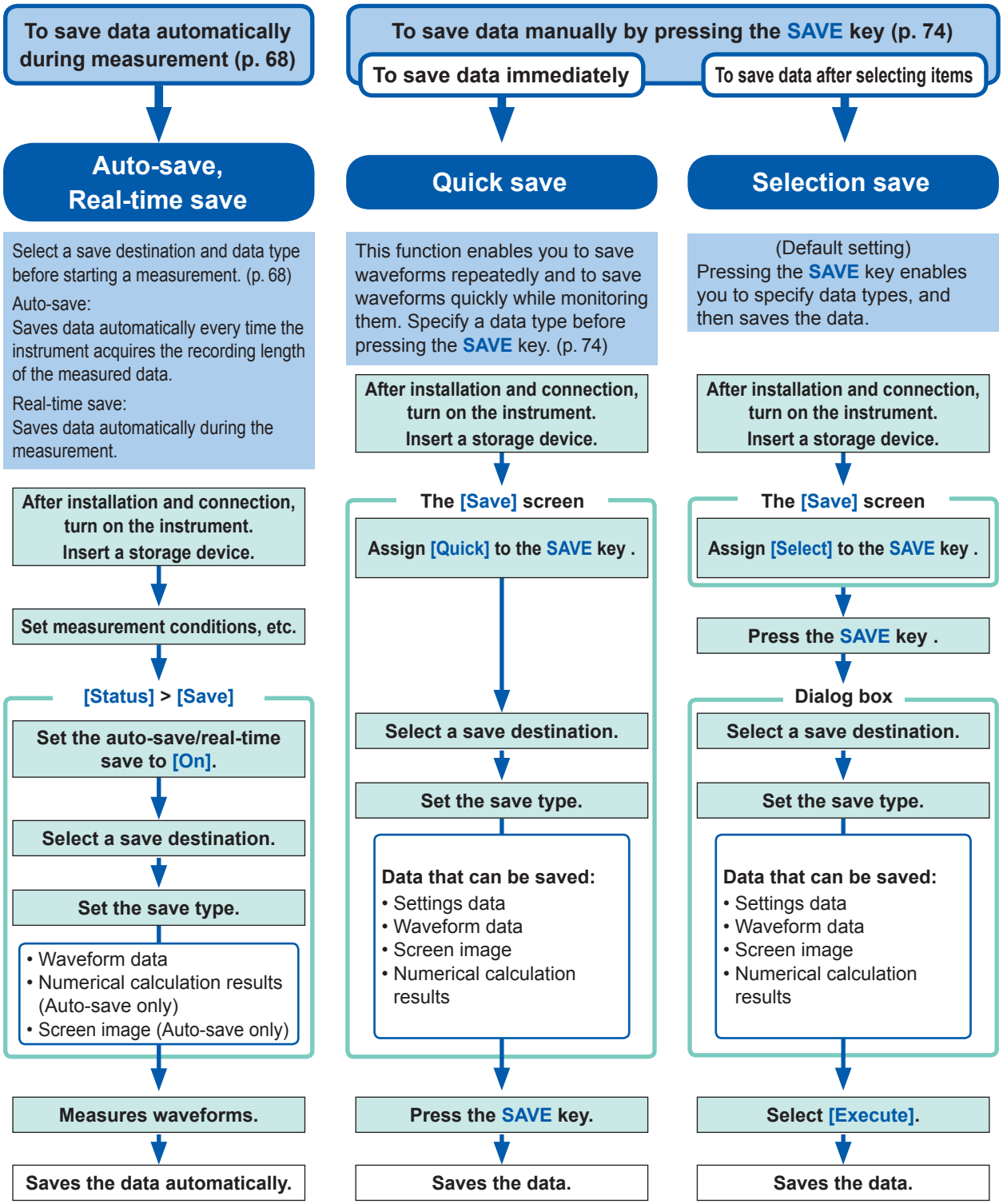
*5: BMP format: Standard Windows® graphic format in which various graphics programs can open files
PNG format: Internationally standardized image format conforming to ISO/IEC15948
JPEG format: Internationally standardized image format conforming to ISO/IEC10918

*6: When one of the separators other than **[Comma ,]** is selected in the **[Region]** setting, files are saved with the .TXT extension. (p. 147)

4.2 Saving Data

Save types and setting procedure

There are mainly three types of save operation.



Check the following before saving data:

- Have you already inserted and initialized the storage device?
  Refer to “Formatting Media” in “2.7 Preparing Storage Devices (Recording Media)” in Quick Start Manual.
- Is the save destination specified correctly?
- When the auto-save is used, is **[Auto save settings]** set to **[On]**?

Saving waveform data automatically

The instrument saves data automatically every time it acquires the recording length of the measured data. Set a save destination and items to be saved before starting measurement.

> [Status] > [Save]

1 Set [Auto save settings] to [On] or [Off].

2 Set [Media].

Select a save destination.

SSD/HDD	Built-in drive
SD Card	SD memory card
USB Memory☑	USB flash drive
Mail	Sends measured data to a PC in the network or to a remote PC as an email attachment.
FTP	Sends measured data to a PC connected to the network

(1) When you select a save destination, the state of the storage device such as its drive letter and capacity is displayed on the right. If no media is inserted, **[None]** is displayed.
(2) When **[USB Memory]** is selected as the save destination, select which USB flash drive you would like to use as a save destination from all attached USB flash drives.

- The **[HIOKI_MR6000]** folder is automatically created in the specified save destination, and sub-folders are automatically created according to **[Type]** in the folder.
  Waveform (Binary), Waveform (Text), Waveform (Float): WAVE
  Setting: CONFIG
  Numerical calculation results: MEASURE
  Screen image: PICT
  When **[FTP]** is selected, set the LAN setting and the FTP client functions.
  Refer to “Configuring the LAN settings with the instrument” (p. 150) and “9.3 Sending Data to a PC With the FTP Client Function” (p. 158)
- For protecting data, use the following Hioki's options:
  Model U8332 SSD Unit, Model U8333 HD Unit, Model Z4006 USB Drive, Model Z4001, and Model Z4003 SD Memory Card

3 Type a file name in the [File name] box.

- Number of characters of a file name: Up to 100 characters
- Maximum length of a file name including its path: 255 characters

4 Set [Waveform].

Off☑	Does not save waveforms.
On	Saves waveforms.

[Type]

Waveform (Binary)☑	Saves waveform data in binary format. (Only data saved in binary format can be loaded onto the instrument)
Waveform (Text)	Saves waveform data in text format. (The instrument decimates the data and saves the remaining data as a file. The files can be opened with editors and spreadsheet software installed in PCs; however, they cannot be loaded onto the instrument.)

[Method]

Set the countermeasure method to be taken if the size of waveform data to be saved exceeds the capacity of the storage device.

Normal☑	Stops the auto-save if the storage device is full.
Delete	Deletes old files and continues the auto-save even when the storage device is full (waveform files only). The instrument deletes files created after the measurement has started; it does not previously existing files.

[Channel]

All☑	Saves the data acquired through all measured channels (channels with measurement set to **[On]**). Saves the data acquired through the channels the waveform display of which is set to **[Off]**.
Display	Saves the data acquired through the channels the waveform display of which is set to **[On]** on all sheets.

[Divide] (when [Type] is set to [Waveform (Binary)])

Off☑	Saves a file without dividing it.
16 MB, **32 MB**, **64 MB**	Select this option to divide a large file into several files and save them. A file is divided into several files each of which has the specified size. The instrument creates a folder with the specified name, divides a file into several files, and then saves them in the folder.

A folder is automatically created, and then waveform files and an index file (extension: .IDX) are created in the folder. Loading the IDX file allows the waveform files to be loaded in a batch.

[Divide] (when **[Type]** is set to **[Waveform (Text)]**)

Off☑	Saves a file without dividing it.
60,000 data, **1,000,000 data**	Divides a file into several files each of which contains the specified number of data points.

[Thin out] (when [Type] is set to [Waveform (Text)])

Storing files in text format requires a lot of storage space. Data decimation can reduce the file size.

Off☑	No data is decimated.
On (**2** to **1,000**)	Allows you to set the decimation number. One out of the specified number of data points is retained.

Example: When **[Thin out]** is set to **[2]**, every two pieces of data are saved. The number of data points is reduced by half of the original amount.

5 Set [Calculation result].

Off☑	Does not save numerical calculation results.
On	Saves numerical calculation results.

[File]

New☑	Creates a new file for each measurement and saves it.
Append	Appends data to an existing file and saves it.

[Divide]

Off☑	Does not divide a file.
Split by Calc. No.	Creates a file for each calculation number.

6 Set [Screen image].

Off☑	Does not save the screen image.
On	Saves the screen image.

[Type]

BMP☑, **PNG**, **JPEG**

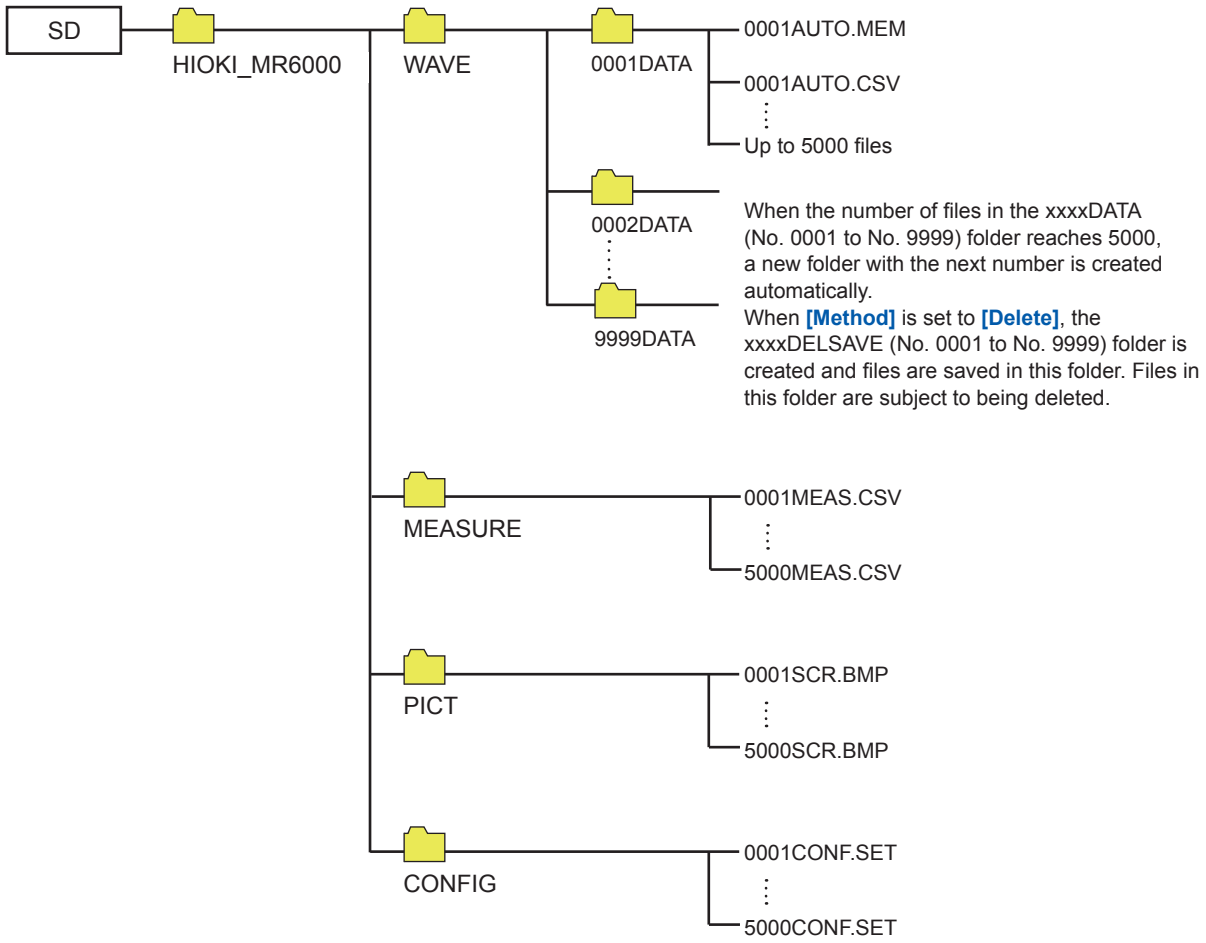
When data in text format or numerical calculation results is selected to be saved

Characters or display items used on the instrument are converted as follows:

Character used on the instrument	Saved character
²	^2
³	^3
μ	~u
Ω	~o
ε	~e
°	~c
±	~+

Structure of the save destination folder

The instrument saves folders under the folder “HIOKI_MR6000” as follows.
Every folder can retain up to 5000 files and folders collectively.



Real-time save

Since setting the real-time save to **[On]** allows the data to be saved in a storage device simultaneously with measurement, long-time measurement can be performed regardless of the capacity of the internal memory.
The measurement condition settings are different between setting the real-time save to **[On]** and **[Off]**.

- When the real-time save is set to **[On]**, the auto-save and the trigger functions cannot be used.
- No storage device can be removed or replaced during the real-time save.
- If the message, Error No. 235 **[Real-time save could not be completed within available time.]** is displayed, normal data may not be recorded in a waveform file saved in a storage device.
- The operation may be automatically restricted or the magnification may be changed if there is a risk that saving data cannot be completed in time during the real-time save.
- When any numerical calculation is set, only manual calculation can be executed.

  After the measurement has been complete, execute **[Execute]**, which is accessible by proceeding in the following order:
   **> [Calculation] > [Numeric calculation]**

Maximum recording time

- When the real-time save is set to **[On]**, the maximum recording time is determined based on the recording interval, the remaining capacity of the storage device, and the number of channels used.
- When the sampling rate is set to a slow rate, the recording time is set to a long term (1 year or more) depending on a condition. The operation cannot be guaranteed because the warranty period or product life may disturb it.
- When the external sampling is used, the maximum recording time is calculated assuming a recording interval of 10 Ms/s.

Refer to “Maximum recording time when the real-time save is on (reference)” (p. 193).

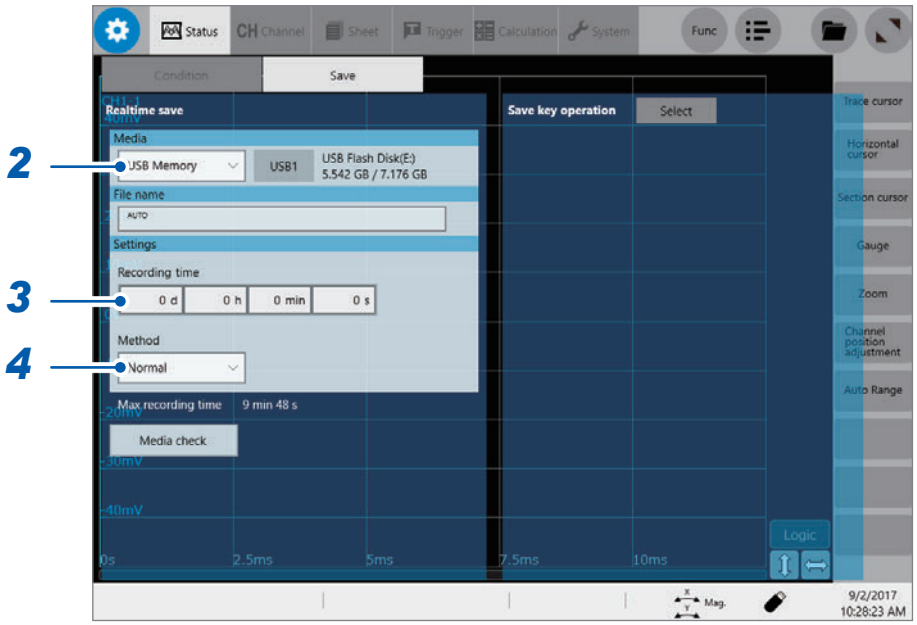
Measured data

When recording waveforms with the real-time save set to **[On]**, measured waveform data (.MEM or .REC) is directly saved to a storage device. If the file size is large, the file is automatically divided into several files each of which has 512 MB and then saved.

Deleting and saving files when data is saved in real time

- If the capacity of the storage device becomes full while files are being stored, the instrument deletes the waveform files created after the measurement has started beginning from the oldest automatically, securing free space in the storage device. However, when free space in a storage device is less than the sum of the created file size and 512 MB before starting a measurement, the instrument cannot overwrite any new files over the older files. Use a storage device with as much free space as possible.
- Waveform files saved in the past are not deleted.
- When **[Method]** is set to **[Delete]**, the recording length can be set to 10000 days at a maximum; however, the data that is retained after the measurement has stopped limited to a free space size of a storage device at the start of recording (recording time of the normal saving).

> [Status] > [Save]



1 On the [Condition] screen, configure the [Realtime save] and [Sampling] settings.

Refer to “1.2 Configuring Measurement Conditions” (p. 5).

2 Set [Media].

3 Set [Recording time].

Enter the recording time.

d	0 to 10000 (days)
h	0 to 23 (hours)
min	0 to 59 (minutes)
s	0 to 59 (seconds)

4 Set [Method].

Set the countermeasure method used if a space of a storage device is insufficient.

Normal☑	Stops the real-time save and measurement if the storage device is full.
Delete	Deletes old files and saves files in real time if the storage device is full (waveform files only). The instrument deletes files created after the measurement has started; it does not delete previously existing files.

Setting [Media] to [FTP] forces this setting into [Normal].

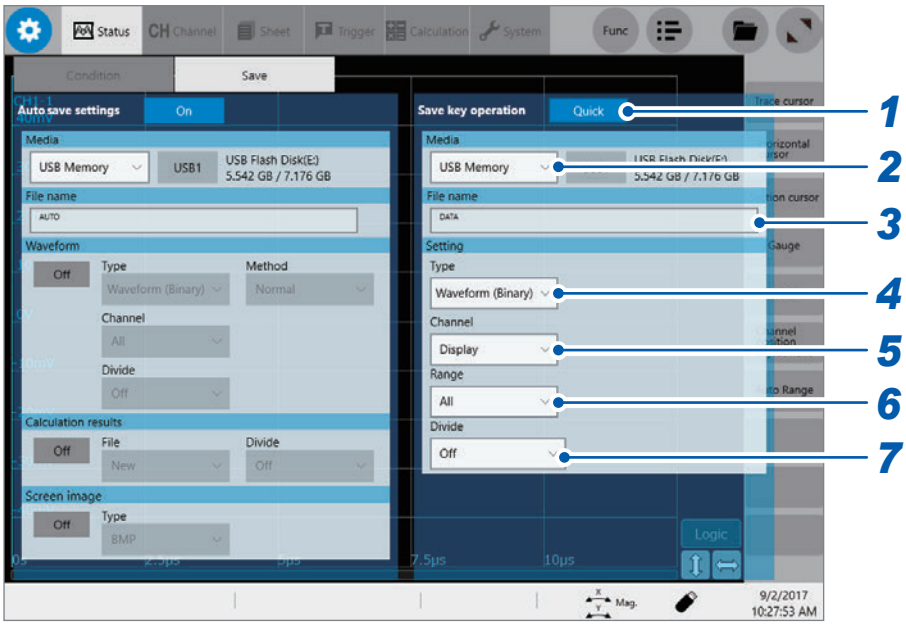
5 Check the input channel settings and other settings, and then start a measurement (by pressing the START key).

The data is saved in the storage device in real time during the measurement.

Freely selecting data items to be saved and save files (SAVE key)

To save a file immediately by pressing the **SAVE** key, you need to specify the items to be saved beforehand.
You can save the following types of data: (Setting data, waveform data, screen images, and numerical calculation results)

> **[Status] > [Save]**



1 Set [Save key operation].

Selects the save method implemented when the **SAVE** key is pressed.

Select☑	Displays the dialog box to allow you to select items to be saved and saves them. Refer to “Selection save” (p. 67).
Quick	Saves data consisting of pre-specified items immediately. Refer to “Quick save” (p. 67).

When **[Select]** is selected, you can configure the subsequent settings in the dialog box that is displayed when the **SAVE** key is pressed at the start of measurement. This operation cannot be executed if another dialog box is open.

2 Set [Media] (Refer to p. 68).

3 Type the file name in the [File name] box.

- Number of characters of a file name: Up to 100 characters
- Maximum length of a file name including its path: 255 characters

4 Set [Type].

Waveform (Binary)☑	Saves waveform data in binary format. Select this option to reload the waveforms with the instrument.
Waveform (Text)	Saves waveform data in text format. Select this option to load the waveforms with a PC.
Waveform (Float)	Saves waveform data in binary format (32-bit floating point). Select this option to load the waveforms with a PC.
Screen image	Saves a screenshot. You can display the saved data on a PC with graphic viewing software.
Calc. Result	Saves numerical calculation results.
Setting	Saves the present measurement conditions.

5 Set [Channel].

When **[Type]** is set to **[Waveform (Binary)]** or **[Waveform (Text)]**

All	Saves the data acquired through all measured channels (channels with measurement set to **[On]**). Saves the data acquired through the channels with the display setting set to **[Off]**.
Display☑	Saves the data acquired through the channels with the display setting set to **[On]** on all sheets.

6 Set [Range].

When **[Type]** is set to **[Waveform (Binary)]** or **[Waveform (Text)]**

All☑	Saves the entire acquired data.
Segment 1	Saves data in the segment between Section cursors **[1A]** and **[1B]**.
Segment 2	Saves data in the segment between Section cursors **[2A]** and **[2B]**.

The instrument saves the data acquired through the channels displayed on the screen.
Refer to “2.2 Specifying the Waveform Range (Section Cursor)” (p. 26).
When no target section cursors are set, the entire data is saved regardless of the **[Range]** setting.

7 Set [Divide].

When **[Type]** is set to **[Waveform (Binary)]**.

Off☑	Saves a file without dividing it.
16 MB, **32 MB**	Select this option to divide a large file into several files and save them. Divides a file into several files each of which has the specified size. Creates a folder with the specified name, divides a file into several files, and then saves them in the folder.

The instrument creates a folder automatically, and then creates the waveform files and an index file (extension: .IDX) in the folder. Loading the IDX file allows the waveform files to be loaded in a batch.

When **[Type]** is set to **[Waveform (Text)]**.

Off☑	Saves a file without dividing it.
60,000 Data, **1,000,000 Data**	Divides a file into several files each of which contains the specified number of data points.

8 Set details for each [Type].

Type	Settings		Description
Waveform (Text)	**Thin out**	**Off**☑, **On** (**2** to **1,000**)	A large amount of space is required to save files in text format. Data decimation prior to saving it can reduce the file size. Allows you to set the decimation number (One out of the decimation number of data points is retained.). Example: When **[2]** is set, every two data points are saved. The number of data points is reduced by half of the original number.
	Data	**All**☑	Saves all data.
		Event	Saves only the data points at event marks.
Screen image (screenshot)	**Type**	**BMP**☑, **PNG**, **JPEG**	Allows you to set the type for saving the image file.
Calc. Result	**File**	**New**☑	Saves files with a new file name each time. Sequence numbers are automatically allocated when the same name is given.
		Append	Appends data to the same file and saves it.
	Divide	**Off**☑	Saves all calculations in a single file.
		Split by Calc. No.	Creates a new folder, divides a file into several files according to calculation number, and save them in the folder. The string "_K + sequential number" is appended following each file name.

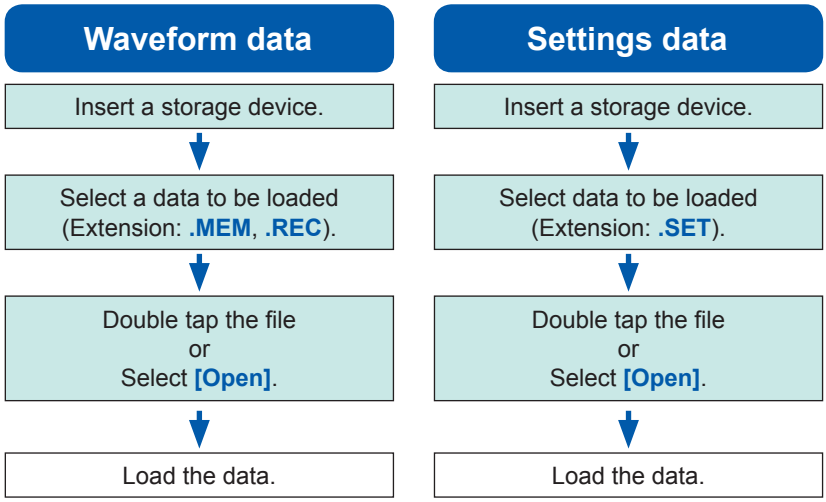
Whenever the **SAVE** key is pressed, the instrument saves data in specified settings.

4.3 Loading Data

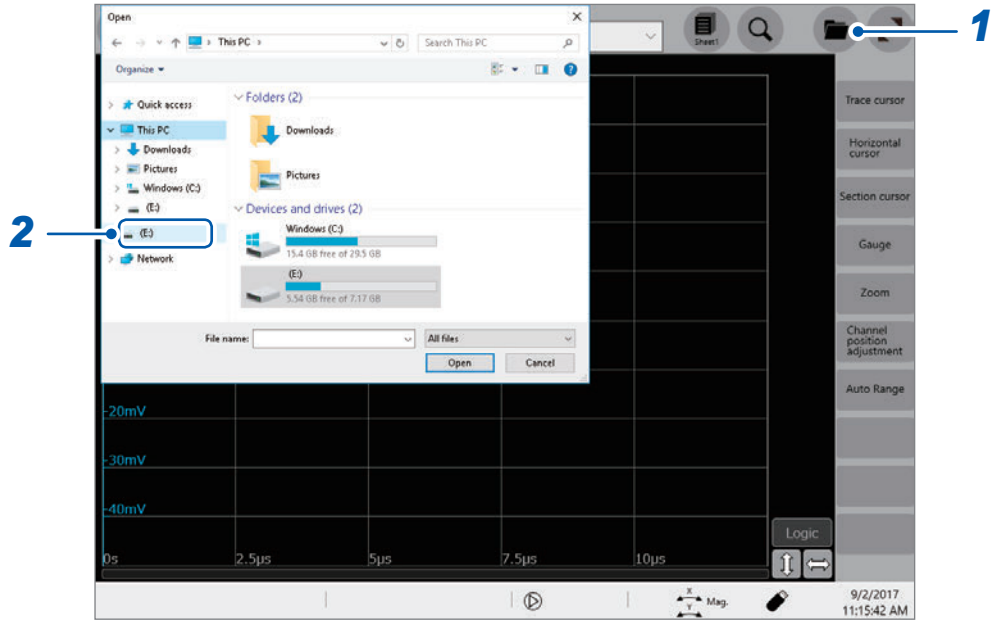
You can load the data saved in a storage device or written in the internal memory of the instrument.

Data loading procedure

Before attempting to load the data, make sure that a storage device is inserted, and the save destination is correctly specified.
Open the file screen, select a storage device, and double-click the file to be loaded.
Waveform and settings files saved in waveform (binary) format can be loaded on the instrument.
Only files that can be loaded on the instrument are displayed on the file screen.



To display the file screen



1 **Open the file screen.**

2 **Select a storage device to be operated.**

When loading data from a storage device

Insert a storage device before selecting it.

Others

- You can load data saved with Model MR6000 Memory HiCorder only.
- Loading a waveform file changes the settings of the instrument to those when the waveform file was saved. When a measurement starts with this state, the instrument measures waveforms with the settings of the loaded waveform file; however, the settings of the modules are restored to those set before the waveform file was loaded. To discard the module settings of the loaded waveform file, execute **[Initialize waveform data]** (Refer to “6.2 Initializing the Instrument” in the Quick Start Manual.).
- Loading a waveform file suspends the waveform monitor until one of the following operation is performed:
  - Starting a measurement
  - Initializing the instrument by executing **[Initialize waveform data]**, **[Initialize Settings]**, or **[Initialize all]**
  - Loading a setting file

Loading the settings automatically (Auto-setup function)

The instrument loads the setting data with the file name “STARTUP” in the **[CONFIG]** folder in the **[HIOKI_MR6000]** folder at the time of startup. The instrument searches the drives beginning from drive D in alphabetical order for the file “STARTUP.SET,” loading the file found first.

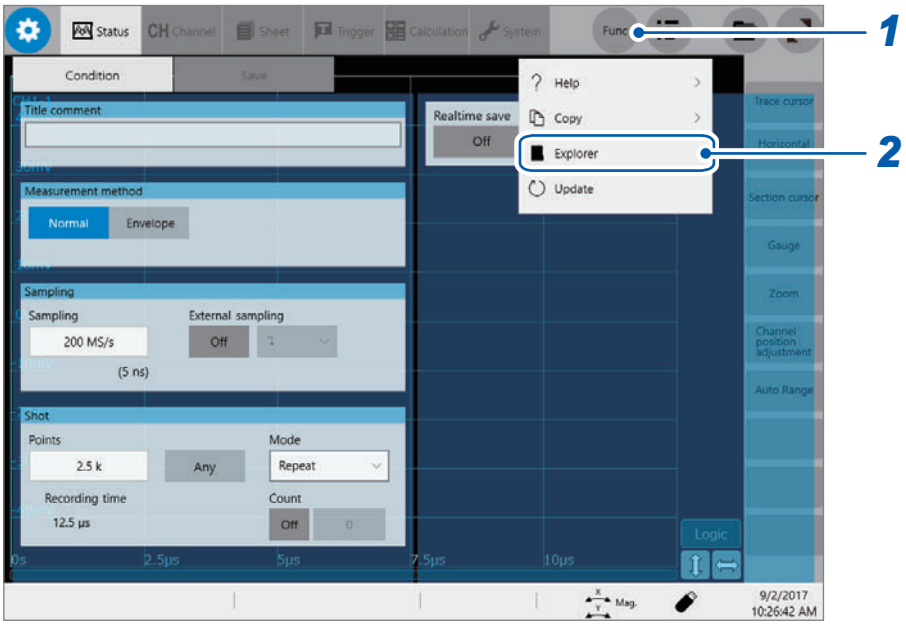
4.4 Managing Files

Opening the explorer allows you to manage data saved in storage devices.

Operation available on the explorer

Changing storage devices	Storage devices can be changed.
Sorting files	Files on a file list can be sorted based on the selected basis.
Moving files to a folder	Files can be moved to a selected folder.
Copying files	Files can be copied to a specified folder. When folders are selected to be copied, the selected folders with files included are copied to the specified folder.
Creating a folder	A new folder can be created.
Renaming a file	A file or folder can be renamed.
Deleting files	Files and folders can be deleted.
Formatting a storage device	A storage device can be formatted.

To open the explorer



1 **Tap [Func].**

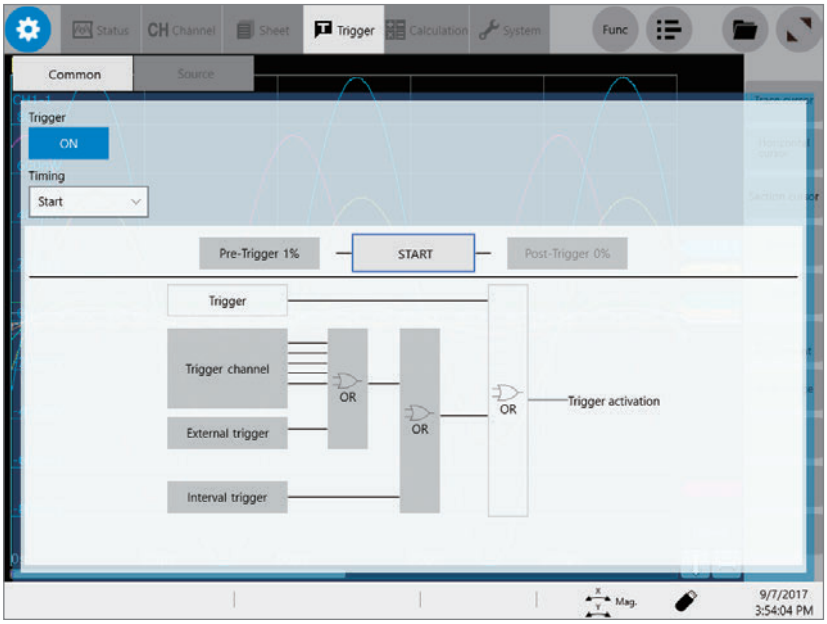
2 **Select [Explorer].**

Explorer is displayed.
Select a storage device to be operated.

5 Setting the Trigger

The trigger function allows the instrument to start and stop recording using specific signals. When recording is started or stopped by specific signals, it is referred to as “the instrument is triggered” or “the start/stop trigger is activated.”
When the real-time save is set to **[On]**, the trigger function cannot be used.
In this chapter, the mark T represents the point the start trigger is activated; the mark T represents the point the stop trigger is activated.
In the descriptions of each trigger source, the mark T represents the point each trigger condition is satisfied and the point each trigger is generated.

> **[Trigger] > [Common]**



Operation available on the [Trigger] screen

Setting the trigger
- Trigger timing (p. 84)
- Pre-trigger, post-trigger (p. 86)
- Trigger logical condition (logical AND or OR) among the trigger sources (p. 91)

Setting the trigger sources

Setting the analog trigger (p. 93)
- Level trigger
- Window trigger
- Period trigger
- Glitch trigger
- Voltage drop trigger

Setting the logic trigger (p. 102)
- Logic-trigger conditions
- Trigger filter
- Trigger pattern

Setting the interval trigger (p. 104)

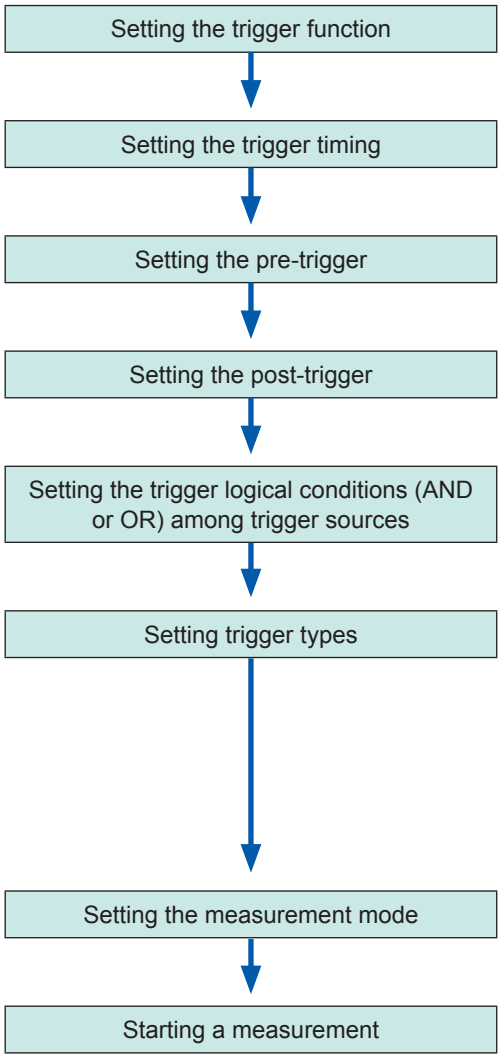
Setting the external trigger (p. 106)

Forcible trigger (p. 106)

Trigger output (p. 183)

5.1 Trigger Setting Procedure

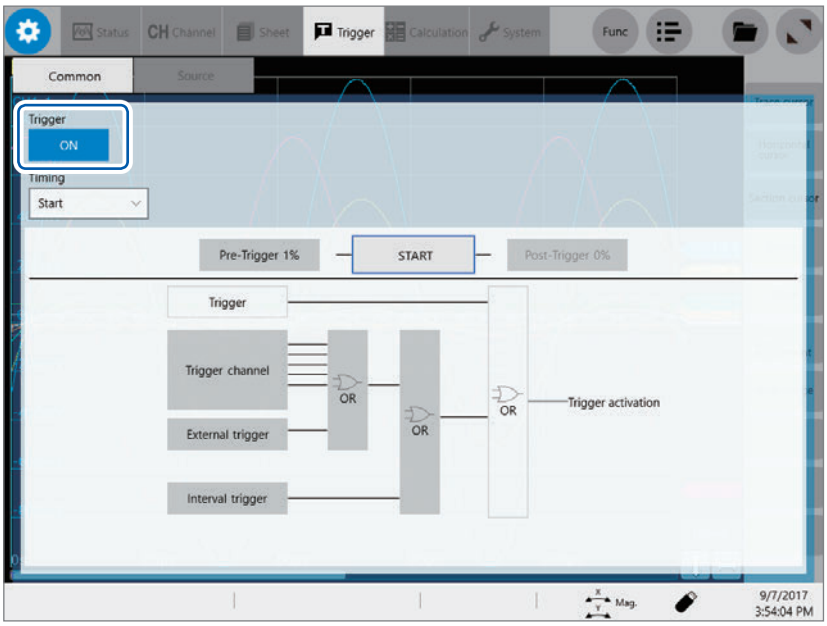
- The instrument is triggered based on the trigger conditions (logical AND or logical OR) among trigger sources except for the forcible trigger. (p. 91)
- When triggered, the instrument outputs the TRIG OUT signal from the external control terminal. (p. 183)



Enable the trigger function.	(p. 83)
Set the start/stop timing of recordings controlled by triggers.	(p. 84)
Set a recording length preceding the start trigger point.	(p. 86)
Set a recording length following the stop trigger point.	(p. 86)
Set the trigger logical conditions (AND or OR) among the analog, logic, external, and interval triggers to trigger the instrument.	(p. 91)
Set the trigger-source-specified trigger conditions.	
• Analog trigger	(p. 93)
• Logic trigger	(p. 102)
• Interval trigger	(p. 104)
• External trigger	(p. 106)
• Forcible trigger	(p. 106)
Set whether the instrument waits for a trigger repeatedly after a measurement has been stopped or not.	(p. 6)
Press the **START** key to start a measurement. (The key lights up in green.) When the trigger conditions are satisfied, the instrument starts to acquire data. To stop the measurement, press the **STOP** key. Press the key once: Stops the measurement once the instrument has acquired the specified recording length of data. Press the key twice: Stops the recording immediately.	

5.2 Enabling the Trigger Function

> [Trigger] > [Common]



Set [Trigger] to [ON].

OFF☑	Disables the trigger function.
ON	Enables the trigger function.

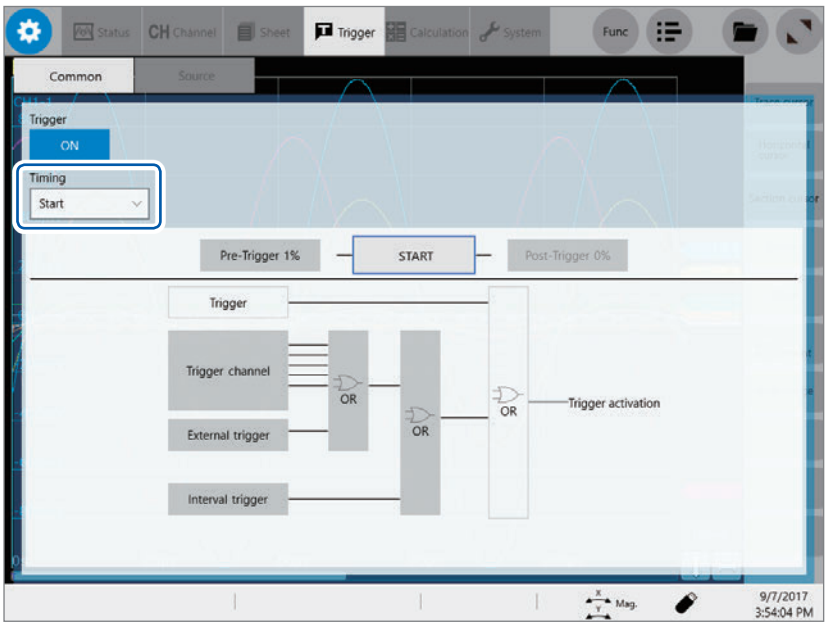
To copy settings to other channels

You can copy settings on the analog trigger setting screen.
Refer to “3.5 Copying Settings (Copy Function)” (p. 50).

