

HIOKI

MR8740T

MR8740-50

Instruction Manual

MEMORY HiCORDER

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EN



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Introduction

Thank you for choosing the Hioki MR8740T Memory HiCorder. Preserve this manual carefully and keep it handy to make full use of this instrument for a long time.

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	–	✓

Notations

*	Additional information is presented below.
☑	Indicates the initial setting values of the items. Initializing the instrument restores settings to each of these values.
(p.)	Indicates the location of reference information.
START (Bold-faced)	Names and keys on the screen are shown 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) values, with the following meanings:

f.s.	(maximum display value or scale length) The maximum displayable value or scale length.
rdg.	(displayed value) The value currently being measured and displayed on the measuring instrument.
setting	(setting value) Indicates the value set as the output voltage, current, or other quantity.

How to Refer to This Document

How to open a screen

Indicates the order of clicking the screens.

The button  represents the setting key.

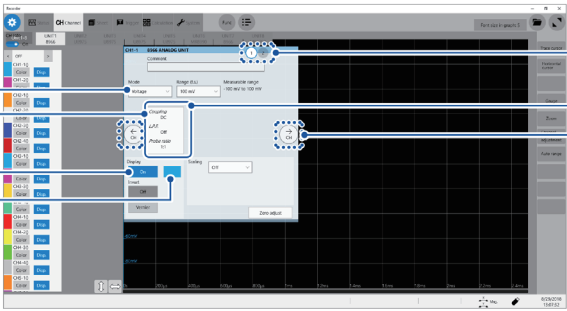
Procedure numbers


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

Options and explanations

Describes selectable settings when an item is clicked.

The icon indicates the default setting of the item.



 > [Channel] > [UNIT]

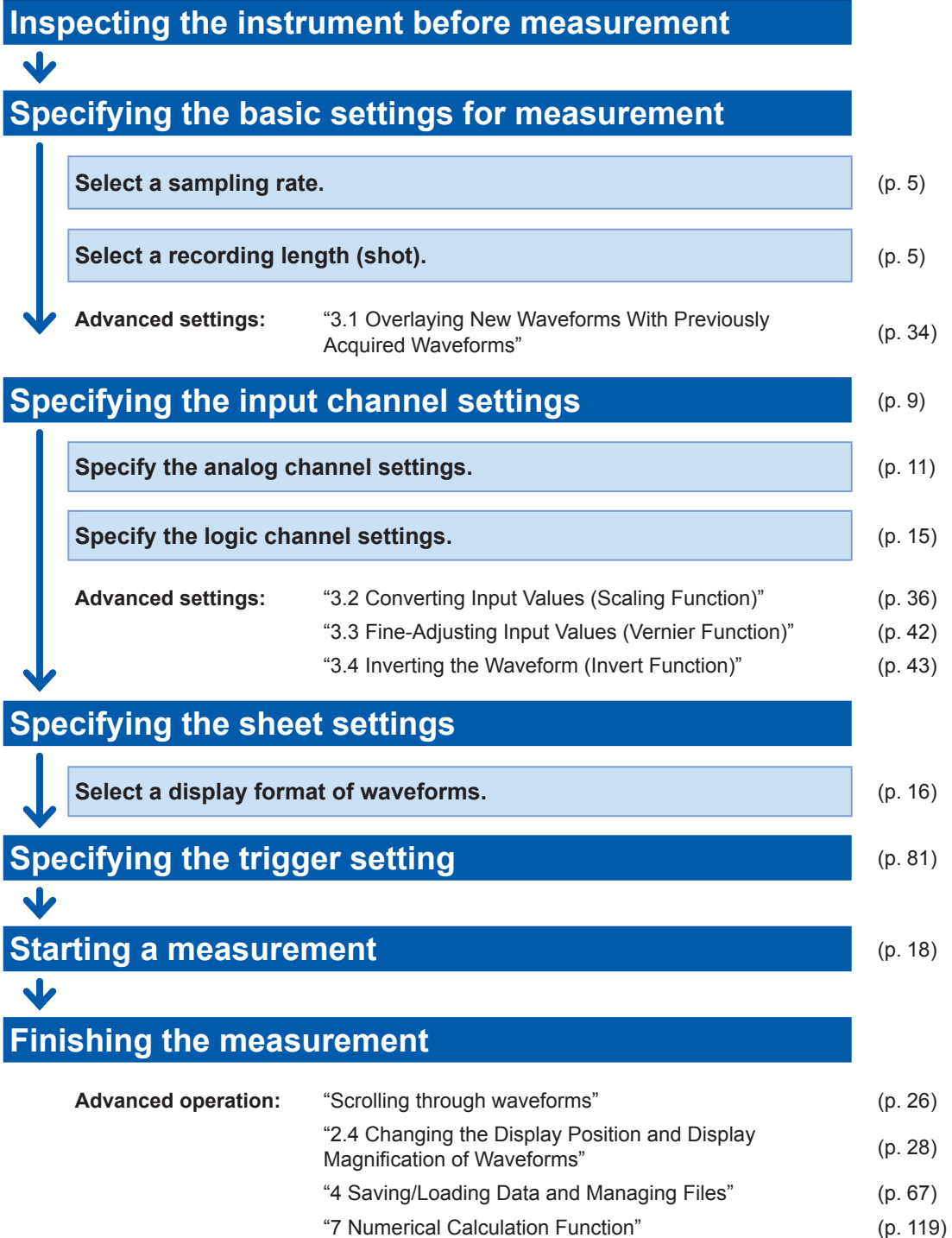
- 1 Type a comment in [Comment].
Number of characters that can be entered: up to 40
- 2 Select a measurement mode in [Mode].

Voltage ^{ES}	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 Specifying Module-Specific Settings" of Instruction Manual.

- 3 Select a measurement range in [Range (f.s.)] of each channel.
The measurement ranges that can be set varies depending on modules. If an input voltage exceeds the measurable range (overrange), change the measurement range to one with a lower sensitivity.

1.1 Measurement Procedure



Automatic setting

Clicking **[Auto range]** on the waveform screen automatically specifies the sampling rate, measurement range, and zero position of the input waveform and 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

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

To initialize the instrument (restoring the basic settings)

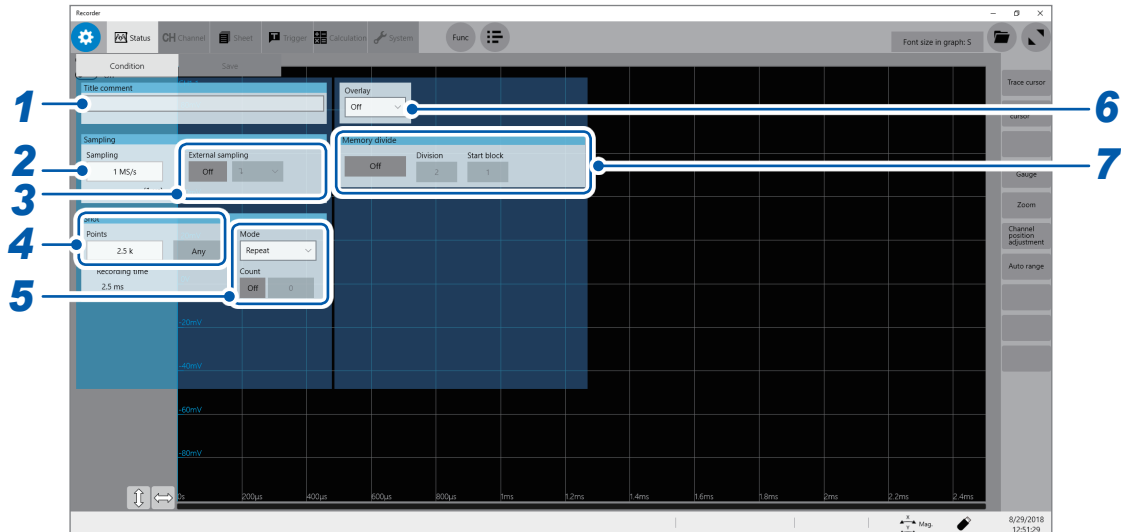
 Tracking > **[System]** > **[Initialize]** restores the instrument settings to the factory default.

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 Specifying Measurement Conditions

Specify conditions required for measurement, such as the sampling rate ([**Sampling**]) and recording length ([**Shot**]).

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



1 Type a comment in [**Title comment**].
Number of characters that can be entered: up to 40

2 Select a sampling rate in [**Sampling**].
Refer to “Sampling rate setting guideline” (p. 7).

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

3 Select an external sampling setting in the [**External sampling**] setting.

Off <input type="checkbox"/>	Disables the external sampling function.
On	Select this option to sample data at a sampling rate defined by a signal inputted into the external control terminal (EXT.SMPL).

<input type="checkbox"/> ↑	Samples data at rising edges of the input signal.
<input checked="" type="checkbox"/> ↓	Samples data at falling edges of the input signal.

4 Enter a recording length in [**Shot**].
Click [**Points**] to select an option for 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

Enabling [**Any**] and clicking [**Points**] allows you to type the number of points in increments of 100.
The maximum recording length that can be set varies depending on the number of channels to be measured.

5 Select a recording mode in [Mode].

Single	Measures waveforms only once. Clicking the start icon starts recording waveforms, and then stops when the waveforms with the specified recording length have been acquired.
Repeat <input checked="" type="checkbox"/>	Measures waveforms repeatedly. Clicking the stop icon stops the measurement.

When [Repeat] mode is set and [Count] is set to [On], the specified number of measurements are performed.

6 Specify the [Overlay] setting.

Refer to “3.1 Overlaying New Waveforms With Previously Acquired Waveforms” (p. 34).

7 Specify the [Memory divide] settings.

Refer to “Memory Dividing Function” (p. 159).

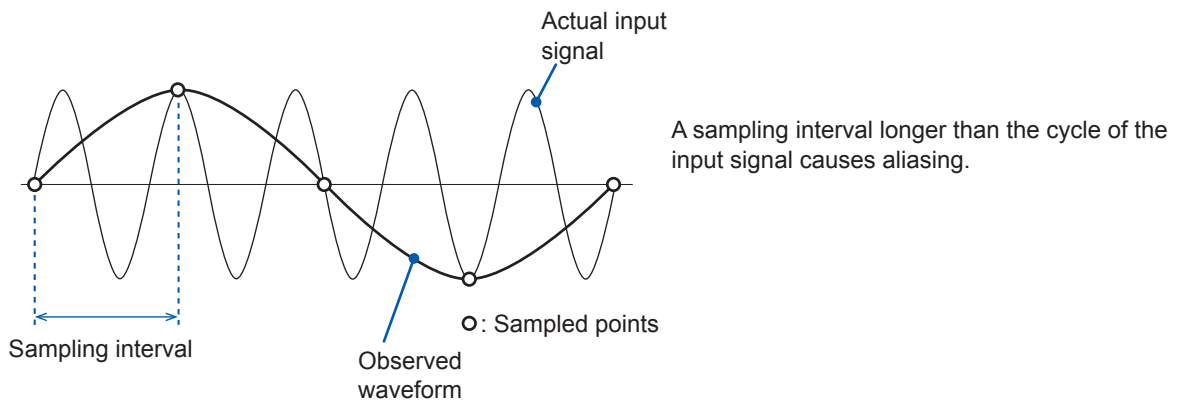
Sampling rate setting guideline

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

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



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

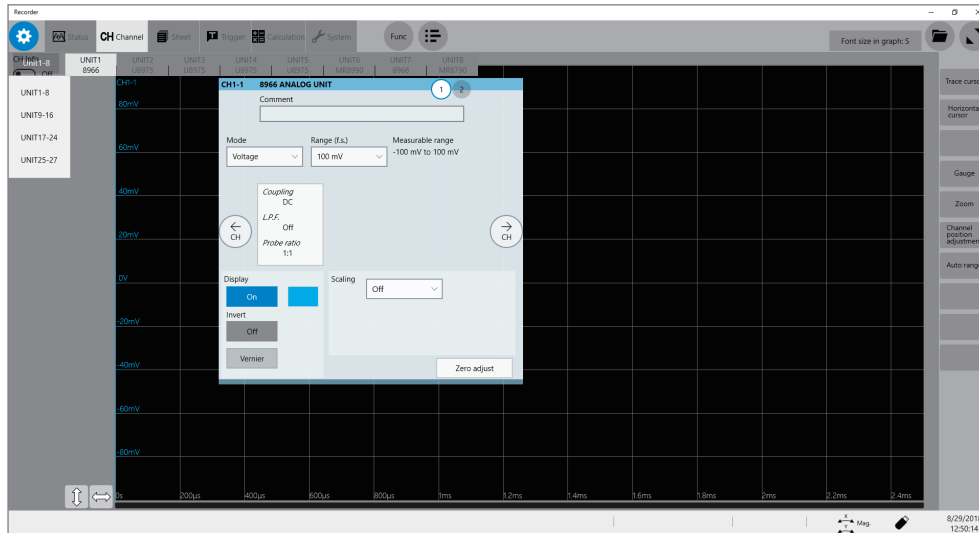
The data update rate is not allowed to exceed the maximum sampling rate of each module. The same data are measured until they get updated, causing the instrument to plot a stair-step waveform.

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. 46
Model 8968 High Resolution Unit	1 MS/s (1 μ s)	–
Model U8969 Strain Unit	200 kS/s (5 μ s)	p. 48
Model 8970 Freq Unit	Varies according to the setting.	p. 50
Model 8971 Current Unit	1 MS/s (1 μ s)	p. 53
Model 8972 DC/RMS Unit	Varies according to the response setting.	p. 54
Model 8973 Logic Unit	20 MS/s (50 ns)	–
MR8990 Digital Voltmeter Unit	Varies according to the NPLC setting.	p. 55
Model U8974 High Voltage Unit	1 MS/s (1 μ s)	p. 57
Model U8975 4ch Analog Unit	5 MS/s (200 ns)	–
Model U8991 Digital Voltmeter Unit	Varies according to the NPLC setting.	p. 58

1.3 Specifying the Input Channel Setting

Specify the settings of the analog and logic channels.




Operation available on the [Channel] screen

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


Channel setting procedure

Analog channels (CH1 through CH32) setting procedure

Specifying input settings


- 
- Select a measurement mode. (p. 11)
 - Select a measurement range for each measurement target. (p. 11)
 - Convert input values (scaling function). (p. 14)
 - Select an input coupling setting. (p. 12)
 - Select a low-pass filter cutoff frequency (if noise is present). (p. 12)

Specifying the display settings

- 
- Select a waveform color. (p. 14)
 - Convert input values (scaling function). (p. 14)

Logic channels (Model 8973 Logic Unit) setting procedure

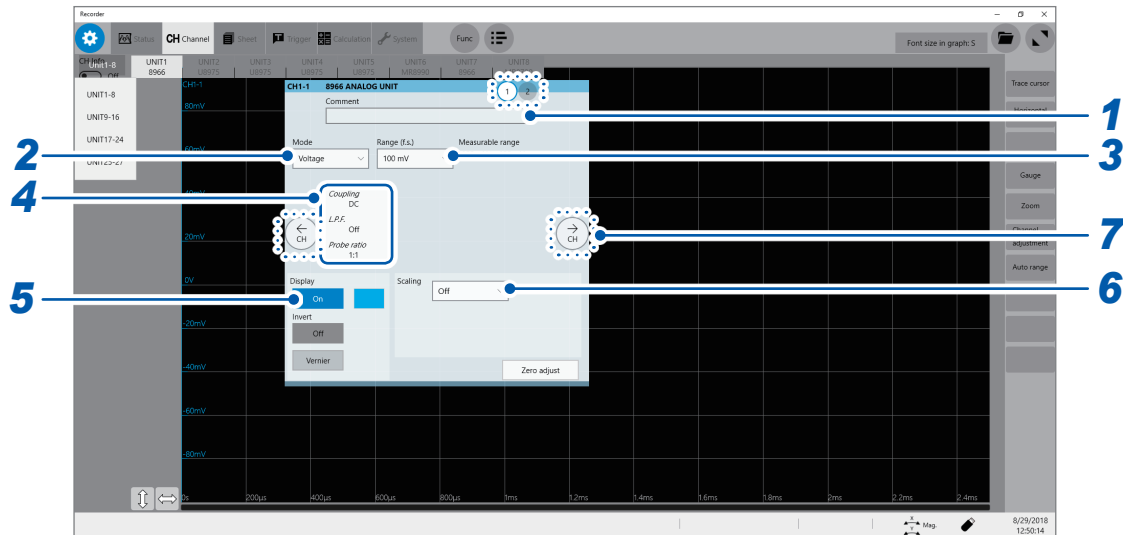
Specifying the display settings

- 
- Select a logic recording width setting. (p. 15)
 - Specify display positions of waveforms. (p. 15)
 - Specify display colors of waveforms. (p. 15)

Analog channels

For details on specifying each module setting, refer to “3.6 Specifying Module-Specific Settings” (p. 45).

 > [Channel] > [UNIT]



1 Type a comment in [Comment].

Number of characters that can be entered: up to 40

2 Select a recording mode in [Mode].

Voltage <input checked="" type="checkbox"/>	Measures a waveform in voltage mode.
Temperature	Measures a waveform in temperature mode.

Selectable modes vary depending on the installed modules.
Refer to “3.6 Specifying Module-Specific Settings” (p. 45).

3 Select a measurement mode in [Range (f.s.)].

Select a 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 with a lower sensitivity.

For Model MR8990 and Model U8991, starting a measurement using a high-sensitivity range with the input terminal open causes an input signal to be overrange.

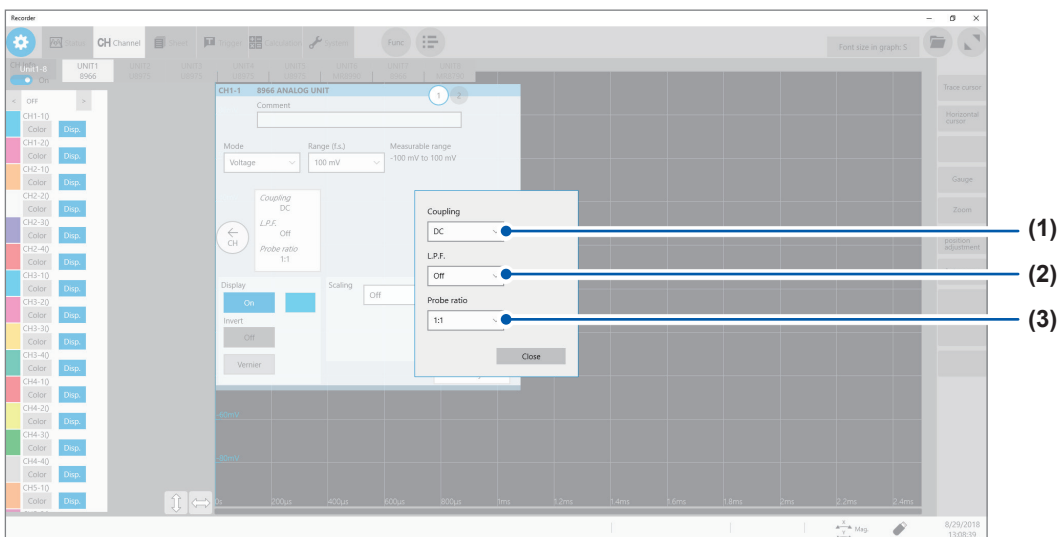
After changing [Range (f.s.)], check values in [Level], [Upper], [Lower], and other values of the trigger, search, and numerical calculation functions.

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 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 Model U8991 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.

4 Specify the [Coupling], [L.P.F.], and [Probe ratio] settings.

Clicking the screen opens the setting dialog box.



(1) Select an input coupling setting in [Coupling].

Select a coupling method for an input signal. In general, use the DC coupling.

DC <input checked="" type="checkbox"/>	Measures both DC and AC components of an input signal.
AC <input type="checkbox"/>	Measures an AC component only of an input signal. A DC component can be eliminated.
GND <input type="checkbox"/>	Connect the input terminal to the ground (Enables you to check the zero position).

(2) Select a low-pass filter cutoff frequency setting in [L.P.F.].

Enabling the low-pass filter installed in the module allows elimination of unwanted high-frequency components. The filters available vary depending on the module types. Use an adequate filter in accordance with the characteristics of an input signal.

Example: Model 8966 Analog Unit

OFF <input checked="" type="checkbox"/> , 5 Hz, 50 Hz, 500 Hz, 5 kHz, 50 kHz, 500 kHz
--

(3) Select a probe ratio setting in [Probe ratio].

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

1:1 <input type="checkbox"/>	Select this ratio when using Model L9197, Model L9198, Model L9790, or Model L9217 Connection Cord.
1:10	Select this ratio when using Model 9665 10:1 Probe.
1:100	Select this ratio when using Model 9666 100:1 Probe, Model P9000-01 Differential Probe, or Model P9000-02 Differential Probe.
1:1000	Select this ratio when using Model 9322 Differential Probe, Model P9000-01 Differential Probe, or Model P9000-02 Differential Probe.

5 Specify the display preferences in [Display].

On <input type="checkbox"/>	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 other lines.
	Invert (OFF <input type="checkbox"/>, ON <input type="checkbox"/>)	When the signs of displayed waveforms are reversed, the waveforms can be inverted. Refer to “3.4 Inverting the Waveform (Invert Function)” (p. 43).
	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. 42).
Off <input type="checkbox"/>	Displays no waveforms.	

6 Specify the [Scaling] settings.

Refer to “3.2 Converting Input Values (Scaling Function)” (p. 36).

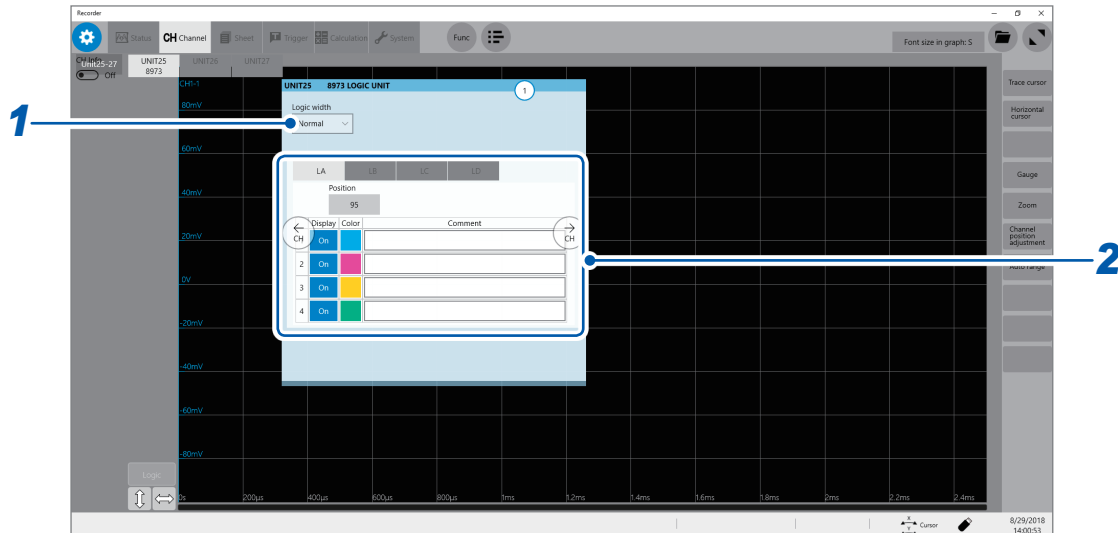
7 Switch the channels.

Click the corresponding location to switch the channels.

Logic channels

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

 > [Channel]



1 Select a logic width in [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.

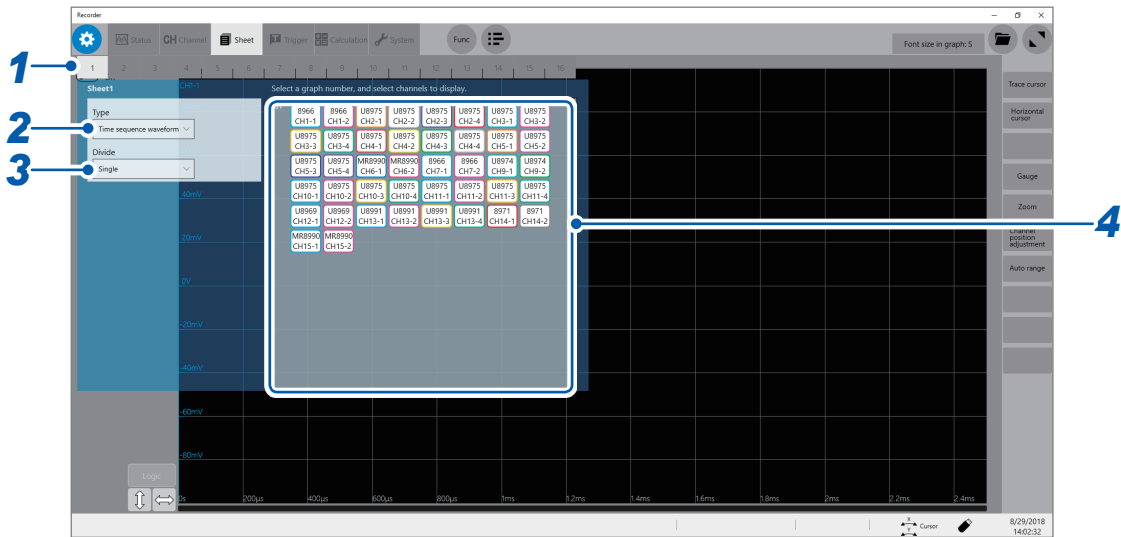
Wide	Increases the width of the waveforms.
Normal <input checked="" type="checkbox"/>	Displays the waveforms in normal width.
Narrow	Reduces the width of the waveforms.

2 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 percentage point. This setting is shared by all probes (LA through LD). You can move the logic position freely within the screen limits.
Display	Specifies whether to display each logic waveform.
Color	Allows you to select a display color of each waveform. You can also select the same color as other lines.
Comment	Allows you to type a comment for each channel. Number of characters that can be entered: up to 40

1.4 Specifying the Sheet Settings

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 a sheet to be displayed on the waveform screen.



1 Select a sheet.

2 Select a display setting in **[Type]**.

Time sequence waveform <input checked="" type="checkbox"/>	Displays time-sequence waveforms.
---	-----------------------------------

3 Select a division number in **[Divide]**.

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

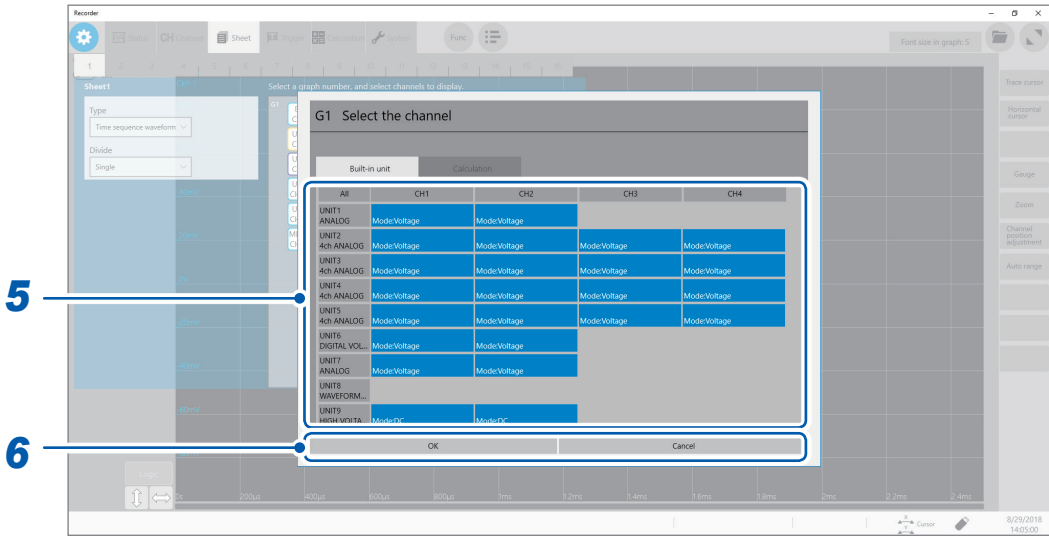
Single <input checked="" type="checkbox"/> , Dual , Quad , Octa , Hexadeca

4 Assign channels to the graph.

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

5 Select channels to be displayed on the graph.

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

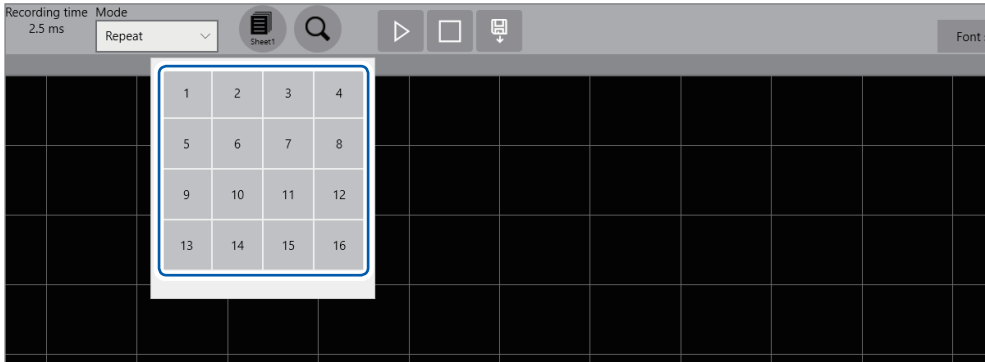


6 Click [OK].

The selection is confirmed.

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

Switching sheets on the waveform screen



Select sheet numbers to be displayed.

1.5 Starting/Stopping the Measurement

Starting a measurement

Clicking the start icon starts a measurement.

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

Refer to “12 Externally Controlling the Instrument” (p. 191).

Waveform display during measurement

In general, the waveforms appear after data with the specified recording length has been acquired. When the measurement is performed at a relatively slow speed, the waveforms appear while the data is being acquired.

However, even if a slow-speed range is set, the waveforms appear 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 “Automatically saving waveform data” (p. 70).

Stopping the measurement

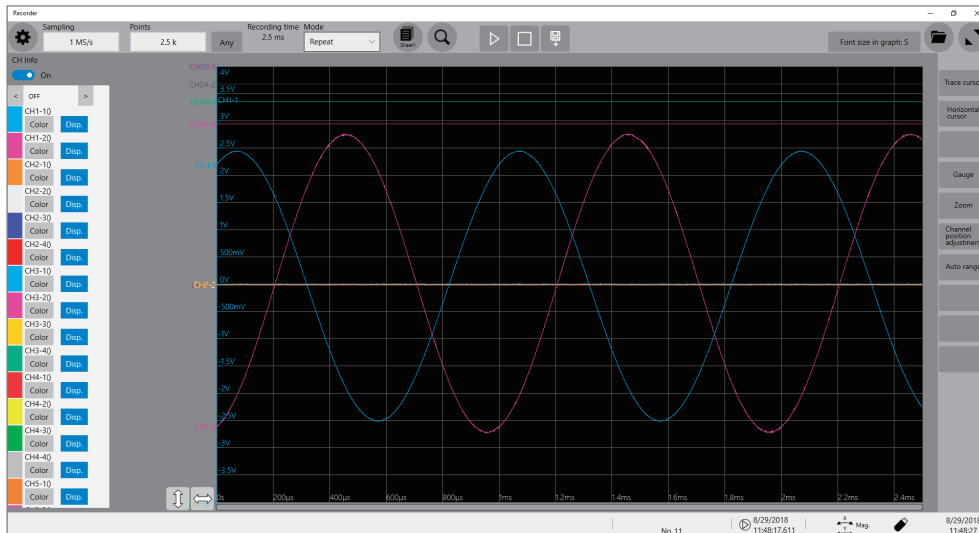
Clicking the stop icon once stops the measurement after the waveforms with the specified recording length have been acquired.

Click the stop icon once and click **[OK]** on the dialog box displayed to stop the measurement.

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 settings on this screen.



Operation available on the waveform screen

Use the trace cursors

- Reading measured values (p. 20)

Changing the display magnification of waveforms

- Magnifying/demagnifying waveforms (p. 28)
- Magnifying a part of waveforms horizontally (p. 32)

Moving the waveform display position

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

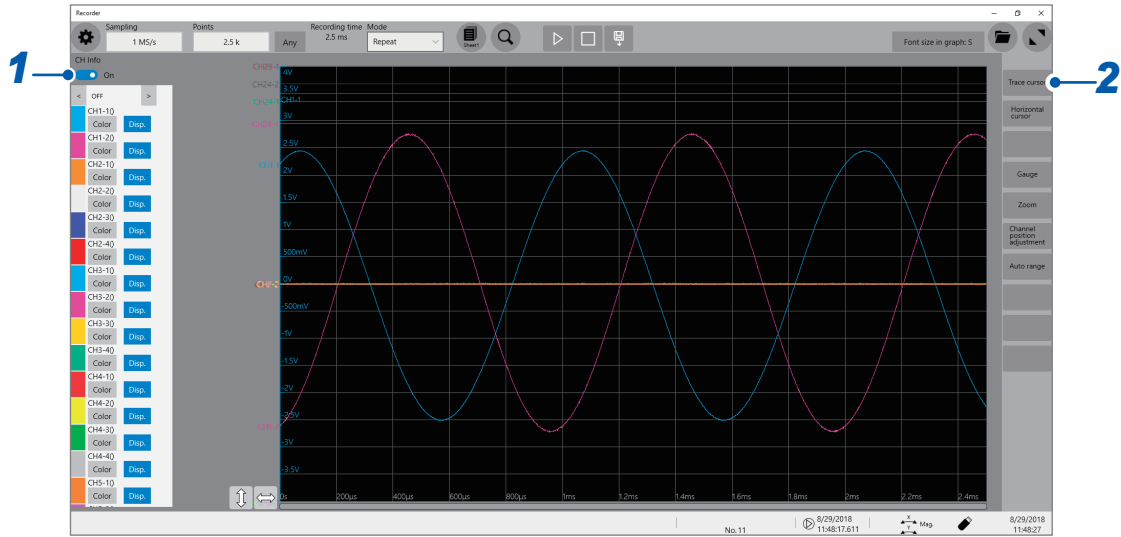
2

2.1 Reading Measured Values (Trace Cursors)

You can read measured values (scaled values when the scaling is used) using trace cursors on the waveform screen. The instrument can simultaneously display up to eight trace cursors. You can read differences in times and measured values at any two cursors you select among all cursors.

1 Set [CH Info] to [On].

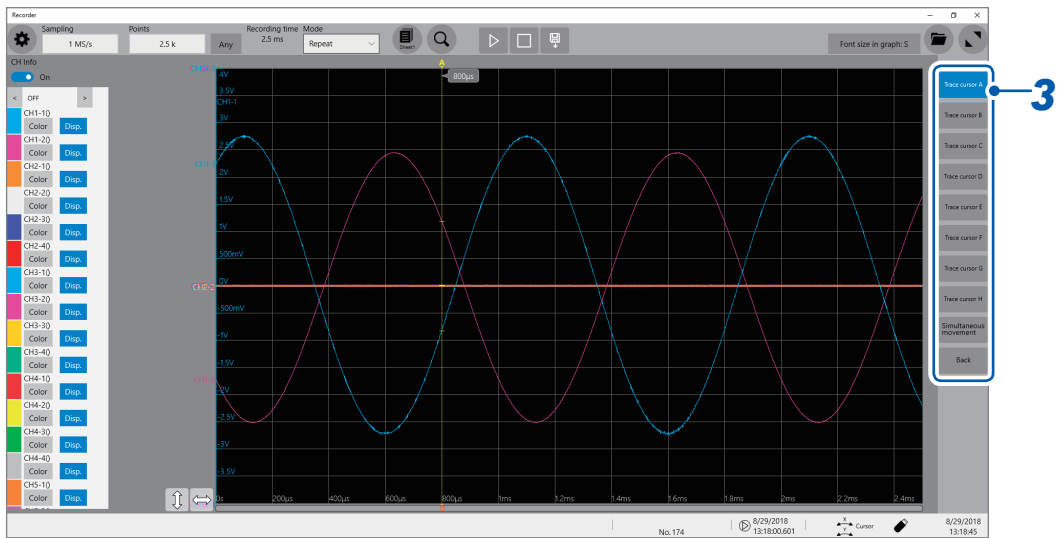
Click [CH Info] to switch between [On] and [Off] for the display setting of each channel.