5.3 Setting the Trigger Timing

Configure the waveform recording settings the instrument follows when it is triggered.

> [Trigger] > [Common]

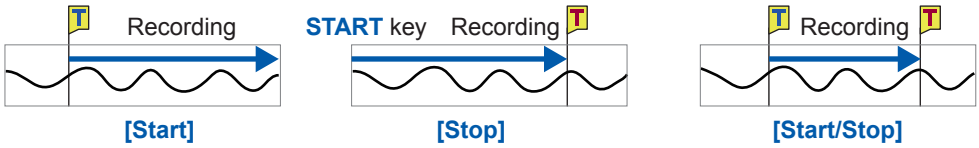


Start☑	Starts recording when the instrument is triggered, and stops the recording once the specified recording length of data has been recorded.
Stop	Starts recording when the **START** key is pressed, and stops the recording when the instrument is triggered.
Start/Stop	Starts recording when a start trigger is activated and records data until a stop trigger is activated.

When Model U8975 4ch Analog Unit or MR8990 Digital Voltmeter Unit or both are included in the measurement modules, the displayed trigger point may lag behind the actual trigger point by one sample.

Trigger timing

Behavior varies depending on the mode.



	[Start]	[Stop]	[Start/Stop]
Starts recording	Starts recording when the instrument is triggered.	Starts recording when you press the **START** key.	Starts recording when a start trigger is activated.
Stops the recording	↓	↓	↓
When the mode is set to **[Single]**	Stops the recording after acquiring the specified recording length of data.	Stops the recording when the instrument is triggered.	Stops the recording when a stop trigger is activated.

When the instrument is not triggered even after the specified recording length has elapsed:

[Stop] or **[Start/Stop]**: Stops the recording after acquiring the specified recording length of data.

When the mode is set to **[Repeat]**	Starts recording, stops the recording after having acquired the specified recording length of the data, and then waits for a trigger. When triggered again, starts recording, stops the recording after having acquired the specified recording length of the data, and then waits for a trigger (repeats this sequence).	When triggered, stops the recording, and then starts another recording (repeats this sequence).	When the stop trigger is activated, stops the recording, and then waits for a start trigger. When the start trigger is activated again, starts another recording until the stop trigger is activated one more time (repeats this sequence).

When the instrument is not triggered even after the specified recording length has elapsed:

[Stop]: After having acquired the specified recording length of the data, the instrument starts another recording.
The instrument repeats this sequence until triggered.

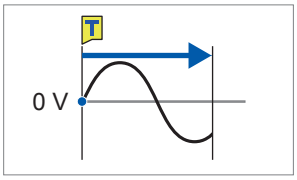
[Start/Stop]: Starts recording, stops the recording after having acquired the specified recording length of the data, and then waits for a start trigger .

Example of trigger timing

When the trigger type is set to level trigger; level, to 0.000 V; and slope, to positive **[↗]**.

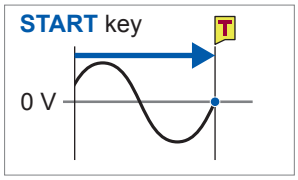
Setting of **[Timing]**

[Start]



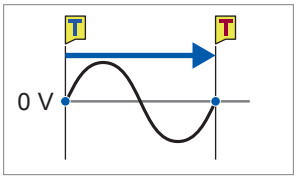
Records the specified recording length of the data.

[Stop]



Starts recording when the **START** key is pressed. Continues the recording until the stop trigger is activated.

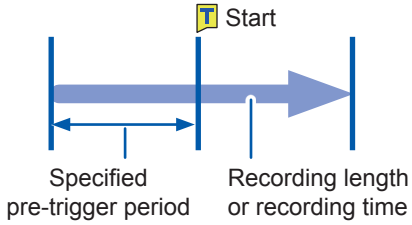
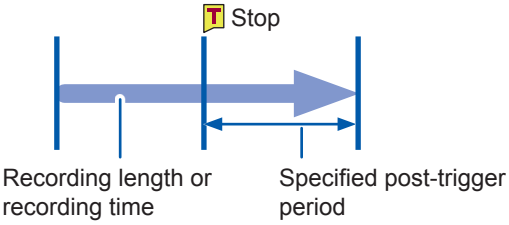
[Start/Stop]



Starts recording when the start trigger is activated. Continues the recording until the stop trigger is activated.

The above processes are repeated when trigger mode is set to **[Repeat]**.

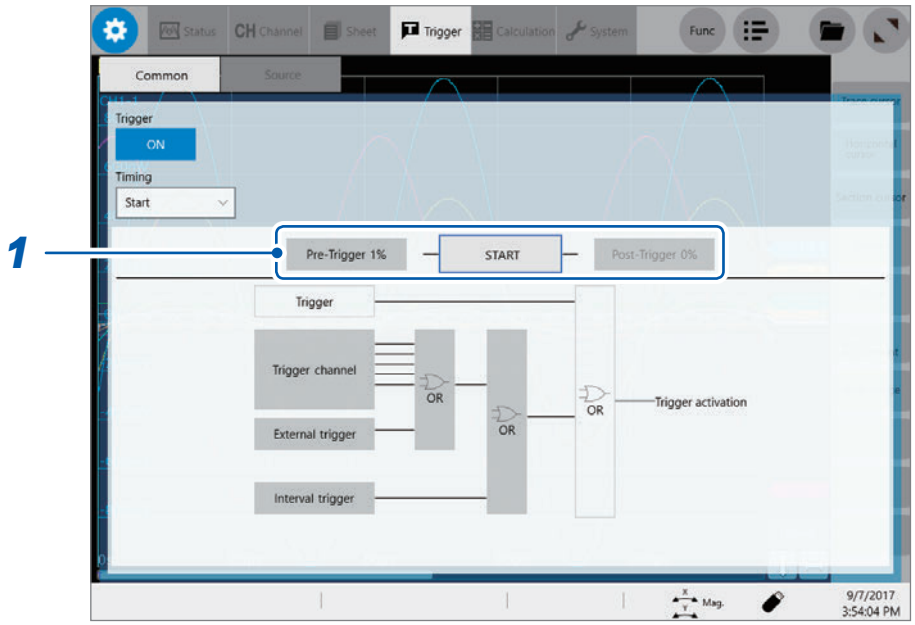
5.4 Setting the Pre-trigger and Post-trigger

Pre-Trigger	You can record not only the waveforms appearing after the start trigger has been activated, but also those appearing before the trigger is activated. Setting of timing: **[Start]**, **[Start/Stop]**	**Also records the data before the start trigger.** 
Post-Trigger	You can also record waveforms appearing after the specified recording length elapses from the stop trigger point. Setting of timing: **[Stop]**, **[Start/Stop]**	**Also records the data after the stop trigger.** 

The pre-trigger and post-trigger are set in terms of percentage (%) relative to the recording length.

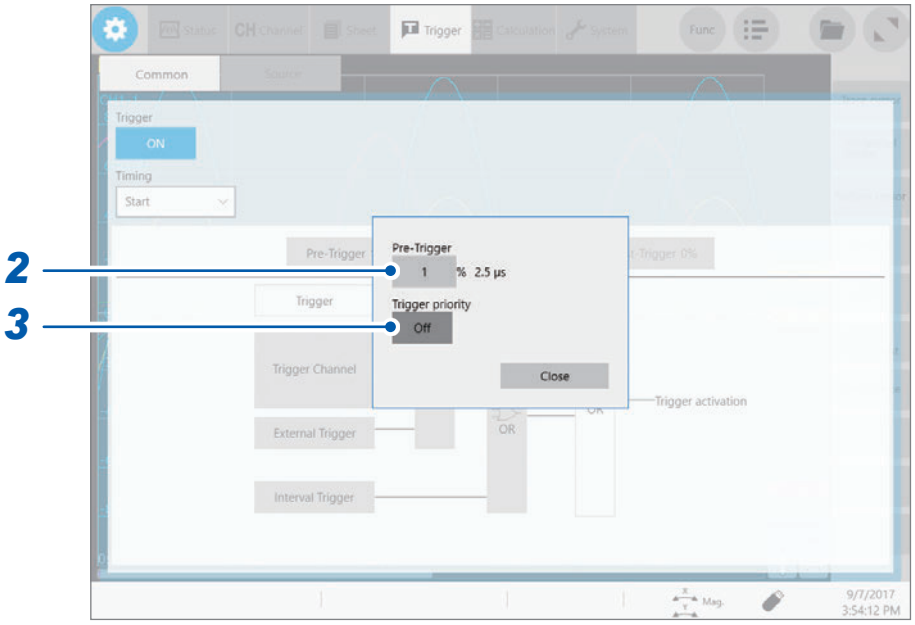
- Setting all the trigger sources (analog, interval trigger, etc.) to **[Off]** disables pre-trigger and post-trigger settings.
- The setting of the recording length or the recording time is prioritized over the post-trigger setting.
  Example: Suppose the recording length is set to 10,000 points and the post-trigger is set to 30%.
  When the stop trigger is activated after 8000 points of the waveforms of has been measured, the instrument records only 2000 points of the waveforms after the stop trigger has been activated.

> [Trigger] > [Common]



1 **Tap [Pre-Trigger 0%] or [Post-Trigger 0%].**

The setting dialog box is displayed.



2 **Set [Pre-Trigger] or [Post-Trigger].**

Pre-Trigger	**0%**☑ to **100%**
Post-Trigger	**0%**☑ to **40%**

Refer to “For saving data acquired by using the envelope on Model U8333 HDD Unit” (p. 197).
When setting both **[Pre-Trigger]** and **[Post-Trigger]** in combination, make sure that the total percentage points of **[Pre-Trigger]** and **[Post-Trigger]** is 80% or less.

Difference between [Waiting for Pre-Trigger] and [Waiting for Trigger]

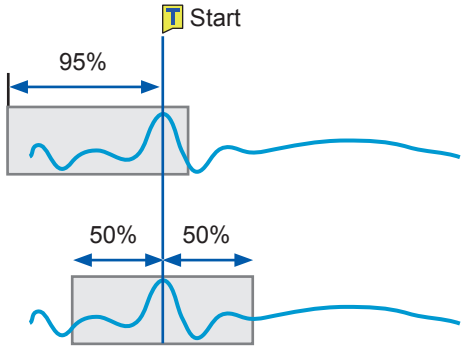
When starting a measurement, the instrument starts filling the pre-trigger memory. During this period, the instrument displays the message **[Waiting for Pre-Trigger]**. After having filled the pre-trigger memory, the instrument displays the message **[Waiting for Trigger]** and starts to wait for a trigger. While **[Waiting for Pre-Trigger]** is being displayed, the instrument is not triggered even when the trigger conditions are satisfied.

Pre-trigger, post-trigger, and recording range

- Using the pre-trigger along with the start trigger setting

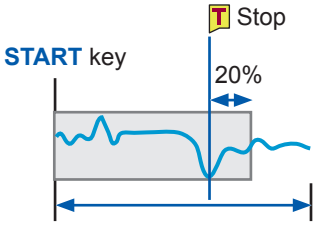
When the pre-trigger period is set to 95%: Records the recording length of the waveforms, 95% of which appear before the start trigger point.

When the pre-trigger period is set to 50%: Records the recording length of the waveforms, 50% of which appear before the start trigger point.



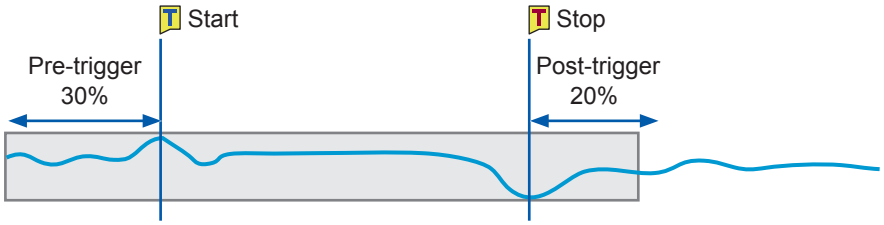
- Using the post-trigger along with the stop trigger setting

When the post-trigger period is set to 20%: Records the recording length of the waveforms, 20% of which appear after the stop trigger point.



Period shorter than the specified recording length or recording time

- Using the pre-trigger and post-trigger along with the start and stop triggers setting



30% of the recording length of the record acquired before the start trigger

20% of the recording length of the record acquired after the stop trigger

3 Set [Trigger priority].

You can choose whether the instrument is triggered or not when the trigger conditions are satisfied while the instrument is filling the pre-trigger memory.

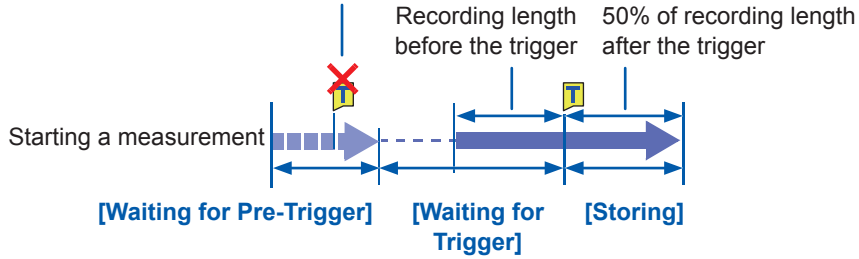
- When the pre-trigger is enabled, the instrument is not triggered once the measurement has started until a certain period has elapsed (while the instrument is filling the pre-trigger memory).
- The message **[Waiting for Pre-Trigger]** is displayed on the screen.

Off☑	Ignores triggers while filling the pre-trigger memory.
On	Accepts a trigger while filling the pre-trigger memory.

When the trigger conditions are satisfied while the message [Waiting for Pre-Trigger] is being displayed

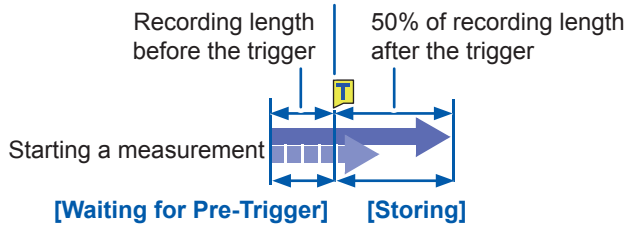
Example: When the pre-trigger period is set to 50%

Trigger priority: [Off] Ignores triggers



(After having recorded 50% of the specified recording length of the data internally, displays **[Waiting for Trigger]**.)

Trigger priority: [On] The instrument is triggered



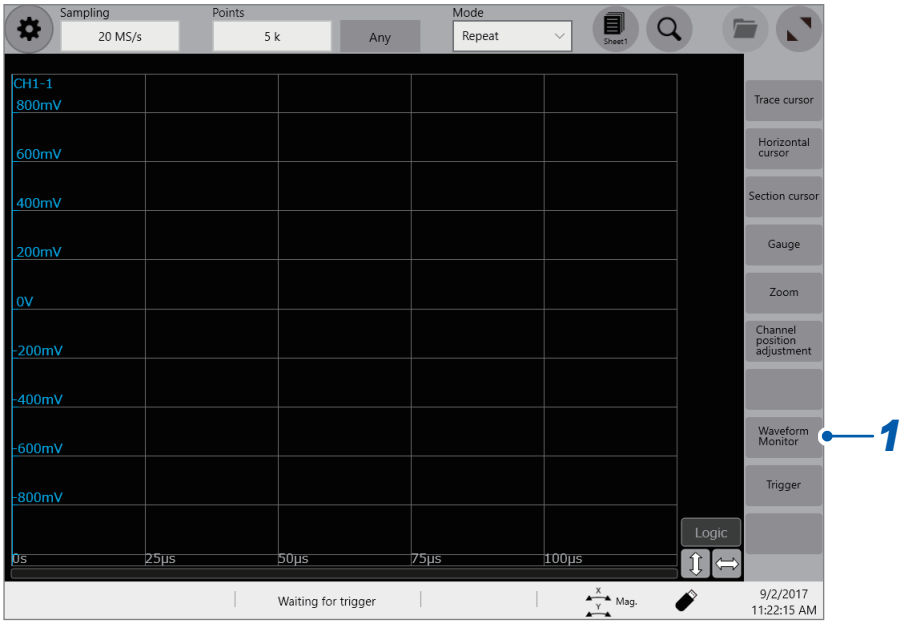
(The instrument is triggered while 50% of the specified recording length is being recorded internally)

When the instrument is triggered while it is filling the pre-trigger memory, the length of the data actually recorded may be shorter than the specified recording length. (In this case, the pre-trigger recording length is shortened. The recording length after the trigger is calculated by subtracting the specified pre-trigger period from the specified recording length.)

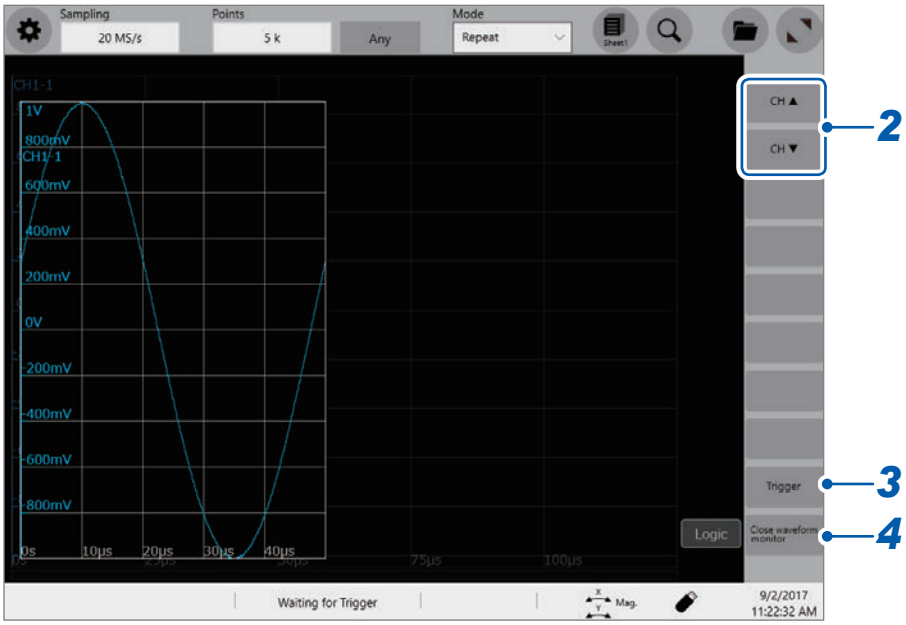
To observe the input waveforms while the instrument is waiting for a trigger

1 **Tap [Waveform monitor].**

A waveform acquired through one of any channels is displayed.



2 **Select a channel to be displayed by tapping [CH ▲] or [CH ▼].**



3 **Tap [Trigger].**

The instrument can be triggered forcibly.

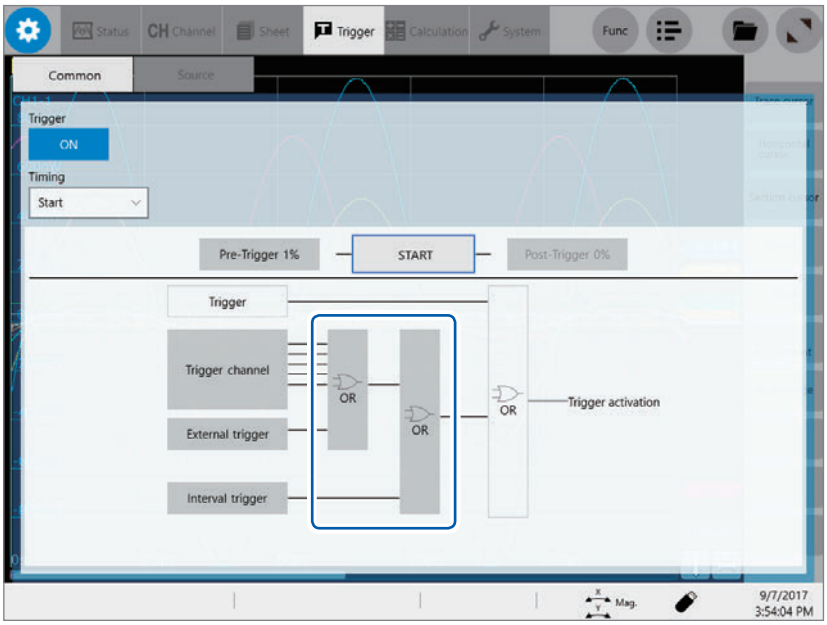
4 **Tap [Close waveform monitor].**

The screen restores to the waveform screen.

5.5 Setting the Trigger Logical Conditions (AND/OR) among Trigger Sources

Set the trigger logical conditions among the analog, logic, external, and interval triggers by choosing between logical AND and OR.
The forcible trigger triggers the instrument regardless of the trigger logical conditions (AND or OR) setting. If all trigger sources are set to off (i.e., with no trigger setting), recording starts immediately (freely running).

> [Trigger] > [Common]



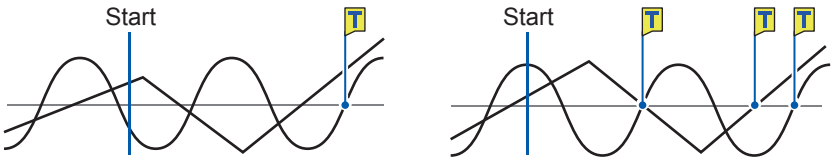
Tap [AND] or [OR], whichever is displayed, to switch to the other.

OR☑	When any one of the specified trigger conditions changes to be satisfied (at a changing point), the instrument is triggered. Thus, even though a trigger condition has been already satisfied when the instrument starts waiting for a trigger, the instrument is not triggered until a changing point is detected.
AND	Only when all of the specified trigger conditions are satisfied, the instrument is triggered. Thus, if all the specified trigger conditions have been already satisfied at the start of waiting for a trigger, the instrument is triggered immediately.

Setting example: To trigger the instrument when a waveform crosses the zero-volt level in the positive direction ([↗]*)

The instrument is triggered based on whether the trigger logical condition is set to logical AND or OR in the following ways:

Channel	Trigger	Level	Slope	Filter
CH1, CH2	Level	0.00 V	↗*	Off



[AND]

One waveform is above 0 V, and the other is also above 0 V.

[OR]

Either waveform crosses 0 V upwards.

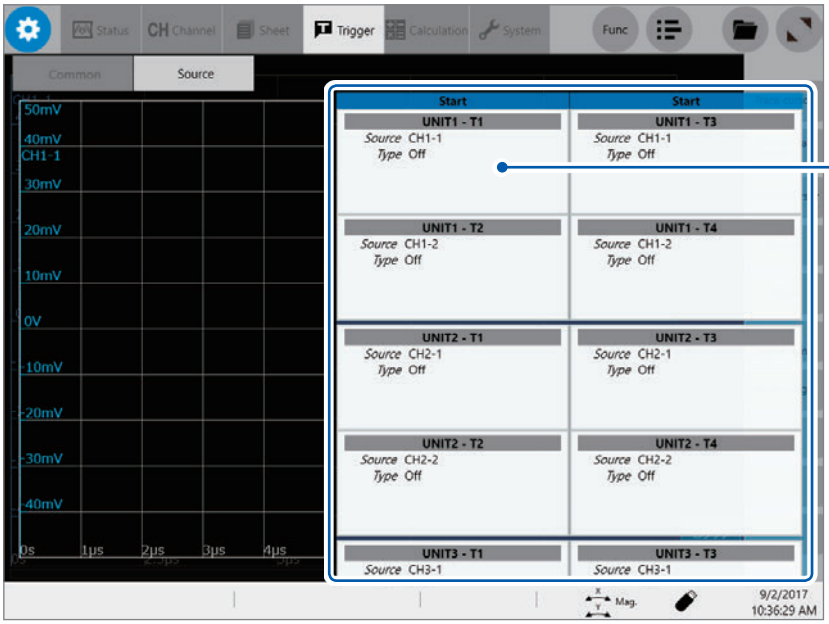
When the trigger timing is set to **[Start/Stop]**, the instrument determines that a logical AND or OR is satisfied in a set of trigger sources assigned to the start trigger or those assigned to the stop trigger.

*: With the **[AND]** setting, the slope setting item is displayed as **[HIGH]**.

5.6 Triggering the Instrument Using Analog Signals

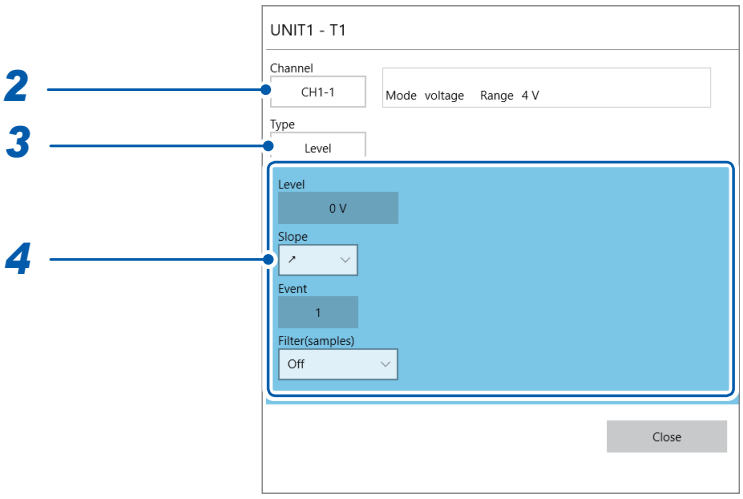
This section explains how to set the analog triggers and types of the analog triggers.

> [Trigger] > [Source]



1 **Tap the trigger source to be set.**

The setting dialog box is displayed.



2 **Select a channel for which the trigger condition is to be set in the [Channel] box.**

See “Settable channels for each trigger source” (p. 94).

3 **Select a type in the [Type] box.**

Off☑, Level, In, Out, Voltage drop, Period-in, Period-out, Glitch

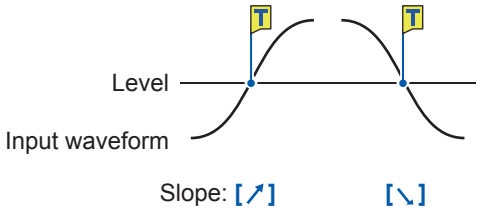
4 **Configure trigger-type-specified settings.**

Settable channels for each trigger source

Trigger source	Unit channel	Calculation channel
UNIT1 – T1, T3	Channels of UNIT1	W1
UNIT1 – T2, T4		W2
UNIT2 – T1, T3	Channels of UNIT2	W3
UNIT2 – T2, T4		W4
UNIT3 – T1, T3	Channels of UNIT3	W5
UNIT3 – T2, T4		W6
UNIT4 – T1, T3	Channels of UNIT4	W7
UNIT4 – T2, T4		W8
UNIT5 – T1, T3	Channels of UNIT5	W9
UNIT5 – T2, T4		W10
UNIT6 – T1, T3	Channels of UNIT6	W11
UNIT6 – T2, T4		W12
UNIT7 – T1, T3	Channels of UNIT7	W13
UNIT7 – T2, T4		W14
UNIT8 – T1, T3	Channels of UNIT8	W15
UNIT8 – T2, T4		W16

1. [Level] trigger

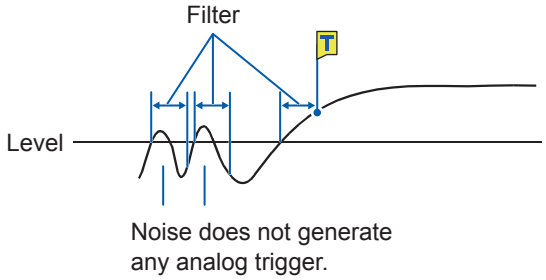
When the input signal crosses the specified level in the positive or negative direction, the analog trigger is generated.



Setting			Description
Level	**–f.s.** to **+f.s.** Default: **0**☑		Allows you to type a level of the level trigger.
Slope	With **OR**	↗☑	The level-trigger condition is satisfied when a waveform crosses the threshold value (level) in the positive direction.
		↘	The level-trigger condition is satisfied when a waveform crosses the threshold value (level) in the negative direction.
	With **AND**	**HIGH**☑	The level-trigger condition is satisfied when a waveform is higher than the threshold value (level).
		LOW	The level-trigger condition is satisfied when a waveform is lower than the threshold value (level).
Event	With **OR**	**1**☑ to **4,000**	Allows you to enter the number of events. The instrument counts the number of times the level-trigger condition is satisfied. The analog trigger is generated when the number reaches the specified number of events.
	With **AND**		Not available
Filter	**Off**☑, **10** to **10,000**		Allows you to enter the filter in terms of the number of samples. Only after the level-trigger condition continues to be satisfied during the specified period, the analog trigger is generated. Setting this option prevents the instrument from being unintentionally triggered due to noise.
	Off☑, **1 ms**, **10 ms**		Allows you to enter the filter in terms of milliseconds when the envelope is used.

With the [Filter] setting

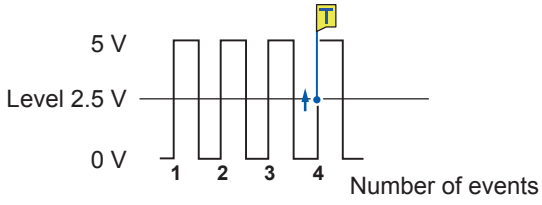
Setting the filter duration prevents the analog trigger from being unintentionally generated due to noise, allowing it to be generated only after the level-trigger condition continues to be satisfied during the specified duration (period) or longer.



With the [Event] setting

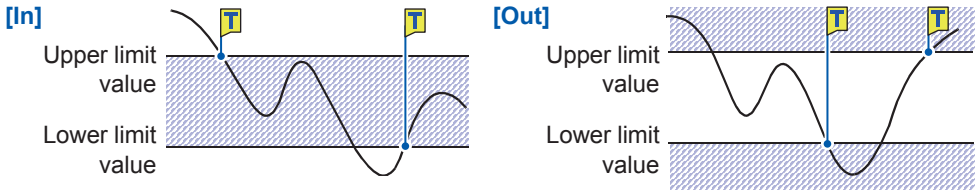
If the trigger condition is repeatedly satisfied, setting the number of events prevents the analog trigger from being generated until the number of times the level-trigger condition is satisfied reaches the specified count number.

Example: When the number of events is set to **[4]** (Slope: **[↗]**).



2. [In] trigger, [Out] trigger

When an input signal falls within (in) or gets out of a range (out), which is determined by specifying upper and lower values, the analog trigger is generated. These triggers are disabled when the sampling rate is set to 200 MS/s.



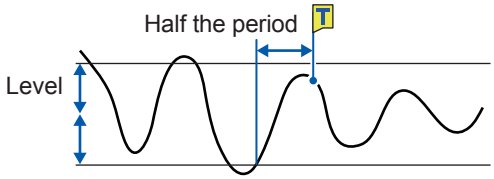
Setting			Description
Event	With **OR**	**1**☑ to **4,000**	Allows you to enter the window trigger in terms of the number of events. The instrument counts the number of times the window-trigger condition is satisfied. Only after the number reaches the specified event number, the analog trigger is generated.
	With **AND**		Not available
Filter	**Off**☑, **10** to **10,000**		Allows you to enter the filter in terms of the number of samples. Only after the window-trigger condition continues to be satisfied during the specified period, the analog trigger is generated. Setting this option prevents the instrument from triggering unintentionally due to noise.
	Off☑, **1 ms**, **10 ms**		Allows you to enter the filter in terms of milliseconds when the envelope is used.
Upper	**–f.s.** to **+f.s.**		Allows you to type an upper limit value.
Lower	**–f.s.** to **+f.s.**		Allows you to type a lower limit value.

The behavior related to the window-in and window-out triggers varies depending on the trigger logical conditions (AND and OR).

With **OR**	**In**	The window-trigger condition is satisfied when the input signal crosses the upper or lower limit value of the threshold (level) and thereby falls within the range, which is specified by the upper and lower limit values of the threshold (level).
	Out	The window-trigger condition is satisfied when the input signal crosses the upper or lower limit value of the threshold (level) and thereby gets out of the range, which is specified by the upper and lower limit values of the threshold (level).
With **AND**	**In**	The window-trigger condition is satisfied when the input signal is inside the range, which is specified by the upper and lower limit values of the threshold (level).
	Out	The window-trigger condition is satisfied when the input signal is outside the range, which is specified by the upper and lower limit values of the threshold (level).

3. [Voltage drop] trigger

When the voltage peak continues to be lower than a specified level for a period of half a cycle or more, the voltage-drop-trigger condition is satisfied. The sampling rate can be set to the range from 2 kS/s to 100 MS/s.
This trigger cannot be set when the envelope is used. This trigger cannot be set either when Model MR8990 or Model 8970 is used.



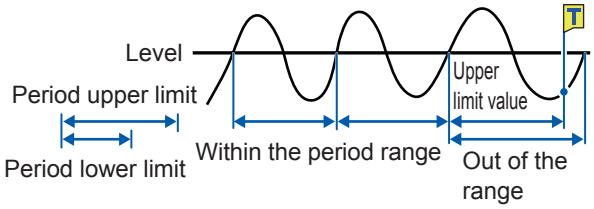
Setting			Description
Level	**0** to **+f.s.** (**100 V**☑)		Allows you to type the level to be used to check for voltage drops.
Frequency	**50 Hz**☑, **60 Hz**		Allows you to choose between 50 Hz and 60 Hz.
RMS (root-mean-square value)	Varies in conjunction with the level settings		Displays a rough indication of the RMS value.
Event	With **OR**	**1**☑ to **4,000**	Allows you to enter the voltage drop trigger in terms of the number of events. The instrument counts the number of times the voltage-drop-trigger condition is satisfied. Only after the number reaches the specified event number, the analog trigger is generated.
	With **AND**		Not available

Behavior of the voltage drop trigger varies depending on the trigger logical conditions (AND and OR).

With **OR**	As soon as the instrument determines that the voltage peak became lower than a specified level for a period of half a cycle or more, the voltage-drop-trigger condition is satisfied.
With **AND**	While the voltage peak is lower than a specified level for a period of half a cycle or more, the voltage-drop-trigger condition continues to be satisfied.

4. [Period-in] trigger and [Period-out] trigger

The instrument measures periods of the input waveform, which are the time lags between consecutive two points at which the input voltage crosses the specified level in the positive or negative direction. The period-trigger condition is satisfied when a period is inside the specified range (In) or outside the specified range (Out).
The trigger point lag behind the actual trigger point by one sample. These triggers are disabled when the sampling rate is set to 200 MS/s.
These triggers cannot be set when the envelope is used. These triggers cannot be set either when Model MR8990 and Model 8970 is used.
Refer to “Operation available on the [Trigger] screen” and “[Period-out] trigger” (p. 100).



Setting			Description
Level	**–f.s.** to **+f.s.** Default: **0**☑		Allows you to type the level for detecting the rising or falling slopes of the signal.
Slope	With **OR**	↗☑, ↘	Allows you to select which of the following points to use to calculate the periods: two consecutive points at which the signal crosses the specified level in the positive direction; or those in the negative direction.
	With **AND**	**HIGH**☑, **LOW**	
Period lower limit*	**0 or 5 times the sampling period or more**		The period-lower limit cannot be set to a value higher than the **[Period upper limit]**. When the period-lower limit is set to **[0]**, the instrument ignores the value under **[Period lower limit]**, and the period-trigger condition is satisfied using the value under **[Period upper limit]** only.
Period upper limit*	**20,000 times or less of the sampling period**		The period-higher limit cannot be set to a value lower than the **[Period lower limit]**.
Event	With **OR**	**1**☑ to **4,000**	Allows you to enter the period trigger in terms of the number of events. The instrument counts the number of times the period-trigger condition is satisfied. Only after the number reaches the specified event number, the analog trigger is generated.
	With **AND**		Not available
Filter	**Off**☑, **10** to **10,000**		Allows you to enter the period trigger in terms of the number of samples. Only after the period-trigger condition continues to be satisfied during the specified period, the analog trigger is generated. Setting this option prevents the instrument from being triggered unintentionally due to noise.

*: The range of values that can be set for **[Period lower limit]** and **[Period upper limit]** varies according to the sampling rate (period).

Setting of the period range

The period range settings of the period trigger vary depending on the sampling period (sampling rate).
(The setting value of the period range also changes in conjunction with the sampling period [sampling rate] setting.)
Check the settings in the **[Sampling]** setting, which is accessible by proceeding in the following order:
[Status] > [Condition] > [Sampling]

To make it the period-trigger condition that only when the input frequency exceeds the upper limit value (when the period becomes shorter):

Set **[Type]** to **[Period-in]** and set **[Period lower limit]** to **[0]**. The instrument ignores the value under **[Period lower limit]**, and the period-trigger condition is satisfied when the input frequency exceeds the value under **[Period upper limit]**.

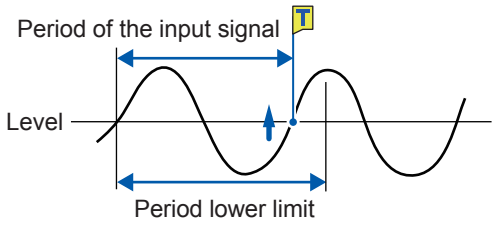
To make it the period-trigger condition that only when the input frequency falls below the upper limit value (when the period becomes longer):

Set **[Type]** to **[Period-out]** and set **[Period lower limit]** to **[0]**. The instrument ignores the value under **[Period lower limit]**, and the period-trigger condition is satisfied when the input frequency falls below the value under **[Period upper limit]**.

[Period-out] trigger

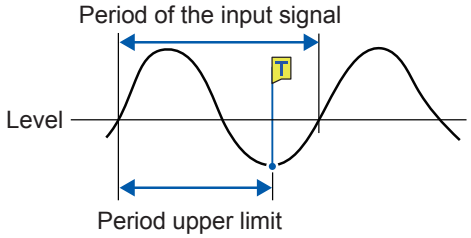
The instrument calculates periods by monitoring times when the input signal crosses the specified level in the positive or negative direction, and the period-trigger condition is satisfied when the period gets out of the specified period range.
The point at which the period-trigger condition is satisfied varies depending on the specified period range and the period of the measuring object.

When the input signal period is shorter than the specified lower limit of the period (with the slope set to positive [↗]).



The period-trigger condition is satisfied when the rising slope of the input signal crosses the specified level before the lower limit of the period elapses.

When the input signal period is longer than the specified upper limit of the period (with the slope set to positive [↗]).

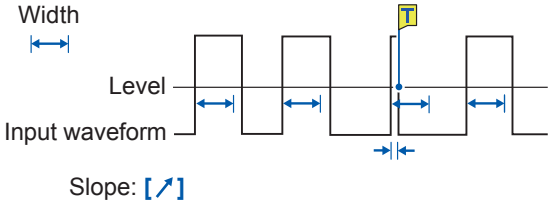


The period-trigger condition is satisfied when the upper limit of the period elapses before the rising slope of the input signal crosses the reference voltage level.

Thus, the point at which the period-out-trigger condition is satisfied varies depending on the upper limit of the period range.

5. Glitch trigger

This trigger cannot be set when the envelope is used. This trigger cannot be set when Model MR8990 is used.
The glitch-trigger condition is satisfied when the pulse width of the input signal that has crossed the specified level is shorter than the specified duration. This trigger is disabled when the sampling rate is set to 200 MS/s.



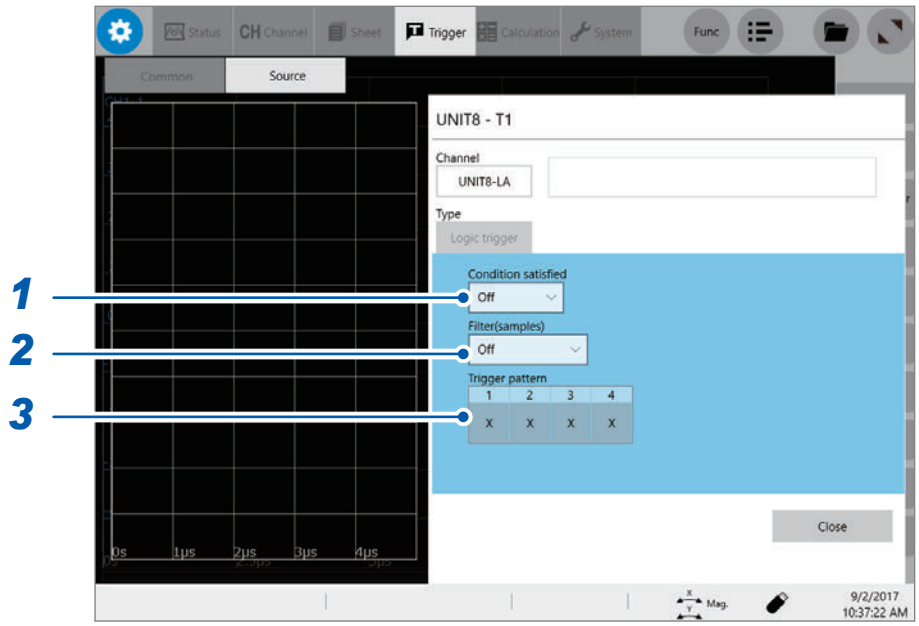
Setting			Description
Level	**–f.s.** to **+f.s.** Default: **0**☑		Allows you to set the level for detecting glitches.
Slope	↗☑, ↘		Allows you to select which of the following points to use to detect glitches: two consecutive points at which the signal crosses the specified level in the positive direction; or those in the negative direction.
Event	With **OR**	**1**☑ to **4,000**	Allows you to enter the glitch trigger in terms of the number of events. The instrument counts the number of times the glitch-trigger condition is satisfied. The analog trigger is generated only after the number reaches the specified event number.
	With **AND**		Not available
Width	**2** times to **4000** times of the sampling period		Allows you to enter the pulse width (time), which is used to determine a glitch. The glitch-trigger condition is satisfied when the pulse width is shorter than the specified duration. (The available setting range varies depending on the sampling period. Lower limit: 2 times sampling period or more; Upper limit: 4000 times sampling period or less)

5.7 Triggering the Instrument With Logic Signals (Logic Trigger)

The section explains how to set the logic triggers.

- Input signals acquired through the logic channels serve as the trigger source.
- You can specify trigger patterns and logic-trigger conditions by choosing between logical AND and OR. When the logic-trigger conditions are satisfied, the logic trigger is generated.
- With the trigger filter setting, no logic triggers are generated until the logic-trigger condition continues to be satisfied during the specified filter.

> [Trigger] > [Source]



1 Set [Condition satisfied].

The logic-trigger condition (logical AND or OR) of each logic signal can be set.

Off☑	Disables the logic trigger.
OR	The logic-trigger condition is satisfied when any one of the logic input signals meets the trigger pattern.
AND	The logic-trigger condition is satisfied when all of the logic input signals meet the trigger pattern.

2 Set [Filter] (as necessary).

You can enter the filter duration that allows the logic trigger to be generated.
Setting the trigger filter prevents the logic trigger from being unintentionally generated due to noise. (p. 95)

Off☑	Disables the trigger filter.
10 to **10000**	Enables the trigger filter. The filter duration can be entered in terms of the number of samples.

When the envelope is used

Off☑	Disables the trigger filter.
1 ms, **10 ms**	Enables the trigger filter.

3 Set [Trigger pattern].

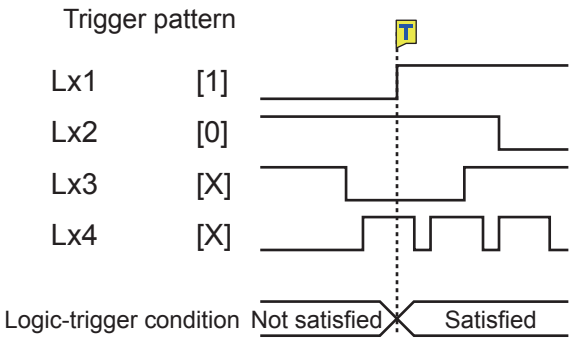
The logic-trigger pattern can be set.

X☑	Ignores the signal.
0	The logic-trigger condition of each logic signal is satisfied when the signal is at a low level.
1	The logic-trigger condition of each logic signal is satisfied when the signal is at a high level.

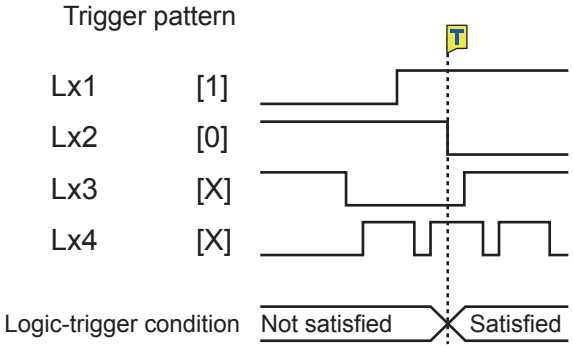
Setting example

The logic-trigger conditions differ depending on a combination of the **[Condition satisfied]** setting (logical OR or AND) **[Trigger pattern]** setting as follows:

OR



AND

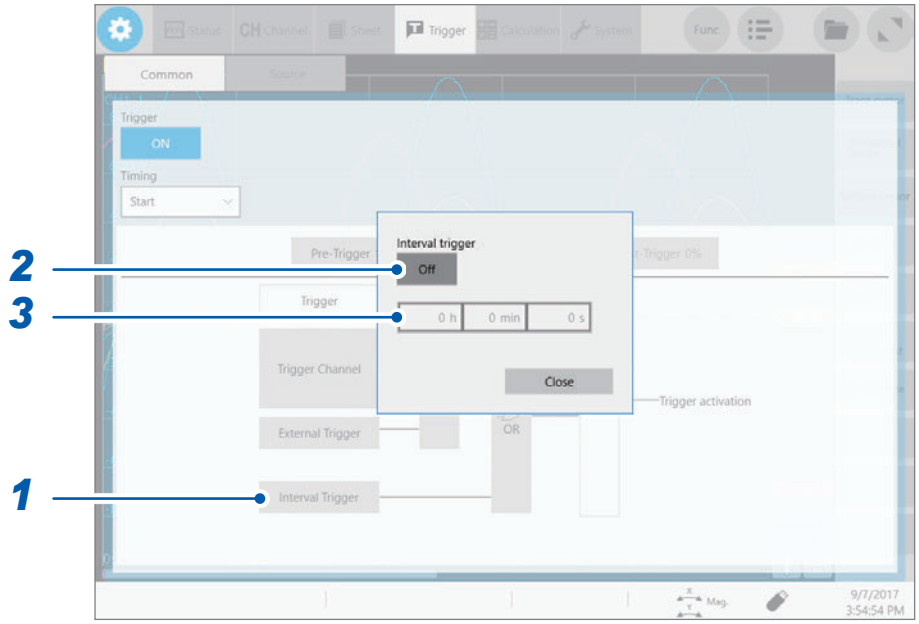


5.8 Triggering the Instrument at Regular Intervals (Interval Trigger)

The start trigger can be activated at specified intervals. Setting the recording mode to **[Repeat]** allows the instrument to record waveforms at regular intervals.

- When using the pre-trigger, the instrument starts monitoring the time of the interval trigger after the first pre-trigger time elapses since the start of measurement.
- No start triggers are activated by any interval triggers while the instrument is filling the pre-trigger memory. The interval trigger triggers the instrument while the instrument is waiting for a trigger after the pre-trigger time has elapsed.
- Since the clock is corrected internally, displayed trigger times may not synchronize with the intervals of the interval trigger.

> **[Trigger] > [Common]**



1 **Tap [Interval trigger].**

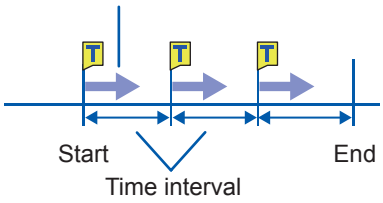
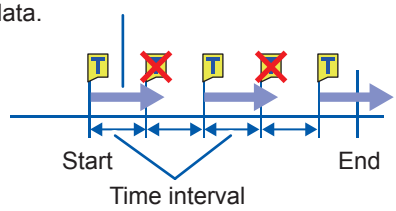
2 **Set [Interval trigger] to [On] or [Off].**

3 **Enter the interval (in terms of [h], [min], and [s]).**

The internal trigger is generated at the start of the measurement, and they are repeatedly generated at the specified intervals.

Acquiring data at time intervals (relation between the time interval and the recording length or recording time)

The instrument is not triggered until having acquired the specified recording length or recording interval of the data.

When the recording length or recording time is shorter than the time interval	When the recording length or recording time is longer than the time interval
The instrument records the specified recording length or recording time of the data.  	The instrument records the specified recording length or recording interval of the data. 

5.9 Triggering the Instrument Externally (External Trigger)

External signals applied to the external control terminals can serve as the trigger sources.
The external signals can also be used to operate multiple instruments in synchronization with each other.
Refer to “External trigger terminal (EXT.TRIG)” (p. 185).

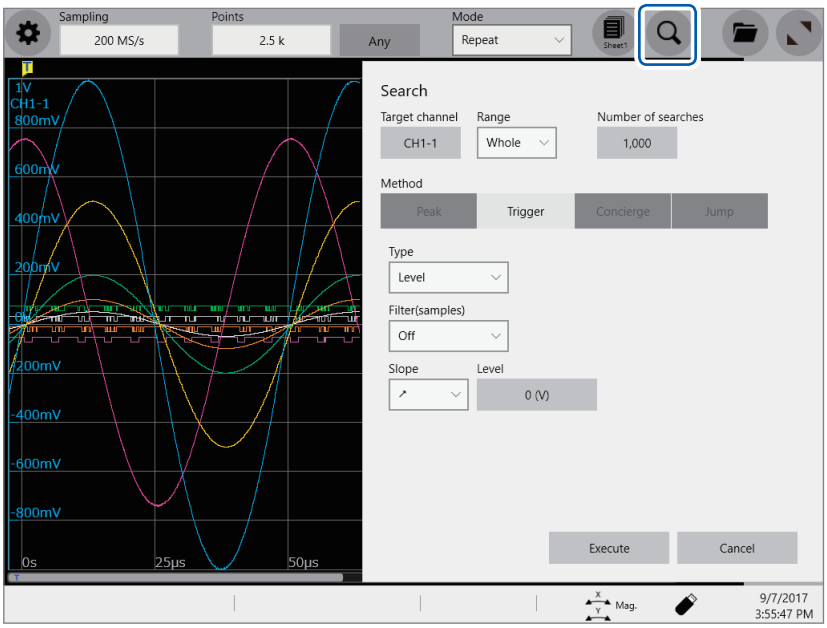
5.10 Triggering the Instrument Manually (Forcible Trigger)

Tapping **[Trigger]** on the right side of the waveform screen allows you to trigger the instrument manually while the instrument is waiting time for a trigger.
The forcible trigger triggers the instrument regardless of the other trigger source settings.

To stop the recording, press the **STOP** key.
Press the key once: Stops the measurement once the instrument has acquired the specified recording length of data.
Press the key twice: Stops the recording immediately.

6 Search Function

Using the search function allows you to search measured waveform data for positions where user-defined search conditions have been satisfied.



Operation available on the search screen

Peak search

You can searches for the maximum, minimum, local maximum (maximal), or local minimum (minimal) value. Select one of them. (p. 108)

Trigger search

You can searches for the position where the specified trigger condition is satisfied. Set the trigger condition. (p. 110)

Memory HiConcierge

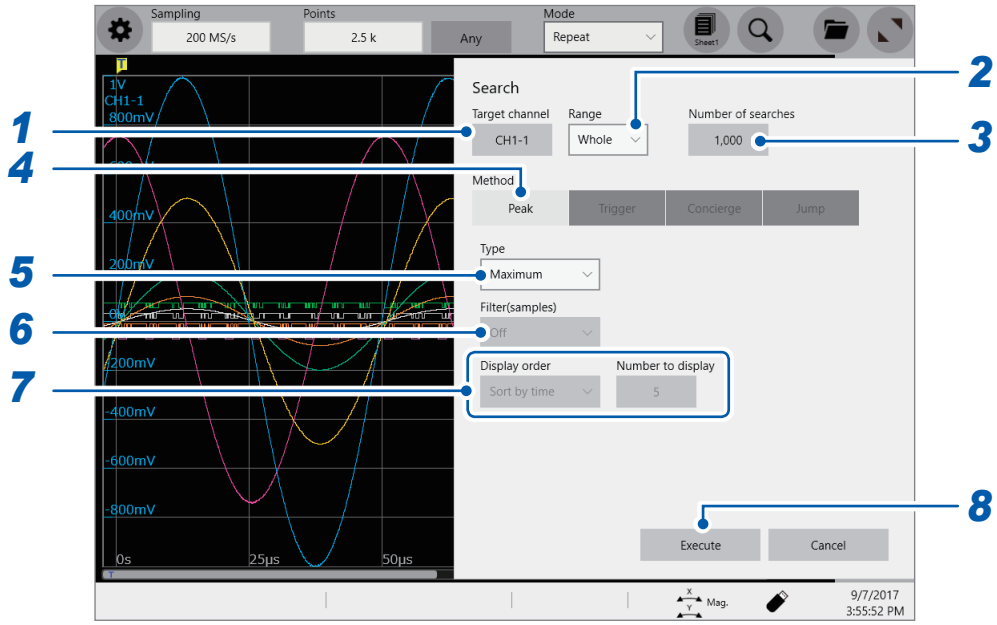
You can detects differences from the fundamental wave automatically based on the histogram or standard deviation. Set the fundamental wave. (p. 114)

Jump

The display can jump to the specified time, trace cursor position, section cursor position, event number, trigger point, or search mark. (p. 116)

6.1 Searching For Peak Values

You can select any one of the maximum, minimum, maximal, and minimal values of the measured data and search for it.



1 Set [Target channel] to be searched.

The channel setting dialog box is displayed.

2 Set the [Range] (scope) to be searched.

Whole☑	Searches all waveform data.
Segment 1, **Segment 2**	Searches the scope specified as Segment 1 or Segment 2.

Refer to “2.2 Specifying the Waveform Range (Section Cursor)” (p. 26).

3 Set [Number of searches].

Set the number of data points to be searched for.

4 Set [Method] to [Peak].

5 Set [Type].

Maximum☑	Searches for the maximum value.
Minimum	Searches for the minimum value.
Maximal	Searches for the maximal values. When the envelope is used, the instrument searches maximum value data for the maximal values.
Minimal	Searches for the minimal values. When the envelope is used, the instrument searches minimum value data for the minimal values.

- If two or more maximum or minimum values exists, the instrument displays a representative value among the search result.
- Multiple maximal or minimal values exists among the search result.

6 **(When [Maximal] or [Minimal] is selected)**

Enter the condition of maximal and minimal values under [Filter].

Off☑	Regards a value as a maximal value when it is larger than values one point before and after, and a minimal value when it is smaller.
10 to **10,000**	Regards a value as a maximal value when it is larger than any other value in the range between the specified points before and after, and a minimal value when it is smaller.

7 **(When [Maximal] or [Minimal] is selected)**

Set [Display order].

Specify the display order.

Sort by time☑	Displays the retrieved positions in chronological order. **[Number to display]** cannot be specified. Up to 1000 positions can be searched for. The searching stops if more than 1000 positions are found.
Sort by data	With **[Maximal]**, displays the number, which is specified by **[Number to display]**, of retrieved positions in descending order. With **[Minimal]**, displays them in ascending order.

Set [Number to display] (when [Display order] is set to [Sort by data]).

Specify the number of positions to be displayed.

8 **Tap [Execute].**

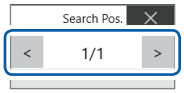
Search marks (S) are put on the positions where the search condition is satisfied.
The search-position switching panel is displayed on the waveform screen.

To stop the searching

Press the **STOP** key.

9 **Change [Search Pos.] and check the search results.**

You can change the retrieved positions by tapping **[<]** or **[>]**.
The display order follows the setting in **[Display order]**.



Tapping **[Next]** executes another search beginning from the next point of the search result. The previous search result is discarded.

To display the search result again

As described in “6.4 Allowing the Display to Jump to the Specified Position” (p. 116), set **[Type]** to **[Search number]**, and then tap **[Execute]**.

6.2 Searching For the Positions Where Trigger Condition Is Satisfied

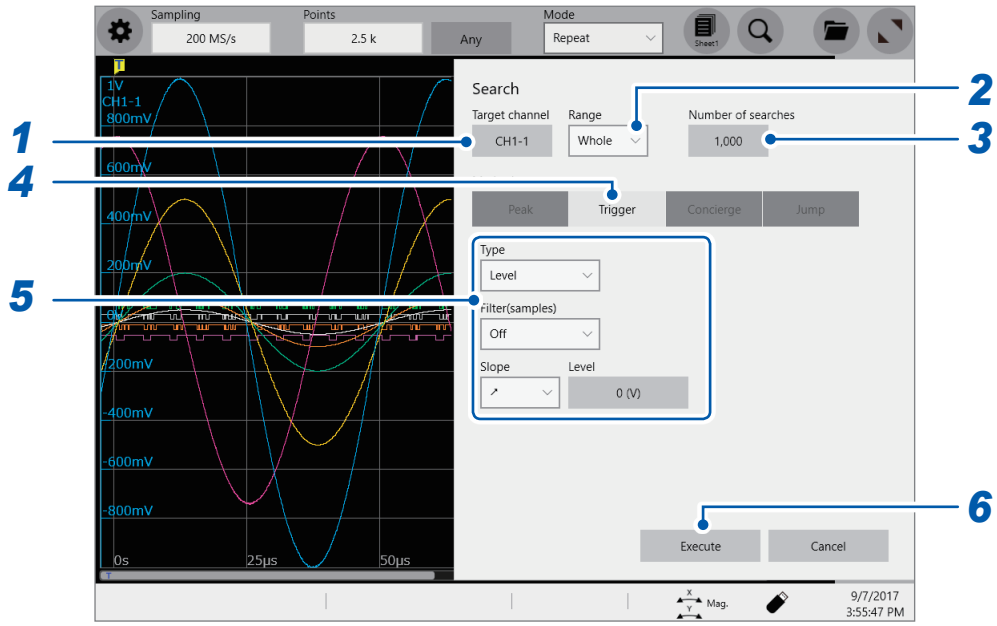
Specifying the trigger condition allows you to search for the position where the trigger condition in the measured data is satisfied.

> >

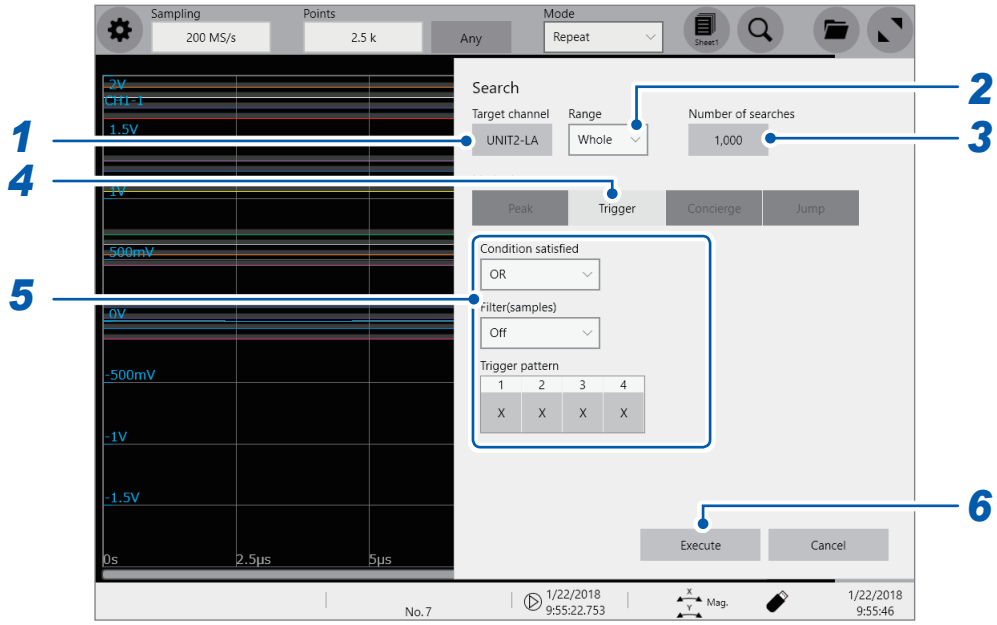
1 **Set [Target channel] to be searched.**

The channel setting dialog box is displayed.

When an analog channel is selected



When an logic channel is selected



2 Set the [Range] (scope) to be searched.

Whole☑	Searches all waveform data.
Segment 1, **Segment 2**	Searches the scope specified as Segment 1 or Segment 2.

3 Set [Number of searches].

Set the number of data points to be searched for.

4 Set [Method] to [Trigger].

5 Set the search condition.

-1. When an analog channel is selected under [Target channel]

Set [Type].

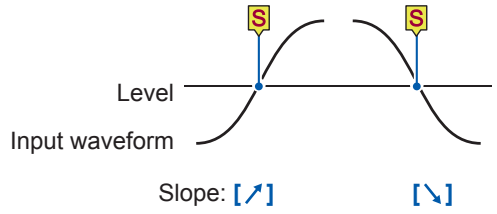
Level☑	Searches for the positions where the waveform data crosses the specified level.
In	Search for the positions where the waveform data falls within the range, which is determined by specified upper and lower limit values.
Out	Search for the positions where the waveform data gets out of the range, which is determined by specified upper and lower limit values.

Set the search condition.

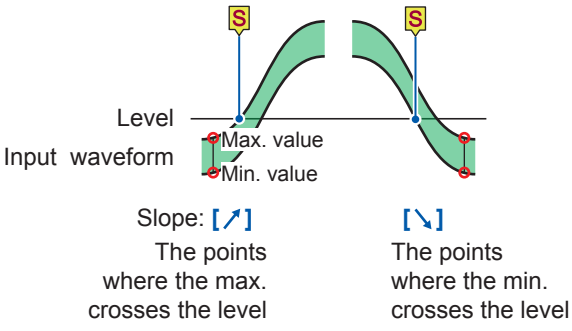
The items to be set may vary depending on the trigger type.

(1) With the [Level] setting

Measurement method: [Normal]



Measurement method: [Envelope]



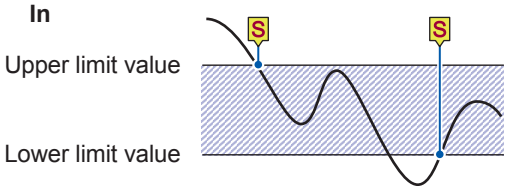
Settings		Description
Filter	**Off**☑, **10** to **10,000**	Allows you to enter the filter in terms of the number of samples. The positions where the search condition continued to be satisfied during the specified period are determined to be the retrieved positions.
Slope	↗☑, ↘	Allows you to select which of the following points to search for, the points at which the signal crosses the specified level in the positive direction or those in the negative direction.

Settings		Description
Level	**−3.4028E+38** to **3.4028E+38** Default: **0**☑	Allows you to set the threshold (level) to be searched for.

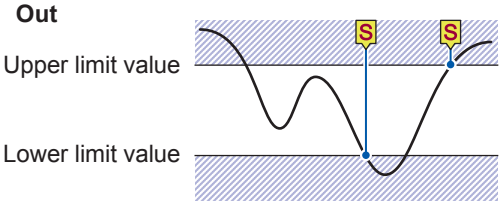
(2) With the [In] or [Out] setting

Measurement method: [Normal]

In

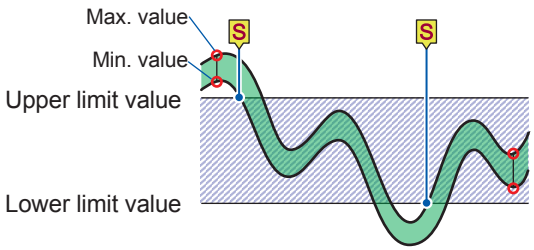


Out



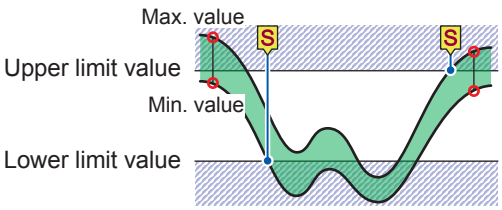
Measurement method: [Envelope]

In



The points where either the max. or min. value falls within the range.

Out

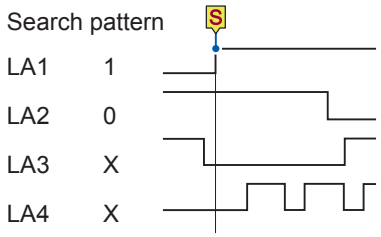


The points where either the max. or min. value gets outside the range.

Setting		Description
Filter(samples)	**Off**☑, **10** to **10,000**	Allows you to enter the filter in terms of the number of samples. The positions where the search condition continues to be satisfied during the specified period are determined to be the retrieved positions.
Upper	**−3.4028E+38** to **3.4028E+38** Default: **0.2**☑	Allows you to type the upper limit value.
Lower	**−3.4028E+38** to **3.4028E+38** Default: **−0.2**☑	Allows you to type the lower limit value.

-2. When a logic channel is selected in [Target channel]

You can search for a position that matches the specified pattern.
This function is not available when the envelope is used.



Setting		Description
Condition satisfied	**OR**☑	The positions where any one of the specified search patterns is satisfied are determined to be the retrieved positions.
	AND	The positions where all the specified patterns are satisfied are determined to be the retrieved positions.
Filter	**Off**☑, **10** to **10,000**	Allows you to enter the filter in terms of the number of samples. The positions where the search condition continues to be satisfied during the specified period are determined to be the retrieved positions.
Trigger pattern	**X**☑	Ignores data.
	0	Searches for low level positions.
	1	Searches for high level positions.

In the logic search, the retrieved position is the point where the condition has changed from “not satisfied” to “satisfied.” Thus, even if the search pattern is satisfied at the start of the search, it is not be regarded as a retrieved position.

6 Tap [Execute].

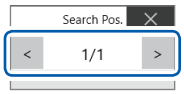
Search marks (S) are put on the positions where the search condition is satisfied. Up to 1000 positions can be retrieved. The searching stops if more than 1000 positions are found.
The search-position switching panel is displayed on the waveform screen.

To stop the searching

Press the **STOP** key.

7 Change [Search Pos.] and check the search results.

You can change the retrieved positions by tapping **[<]** or **[>]**.
The display order follows the setting in **[Display order]**.



Tapping **[Next]** executes another search beginning from the next point of the search result. The previous search result is discarded.

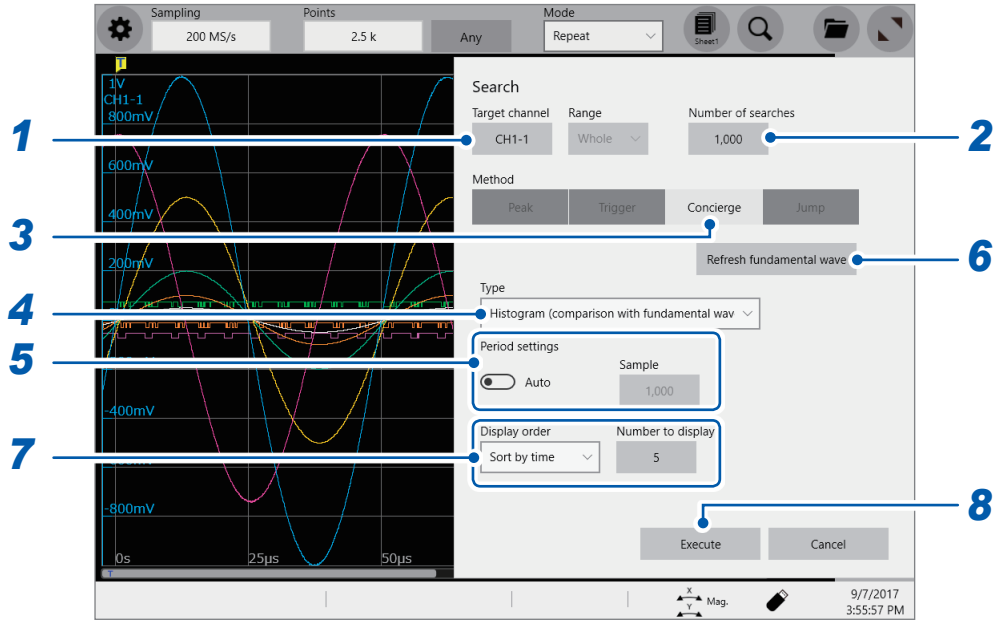
To display the search result again

As described in “6.4 Allowing the Display to Jump to the Specified Position” (p. 116), set **[Type]** to **[Search number]**, and then tap **[Execute]**.

6.3 Searching For Differences from the Fundamental Wave (Memory HiConcierge)

This function is not available when the envelope is used.
Using Memory HiConcierge can detect differences from the specified fundamental waveform based on the histogram or standard deviation.

> >



1 Set [Target channel] to be searched.

The channel setting dialog box is displayed.

2 Set [Number of searches].

Set the number of data points to be searched for.

3 Set [Method] to [Concierge].

4 Set [Type].

Histogram (comparison with fundamental wave) ☑	Searches for differences from the specified fundamental wave based on the histogram.
Histogram (comparison with previous waveform)	Searches for differences from the previous waveform based on the histogram.
Standard deviation (comparison with fundamental wave)	Searches for differences from the specified fundamental wave based on the standard deviation.
Standard deviation (Compared with previous waveform)	Searches for differences from the previous waveform based on the standard deviation.

Memory HiConcierge searches all measured waveform data. You cannot specify a segment to be searched.

5 Set the period to be searched for.

Differences are searches for from the fundamental wave (or the previous waveform) in the specified intervals.

Auto☑	Automatically detects the period.
Any	Allows you to enter the number of samples per period under **[Sample]**.

With the **[Auto]** setting, the period may not be able to be detected depending on the measured waveform. If the fundamental wave is an unintended waveform, change this setting to **[Any]** and specify the period in terms of the number of samples under **[Sample]**.

6 Tap [Refresh fundamental wave] to display the fundamental wave.

The fundamental wave is extracted from the specified one period and displayed on the screen.

7 Set [Display order] and [Number to display].

The display order and the number of values to display can be set.

Sort by time☑	Displays the retrieved positions in chronological order.
Sort by data	Displays the differences from the comparison target (fundamental wave or previous waveform) in descending order.

8 Tap [Execute].

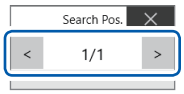
The search marks (S) are put on the positions where the search condition is satisfied.
The search-position switching panel is displayed on the waveform screen.

To stop the searching

Press the **STOP** key.

9 Change [Search Pos.] to check the search results.

You can change the retrieved positions by tapping **[<]** or **[>]**.
The display order follows the setting in **[Display order]**.



Tapping **[Next]** executes another search beginning from the next point of the search result. The previous search result is discarded.

To display the search result again

As described in “6.4 Allowing the Display to Jump to the Specified Position” (p. 116), set **[Type]** to **[Search number]**,and then tap **[Execute]**.

6.4 Allowing the Display to Jump to the Specified Position

The display can jump to the specified time, trace cursor position, section cursor position, event number, trigger point, or search mark.

>

1 Set **[Method]** to **[Jump]**.

2 Set **[Type]**.

Event mark☑	Allows you to enter **[Event mark number]** to which the display is to jump.	
Cursor	Allows you to select a position, at which a trace cursor or section cursor is specified, the display is to jump to.	
Time	**Time**	Allows you to enter an absolute time to which the display is to jump when **[Time value display]** is set to **[Date]**, which is accessible by proceeding in the following order: **[System]** > **[Env.]** > **[Time value display]**
	Time from trigger point	Allows you to enter a relative time to which the display is to jump with the trigger point position being fixed at zero when **[Time value display]** is set to **[Time]** or **[Mod 60]**, which is accessible by proceeding in the following order: **[System]** > **[Env.]** > **[Time value display]**
	Points	Allows you to enter **[Points]** to which the display is to jump when measurement is performed using the external sampling or when **[Time value display]** is set to **[Samples]**, which is accessible by proceeding in the following order: **[System]** > **[Env.]** > **[Time value display]**
Trigger Pos.	The display jumps to the start or stop trigger point.	
Search number	Allows you to enter **[Search number]** to which the display is to jump.	

3 **Tap [Execute].**

The search marks (S) are put on the positions where the search condition is satisfied.

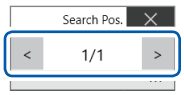
When **[Type]** is set to **[Event mark]**, the display jumps to the position of a event mark (E).

When **[Type]** is set to **[Search number]**, the display jumps to the position of a search mark (S).

The jump-position switching panel is displayed on the waveform screen.

4 **Change [Search Pos.] to check the jump result.**

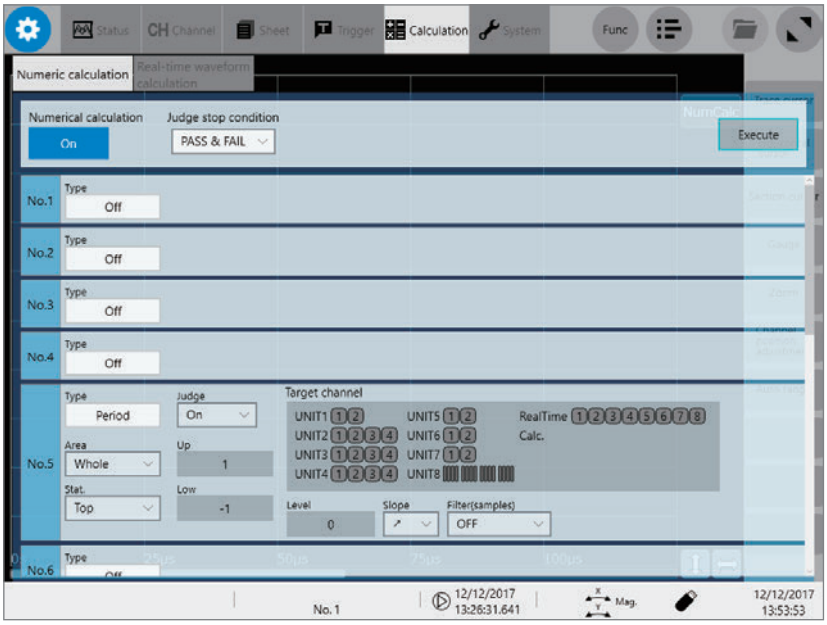
You can change the retrieved positions by tapping **[<]** or **[>]**.



7 Numerical Calculation Function

The numerical calculation function cannot be used when the envelope is used.
Results calculated from the acquired waveforms are displayed as numerical values on the waveform screen. These calculation results can be evaluated on a pass/fail basis.

> [Calculation] > [Numeric calculation]



Operation available on the [Numeric calculation] screen

Numerical Calculation

- Average
- RMS
- P-P
- Maximum
- Time to maximum
- Minimum
- Time to minimum
- Period
- Frequency
- Rise time
- Fall time
- Standard deviation
- Area
- X-Y area
- Time to level
- Level at time
- Pulse width
- Duty ratio
- Pulse count
- Arithmetic operations
- Time difference
- Phase contrast
- High level
- Low level
- Intermediate value
- Amplitude
- Overshoot
- Undershoot
- +Width
- −Width
- Burst width
- Accumulation
- Angle of XY waveform

(33 types in total)

- Calculation of the data between section cursors
  Numerical calculations can be performed for the data within the range specified with section cursors.

Formula details: “The target channel to be calculated and the calculation condition of each calculation type” (p. 125)

Evaluating the numerical calculation results on a pass/fail basis (p. 132)

You can evaluate the results of numerical calculations by comparing them with specified reference ranges, giving pass or fail judgments.

You can execute up to 16 types of numerical calculations simultaneously. When the scaling function is enabled, scaled values are calculated.

7.1 Numerical Calculation Procedure

The following two methods are available:

Calculating the data automatically after the measurement	The numerical calculation settings must be configured before starting a measurement (not available when the real-time save is set to on).
Calculating the existing data	The calculations can be performed for the data that has been already acquired and that saved on storage devices.

Performing calculation during measurement

Configuring the calculation settings

Configure the calculation settings on the [Numeric calculation] screen. (p. 122)

Set the evaluation criteria to evaluate the calculation results. (p. 132)

To save the calculation results automatically, configure the saving settings before starting a measurement.
• Set [Calculation result]. (p. 70)

↓

Starting a measurement

↓

Acquiring the data

The instrument acquires the data when the trigger conditions are satisfied.
(If no trigger is set, pressing the START key allows the instrument to start acquiring the data.)

↓

Performing the calculation

The message [Calculating] is displayed on the status bar of the screen.
The calculations are performed from No. 1 to No. 16 in turns.
(To force-quit the calculation, press the STOP key.)

↓

Displaying the calculation results

Numerical calculation results are displayed on the waveform screen. (p. 131)

↓

(Evaluating the calculation results)

(Only when the evaluation is enabled)

↓

(Saving the results)

(When the auto-save is set to [On])
The calculation results are automatically saved.

↓

Finishing the measurement

Calculating the existing data

(Loading the data)	**(To load the measured data to be calculated from a storage device)**	(p. 77)
↓		
Configuring the calculation settings	**Configure the calculation settings on the [Numeric calculation] screen.** Set the evaluation criteria to evaluate the calculation results.	(p. 122) (p. 132)
↓		
Performing the calculation	**Select [Execute] to execute the calculation.** (To force-quit the calculation, press the **STOP** key.)	
↓		
Displaying the calculation results	**Numerical calculation results are displayed on the waveform screen.**	(p. 131)
↓		
(Evaluating the calculation results)	**(Only when the evaluation is enabled)**	
↓		
(Saving the results)	**Save the calculation results as needed.** • To save the results, press the **SAVE** key .	