2 Click [Trace cursor].

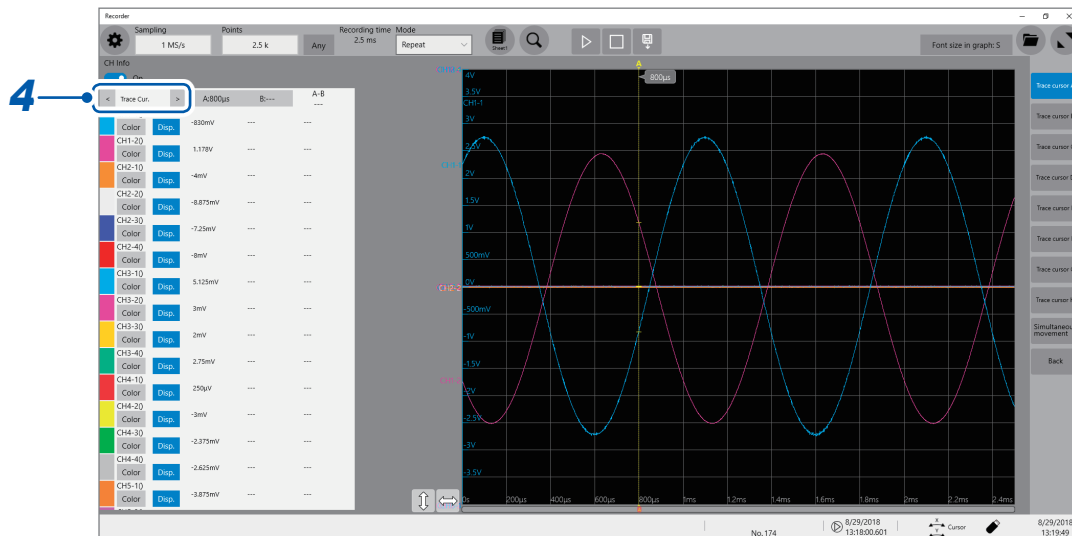
3 Select one or more cursors from [Trace cursor A] through [Trace cursor H] by clicking them.

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



4 Set the display item to [Trace Cur].

Set the display item to [Trace Cur] by clicking [**<**] or [**>**].

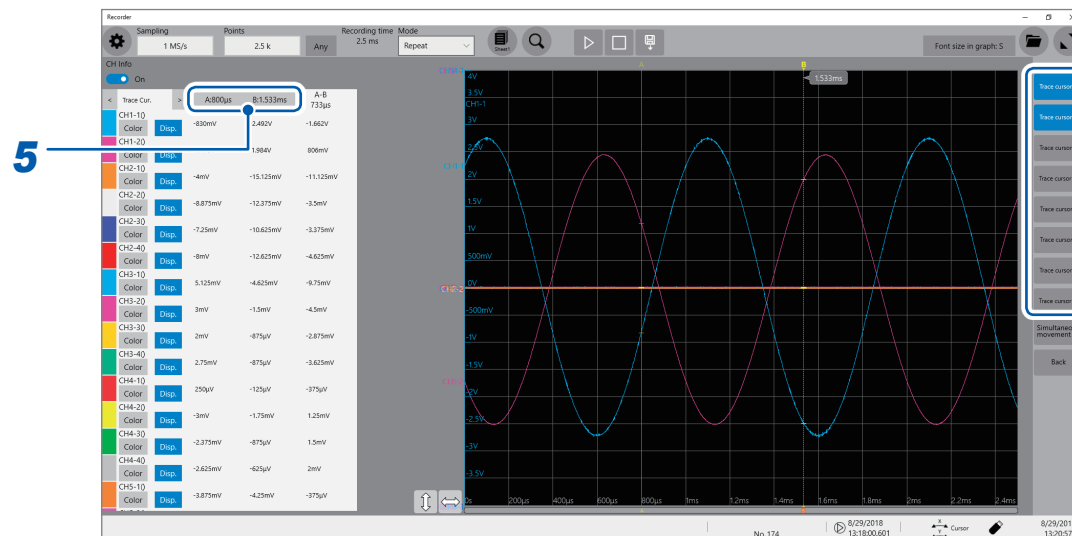


5 Specify the [Cursor value 1] and [Cursor value 2] settings.

Click each of [Cursor value 1] and [Cursor value 2] in turn and select a cursor to be assigned among A ([Trace cursor A]) through H ([Trace cursor H]). (Default setting [Cursor value 1]: [Trace cursor A], [Cursor value 2]: [Trace cursor B])

Displays the difference in measured value between [Cursor value 1] and [Cursor value 2].

If you select a trace other than the one selected in step 3, the instrument displays [---] in the difference field.



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

Sliding the mouse cursor 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 the mouse cursor 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.

Stopping dragging the mouse cursor reverts the display to the original magnification.

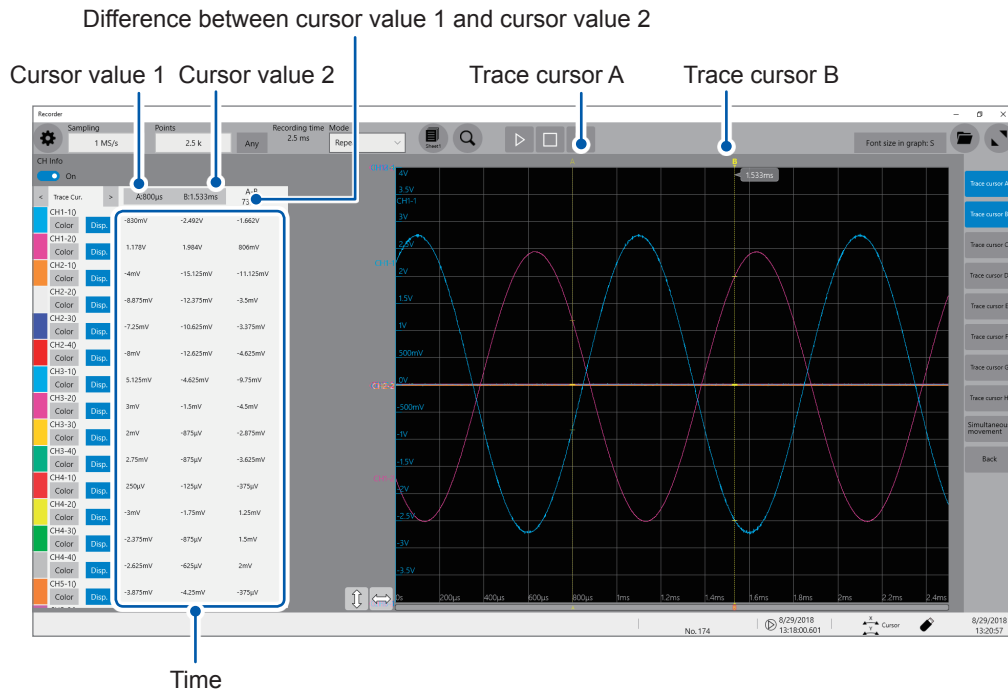
To move the cursors precisely

Select a cursor and rotate the wheel button upward or downward to move the cursor one sample at a time.

If no trace cursors appear on the screen even though the trace cursors are enabled

Check the positions of the trace cursors on the scroll bar. (p. 27)

Reading measured values on the waveform screen When the trace cursor is selected



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

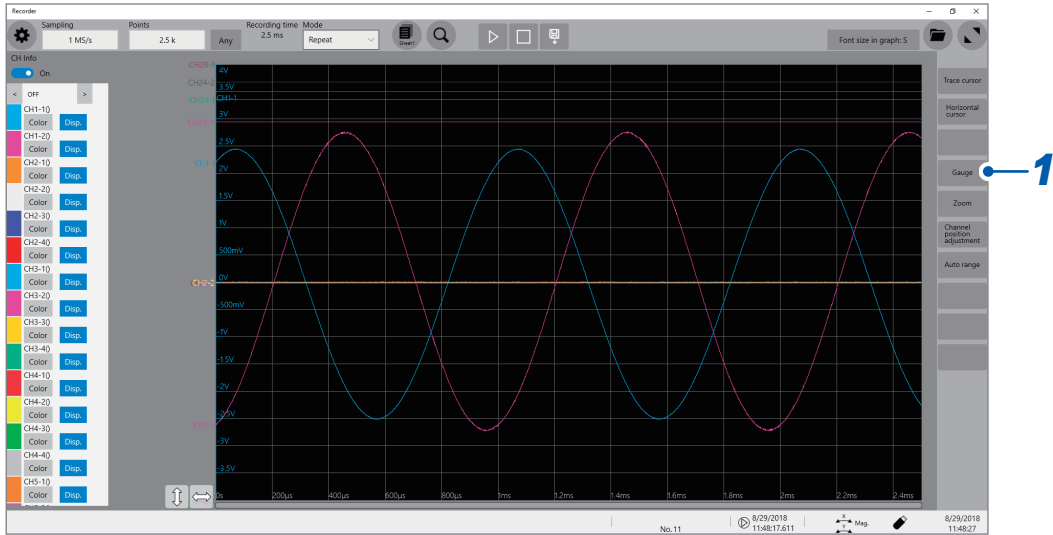
Cursor type	Cursor value
Trace cursor	<p>When trace cursor A is assigned to cursor value 1; and trace cursor B, to cursor value 2.</p> <p>Time: A period of time from the trigger point or starting point of recording until the trace cursor selected for cursor value 1 or cursor value 2</p> <p>B - A: Difference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

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

2.2 Displaying Vertical Scales (Gauge Function)

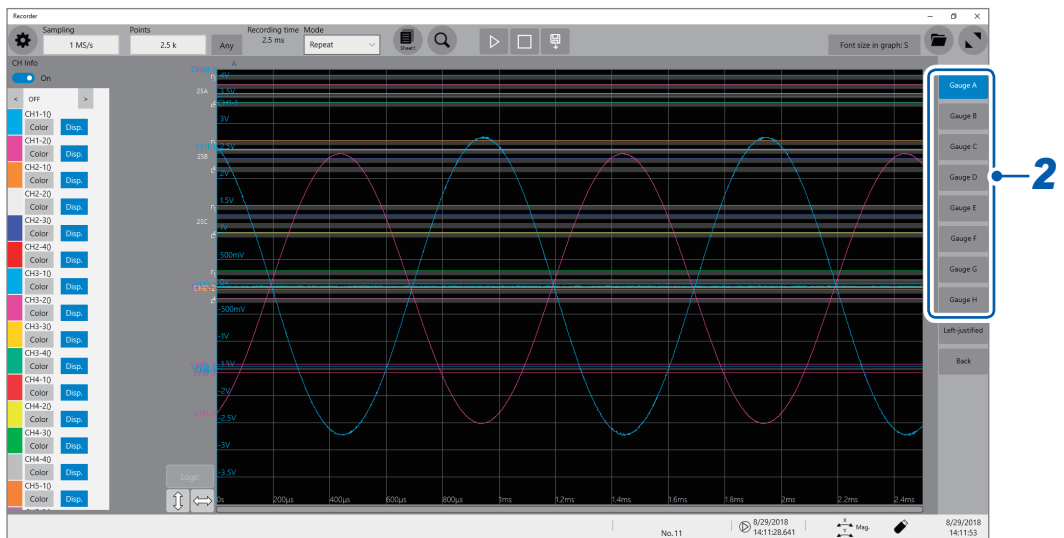
Using the gauge function enables the vertical scales (for convenience, hereafter referred to as “gauges”) to be displayed overlapping waveforms.

1 Click [Gauge].



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

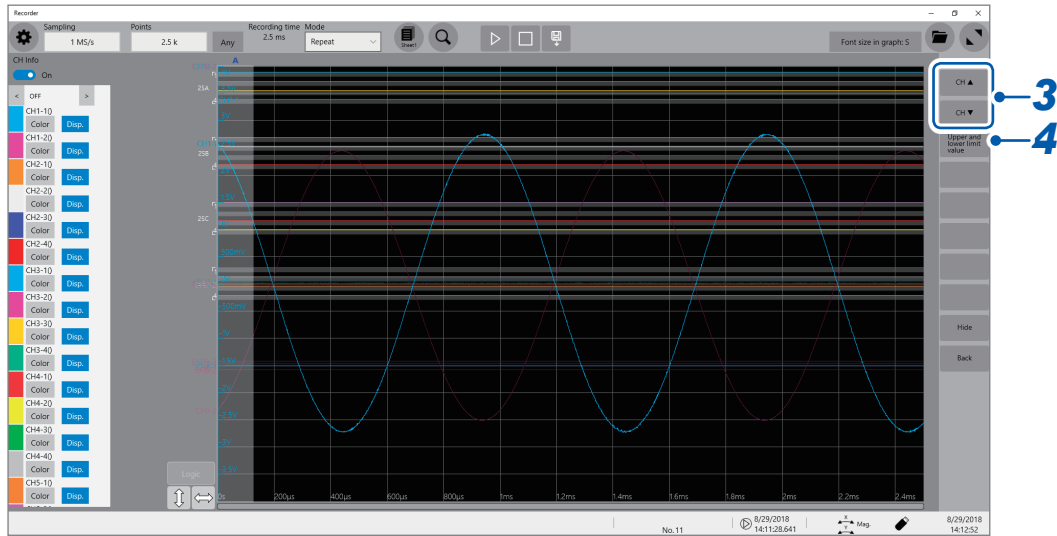
Gauges appear on the screen.
Click a gauge to select it and drag it to move.



Clicking [Left-justified] aligns the gauges to the left.

3 Click [CH ▲] or [CH ▼].

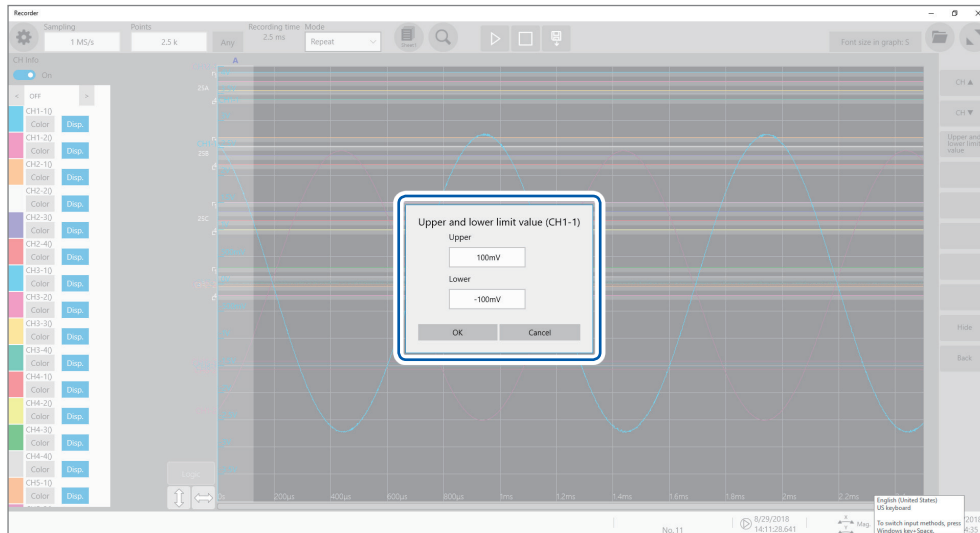
You can switch channels to be displayed along with the gauge.



Clicking [Hide] hides the gauges.

4 Click [Upper and lower limit value].

The setting dialog box opens. You can specify the display range of each channel. Type an upper and lower values in [Upper] and [Lower], respectively, and click [OK].

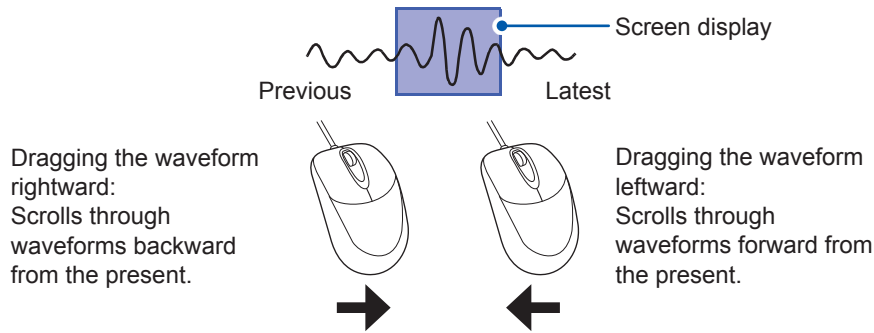


2.3 Scrolling Through Waveforms

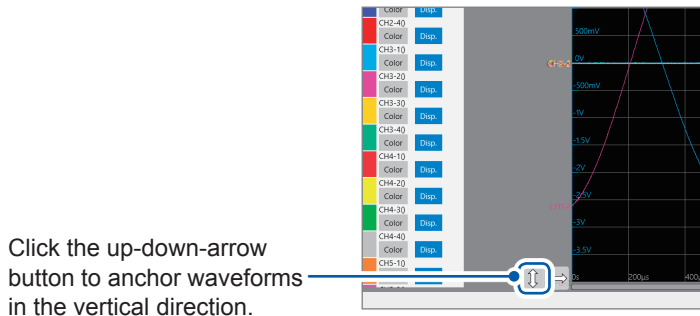
Scrolling through waveforms

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

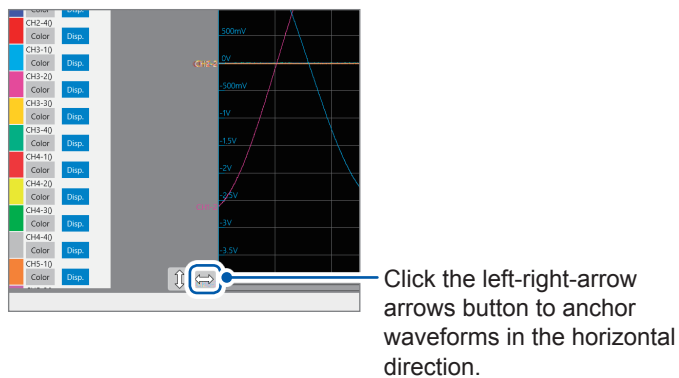
Scrolling direction



To anchor the waveforms vertically



To anchor the waveforms horizontally

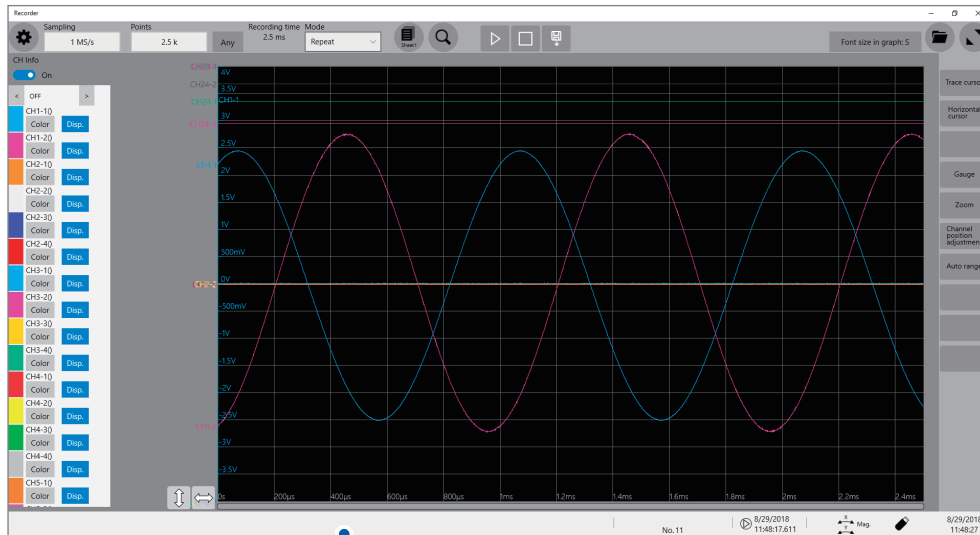


To observe waveforms previously obtained during slow-speed measurement

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

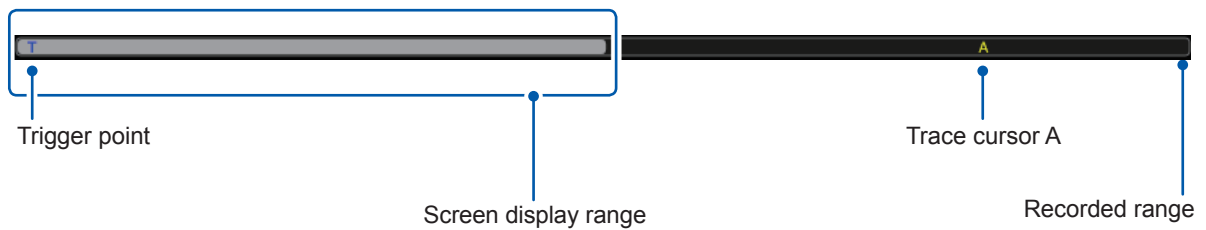
Checking a position of waveforms with the scroll bar

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 and trace cursors.



Scroll bar


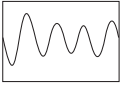

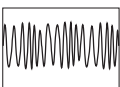
Verifying the position of the trigger point and cursors on the scroll bar



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

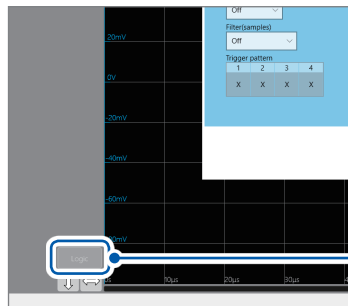
2.4 Changing the Display Position and Display Magnification of Waveforms

You can change the display magnification of waveforms by pointing to the time axis on the waveform screen and rotating the wheel button.

	<p>Rotating the wheel button upward (↑)</p>		<p>Magnifies waveforms.</p>
	<p>Rotating the wheel button downward (↓)</p>		<p>Demagnifies waveforms.</p>

To change the display position of logic channels in a batch

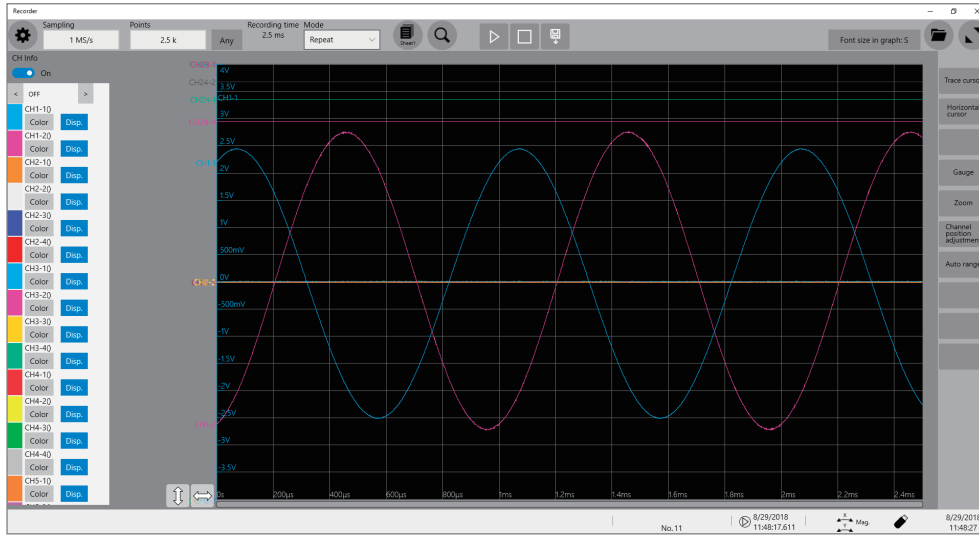
Select **[Logic]** and drag waveforms on the waveform screen to move logic channels only. When **[Logic]** is not selected, only analog channels can be moved.



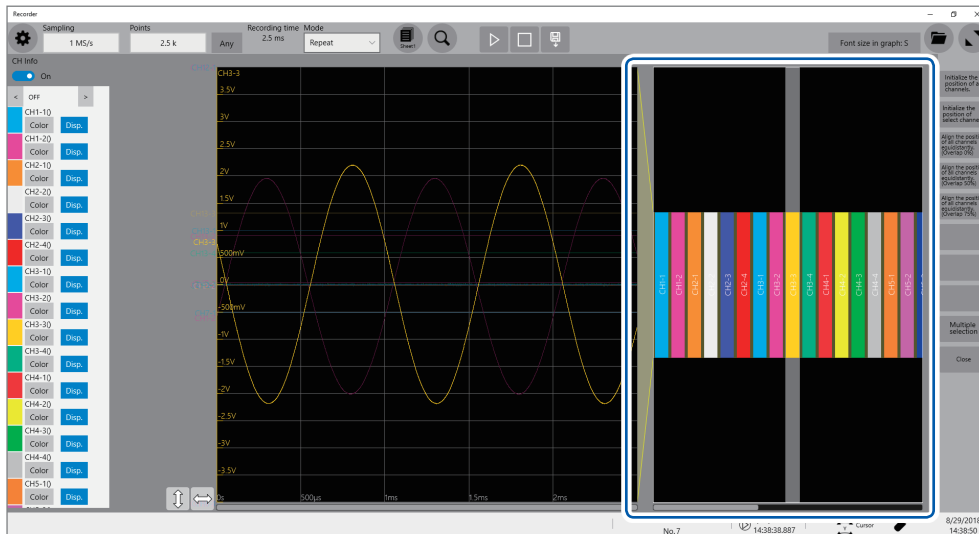
Click the **[Logic]** button to select or deselect logic channels as a scroll target.

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

- 1 Click [Channel position adjustment].

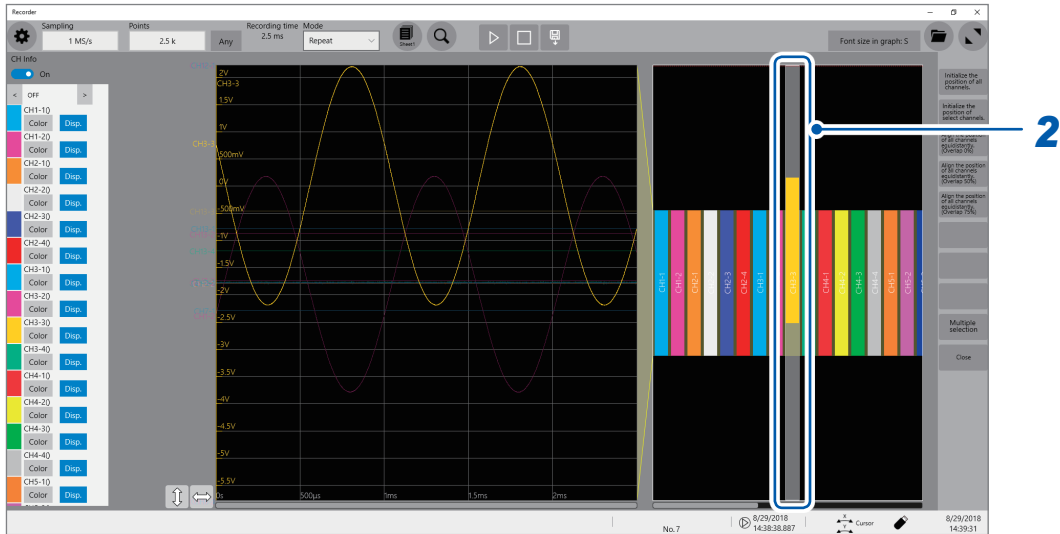


The channel position adjustment screen appears.

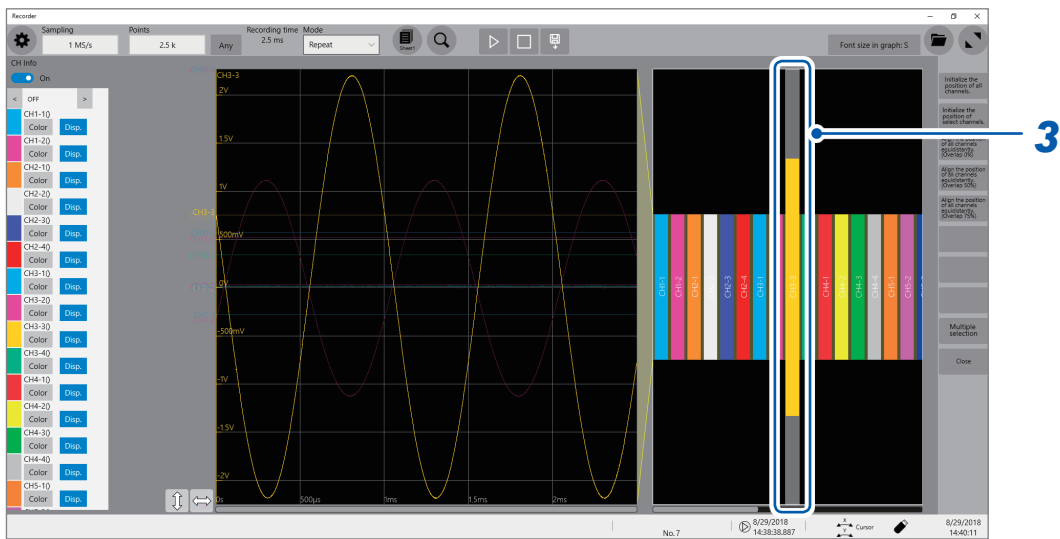


The yellow area shows the display range of the waveform screen.

- 2** Click a channel number the display position you want to change.
Dragging and thus moving the selected area changes the display position.



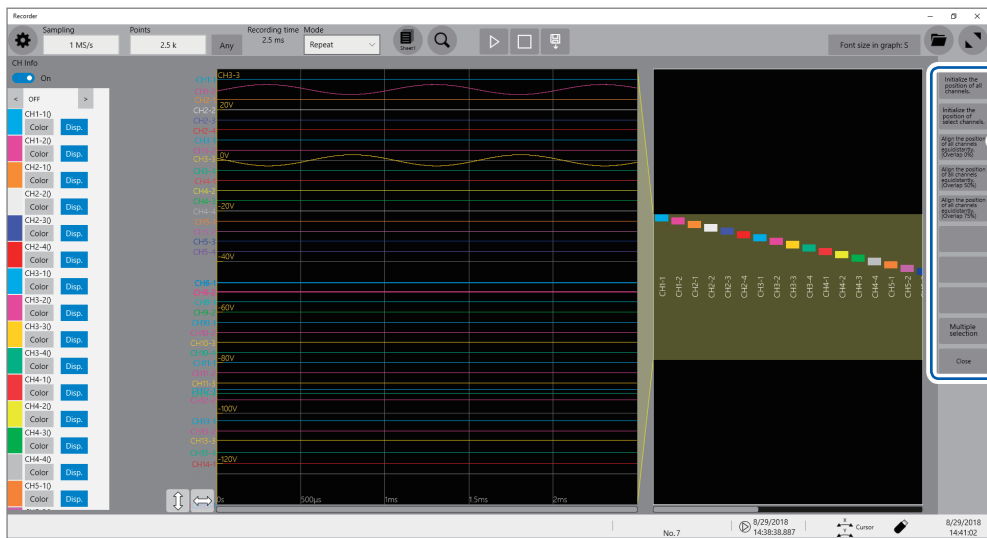
- 3** Click a channel number the display position you want to change.
Rotating the wheel button while pointing to the selected area changes the display magnification.



4 Adjust the display position and magnification.

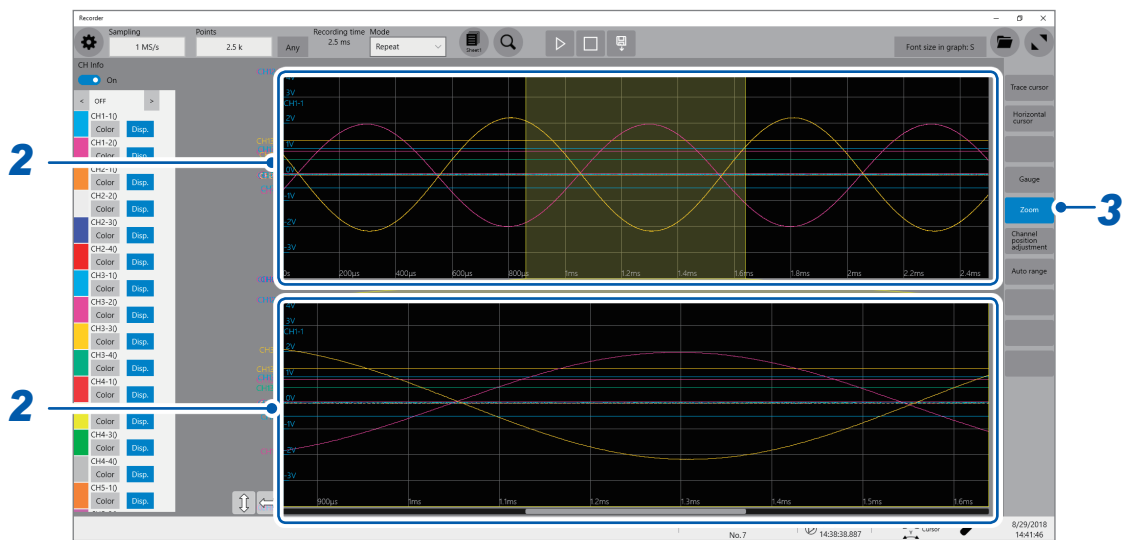
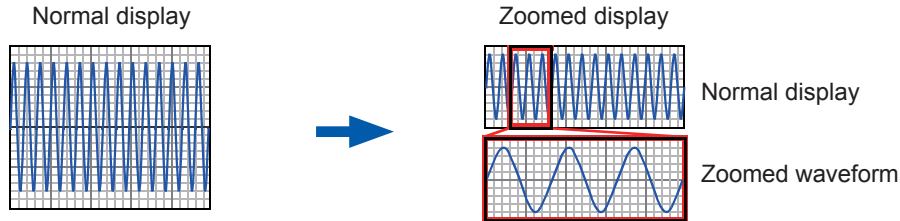
The display can be adjusted as follows depending on the selected state.

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 selected channels only 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.



2.5 Enlarging a Part of the Waveform (Zoom Function)

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



1 Click [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.

You can change the display magnification on each screen.

3 Scroll through the waveform to be observed.

Drag waveforms to scroll through them on each screen.

To cancel the zoomed display

Click [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.