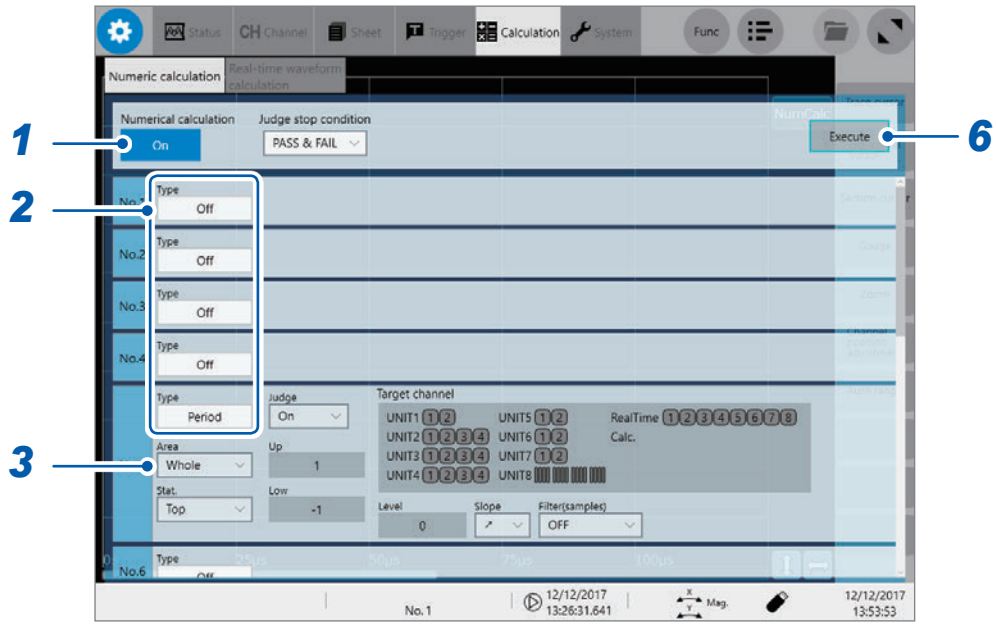
To specify a waveform scope for calculation

Before execute the calculation, specify the calculation scope with the section cursors on the waveform screen. Set **[Area]** to **[Segment 1]** or **[Segment 2]** on the **[Numeric calculation]** screen.

Refer to “2.2 Specifying the Waveform Range (Section Cursor)” (p. 26) and “7.2 Setting Numerical Calculation” (p. 122).

7.2 Setting Numerical Calculation

> [Calculation] > [Numeric calculation]



1 Set [Numerical calculation] to [On] or [Off].

2 Set [Type].

Off☑	The instrument does not perform any calculation.
Average	Average value of the waveform data
RMS	RMS value of the waveform data
P-P	Peak-to-peak value of the waveform data
Maximum	Maximum value of the waveform data
Time to maximum	Time elapsed from the trigger point to the time of the maximum value
Minimum	Minimum value of the waveform data
Time to minimum	Time elapsed from the trigger point to the time of the minimum value
Period*2	Period of the waveform data
Frequency*2	Frequency of the waveform data
Rise time*1	Rise time of the waveform data
Fall time*1	Fall time of the waveform data
Standard deviation	Standard deviation of the waveform data
Area	Area enclosed by the horizontal axis and waveform data
X-Y area	Area enclosed by the X-Y composite curve
Time to level*2	Time elapsed from the trigger point to the time when the waveform data reached the specified level
Level at time*2	Measured value when the specified time has elapsed from the trigger point
Pulse width*2	Pulse width of the waveform data
Duty ratio*2	Duty ratio of the waveform data
Pulse count*2	Number of pulses of the waveform data
Arithmetic operations	Four arithmetic operations of the numerical calculation results
Time difference*2	Time lag between Phenomena A and B
Phase contrast*2	Time lag between Phenomena A and B represented as the phase difference
High level*1	High level of the waveform data
Low level*1	Low level of the waveform data
Intermediate value	Intermediate value of the waveform data
Amplitude*1	Amplitude value of the waveform data
Overshoot*1	Overshoot value of the waveform data
Undershoot*1	Undershoot value of the waveform data
+Width*1	Time value above the intermediate level
−Width*1	Time value below the intermediate level
Burst width*2	Burst width of the waveform data
Accumulation	Accumulated value of the waveform data
Angle of XY waveform	Slope angle of the regression line on the X-Y composite curve

*1: Unable to calculate the data acquired through the measurement channels of Model MR8990 Digital Voltmeter Unit.
*2: The settings can also be configured for the logic channels.
Refer to “The target channel to be calculated and the calculation condition of each calculation type” (p. 125).

3 Set [Area].

The calculation range for each item to be calculated can be set.

Whole☑	Calculates whole waveforms.
Segment 1	Calculates the waveform between cursors of Segment 1.
Segment 2	Calculates the waveform between cursors of Segment 2.

When selecting **[Segment 1]** or **[Segment 2]**, specify the calculation scope with the section cursors on the waveform screen. When no waveforms have been acquired by the instrument, perform another measurement and thereby specify the scope. Doing so allows you to calculate the data acquired within the specified scope from the next measurement.

4 Select the target channel to be calculated.

Tap the target channel to display the channel selection screen.
Refer to “The target channel to be calculated and the calculation condition of each calculation type” (p. 125).

5 Set the calculation condition.

Refer to “The target channel to be calculated and the calculation condition of each calculation type” (p. 125).

6 Execute the calculation.

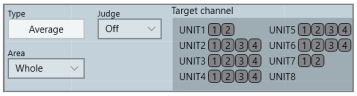
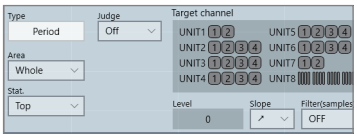
To calculate the existing data

Tap **[Execute]**.

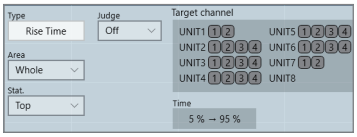
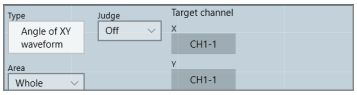
To execute calculations automatically after the measurement

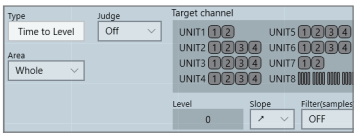
Press the **START** key to start a measurement.

The target channel to be calculated and the calculation condition of each calculation type

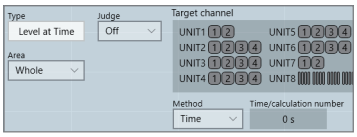
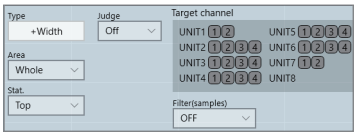
Calculation type	Setting		Description	Sample screen
Average **RMS** **P-P** **Maximum** **Time to maximum** **Minimum** **Time to minimum** **Standard deviation** **Area** **High level** **Low level** **Intermediate value** **Amplitude** **Overshoot** **Undershoot** **Accumulation**	**Target channel** (Analog, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	For **[Area]** or **[Accumulation]**, set **[Method]**. (**Total**☑, **Absolute value**, **Positive**, **Negative**)		Calculates the area or count according to the method specified here.	
Period **Frequency** **Pulse width** **Duty ratio**	**Target channel** (Analog, logic, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Level*		Allows you to type a level. The instrument calculates values based on a period of time when the waveform crossed the level specified here. Not available for logic channels.	
	Slope No slope is set for duty ratio.	↗☑	Calculates values based on a period of time when the waveform crosses the specified level in the positive direction.	
		↘	Calculates values based on a period of time when the waveform crosses the specified level in the negative direction.	
	Filter(samples) (**Off**☑, **10** to **10,000**)		Allows you to enter the duration during which the waveform is considered to have crossed the specified level. Only after the waveform data has crossed the level and has never crossed the level again during the specified filter duration, the waveform is considered to have crossed the level. This is useful to eliminate false level-crossing events caused by noise.	
	Stat.	**Top**☑	Detects the value obtained first from the beginning within the specified range.	
		Average	Calculates the average, maximum, or minimum value for each parameter within the specified range.	
		Max		
		Min		

*: The settable range are between −9.9999E+29 and −1.0000E-29, 0, and between +1.0000E-29 and +9.9999E+29. A five-digit figures or less can be specified (A 10-digit figures or less can be specified for the time in Level at time).

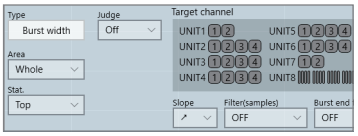
Calculation type	Setting		Description	Sample screen
Rise time **Fall time**	**Target channel** (Analog, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Time (%) (**5%** → **95%**☑ to **30%** → **70%** or **95%** → **5%**☑ to **70%** → **30%**)		Allows you to specify which part of the waveform between the upper and lower limits is used for calculating the rise time (or fall time). The rise time (or fall time) is calculated based on the percentage, which is specified here, of the range between the upper and lower limit values.	
	Stat.	**Top**☑	Detects the value obtained first from the beginning within the specified range.	
		Average	Calculates the average, maximum, or minimum value of each parameter within the specified range.	
		Max		
		Min		
X-Y area **Angle of XY waveform**	**Target channel** (**X**, **Y**) (Analog, real-time waveform calculation)		Allows you to assign channels to the X- and Y-axis.	
	For **[X-Y area]**, set **[Method]**. (**Coordinate method**☑, **Trapezoidal approximation**)		Calculates the X-Y area according to the calculation method.	

Calculation type	Setting		Description	Sample screen
Time to level **Pulse count**	**Target channel** (Analog, logic, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Level*		Allows you to type a level. The instrument detects the time when the waveform crossed the level specified here (Time to level). It detects the number of times the pulses crossed the level specified here (Pulse count). Not available for logic channels.	
	Slope	↗☑	Detects the time when the waveform crosses the specified level in the positive direction (Time to level). Detects the number of times the pulses crossed the level specified level in the positive direction (Pulse count).	
		↘	Detects the time when the waveform crosses the specified level in the positive direction (Time to level). Detects the number of times the pulses crossed the level specified level in the positive direction (Pulse count).	
	Filter(samples) (**OFF**☑, **10** to **10,000**)		Allows you to enter the duration during which the waveform is considered to have crossed the specified level. Only after the waveform has crossed the level and has never crossed the level again within the specified filter duration, the waveform is considered to have crossed the level. This is useful to exclude level crossing events caused by noise.	

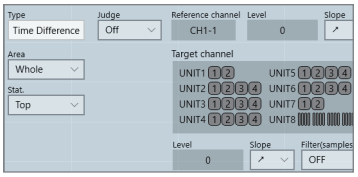
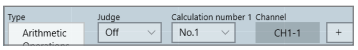
*: The settable range are between −9.9999E+29 and −1.0000E-29, 0, and between +1.0000E-29 and +9.9999E+29. A five-digit figures or less can be specified (A 10-digit figures or less can be specified for the time in Level at time).

Calculation type	Setting		Description	Sample screen
Level at time	**Target channel** (Analog, logic, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Method		Allows you to set the time-specifying method.	
	Time☑	**Time**	Allows you to type a time for calculating the measured value with the trigger point position being fixed at zero.	
	Calc. No.	**Calculation No.**	Allows you to select a calculation number when the numerical calculation results are used. No calculations are performed if you designate a number greater than the specified calculation number. Specifying the range for Segment 1 and Segment 2 is not available.	
+Width **−Width**	**Target channel** (Analog, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Filter(samples) (**Off**☑, **10** to **10,000**)		Allows you to enter the duration during which the waveform is considered to have crossed the specified level. Only after the waveform has crossed the level and has never crossed the level again within the specified filter duration, the waveform is considered to have crossed the level. This is useful to eliminate false level-crossing events caused by noise.	
	Stat.	**Top**☑	Detects the value obtained first from the beginning within the specified range.	
		Average	Calculates the average, maximum, or minimum value of each parameter within the specified range.	
		Max		
		Min		

*: The settable range are between −9.9999E+29 and −1.0000E-29, 0, and between +1.0000E-29 and +9.9999E+29. A five-digit figures or less can be specified (A 10-digit figures or less can be specified for the time in Level at time).

Calculation type	Setting		Description	Sample screen
Burst width	**Target channel** (Analog, logic, real-time waveform calculation)		Allows you to specify channels as calculation targets.	
	Slope (Logic channels only)	↗☑	Detects the rising edges and calculates the burst width.	
		↘	Detects the falling edges and calculates the burst width.	
	Filter(samples) (**Off**☑, **10** to **10,000**)		Allows you to enter the duration during which the waveform is considered to have crossed the specified level. Only after the waveform has crossed the level and has never crossed the level again within the specified filter duration, the waveform is considered to have crossed the level. This is useful to eliminate false level-crossing events caused by noise.	
	Burst end filter(samples) (**Off**☑, **10** to **10,000**)		Allows you to set the duration used to determine whether the waveform is a burst signal. If the period between the time when the waveform data falls within the range, which is specified with the window levels, and the time when it gets out of the range becomes longer than the specified filter period, the detected period is determined to be a burst duration.	
	Window-level range* (**Up**, **Low**)		Allows you to type the upper and lower limit values used to determine whether the waveform is a burst signal.	
	Stat.	**Top**☑	Detects the value obtained first from the beginning within the specified range.	
		Average	Calculates the average, maximum, or minimum value of each parameter within the specified range.	
		Max		
		Min		

*: The settable range are between −9.9999E+29 and −1.0000E-29, 0, and between +1.0000E-29 and +9.9999E+29. A five-digit figures or less can be specified (A 10-digit figures or less can be specified for the time in Level at time).

Calculation type	Setting		Description	Sample screen
Time difference **Phase contrast**	**Reference channel**, **Target channel** (Analog, logic, real-time waveform calculation)		Allows you to specify the reference channel and the target channel.	
	Level*		Allows you to type a level. The instrument calculates the value based on the time when the waveform crossed the level specified here. Not available for logic channels.	
	Slope	↗☑	Calculates values based on the interval when the waveform crosses the specified level in the positive direction.	
		↘	Calculates values based on the interval when the waveform crosses the specified level in the negative direction.	
	Filter(samples) (**Off**☑, **10** to **10,000**)		Allows you to enter the duration during which the waveform is considered to have crossed the specified level. Only after the waveform has crossed the level and has never crossed the level again within the specified filter duration, the waveform is considered to have crossed the level. This is useful to eliminate false level-crossing events caused by noise.	
	Stat.	**Top**☑	Detects the value obtained first from the beginning within the specified range.	
		Average **Max** **Min**	Calculates the average, maximum, or minimum value of each parameter within the specified range.	
Arithmetic operations	**Calculation number 1**, **Calculation number 2** (No. 1 to No. 15)		Allows you to specify the two numerical calculation numbers to be calculated.	
	Target channel		Allows you to specify channels as calculation targets.	
	Operator (**+**, **−**, **×**, **÷**)		Allows you to specify an operator out of the four basic arithmetic operations.	

*: The settable range are between −9.9999E+29 and −1.0000E-29, 0, and between +1.0000E-29 and +9.9999E+29. A five-digit figures or less can be specified (A 10-digit figures or less can be specified for the time in Level at time).

- With the **[Period]**, **[Frequency]**, **[Rise time]**, and **[Fall time]** calculations, the instrument may not be able to perform calculations depending on the condition of waveform data.
- With the **[Period]** and **[Frequency]** calculation, correct measurement results may not be obtained if the filter setting is close to 1/2 of the period (An integer multiple of the actual period may be calculated).
- When the scaling is enabled, the waveform data is scaled before the numerical calculation is performed. The units for parameter values are those set in the scaling function.
- If the waveform of the calculation target channel exceeds the measurable range (overrange occurs), the instrument substitutes the upper or lower measurement limit for values that exceed the measurable range, and then execute the calculation.

Refer to “3.2 Converting Input Values (Scaling Function)” (p. 42).

Settings: Calculations for which [Stat.] can be set

Period, Frequency, Rise time, Fall time, Pulse width, Duty ratio, Time difference, Phase contrast, +Width, −Width, and Burst width

Top☑	Calculates the data within the calculation range in the initial condition.
Average	Calculates the average value of the calculation results for the data within the calculation range.
Max	Calculates the maximum value of the calculation results for the data within the calculation range.
Min	Calculates the minimum value of the calculation results for the data within the calculation range.

Displaying the numerical calculation results

The calculation results can be checked on the waveform screen.

> **[NumCalc]**

- You can display or hide the screen of the numerical calculation results every time you tap the screen.
- If no periods are found or the calculation is aborted, the character string **[******]** is displayed instead of the calculation result.
- For the channels that are not specified as the calculation target, the character **[-]** is displayed.

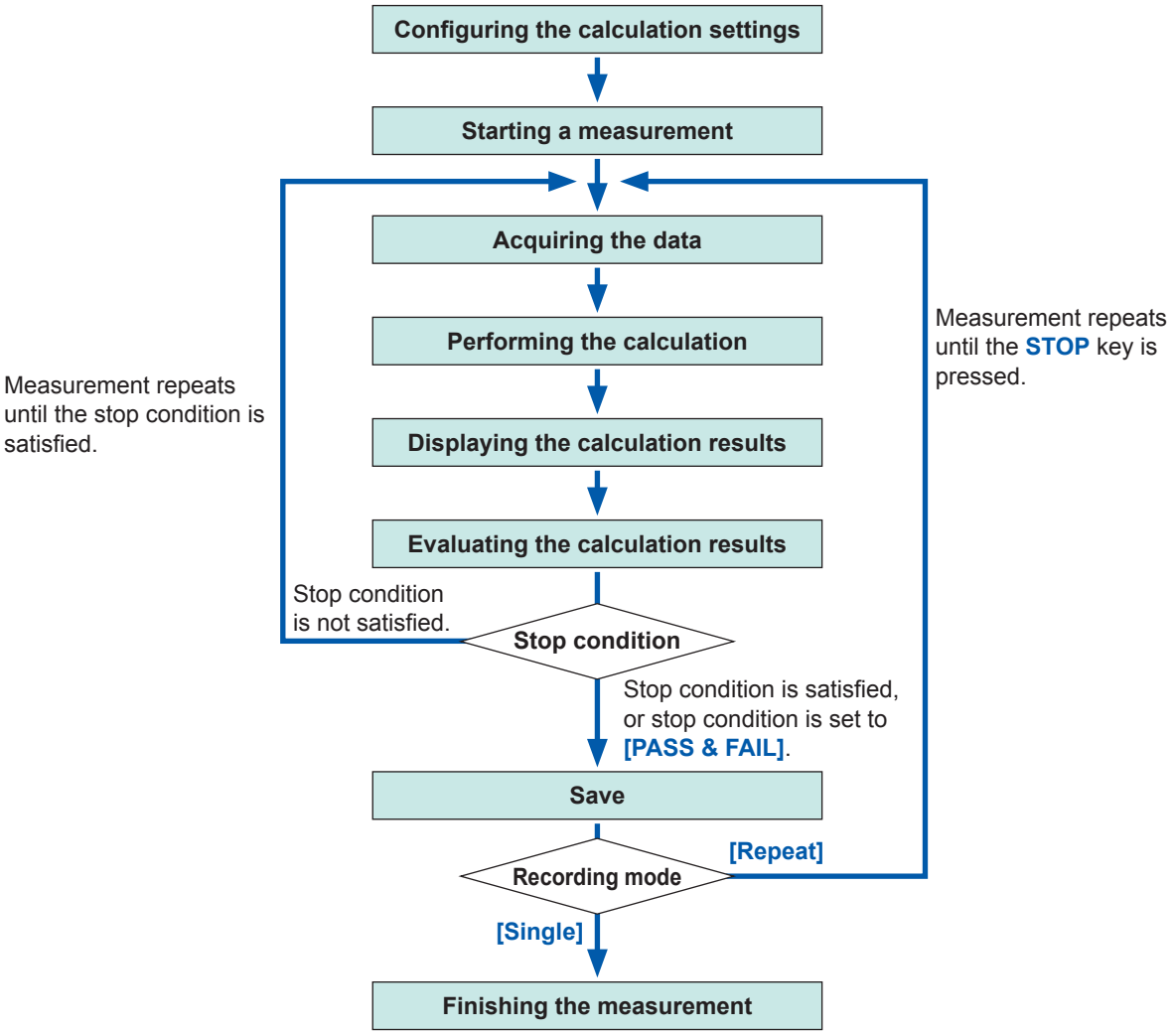
To save the calculation results after the measurement

Refer to “Freely selecting data items to be saved and save files (SAVE key)” (p. 74).

7.3 Evaluating the Calculation Results on a Pass/Fail Basis

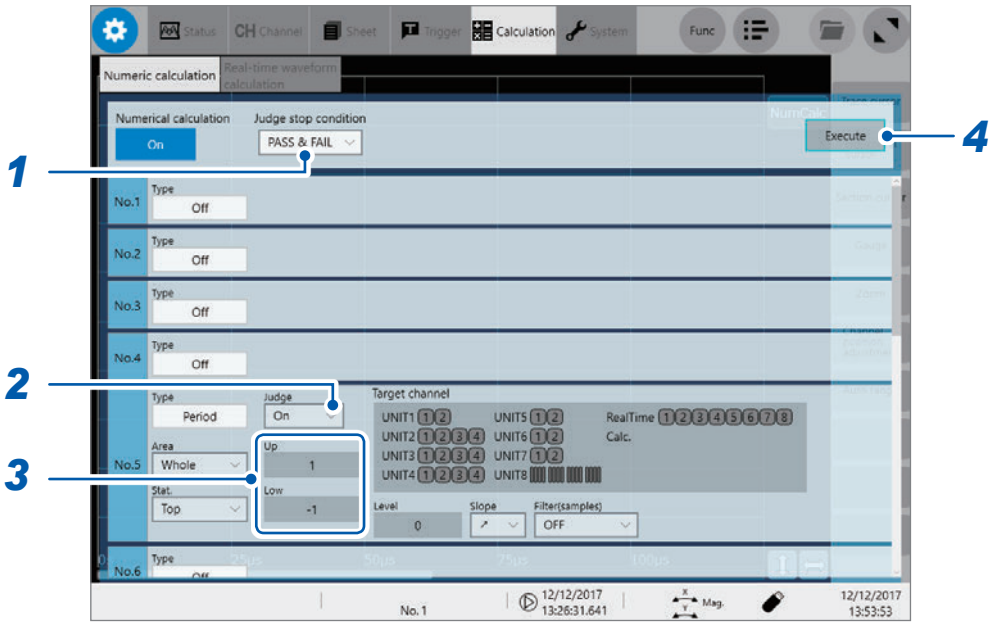
You can specify the evaluation criteria (**[Up]** and **[Low]**) to evaluate the numerical calculation results on a pass/fail basis.
The evaluation criteria can be specified for each numerical calculation.

The waveform acquisition processing varies depending on recording mode setting (**[Single]** or **[Repeat]**) and the stop condition specified to stop the measurement depending on an evaluation (**[PASS]**, **[FAIL]**, or **[PASS & FAIL]**).



Auto-save is not be carried out until the stop condition is satisfied at the end of calculation evaluation.

> [Calculation] > [Numeric calculation]



1 Set [Judge stop condition].

PASS	Stops the measurement when the calculation result falls within the criteria range (pass judgment).
FAIL	Stops the measurement when the calculation result is outside the criteria range (fail judgment).
PASS & FAIL☑	Stops the measurement regardless whether a pass or fail judgment is given.

2 Set [Judge] to [On] or [Off].

Off☑	No evaluation is performed.
On	The FAIL judgment is given if the result is outside the criteria range. Calculated values in a channel for which the FAIL judgment is given are highlighted in red.

3 Type evaluation criteria values.

Type the upper and lower values in the **[Up]** and **[Low]** boxes, respectively.
Valid range: −9.9999E+29 to -1.0000E−29, 0, +1.0000E−29 to +9.9999E+29

4 Execute the calculation.

To evaluate the existing data

Tap **[Execute]**.

To execute evaluation automatically after the measurement

Press the **START** key to start a measurement.

About upper and lower limit values

You cannot specify a lower value in the **[Up]** box than that in the **[Low]** value.
Neither can you specify a higher value in the **[Low]** box than that in the **[Up]** box.

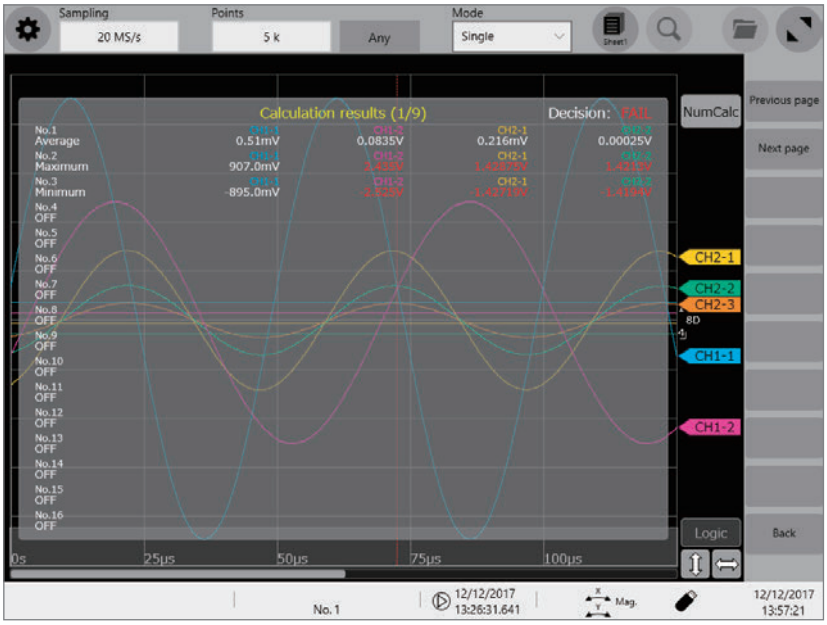
To record all of the calculation results

Set the judge stop condition to **[PASS & FAIL]**.

Displaying the evaluation results and outputting signals externally

The numerical calculation evaluation results are displayed on the numerical calculation results screen on the waveform screen.

Values falling within the evaluation criteria range: Pass judgment
Values being outside the evaluation criteria range: Fail judgment (highlighted in red)



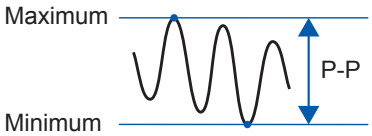
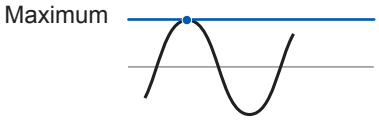
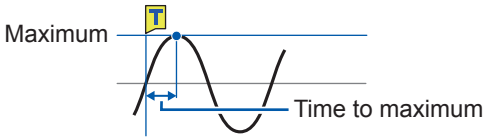
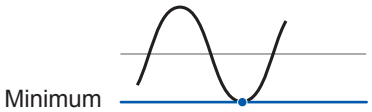
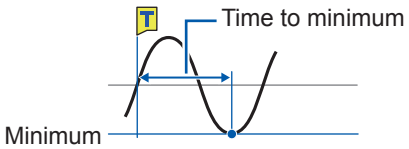
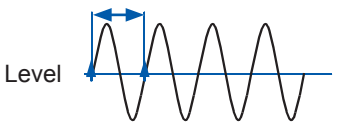
When a pass judgment is given

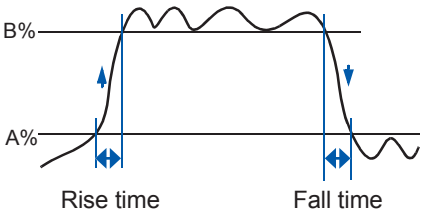
When the external output terminals (OUT 1, OUT 2) are set to **[Judge(Pass)]**, the PASS signal is output from the external output terminals (OUT 1, OUT 2).

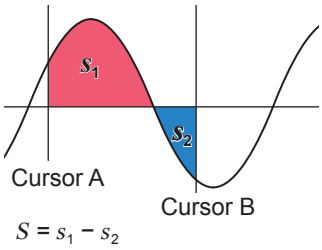
When a fail judgment is given

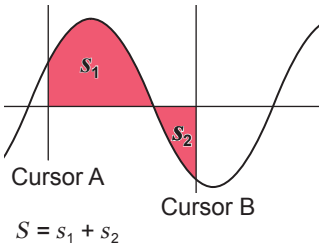
When the external output terminals (OUT 1, OUT 2) are set to **[Judge(Fail)]**, the FAIL signal is output from the external output terminals (OUT 1, OUT 2). A fail judgment is given when any one of the channels is judged to be a fail.

7.4 Numerical Calculation Types and Descriptions

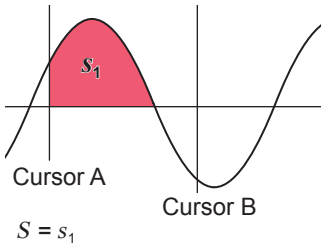
Calculation type	Description	
Average	Calculates the average value of the waveform data. $AVE = \frac{1}{n}\sum_{i=1}^{n} di$ AVE: Average n: Number of data points di: i-th data point acquired through the channel	
RMS	Calculates the RMS value of the waveform data. When the scaling is enabled, the waveform data that has been scaled is calculated. $RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n} di^2}$ RMS: Root-mean-squire value n: Number of data points di: i-th data point acquired through the channel	
P-P	Calculates the difference (peak-to-peak value) between the maximum and minimum values of the waveform data.	
Maximum	Calculates the maximum value of the waveform data.	
Time to maximum	Calculates the period of time (unit: s) from the trigger point to the maximum value. When there are two or more points of the maximum value, the first of them in the waveform to be calculated is used as the maximum value.	
Minimum	Calculates the minimum value of the waveform data.	
Time to minimum	Calculates the period of time (unit: s) from the trigger point to the minimum value. When there are two or more points of the minimum value, the first of them in the waveform to be calculated is used as the minimum value.	
Period **Frequency**	Displays the period (unit: s) and frequency (unit: Hz) of the signal waveform. Calculates the period and frequency based on the time lag between the time when the waveform crossed the specified level in the positive (or negative) direction the first time and the time when it next crossed the specified level. Settings: **Level**, **Slope**, **Filter**, **Stat.**	

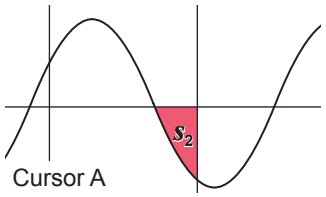
<table>
<tr><th>Calculation type</th><th>Description</th></tr>
<tr><td>Rise time
Fall time</td><td>Calculates the A%-to-B% rise time (or the B%-to-A% fall time) (unit: s) based on the 0% and 100% levels, which are calculated based on the histogram (frequency distribution), of the acquired waveform data.
The rise time (or fall time) of the first rising (or falling) slope in the acquired waveform data is calculated.
When the range is specified with section cursors, calculates the rise time (or fall time) of the first rising (or falling) slope appearing between the cursors.
The values of A and B can be specified (unit: %). The values of A and B varies along with each other. When the value of A is 5%, the value of B is specified to 95%; when the value of A is 30%, the value of B is specified to 70%.
Settings: Rise time (A% to B%) and Fall time (B% to A%) values (%), Stat.
 

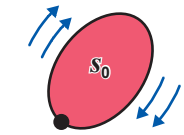
A: 5% to 30%
B: 95% to 70%</td></tr>
<tr><td>Standard deviation</td><td>Calculates the standard deviation of the waveform data.
$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(di - AVE)^2}$
σ: Standard deviation
AVE: Average
n: Number of data points
di: i-th data point acquired through the channel</td></tr>
<tr><td>Area
Method: Total</td><td>Calculates the area by subtracting the area (unit: V·s) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is negative from the area (unit: V·s) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive.
When the range is specified with section cursors, calculates the area between the cursors.
$S = \sum_{i=1}^{n} di \cdot h$
S: Area
n: Number of data points
di: i-th data point acquired through the channel
$h = \Delta t$: Sampling interval
 

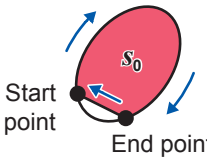
$S = s_1 - s_2$</td></tr>
<tr><td>Area
Method:
Absolute value</td><td>Calculates the area value (unit: V·s) enclosed by the zero-level (zero-potential) line and the signal waveform.
When the range is specified with section cursors, calculates the area between the cursors.
$S = \sum_{i=1}^{n} |di| \cdot h$
S: Area
n: Number of data points
di: i-th data point acquired through the channel
$h = \Delta t$: Sampling interval
 

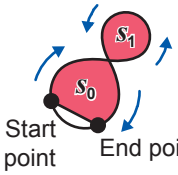
$S = s_1 + s_2$</td></tr>
</table>

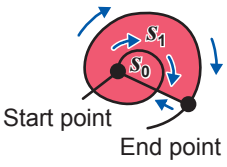
<table>
<tr><th>Calculation type</th><th colspan="2">Description</th></tr>
<tr><td>Area
Method: Positive
(Only the part where the amplitude is positive)</td><td>Calculates the area value (unit: V·s) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive.
When the range is specified with section cursors, calculates the area between the cursors.
$S = \sum_{i=1}^{n} di \bullet h$
$di > 0$
S: Area
n: Number of data points
di: i-th data point acquired through the channel
$h = \Delta t$: Sampling interval</td><td> 

$S = s_1$</td></tr>
<tr><td>Area
Method: Negative
(Only the part the where amplitude is negative)</td><td>Calculates the area value (unit: V·s) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is negative.
When the range is specified with section cursors, calculates the area between the cursors.
$S = \sum_{i=1}^{n} di \bullet h$
$di < 0$
S: Area
n: Number of data points
di: i-th data point acquired through the channel
$h = \Delta t$: Sampling interval</td><td> 

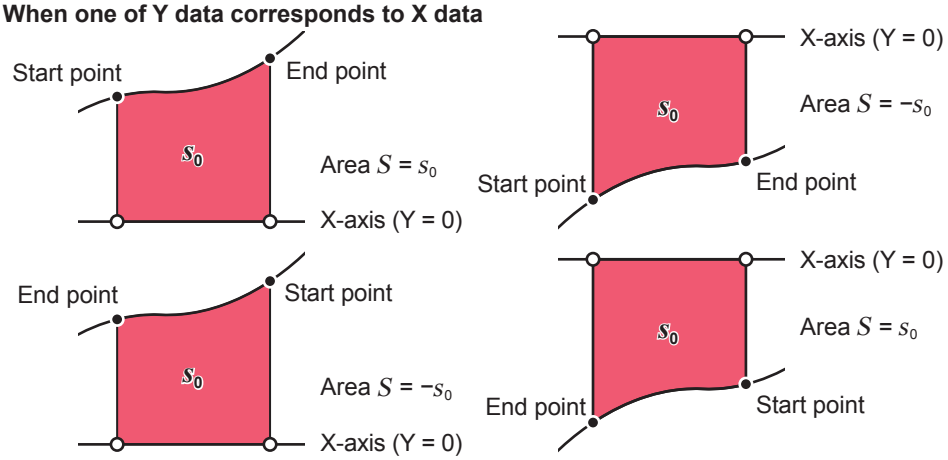
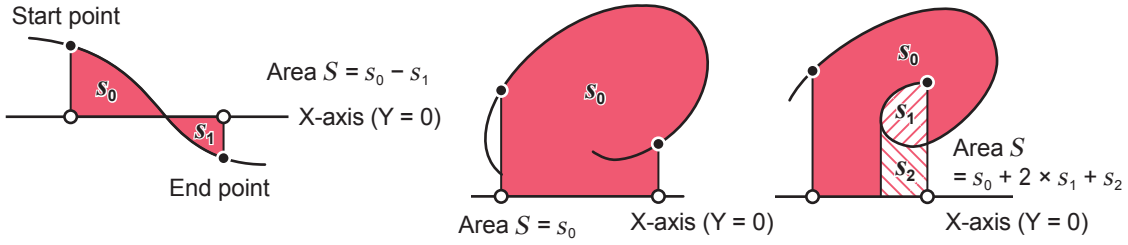
$S = -s_2$</td></tr>
<tr><td>X-Y area
Method:
Coordinate method</td><td colspan="2">Calculates the area (unit: V^2) of the figure enclosed by the X-Y composite curve. The areas of the parts enclosed by the lines are calculated as illustrated below. The area can be calculated even when the X-Y composite curve is not displayed.
The calculation range can be specified on the horizontal axis (time-axis) waveform of each channel with the section cursors. The area of the X-Y composite curve is calculated within the specified range (It is not possible to specify the range directly on the X-Y waveform with the section cursors).
Refer to “2.1 Reading Measured Values (Trace Cursors)” (p. 22).
When multiple loops are plotted
 

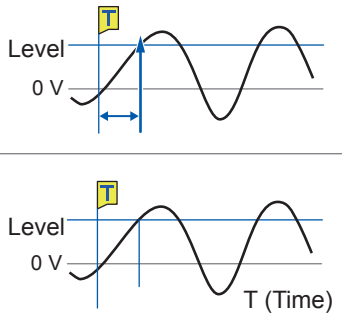
$S = n \times s_0$
S: Area
n: Number of loops
When an open curve is plotted
 

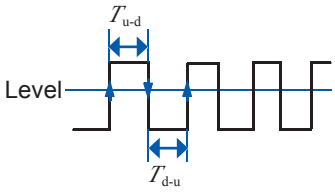
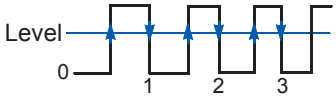
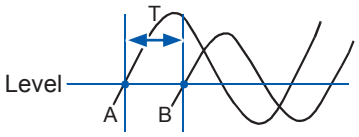
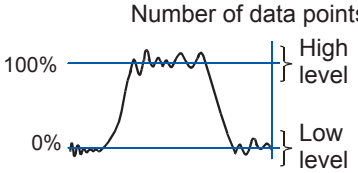
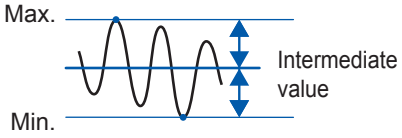
$S = s_0$
S: Area
(Closed area is created by connecting the start and end points with a straight line)
When a figure of eight is plotted
 

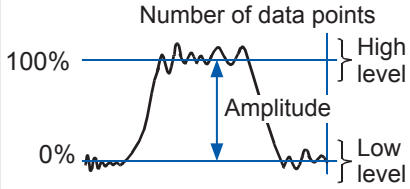
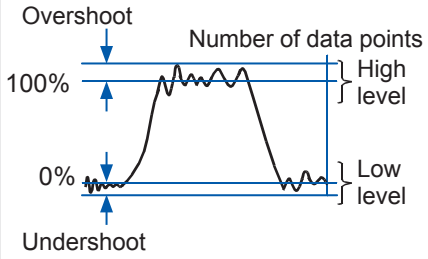
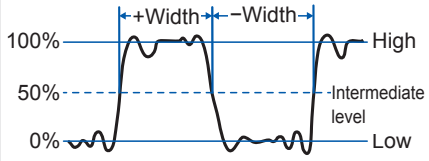
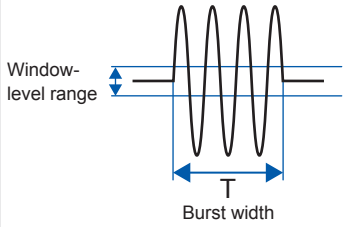
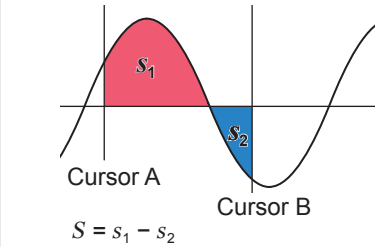
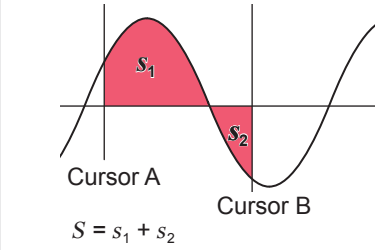
$S = |s_0 - s_1|$
S: Area
When a spiral loop is plotted
 

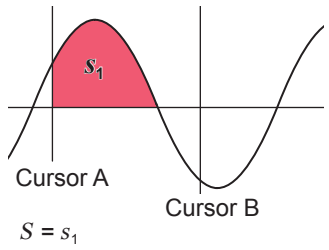
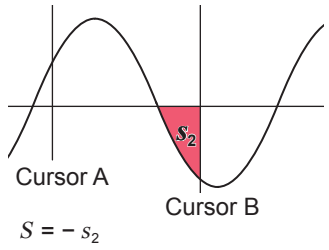
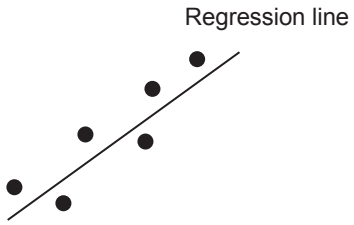
$S = s_0 \times 2 + s_1$
S: Area
(The number of overlapping segments increases with the number of loops)</td></tr>
</table>

Calculation type	Description
X-Y area **Method**: **Trapezoidal approximation**	Calculates the area (unit: V^2) of the figure enclosed by the X-Y composite curve using the trapezoidal approximation method. The areas of the parts enclosed by the lines are calculated as illustrated below. The area can be calculated even when the X-Y composite curve is not displayed. The calculation range can be specified on the horizontal axis (time-axis) waveform of each channel with the section cursors. The area of the X-Y composite curve is calculated within the specified range (It is not possible to specify the range directly on the X-Y waveform with the section cursors). **When one of Y data corresponds to X data**  **When the waveform includes negative amplitude** **When multiple pieces of Y data correspond to XY data** 
Time to level	Searches the calculation range from the beginning for the point when the signal crossed the specified level and calculates the time from the trigger point to the point searched for. Settings: **Level**, **Slope**, **Filter**
Level at time	Calculates the level when the specified time has elapsed from the trigger point. The time can also be specified based on previously calculated results. Settings: **Method** (**Time**, **Calc. No.**), **Time/ calculation number** (**No. 1** to **No. 16**)
Pulse width	Calculates the pulse width based on the time lag between the time when the waveform crossed the specified level in the positive (or negative) direction and the time when it next crossed the specified level in the opposite direction. Settings: **Level**, **Slope**, **Filter**, **Stat.**



Calculation type	Description	
Duty ratio	Calculates the duty ratio based on the time lag between the time when the waveform crossed the specified level in the positive direction and the time when it next crossed the specified level in the opposite direction, and the time lag between the time when the waveform crossed the specified level in the negative direction and the time when it next crossed the specified level in the opposite direction. Duty ratio $= \frac{T_{u\text{-}d}}{T_{u\text{-}d} + T_{d\text{-}u}} \times 100$ [%] $T_{u\text{-}d}$: Time from rising edge to falling edge (unit: s) $T_{d\text{-}u}$: Time from falling edge to rising edge (unit: s) Settings: **Level**, **Filter**, **Stat.**	
Pulse count	Counts the number of the pulses that crossed the specified level in the positive (or negative) direction. For the pulse count, it is considered as one count that the period between the point when a pulse crossed the level in the positive direction and the point when the pulse crossed the level in the negative direction (otherwise, between that in the negative direction and in the positive direction). Settings: **Level**, **Slope**, **Filter**	
Arithmetic operations	Performs arithmetic operations using the numerical calculation results freely selected. Settings: **Calculation number 1**, Arithmetic operations (**+**, **−**, **×**, **÷**), **Calculation number 2**	
Time difference	Calculates the time lag T [unit: s] between when Waveform A crossed the specified level in the positive (or negative) direction and when Waveform B crossed it in the same direction. (Time lag T) = (Time when Waveform B crossed the level) − (Time when Waveform B crossed the level) Settings: Waveform A (**Reference channel**, **Level**, **Slope**, **Filter**); Waveform B (**Target channel**, **Level**, **Slope**, **Filter**)	
Phase contrast	Calculates the phase difference (unit: degree [°]) with reference to Waveform A based on the time lag between when Waveform A crossed the specified level in the positive (or negative) direction and when Waveform B crossed it in the same direction. Phase difference $= \frac{\text{Time lag between waveforms A and B (T)}}{\text{Period of waveform A}} \times 360$ [°] Settings: Waveform A (**Reference channel**, **Level**, **Slope**, **Filter**); Waveform B (**Target channel**, **Level**, **Slope**, **Filter**)	
High level **Low level**	Calculates the low and high levels considering 0% and 100%, respectively, of the acquired waveform data to be them based on the histogram (frequency distribution).	
Intermediate value	Calculates the average of the maximum and minimum values of the waveform data. [(Maximum value) + (Minimum value)] / 2	

Calculation type	Description	
Amplitude	Calculates the value (amplitude) between the low and high levels, which are calculated considering 0% and 100%, respectively, of the acquired waveform data to be them based on the histogram (frequency distribution). (High level) − (Low level)	
Overshoot **Undershoot**	Calculates the ratio of the difference between the maximum (or minimum) value and the high (or low) level to the difference between the high and low levels, which are calculated considering 0% and 100%, respectively, of the acquired waveform data to be them based on the histogram (frequency distribution). {[(Maximum value) − (High level)] / [(High level) − (Low level)]} × 100 {[(Low level) − (Minimum value)] / [(High level) − (Low level)]} × 100	
+Width (Period during which the waveform is above the intermediate level) **−Width** (Period during which the waveform is below the intermediate level)	Calculates the time lag between the time when the waveform crossed the intermediate line level (50%) in the positive (or negative) direction and the time when it next crossed the intermediate level in the opposite direction. Settings: **Filter**, **Stat.**	
Burst width	Calculates the time during which the burst signal is output. Settings: **Filter**, **Burst end filter**, Window (**Up**, **Low**), **Stat.**	
Accumulation Method: **Total**	Calculates the count by subtracting the count (V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is negative from the count (unit: V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive. When the range is specified with section cursors, calculates the area between the cursors. $S = \sum_{i=1}^{n} di$ S: Area n: Number of data points di: i-th data point acquired through the channel	
Accumulation Method: **Absolute value**	Calculates the count (unit: V) enclosed by the zero-level (zero-potential) line and the signal waveform. When the range is specified with section cursors, calculates the area between the cursors. $S = \sum_{i=1}^{n} \lvert di \rvert$ S: Area n: Number of data points di: i-th data point acquired through the channel	

Calculation type	Description	
Accumulation Method: Positive (Only the part where the amplitude is positive)	Calculates the count (unit: V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive. When the range is specified with section cursors, calculates the area between the cursors. $S = \sum_{i=1}^{n} di$ $(di > 0)$ S: Area n: Number of data points di: i-th data point acquired through the channel	
Accumulation Method: Negative (Only the part the where amplitude is negative)	Calculates the count (unit: V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is negative. When the range is specified with section cursors, calculates the area between the cursors. $S = \sum_{i=1}^{n} di$ $(di < 0)$ S: Area n: Number of data points di: i-th data point acquired through the channel	
Angle of XY waveform	Calculates the regression line on the X-Y composite curve, and then the slope angle. $SLOPE = \frac{\sum_{i=1}^{n}(x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$ $\theta = SLOPE \cdot \frac{180}{a\tan(1.0) \cdot 4}$ [°] xi: i-th data point acquired through the X-axis channel yi: i-th data point acquired through the Y-axis channel $\bar{x}$: Average value of the X-axis channel $\bar{y}$: Average value of the Y-axis channel	

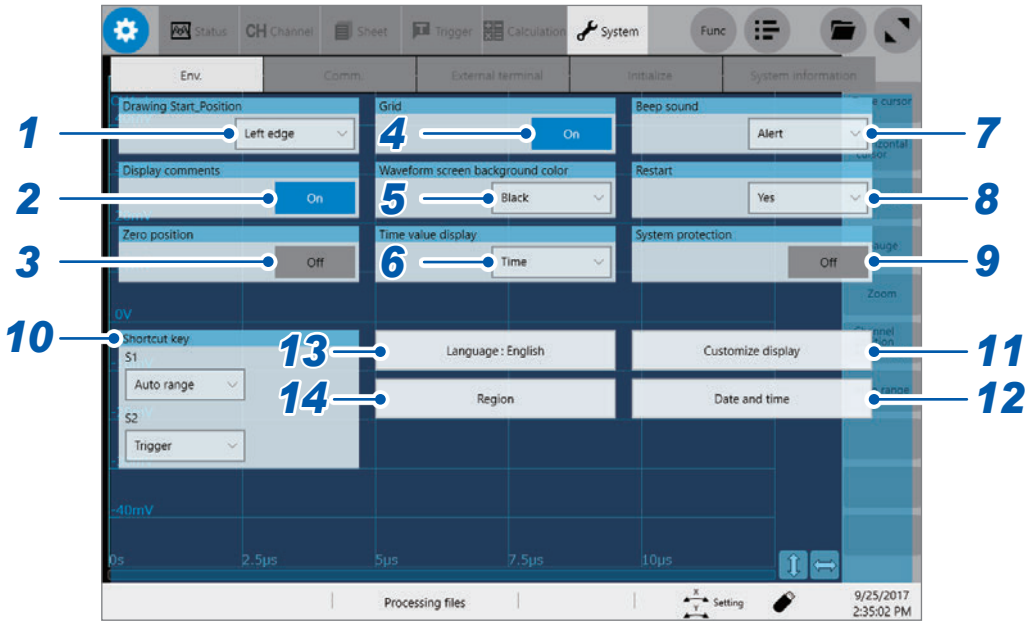
8 Setting the System Environment

You can set the system environment for the instrument.

IMPORTANT

Do not change any settings for Windows® other than those described in this manual.
Doing so may cause the system operation to become unstable.

> [System] > [Env.]



1 Set [Drawing Start_Position].

Left edge☑	Starts the scrolling display from the left side of the waveform screen.
Right edge	Starts the scrolling display from the right side of the waveform screen.

2 Set [Display comments].

You can display the title comment and each channel comment on the waveform screen. Each channel comment is displayed along with each input-channel marker.

On☑	Displays comments.
Off	Does not display any comments.

3 Set [Zero position].

You can display the markers at the zero position of each input channel on the time-axis waveform display.

Off☑	Does not display any markers.
On	Displays the markers at the zero position on the left side of the waveform screen.

4 Set [Grid].

You can display the grid (graticule) on the waveform screen or hidden.

On☑	Displays the solid-line grid.
Off	Does not display any grids.

5 Set [Waveform screen background color].

You can choose a background color of the waveform screen.

Black☑	Sets the background color of the waveform screen to black.
White	Sets the background color of the waveform screen to white.

6 Set [Time value display].

You can select a display format of the lapse time from the trigger point.

Time☑	Displays the lapse time from the trigger point (the unit is fixed).
Mod 60	Displays the lapse time from the trigger point (in the sexagesimal [base 60] system).
Date	Displays the date and time when the waveform has been acquired.
Samples	Displays the number of data points from the trigger point.

- During the external sampling is used, this setting is fixed to **[Samples]**.
- These settings are also applied to the values of the trace cursors.

7 Set [Beep sound].

Beep sounds can be emitted for warnings and operating conditions.

Off	Does not allow the instrument to beep.
Alert☑	Allows the instrument to beep in the following cases: • If an error message or warning is displayed • If a fail judgment is given
Alert+Action	Allows the instrument to beep when the instrument starts a measurement, is triggered, stops the measurement, and completes auto-saving, in addition to the cases described above.

8 Set [Restart].

You can select whether to restart the measurement immediately or not after changing a setting that affects measurement during the measurement.

No	Does not restart any measurement. No settings can be changed during measurement.
Yes☑	If a setting is changed during measurement, the changes are applied and then the instrument restart the measurement.

9 Set [System protection].

On☑	Protects the system from unexpected power interruptions.
Off	Does not protect the system.

This system protection function uses the UWF (Unified write filter) feature installed in Windows®. If the system is continuously running for one month or more, it is recommended that this function be turned off and an external UPS be prepared.

10 Set [Shortcut key].

The operation can be assigned to the **S1** and **S2** keys.

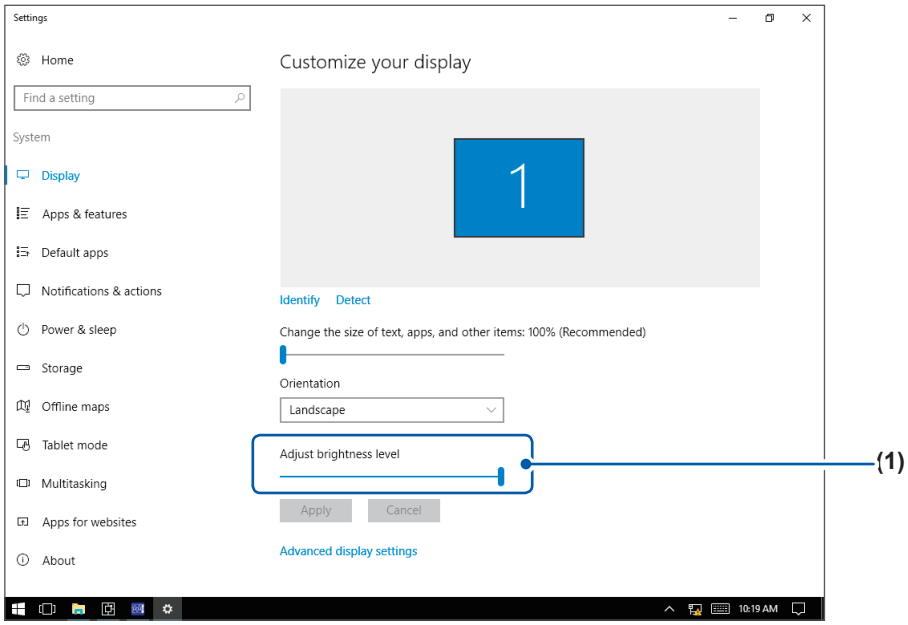
Off	Does not execute any operation.
Auto range☑	Executes the auto-range. (Default setting for the **S1** key)
Trigger☑	Executes the forcible trigger. (Default setting for the **S2** key)
Whole wave	Magnifies/demagnifies the recording length of the waveforms so that they fit the single screen width, and then displays them. If the recording length is relatively long, displaying the waveforms may require a lot of time.
Default mag.	Displays the waveforms at the default display magnification.

11 Tap [Customize display].

The Settings screen is displayed.

To adjust the brightness

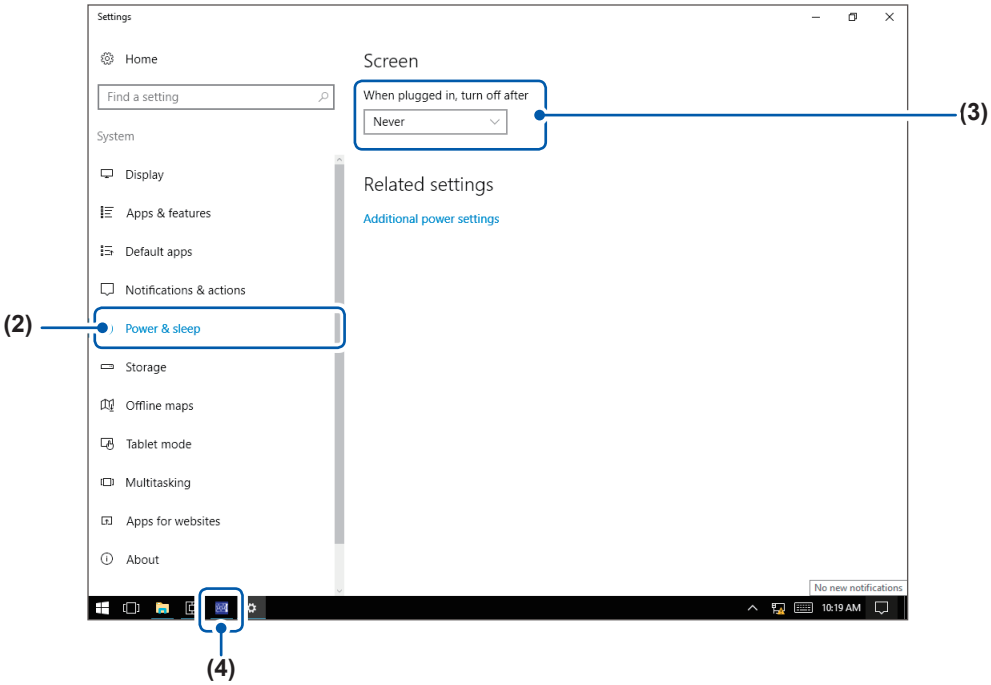
(1) Adjust the brightness level with the [Adjust brightness level] slider.



To turn off the display automatically (To blanking the screen automatically)

(2) Tap [Power & sleep].

(3) Select a length of time after which the screen is blanked.



(4) Tap the icon on the taskbar to restore the display to the [Env.] screen of the Recorder.

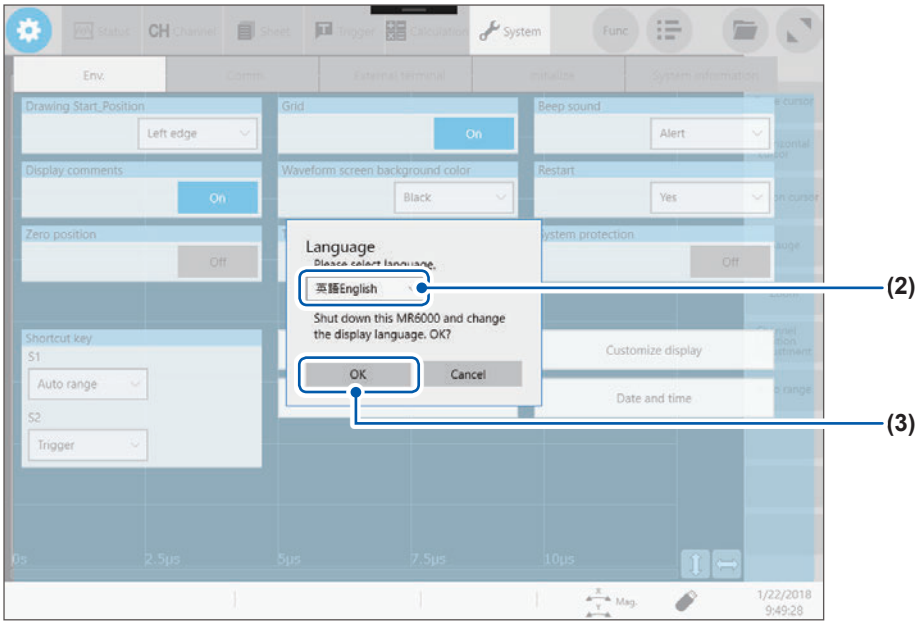
12 Set [Date and Time].

Refer to “2.10 Setting the Clock” in Quick Start Manual.

13 Change the display languages.

(1) Tap [Language: English].

The language setting dialog box is displayed.



(2) Select another language.

English☑, **Japanese**

(3) Tap [OK].

The instrument is turned off.

(4) Press the power key.

The instrument starts up with the display in the selected language.

14 Change [Region] (the region-specific settings).

Select characters that represent the decimal point and the separator used in data included in waveform files (text format) and numerical calculation result files.

[Decimal point]

Period . ☑	Designates the period (.) as the decimal point.
Comma ,	Designates the comma (,) as the decimal point.

[Separator]

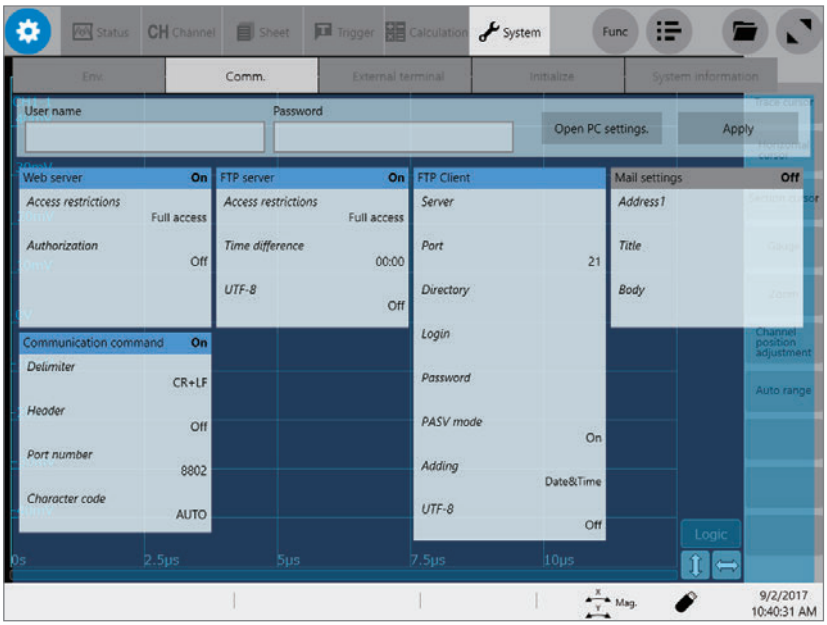
Comma , ☑	Designates the comma (,) as the separator.
Space	Designates the space character as the separator.
Tab	Designates the tab character as the separator.
Semicolon ;	Designates the semicolon (;) as the separator.

- Either the decimal point or separator, but not both, can be set to **[Comma ,]**.
- Filenames have the .CSV extension with the **[Comma ,]** separator setting; the .TXT extension with the other separator settings.

9 Connecting the Instrument to PCs

Read the section “Before connecting the instrument to an external device” in “Operation Precautions” of Quick Start Manual carefully.
This instrument is equipped with the Ethernet 1000BASE-T interface for LAN communications. You can control the instrument with computers (PCs) or other devices connected to your network with 10BASE-T or 100BASE-TX or 1000BASE-T cable (maximum length: 100 m).

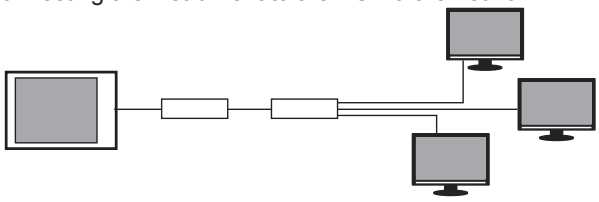
> [System] > [Comm.]



Operation available on the [Comm.] screen

Setting LAN, connecting the instrument via LAN **(p. 150)**

• Connecting the instrument to the PC via the network



• Connecting the instrument to the PC directly

Remotely controlling the instrument with an Internet browser **(p. 164)**

Sending emails **(p. 171)**

FTP server function **(p. 155)**

Using an FTP client software installed on the PC allows you to transfer files from storage devices attached to the instrument to the PC, and handle the files.

FTP client function **(p. 158)**

Using this function allows you to send data to the FTP server of the PC. Measured data can be sent on completion of each measurement. You can also send data manually.

Controlling the instrument with the command communications **(p. 176)**

You can control the instrument with programs you created after connecting the PC to the command communications port using the TCP. For more information about the commands, refer to the Communications Command Instruction Manual on the accompanying application disc.

9.1 Configuring the LAN Settings and Connecting to the Network

Before accessing the instrument with a PC using the FTP or an Internet browser, or using command communication, configure the LAN settings of the instrument and connect the instrument to your PC with a LAN cable.
Be sure to configure the LAN settings before connecting the instrument to the network. When you change the settings while the instrument is connected to the network, the IP addresses may not be unique or invalid address data may be transmitted over the network.
For more information on how to connect the instrument to PCs, refer to “2.6 Connecting the Instrument with PCs” in Quick Start Manual.

IMPORTANT
Do not change any settings for Windows® other than those described in this manual.
Doing so may cause the system operation to become unstable.

Configuring the LAN settings with the instrument

Items to be checked before configuring the LAN settings

The required settings are different depending on whether you are to connect the instrument to an existing network or establish a new network consisting of only the instrument and a PC.

When connecting the instrument to the existing network

The following items must be assigned in advance by your network administrator. Be sure that there is no conflict with other devices.

- **The PC name and address of the instrument**
  PC name (up to 15 characters): ... _____
  IP address: ..... ___.___.___.___
  Subnet mask: ..... ___.___.___.___
- **Gateway**
  Whether to use a gateway: ..... Yes/No
  IP address (When used): ..... ___.___.___.___

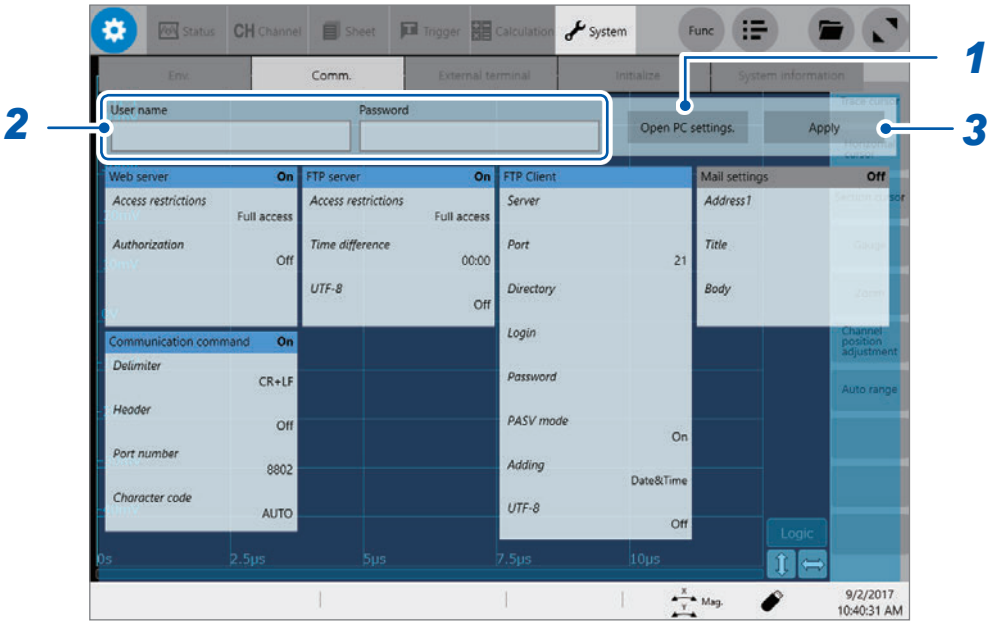
When establishing a new network consisting of a PC and the instrument

(Using the instrument on the local network that does not connect to any external networks)
When no administrator exists for your network or you are entrusted with the settings, the following addresses are recommended.
Setting example:

IP Address
PC: 192.168.0.1
Recorder 1: 192.168.0.2
Recorder 2: 192.168.0.3 . . . Assign numbers in a sequential order.
↓ ↓
PC name.....Any name (Must be unique)
Subnet mask.....255.255.255.0
Gateway .....Off

Setting items

> [System] > [Comm.]



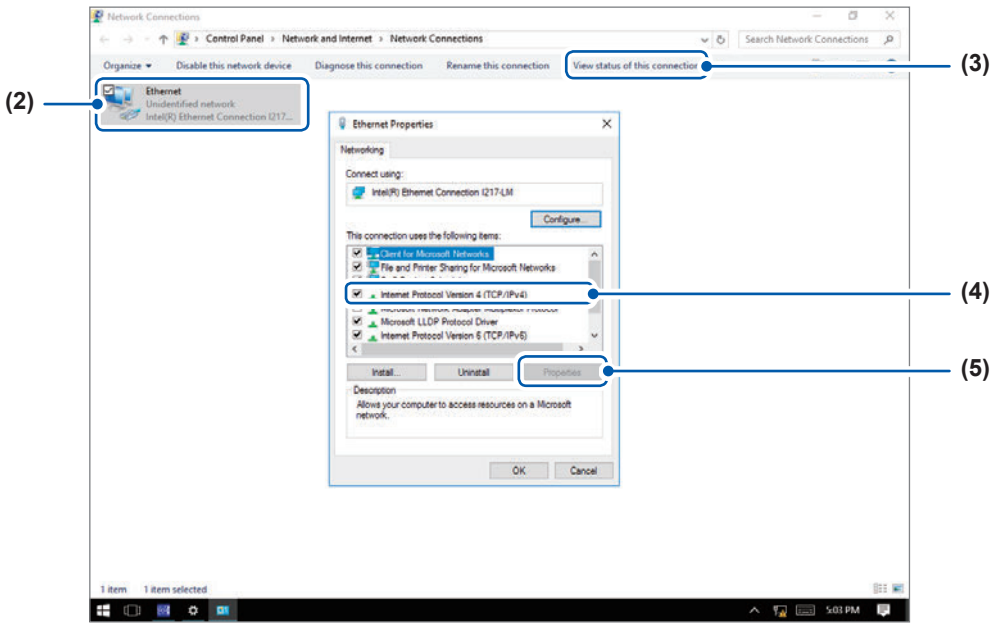
1 **Tap [Open PC settings.].**

The Ethernet settings screen is displayed.

(1) **Tap [Change adapter options].**
The **[Network Connections]** screen is displayed.

(2) **Tap [Ethernet].**

(3) **Tap [Change settings of this connection].**
The **[Ethernet Properties]** window is displayed.



(4) **Tap [インターネット プロトコル バージョン 4 (TCP/IPv4)] (“Internet Protocol Version 4 (TCP/IPv4)” in Japanese).**

(5)

(6) **Tap [Properties].**
The **[インターネット プロトコル バージョン 4 (TCP/IPv4) Properties]** (“Internet Protocol Version 4 (TCP/IPv4 Properties)” in Japanese) window is displayed.

(7) **Enter the necessary information.**

IP address	The IP addresses identify individual devices on the network. Assign a unique address different from that of other devices.
Subnet mask	The subnet mask divides the IP address into the network address and the host address. Set the subnet mask in the same way as those of other devices on the network.
Default gateway	For network connection When the PC (the communication device) is connected to another network than the instrument, specify a gateway device. When the PC is connected to the same network, usually assign the same address as the default gateway in the PC communications settings.

(8) **Tap [OK].**

(9) **Tap [OK] to close the [Ethernet Properties] window.**

(10) **Tap the close button ([×]) to close the [Network Connections] window.**

(11) **Tap the icon on the taskbar to restore the display to the [Comm.] screen of the Recorder.**

2 Type a user name and password in the [User name] and [Password] boxes, respectively.

These are used when you log in to the FTP of the instrument or use the Internet browser installed in the PC (When the authorization setting is set to **[On]**).
With the authorization setting, you cannot log in until you enter the user name and password that are same as those you set beforehand. Configuring this setting is recommended when you would like to restrict the users to access the instrument.
The password is hidden behind the asterisks (*).

Characters that can be used: Alphabetic characters and symbols (however, the colon [:] is prohibited.)

When you would like to allow anyone to access the network or log in as an “anonymous” FTP client, leave the **[User name]** and **[Password]** boxes blank.

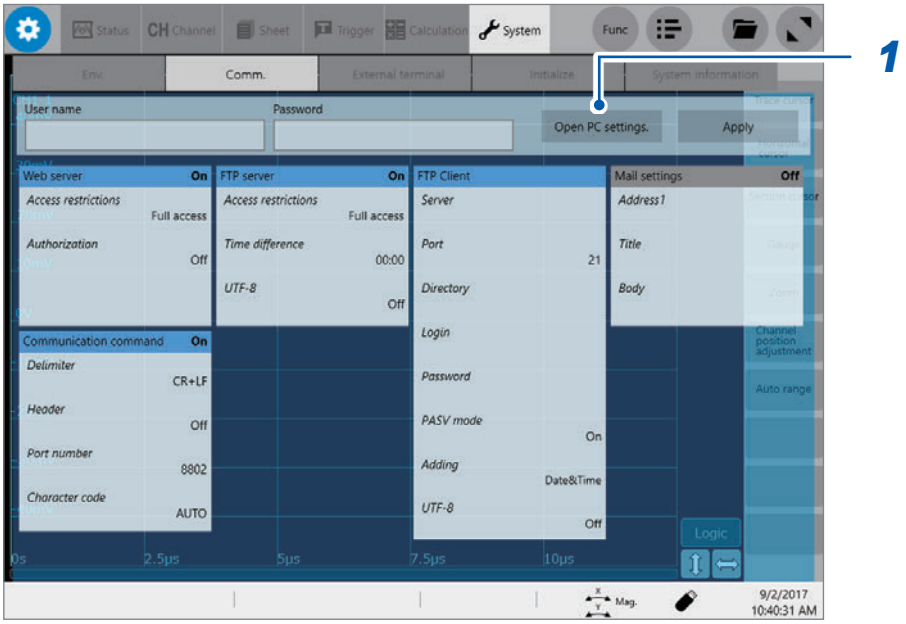
3 Tap [Apply].

Tap **[OK]** to confirm the setting.

Renaming the PC

This name in the **[Current PC name]** box identifies the instrument on the network.
If necessary, change the PC name to a unique one among the network devices.

> **[System] > [Comm.]**



1 **Tap [Open PC settings.].**
The Ethernet settings screen is displayed.

2 **Tap [Home].**
The Windows® settings screen is displayed.

3 **Tap [System].**

4 **Tap [About] under System.**

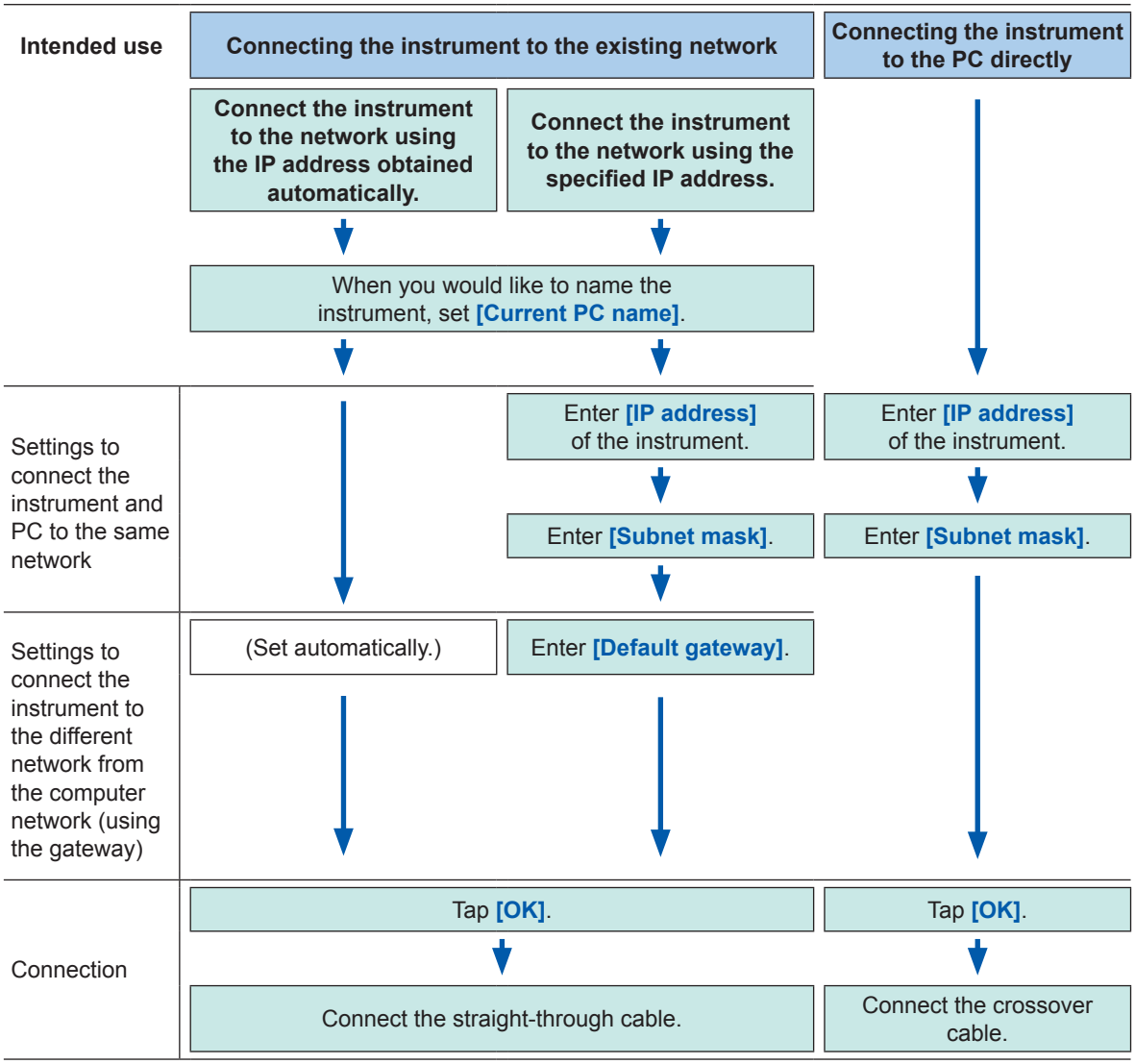
5 **Tap [Rename PC] and type another name in the [Current PC name] box.**

6 **Tap [Next].**
Restarting the instrument is required.

7 **Tap [Restart now].**

LAN setting procedure

Follow this procedure in accordance with the intended usage.
For details on each setting, refer to “Setting items” (p. 151).
For details on your network including the IP address, contact your network administrator.



9.2 Managing Data in the Instrument With the FTP Server Function

Using the FTP client software installed in the PC allows you to transfer files from storage devices in the instrument to the PC, and manage the files with the PC.

- The instrument is equipped with an FTP server.
- The instrument can be operated with Internet Explorer® and various free software.

Precautions when the FTP is used

- The FTP server of the instrument allows only one connection at a time. Multiple PCs cannot access the server simultaneously.
- If no command is sent from the PC for more than one minute after the PC was connected to the FTP server, the FTP session may time out. If this occurred, reconnect the computer via the FTP.
- The FTP session is interrupted during real-time saving (during measurement).
- Before inserting or removing an SD memory card or USB flash drive, terminate the FTP connection first.
- Do not handle any files during an FTP session.
- With Internet Explorer®, the updated date of files may not match those saved in the instrument.
- With Internet Explorer®, temporary Internet files created during the previous access are retained; thus, the previous data may be acquired instead of the updated data.
- If you cancel the transfer of selected files or folders before its completion, some FTP client/browser programs may delete all of them from the source regardless of whether they have been transferred or not. Avoid moving files and folders. Download files and folders using the copy function, and then delete them.
- Be careful that the user name and password themselves will get transmitted via the network when the FTP server is used.
- When a file is uploaded, the time stamp on the file will change to the uploading time.
- Each of the storage media appears as a directory on the FTP server.