Converting input values (scaling) (p. 36)

Fine-adjusting input values (p. 42)

Inverting waveforms (p. 43)

Copying a setting to another channel (p. 44)

Advanced measurements and settings

- Overlaying new waveforms with previously acquired waveforms (p. 34)

Detailed module settings (p. 45)

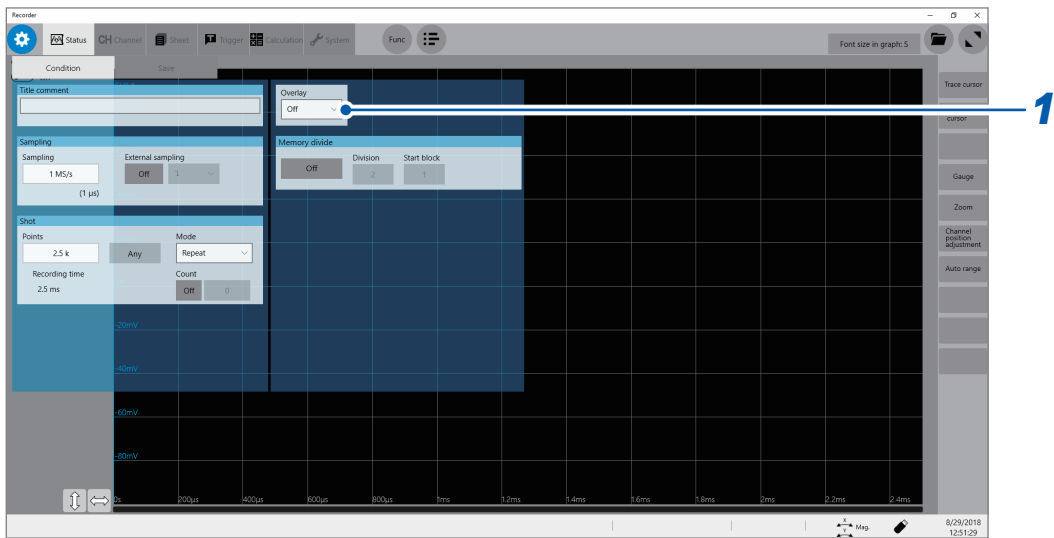
- Anti-aliasing filters
- Thermocouple types
- Reference junction compensation
- Wire break detection
- Data refresh
- Executing auto-balance
- Probe division ratio
- Response time
- Measurement mode

3.1 Overlaying New Waveforms With Previously Acquired Waveforms

New waveforms 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]**

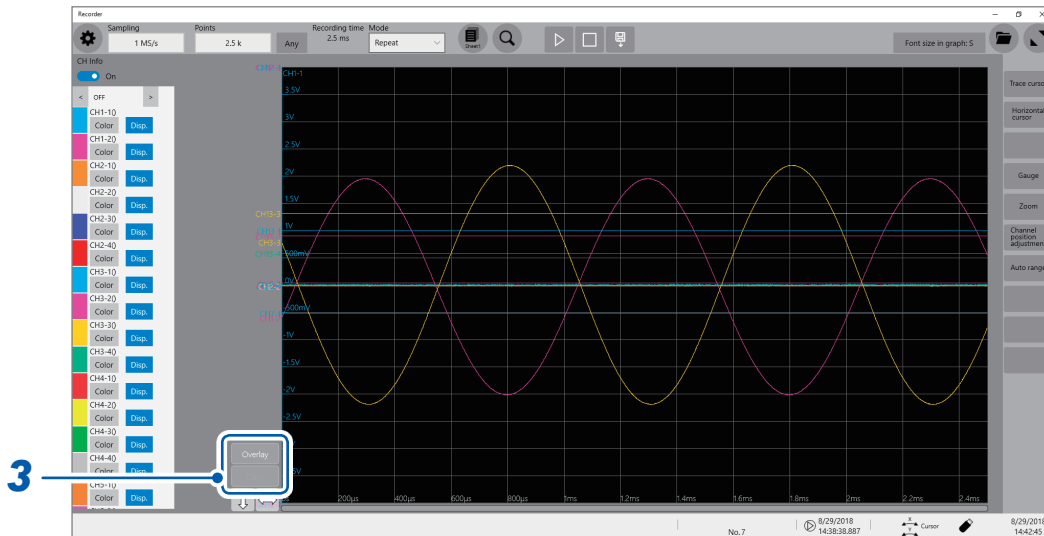


1 Select an overlay setting in **[Overlay]**.

Off <input checked="" type="checkbox"/>	Does not overlay the waveforms.
Auto	Overlays waveforms newly acquired 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	Manually overlays the new waveforms with the presently displayed waveforms. Refer to Step 3 “Overlay the waveforms manually (leaving any waveform to be displayed on the screen).” (p. 35).

Refer to “When the overlay function is enabled (When **[Overlay]** is set to **[Auto]** or **[Manual]**)” (p. 35).



2 Click the button  to display the waveform screen.



3 Overlay the waveforms manually (leaving any waveform to be displayed on the 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 most recently acquired.
- 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 the waveforms most recently displayed only and clears the others in the following cases:
 - After changing the [Sheet] setting, which is accessible by tracking the following order:
 > [Sheet]
 - After changing the waveform display settings (switching between on and off for the display setting or changing waveform color) in the [Channel] screen, which is accessible by tracking in the following order:  > [Channel]
 - After executing the search.
 - After changing the waveform display settings (switching between on and off for the display setting or changing waveform color) in [CH info] on the waveform screen.

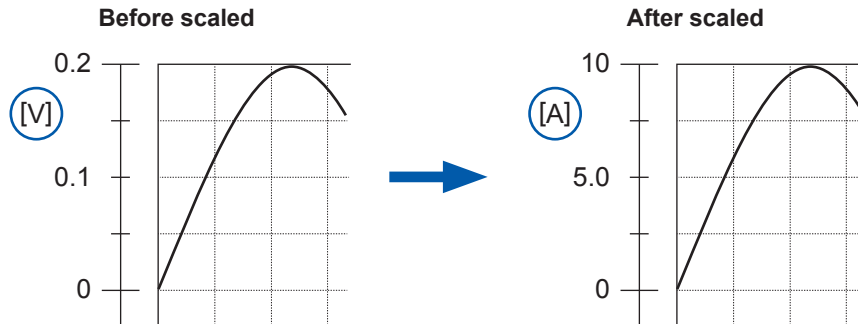
3.2 Converting Input Values (Scaling Function)

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.

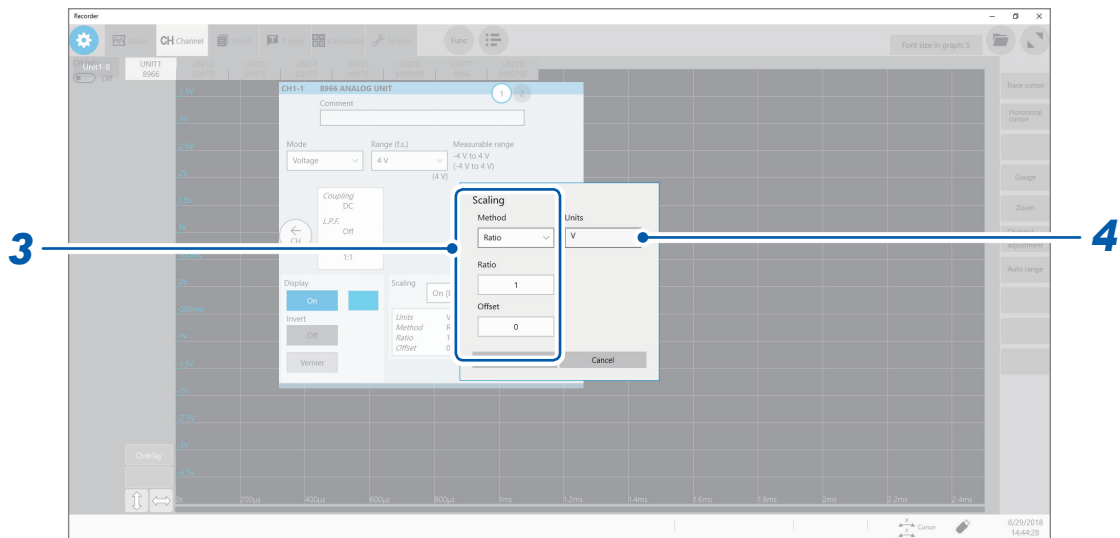
Gauge scales, scaled values (upper and lower limits of the vertical axis or voltage axis), and measured values at trace cursors are expressed as scaled values in terms of the specified units. You can scale the input values for each channel.



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)



1 Select a scaling setting in **[Scaling]**.

Off <input checked="" type="checkbox"/>	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 Click a setting item.

The setting dialog box opens.

3 Select a setting method in [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 [Ratio].

-9.9999E+9 to 9.9999E+9

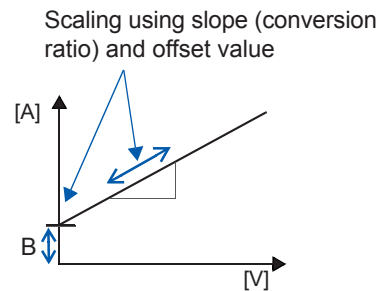
Type a numerical value in [Offset].

-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



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

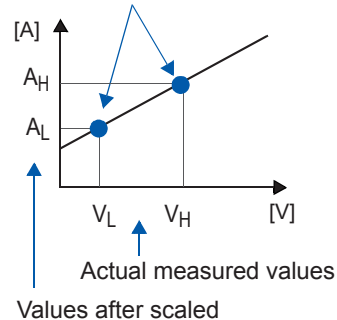
Specify two points of the input signal in terms of volts, corresponding two points after scaled, and a measurement unit to be used. The instrument converts (scales) measured values acquired in terms of volts into values in the specified measurement unit.

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 measurement range according to the current sensor.

Sensor	Measurement 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

Setting example:

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

Five-digit numbers 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

Five-digit numbers or less can be specified.

Specify 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 $\mu\text{V/V}$ 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 [Units].

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. 44).

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 $0.001442 \text{ G/1} \times 10^{-6} \text{ strain}^*$ as values in terms of gees (G)

(*: $10^{-6} \text{ strain} = \mu\epsilon$)

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 the **[Rating]** setting" in "3.2 Converting Input Values (Scaling Function)" (p. 40).

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 $0.952 (\approx 2 / 2.1)$.

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 = $0.952 \times 0.001442 = 0.0013728$

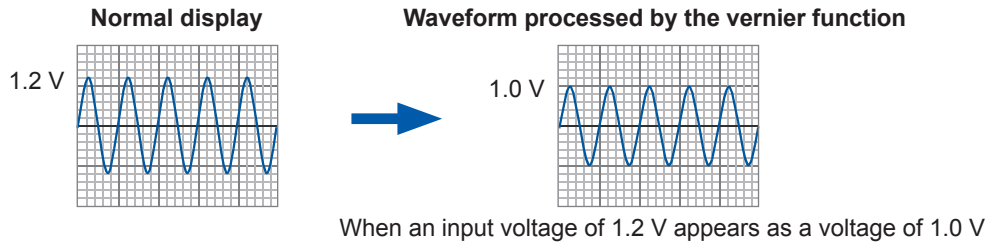
Type **[0.0013728]** as the conversion ratio.

*: 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.

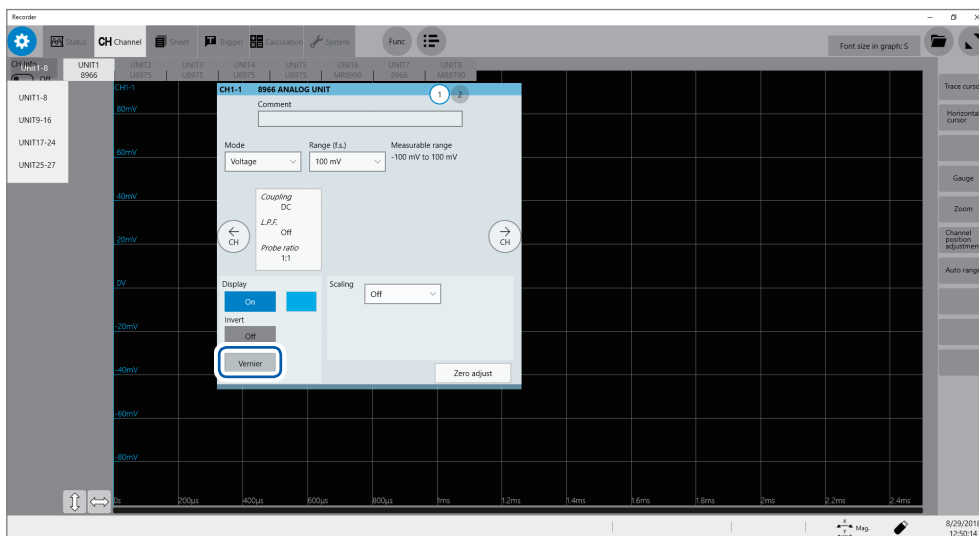
Refer to "Scaling method for strain gauges" (p. 203).

3.3 Fine-Adjusting Input Values (Vernier Function)

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



 > [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.

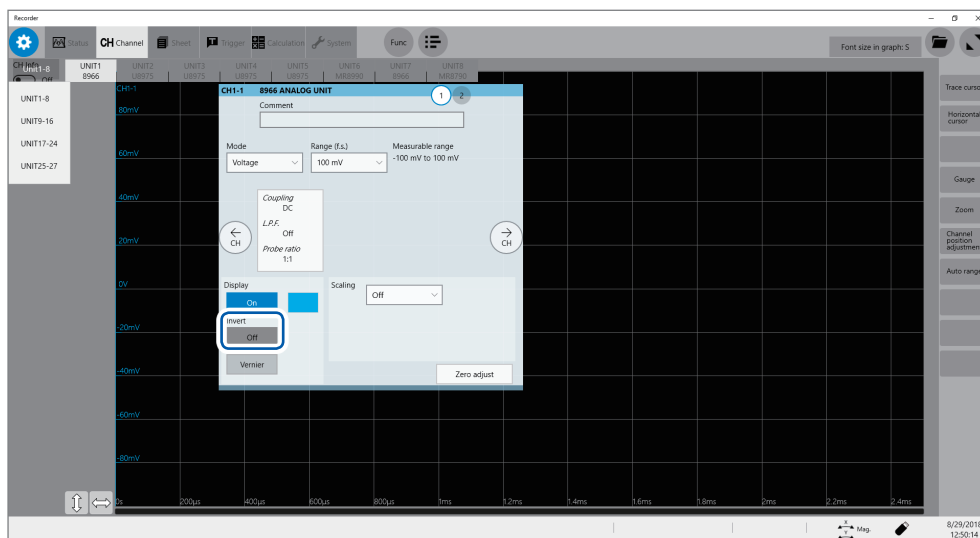
3.4 Inverting the Waveform (Invert Function)

This function can be used for analog channels only. The positive and negative sides of waveforms get inverted.

The waveform data (saved as files) is that inverted by the invert function.

Example:

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



Set **[Invert]** to **[On]** or **[Off]**.

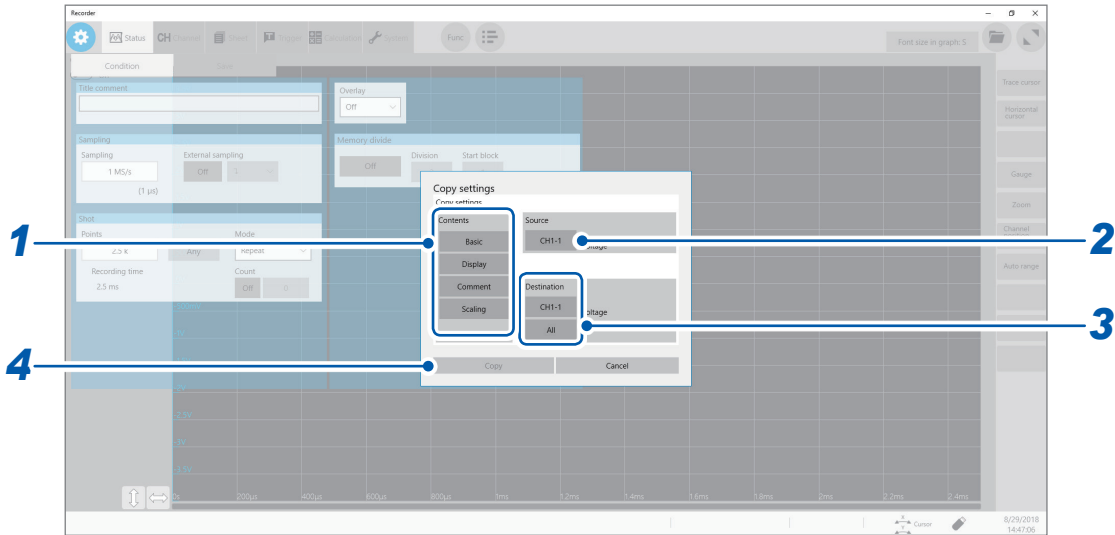
This setting is not available for Model 8967 Temp Unit, Model 8970 Freq Unit, and Model 8973 Logic Unit.

3.5 Copying Settings (Copy Function)

You can copy settings of other channels, as well as the trigger settings.

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

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



1 Specify a copy contents setting in [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 Select a source channel in [Source].

Select the source channel to be copied.

3 Specify copy destinations in [Destination].

CH1-1 <input checked="" type="checkbox"/> (Channel selection)	Click this option when you would like to copy the settings to any one of the channels. Select a destination channel from the list.
All	Copies settings to all channels of UNIT 1 through UNIT 27.

4 Click [Copy].

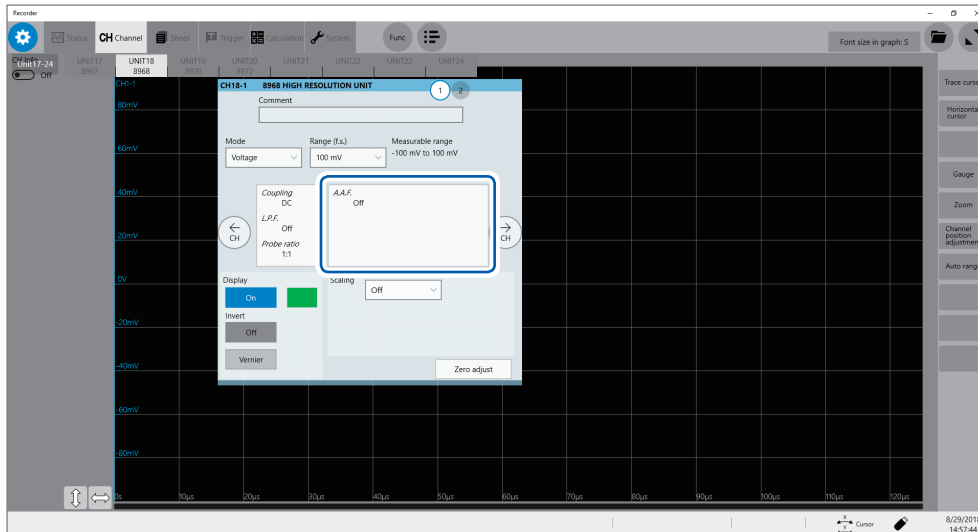
After copying the settings, check that the [Range (f.s.)] setting, as well as values in [Level], [Upper], [Lower] of the numerical calculation function, the trigger function, and the search function are appropriate.

3.6 Specifying Module-Specific Settings

The advanced settings can be specified for each module.

Specifying Model 8968 High Resolution Unit settings

 > [Channel] > [8968]



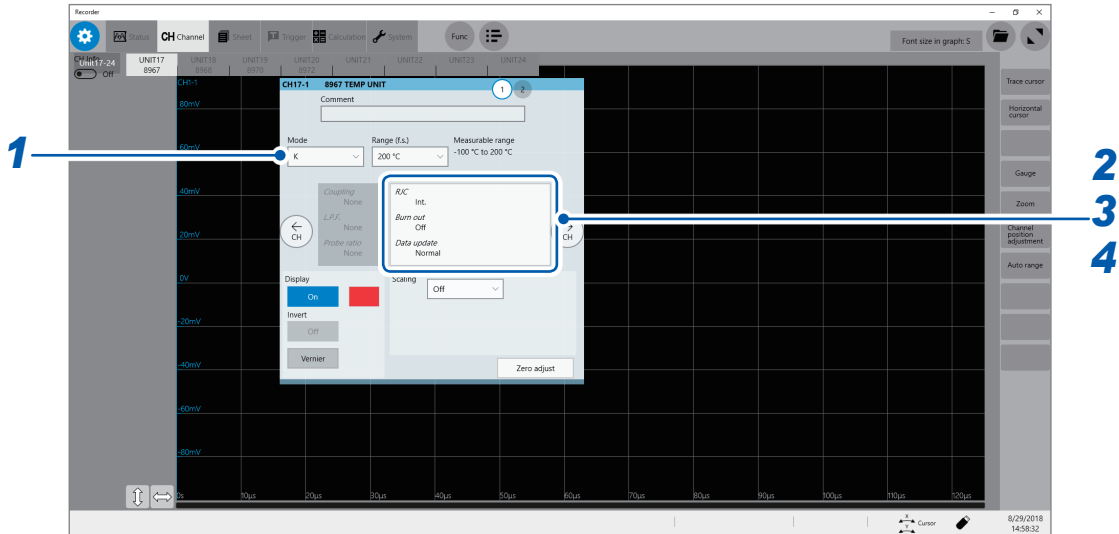
Select an anti-aliasing filter setting in [A.A.F.].

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 <input type="checkbox"/>	Disables the anti-aliasing filter.
On <input type="checkbox"/>	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)

Specifying Model 8967 Temp Unit settings

 > [Channel] > [8967]



1 Select a thermocouple type in [Mode].

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

Mode	Measurable range	Mode	Measurable range
K <input checked="" type="checkbox"/>	-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 Select a reference junction setting in [RJC].

Int. <input checked="" type="checkbox"/>	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 Select a thermocouple break setting in [Burn out].

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

Off <input checked="" type="checkbox"/>	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 Select a data update setting in [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.

Specifying Model U8969 Strain Unit settings

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

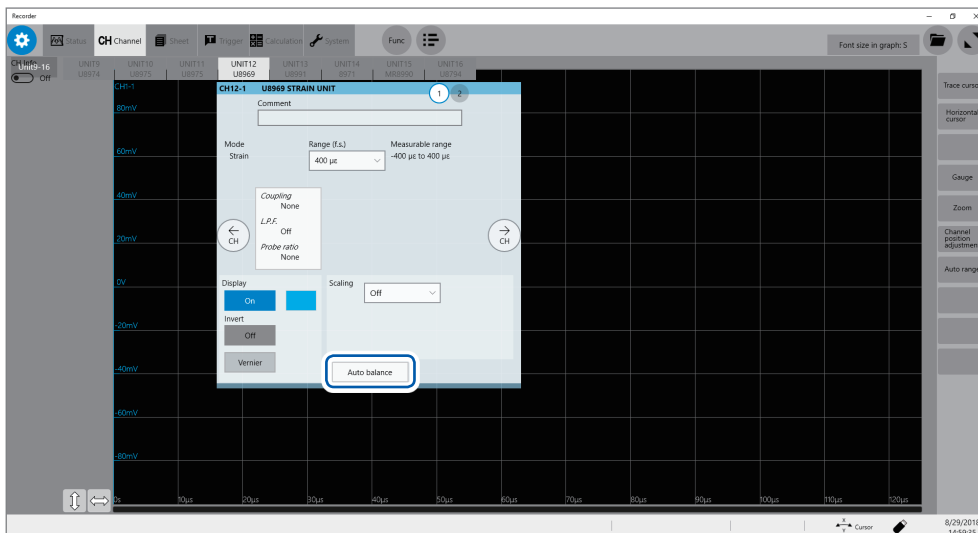
You can use Model 8969 Strain Unit you own with this instrument. The instrument displays the model name of Model 8969 Strain Unit as **[U8969]**.

Before executing 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 auto-balance without any input including distortion.
- The auto-balance cannot be executed during measurement.
- No operation is accepted during auto-balance.

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

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



Click **[Auto balance]**.

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

To execute auto-balance on the list screen

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

Executes auto-balance for all channels of Strain Unit installed in the instrument.

In the following cases, execute auto-balance again.

- After changing the vertical axis (strain axis) range
- After replacing any 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.)

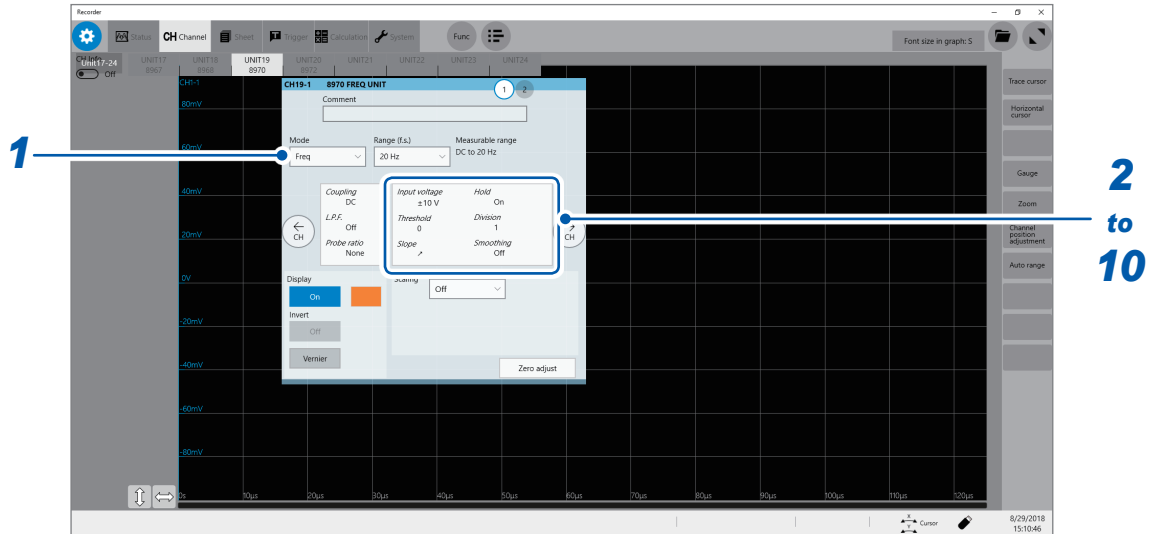
If auto-balance fails

Verify the following, and execute 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?

Specifying Model 8970 Freq Unit settings

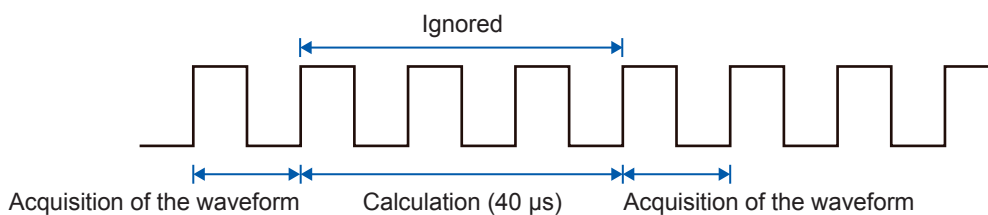
 > [Channel] > [8970]



1 Select a measurement mode in [Mode].

Frequency <input checked="" type="checkbox"/>	Measures the frequency of a waveform (in hertz [Hz]).
Rotation speed	Measures the number of rotations of a measurement target (in rotations per minute [r/min]).
Power frequency	Measures power frequency fluctuation (in hertz [Hz]).
Count	Accumulates the number of input pulses.
Duty ratio	Measures duty ratios of the waveform to be measured (in percent [%]).
Pulse width	Measures pulse widths (in second [s]).

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



2 Select an input voltage setting in [Input voltage].

Select a maximum level of an input signal.

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

3 Type a threshold value in [Threshold].

- Measured values are acquired based on the following: the interval between the subsequent two points 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 Select a crossing direction in [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 an encoder that outputs 360 pulses per rotation, set [Division] to [360] to measure the frequency of each rotation. When [Division] is not used, set it to [1].

6 Select a start timing setting in [Timing].

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

You can set when to start accumulating the number of pulses.

Start	Clicking the start icon starts accumulating.
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 a measurement. Thus, the count value is not zero at the start point.
- When [Timing] is set to [Start], an input that exceeds the trigger level does not trigger the instrument while the message [Waiting for Pre-trigger] is being displayed. Furthermore, the time for internal processing at the start and the trigger priority setting may not cause the instrument to trigger even when the input signal exceeds the specified trigger level.

7 Select a count-over setting in [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 Select a threshold level setting in [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 Select a smoothing setting in [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 that with this setting set to off)

10 Select a hold setting in [Hold].

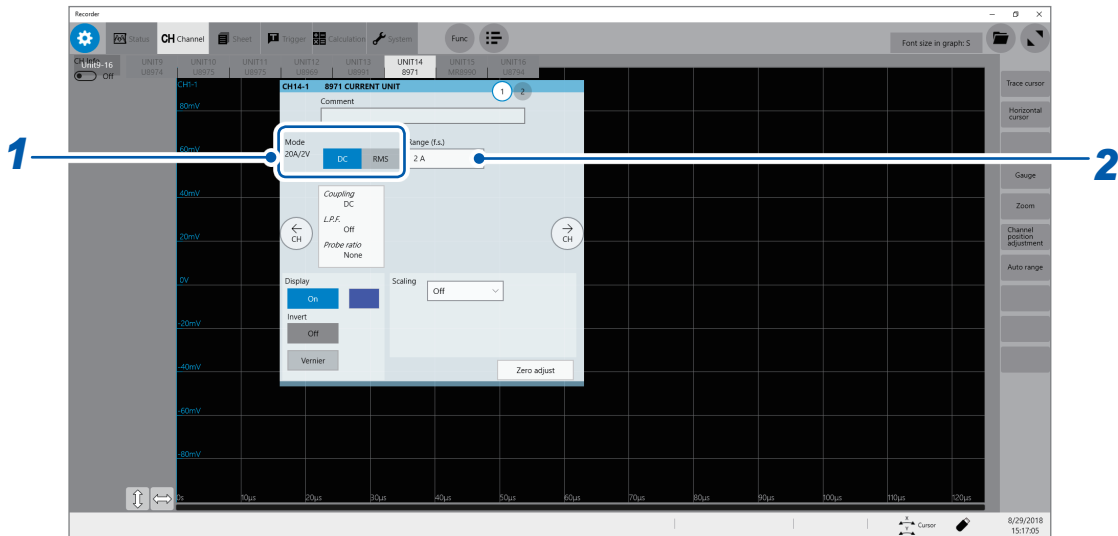
Only when [Mode] is set to [Freq] or [Revolution], this setting is available.

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 after the frequency reaches a value 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.

Specifying Model 8971 Current Unit settings

> [Channel] > [8971]



3
Advanced Functions

1 Select a measurement mode in [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 Model CT6862 AC/DC Current Sensor is connected
500A/2V	When one of the following current sensors is connected: Models 9709, Model CT6844, CT6845, CT6846*, and 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 zero-adjustment after you change the setting. Execute zero-adjustment without any input.

DC	For current measurement
RMS	For RMS measurement

2 Select a measurement range in the [Range (f.s.)] range.

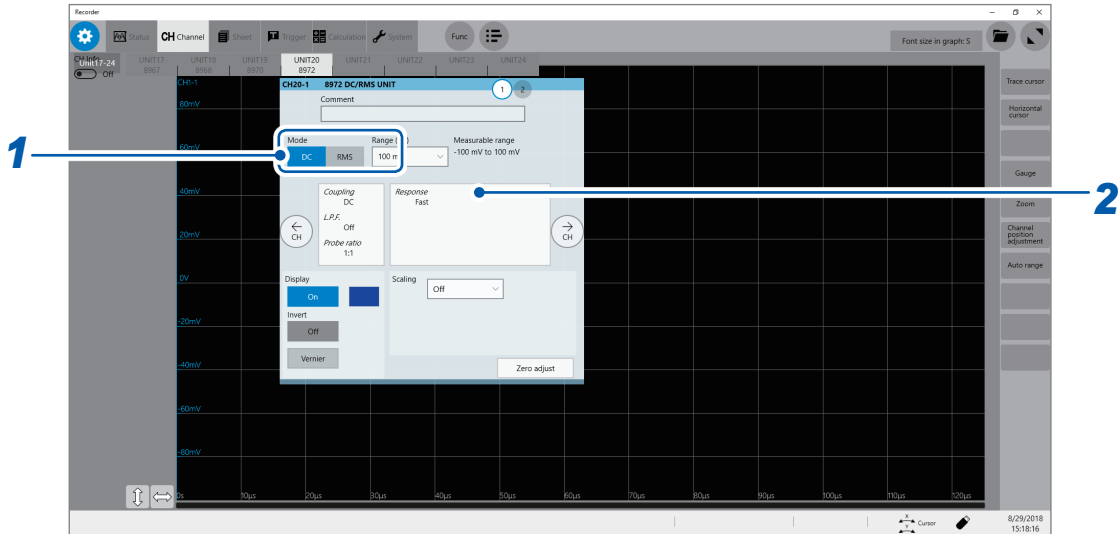
Select a measurement range from the scaled set values for the automatically recognized current sensor.

IMPORTANT

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

Specifying Model 8972 DC/RMS Unit settings

 > [Channel] > [8972]



1 Select a measurement mode in [Mode].

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

DC <input checked="" type="checkbox"/>	For voltage measurement
RMS	For RMS measurement

2 Select a response time setting in [Response].

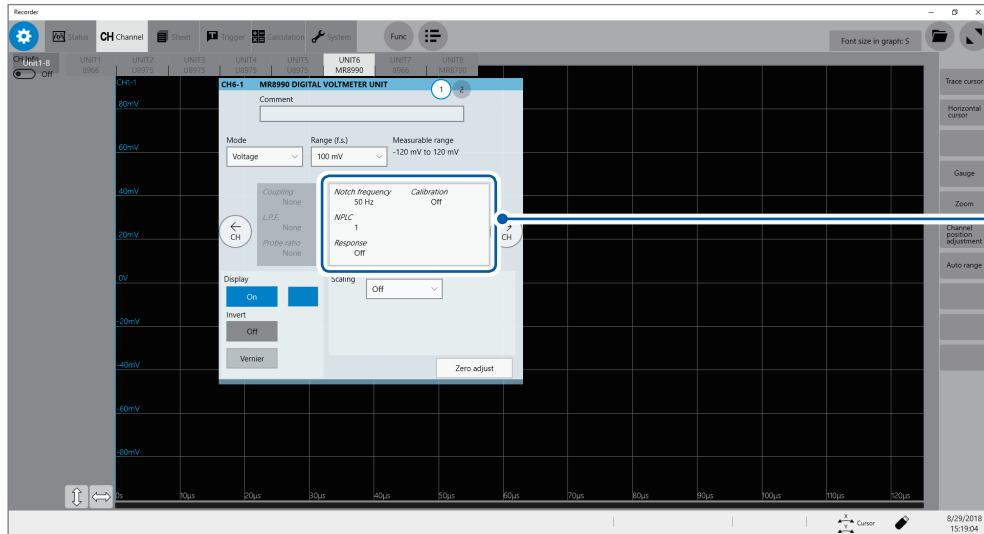
Select a response time setting for RMS measurement.

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 <input checked="" type="checkbox"/>	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.

Specifying Model MR8990 Digital Voltmeter Unit settings

 > [Channel] > [MR8990]



1
to
4

3

Advanced Functions

1 Select a notch frequency in [Notch frequency].

Allows you to specify a power frequency.
Specify a power frequency according to the power frequency in your region.

50 Hz <input checked="" type="checkbox"/>	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 Select an integration time in [NPLC].

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

0.1 to 0.9, 1 <input checked="" type="checkbox"/> 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 is obtained.
The measured data update rate is calculated to be 200 ms.

(Increasing NPLC may reduce fluctuation in measured values caused due to exogenous noise or an EMC environment.)

3 Select a high-speed response setting in [Response].

Data can be updated at high speed.

Off <input checked="" type="checkbox"/>	Updates data at intervals of the integration time specified under NPLC.
On	Calculates the moving average and thereby updates the data at high speed. <ul style="list-style-type: none"> • 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 Select a calibration setting in [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 <input type="checkbox"/>	Does not calibrate the module nor synchronize the channels.
On <input type="checkbox"/>	Calibrates the instrument and synchronizes the channels.
Synchronization <input type="checkbox"/>	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*.