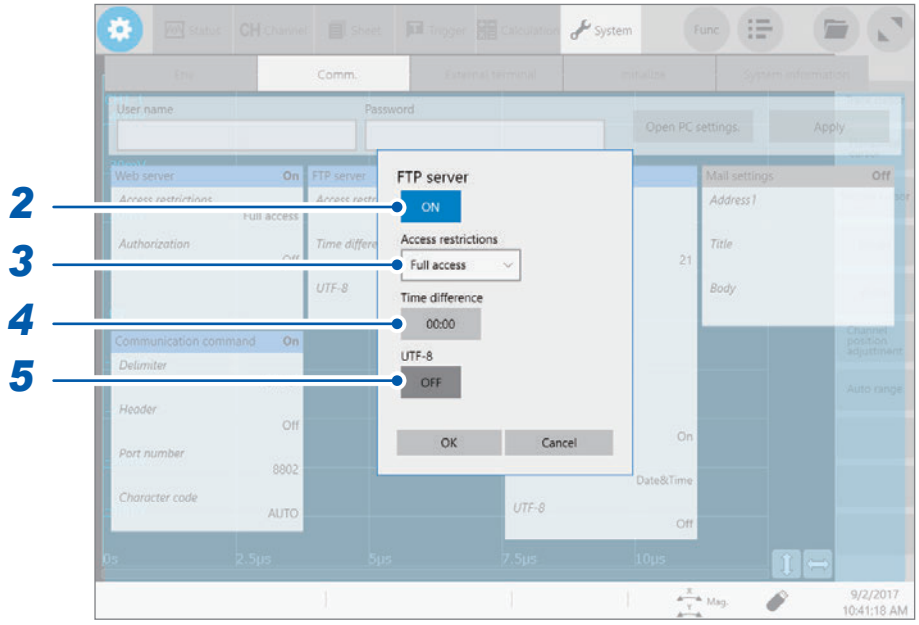
/STORAGE	Directory containing measured data written in the instrument (Writing data is prohibited.)
/D to **/Z**	Storage devices serving as drives

Setting the FTP sever with the instrument

> [System] > [Comm.]

1 **Tap [FTP server].**

The settings dialog box is displayed.



2 **Set [FTP server] to [ON] or [OFF].**

3 **Set [Access restrictions].**

Read only	Enables you to read files only. This setting prevents files from being deleted or changed from outside the instrument.
Full access☑	Enables you to write (upload) files on the storage media, as well as delete and rename files.

4 **Set [Time difference].**

In general, use the instrument with the default setting of **[00:00]**.

Setting the time difference between files

With some versions of Internet Explorer®, the time stamps may differ between those on the files in the PC and the instrument to a certain extent. In this case, you can correct the time stamp by specifying the time difference. However, the corrected time stamp will differ from that on files in FTP clients other than Internet Explorer®.
Example: −9:00

5 **Set [UTF-8] to [ON].**

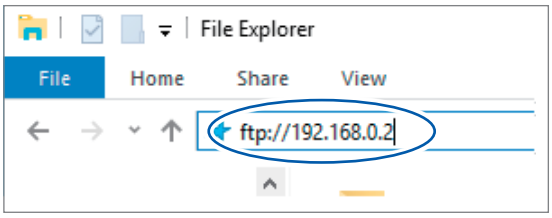
The character code UTF-8 is supported.

Operating the instrument with a PC (FTP server function)

The following example shows how to operate the instrument with File Explorer on Windows 10.

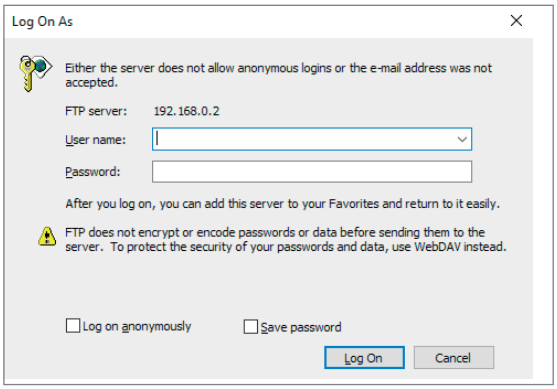
1 Run File Explorer on the PC.

Click the File Explorer icon on the Windows 10 taskbar to start File Explorer.



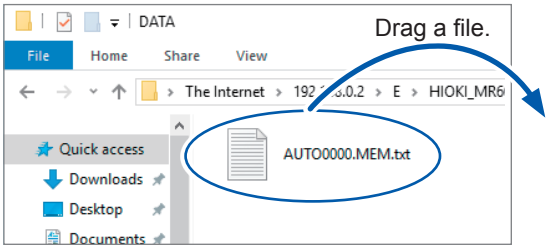
2 Type the IP address.

Click the address bar in File Explorer and type the IP address.
Type the character string **[ftp://]** followed by the IP address of the instrument.



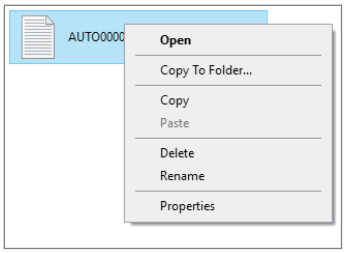
3 Log on to the FTP server.

The Log On As screen is displayed when **[User name]** and **[Password]** for the instrument has been registered. Type the user name and password in the **[User name]** and **[Password]** boxes, respectively,



4 Download the file.

Select the file you would like to download from the list of files. Drag the file to the download destination (Press and hold the mouse left button on the file, move it to the intended location while pressing the button, and then release the button).



5 Delete or rename the file.

Right-click a file in the FTP folder list, and select **[Delete]** or **[Rename]** from the shortcut menu.

9.3 Sending Data to a PC With the FTP Client Function

The instrument is equipped with the FTP transmission function (FTP client). It can send data to the FTP server on the network.

FTP transmission method

Real-time save data transmission	Automatically sends the measured data during measurement. Configure the real-time save settings and specify the save destination to **[FTP]**.
Auto-save data transmission	Automatically sends the data to be saved on completion of the measurement, according to the auto-save settings. Configure the auto-save settings and specify the save destination to **[FTP]**.
Transmission with the SAVE key	When you press the SAVE key, the data to be saved is automatically sent. Configure the manual save settings and specify the save destination to **[FTP]**.

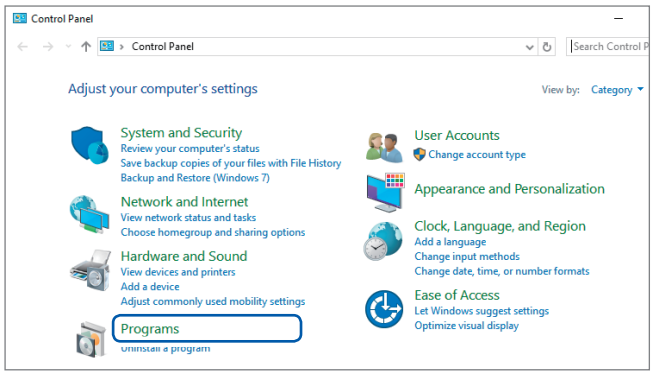
- The date of the file sent to the PC becomes the date the file was sent.
- Transmission to all FTP servers cannot be guaranteed due to differences among servers.
- If a file with the same name exists in the destination, the file is overwritten.

Setting up an FTP server on a PC

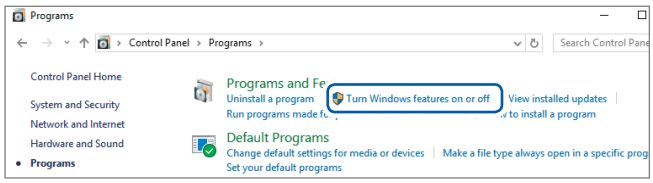
The following example shows how to set the FTP server on Windows 10.
The Microsoft® Windows® Home Edition does not include an FTP server. Use free software such as the FileZilla Server.

- The required settings may vary depending on the environment. When necessary, refer to the help content of the FTP server or consult your network administrator.
- Microsoft® Windows® administrator privileges are required for setup.

Enabling the FTP

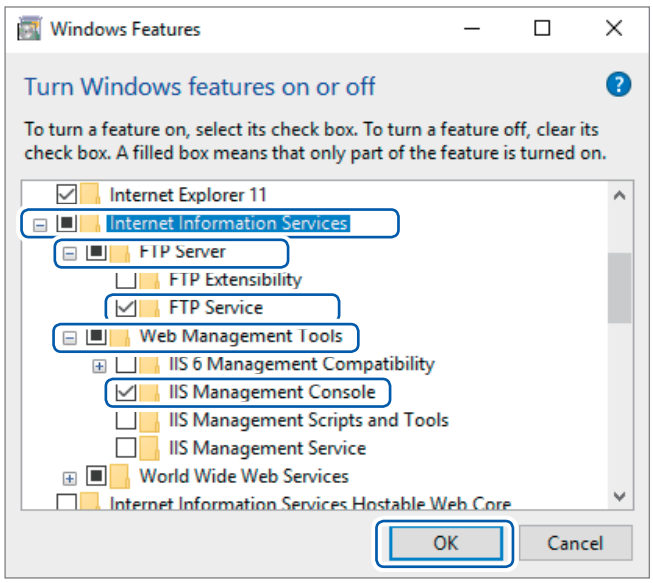


1 **Click [Programs] on [Control Panel].**



2 **Click [Turn Windows features on or off].**

The **[Windows Features]** dialog box is displayed.



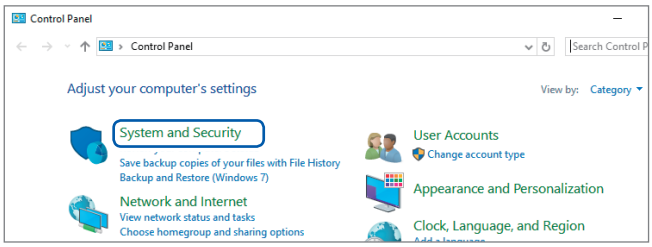
3 **Click [+] on the left of [Internet Information Services] to expand it.**

Click [+] on the left of [FTP Server] to expand it, and then select [FTP Service].

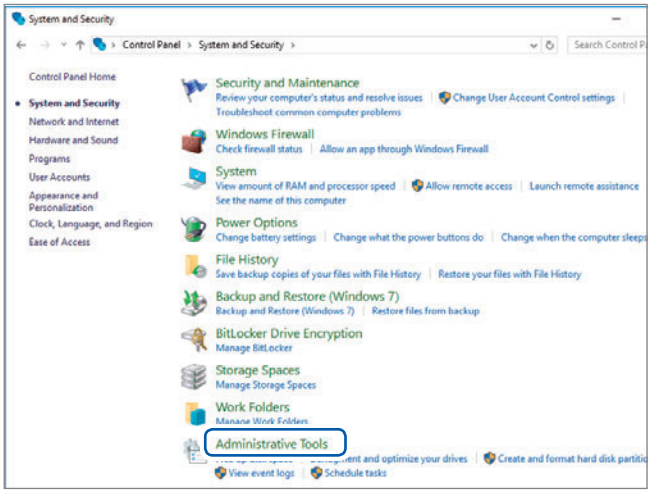
Click [+] on the left of [Web Management Tools] to expand it, and then select [IIS Management Console].

Click [OK].

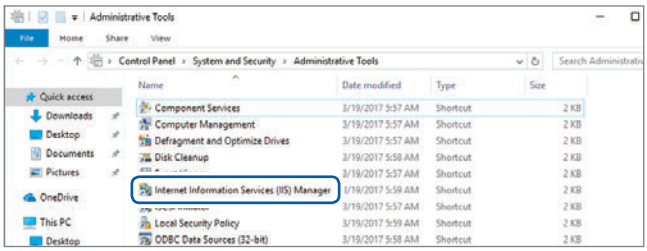
Setting up the FTP



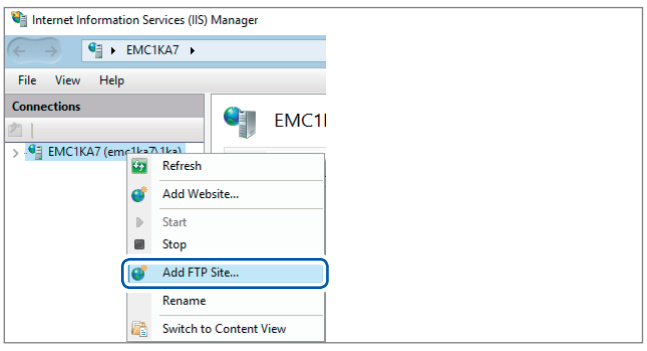
4 Click [System and Security] on [Control Panel].



5 Click [Administrative Tools].

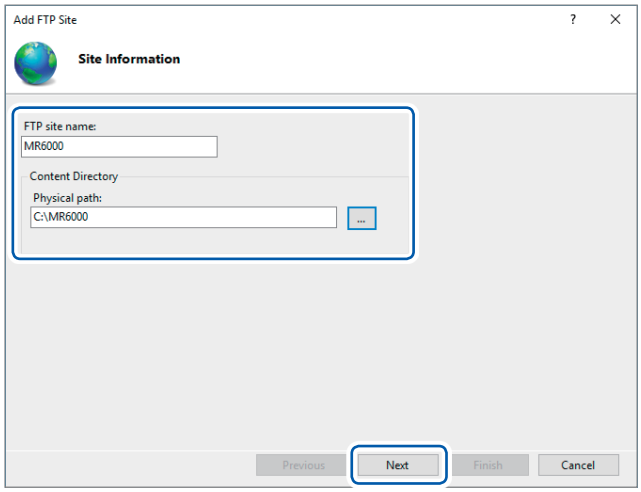


6 Double-click [Internet Information Services (IIS) Manager].



7 **Right-click on the item displayed under [Connections] on the left side of the screen to display the shortcut menu, then click [Add FTP Site].**

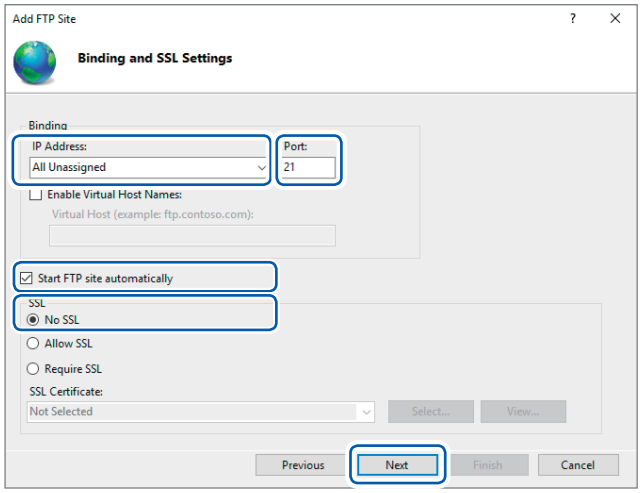
Communication may be blocked depending on the settings of the PC protecting software (example: firewall).



8 Enter the site information.

Example:
[FTP site name]: **[MR6000]**
[Content Directory]:
Specify the directory to which data from the FTP client will be saved.

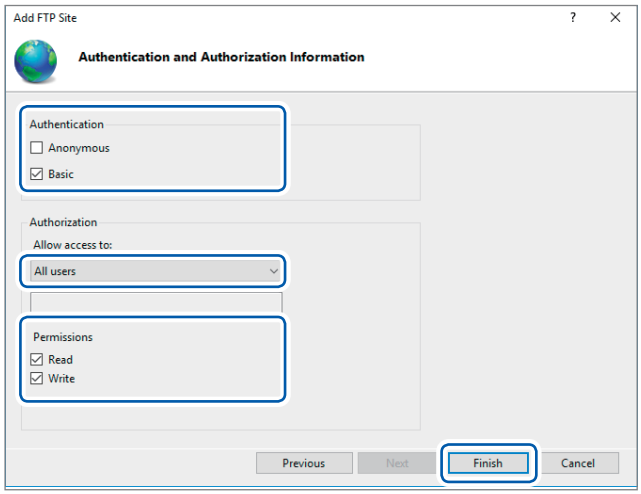
Click [Next].



9 Set [Binding] and [SSL] as follows:

[IP Address]	**[All Unassigned]**
[Port]	**[21]**
[Start FTP site automatically]	Select
[SSL]	**[No SSL]**

Click [Next].



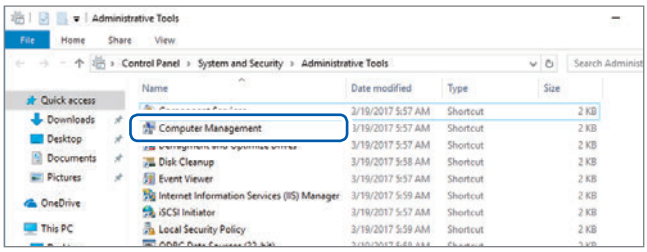
10 Set [Authentication and Authorization Information] as follows:

[Authentication]	Select **[Basic]**.
[Authorization]	**[All users]**
[Permissions]	Select both **[Read]** and **[Write]**.

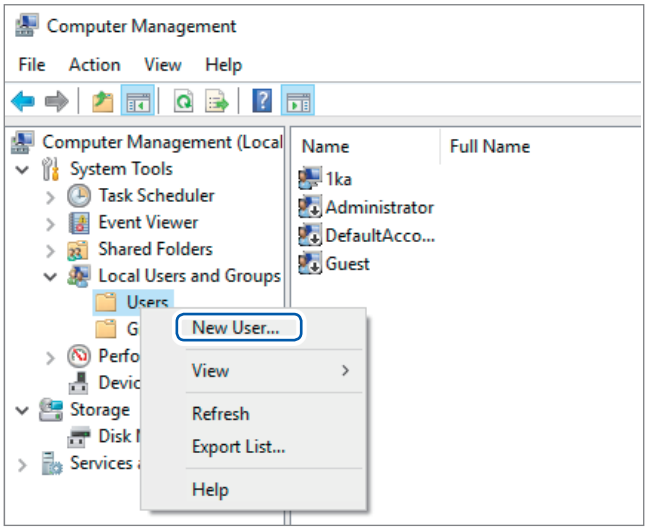
Click [Finish].

Configuring user access settings

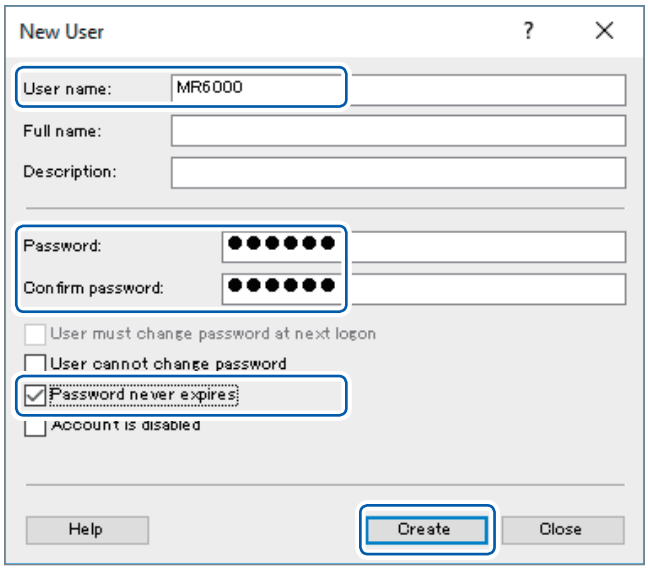
Configure this setting to use the FTP client with the instrument.
Refer to “4 Type your login name and password in the [Login] and [Password] boxes, respectively.” (p. 163).
You can use the FTP with entered **[User name]** and **[Password]**.



11 **Select [Computer Management] in [Administrative Tools] mentioned in step *5* (p. 160).**



12 **Right-click [Users] under [Local Users and Groups], then select [New User].**



13 **Type your user name, password, and the same password in the [User name], [Password], and [Confirm password] boxes, respectively, then select [Password never expires].**

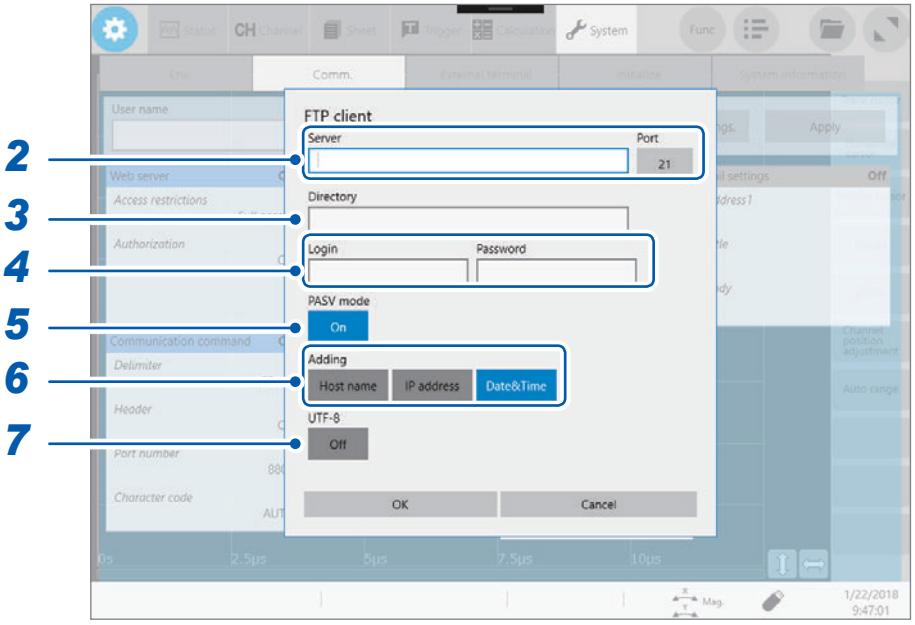
Click [Create].

Setting the FTP client with the instrument

> [System] > [Comm.]

1 Tap [FTP Client].

The settings dialog box is displayed.



2 Set [Server] and [Port].

Tap the boxes to open the touch key or the numeric input dialog box.
Type the PC name or the IP address in the **[Server]** box. In the **[Port]** box, enter the port number with which the FTP server is operating if the number is not the standard number of 21.

3 Type a directory name in the [Directory] box.

Specify the directory of the FTP server to which you would like to save the data when the data is sent.

4 Type your login name and password in the [Login] and [Password] boxes, respectively.

Type a login name and password to log in to the FTP server. Enter **[User name]** and **[Password]** entered in the FTP server setting.
Refer to “Configuring user access settings” (p. 162).

5 Set [PASV Mode].

To use **[PASV Mode]** during communication, set it to **[On]**.

6 Set [Adding].

Tap the buttons to add identifiers to the file name.

- No identifiers are added when a file is selected and sent on the file screen. Files with the same name are overwritten.
- When the **[Calculation result]** is to be saved or the file specification is set to **[Append]**, no data or time is included in the identifier. Moreover, if a file with the same name exists, the instrument tries to append the file.
- When **[Adding]** is not set, a file with the same name is overwritten. Note that all files with the same name will be overwritten if **[Date&Time]** is disabled with the continuous measurement setting and some others.

7 Set [UTF-8] to [On].

The character code UTF-8 is supported.

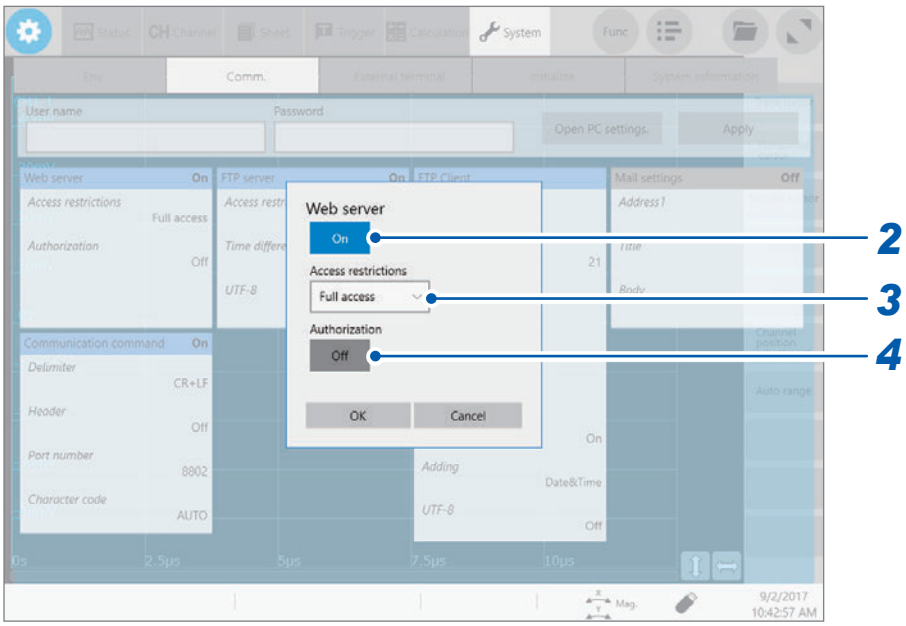
9.4 Operating the Instrument with a Browser Installed in a PC

You can configure the instrument settings, operate the instrument, and acquire data from a PC with a web browser such as Internet Explorer®. Internet Explorer® Version 8 or later is recommended.

> [System] > [Comm.]

1 **Tap [Web server].**

The settings dialog box is displayed.



2 **Set [Web server] to [On] or [Off].**

3 **Set [Access restrictions].**

Monitor only	Allows you to view only the screen/status from the browser (measured data can be acquired).
Full access☑	Allows you to operate the instrument and configure settings from the browser.

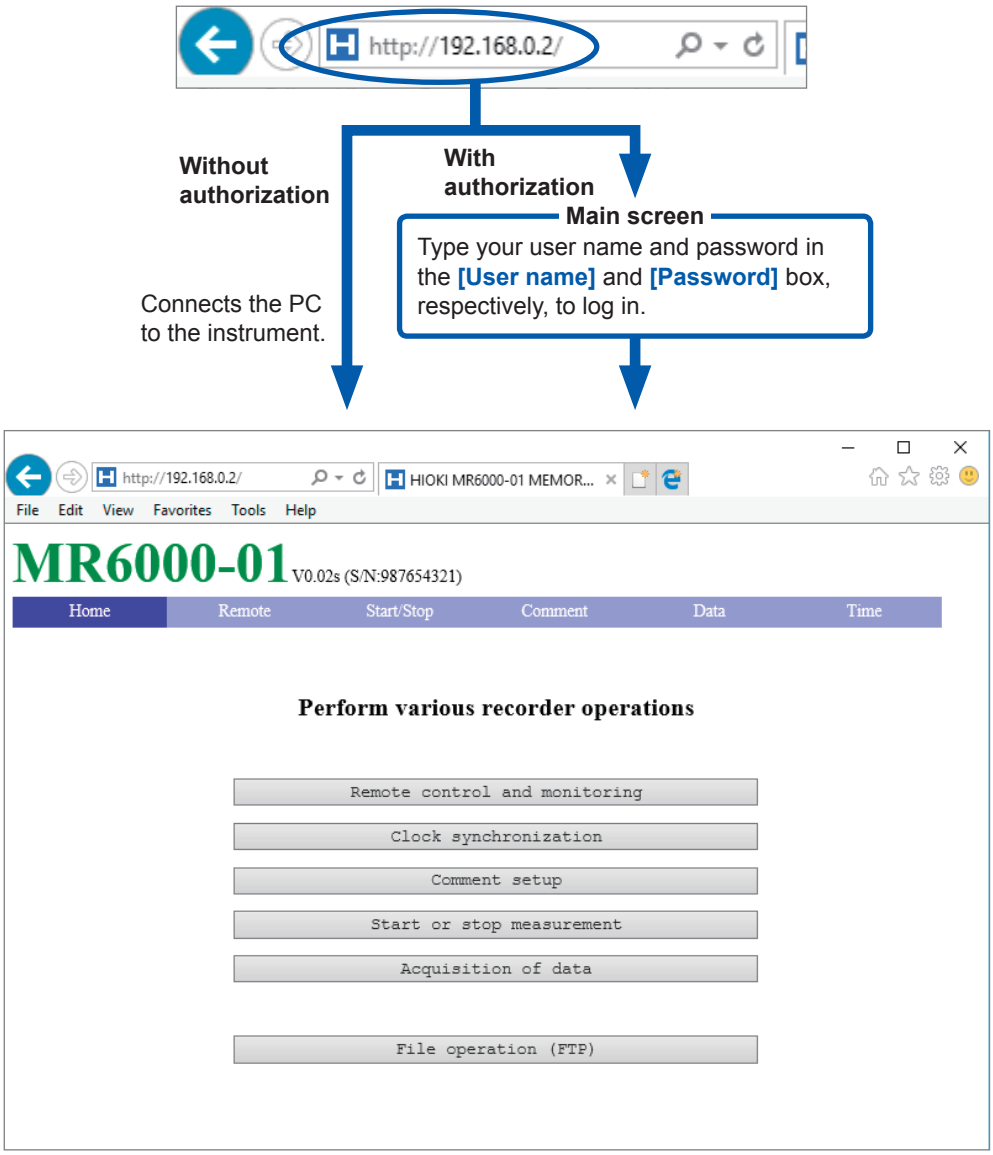
4 **Set [Authorization] to [On] or [Off].**

Off☑	Allows you to operate the instrument without the web server authentication.
On	Allows you to operate the instrument with the web server authentication.

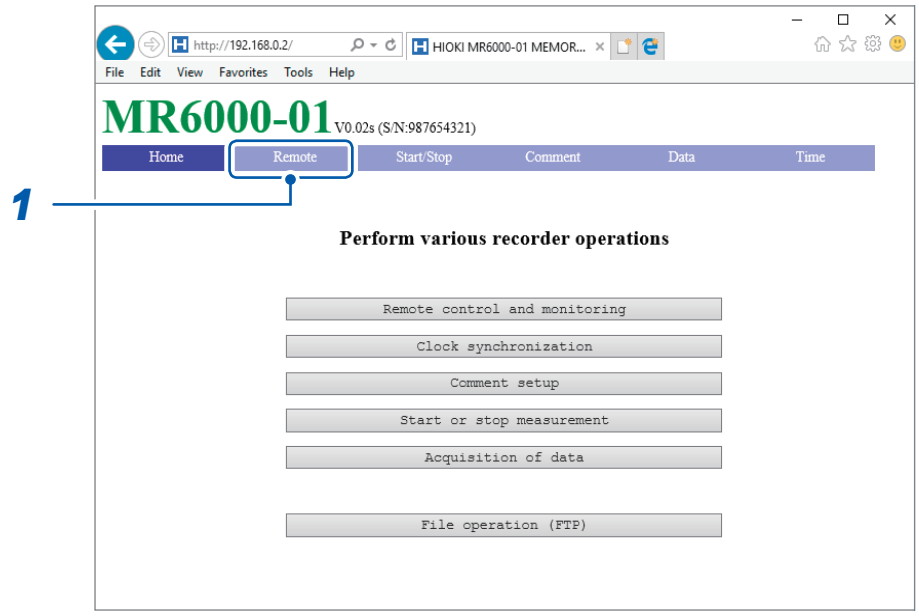
Connecting the PC to the instrument with Internet browser

The following example shows how to connect the PC to the instrument with Internet Explorer® on Windows 10.
Start Internet Explorer® on the PC and type the character string **[http://]** followed by the IP address or the PC name in the address bar.

When the IP address of the instrument is “192.168.0.2”

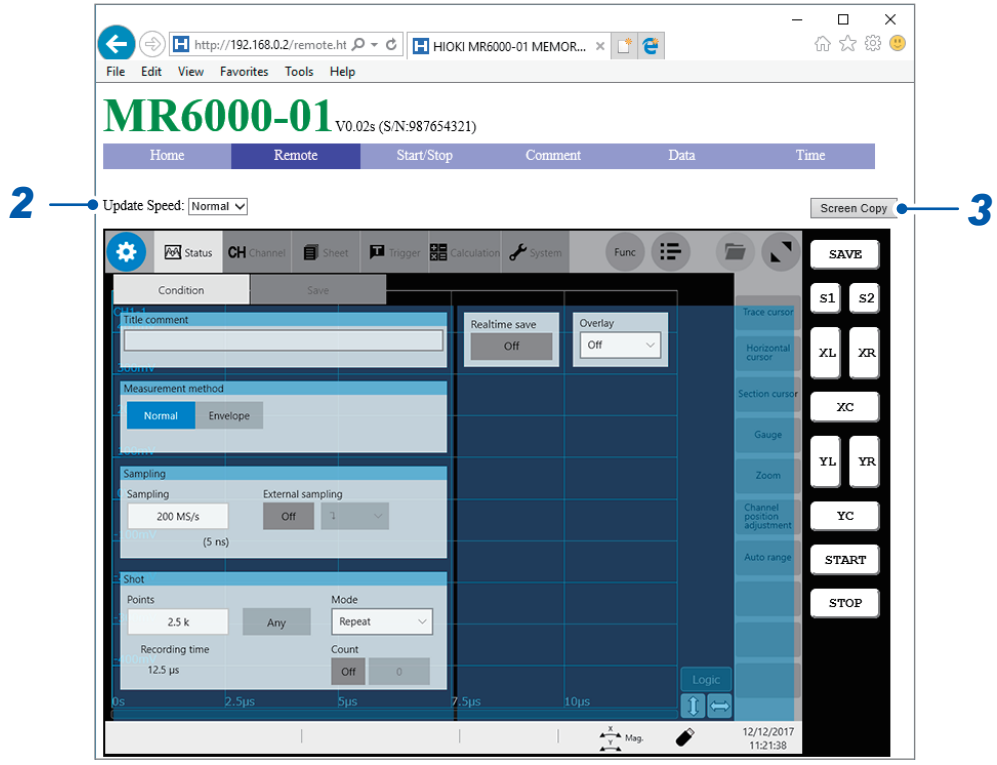


Operating the instrument remotely



1 **Click [Remote] on the menu.**

The screen switches to the remote operation screen, and the screen displayed on the instrument is displayed as it is on the browser.
The operation panel buttons conform to the buttons on the instrument. Clicking the screen with a mouse (same as tapping the screen of the instrument) allows you to operate the instrument remotely.

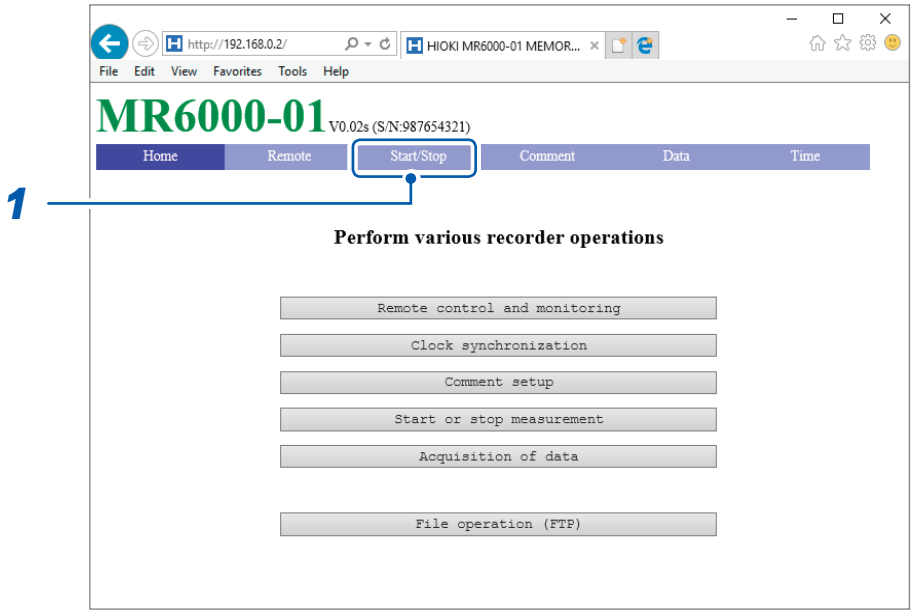


2 **Select [Update Speed].**

3 **To save a screenshot, click [Screen Copy].**

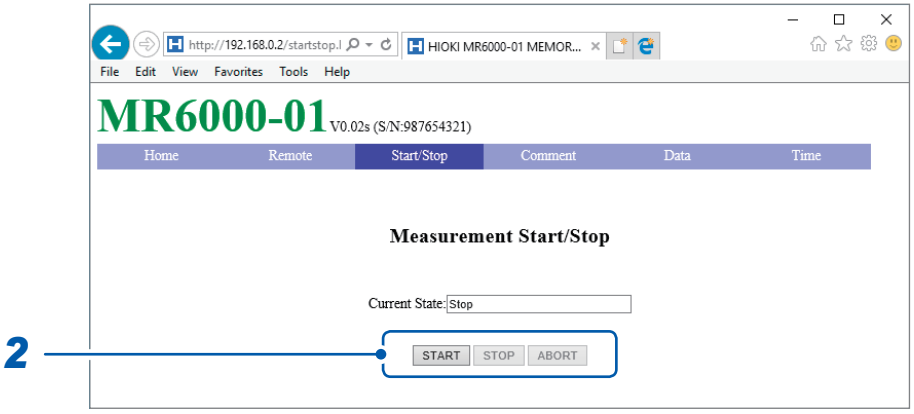
Starting/Stopping the instrument

You can start and stop the measurement remotely.



1 Click [Start/Stop] on the menu.

The **[Measurement Start/Stop]** screen is displayed.



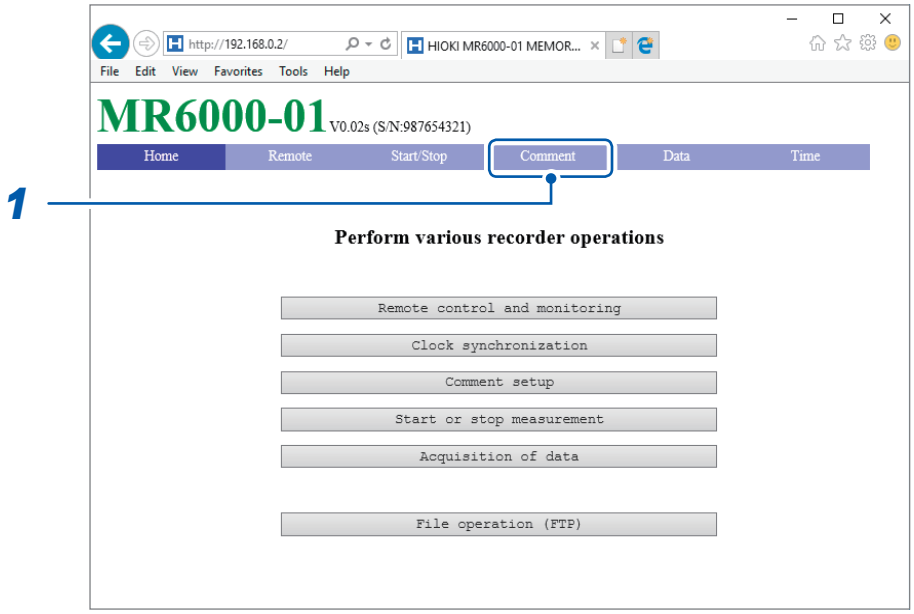
2 Select an operation.

START	Starts a measurement.
STOP	Stops the measurement.
ABORT	Stops the measurement immediately.

No post-measurement processes such as numerical calculations and automatic saving are performed.

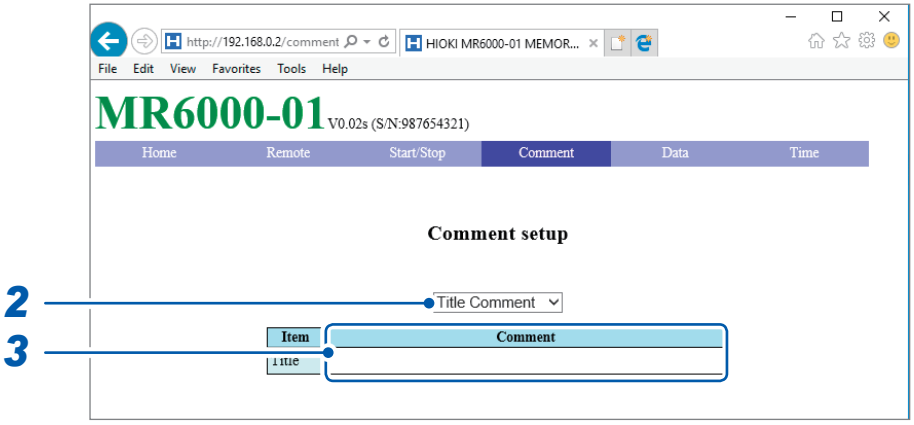
Setting the comment

You can enter a comment.