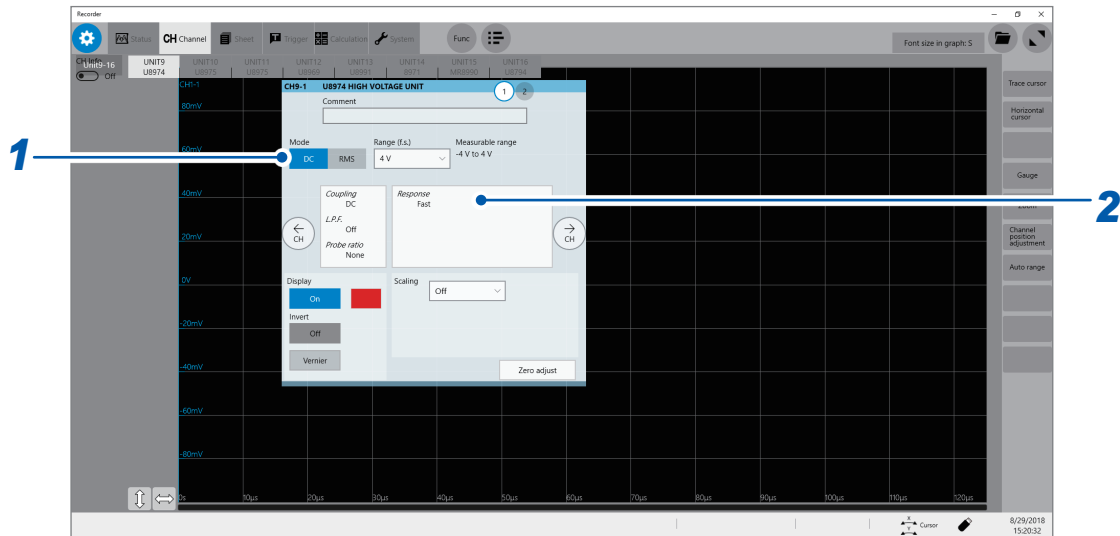
*: The integration time varies depending on the NPLC setting.

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 “2.9 Executing Calibration (When Model MR8990 is Installed)” in Quick Start Manual.

Specifying Model U8974 High Voltage Unit settings

 > [Channel] > [U8974]



1 Select a measurement mode in [Mode].

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

DC <input checked="" type="checkbox"/>	For voltage measurement
RMS	RMS measurement

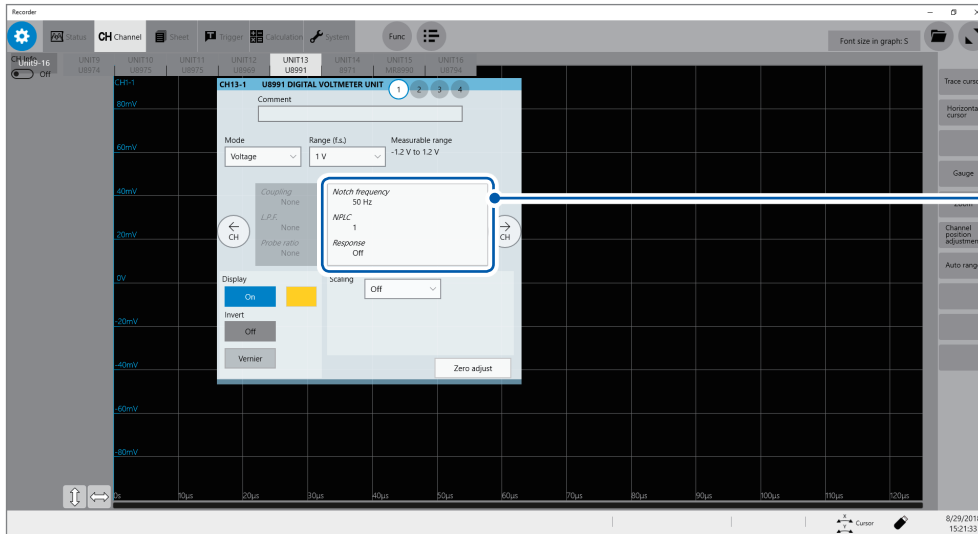
2 Select a response time setting in [Response].

Select a response time setting 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 <input checked="" type="checkbox"/>	Sets the response time to 150 ms.
Normal	Sets the response time to 500 ms.
Slow	Sets the response time to 2.5 s.

Specifying Model U8991 Digital Voltmeter Unit settings

 > [Channel] > [U8991]



1 Select a notch frequency in [Notch frequency].

Allows you to specify a power frequency.
Specify a power frequency according to the power frequency in your region.

50 Hz <input checked="" type="checkbox"/>	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 Select an integration time in [NPLC].

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

1 <input checked="" type="checkbox"/> , 10, 100
--

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

(Increasing NPLC may reduce fluctuation in measured values caused due to exogenous noise or an EMC environment.

3 Select a high-speed response setting in [Response].

Data can be updated at high speed.

Off <input checked="" type="checkbox"/>	Updates data at intervals of the integration time specified under NPLC.
On	Calculates moving averages every 1 PLC and updates the data.

Specifying Model MR8790 Waveform Generator Unit setting

The setting of Model MR8790 Waveform Generator Unit is specified via communication commands. For more information about the commands, refer to the Communications Command Instruction Manual on the accompanying application disc.

Channels in which Model MR8790 is installed cannot be used for measurement.

Type

Allows you to choose a waveform type.

DC [☑]	Outputs a DC signal.
Sine wave	Outputs a sine wave signal.

Frequency

Allows you to type an output signal frequency.

0 Hz to 20000 Hz

Amplitude

Allows you to type an output signal amplitude.

Accuracy of the output voltage, which consists of amplitude and an offset value, is guaranteed in the range between -10 V and +10 V.

An output waveform will appear with its upper parts limited to about +14 V and lower about -14 V when the sum of the amplitude and offset value is set to out of the accuracy-guaranteed range.

0.000 V p-p to 20.000 V p-p

Offset

When **[Type]** is set to **[DC]** Allows you to type a DC voltage.

When **[Type]** is set to **[Sine wave]** Allows you to type an offset voltage.

Accuracy of the output voltage, which consists of amplitude and an offset value, is guaranteed in the range between -10 V and +10 V. An output waveform will appear with its upper parts limited to about +14 V and lower about -14 V when the sum of the amplitude and offset value is set to out of the accuracy-guaranteed range.

-10.000 V to +10.000 V

Output

Allows you to switch waveform output settings.

Off [☑]	Does not output a waveform
On	Outputs a waveform

Output terminal state

Allows you to choose an output terminal status with the output turned off.

Open [☑]	Disconnect the output terminals from the internal circuit and opens the terminal.
Short	Disconnect the output terminals from the internal circuit and short-circuits the terminal.

Specifying Model MR8791 Pulse Generator Unit settings

The setting of Model MR8791 Pulse Generator Unit is specified via communication commands. For more information about the commands, refer to the Communications Command Instruction Manual on the accompanying application disc.

Channels in which Model MR8791 is installed cannot be used for measurement.

Mode

Allows you to choose an output type.

Pulse <input checked="" type="checkbox"/>	Outputs a pulse waveform.
Pattern	Outputs a pattern waveform.

For more information about details of the pattern output setting, see the instruction manuals of Model U8793, Model MR8790, and Model MR8791.

Frequency

Allows you to specify a pulse output frequency.

0.0 Hz to 20000.0 Hz

Duty ratio

Allows you to specify a pulse duty ratio.

0.0% to 100.0%

Output

Allows you to switch a waveform output.

Off <input checked="" type="checkbox"/>	Outputs a waveform
On	Outputs a waveform

Output configuration

Allows you to choose an output status.

TTL <input checked="" type="checkbox"/>	TTL-level output (amplitude: 0-5 V)
OC	Open-collector output

Specifying Model U8794 VIR Generator Unit settings

The setting of Model U8794 VIR Generator Unit is specified via communication commands. For more information about the communications commands, refer to the Communications Command Instruction Manual on the accompanying application disc.

Channels in which Model U8794 is installed cannot be used for measurement.

Type

Allows you to choose an output type.

V [Ⓜ]	DC voltage
I	DC current
R	Resistance (simulated)
AC	AC voltage

Voltage output

Outputs a DC voltage.

-0.1 V to 5.3 V

The output current range is from -5 mA to +5 mA.

IMPORTANT

The instrument accepts a load resistance of 1 kΩ or more. Do not connect a load with a resistance less than the acceptable load resistance or short-circuit the output terminal. The instrument may be damaged.

Current output

Outputs a DC current.

-5 mA to +5 mA

The output voltage range is from -0.1 V to +5.3 V.

The instrument switches generation ranges to an appropriate range based on the specified current value.

-5 mA to -1 mA, 1 mA to 5 mA	5 mA range
-1 mA to -250 μA, 250 μA to 1 mA	1 mA range
-250 μA to -50 μA, 50 μA to 250 μA	250 μA range
-50 μA to 50 μA	50 μA range

You can check the current-generation range by sending a command.

Resistance generation

Resistance generation method

The instrument uses an electric circuit to simulate resistance generation. The instrument generates a current $I_{out} = V_{meas} / R_{set}$ based on an output terminal voltage V_{meas} and a specified resistance value R_{set} .

10 Ω to 1 M Ω

IMPORTANT

The instrument cannot generate a set resistance value under any one of the following conditions:

- If the instrument is connected to a measuring instrument that outputs a constant current to measure the resistance of a target based on the voltage across both ends of the target (Example: workbench-type digital multi-meter)
- If the voltage on the OUTPUT terminal exceeds the range between 0 V and 5 V
- If the current outputted from the instrument exceeds the range between -5 mA and 5 mA

Optimizing a resistance generation response

Presuming the characteristic of a measurement target

The resistance generation function of the instrument can presume the characteristic of a measurement target and optimize a resistance generation response based on the presumed result.

IMPORTANT

- When a connected target has an output resistance of less than 1 k Ω , a current that exceeds the specification will flow, resulting in damage to the instrument and the connected target.
- A time required for presumption varies depending on the characteristic of a connected target. It must take 1.6 seconds at a maximum.
- When you exchange connected targets, execute presumption of the connected target again or restore the presumption result of the connected target to the default.

Manually optimizing a resistance generation response

You can use the response coefficient command to regulate a response.

Lowering the response coefficient, which causes a slower response however, can prevent oscillations and overshoots.

IMPORTANT

When you adjust a response coefficient manually, specify an appropriate response coefficient while observing waveforms with another instrument such as an oscilloscope.

Voltage generation and measurement function

Outputting a DC voltage

The instrument can output a sine wave with a DC voltage superimposed.

DC offset voltage	0.1 V to 2.5 V
Amplitude	0.1 Vp-p to 5.0 Vp-p
Frequency	10 Hz, 20 Hz, 50 Hz, 100 Hz

IMPORTANT

- If you select a frequency other than the frequencies that can be specified, the instrument sets a frequency to the one that is the closest.
- The instrument accepts a load resistance of 1 k Ω or more. Do not connect a load with a resistance less than the acceptable load resistance or short-circuit the output terminal. The instrument may be damaged.

Measuring AC currents

The instrument can measure a difference between the maximum and minimum values of the most recent three waves.

Switching the OUTPUT terminal

Switching the OUTPUT terminal status

You can switch between the short-circuited state and open state for the OUTPUT terminal.

OPEN	Disconnects the OUTPUT terminal from the output circuit and the GND terminal.
SHORT	Connects the OUTPUT terminal with the GND terminal.
NORMAL	Connects the OUTPUT terminal with the internal output circuit.

Terminal setting	Internal circuit
OPEN	
SHORT	
NORMAL	

IMPORTANT
 Do not set the OUTPUT terminal status to SHORT when a power supply device connects with the OUTPUT terminal. A short-circuit current will flow, resulting in damage to the instrument or power supply device.

Self-diagnosis function

Simple test

At a time when you have sent a query for testing, the instrument measures an output value of the instrument with the internal measuring circuit and return the specified value and a measured value. For the voltage output setting, the instrument sends back the specified voltage and a measured voltage value. For the current output setting, the instrument sends back the specified current and a measured current value.

Comprehensive test

The instrument outputs the following voltages and currents of each output function and each generation range, measuring them with the internal measurement circuit. Then, the instrument sends back measured values of each output value.

Output item	Generation range	Measurement range	Output testing point
Voltage	5 V	0.5 V	0 V
			0.5 V
		5 V	0 V
			5 V
Current	5 mA	5 mA	5 mA
			1.1 mA
	1 mA	1 mA	1 mA
			275 μ A
	250 μ A	250 μ A	250 μ A
			55 μ A
	50 μ A	50 μ A	50 μ A
			0 μ A

IMPORTANT

Do not connect anything with the OUTPUT terminal during comprehensive tests. The instrument outputs a zero-volt signal and connects the OUTPUT terminal with the GND terminal (in the short-circuit state) during the comprehensive tests. If a power supply device is connected with the instrument, a short-circuit current will flow, resulting in damage to the instrument or the power supply device. The comprehensive test results may be affected depending on devices connected.

Offset canceling function**Regulating the zero point of the output circuit**

The instrument measures an output circuit offset with the internal measurement circuit and outputs a value the offset value is subtracted from.

IMPORTANT

Do not connect anything with the OUTPUT terminal during an offset measurement. The instrument outputs a zero-volt signal and connects the OUTPUT terminal with the GND terminal (in the short-circuit state) during the offset measurement. If a power supply device connects with the instrument, a short-circuit current will flow, resulting in damage to the instrument or power supply device. The offset value may be affected depending on devices connected.

To perform precise measurements

IMPORTANT

Be careful of the following points when the instrument is set outputting a current of 100 μA or less with the current output function or generating a resistance of 50 $\text{k}\Omega$ or more with the resistance generation function, or when a device connected with the instrument has an output resistance of 50 $\text{k}\Omega$.

- We recommend you to use measurement cables with an insulating sheath made of polyethylene (PE) or Teflon* (TFE). Using measurement cables with a low-resistance insulating sheath will increase leak currents, with the result that accuracy is affected significantly.
- The instrument will become susceptible to exogenous noise. We recommend you to use shielded measurement cables or connect a capacitor between the OUTPUT terminal and GND terminal.

*: Trademark of another company

4

Saving/Loading Data and Managing Files

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

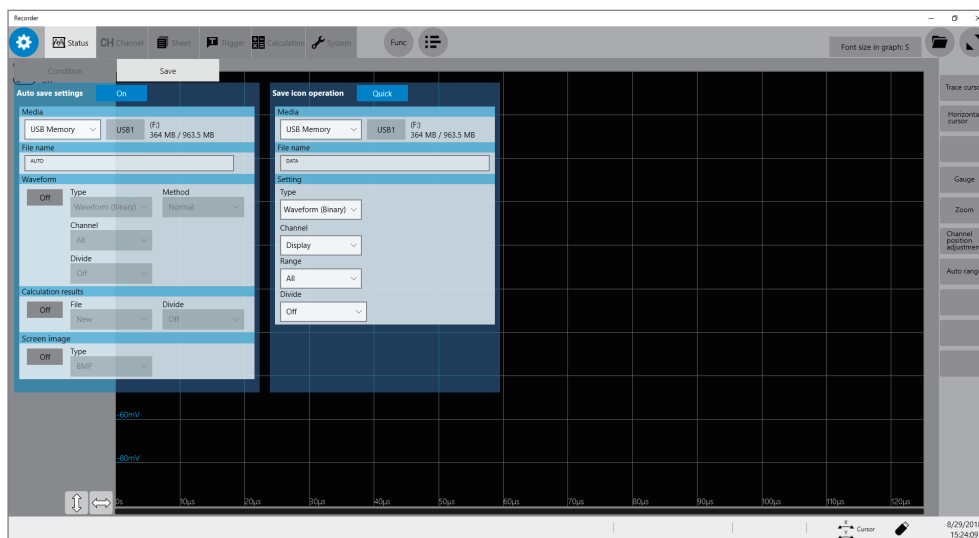
Before saving data, specify the save setting on the **[Save]** screen, which is accessible by tracking in the following order: **[Status]** > **[Save]**

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

Specifying the auto-save method settings for measured data (p. 70)

Save icon operation

- Allows you to select an action to be taken when you click the save icon. (p. 74)
- Specifying 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.

✓: Enable, –: Disable

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 trace cursors (acquired in the instrument)	Binary	MEM	Binary data	✓	✓	✓	– * 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	JPEG	Image data (JPEG format)	✓	✓	–	✓
Numerical calculation result:	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. 69)

To save a part of waveforms: Specify a saving range with section cursors. (p. 20)

*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® image file format in which various graphics programs can open files
Various graphics programs can open these files.

PNG format: Internationally standardized image file format conforming to ISO/IEC15948

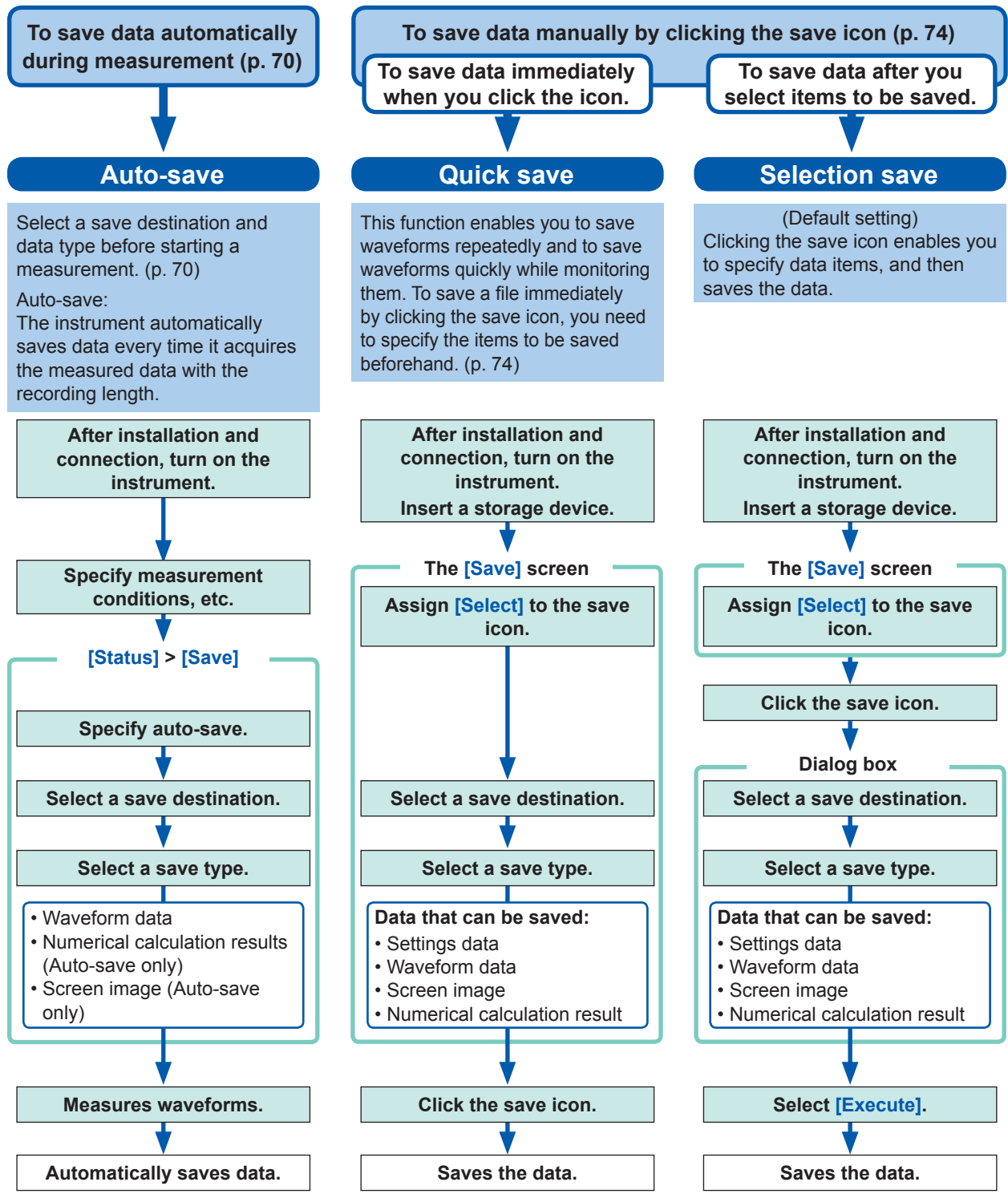
JPEG format: Internationally standardized image file format conforming to ISO/IEC10918

*6: When one of the separators other than [Comma ,] is selected in [Region], files are saved with the .TXT extension. (p. 157)

4.2 Saving Data

Saving types and setting procedure

There are mainly three types of saving operation.



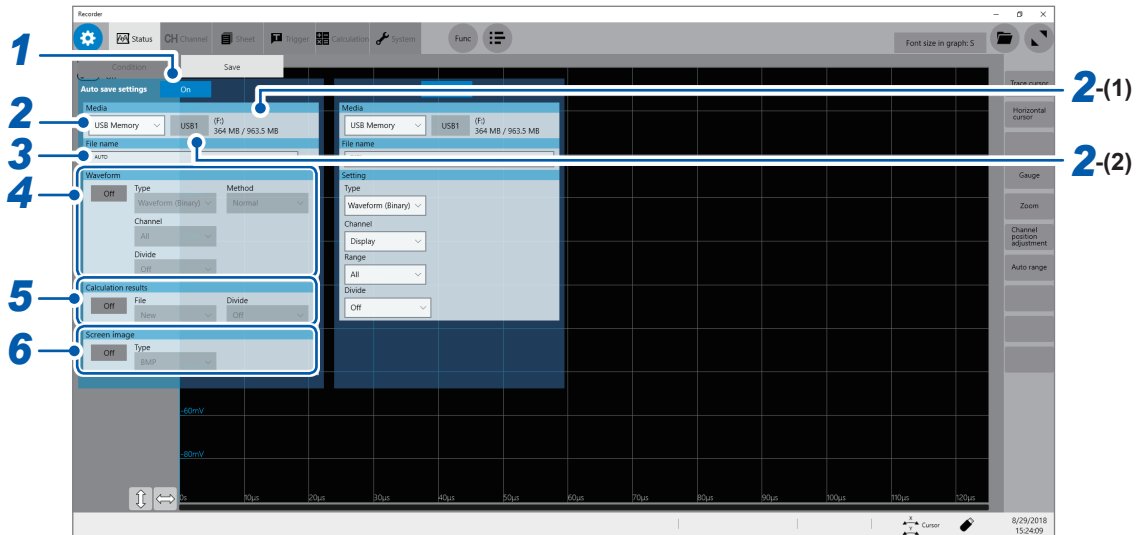
Check the following before saving data:

- Have you already inserted and initialized the storage device?
Refer to “Formatting Media” in “2.5 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]?

Automatically saving waveform data

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

 > [Status] > [Save]



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

2 Select a save destination in [Media].

SSD/HDD <input checked="" type="checkbox"/>	Built-in SSD
USB flash drive	USB flash drive
E-mail transmission	Sends measured data to a PC in the network or to a remote PC as an email attachment.
FTP transfer:	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 appears on the right. If no storage device is inserted, [None] appears.

(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_MR8740T] 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 result: MEASURE

Screen image: PICT

When [FTP] is selected, specify the LAN and FTP client function settings.

Refer to “Specifying the LAN settings with the instrument” (p. 168) and “11.3 Sending Data to a PC With the FTP Client Function” (p. 178).

- Use Model Z4006 USB Drive (Hioki's option) for protecting data.

3 Type a file name in [File name].

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

4 Select a wave saving setting in [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]

Select an action 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.
Older-file overwriting	Deletes old files and continues the auto-save even when the storage device is full (waveform files only). The instrument deletes files only created after the measurement has started. It does not delete previously existing files.

[Channel]

All [☐]	Saves measured data of all channels. Saves the data acquired across the channels the waveform display of which is set to [Off] .
Display	Saves the data acquired across 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 size specified. The instrument creates a folder with the name specified, 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 according to data (row) specified.

[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 you specify **[2]**, every two data points are saved. The number of data points is reduced by half of the original amount.

5 Select a calculation result setting in **[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 Select a screen image saving setting in **[Screen image]**.

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

[Type]

BMP, PNG, JPEG

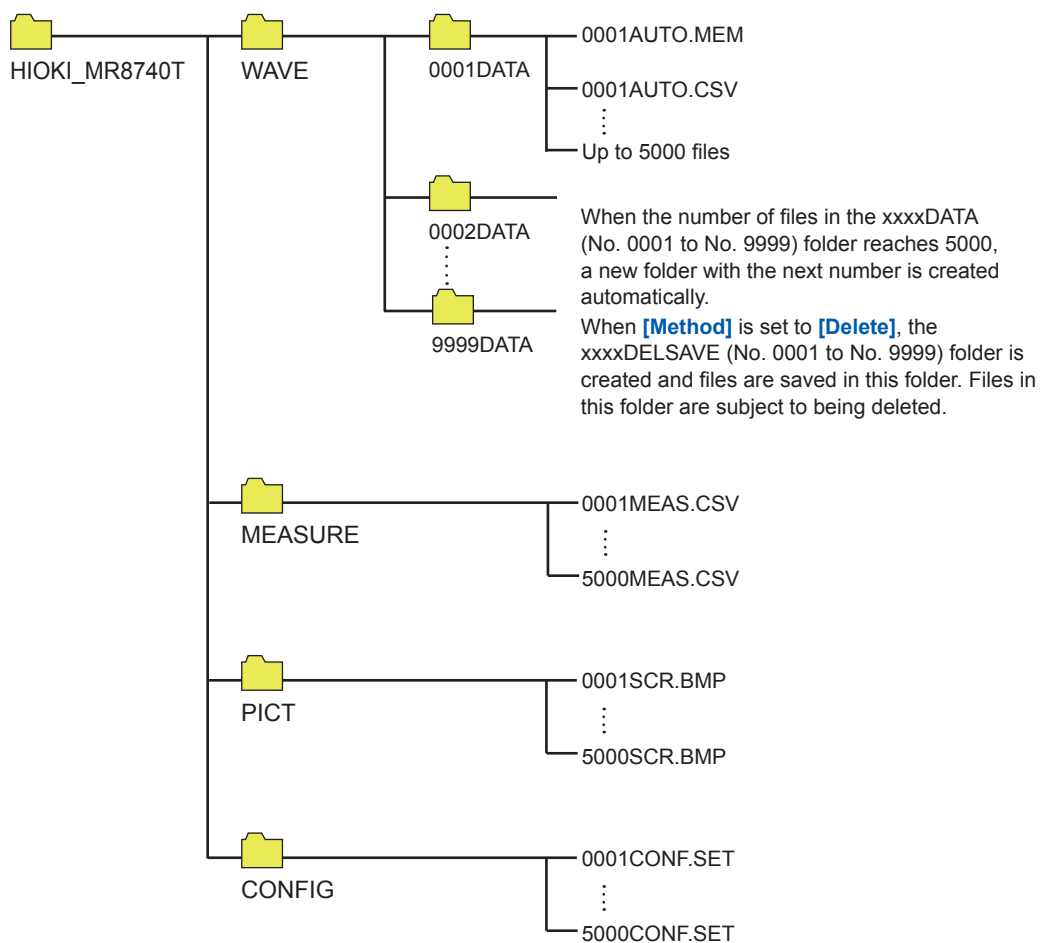
When data in text format or numerical calculation results are selected to be saved

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_MR8740T” as follows.
Every folder can retain up to 5000 files and folders collectively.

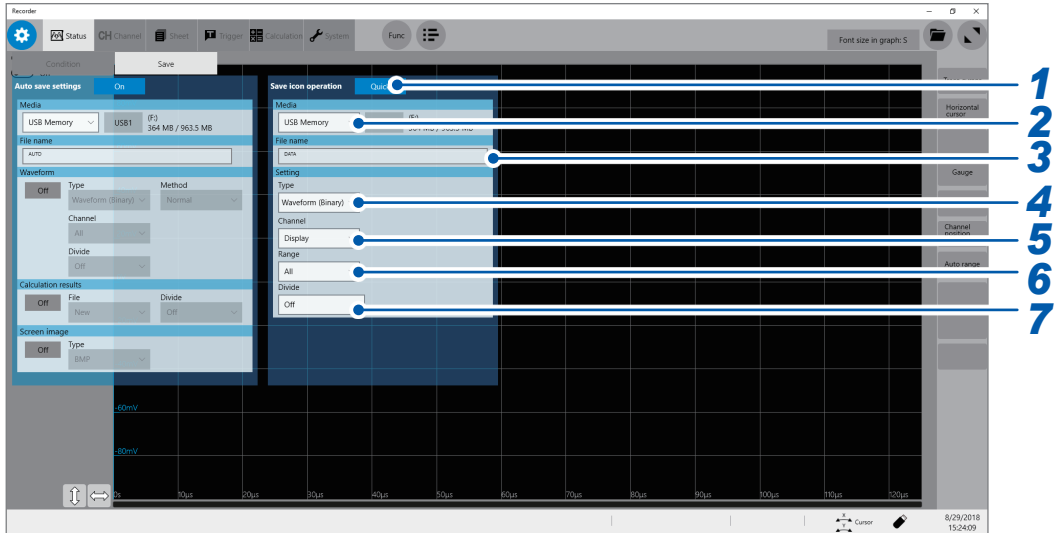


Freely selecting data items to be saved and save files (save icon)

To save a file immediately by clicking the save icon, you need to specify items to be saved beforehand.

You can save the following types of data: (Setting data, waveform data, screenshot, and numerical calculation results)

 > [Status] > [Save]



1 Select a save icon operation in [Save icon operation].

Allows you to select a save method implemented when the save icon is clicked.

Select <input checked="" type="checkbox"/>	Displays the dialog box to allow you to select items to be saved and saves them. Refer to “Selection save” (p. 69).
Quick save:	Saves data consisting of pre-specified items immediately. Refer to “Quick save” (p. 69).

When [Select] is selected, you can specify the subsequent settings in the dialog box that appears when you click the save icon at the start of measurement. This operation cannot be executed if another dialog box is open.

2 Select a save destination in [Media] (Refer to p. 70).

3 Type the file name in [File name].

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

4 Select a save type in [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. The data saved can be viewed on a computer with image viewing software.
Numerical calculation result:	Saves numerical calculation results.
Setting	Saves the present measurement conditions.

5 Select a save channel setting in [Channel].

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

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

6 Select a save range setting in [Range].

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

All [□]	Saves all the data written in the memory.
A_B	Saves the data in the section between trace cursors [A] and [B] .
C_D	Saves the data in the section between trace cursors [C] and [D] .

The instrument saves the data acquired across the channels displayed on the screen.
When no target trace cursors are set, all data is saved even if **[A_B]** or **[C_D]** is selected.

7 Select a file division setting in [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. A file is divided into several files each of which has the size specified. The instrument creates a folder with the name specified, 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.

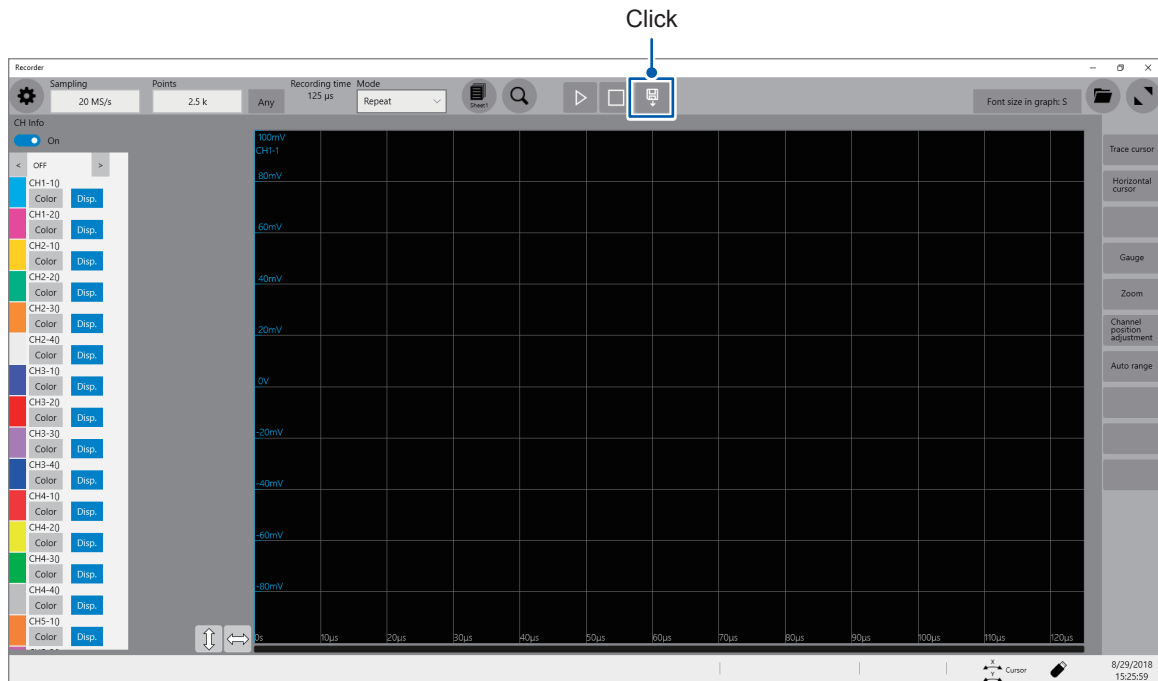
When [Type] is set to **[Waveform (Text)]**.

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 Specify detail settings for each saving type in [Type].

Saving format	Setting		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 you specify [2], every two data points are saved. The number of data points is reduced by half of the original amount.
	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.
Numerical calculation result	File designation	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.
	File division	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 you click the save icon, the instrument saves data in the setting specified.



4.3 Loading Data

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

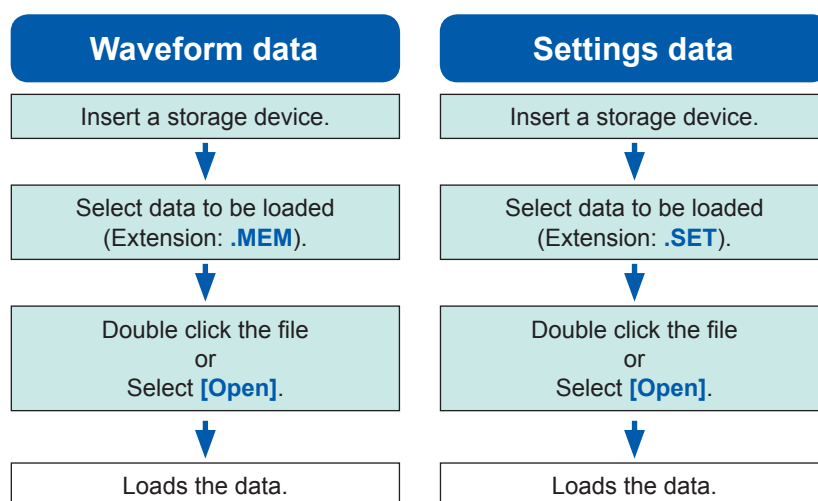
Data loading procedure

Before attempting to load the data, make sure that a storage device is inserted, and the save destination is correctly specified.

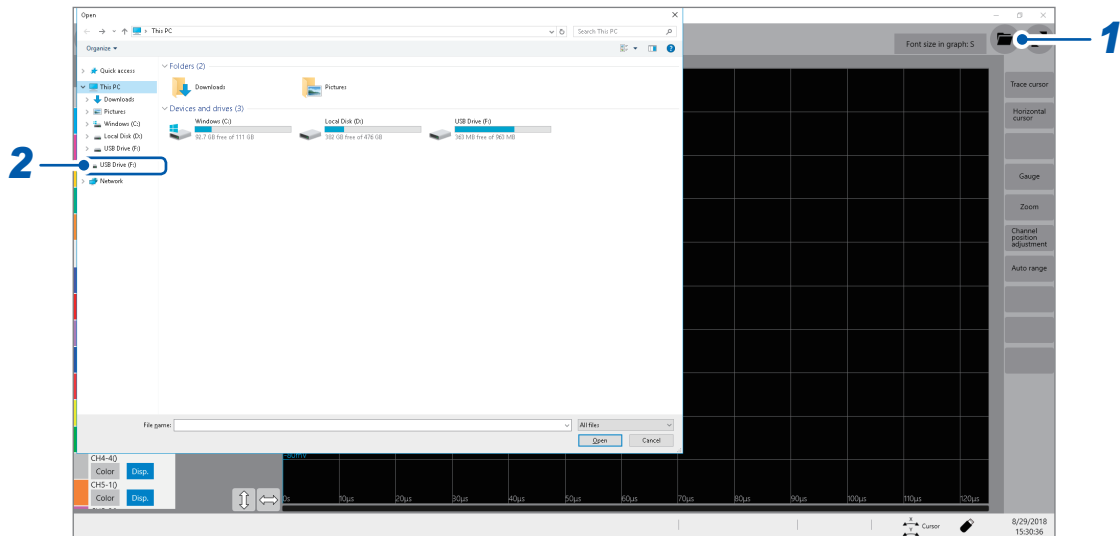
Open the file screen, select a storage device, and double-click the file to be loaded.

Waveform and settings files saved in waveform (binary) format can be loaded on the instrument.

Only files that can be loaded on the instrument appear 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 MR8740T 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 Quick Start Manual.).
- Loading a waveform file suspends the waveform monitor until one of the following actions is performed:
 - Start a measurement.
 - Initializing the instrument by executing **[Initialize waveform data]**, **[Initialize Settings]**, or **[Initialize all]**
 - Loading a setting file

Automatically loading the settings (Auto-setup function)

The instrument loads the setting data with the file name “STARTUP” stored in the **[CONFIG]** folder in the **[HIOKI_MR8740T]** 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

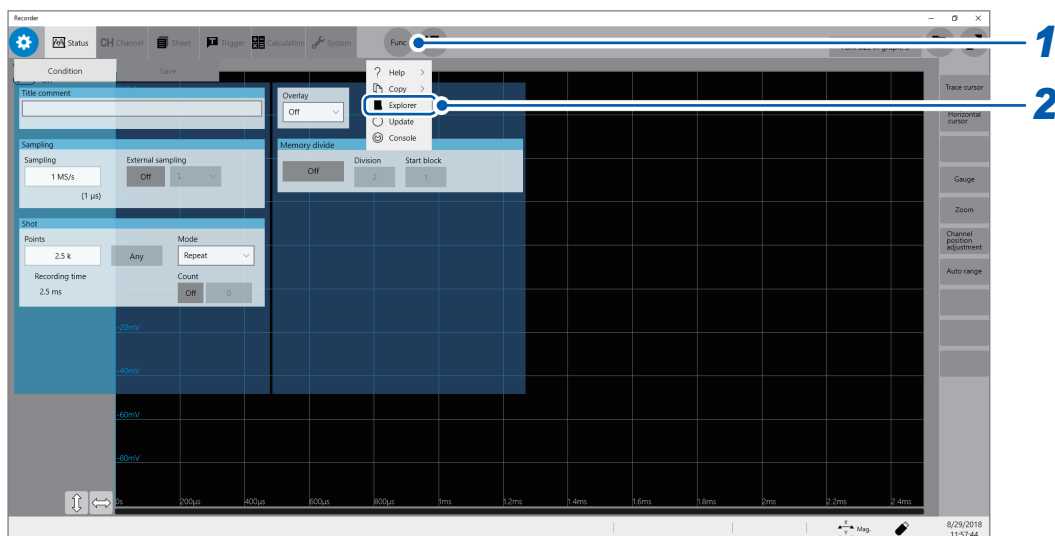
Opening the explorer allows you to manage data saved in storage devices.

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.
Format	A storage device can be formatted.

4

To open the explorer



- 1** Click [Func].
- 2** Select [Explorer].
Explorer appears.
Select a storage device to be operated.

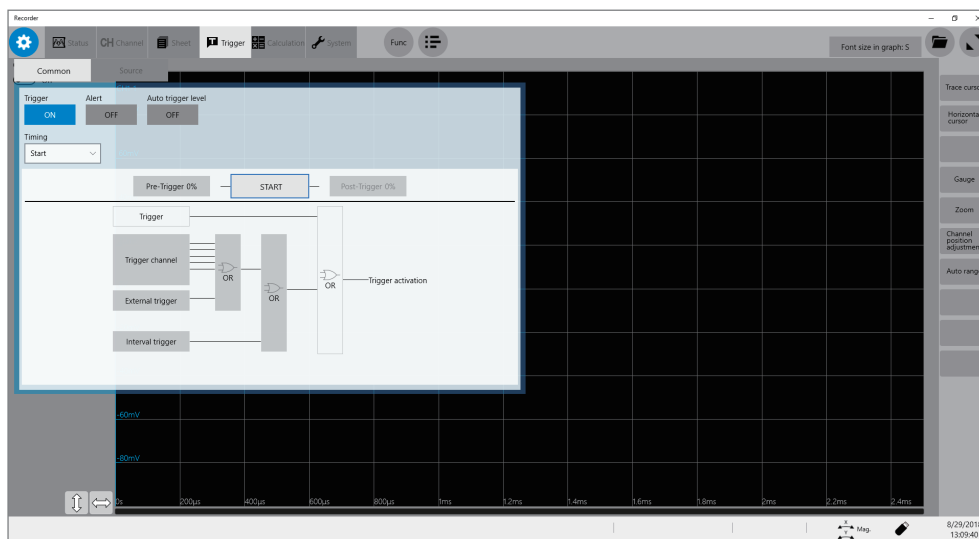
5 Specifying the Trigger Settings

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 called “The instrument is triggered.”

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

Specifying the trigger setting

- Trigger timing (p. 84)
- Pre-Trigger (p. 86)
- Trigger logical-condition (logical AND or OR) among the trigger sources (p. 89)

Specifying the trigger source settings

Specifying the analog trigger settings (p. 90)

- Level trigger
- Window trigger
- Period trigger
- Glitch trigger
- Voltage drop trigger

Specifying the interval trigger settings (p. 100)

Specifying the external trigger settings (p. 102)

Forcible trigger (p. 102)

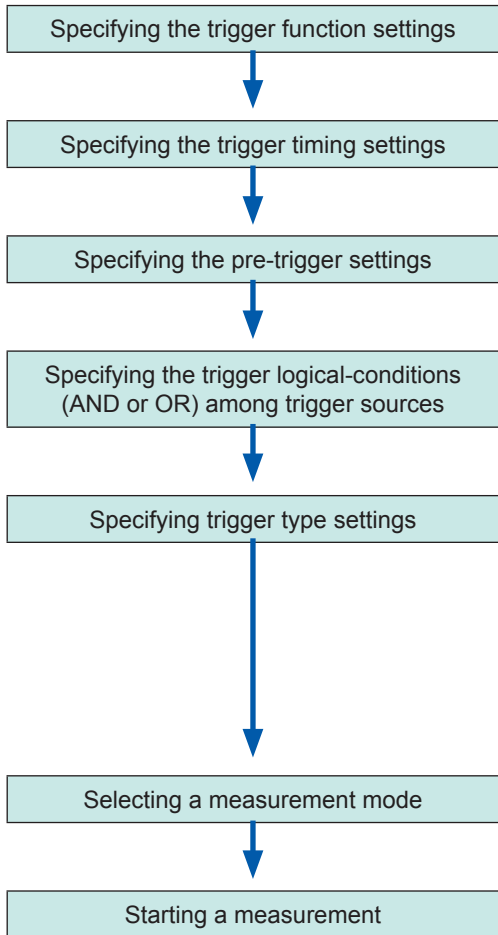
Specifying the logic trigger settings (p. 98)

- Logic-trigger satisfying conditions
- Trigger filter
- Trigger pattern

Trigger output (p. 195)

5.1 Trigger Setting Procedure

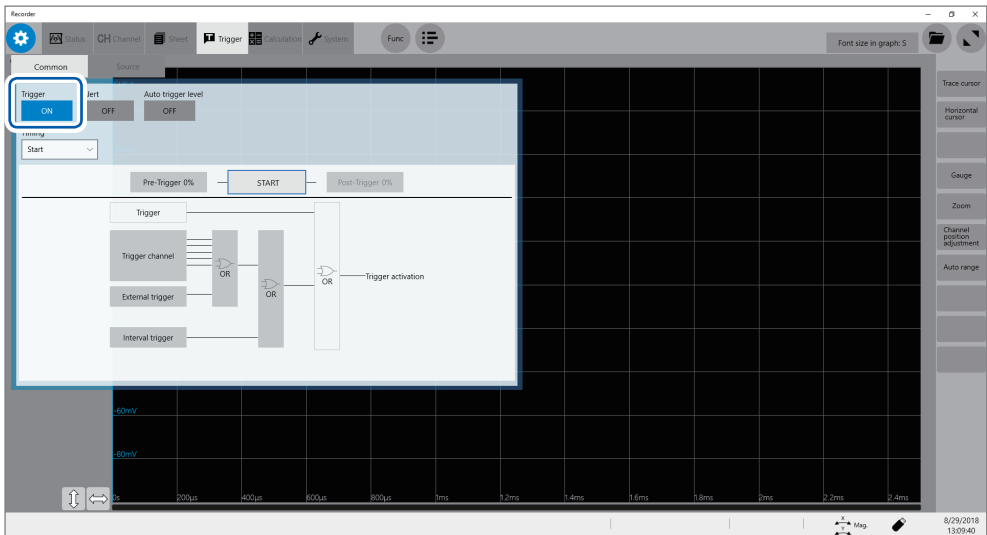
- The instrument is triggered based on the trigger conditions (logical AND or logical OR) among trigger sources except for the forcible trigger. (p. 89)
- When triggered, the instrument outputs the TRIG OUT signal from the external control terminal. (p. 195)



Enable the trigger function.	(p. 83)
Specify the start/stop timing of recordings controlled by triggers.	(p. 84)
Specify a recording length preceding the start trigger point.	(p. 86)
Specifying the trigger logical-conditions (AND or OR) among the analog, logic, external, and interval triggers to trigger the instrument.	(p. 89)
Specify the trigger-source-specified trigger conditions.	
• Analog trigger	(p. 90)
• Logic trigger	(p. 98)
• Interval trigger	(p. 100)
• External trigger	(p. 102)
• Forcible trigger	(p. 102)
Specify whether the instrument repeatedly waits for a trigger after a measurement has been stopped or not.	(p. 6)
Clicking the start icon starts a measurement. (The key green LED lights up.) When the trigger conditions are satisfied, the instrument starts to acquire data.	
To stop the measurement, click the stop icon. Click the icon once: Stops the measurement after data with the specified recording length has been acquired. Click the icon twice: Immediately stops the recording.	

5.2 Enabling the Trigger Function

 > [Trigger] > [Common]



Set [Trigger] to [ON].

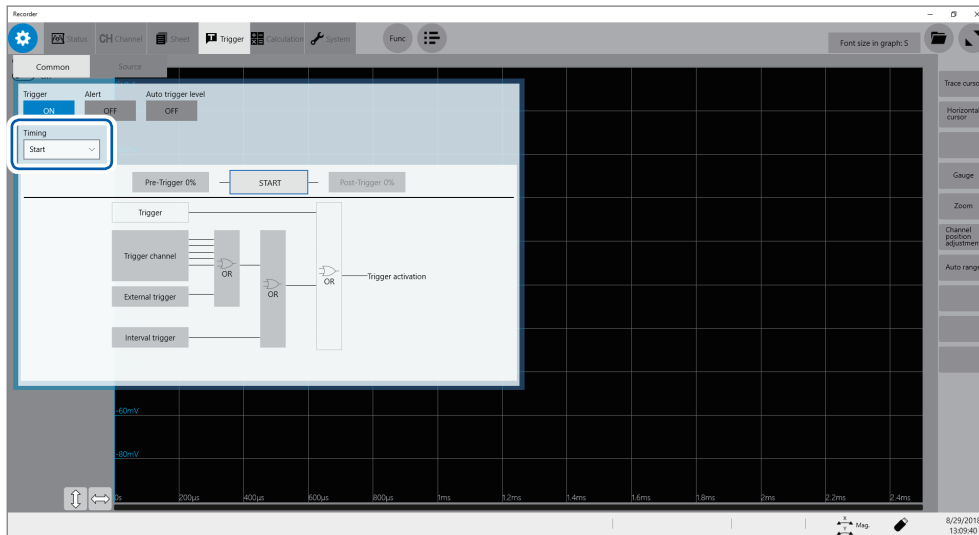
On <input checked="" type="checkbox"/>	Enables the trigger function.
Off	Disables the trigger function.

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. 44).

5.3 Trigger timing

 > [Trigger] > [Common]

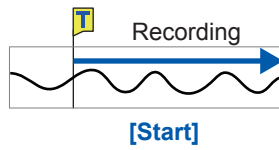


START

Starts a recording when triggered and stops the instrument has acquired waveforms with the recording length.

A displayed trigger point may lag behind the actual trigger point by some samples between one and four when measuring modules include any one of the following modules: Model U8975 4ch Analog Unit, Model MR8990 Digital Voltmeter, and Model U8991 Digital Voltmeter Unit.

Trigger timing



Starts recording

Starts recording when the instrument is triggered.

Stops the recording



When the mode is set to **[Single]**

Stops the recording after data with the specified recording length has been acquired.

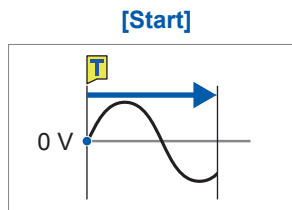
When the mode is set to **[Repeat]**

Starts recording, stops the recording after the data with the specified recording length has been acquired, and then waits for a trigger. When triggered again, starts recording, stops the recording after the data with the specified recording length has been acquired, and then waits for a trigger (repeats this sequence).

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]**



Records the data with the specified recording length.

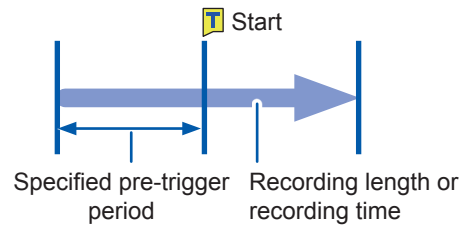
The above processes are repeated when the trigger mode is set to **[Repeat]**.

5.4 Specifying the Pre-trigger settings

Pre-Trigger

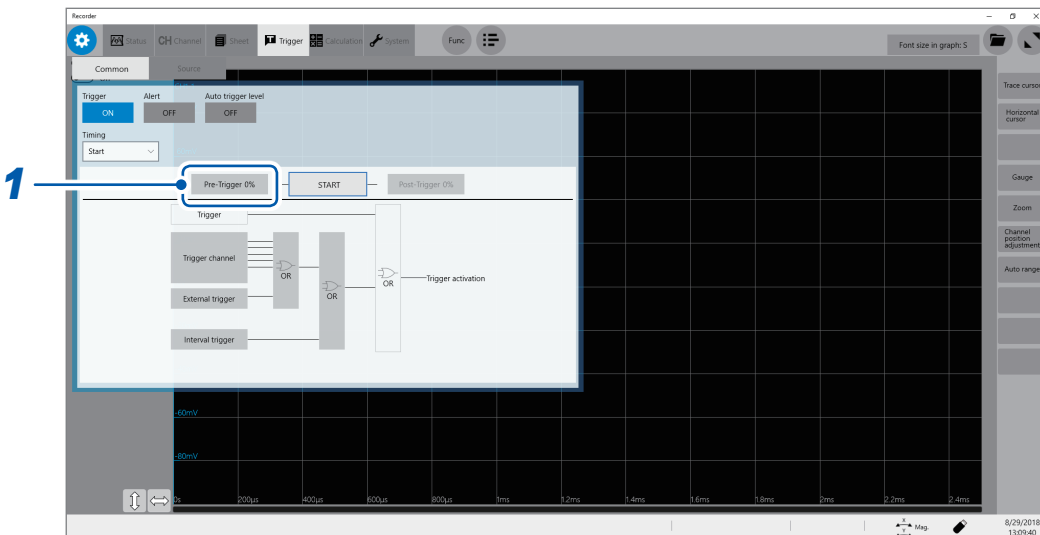
You can record not only the waveforms appearing after the start trigger has been activated, but also those appearing before the trigger is activated.

Also records the data before the start trigger.



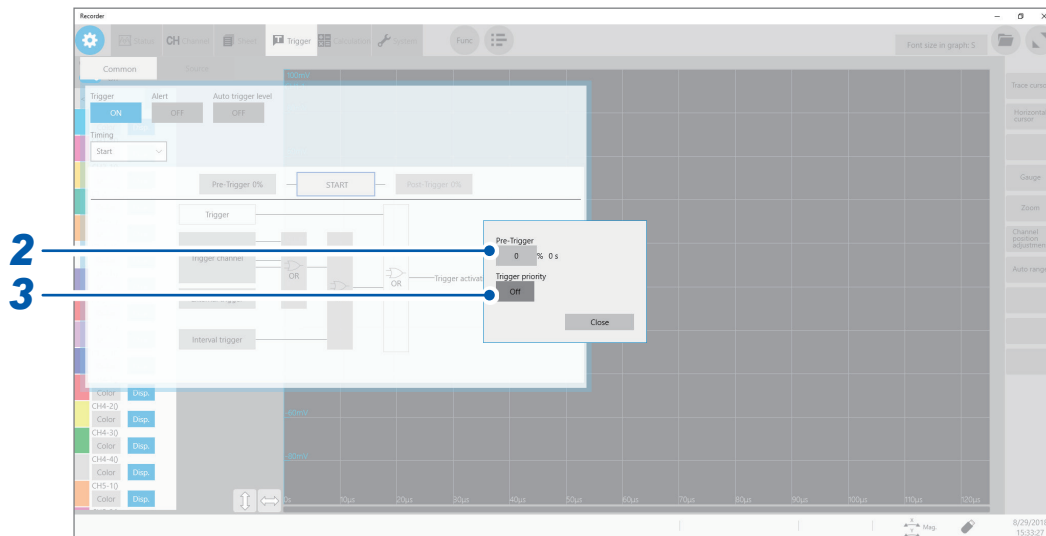
The pre-trigger and post-trigger are set in terms of percentage (%) relative to the recording length. Setting all the trigger sources (analog, interval triggers, etc.) to **[Off]** disables pre-trigger and post-trigger settings.

 > [Trigger] > [Common]

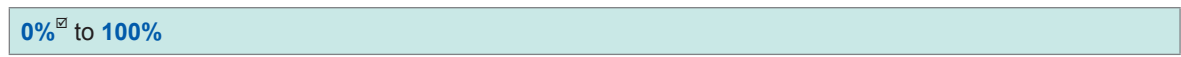


1 Click **[Pre-Trigger 0%]**.

The setting dialog box will appear.



2 Enter the pre-trigger length in **[Pre-Trigger]**.



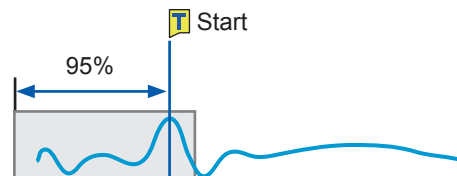
Difference between [Waiting for Pre-Trigger] and [Waiting for Trigger]

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.

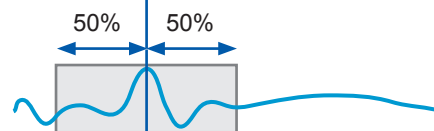
Pre-trigger and recording range

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

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



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



3 Select a trigger priority in **[Trigger priority]**.

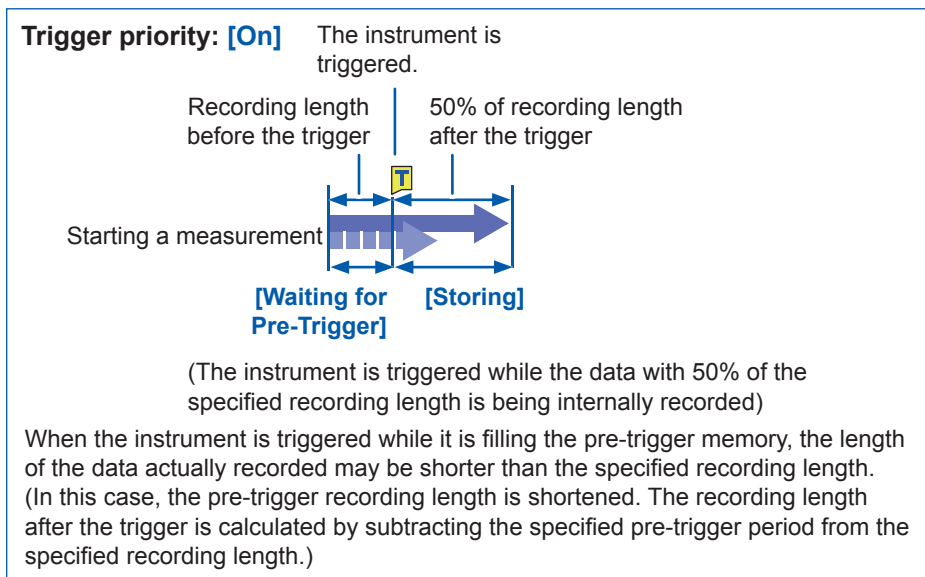
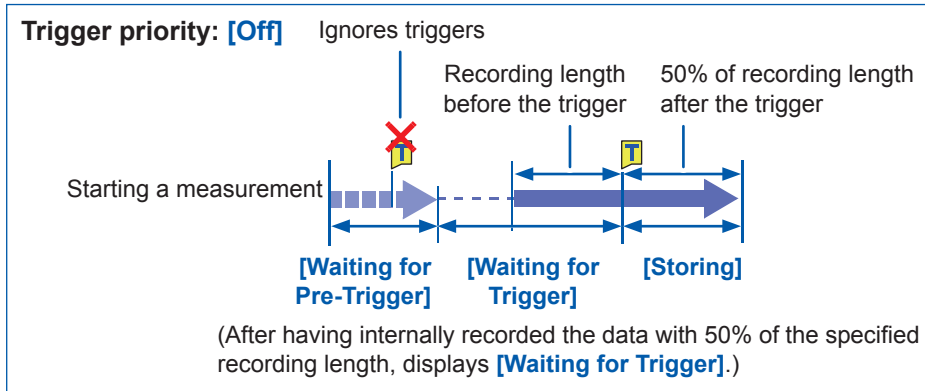
You can choose whether the instrument is triggered or not when the trigger conditions are satisfied while the instrument is filling the pre-trigger memory.

- 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]** appears on the screen.

Off <input type="checkbox"/>	Ignores triggers while filling the pre-trigger memory.
On <input type="checkbox"/>	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%

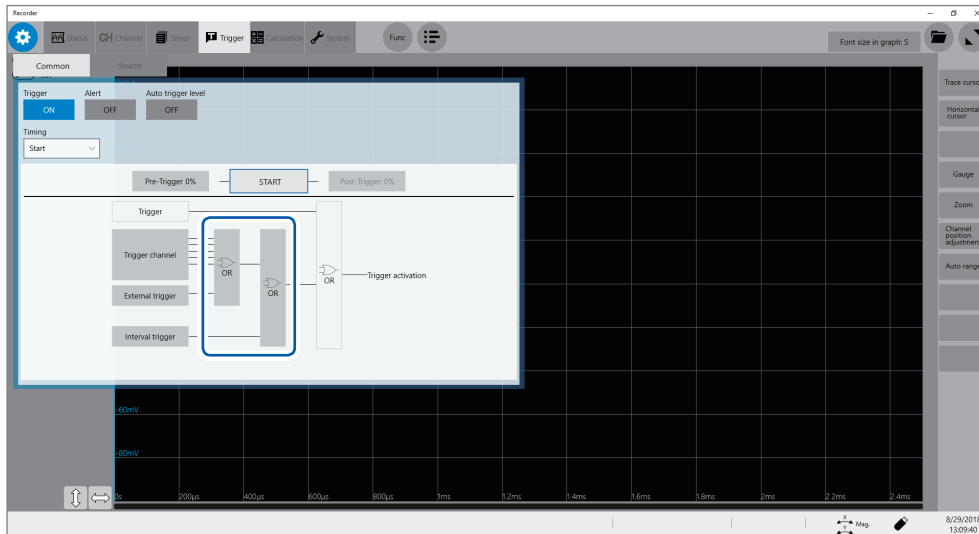


5.5 Specifying the Trigger Logical-Conditions (AND/OR) among Trigger Sources

Specify 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]



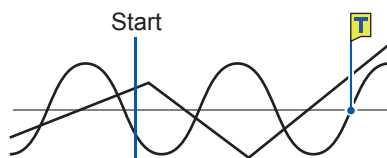
Click **[AND]** or **[OR]**, whichever appears, to switch to another.

OR <input checked="" type="checkbox"/>	When any one of the specified trigger conditions changes from not being satisfied to being 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 ([↗])*

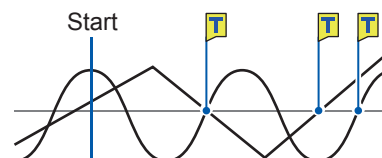
The instrument is triggered based on whether the trigger logical-condition is set to logical AND or OR in the following ways:

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]

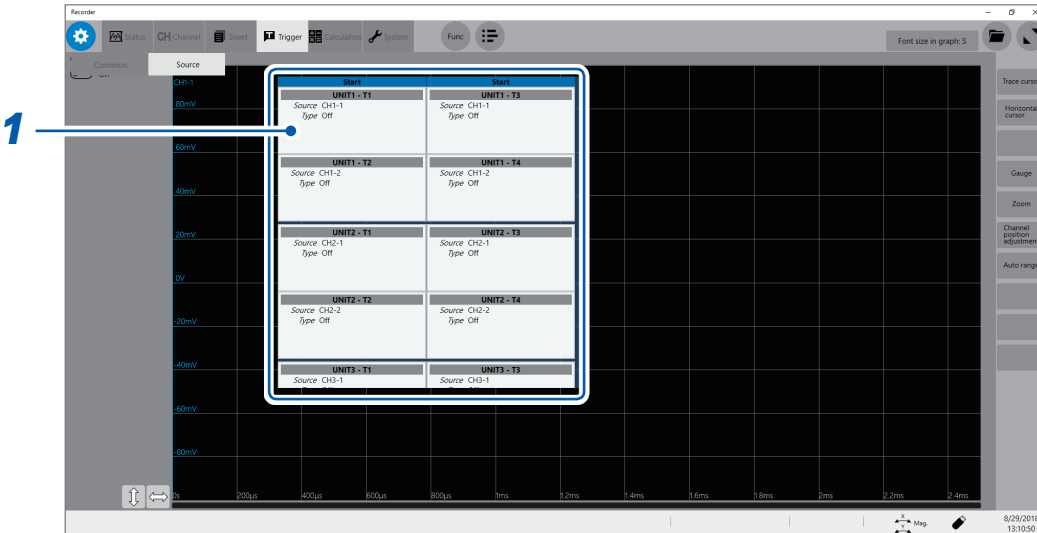
Either waveform crosses 0 V upwards.

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

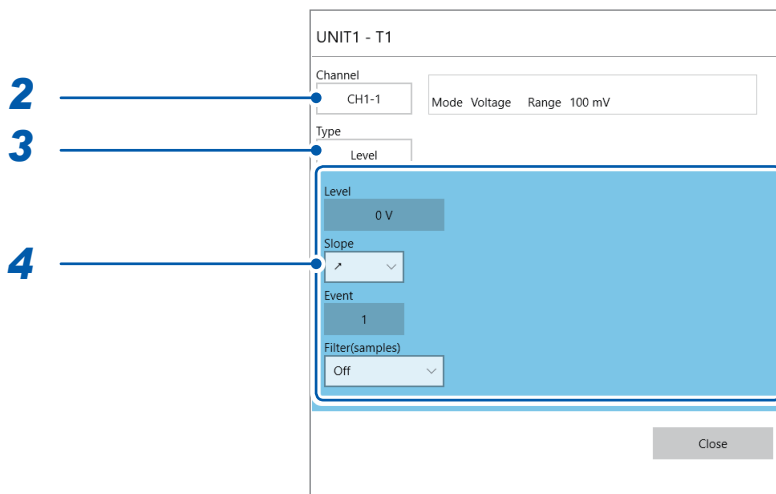
5.6 Triggering the Instrument Using Analog Signals

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

 > [Trigger] > [Source]



1 Click a trigger source you want to specify.
The setting dialog box will appear.



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

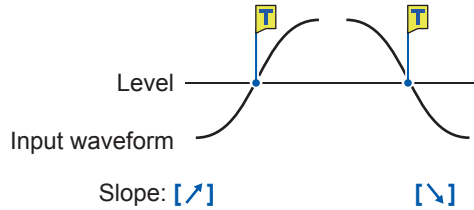
3 Select a type in [Type].

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

4 Specify trigger-type-specified settings.

1. [Level] trigger

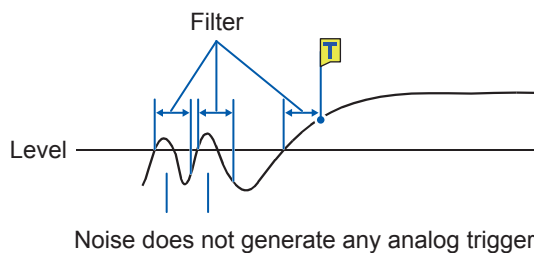
When an input signal crosses the specified level in the positive or negative direction, an analog trigger is generated.



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. An 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, an analog trigger is generated. Specifying this option prevents the instrument from being unintentionally triggered due to noise.	

With the [Filter] setting

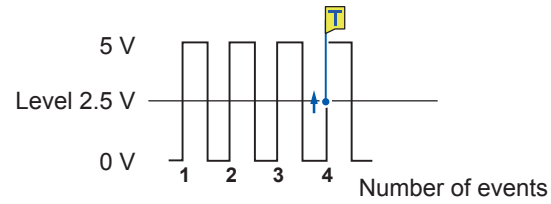
Specifying the filter duration prevents the analog trigger from being unintentionally generated due to noise, allowing it to be generated only after the level-trigger condition continues to be satisfied during the specified duration (period) or longer.



With the [Event] setting

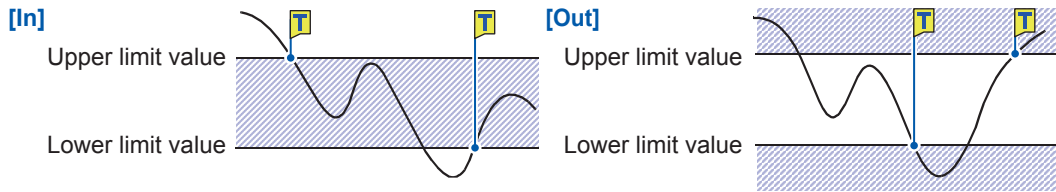
If the trigger condition is repeatedly satisfied, setting the number of events prevents an analog trigger from being generated until the number of times the level-trigger condition is satisfied reaches the specified count number.

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, an analog trigger is generated.



Setting		Description
Event	With OR	1 [□] to 4,000
	With AND	Not available
Filter Trigger 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, an analog trigger is generated. Specifying this option prevents the instrument from being unintentionally triggered due to noise.
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.
Auto-trigger level*	Off [□] , On	With the [On] setting, the instrument automatically specifies a reference level and is triggered when an input signal exceeds the range between the lower value, the sum of the reference level and the lower limit value, and the higher value, the sum of the reference level and the upper limit value. (p. 105) In [Level of the last time], the reference level used in the previous measurement appears.

*: Available for the out trigger function only

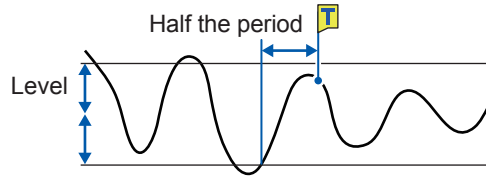
The behavior related to the in and out triggers varies depending on the trigger logical-conditions (AND and OR).

With OR	In	The window-trigger condition is satisfied when an 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 an 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 an 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 an 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 a 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 20 MS/s.

These triggers cannot be specified either when Model 8970, Model MR8990, or Model U8991 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	
Event	With OR	1 [□] to 4,000
	With AND	
		Allows you to enter 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, an analog trigger is generated.
		Not available

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

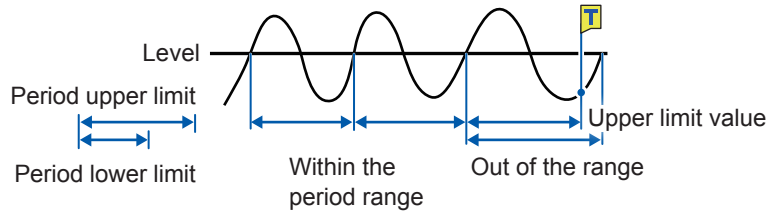
With OR	As soon as the instrument determines that a voltage peak became lower than a specified level for a period of half a cycle or more, the voltage-drop-trigger condition is satisfied.
With AND	While a voltage peak is lower than a specified level for a period of half a cycle or more, the voltage-drop-trigger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

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

The instrument measures periods of an 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 lags behind the actual trigger point by one sample.

These triggers cannot be set either when Model 8970, Model MR8990, or Model U8991 is used. Refer to “Setting of the period range” and “[Period-out] trigger” (p. 96).



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 a 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 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, an 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 period-trigger condition continues to be satisfied during the specified period, an analog trigger is generated. Specifying this option prevents the instrument from being unintentionally triggered due to noise.

*: The range of values that can be set in [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 **[Sampling]**, which is accessible by tracking in the following order: **[Status] > [Condition] > [Sampling]**

To make it the period-trigger condition that only when an 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 an input frequency exceeds the value under **[Period upper limit]**.

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

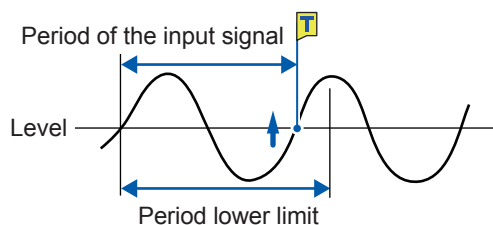
Set **[Type]** to **[Period-out]** and set **[Period lower limit]** to **[0]**. The instrument ignores the value under **[Period lower limit]**, and the period-trigger condition is satisfied when an input frequency falls below the value under **[Period upper limit]**.

[Period-out] trigger

The instrument calculates periods by monitoring times when an input signal crosses the specified level in the positive or negative direction, and the period-trigger condition is satisfied when a period gets out of the specified period range.

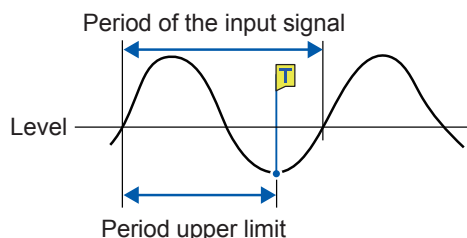
Points at which the period-trigger condition is satisfied varies depending on the specified period range and the period of a measuring object.

When an 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 a rising slope of an input signal crosses the specified level before the lower limit of the period elapses.

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



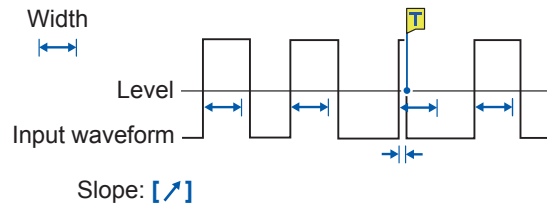
The period-trigger condition is satisfied when the upper limit of the period elapses before a rising slope of an input signal crosses the reference voltage level.

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

5. [Glitch] trigger

The glitch-trigger condition is satisfied when a pulse width of an input signal that has crossed the specified level is shorter than the specified duration.

These triggers cannot be set either when Model MR8990 or Model U8991 is used.