1 Click [Comment] on the menu.

The [Comment setup] screen is displayed.



2 Select the comment type.

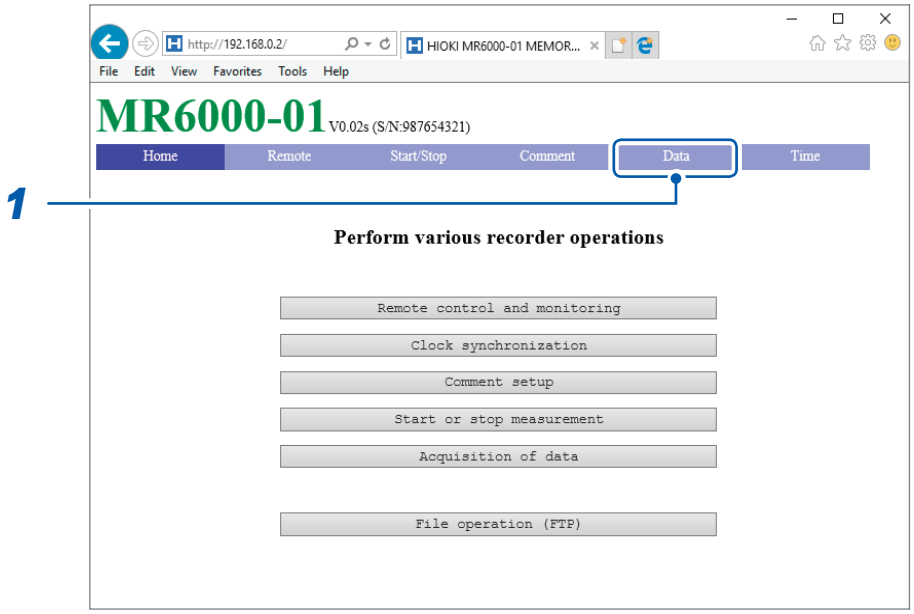
The following comments can be entered.

Title Comment☑, Analog Channel, Logic Channel, Real-time Waveform Calculation

3 Type a comment.

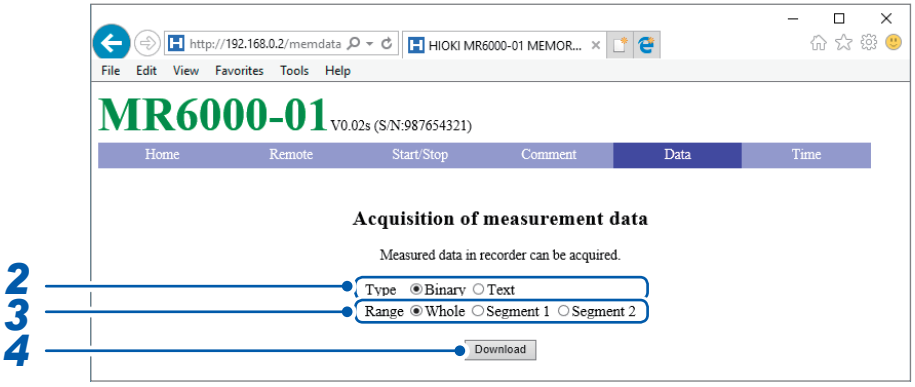
Acquiring data from the instrument

The data written in the memory of the instrument can be acquired.



1 **Click [Data] on the menu.**

The **[Acquisition of measurement data]** screen is displayed.



2 **Select a data type.**

Binary, **Text**

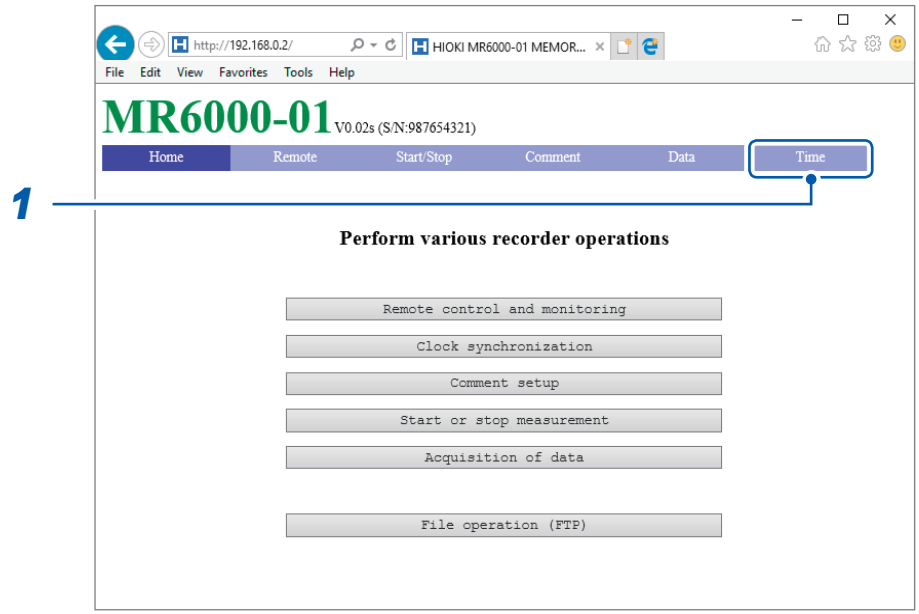
3 **Select a range of data.**

Whole, **Segment 1**, **Segment 2**

4 **Click [Download].**

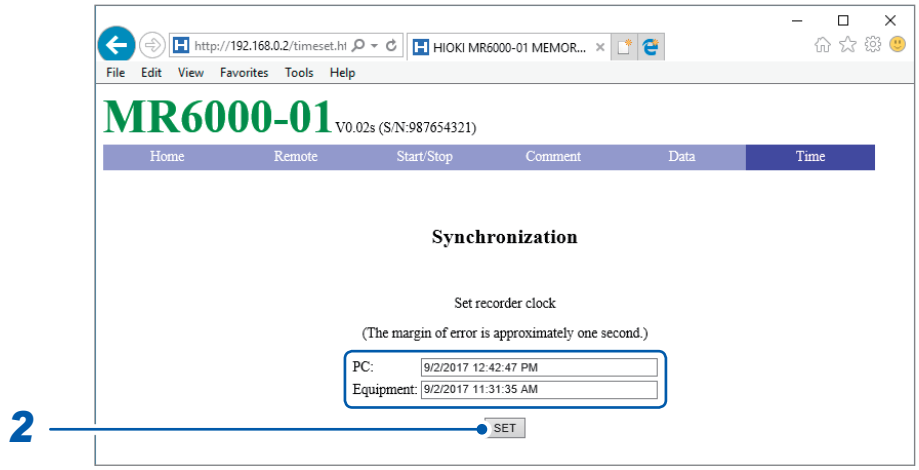
Setting the clock

The time of the clock in the PC can be set to that in the instrument. The clock cannot be set during measurement.



1 Click [Time] on the menu.

The **[Synchronization]** screen is displayed, and the time of the clock in the PC and the recorder (instrument) are displayed.



2 Click [SET].

The time of the clock in the PC is set to that in the recorder (instrument). However, errors of plus or minus one second may occur.

Handling files

Files in the instrument can be transferred.
Refer to “9.2 Managing Data in the Instrument With the FTP Server Function” (p. 155).

9.5 Sending Emails

The instrument is equipped with the email sending function. You can send emails to PCs in the network or to PCs installed in remote locations via the SMTP server. Moreover, you can install the instrument in a remote location and collect measured data through an email attachment.

Email sending method

Auto-save email	Automatically sends the email with the data saved on completion of the measurement attached, according to the auto-save settings. Configure the auto-save setting and set the save destination to **[Mail]**.
Manual email-sending with the SAVE key	When you press the SAVE key, the email with the data saved attached is automatically sent. Set the save destination of the manual-save setting to **[Mail]**.
Test email	Checks if an email is successfully sent.

Encryption of email attachments

Data attached to an email, such as screen data and measured data, which can be encrypted, can be prevented from being obtained by a third party.

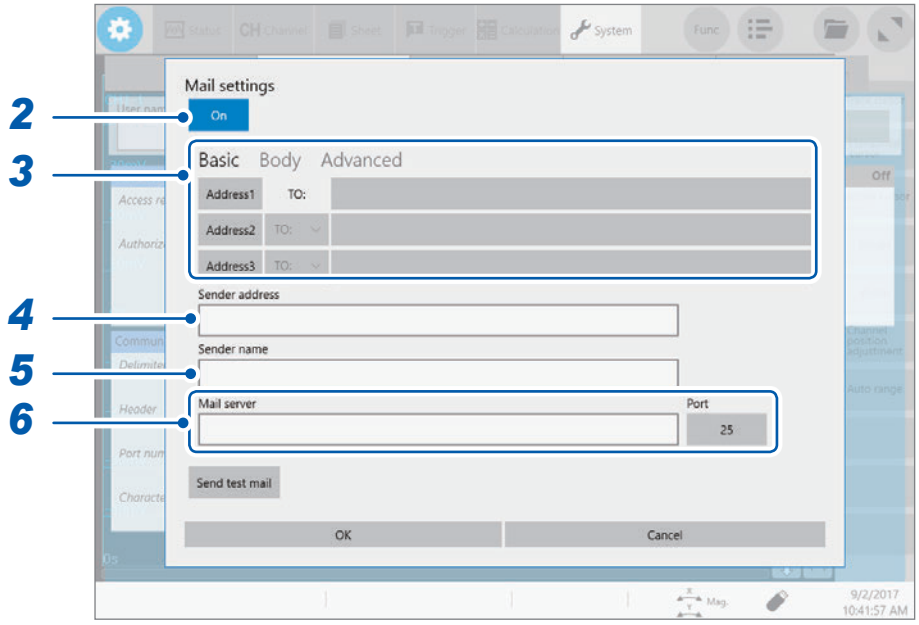
- If transmission conditions are frequently satisfied, emails will also be sent frequently.
- The data size of the email attachment may get extremely large. Depending on the email environment, the email cannot correctly be sent if the size is extremely large.
- The data of the email attachment are encrypted in ZIP format by WinZip 128-bit AE-2/AES encryption. Encrypted files can be unzipped by Corel WinZip or free software such as 7z. (The WinZip AES encryption is stronger and securer than the standard zip encryption; however, supporting software is limited. The encrypted files in this format cannot be unzipped with the built-in zip feature of Microsoft® Windows®.)
- Files are encrypted by 128-bit AES encryption. Presently, the encryption is sufficiently strong; however, Hioki does not guarantee that the files are never decrypted.
- Manage the encrypted password so that it could not be known by a third party. Note that you cannot decrypt any files if you forget your password or type an invalid password.
- When setting or changing the password, send a test email first to check whether the attached data can be unzipped before actually using it.
- Encrypted ZIP files are not compressed.
- When files are encrypted and zipped, sending time is longer due to conversion time.
- The instrument supports pop-before-smtp and smtp-auth (plain, login, cram-md5) as SMTP authentication (Since the instrument does not support IMAP, SSL, or STARTTLS, some mail servers, such as Gmail, cannot send emails).
- Transmission to all SMTP servers cannot be guaranteed due to differences among servers.
- AES is the encryption standard specified in the U.S. Federal Information Processing Standard (FIPS) PUB 197.
- The instrument can only send emails. It does not have any email receiving function.
- Compressed or encrypted data cannot be loaded as it is on the instrument or on the Wave Viewer (Wv).

Configuring the basic setting for sending email

> [System] > [Comm.]

1 **Tap [Mail settings].**

The settings dialog box is displayed.



2 **Set [Mail settings] to [On] or [Off].**

3 **Tap [Basic].**

Tap and select **[Address1]**, then type an email address in the blank box.
When emails are to be sent to multiple addresses, type email addresses in the **[Address2]** and **[Address3]** boxes in the same manner.
Specify the recipient type (**[To]** or **[Bcc]**) for **[Address2]** and **[Address3]**.

4 **Type a sender address in the [Sender address] box.**

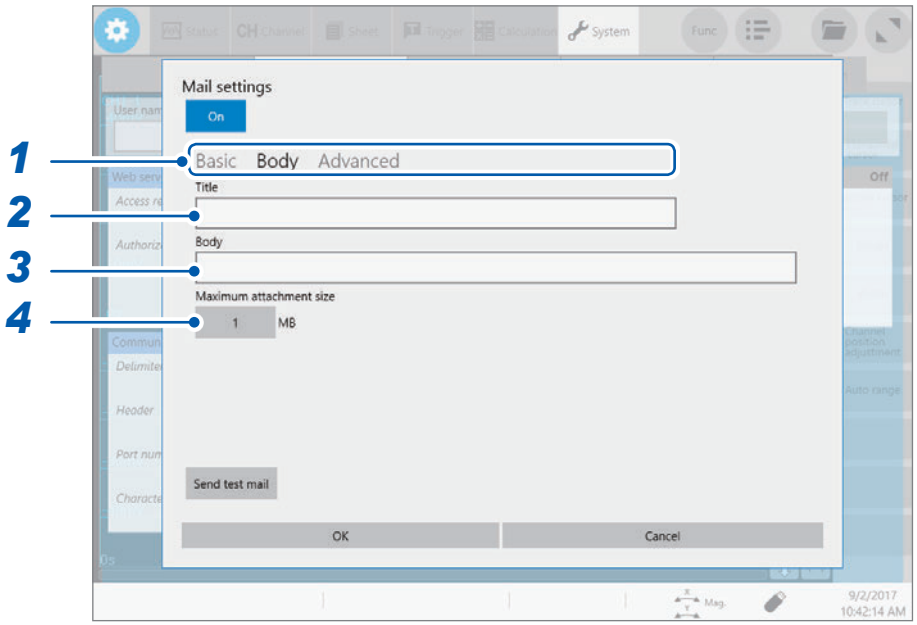
5 **Type a sender name in the [Sender name] box.**

Type a name so that the recipient identifies emails received from the instrument.

6 **Specify [Mail server] and [Port].**

Type the PC name or the IP address in the **[Mail server]** box. In the **[Port]** box, type the port number with which the SMTP server is operating if the number is not the standard number of 25.

Setting email contents



1 Tap **[Body]**.

2 Type a title in the **[Title]** box.

3 Type a body in the **[Body]** box.

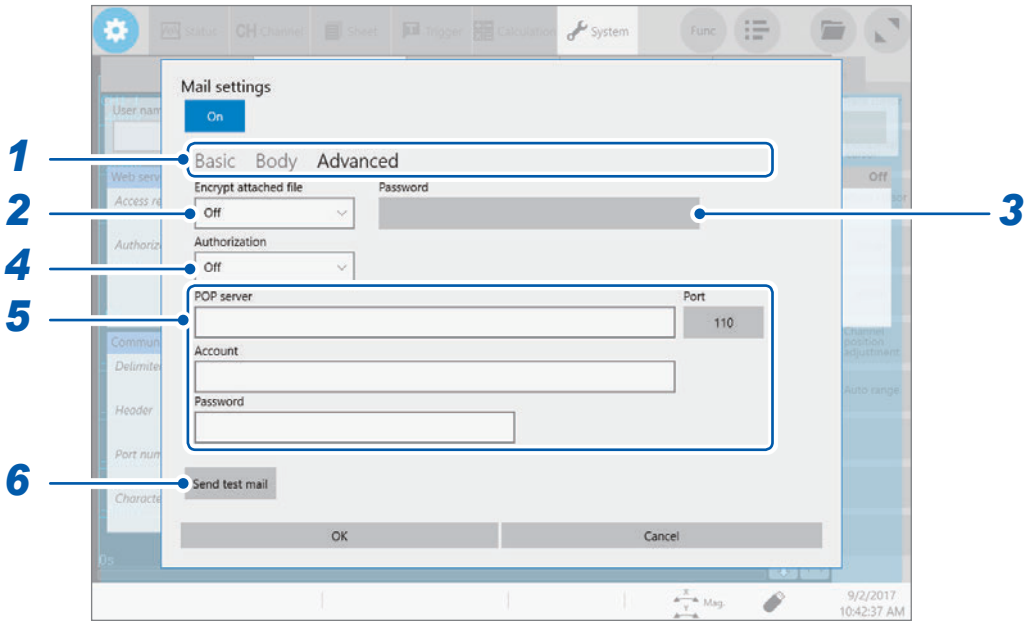
4 Set **[Maximum attachment size]**.

1☑ to 2048

Specify the maximum file size so that no large-size data is sent to the mail server. If the size of the waveform data saved automatically is larger than the specified size, no emails are sent.

- Data of less than the specified file size may also not be sent due to some server restrictions.
- Data is converted (encoded by Base64, compressed, encrypted) for attachment; however, the maximum file size is determined by the size before conversion. Thus, the actually sent data may be larger (approximately 1.3 times) than the restricted size.

Setting authentication, compression, and encryption for emails to be sent



1 **Tap [Advanced].**

2 **Set [Encrypt attached file].**

Off☑	The file is attached in unchanged format.
ZIP	The file is zip-compressed and attached.
ZIP+AES	The file is sent in encrypted ZIP format. It is not compressed.

3 **(To encrypt the attached file) Type a password in the [Password] box.**

Number of characters: up to 16

4 **(When mail authorization is required) Set [Authorization].**

Set the authorization protocol.

Off☑	Does not authorize any emails.
POP	Uses POP (APOP) before SMTP.
SMTP	Uses SMTP (supports CRAM-MD5, PLAIN, and LOGIN).

5 **Set the authorization information.**

- When **[POP]** is used
  Set **[POP server]** and **[Port]**.
  If they are left blank, the mail server address is used for transmission (usually the same).
  Type your account and password in the **[Account]** and **[Password]** boxes, respectively.

- When **[SMTP]** is used
  Set **[SMTP Server]** and **[Port]**.
  Type your account and password in the **[Account]** and **[Password]** boxes, respectively.

6 Check if the email can normally be sent.

Tap **[Send test mail]**.
A test email with specified contents is sent.
Check if the email can normally be received. If the test email is not received by the specified address, check your settings.
If encryption for the attached file is enabled, images in the test email are encrypted.
Be sure to decompress it to check whether the password is correctly set.

9.6 Controlling the Instrument with Command Communications (LAN)

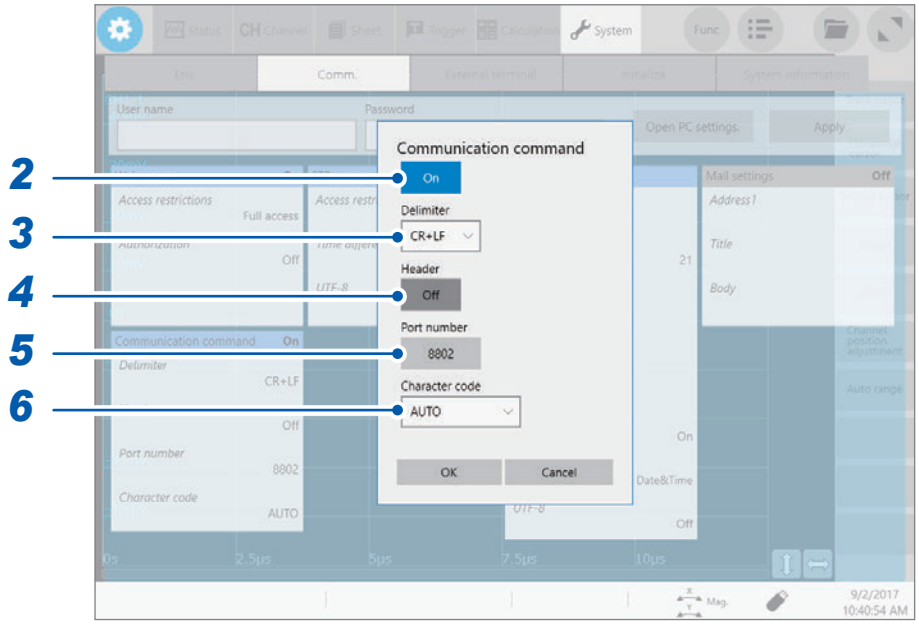
You can control the instrument remotely using commands via the communications interface. Communication is possible with a LAN connection.
For details, refer to the Communication Command Instruction Manual on the accompanying application disc.

Before using command communications, configure the LAN settings and connect the instrument. Refer to “9.1 Configuring the LAN Settings and Connecting to the Network” (p. 150).

> [System] > [Comm.]

1 **Tap [Communication command].**

The settings dialog box is displayed.



2 **Set [Communication command] to [On] or [Off].**

3 **Set [Delimiter].**

Select a character code (line feed code) indicating the data delimiter.

CR+LF☑	Sends the character codes 0x0d and 0x0a.
LF	Sends the character code 0x0a.

4 **Set [Header].**

Specifies whether to prefix the header to the command response data or not.

Off☑	Does not prefix any header to response data.
On	Prefixes the header to response data.

5 **Set [Port number].**

Specify only the most significant 3 digits of the 4-digit port number. The last digit is fixed to **[2]**.

6 **Set [Character code].**

AUTO☑	Sets the text code automatically.
SJIS	Sets the text code to SJIS.
UTF-8	Sets the text code to UTF-8.

10 Controlling the Instrument Externally

Read the section “Before connecting to an external device” in “Operation Precautions” of Quick Start Manual carefully.
Connecting the external device to external control terminal allows you to start and stop the measurement from the external device.
This chapter describes how to exchange signals through the terminals, enabling you to control the instrument externally.
The term “external control terminals” is refer to all of those terminals collectively.
Signals input into the external control terminals are valid even when the key lock function is engaged.

Refer to “2.5 Connecting the External Control Terminals” in Quick Start Manual for information on how to connect the external control terminals.

10.1 External Input and Output

External input (IN1), (IN2)

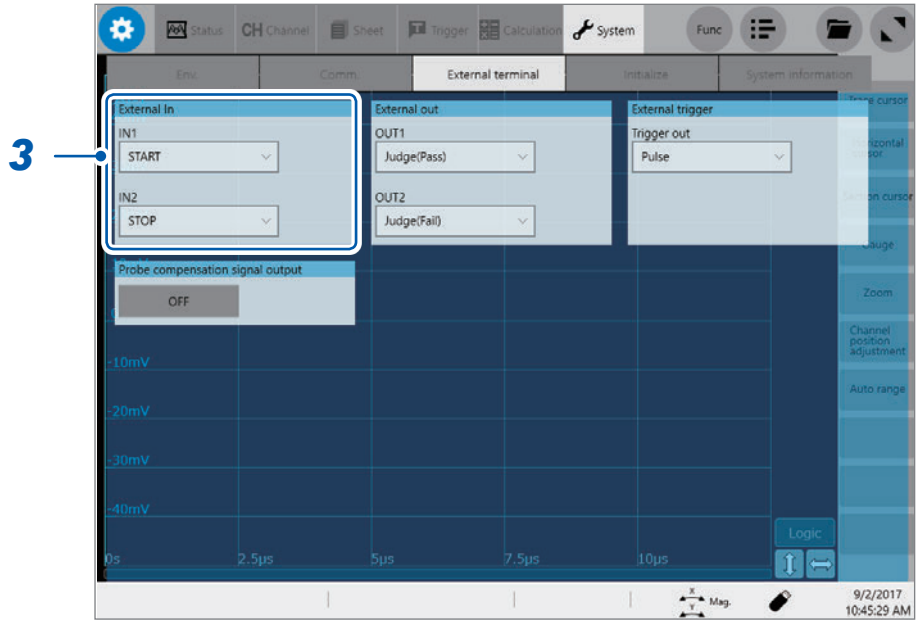
Externally inputting signals can start and stop the measurement as well as save the data. In factory default settings, the START signal is assigned to the IN1 terminal, and the Stop signal to the IN2 terminal.

Signal inputting procedure

1 Connect each of the IN1, IN2, and GND terminals to an external signal-outputting device with the wires.

Refer to “2.5 Connecting the External Control Terminals” in Quick Start Manual.

2 > **[System]** > **[External terminal]**



3 Set [External In].

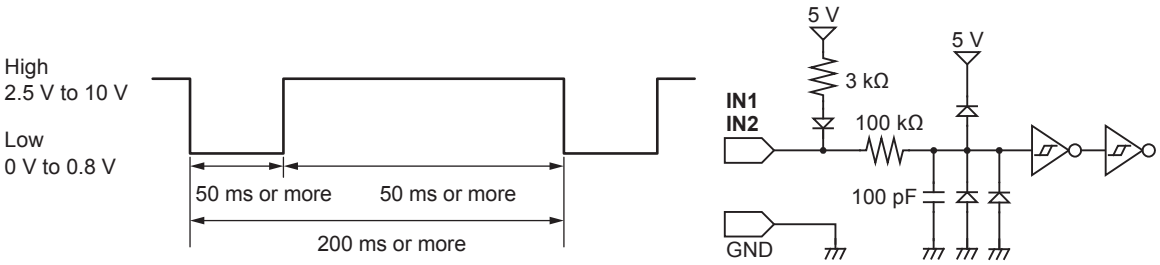
Select any two of the actions to be performed by the instrument in response to the external input signal.

START	Starts a measurement.
STOP	Stops the measurement. (Post-measurement processes such as numerical calculations and automatic saving are performed.)
START/STOP	Starts a measurement when the low-level signal is input; stops the measurement when the high-level signal is input.
SAVE	Saves the measured data on the storage device specified in **[Quick]**, which is accessible by proceeding in the following order: **[Status] > [Save] > [Save key operation] > [Quick]**
ABORT	Forcefully terminates the measurement. (No post-measurement processes such as numerical calculations or automatic saving are performed.)
EVENT	Puts on a event mark. The event marks are put on the Waveform screen. The event mark can be put by pressing the **START** key during measurement.

4 Short-circuit the terminal and GND, or input pulse waves or rectangular waves to the terminal. The signal shall be with a high-level voltage of between 2.5 V and 10 V and a low-level voltage of between 0 V and 0.8 V.

The low level of the input waveform controls the instrument.

Available voltage range	High level: 2.5 V to 10 V; Low level: 0 V to 0.8 V
Pulse width	High-level duration: 50 ms or more; Low-level duration: 50 ms or more
Pulse interval	200 ms or more
Maximum input voltage	10 V DC



External output (OUT1), (OUT2)

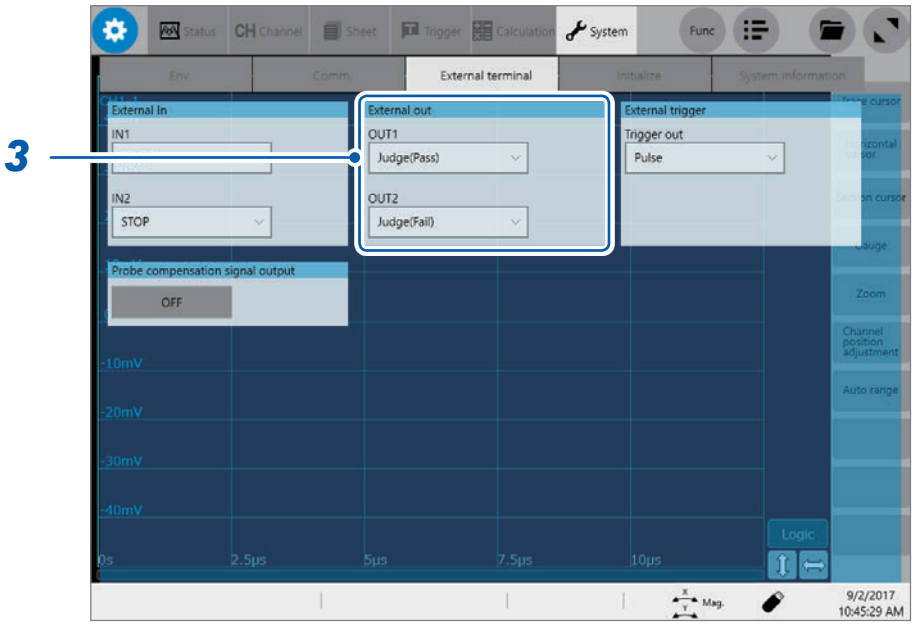
The instrument can output various signals depending on its state.

Signal outputting procedure

1 Connect each of the OUT1, OUT2, and GND terminals to an external signal-inputting device with wires.

Refer to “2.5 Connecting the External Control Terminals” in Quick Start Manual.

2 > [System] > [External terminal]



3 Set [External out].

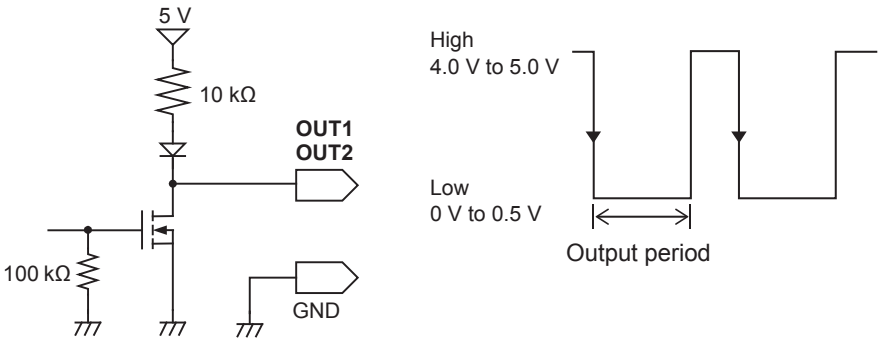
Select any two of the conditions under which the instrument outputs a signal.

Judge(Pass)	Outputs the low-level signal when a pass judgment is given to the numerical calculation result.
Judge(Fail)	Outputs the low-level signal when a fail judgment is given to the numerical calculation result.
Error	Outputs a low-level signal when an error occurs.
Busy	Outputs a low-level signal while rejecting a START signal because the instrument is in the busy state such as performing the measurement and saving the data.
Waiting trigger	Outputs a low-level signal while waiting for a trigger.

The instrument continues outputting the signal for a pass/fail judgment (low-level output) until it starts the next measurement.

The instrument can output various signals depending on its state.

Output signal	Open-drain output (with voltage output), active low	
Output voltage range	High level:	4.0 V to 5.0 V
	Low level:	0 V to 0.5 V
Maximum input voltage	50 V DC, 50 mA, 200 mW	



Trigger output (TRIG.OUT)

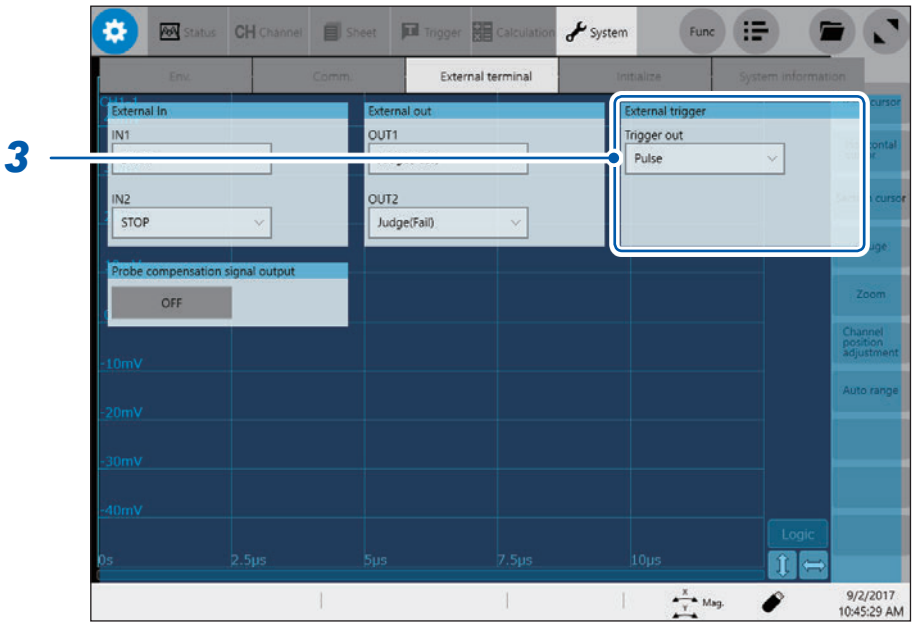
The instrument outputs the signal when it is triggered. This feature allows multiple instruments to be controlled, achieving the synchronous operation.

Signal outputting procedure

1 Connect each of the TRIG OUT and GND terminals to an external signal-inputting device with wires.

Refer to “2.5 Connecting the External Control Terminals” in Quick Start Manual.

2 > [System] > [External terminal]



3 Set [Trigger out] under [External trigger].

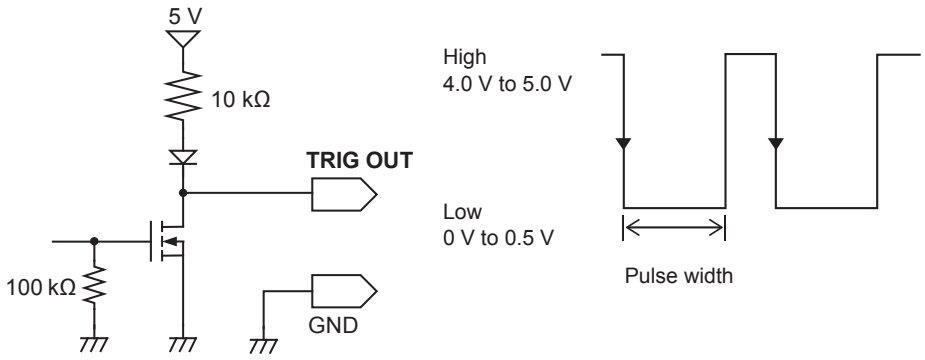
Select an output signal type for the trigger output terminal.

Pulse☑	Outputs the low-level signal, and then switches it to the high level after the specified time has elapsed.
Level	Outputs the low-level signal after triggered, continuing outputting it during the measurement.

When triggered, the instrument outputs the pulse wave, which switches from the high level (4.0 V to 5.0 V) to the low level (0 V to 0.5 V).

Output signal	Open-drain output (with voltage output), active low*	
Output voltage range	High level:	4.0 V to 5.0 V
	Low level:	0 V to 0.5 V
Pulse width	When the pulse setting is used:	2 ms ± 1 ms
	When the level setting is used:	(Sampling rate) × (Number of data points after trigger) or longer
Maximum input voltage	50 V DC, 50 mA, 200 mW	

*: The instrument is triggered when the signal voltage level switches from the high level to the low level.



When the auto-range function is used, the instrument is triggered, outputting the TRIG OUT signal. Be careful when performing auto-range measurement while using the TRIG OUT signals.

External trigger terminal (EXT.TRIG)

Externally inputting the trigger signal can trigger the instrument. This feature allows multiple instruments to be controlled, achieving the synchronous operation.

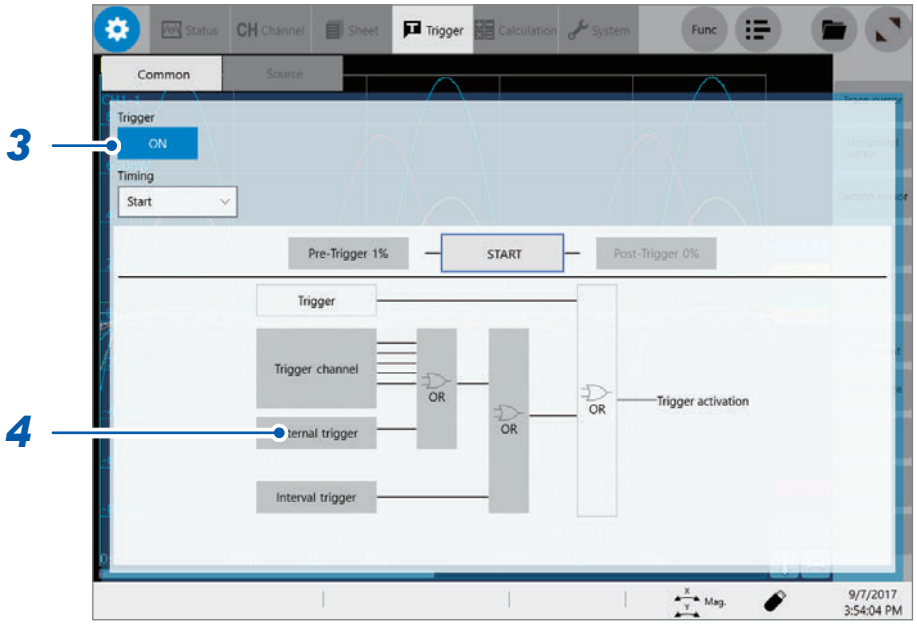
Signal inputting procedure

1 **Connect each of the EXT.TRIG and GND terminals to an external signal-outputting device with wires.**

Refer to “2.5 Connecting the External Control Terminals” in Quick Start Manual.

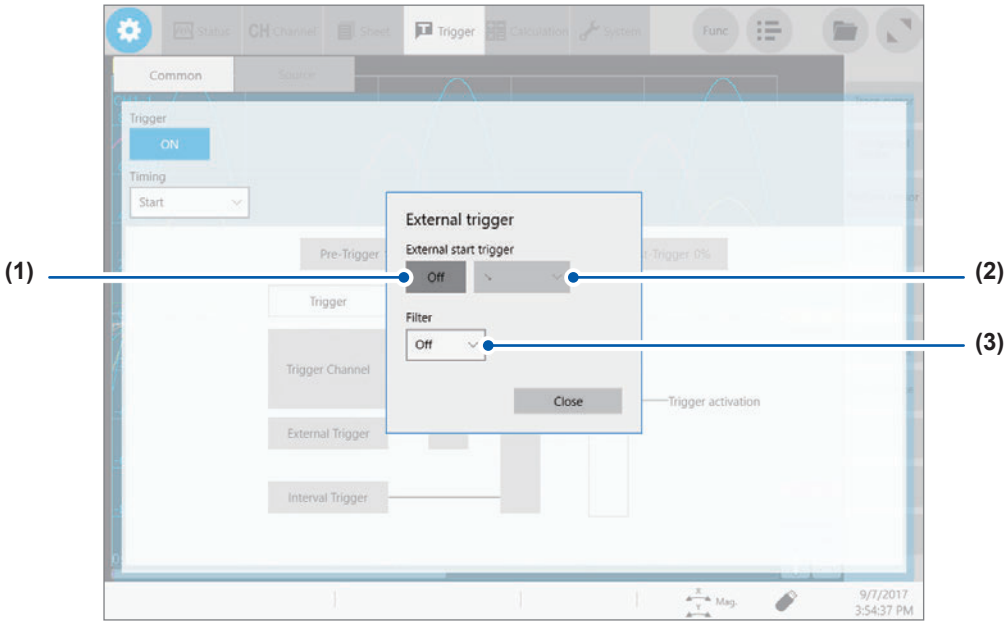
2 > **[Trigger]** > **[Common]**

3 **Set [Trigger] to [ON].**



4 Tap [External trigger].

The settings dialog box is displayed.



(1) Set [External start trigger] to [On].