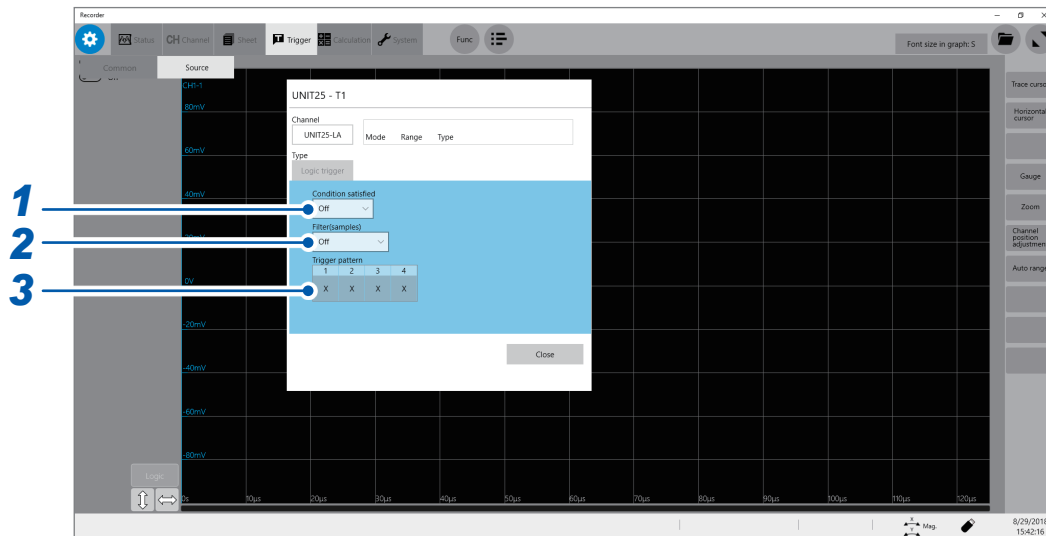
Setting		Description
Level	-f.s. to +f.s. Default: 0	Allows you to specify the level for detecting glitches.
Slope	↗, ↘	Allows you to select which of the following points to use to detect glitches: two consecutive points at which a signal crosses the specified level in the positive direction; or those in the negative direction.
Event	With OR 1 to 4,000	Allows you to enter the number of events. The instrument counts the number of times the glitch-trigger condition is satisfied. An 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 a 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 across 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, a 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 Select a trigger satisfying condition in [Condition satisfied].

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

Off <input checked="" type="checkbox"/>	Disables the logic trigger.
OR	The logic-trigger condition is satisfied when any one of logic input signals meets the trigger pattern.
AND	The logic-trigger condition is satisfied when all logic input signals meet the trigger pattern.

2 Specify the trigger filter setting in [Filter] in (as necessary).

You can enter the filter duration that allows the logic trigger to be generated.

Specifying the trigger filter setting prevents a logic trigger from being unintentionally generated due to noise. (p. 91)

Off <input checked="" type="checkbox"/>	Disables the trigger filter.
10 to 10000	Enables the trigger filter. The filter duration can be entered in terms of the number of samples.

3 Select a trigger pattern in [Trigger pattern].

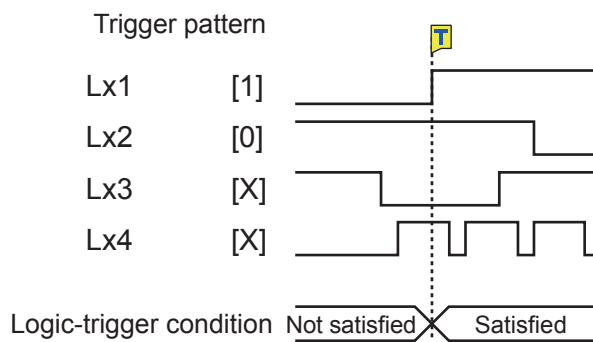
The logic-trigger pattern can be set.

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.

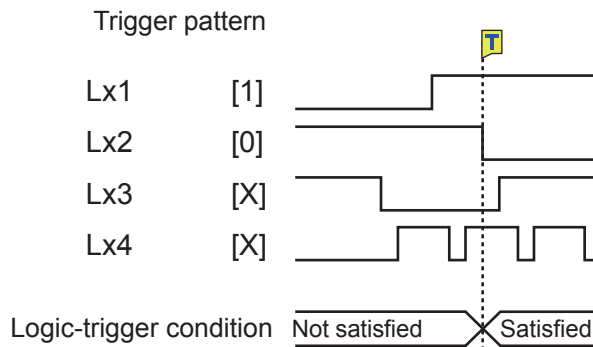
Setting example

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

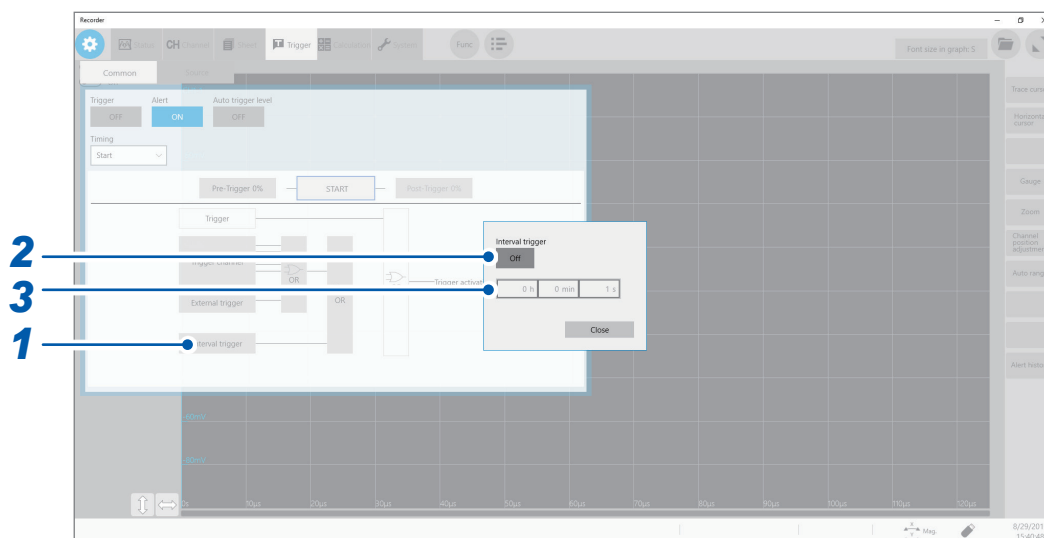


5.8 Triggering the Instrument at Regular Intervals (Interval Trigger)

Start triggers 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 internally corrected, displayed trigger times may not synchronize with the intervals of the interval trigger.

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

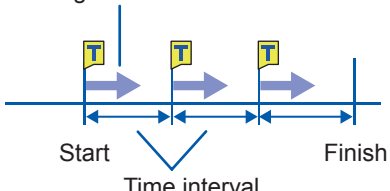
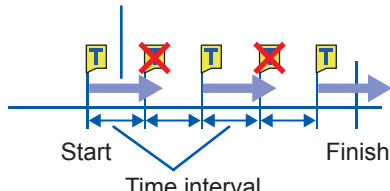


- 1** Click **[Interval trigger]**.
- 2** Set **[Interval trigger]** to **[On]** or **[Off]**.
- 3** Enter the interval (in terms of **[h]**, **[min]**, and **[s]**).

An internal trigger is generated at the start of the measurement, and triggers 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 data with the specified recording length or recording interval.

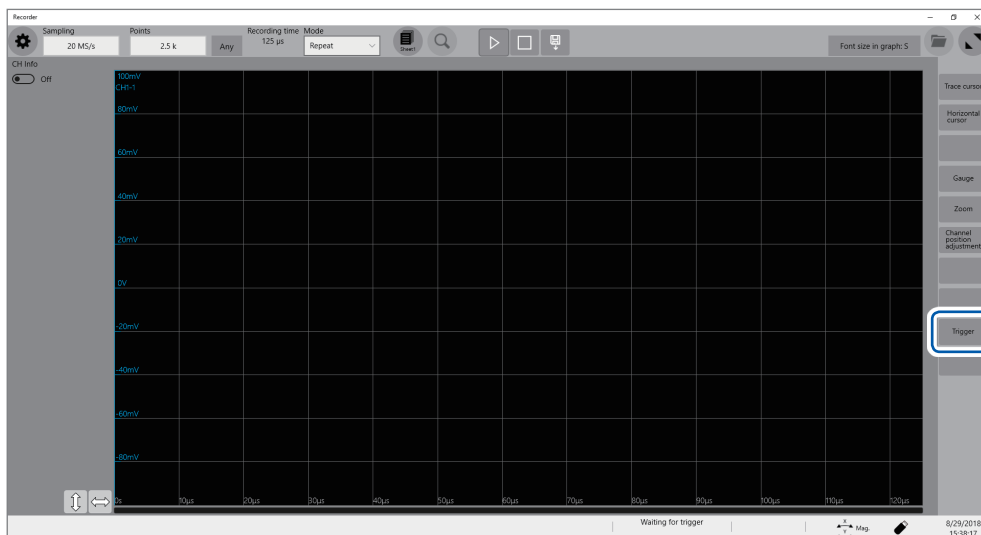
When the recording length or recording time is shorter than the time interval	When the recording length or recording time is longer than the time interval
<p>The instrument records the data with the specified recording length or recording time.</p> 	<p>The instrument records the data with the specified recording length or recording interval.</p> 

5.9 Triggering the Instrument Externally (External Trigger)

External signals applied to the external control terminals can serve as 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. 197).

5.10 Manually Triggering the Instrument (Forcible Trigger)



Clicking **[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.

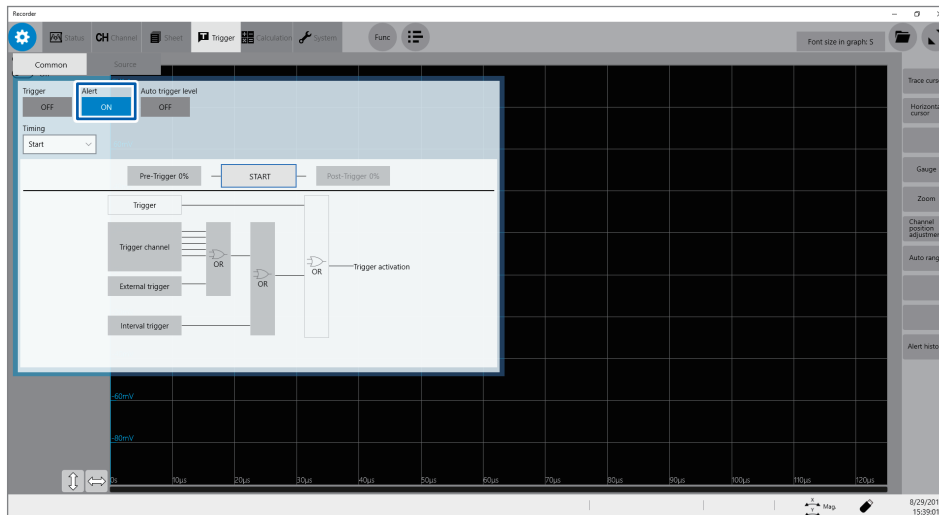
The forcible trigger triggers the instrument regardless of the other trigger source settings.

To stop the measurement, click the stop icon.

- Clicking the stop icon once stops the measurement after the instrument has acquired the waveforms with the specified recording length.
- Click the stop icon once and click **[OK]** on the dialog box displayed to stop the measurement.

5.11 Issuing an Alert Using Triggers (Alert Function)

The alert function detects trigger-condition satisfying points based on trigger settings. When **[Beep sound]** is set to **[Alert]** or **[Alert+Action]**, the instrument continues to beep while the trigger condition is being satisfied. Also, the CMD ERR red LED lights up when the instrument alerts you. The LED goes off when the instrument lifts the alert.

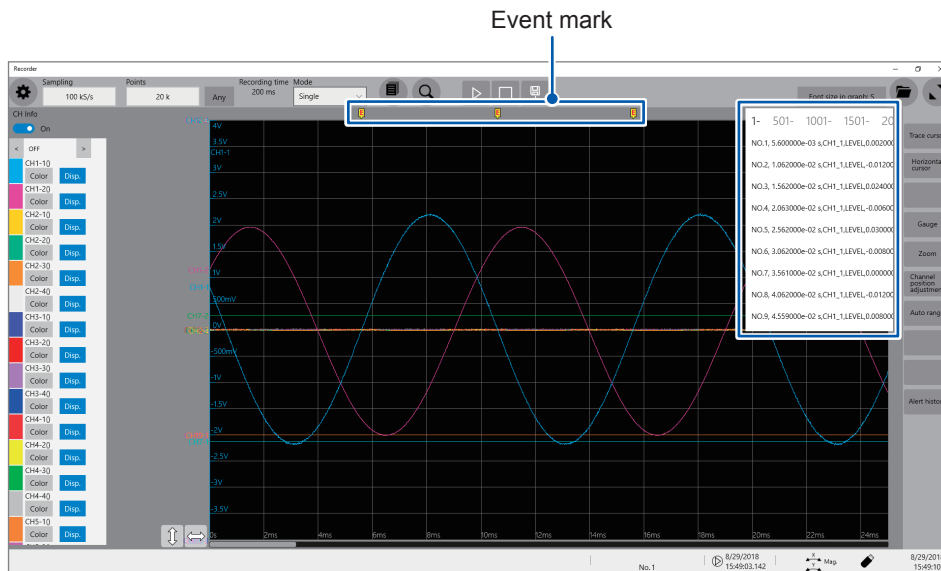


Setting **[Alert]** to **[On]** limits the sampling rate to 100 kS/s or lower. The event number of the trigger setting is fixed at **1**.

 > [Trigger] > [Common]

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

Off <input checked="" type="checkbox"/>	Does not alert you.
On <input type="checkbox"/>	Alerts you.



The instrument puts event marks (E) at the position when the specified trigger condition is satisfied (alert issued) and when the condition fails to be satisfied (alert lifted). At the upper right of the screen, the instrument displays the time when the condition is satisfied, channel number, trigger type, measured value and a character string [Out] or [In].

The string [Out] or [In] is intended for use with the out trigger setting; however, with another trigger setting, the instrument displays [Out] when the condition is satisfied and [In] when the condition fails to be satisfied.

Out	When a condition is satisfied (for the out trigger setting, when a signal gets out of the specified range)
In	When a condition is not satisfied (for the out trigger setting, when a signal falls within the specified range)

If the condition is satisfied and fails to be satisfied repeatedly within 100 ms, the instrument may group this condition changes into one and display it as the following.

Out_In	When a condition is first not satisfied, then the status repeatedly changes, and finally fails to be satisfied
Out_In_Out	When a condition is first not satisfied, then the status repeatedly changes, and is finally satisfied
In_Out	When a condition is first satisfied, then the status repeatedly changes, and is finally satisfied
In_Out_In	When a condition is first satisfied, then the status repeatedly changes, and finally fails to be satisfied

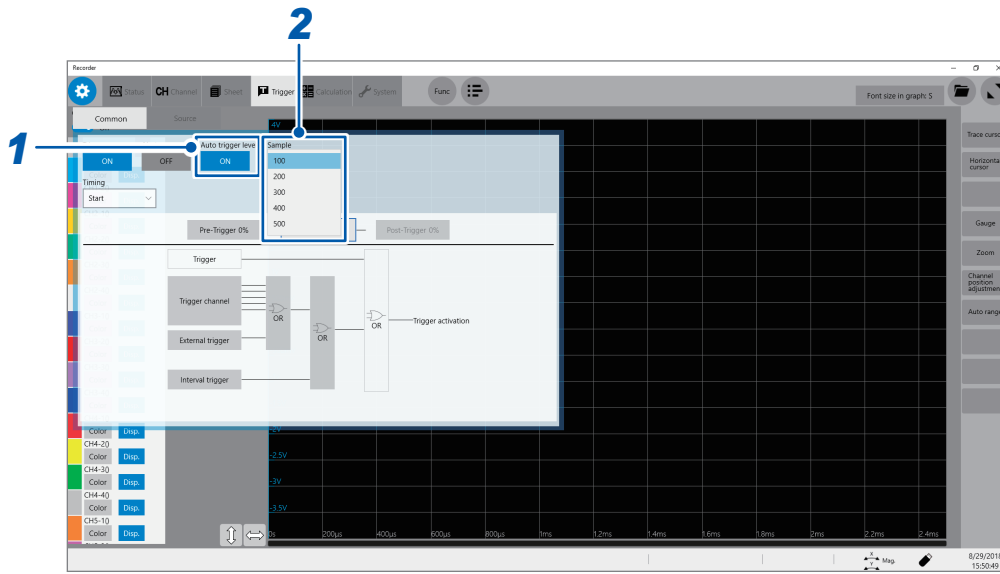
When an alert condition specified for a channel has already been satisfied, the instrument with the alert settings specified for multiple channels displays the first alert at the same position as a position a condition for another channel is next satisfied at.

5.12 Automatically Specifying the Trigger Level (Auto-trigger Level)

When you enable this setting, the instrument performs a preliminary measurement before an actual measurement.

In the preliminary measurement, the instrument acquires the specified number of data and specifies the average value of them as the reference of the out trigger. Then, the instrument performs the actual measurement using this trigger.

This function is useful when you use the out trigger setting with the trigger and alert functions.



> [Trigger] > [Common]

- 1 Select an automatic trigger level setting in [Auto-trigger level].

<input checked="" type="radio"/> Off	Disables the auto-trigger level function.
<input type="radio"/> On	Automatically specifies the reference level of the out trigger.

- 2 Select an option of the number of samples in [Points].

<input checked="" type="checkbox"/> 100, 200, 300, 400, 500

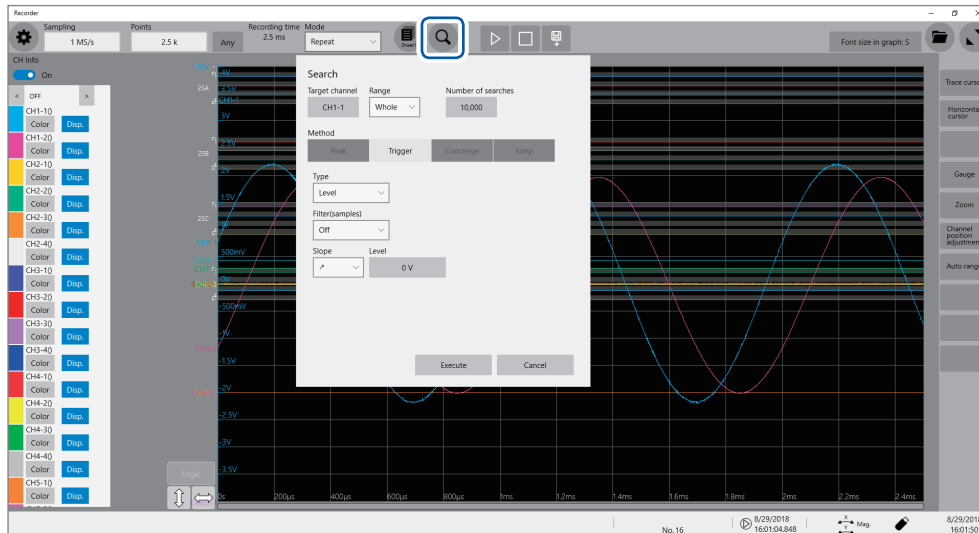
- 3 Specify the trigger setting for each channel.

On the trigger setting screen, set the trigger type of a channel to be used to out, and set [Auto-trigger level] to [On]. (p. 93)

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

Trigger search

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

Memory HiConcierge

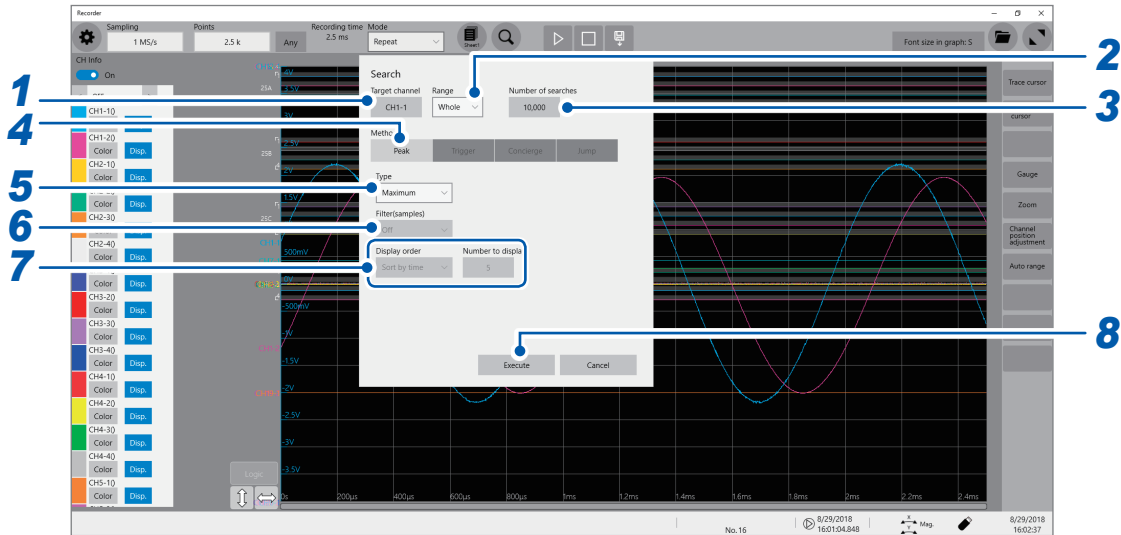
You can automatically detect differences from the fundamental wave based on the histogram or standard deviation. Specify the fundamental wave. (p. 114)

Jump

The display can jump to the specified time, trace 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 Select a channel to be searched in **[Target channel]**.

The channel setting dialog box appears.

2 Select a search range setting in **[Range]**.

Whole <input checked="" type="checkbox"/>	Searches all waveform data.
A_B, C_D	Searches the scope specified with trace cursors A and B or trace cursors C and D.

3 Type the number of points searched for in **[Number of searches]**.

Specify the number of data points to be searched for.

4 Set **[Method]** to **[Peak]**.

5 Select a search type in **[Type]**.

Maximum <input checked="" type="checkbox"/>	Searches for the maximum value.
Minimum	Searches for the minimum value.
Maximal	Searches for the maximal values.
Minimal	Searches for the minimal values.

- If two or more maximum or minimum values exists, the instrument displays any one of them as a representative value among the search result.
- Multiple maximal or minimal values exist 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 the values found 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)

Select a display order setting in [Display order].

Specify the display order.

Sort by time [☑]	Displays the search-result positions in chronological order. [Number to display] cannot be specified. Up to 10,000 positions can be searched for. The searching stops if more than 10,000 positions are found.
Sort by data	With the [Maximal] setting, displays the number, which is specified by [Number to display], of search-result positions in descending order. With the [Minimal] setting, displays them in ascending order.

Select the number of display position in [Number to display] (when [Display order] is set to [Sort by data]).

Specify the number of positions to be displayed.

8 Click [Execute].

The instrument puts search marks (S) on positions where the search condition is satisfied. The search-position switching panel appears on the waveform screen.

To stop the searching

Click the stop icon.

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

You can switch the search-result positions by clicking [<] or [>]. The display order follows the setting in [Display order].



Clicking [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 click [Execute].

6.2 Searching For Positions Where Trigger Condition Is Satisfied

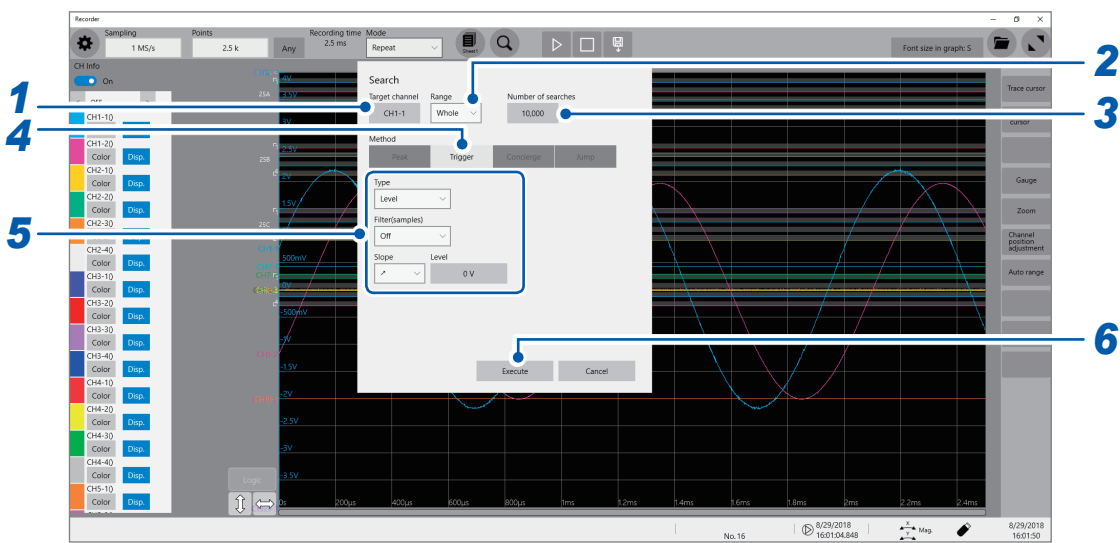
Specifying the trigger condition allows you to search the measured data for positions where the trigger condition is satisfied.



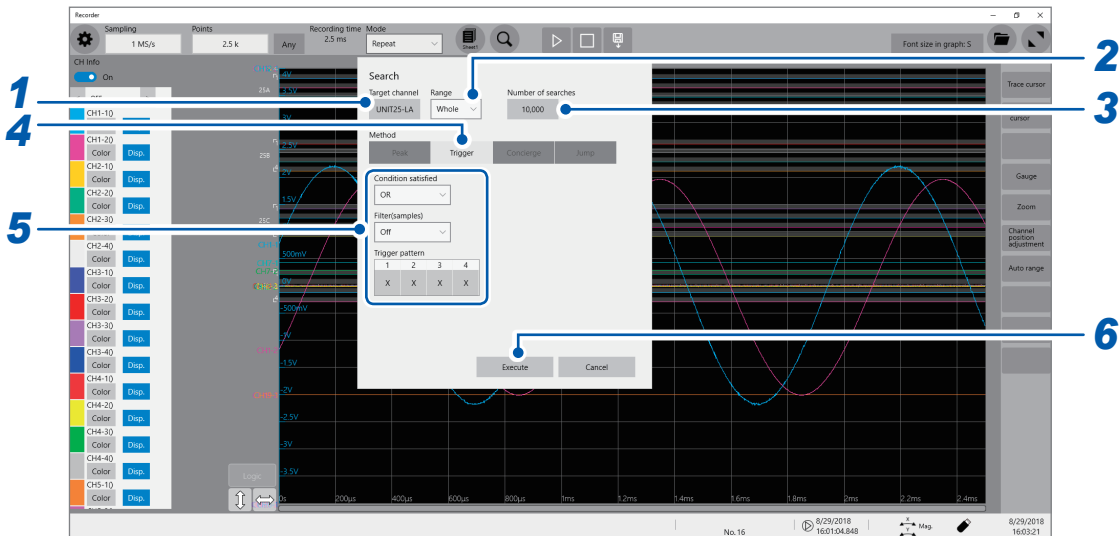
1 Select a channel to be searched in [Target channel].

The channel setting dialog box appears.

When an analog channel is selected



When a logic channel is selected



2 Select a search range setting in [Range].

Whole	Searches all waveform data.
A_B, C_D	Searches the scope specified with trace cursors A and B or trace cursors C and D.

3 Type the number of points searched for in **[Number of searches]**.

Specify the number of data points to be searched for.

4 Set **[Method]** to **[Trigger]**.

5 Specify the search condition.

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

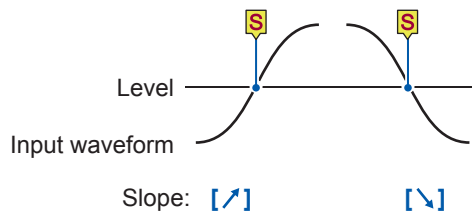
Select a search type in **[Type]**.

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

Specify the search condition.

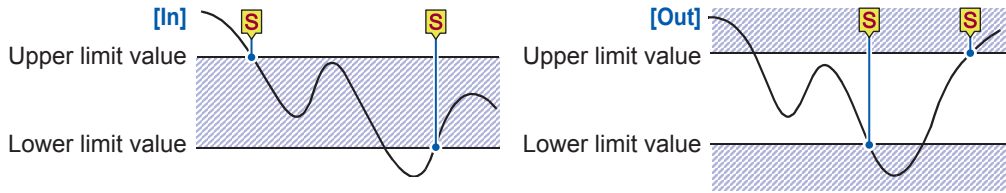
The items to be set may vary depending on the trigger type.

(1) With the [Level] setting



	Setting	Description
Filter	Off [☑] , 10 to 10,000	Allows you to enter the filter in terms of the number of samples. Positions where the search condition continues to be satisfied during the specified period are determined to be the search-result 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.
Level	-3.4028E+38 to 3.4028E+38 Default: 0 [☑]	Allows you to enter the threshold (level) to be searched for.

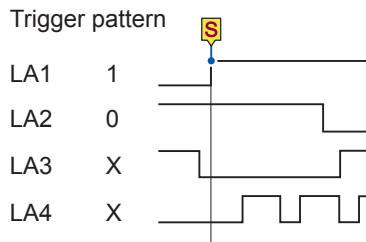
(2) With the [In] or [Out] setting



Setting		Description
Filter	Off [☑] , 10 to 10,000	Allows you to enter the filter in terms of the number of samples. Positions where the search condition continues to be satisfied during the specified period are determined to be the search-result positions.
Upper limit value	-3.4028E+38 to 3.4028E+38 Default: 0.2 [☑]	Allows you to type the upper limit value.
Lower limit value	-3.4028E+38 to 3.4028E+38 Default: 0.2 [☑]	Allows you to type a lower limit value.

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

You can search for a position that matches the specified pattern.



Setting		Description
Condition satisfied	OR [☑]	The positions where any one of the specified search patterns is satisfied are determined to be the search-result positions.
	AND	The positions where all the specified patterns are satisfied are determined to be the search-result 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 search-result positions.
Trigger pattern	X [☑]	Ignores data.
	0	Searches for low-level positions.
	1	Searches for high-level positions.

In the logic search, the search-result position is the point where the condition that has not been satisfied changes to being satisfied. Thus, even if the search pattern is satisfied at the start of the search, it is not regarded as a search-result position.

6 Click [Execute].

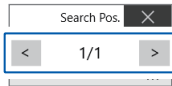
Search marks (S) are put at the positions where the search condition is satisfied. Up to 10,000 positions can be retrieved. The searching stops if more than 10,000 positions are found. The search-position switching panel appears on the waveform screen.

To stop the searching

Clicking the stop icon to stop the search.

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

You can switch the search-result positions by clicking [←] or [→]. The display order follows the setting in [Display order].



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

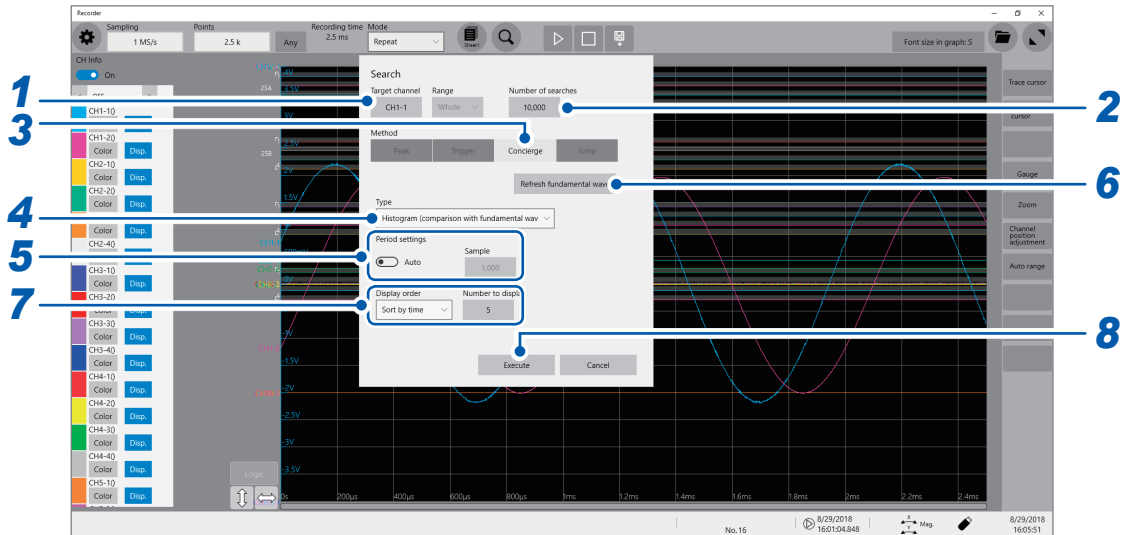


To display the search result again

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

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

Using Memory HiConcierge can detect differences from the specified fundamental waveform based on the histogram or standard deviation.




- 1** Select a channel to be searched in [Target channel].
The channel setting dialog box appears.
- 2** Type the number of points searched for in [Number of searches].
Specify the number of data points to be searched for.
- 3** Set [Method] to [Concierge].
- 4** Select a search type in [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 Select a search period setting.

Searches for differences 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 Click **[Refresh fundamental wave] to display the fundamental wave.**

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

7 Select a display order setting in **[Display order] and type the number of display in **[Number to display]**.**

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

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

8 Click **[Execute].**

Search marks (S) are put at the positions where the search condition is satisfied.

The search-position switching panel appears on the waveform screen.

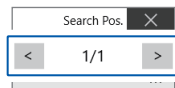
To stop the searching

Click the stop icon.

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

You can switch the search-result positions by clicking **[<]** or **[>]**.

The display order follows the setting in **[Display order]**.



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

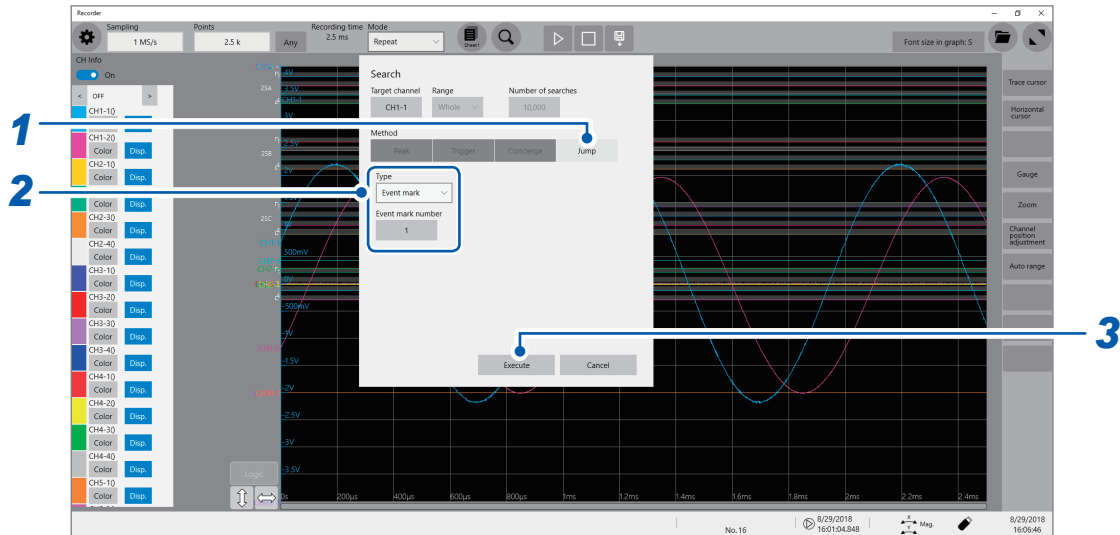


To display the search result again

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

6.4 Allowing the Display to Jump to the Specified Position

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



- 1 Set [Method] to [Jump].
- 2 Select a search type in [Type].

Event mark <input checked="" type="checkbox"/>	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 is specified, the display is to jump to.	
Time	Time	Allows you to enter an absolute time the display is to jump to when [Time value display] is set to [Date], which is accessible by tracking 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 fixed at zero when [Time value display] is set to [Time] or [Mod 60], which is accessible by tracking 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 tracking in the following order: [System] > [Env.] > [Time value display]
Trigger	The display jumps to the start trigger point.	
Search number	Allows you to enter [Search number] the display is to jump to.	

3 Click [Execute].

Search marks (S) are put at the positions where the search condition is satisfied.

When [Type] is set to [Event mark], the display jumps to the position of an 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 appears on the waveform screen.

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

You can switch the search-result positions by clicking [<] or [>].

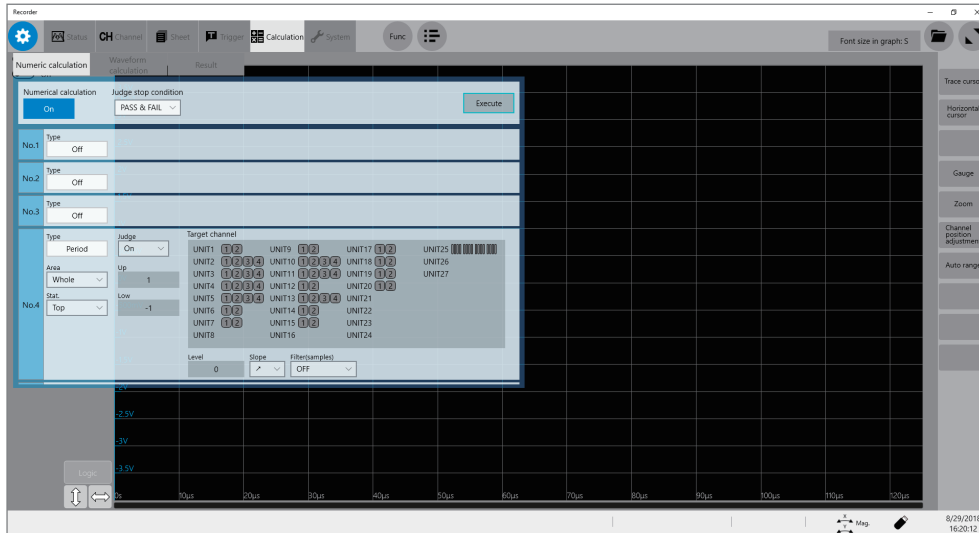


7

Numerical Calculation Function

Results calculated from the acquired waveforms appear 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 the cursors
Numerical calculations can be performed for the data within the range specified with the trace 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. 134)

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

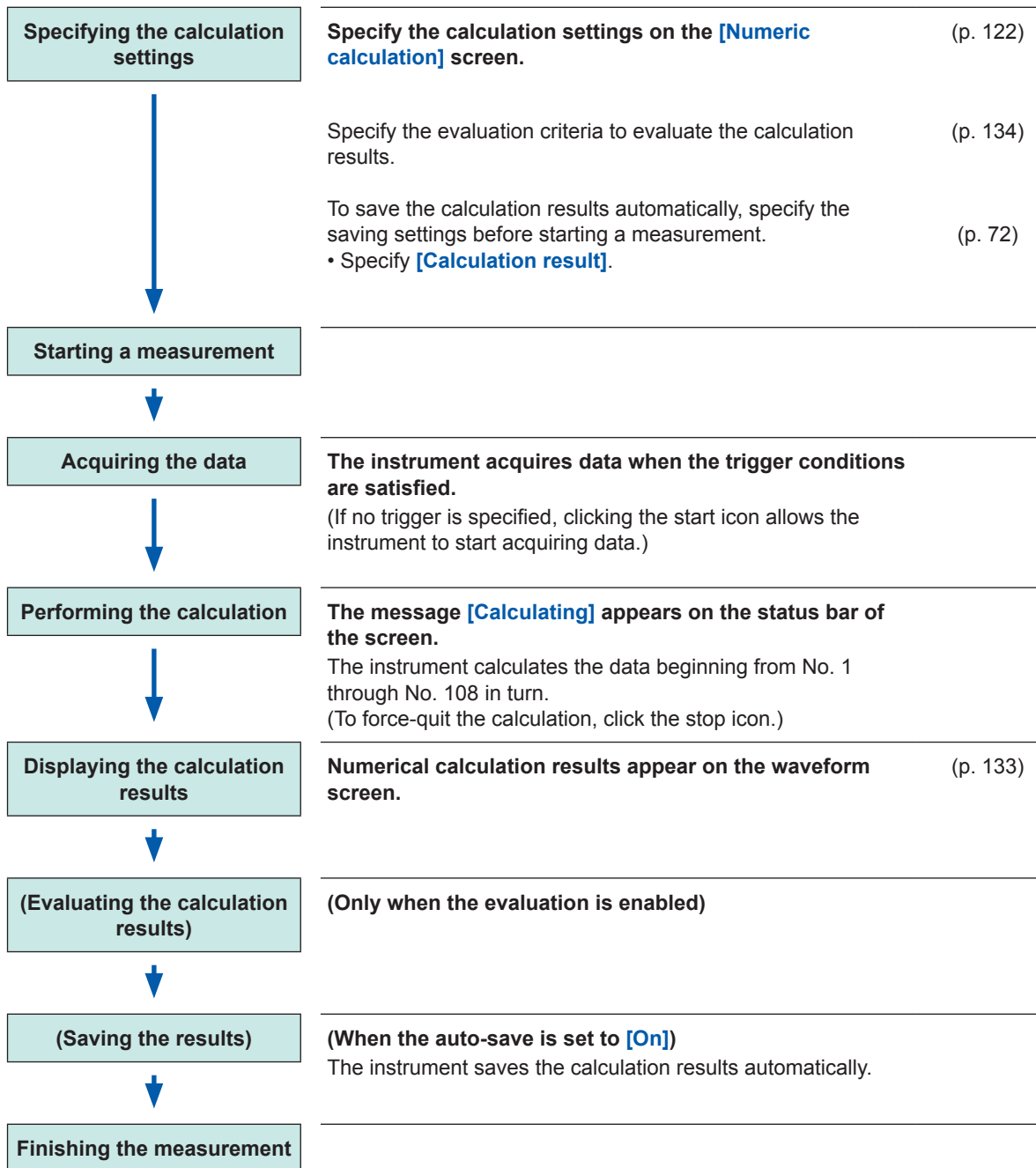
You can execute up to 108 types of numerical calculations simultaneously. When the scaling function is enabled, scaled values are calculated.

7.1 Numerical Calculation Procedure

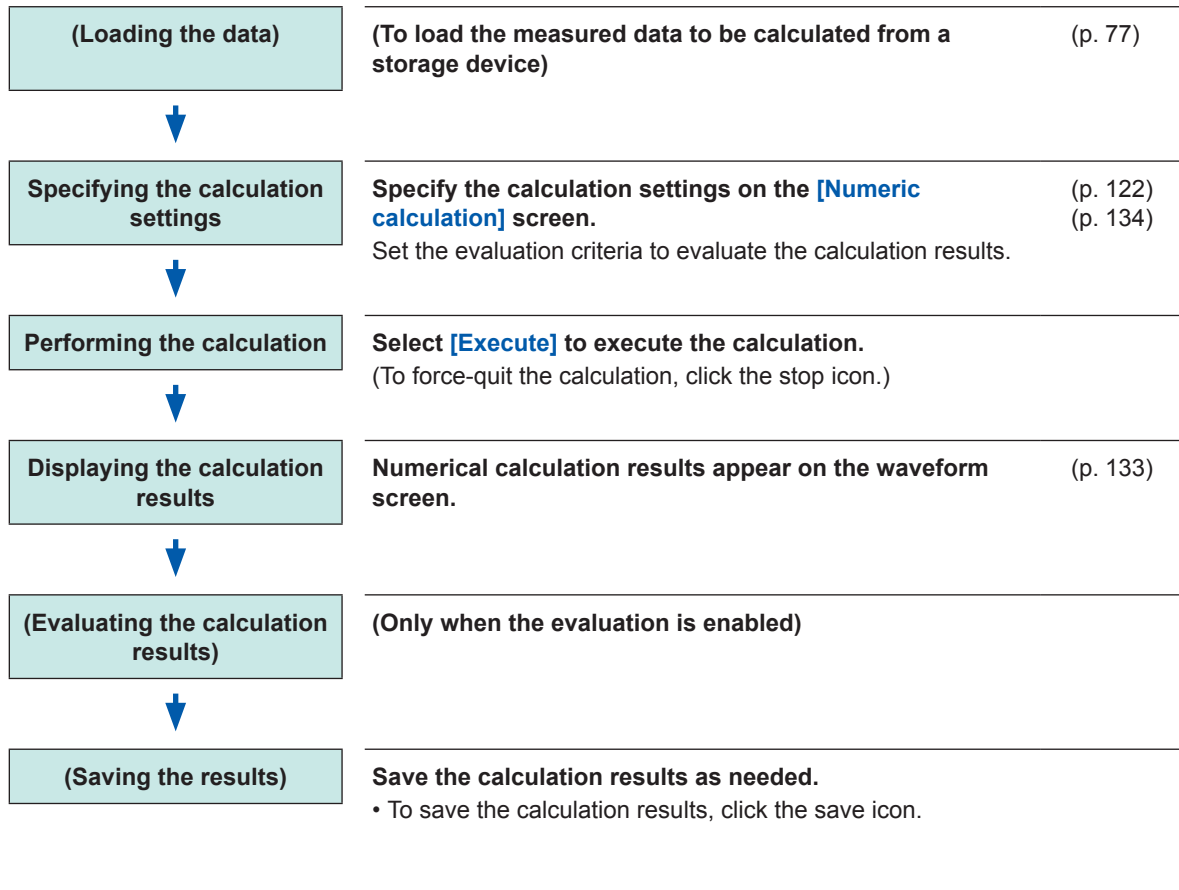
The following two methods are available:

Calculating the data automatically after the measurement	You must specify the numerical calculation settings before starting a measurement.
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



Calculating the existing data

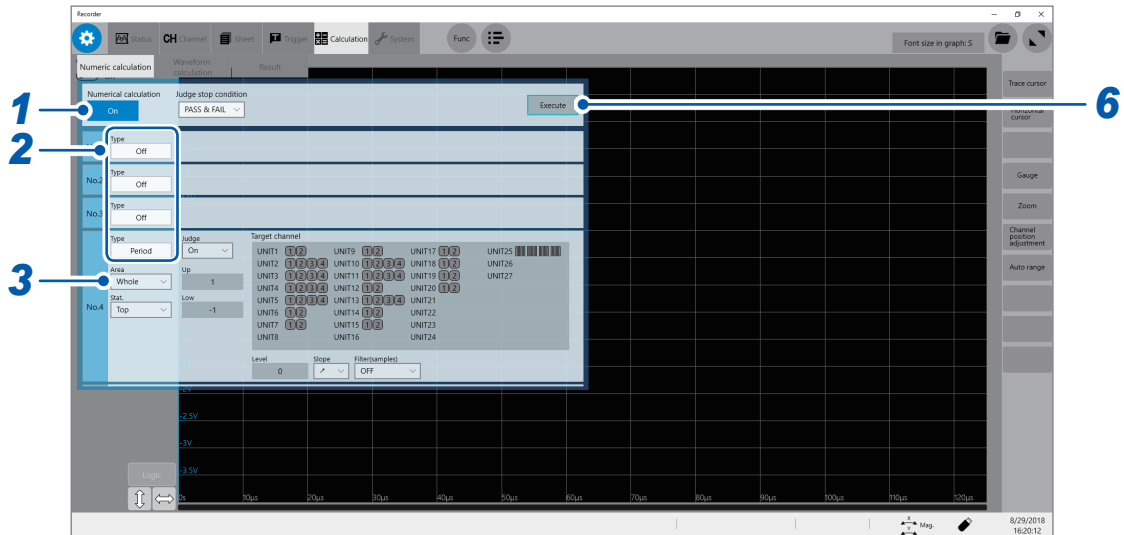


To specify a waveform scope for calculation

Specify the calculation scope with the trace cursors on the waveform screen before executing the calculation. Set **[Area]** to **[A_B]** or **[C_D]** on the **[Numeric calculation]** screen. Refer to “7.2 Specifying the Numerical Calculation Setting” (p. 122).

7.2 Specifying the Numerical Calculation Setting

 > [Calculation] > [Numeric calculation]



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

2 Select a calculation type in [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 across the measurement channels of Model MR8990 Digital Voltmeter Unit and Model U8991 Digital Voltmeter Unit.

*2: The settings can also be specified for the logic channels. Refer to “The target channel to be calculated and the calculation condition of each calculation type” (p. 125).

3 Select a calculation range in [Area].

You can specify the calculation range for each item to be calculated.

Whole [□]	Calculates whole waveforms.
A_B	Calculates the waveform between trace cursors A and B.
C_D	Calculates the waveform between trace cursors C and D.

When selecting [A_B] or [C_D], specify the calculation scope with the trace 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.

Click 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 Specify the calculation conditions.

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

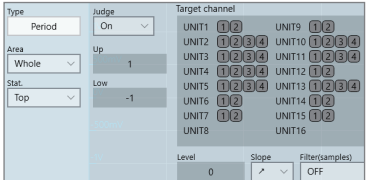


Click [Execute].

To execute calculations automatically after the measurement

Clicking the start icon starts a measurement.

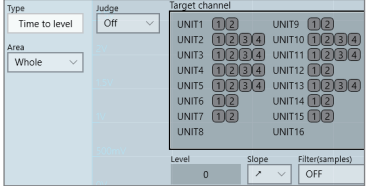


The target channel to be calculated and the calculation condition of each calculation type

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	<p>Target channel (Analog, waveform calculation)</p> <p>With the [Area] or [Accumulation] setting, set [Method]. (Total[□], Absolute value, Positive, Negative)</p>	<p>Allows you to specify channels as calculation targets.</p> <p>Calculates the area or accumulation according to the method specified here.</p>	

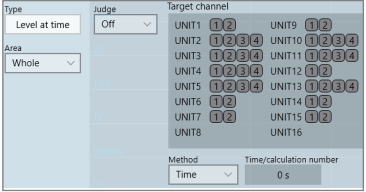

Calculation type	Setting	Description	Sample screen	
Period Frequency Pulse width Duty ratio	Target channel (Analog, logic, waveform calculation)	Allows you to specify channels as calculation targets.		
	Level*	The instrument calculates values based on a period of time when the waveform crossed the level specified here. Not available for logic channels.		
	Slope No slope can be specified for calculating the 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 Max Min		Calculates the average, maximum, or minimum value for each parameter within the specified range.

*: The range that can be set are between $-9.9999E+29$ and $-1.0000E-29$, 0, and between $+1.0000E-29$ and $+9.9999E+29$. Five-digit numbers or less can be specified (Ten-digit numbers or less can be specified for the time in Level at time).

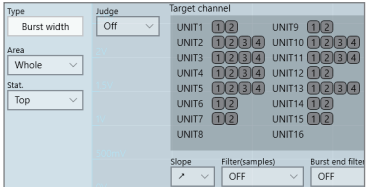


Calculation type	Setting	Description	Sample screen	
Rise time Fall time	Target channel (Analog, waveform calculation)	Allows you to specify channels as calculation targets.		
	Time (%) (5%→95% to 30% → 70% or 95% → 5% to 70%→30%)	Allows you to specify which part of the waveform between the upper and 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 Max Min	Calculates the average, maximum, or minimum value for each parameter within the specified range.		
X-Y area Angle of XY waveform	Target channel (X, Y) (Analog, waveform calculation)	Allows you to assign channels to the X- and Y-axis.		
	With the [X-Y area] setting, 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, waveform calculation)	Allows you to specify channels as calculation targets.	
	Level*	Detects the times when the pulses crossed the level specified level or the number of the pulses that crossed the level. Not available for logic channels.	
	Slope	 Detects the times when the pulses crossed the level specified level in the positive direction or the number of the pulses that crossed the level in the positive direction.	
		 Detects the times when the pulses crossed the level specified level in the negative direction or the number of the pulses that crossed the 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.	




*: The range that can be set are between $-9.9999E+29$ and $-1.0000E-29$, 0, and between $+1.0000E-29$ and $+9.9999E+29$. Five-digit numbers or less can be specified (Ten-digit numbers 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, waveform calculation)	Allows you to specify channels as calculation targets.		
	Method	Allows you to set the time-specifying method.		
	<table border="1"> <tr> <td>Time</td> <td>Time</td> </tr> </table>	Time		Time
Time	Time			
<table border="1"> <tr> <td>Calc. No.</td> <td>Calculation No.</td> </tr> </table>	Calc. No.	Calculation No.	Allows you to select a calculation number when the numerical calculation results are used. You cannot specify a number that exceeds the calculation number you specify. Specifying a range is not available.	
Calc. No.	Calculation No.			
+Width -Width	Target channel (Analog, 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.
	<table border="1"> <tr> <td>Average</td> </tr> <tr> <td>Max</td> </tr> <tr> <td>Min</td> </tr> </table>	Average		Max
Average				
Max				
Min				

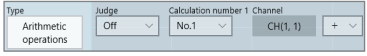
7

Calculation type	Setting	Description	Sample screen	
Burst width	Target channel (Analog, logic, 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 for each parameter within the specified range.		
Max				
Min				

*: The range you can specify are between $-9.9999E+29$ and $-1.0000E-29$, 0, and between $+1.0000E-29$ and $+9.9999E+29$. Five-digit numbers or less can be specified (Ten-digit numbers 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, waveform calculation)	Allows you to specify the reference channel and the target channel.		
	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 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 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 for each parameter within the specified range.		
Min				

7

Calculation type	Setting	Description	Sample screen
Arithmetic operations	Calculation number 1, Calculation number 2 (No. 1 through No. 107)	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 range you can specify are between $-9.9999E+29$ and $-1.0000E-29$, 0, and between $+1.0000E-29$ and $+9.9999E+29$. Five-digit numbers or less can be specified (Ten-digit numbers 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 waveform), 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. 36).

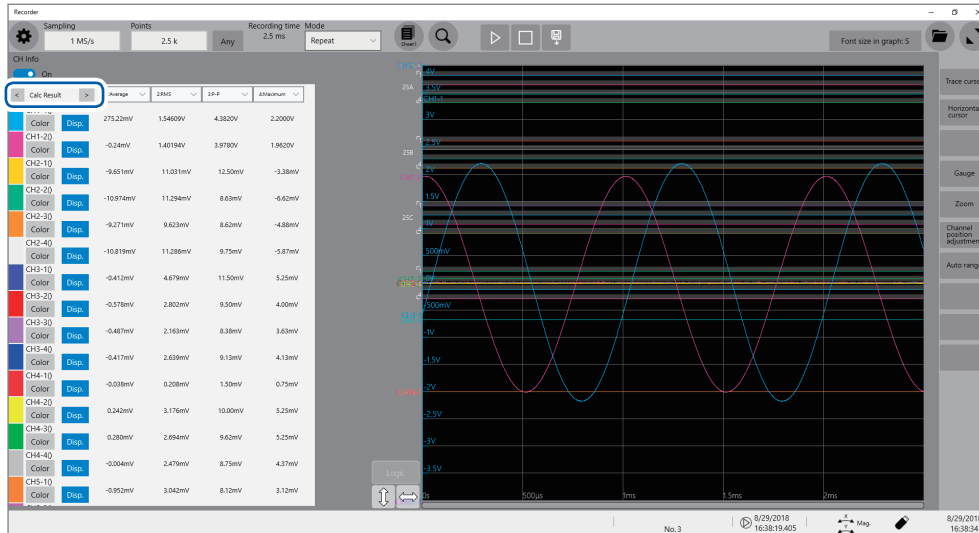
Settings: Calculations for which **[Stat.]** can be set

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

You can check the calculation results on the waveform screen.



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

1 Set a display type to **[Calc Result]**.

Click **[<]** or **[>]** to set the display type to **[Calc Result]**.

To save the calculation results after the measurement

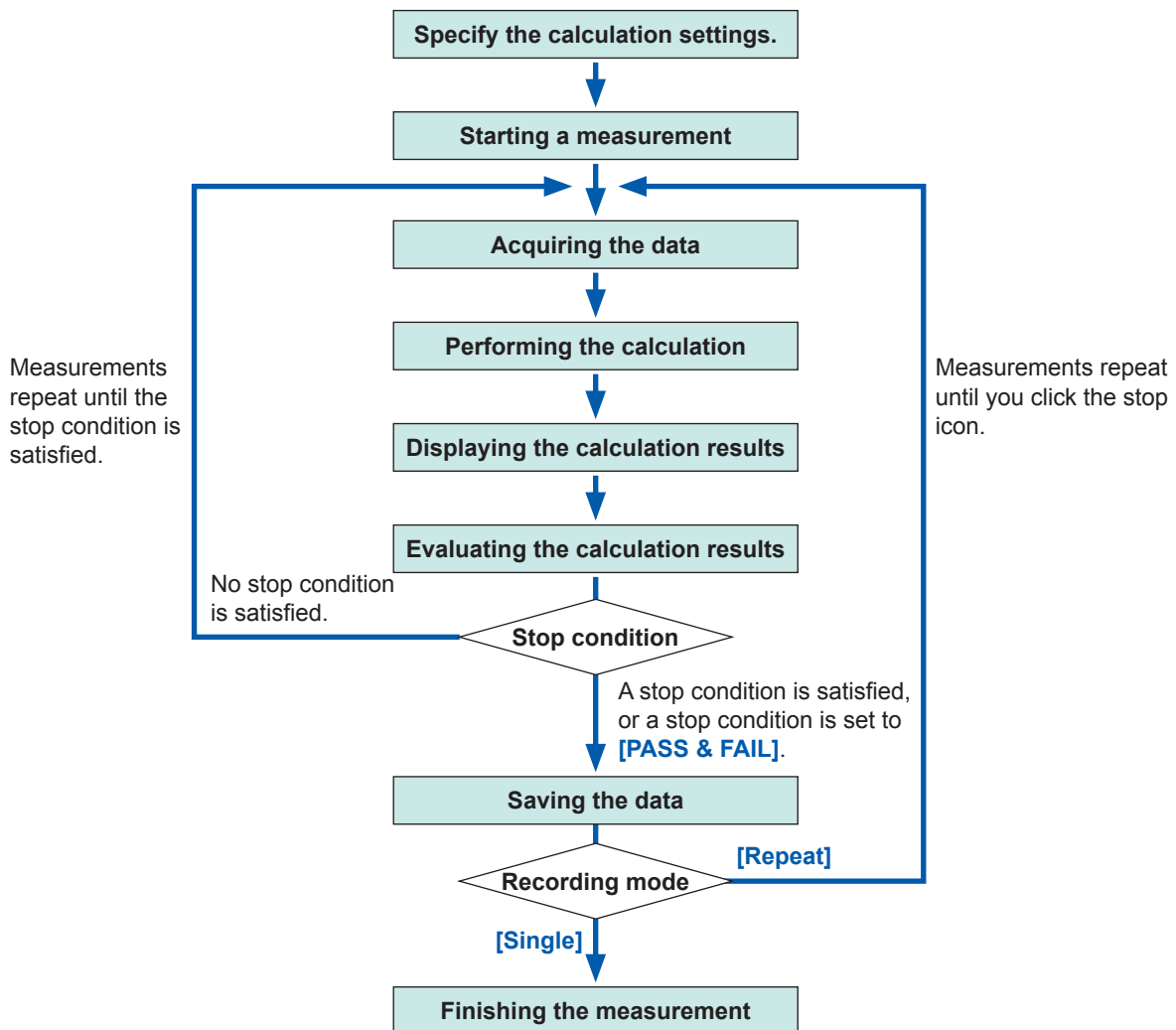
Refer to “Freely selecting data items to be saved and save files (save icon)” (p. 74).

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.

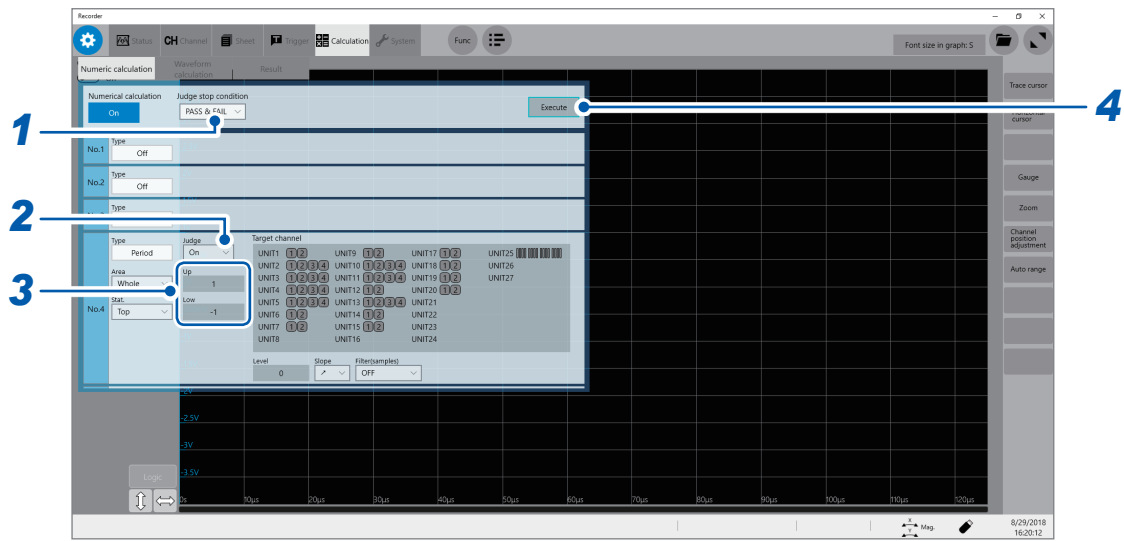
The evaluation criteria can be specified for each numerical calculation.

The waveform acquisition process varies depending on the 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 carried out until the stop condition is satisfied at the end of calculation evaluation.


 > [Calculation] > [Numeric calculation]



1 Select a judge stop condition in [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 [Up] and [Low], 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

Click [Execute].

To execute evaluation automatically after the measurement

Clicking the start icon starts a measurement.

About upper and lower limit values

You cannot specify a lower value in **[Up]** than the value in **[Low]**.

Neither can you specify a higher value in **[Low]** than the value in **[Up]**.

To record all of the calculation results

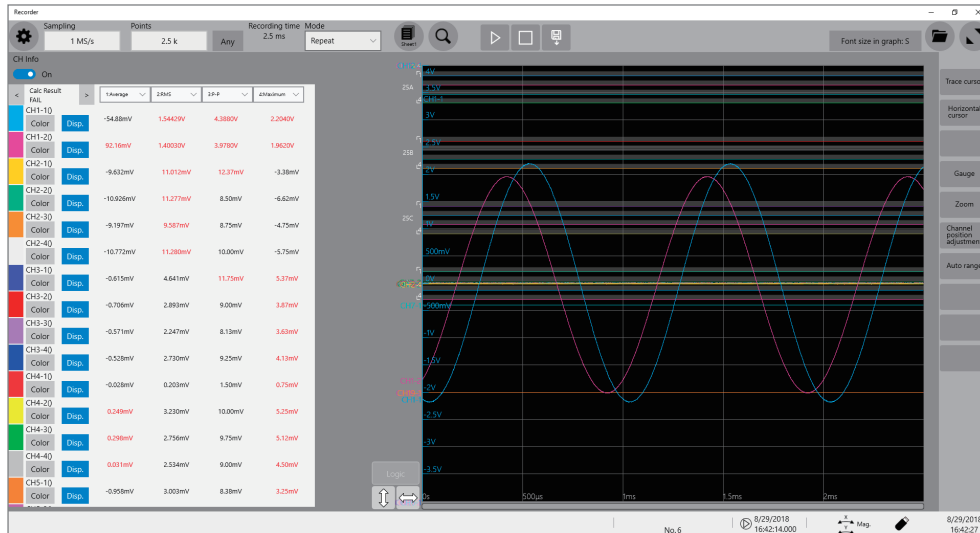
Set the judge stop condition to **[PASS & FAIL]**.

Displaying the evaluation results and outputting signals externally

The numerical calculation evaluation results appear on the numerical calculation results screen on the waveform screen.

Values that fall within the evaluation criteria range: Pass judgment

Values that are outside the evaluation criteria range: Fail judgment (highlighted in red)





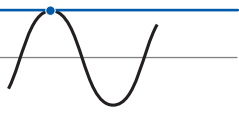
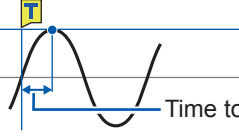
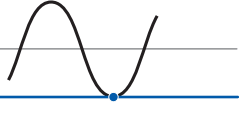
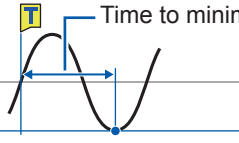
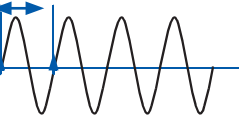
When a pass judgment is given

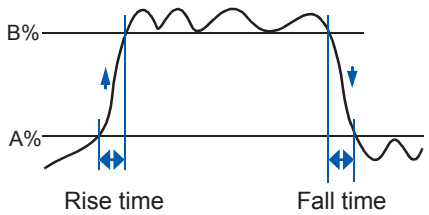
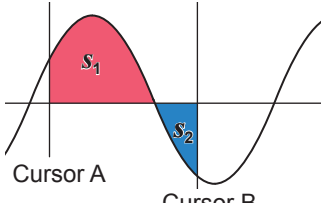
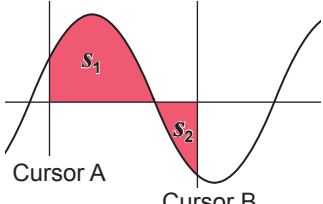
When the external output terminals (OUT 1, OUT 2) are set to **[Judge(Pass)]**, the PASS signal is output from the external output terminals (OUT 1, OUT 2).

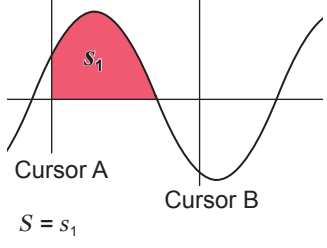
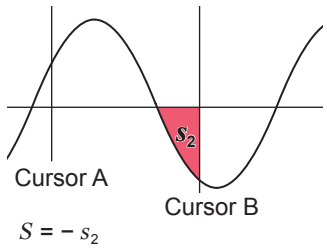
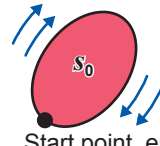
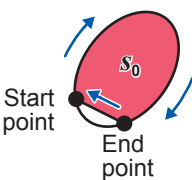
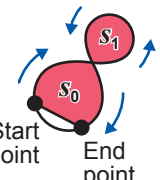
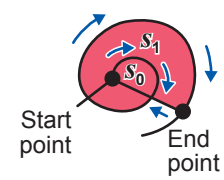
When a fail judgment is given

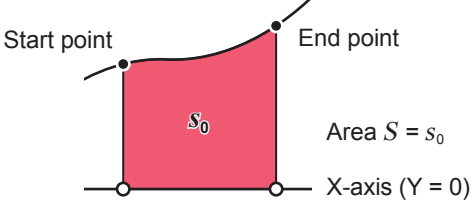
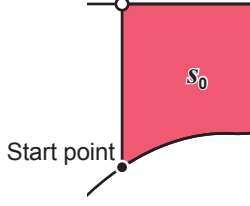
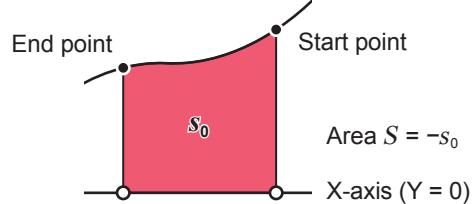
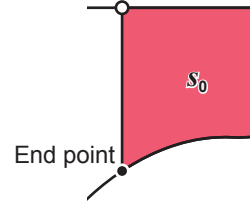
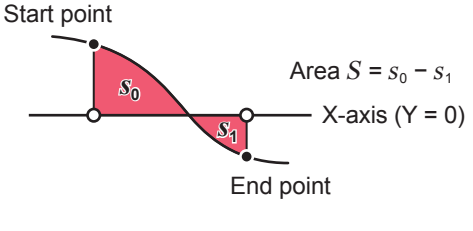
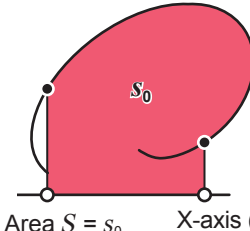
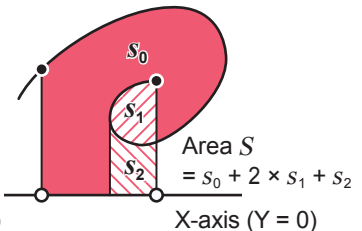
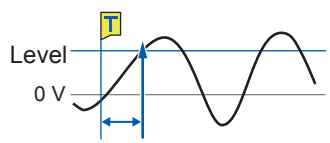
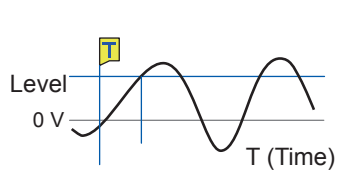
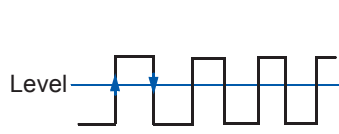
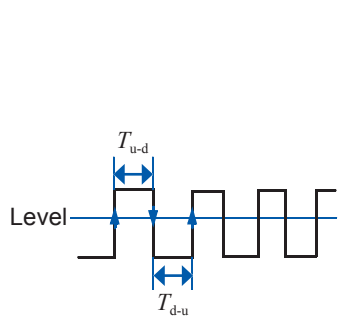
When the external output terminals (OUT 1, OUT 2) are set to **[Judge(Fail)]**, the FAIL signal is output from the external output terminals (OUT 1, OUT 2). A fail judgment is given when any one of the channels is judged to be a fail.