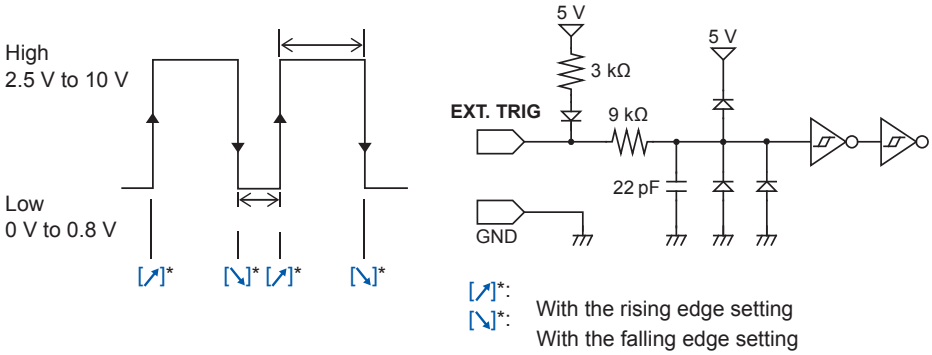
(2) Select whether the instrument accepts the external trigger on the rising edge [↗]* or falling edge [↘]* of the waveform.

(3) Set [Filter] to [On] or [Off].

5 Short-circuit the EXT.TRIG terminal and GND, or input the pulse waves or rectangular waves to the EXT.TRIG terminal. The signal shall be with a high-level voltage of between 2.5 V and 10 V and a low-level voltage of between 0 V and 0.8 V.

The instrument accepts the external trigger on the rising or falling edge of the input waveform.

Available voltage range	High level: 2.5 V to 10 V; Low level: 0 V to 0.8 V	
Pulse width	When Filter is Off	High level: 1 ms or more; Low level: 2 µs or more
	When Filter is On	High and Low level: 2.5 ms or more
Maximum input voltage	10 V DC	



*: When the trigger logical condition is set to **[AND]**, **[HIGH]** and **[LOW]** are displayed instead of **[↗]** and **[↘]**, respectively.

10.2 External Sampling (EXT.SMPL)

Externally inputting the signal can control the sampling rate.

Signal inputting procedure

1 **Connect the external sampling terminal of the instrument and the sampling signal-outputting device with the SMB cable.**
Refer to “2.4 External Sampling (EXT.SMPL)” in Quick Start Manual.

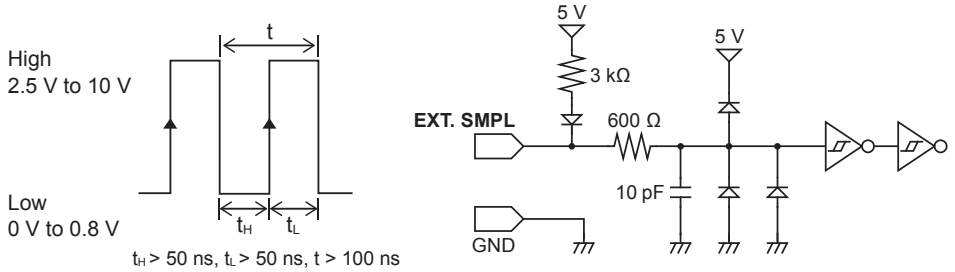
2 **> [Status] > [Condition]**

3 **Set [External sampling] to [On] or [Off].**

4 **Select a sampling signal edge ([⤴] or [⤵]).**

5 **Input the pulse waves or rectangular waves to the EXT.SMPL terminal. The signal shall be with a high-level voltage of between 2.5 V and 10 V and a low-level voltage of between 0 V and 0.8 V.**

Available voltage range	High level: 2.5 V to 10 V; Low level: 0 V to 0.8 V
Pulse width	High and low level: 50 ns or more
Response frequency	10 MHz or less
Maximum input voltage	10 V DC



- If a sampling signal of 5 MHz or more is input, trigger points are delayed by one sample.
- When Model 8968 High Resolution Unit is used, the anti-aliasing filter ([A.A.F.]) setting of [On] is invalid, which is accessible by proceeding in the following order:
  > [Channel] > [each Unit]

11 Appendix

11.1 Information for Reference Purposes

Waveform file size (for reference)

MEM file size (waveforms acquired without using the envelope)

(MEM file size) = (Setting part size) + (Data part size)
(Setting part size) = 187392 + 512 × [(Number of analog channels) + 4 × (Number of logic channels) + (Number of real-time calculation channels)]
(Data part size) = {2 × [(Number of analog channels other than Model MR8990) + (Number of logic modules)] + 4 × [(Number of Model MR8990 channels) + (Number of real-time calculation channels)]} × (Number of data points)

Recording length (Points)	Number of channels used					
	1	2	4	8	16	32
2.5 k	192 KB	198 KB	209 KB	231 KB	275 KB	363 KB
5 k	197 KB	208 KB	229 KB	271 KB	355 KB	523 KB
10 k	207 KB	228 KB	269 KB	351 KB	515 KB	843 KB
20 k	227 KB	268 KB	349 KB	511 KB	835 KB	1.5 MB
50 k	287 KB	388 KB	589 KB	991 KB	1.8 MB	3.4 MB
100 k	387 KB	588 KB	989 KB	1.8 MB	3.4 MB	6.6 MB
200 k	587 KB	988 KB	1.8 MB	3.4 MB	6.6 MB	13 MB
500 k	1.2 MB	2.2 MB	4.2 MB	8.2 MB	16.2 MB	32.2 MB
1 M	2.2 MB	4.2 MB	8.2 MB	16.2 MB	32.2 MB	64.2 MB
2 M	4.2 MB	8.2 MB	16.2 MB	32.2 MB	64.2 MB	128.2 MB
5 M	10.2 MB	20.2 MB	40.2 MB	80.2 MB	160.2 MB	320.2 MB
10 M	20.2 MB	40.2 MB	80.2 MB	160.2 MB	320.2 MB	640.2 MB
20 M	40.2 MB	80.2 MB	160.2 MB	320.2 MB	640.2 MB	1 G 280 MB
50 M	100.2 MB	200.2 MB	400.2 MB	800.2 MB	1 G 600 MB	–
100 M	200.2 MB	400.2 MB	800.2 MB	1 G 600 MB	–	–
200 M	400.2 MB	800.2 MB	1 G 600 MB	–	–	–
500 M	1 GB	2 GB	–	–	–	–
1 G	2 GB	–	–	–	–	–

- These sizes, which can be used only as a reference, of MEM files are acquired when analog channels (other than Model MR8990) are used. Any number of logic channels on one module occupies one channel; one analog channel (Model MR8990) and one real-time calculation channel occupies two channels each.
- When the size exceeds 512 MB, the file is divided into multiple files each of which has approximately 512 MB and they are saved.

REC file size (waveforms acquired by using the envelope)

(REC file size) = (Setting part size) + (Data part size)
(Setting part size) = 187392 + 512 × [(Number of analog channels) + 4 × (Number of logic channels) + (Number of real-time calculation channels)]
(Data part size) = {2 × [(Number of analog channels other than Model MR8990) + (Number of logic modules)] + 4 × [(Number of Model MR8990 channels) + (Number of real-time calculation channels)]} × (Number of data points) × 2

Recording length (Points)	Number of channels used					
	1	2	4	8	16	32
2.5 k	197 KB	208 KB	229 KB	271 KB	355 KB	523 KB
5 k	207 KB	228 KB	269 KB	351 KB	515 KB	843 KB
10 k	227 KB	268 KB	349 KB	511 KB	835 KB	1.5 MB
20 k	267 KB	348 KB	509 KB	831 KB	1.5 MB	2.8 MB
50 k	387 KB	588 KB	989 KB	1.8 MB	3.4 MB	6.6 MB
100 k	587 KB	988 KB	1.8 MB	3.4 MB	6.6 MB	13 MB
200 k	987 KB	1.8 MB	34 MB	6.6 MB	13 MB	25.8 MB
500 k	2.2 MB	4.2 MB	8.2 MB	16.2 MB	32.2 MB	64.2 MB
1 M	4.2 MB	8.2 MB	16.2 MB	32.2 MB	64.2 MB	128.2 MB
2 M	8.2 MB	16.2 MB	32.2 MB	64.2 MB	128.2 MB	256.2 MB
5 M	20.2 MB	40.2 MB	80.2 MB	160.2 MB	320.2 MB	640.2 MB
10 M	40.2 MB	80.2 MB	160.2 MB	320.2 MB	640.2 MB	1 G 280 MB
20 M	80.2 MB	160.2 MB	320.2 MB	640.2 MB	1 G 280 MB	–
50 M	200.2 MB	400.2 MB	800.2 MB	1 G 600 MB	–	–
100 M	400.2 MB	800.2 MB	1 G 600 MB	–	–	–
200 M	800.2 MB	1 G 600 MB	–	–	–	–
500 M	2 GB	–	–	–	–	–

- These sizes, which can be used only as a reference, of REC files are acquired when analog channels (other than Model MR8990) are used. Any number of logic channels on one module occupies one channel; one analog channel (Model MR8990) and one real-time calculation channel occupies two channels each.
- When the size exceeds 512 MB, the file is divided into multiple files each of which has approximately 512 MB and they are saved.

Waveform (text) file size

File size of waveforms acquired without using the envelope

(Text file size) = (Header part size) + (Data part size)
(Header part size) = Maximum of 14 KB (varies depending on the setting condition)
(Data part size) = [24 + 14 × (Number of analog channels) + 32 × (Number of logic modules) + 14 × (Number of real-time calculation channels)] × (Number of data points)

Recording length (Points)	Number of channels used					
	1	2	4	8	16	32
2.5 k	235 KB	270 KB	340 KB	480 KB	760 KB	1.4 MB
5 k	330 KB	400 KB	540 KB	820 KB	1.4 MB	2.5 MB
10 k	520 KB	660 KB	940 KB	1.5 MB	2.7 MB	4.9 MB
20 k	900 KB	1.2 MB	1.8 MB	2.9 MB	5.1 MB	9.6 MB
50 k	2 MB	2.8 MB	4.2 MB	7 MB	12.6 MB	23.8 MB
100 k	4 MB	5.4 MB	8.2 MB	13.8 MB	25 MB	47.4 MB
200 k	7.8 MB	10.6 MB	16.2 MB	27.4 MB	49.8 MB	94.6 MB
500 k	19.2 MB	26.2 MB	40.2 MB	68.2 MB	124.2 MB	236.2 MB
1 M	38.2 MB	52.2 MB	80.2 MB	136.2 MB	248.2 MB	472.2 MB
2 M	76.2 MB	104.2 MB	160.2 MB	272.2 MB	496.2 MB	944.2 MB
5 M	190.2 MB	260.2 MB	400.2 MB	680.2 MB	1 G 240 MB	2 G 360 MB
10 M	380.2 MB	520.2 MB	800.2 MB	1 G 360 MB	2 G 480 MB	4 G 720 MB
20 M	760.2 MB	1 G 40 MB	1 G 600 MB	2 G 720 MB	4 G 960 MB	9 G 440 MB
50 M	1 G 900 MB	2 G 600 MB	4 GB	6 G 800 MB	12 G 400 MB	–
100 M	3 G 800 MB	5 G 200 MB	8 GB	13 G 600 MB	–	–
200 M	7 G 600 MB	10 G 400 MB	16 GB	–	–	–
500 M	19 GB	26 GB	–	–	–	–
1 G	38 GB	–	–	–	–	–

- These sizes, which can be used only as a reference, of text files are acquired when analog channels (other than Model MR8990) are used.
- Depending on the setting condition, the size may slightly differ from those provided in the above table. Allow a 20% margin of the size provided in the above table.
- When the size exceeds 512 MB, the file is divided into multiple files each of which has approximately 512 MB and they are saved.

File size of waveforms acquired by using the envelope

(Text file size) = (Header part size) + (Data part size)
(Header part size) = Maximum of 14 KB (varies depending on the set condition)
(Data part size) = {24 + [14 × (Number of analog channels) + 32 × (Number of logic modules) + 14 × (Number of real-time calculation channels) × 2} × (Number of data points)

Recording length (Points)	Number of channels used					
	1	2	4	8	16	32
2.5 k	270 KB	340 KB	480 KB	760 KB	1.4 MB	2.5 MB
5 k	400 KB	540 KB	820 KB	1.4 MB	2.5 MB	4.8 MB
10 k	660 KB	940 KB	1.5 MB	2.7 MB	4.9 MB	9.4 MB
20 k	1.2 MB	1.8 MB	2.9 MB	5.1 MB	9.6 MB	18.6 MB
50 k	2.8 MB	4.2 MB	7 MB	12.6 MB	23.8 MB	46.2 MB
100 k	5.4 MB	8.2 MB	13.8 MB	25 MB	47.4 MB	92.2 MB
200 k	10.6 MB	16.2 MB	27.4 MB	49.8 MB	94.6 MB	184.2 MB
500 k	26.2 MB	40.2 MB	68.2 MB	124.2 MB	236.2 MB	460.2 MB
1 M	52.2 MB	80.2 MB	136.2 MB	248.2 MB	472.2 MB	920.2 MB
2 M	104.2 MB	160.2 MB	272.2 MB	496.2 MB	944.2 MB	1 G 840 MB
5 M	260.2 MB	400.2 MB	680.2 MB	1 G 240 MB	2 G 360 MB	4 G 600 MB
10 M	520.2 MB	800.2 MB	1 G 360 MB	2 G 480 MB	4 G 720 MB	9 G 200 MB
20 M	1 G 40 MB	1 G 600 MB	2 G 720 MB	4 G 960 MB	9 G 440 MB	–
50 M	2 G 600 MB	4 GB	6 G 800 MB	12 G 400 MB	–	–
100 M	5 G 200 MB	8 GB	13 G 600 MB	–	–	–
200 M	10 G 400 MB	16 GB	–	–	–	–
500 M	26 GB	–	–	–	–	–

- These sizes, which can be used only as a reference, of text files are acquired when analog channels (other than Model MR8990) are used.
- Depending on the setting condition, the size may slightly differ from those provided in the above table. Allow a 20% margin of the size provided in the above table.
- When the size exceeds 512 MB, the file is divided into multiple files each of which has approximately 512 MB and they are saved.

Maximum recording time when the real-time save is on (reference)

The maximum recording time is expressed in the following formula.

(Max. recording time) = [(Recording capacity) × (Sampling time)] ÷ [(Number of channels used) × 2]

(Number of channels used) = [(Number of analog channels other than Model MR8990) + (Number of logic modules) + (Number of Model MR8990 channels)] × 2 + (Number of real-time calculation channels) × 2

The maximum recording times for saving data to each storage device are shown in the following table (assume that each storage device is empty). Since the capacity of the header of the waveform file is not included, use about 90% of the recording time provided in the table as a reference. Depending on the condition, the recording time can be set to a long term (1 year or more); however, we cannot guarantee operation if the term exceeds the guarantee period or product life.

For saving data acquired without using the envelope on Model U8332 SSD Unit

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
20 MS/s	53 min 20 s	–	–	–	–
10 MS/s	1 h 46 min 40 s	53 min 20 s	–	–	–
5 MS/s	3 h 33 min 20 s	1 h 46 min 40 s	53 min 20 s	–	–
2 MS/s	8 h 53 min 20 s	4 h 26 min 40 s	2 h 13 min 20 s	1 h 6 min 40 s	–
1 MS/s	17 h 46 min 40 s	8 h 53 min 20 s	4 h 26 min 40 s	2 h 13 min 20 s	1 h 6 min 40 s
500 kS/s	1 d 11 h 33 min 20 s	17 h 46 min 40 s	8 h 53 min 20 s	4 h 26 min 40 s	2 h 13 min 20 s
200 kS/s	3 d 16 h 53 min 20 s	1 d 20 h 26 min 40 s	22 h 13 min 20 s	11 h 6 min 40 s	5 h 33 min 20 s
100 kS/s	7 d 9 h 46 min 40 s	3 d 16 h 53 min 20 s	1 d 20 h 26 min 40 s	22 h 13 min 20 s	11 h 6 min 40 s
50 kS/s	14 d 19 h 33 min 20 s	7 d 9 h 46 min 40 s	3 d 16 h 53 min 20 s	1 d 20 h 26 min 40 s	22 h 13 min 20 s
20 kS/s	37 d 0 h 53 min 20 s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s	4 d 15 h 6 min 40 s	2 d 7 h 33 min 20 s
10 kS/s	74 d 1 h 46 min 40 s	37 d 0 h 53 min 20 s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s	4 d 15 h 6 min 40 s
5 kS/s	148 d 3 h 33 min 20 s	74 d 1 h 46 min 40 s	37 d 0 h 53 min 20 s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s
2 kS/s	370 d 8 h 53 min 20 s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s	46 d 7 h 6 min 40 s	23 d 3 h 33 min 20 s
1 kS/s	740 d 17 h 46 min 40 s	370 d 8 h 53 min 20 s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s	46 d 7 h 6 min 40 s
500 S/s	1481 d 11 h 33 min 20 s	740 d 17 h 46 min 40 s	370 d 8 h 53 min 20 s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s
200 S/s	3703 d 16 h 53 min 20 s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s	462 d 23 h 6 min 40 s	231 d 11 h 33 min 20 s
100 S/s	7407 d 9 h 46 min 40 s	3703 d 16 h 53 min 20 s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s	462 d 23 h 6 min 40 s
50 S/s	10000 d	7407 d 9 h 46 min 40 s	3703 d 16 h 53 min 20 s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s
20 S/s	10000 d	10000 d	9259 d 6 h 13 min 20 s	4629 d 15 h 6 min 40 s	2314 d 19 h 33 min 20 s
10 S/s	10000 d	10000 d	10000 d	9259 d 6 h 13 min 20 s	4629 d 15 h 6 min 40 s
5 S/s	10000 d	10000 d	10000 d	10000 d	9259 d 6 h 13 min 20 s
2 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/s	10000 d	10000 d	10000 d	10000 d	10000 d

For saving data acquired without using the envelope on Model U8333 HDD Unit

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
10 MS/s	2 h 12 min 48 s	–	–	–	–
5 MS/s	4 h 25 min 36 s	2 h 12 min 48 s	–	–	–
2 MS/s	11 h 4 min 0 s	5 h 32 min 0 s	2 h 46 min 0 s	–	–
1 MS/s	22 h 8 min 1 s	11 h 4 min 0 s	5 h 32 min 0 s	2 h 46 min 0 s	–
500 kS/s	1 d 20 h 16 min 3 s	22 h 8 min 1 s	11 h 4 min 0 s	5 h 32 min 0 s	2 h 46 min 0 s
200 kS/s	4 d 14 h 40 min 8 s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s	13 h 50 min 1 s	6 h 55 min 0 s
100 kS/s	9 d 5 h 20 min 17 s	4 d 14 h 40 min 8 s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s	13 h 50 min 1 s
50 kS/s	18 d 10 h 40 min 35 s	9 d 5 h 20 min 17 s	4 d 14 h 40 min 8 s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s
20 kS/s	46 d 2 h 41 min 29 s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s	5 d 18 h 20 min 11 s	2 d 21 h 10 min 5 s
10 kS/s	92 d 5 h 22 min 59 s	46 d 2 h 41 min 29 s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s	5 d 18 h 20 min 11 s
5 kS/s	184 d 10 h 45 min 59 s	92 d 5 h 22 min 59 s	46 d 2 h 41 min 29 s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s
2 kS/s	461 d 2 h 54 min 57 s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s	57 d 15 h 21 min 52 s	28 d 19 h 40 min 56 s
1 kS/s	922 d 5 h 49 min 55 s	461 d 2 h 54 min 57 s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s	57 d 15 h 21 min 52 s
500 S/s	1844 d 11 h 39 min 50 s	922 d 5 h 49 min 55 s	461 d 2 h 54 min 57 s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s
200 S/s	4611 d 5 h 9 min 35 s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s	576 d 9 h 38 min 41 s	288 d 4 h 49 min 20 s
100 S/s	9222 d 10 h 19 min 10 s	4611 d 5 h 9 min 35 s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s	576 d 9 h 38 min 41 s
50 S/s	10000 d	9222 d 10 h 19 min 10 s	4611 d 5 h 9 min 35 s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s
20 S/s	10000 d	10000 d	10000 d	5764 d 0 h 26 min 59 s	2882 d 0 h 13 min 29 s
10 S/s	10000 d	10000 d	10000 d	10000 d	5764 d 0 h 26 min 59 s
5 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
2 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/s	10000 d	10000 d	10000 d	10000 d	10000 d

For saving data acquired without using the envelope on Model Z4006 USB Drive

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
5 MS/s	13 min 25 s	–	–	–	–
2 MS/s	33 min 32 s	16 min 46 s	–	–	–
1 MS/s	1 h 7 min 5 s	33 min 32 s	16 min 46 s	–	–
500 kS/s	2 h 14 min 10 s	1 h 7 min 5 s	33 min 32 s	16 min 46 s	–
200 kS/s	5 h 35 min 26 s	2 h 47 min 43 s	1 h 23 min 51 s	41 min 55 s	20 min 57 s
100 kS/s	11 h 10 min 53 s	5 h 35 min 26 s	2 h 47 min 43 s	1 h 23 min 51 s	41 min 55 s
50 kS/s	22 h 21 min 47 s	11 h 10 min 53 s	5 h 35 min 26 s	2 h 47 min 43 s	1 h 23 min 51 s
20 kS/s	2 d 7 h 54 min 28 s	1 d 3 h 57 min 14 s	13 h 58 min 37 s	6 h 59 min 18 s	3 h 29 min 39 s
10 kS/s	4 d 15 h 48 min 57 s	2 d 7 h 54 min 28 s	1 d 3 h 57 min 14 s	13 h 58 min 37 s	6 h 59 min 18 s
5 kS/s	9 d 7 h 37 min 55 s	4 d 15 h 48 min 57 s	2 d 7 h 54 min 28 s	1 d 3 h 57 min 14 s	13 h 58 min 37 s
2 kS/s	23 d 7 h 4 min 49 s	11 d 15 h 32 min 24 s	5 d 19 h 46 min 12 s	2 d 21 h 53 min 6 s	1 d 10 h 56 min 33 s
1 kS/s	46 d 14 h 9 min 38 s	23 d 7 h 4 min 49 s	11 d 15 h 32 min 24 s	5 d 19 h 46 min 12 s	2 d 21 h 53 min 6 s
500 S/s	93 d 4 h 19 min 17 s	46 d 14 h 9 min 38 s	23 d 7 h 4 min 49 s	11 d 15 h 32 min 24 s	5 d 19 h 46 min 12 s
200 S/s	232 d 22 h 48 min 14 s	116 d 11 h 24 min 7 s	58 d 5 h 42 min 3 s	29 d 2 h 51 min 1 s	14 d 13 h 25 min 30 s
100 S/s	465 d 21 h 36 min 28 s	232 d 22 h 48 min 14 s	116 d 11 h 24 min 7 s	58 d 5 h 42 min 3 s	29 d 2 h 51 min 1 s
50 S/s	931 d 19 h 12 min 56 s	465 d 21 h 36 min 28 s	232 d 22 h 48 min 14 s	116 d 11 h 24 min 7 s	58 d 5 h 42 min 3 s
20 S/s	2329 d 12 h 2 min 20 s	1164 d 18 h 1 min 10 s	582 d 9 h 0 min 35 s	291 d 4 h 30 min 17 s	145 d 14 h 15 min 8 s
10 S/s	4659 d 0 h 4 min 41 s	2329 d 12 h 2 min 20 s	1164 d 18 h 1 min 10 s	582 d 9 h 0 min 35 s	291 d 4 h 30 min 17 s
5 S/s	9318 d 0 h 9 min 23 s	4659 d 0 h 4 min 41 s	2329 d 12 h 2 min 20 s	1164 d 18 h 1 min 10 s	582 d 9 h 0 min 35 s
2 S/s	10000 d	10000 d	5823 d 18 h 5 min 52 s	2911 d 21 h 2 min 56 s	1455 d 22 h 31 min 28 s
1 S/s	10000 d	10000 d	10000 d	5823 d 18 h 5 min 52 s	2911 d 21 h 2 min 56 s

- When saving data in Model Z4003 SD memory card, consider the recording time to be about 1/2 of the time provided in the above table as a reference.
- When saving data in Model Z4001 SD memory card, consider the recording to be about 1/8 of the time provided in the above table as a reference.

For saving data acquired by using the envelope on Model U8332 SSD Unit

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
10 MS/s	53 min 20 s	–	–	–	–
5 MS/s	1 h 46 min 40 s	53 min 20 s	–	–	–
2 MS/s	4 h 26 min 40 s	2 h 13 min 20 s	1 h 6 min 40 s	–	–
1 MS/s	8 h 53 min 20 s	4 h 26 min 40 s	2 h 13 min 20 s	1 h 6 min 40 s	–
500 kS/s	17 h 46 min 40 s	8 h 53 min 20 s	4 h 26 min 40 s	2 h 13 min 20 s	1 h 6 min 40 s
200 kS/s	1 d 20 h 26 min 40 s	22 h 13 min 20 s	11 h 6 min 40 s	5 h 33 min 20 s	2 h 46 min 40 s
100 kS/s	3 d 16 h 53 min 20 s	1 d 20 h 26 min 40 s	22 h 13 min 20 s	11 h 6 min 40 s	5 h 33 min 20 s
50 kS/s	7 d 9 h 46 min 40 s	3 d 16 h 53 min 20 s	1 d 20 h 26 min 40 s	22 h 13 min 20 s	11 h 6 min 40 s
20 kS/s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s	4 d 15 h 6 min 40 s	2 d 7 h 33 min 20 s	1 d 3 h 46 min 40 s
10 kS/s	37 d 0 h 53 min 20 s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s	4 d 15 h 6 min 40 s	2 d 7 h 33 min 20 s
5 kS/s	74 d 1 h 46 min 40 s	37 d 0 h 53 min 20 s	18 d 12 h 26 min 40 s	9 d 6 h 13 min 20 s	4 d 15 h 6 min 40 s
2 kS/s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s	46 d 7 h 6 min 40 s	23 d 3 h 33 min 20 s	11 d 13 h 46 min 40 s
1 kS/s	370 d 8 h 53 min 20 s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s	46 d 7 h 6 min 40 s	23 d 3 h 33 min 20 s
500 S/s	740 d 17 h 46 min 40 s	370 d 8 h 53 min 20 s	185 d 4 h 26 min 40 s	92 d 14 h 13 min 20 s	46 d 7 h 6 min 40 s
200 S/s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s	462 d 23 h 6 min 40 s	231 d 11 h 33 min 20 s	115 d 17 h 46 min 40 s
100 S/s	3703 d 16 h 53 min 20 s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s	462 d 23 h 6 min 40 s	231 d 11 h 33 min 20 s
50 S/s	7407 d 9 h 46 min 40 s	3703 d 16 h 53 min 20 s	1851 d 20 h 26 min 40 s	925 d 22 h 13 min 20 s	462 d 23 h 6 min 40 s
20 S/s	10000 d	9259 d 6 h 13 min 20 s	4629 d 15 h 6 min 40 s	2314 d 19 h 33 min 20 s	1157 d 9 h 46 min 40 s
10 S/s	10000 d	10000 d	9259 d 6 h 13 min 20 s	4629 d 15 h 6 min 40 s	2314 d 19 h 33 min 20 s
5 S/s	10000 d	10000 d	10000 d	9259 d 6 h 13 min 20 s	4629 d 15 h 6 min 40 s
2 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
30 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
12 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
6 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
2 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/min	10000 d	10000 d	10000 d	10000 d	10000 d

For saving data acquired by using the envelope on Model U8333 HDD Unit

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
5 MS/s	2 h 12 min 48 s	–	–	–	–
2 MS/s	5 h 32 min 0 s	2 h 46 min 0 s	–	–	–
1 MS/s	11 h 4 min 0 s	5 h 32 min 0 s	2 h 46 min 0 s	–	–
500 kS/s	22 h 8 min 1 s	11 h 4 min 0 s	5 h 32 min 0 s	2 h 46 min 0 s	–
200 kS/s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s	13 h 50 min 1 s	6 h 55 min 0 s	3 h 27 min 30 s
100 kS/s	4 d 14 h 40 min 8 s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s	13 h 50 min 1 s	6 h 55 min 0 s
50 kS/s	9 d 5 h 20 min 17 s	4 d 14 h 40 min 8 s	2 d 7 h 20 min 4 s	1 d 3 h 40 min 2 s	13 h 50 min 1 s
20 kS/s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s	5 d 18 h 20 min 11 s	2 d 21 h 10 min 5 s	1 d 10 h 35 min 2 s
10 kS/s	46 d 2 h 41 min 29 s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s	5 d 18 h 20 min 11 s	2 d 21 h 10 min 5 s
5 kS/s	92 d 5 h 22 min 59 s	46 d 2 h 41 min 29 s	23 d 1 h 20 min 44 s	11 d 12 h 40 min 22 s	5 d 18 h 20 min 11 s
2 kS/s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s	57 d 15 h 21 min 52 s	28 d 19 h 40 min 56 s	14 d 9 h 50 min 28 s
1 kS/s	461 d 2 h 54 min 57 s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s	57 d 15 h 21 min 52 s	28 d 19 h 40 min 56 s
500 S/s	922 d 5 h 49 min 55 s	461 d 2 h 54 min 57 s	230 d 13 h 27 min 28 s	115 d 6 h 43 min 44 s	57 d 15 h 21 min 52 s
200 S/s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s	576 d 9 h 38 min 41 s	288 d 4 h 49 min 20 s	144 d 2 h 24 min 40 s
100 S/s	4611 d 5 h 9 min 35 s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s	576 d 9 h 38 min 41 s	288 d 4 h 49 min 20 s
50 S/s	9222 d 10 h 19 min 10 s	4611 d 5 h 9 min 35 s	2305 d 14 h 34 min 47 s	1152 d 19 h 17 min 23 s	576 d 9 h 38 min 41 s
20 S/s	10000 d	10000 d	5764 d 0 h 26 min 59 s	2882 d 0 h 13 min 29 s	1441 d 0 h 6 min 44 s
10 S/s	10000 d	10000 d	10000 d	5764 d 0 h 26 min 59 s	2882 d 0 h 13 min 29 s
5 S/s	10000 d	10000 d	10000 d	10000 d	5764 d 0 h 26 min 59 s
2 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/s	10000 d	10000 d	10000 d	10000 d	10000 d
30 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
12 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
6 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
2 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/min	10000 d	10000 d	10000 d	10000 d	10000 d

For saving data acquired by using the envelope on Model Z4006 USB Drive

d: days, h: hours, min: minutes, s: seconds

Sampling rate	Number of channels used				
	2	4	8	16	32
2 MS/s	17 m 53 s	–	–	–	–
1 MS/s	35 m 47 s	17 m 53 s	–	–	–
500 kS/s	1 h 11 m 34 s	35 m 47 s	17 m 53 s	–	–
200 kS/s	2 h 58 m 57 s	1 h 29 m 28 s	44 m 44 s	22 m 22 s	–
100 kS/s	5 h 57 m 54 s	2 h 58 m 57 s	1 h 29 m 28 s	44 m 44 s	22 m 22 s
50 kS/s	11 h 55 m 49 s	5 h 57 m 54 s	2 h 58 m 57 s	1 h 29 m 28 s	44 m 44 s
20 kS/s	1 d 5 h 49 m 34 s	14 h 54 m 47 s	7 h 27 m 23 s	3 h 43 m 41 s	1 h 51 m 50 s
10 kS/s	2 d 11 h 39 m 8 s	1 d 5 h 49 m 34 s	14 h 54 m 47 s	7 h 27 m 23 s	3 h 43 m 41 s
5 kS/s	4 d 23 h 18 m 16 s	2 d 11 h 39 m 8 s	1 d 5 h 49 m 34 s	14 h 54 m 47 s	7 h 27 m 23 s
2 kS/s	12 d 10 h 15 m 41 s	6 d 5 h 7 m 50 s	3 d 2 h 33 m 55 s	1 d 13 h 16 m 57 s	18 h 38 m 28 s
1 kS/s	24 d 20 h 31 m 23 s	12 d 10 h 15 m 41 s	6 d 5 h 7 m 50 s	3 d 2 h 33 m 55 s	1 d 13 h 16 m 57 s
500 S/s	49 d 17 h 2 m 47 s	24 d 20 h 31 m 23 s	12 d 10 h 15 m 41 s	6 d 5 h 7 m 50 s	3 d 2 h 33 m 55 s
200 S/s	124 d 6 h 36 m 58 s	62 d 3 h 18 m 29 s	31 d 1 h 39 m 14 s	15 d 12 h 49 m 37 s	7 d 18 h 24 m 48 s
100 S/s	248 d 13 h 13 m 56 s	124 d 6 h 36 m 58 s	62 d 3 h 18 m 29 s	31 d 1 h 39 m 14 s	15 d 12 h 49 m 37 s
50 S/s	497 d 2 h 27 m 52 s	248 d 13 h 13 m 56 s	124 d 6 h 36 m 58 s	62 d 3 h 18 m 29 s	31 d 1 h 39 m 14 s
20 S/s	1242 d 18 h 9 m 42 s	621 d 9 h 4 m 51 s	310 d 16 h 32 m 25 s	155 d 8 h 16 m 12 s	77 d 16 h 8 m 6 s
10 S/s	2485 d 12 h 19 m 24 s	1242 d 18 h 9 m 42 s	621 d 9 h 4 m 51 s	310 d 16 h 32 m 25 s	155 d 8 h 16 m 12 s
5 S/s	4971 d 0 h 38 m 49 s	2485 d 12 h 19 m 24 s	1242 d 18 h 9 m 42 s	621 d 9 h 4 m 51 s	310 d 16 h 32 m 25 s
2 S/s	10000 d	6213 d 18 h 48 m 32 s	3106 d 21 h 24 m 16 s	1553 d 10 h 42 m 8 s	776 d 17 h 21 m 4 s
1 S/s	10000 d	10000 d	6213 d 18 h 48 m 32 s	3106 d 21 h 24 m 16 s	1553 d 10 h 42 m 8 s
30 S/min	10000 d	10000 d	10000 d	6213 d 18 h 48 m 32 s	3106 d 21 h 24 m 16 s
12 S/min	10000 d	10000 d	10000 d	10000 d	7767 d 5 h 30 m 40 s
6 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
2 S/min	10000 d	10000 d	10000 d	10000 d	10000 d
1 S/min	10000 d	10000 d	10000 d	10000 d	10000 d

- When saving data in Model Z4003 SD memory card, consider the recording to be about 1/2 of the time provided in the above table as a reference.
- When saving data in Model Z4001 SD memory card, consider the recording to be about 1/8 of the time provided in the above table as a reference.

Scaling method for strain gauges

This section describes how to determine the scaling conversion ratio when measurement is performed with strain gauges and Model U8969 Strain Unit.
The appropriate conversion formula into stress varies depending on how the strain gauges are used.
There are 3 methods: the 1-gauge, 2-gauge, and 4-gauge methods. The 2-gauge method is used for measurement involving temperature compensation.

E: Young's modulus, ν: Poisson's ratio, ε: Measured value of the strain gauge

Measuring tensile and compressive stress: Stress (σ) = E × ε

When measurement is performed involving temperature compensation with 2 or 4 gauges, position the gauges perpendicularly to each other.
Stress (σ) is multiplied by 1 / (1 + ν) for the 2-gauge method, and 1 / {2 (1 + ν)} for the 4-gauge method.

Measuring bending stress: Stress (σ) = E × ε

When the measurement is performed involving temperature compensation with 2 or 4 gauges, stress (σ) is multiplied by 1/2 or 1/4, respectively.

Measuring torsional stress: Stress (σ) = E / [2 (1 + ν)] × ε (with 2 gauges)

When the 4-gauge method is used, stress is halved.

Refer to the strain gauge instruction manual for combining strain gauges for each measurement.

Example: Measuring compressive stress
Using the 1-gauge method; material of measured object: aluminum; Young's modulus: 73 (GPa) (Refer to the table below.)
$\sigma = 73 \times 10^{9} \times$ (Measured value) $\times 10^{-6}$ [unit of measured value: $\mu\varepsilon$]
= 73 × (Measured value) [unit: kPa]
= 7.44* × (Measured value) [unit: gf/mm^2]
*: 1 Pa = 1.01971621 × 10^{-7} kgf/mm^2 = 1 N/m^2

Conversion ratio: 7.44; unit: gf/mm^2
Enter this value as the scaling conversion ratio.

Mechanical properties of industrial materials

Material	Modulus of longitudinal elasticity (Young's modulus)	Poisson's ratio
	E (GPa)	ν
Carbon steel (Carbon content: 0.1% to 0.25%)	205	0.28 to 0.3
Carbon steel (Carbon content: less than 0.25%)	206	0.28 to 0.3
Spring steel (Quenched)	206 to 211	0.28 to 0.3
Nickel steel	205	0.28 to 0.3
Cast iron	98	0.2 to 0.29
Brass (Cast)	78	0.34
Phosphor bronze	118	0.38
Aluminum	73	0.34
Concrete	20 to 29	0.1

Refer to "3.2 Converting Input Values (Scaling Function)" (p. 42).

Example of a waveform text file

The waveform text file consists of a header and data.
The header includes the following information:

(1) Title comment
(2) Recording length, sampling rate, trigger time
(3) Channel number, module type, measurement range, LPF, channel comment, scaling (setting, conversion ratio, offset), invert

Example of a saved file (data acquired without using the envelope)

```
"Title comment"..... (1)
"Rec length","Sampling","Trigger Time"
"2500 sample","1MS/s","17/09/20 16:42:07.044" ..... (2)

"Channel","Mode","Range(f.s.)","L.P.F.","Comment","Scaling","Ratio","Offset","Invert"
"CH1-1","VOLTAGE","10V","OFF","Analog 1-1","OFF","-","-","OFF" ..... (3)
"CH1-2","VOLTAGE","100mV","OFF","Analog 1-2","OFF","-","-","OFF"
"CH2-1","K","200^cC","---","Temperature 1","ON(SCI)","2.1568E+00","4.9874E+00","OFF"
"CH2-2","K","200^cC","---","Temperature 2","OFF","-","-","ON"
"CH3-1","VOLTAGE","10V","---","Digital Voltmeter Unit 3-1","ON(ENG)","2.4178E+00","1.0254E+01","OFF"
"CH3-2","VOLTAGE","10V","---","Digital Voltmeter Unit 3-2","OFF","-","-","ON"
"L4 A1","-","-","-","4LA1","-","-","-","-"
"L4 A2","-","-","-","4LA2","-","-","-","-"
"L4 A3","-","-","-","4LA3","-","-","-","-"
"L4 A4","-","-","-","4LA4","-","-","-","-"

"Time[s]","CH1-1[V]","CH1-2[V]","CH2-1[^cC]","CH2-2[^cC]","CH3-1[V]","CH3-2[V]","L4A1","L4A2","L4A3","L4A4"
+0.000000000E+00,+1.510000E+00,-3.000000E-04,+3.997600E+02,+3.997600E+02,-9.997559E-03,-9.340576E-02,1,1,1,1
+1.000000000E-06,+1.510000E+00,-2.500000E-04,+3.997600E+02,+3.997600E+02,-9.997559E-03,-9.340576E-02,1,1,1,1
+2.000000000E-06,+1.495000E+00,+2.000000E-04,+3.997600E+02,+3.997600E+02,-9.997559E-03,-9.340576E-02,1,1,1,1
+3.000000000E-06,+1.440000E+00,+3.500000E-04,+3.997600E+02,+3.997600E+02,-9.997559E-03,-9.340576E-02,1,1,1,1
+4.000000000E-06,+1.430000E+00,+2.000000E-04,+3.997600E+02,+3.997600E+02,-9.997559E-03,-9.340576E-02,1,1,1,1
```

Index

Symbol

0-9

A

B

C

D

E

F

G

H

I

L

M

N

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P

Q

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S

T

U

V

W

X

Z

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