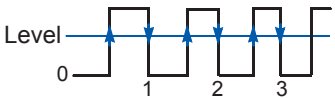
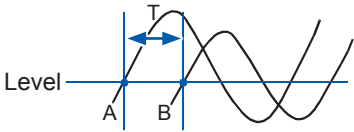

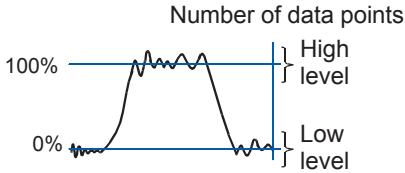
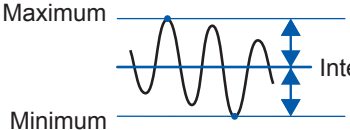
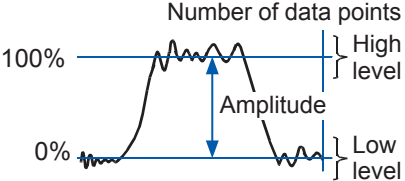
7.4 Numerical Calculation Types and Descriptions

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: ith data point acquired across 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-square value n: Number of data points di: ith data point acquired across the channel	
P-P	Calculates the difference (peak-to-peak value) between the maximum and minimum values of the waveform data.	Maximum  Minimum 
Maximum	Calculates the maximum value of the waveform data.	Maximum 
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.	Maximum 
Minimum	Calculates the minimum value of the waveform data.	Minimum 
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.	Minimum 
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 .	Level 

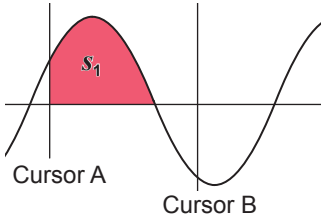
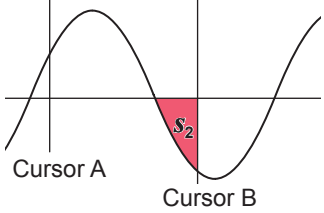
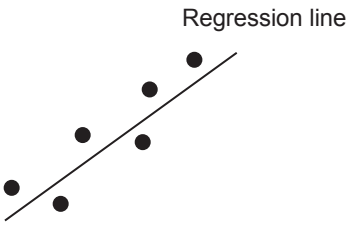
Calculation type	Description	
<p>Rise time Fall time</p>	<p>Calculates the A%-to-B% rise time (or the B%-to-A% fall time) (unit: s) based on the 0% and 100% levels, which are calculated based on the histogram (frequency distribution), of the acquired waveform data.</p> <p>The rise time (or fall time) of the first rising (or falling) slope in the acquired waveform data is calculated.</p> <p>When the range is specified, calculates the rise time (or fall time) of the first rising (or falling) slope that appears between the cursors.</p> <p>The values of A and B can be specified (unit: percent). 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%.</p> <p>Settings: Rise time (A% to B%) and Fall time (B% to A%) values (%), Stat.</p>	 <p>Rise time Fall time</p> <p>A: 5% to 30% B: 95% to 70%</p>
<p>Standard deviation</p>	<p>Calculates the standard deviation of the waveform data.</p> $\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n (d_i - AVE)^2}$ <p>σ: Standard deviation AVE: Average n: Number of data points d_i: ith data point acquired across the channel</p>	
<p>Area Method: Total</p>	<p>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.</p> <p>When the range is specified, calculates the area between the cursors.</p> $S = \sum_{i=1}^n d_i \cdot h$ <p>S: Area n: Number of data points d_i: ith data point acquired across the channel $h = \Delta t$: Sampling interval</p>	 <p>Cursor A Cursor B</p> <p>$S = s_1 - s_2$</p>
<p>Area Method: Absolute value</p>	<p>Calculates the area value (unit: V·s) enclosed by the zero-level (zero-potential) line and the signal waveform.</p> <p>When the range is specified, calculates the area between the cursors.</p> $S = \sum_{i=1}^n d_i \cdot h$ <p>S: Area n: Number of data points d_i: ith data point acquired across the channel $h = \Delta t$: Sampling interval</p>	 <p>Cursor A Cursor B</p> <p>$S = s_1 + s_2$</p>

Calculation type	Description	
<p>Area Method: Positive (Only the part where the amplitude is positive)</p>	<p>Calculates the area 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, calculates the area between the cursors.</p> $S = \sum_{i=1, di > 0}^n di \cdot h$ <p><i>S</i>: Area <i>n</i>: Number of data points <i>di</i>: <i>i</i>th data point acquired across the channel <i>h</i> = Δ<i>t</i>: Sampling interval</p>	 <p>Cursor A Cursor B</p> <p>$S = s_1$</p>
<p>Area Method: Negative (Only the part where the amplitude is negative)</p>	<p>Calculates the area 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, calculates the area between the cursors.</p> $S = \sum_{i=1, di < 0}^n di \cdot h$ <p><i>S</i>: Area <i>n</i>: Number of data points <i>di</i>: <i>i</i>th data point acquired across the channel <i>h</i> = Δ<i>t</i>: Sampling interval</p>	 <p>Cursor A Cursor B</p> <p>$S = -s_2$</p>
<p>X-Y area Method: Coordinate method</p>	<p>Calculates the area (unit: V²) 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. You can specify a calculation range on the horizontal axis (time-axis) waveform of each channel with the 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 cursors). Refer to “2.1 Reading Measured Values (Trace Cursors)” (p. 20).</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="434 1137 842 1348"> <p>When multiple loops are plotted</p>  <p>$S = n \times s_0$ <i>S</i>: Area <i>n</i>: Number of loops</p> <p>Start point, end point</p> </div> <div data-bbox="869 1137 1380 1370"> <p>When an open curve is plotted</p>  <p>$S = s_0$ <i>S</i>: Area (Closed area is created by connecting the start and end points with a straight line)</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div data-bbox="434 1377 842 1624"> <p>When a figure of eight is plotted</p>  <p>$S = s_0 - s_1$ <i>S</i>: Area</p> <p>Start point End point</p> </div> <div data-bbox="869 1377 1380 1624"> <p>When a spiral loop is plotted</p>  <p>$S = s_0 \times 2 + s_1$ <i>S</i>: Area (The number of overlapping segments increases with the number of loops)</p> <p>Start point End point</p> </div> </div>	
<p>X-Y area Method: Trapezoidal approximation</p>	<p>Calculates the area (unit: V²) 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 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 cursors).</p>	

Calculation type	Description	
When one of the Y data corresponds to the X data		
 <p>Start point</p> <p>End point</p> <p>Area $S = s_0$</p> <p>X-axis (Y = 0)</p>	 <p>X-axis (Y = 0)</p> <p>Area $S = -s_0$</p> <p>Start point</p> <p>End point</p>	
 <p>End point</p> <p>Start point</p> <p>Area $S = -s_0$</p> <p>X-axis (Y = 0)</p>	 <p>X-axis (Y = 0)</p> <p>Area $S = s_0$</p> <p>End point</p> <p>Start point</p>	
When the waveform includes negative amplitude		
 <p>Start point</p> <p>End point</p> <p>Area $S = s_0 - s_1$</p> <p>X-axis (Y = 0)</p>	When multiple pieces of Y data correspond to XY data	
	 <p>Area $S = s_0$</p> <p>X-axis (Y = 0)</p>	 <p>Area $S = s_0 + 2 \times s_1 + s_2$</p> <p>X-axis (Y = 0)</p>
Time to level	<p>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.</p> <p>Settings: Level, Slope, Filter</p>	 <p>Level</p> <p>0 V</p>
Level at time	<p>Calculates the level when the specified time has elapsed from the trigger point. The time can also be specified based on previously calculated results.</p> <p>Settings: Method (Time, Calc.No.), Time/calculation number (No. 1 to No. 107)</p>	 <p>Level</p> <p>0 V</p> <p>T (Time)</p>
Pulse width	<p>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.</p> <p>Settings: Level, Slope, Filter, Stat.</p>	 <p>Level</p>
Duty ratio	<p>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.</p> $\text{Duty ratio} = \frac{T_{u-d}}{T_{u-d} + T_{d-u}} \times 100 [\%]$ <p>T_{u-d}: Time from rising edge to falling edge (unit: s) T_{d-u}: Time from falling edge to rising edge (unit: s)</p> <p>Settings: Level, Filter, Stat.</p>	 <p>Level</p> <p>T_{u-d}</p> <p>T_{d-u}</p>

Calculation type	Description	
<p>Pulse count</p>	<p>Counts the number of the pulses that crossed the specified level in the positive (or negative) direction.</p> <p>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).</p> <p>Settings: Level, Slope, Filter</p>	
<p>Arithmetic operations</p>	<p>Performs arithmetic operations using the numerical calculation results freely selected.</p> <p>Settings: Calculation number 1, Arithmetic operations (+, -, ×, ÷), Calculation number 2</p>	
<p>Time difference</p>	<p>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.</p> <p>(Time lag T) = (Time when waveform B crossed the level) – (Time when waveform A crossed the level)</p> <p>Settings: Waveform A (Reference channel, Level, Slope, Filter); Waveform B (Target channel, Level, Slope, Filter)</p>	
<p>Phase contrast</p>	<p>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.</p> $\text{Phase difference} = \frac{\text{Time lag between waveforms A and B}}{\text{Period of Waveform A}} \times 360 [^\circ]$ <p>Settings: Waveform A (Reference channel, Level, Slope, Filter); Waveform B (Target channel, Level, Slope, Filter)</p>	
<p>High level Low level</p>	<p>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).</p>	
<p>Intermediate value</p>	<p>Calculates the average of the maximum and minimum values of the waveform data.</p> $[(\text{Maximum value}) + (\text{Minimum value})] / 2$	
<p>Amplitude</p>	<p>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).</p> <p>(High level) – (Low level)</p>	

Calculation type	Description	
Overshoot Undershoot	<p>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).</p> $\frac{\{[(\text{Maximum value}) - (\text{High level})] / [(\text{High level}) - (\text{Low level})]\} \times 100}{\{[(\text{Low level}) - (\text{Minimum value})] / [(\text{High level}) - (\text{Low level})]\} \times 100}$	
+Width (Period during which the waveform is above the intermediate level) -Width (Period during which the waveform is below the intermediate level)	<p>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.</p> <p>Settings: Filter, Stat.</p>	
Burst width	<p>Calculates the time during which the burst signal is output.</p> <p>Settings: Filter, Burst end filter, Window (Up, Low), Stat.</p>	
Accumulation Method: Total	<p>Calculates the accumulation by subtracting the accumulation (V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is negative from the accumulation (unit: V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive.</p> <p>When the range is specified, calculates the accumulation between the cursors.</p> $S = \sum_{i=1}^n di$ <p>S: Accumulation n: Number of data points di: ith data point acquired across the channel</p>	
Accumulation Method: Absolute value	<p>Calculates the accumulation (unit: V) enclosed by the zero-level (zero-potential) line and the signal waveform.</p> <p>When the range is specified, calculates the accumulation between the cursors.</p> $S = \sum_{i=1}^n di $ <p>S: Accumulation n: Number of data points di: ith data point acquired across the channel</p>	

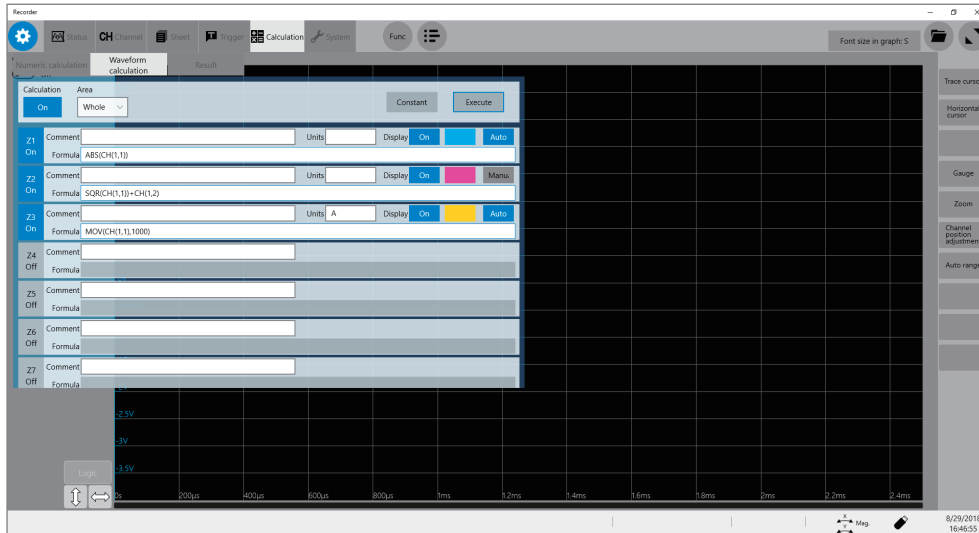
Calculation type	Description	
<p>Accumulation Method: Positive (Only the part where the amplitude is positive)</p>	<p>Calculates the accumulation (unit: V) enclosed by the zero-level (zero-potential) line and the part where the amplitude of the signal waveform is positive. When the range is specified, calculates the accumulation between the cursors.</p> $S = \sum_{i=1, di > 0}^n di$ <p>S: Accumulation n: Number of data points di: ith data point acquired across the channel</p>	 <p>Cursor A Cursor B</p> <p>$S = s_1$</p>
<p>Accumulation Method: Negative (Only the part where the amplitude is negative)</p>	<p>Calculates the accumulation (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, calculates the accumulation between the cursors.</p> $S = \sum_{i=1, di < 0}^n di$ <p>S: Accumulation n: Number of data points di: ith data point acquired across the channel</p>	 <p>Cursor A Cursor B</p> <p>$S = -s_2$</p>
<p>Angle of XY waveform</p>	<p>Calculates the regression line on the X-Y composite curve, and then the slope angle.</p> $SLOPE = \frac{\sum_{i=1}^n (x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sum_{i=1}^n (x_i - \bar{x})^2}$ $\theta = \arctan(SLOPE) \cdot 180 / \pi [^\circ]$ <p>θ: Angle at which X-axis and the regression line intersect xi: ith data point acquired across the X-axis channel yi: ith data point acquired across the Y-axis channel x̄: Average value of the X-axis channel ȳ: Average value of the Y-axis channel</p>	 <p>Regression line</p>

8

Waveform Calculation Function

The instrument can calculate the acquired waveform data using arithmetic equations previously specified and displays the calculation results as waveforms on the waveform screen.

 > [Calculation] > [Waveform calculation]



Operation available on the [Waveform calculation] screen

Waveform Calculation

- Four arithmetic operations (+, -, ×, ÷)
 - Absolute value (ABS)
 - Exponent (EXP)
 - Common logarithm (LOG)
 - Square root (SQR), cube root (CBR)
 - Moving average (MOV)
 - Parallel transition in the time axis direction (12 types in total)
 - Differential (1st-order [DIF], 2nd-order [DIF2])
 - Integration (1st-order [INT], 2nd-order [INT2])
 - Trigonometric function (SIN, COS, TAN)
 - Inverse trigonometric function (ASIN, ACOS, ATAN, ATAN2)
 - Waveform shifting by the PLC delay time specified in Model MR8990 Digital Voltmeter Unit or Model U8991 Digital Voltmeter Unit (PLCS)
 - Calculation by specifying a range between cursors
You can specify a calculation range between trace cursors A and B or between trace cursors C and D.
- Details about arithmetic equations "8.3 Operators of Waveform Calculation and Calculation Results" (p. 154)

In addition to the four arithmetic operations, 11 functions are available to calculate waveform data. You can specify up to 16 arithmetic equations.

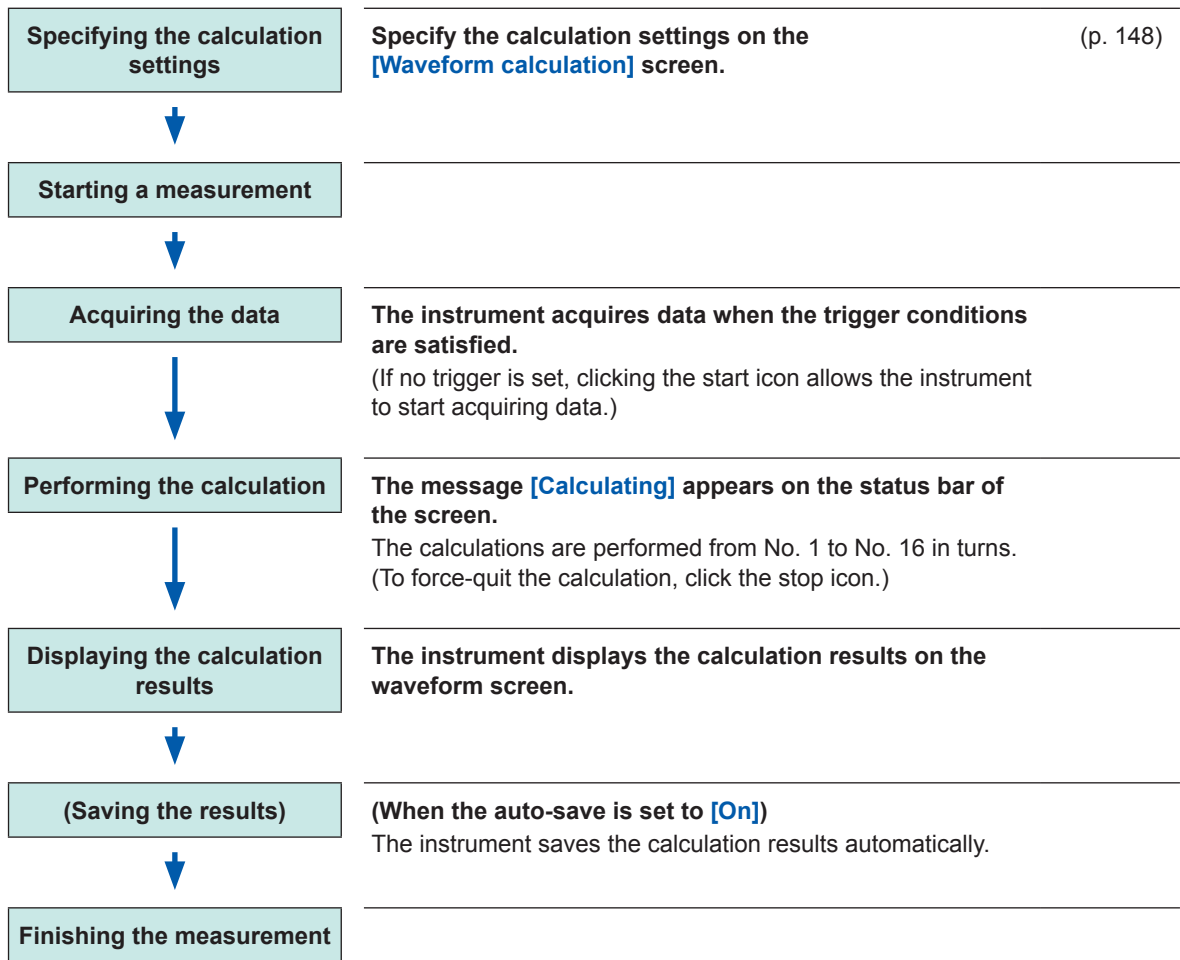
When the scaling function is enabled, scaled values are calculated.

8.1 Waveform Calculation Procedure

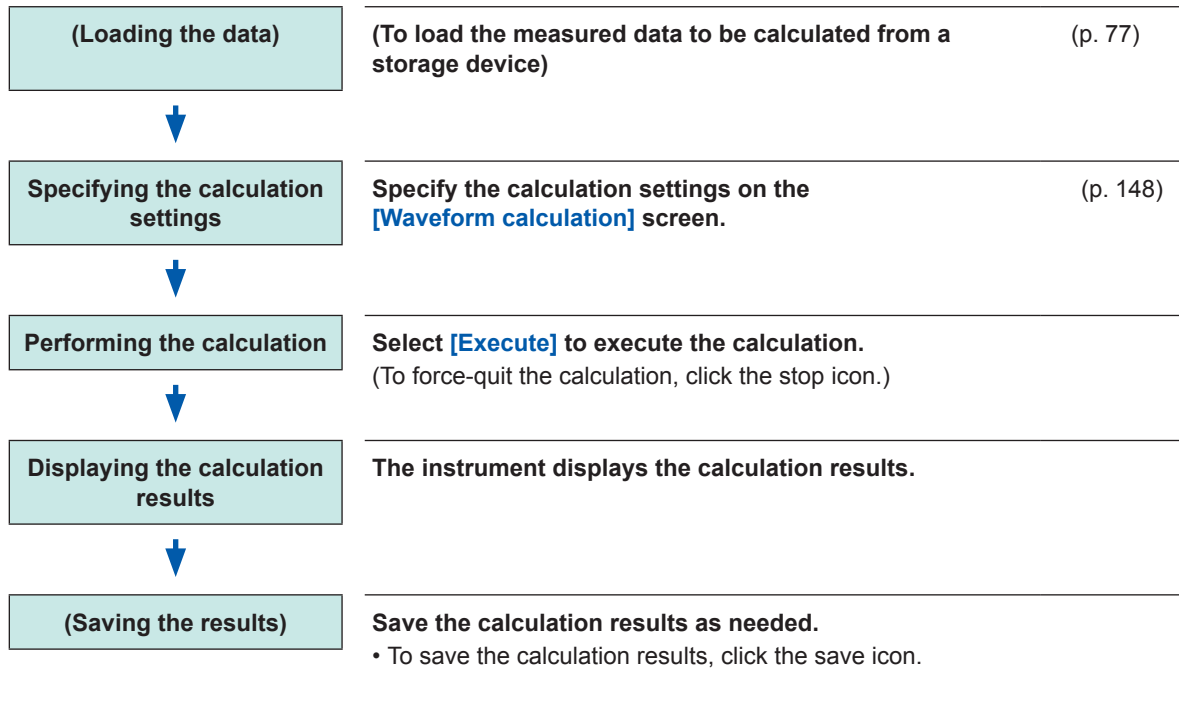
The following two methods are available:

Calculating the data automatically after the measurement	You must specify the waveform calculation settings before starting a measurement.
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



Calculating the existing data



To specify a waveform scope for calculation

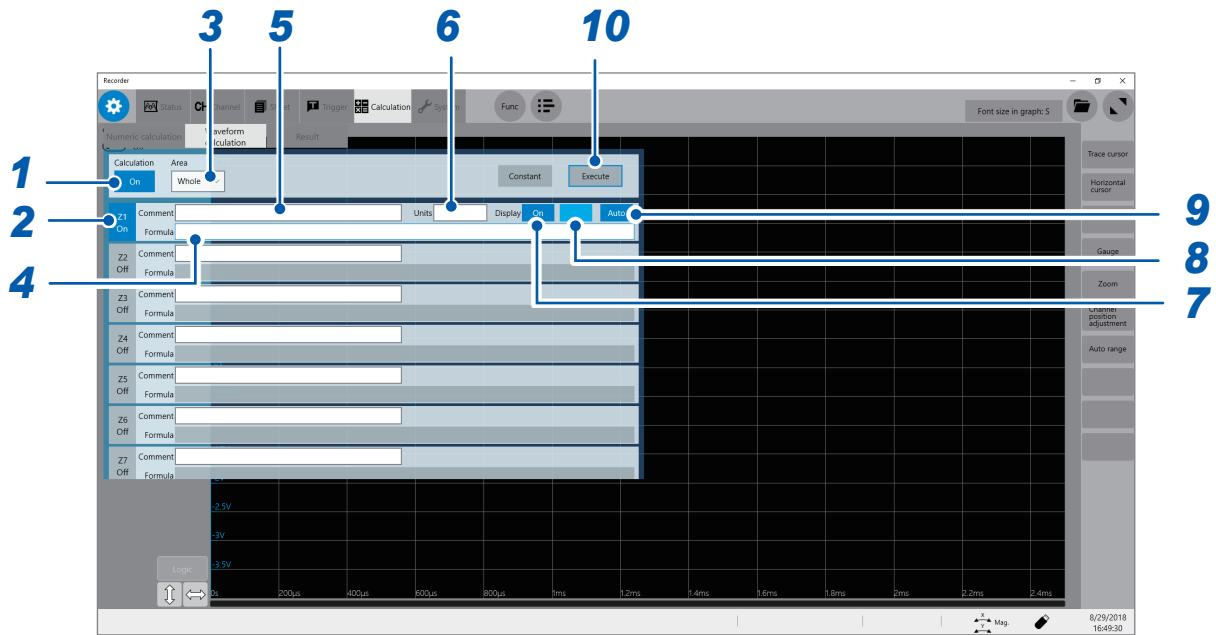
Specify the calculation scope with the trace cursors on the waveform screen before executing the calculation. Set [\[Area\]](#) to [\[A_B\]](#) or [\[C_D\]](#) on the [\[Waveform calculation\]](#) screen.

With the [\[A_B\]](#) setting, the instrument calculates the data between trace cursors A and B; with the [\[C_D\]](#) setting, between trace cursors C and D.


Refer to “8.2 Specifying Waveform Calculation Settings” (p. 148).

8.2 Specifying Waveform Calculation Settings

 > [Calculation] > [Waveform calculation]

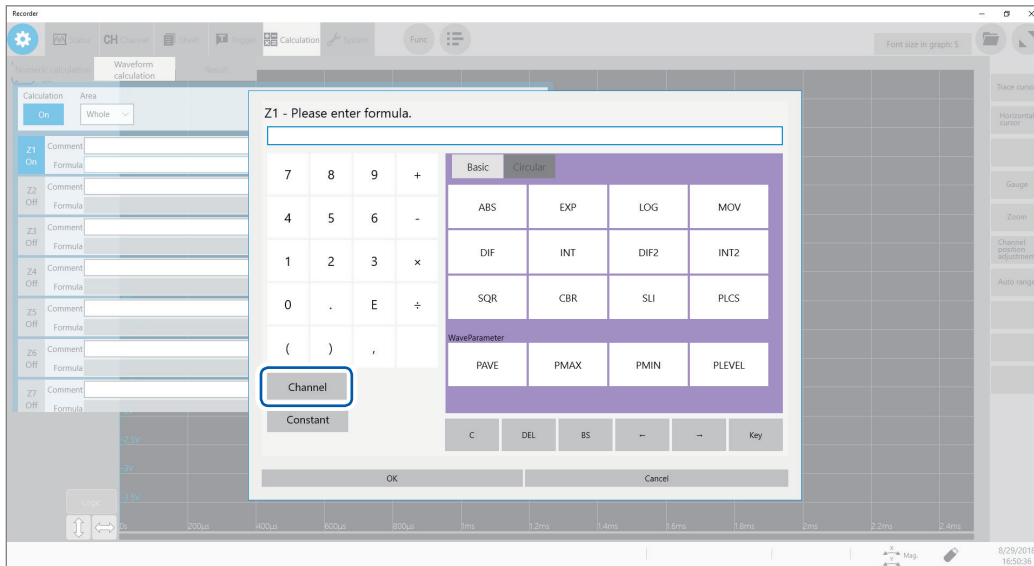


- 1** Enable the waveform calculation function.
Use the mouse to set [Calculation] to [On].
- 2** Specify arithmetic equations.
Use the mouse to specify the [Z1] through [Z16] settings to [On].
- 3** Select a calculation range in [Area].

Whole 	Calculates all waveform data.
A_B	Calculates waveform data between cursors A and B.
C_D	Calculates waveform data between cursors C and D.

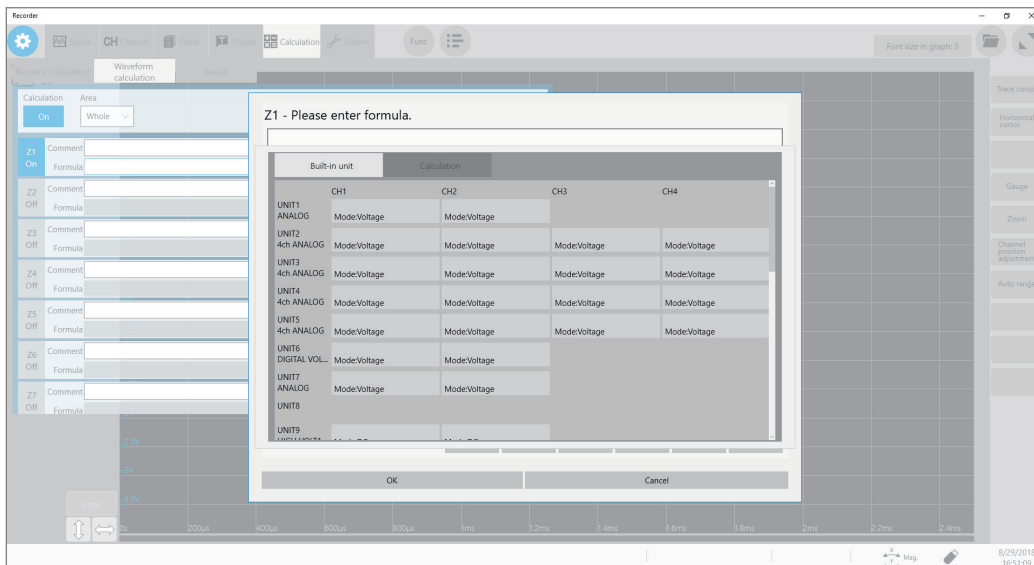
4 Enter an arithmetic equation.

Point to the arithmetic equation field and enter an arithmetic equation.

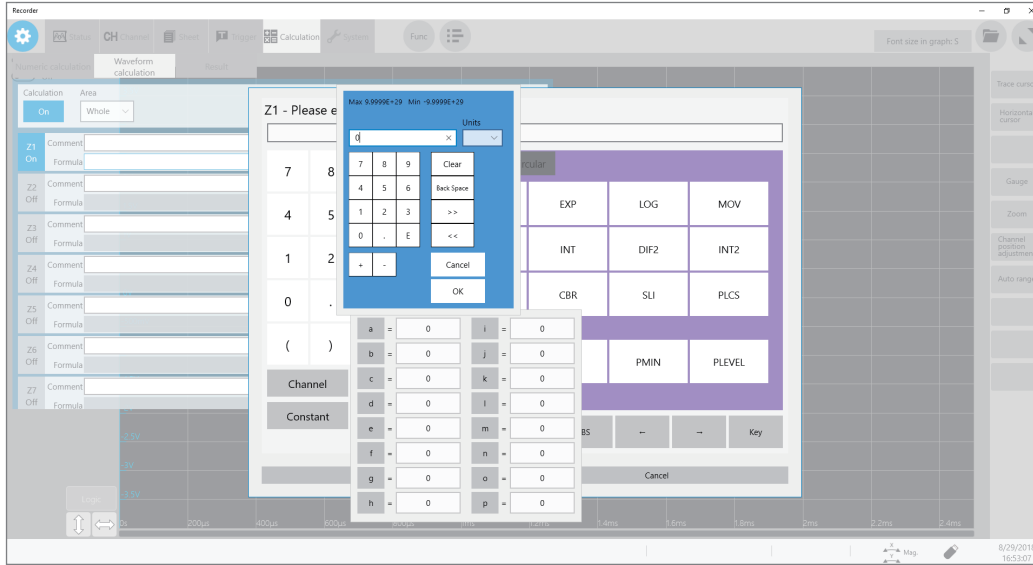


To select a channel

Click **[Channel]** and select a channel you want to calculate.



To enter a constant, you must previously specify the **[Constant]** setting.



5 Type a comment.
Use the keyboard to type a calculation comment.

6 Type a unit.

7 Select a waveform setting in **[Display].**

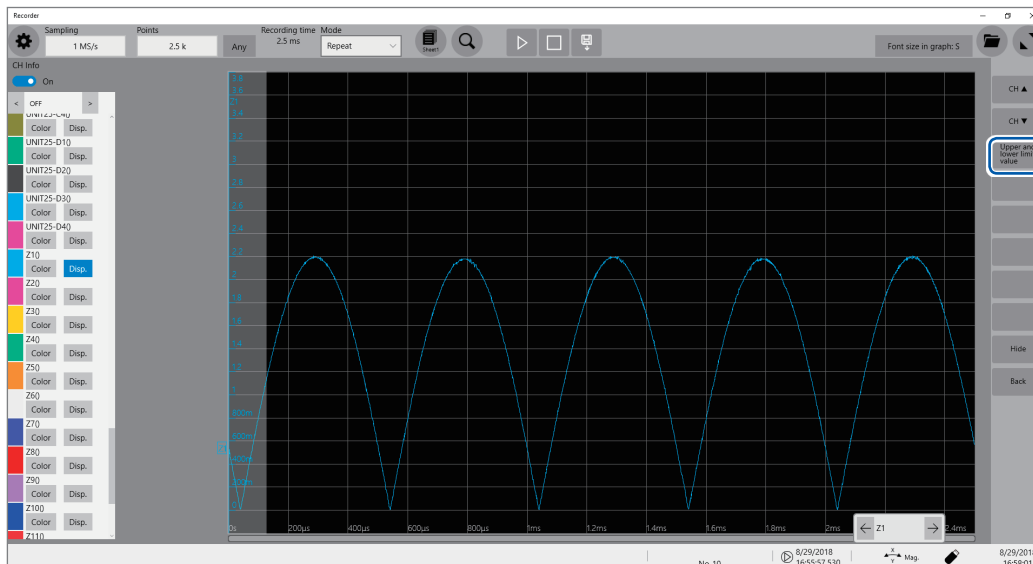
Off <input checked="" type="checkbox"/>	Displays no waveforms.
On	Displays waveforms.

8 Specify a waveform color.

9 Specify the scaling setting for a calculation result.

Auto	Automatically scales a calculation result.
Manual	Select this option to change scaling factors.

To specify the calculation result setting manually



- (1) Click a calculation channel.
- (2) Click **[Upper and lower limit value]** to specify the upper and lower limit values of the calculation result.

10 Execute a calculation.

Click **[Execution]** to calculate the waveforms.

To calculate waveforms during a measurement

Click the start icon to start a measurement.

Once the instrument has acquired waveforms, it displays waveforms calculated.

Entering arithmetic equations

- The length of each arithmetic equation is limited to 80 characters.
- Each constant in an arithmetic equation is limited to 30 digits.
- Use an asterisk (*) and slash (/) to represent multiplication and division, respectively.
- Entering a long, complex equation such as the following cause the equation entering field to be filled with red. Divide the equation into two or more.

$$\underbrace{\text{ABS}(\text{CH1})}_{1} + \underbrace{\text{CH2} * \text{CH3}}_{2} - \underbrace{(\text{CH4} + \text{CH5}) * \text{ABS}(\text{CH6})}_{3}$$

- Entering an equation with a divider of zero results in an output of an overflowed value. (for a positive divisor, +9.9999E+29; for a negative divisor, -99.9999E+29)
- You can use calculation result Zi in other calculations. However, for the Zn-th equation, results Zn-1 or earlier only can be used. (Example: You can use results Z1, Z2, and Z3 for equation Z4)

When an equation includes the following operators: **MOV**, **SLI**, **DIF**, **DIF2**, **PLEVEL**, and **ATAN2** (second parameter)

Specify the second parameter following each of these operators.

Examples of operators and settings

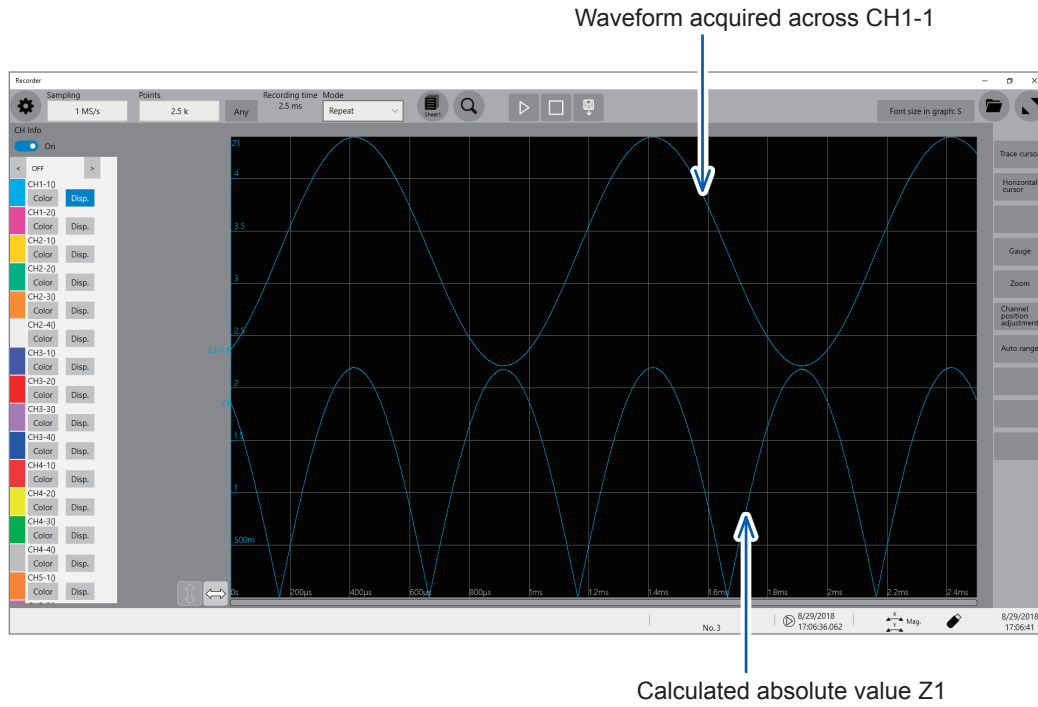
Operator	Setting	Setting example
MOV (moving average) SLI (parallel translation)	Specify the number of moving points. Setting range MOV (moving average): 1 to 5000 SLI : -5000 to 5000 If you omit to enter this setting, the instrument performs the operation supposing that k equals one.	Calculates 10-points moving averages of data acquired across CH1. MOV(CH1,10)
DIF (differential) DIF2 (2nd-order differential)	Specify a sampling interval for differentials Normally specify "1." Specify a larger number to monitor the variation in a waveform that changes slowly. Setting range for DIF and DIF2 : 1 to 5000 If you omit to enter this setting, the instrument performs the operation supposing that k equals one.	To calculate differentials of data acquired across CH2 at intervals of 20 sampled points. MOV(CH2,20)
PLEVEL (level at time)	Specify a time from a trigger point. If you omit this setting, the instrument performs the operation supposing that k equals 0.	Obtains the level a signal reaches 1 ms after the trigger point generated from a signal acquired across CH1-3. PLEVEL(CH(1,3),0.001)
ATAN2 (arc tangent 2)	When you type " ATAN2(y,x) ," the instrument calculates the equation ATAN(y/x) . (p. 155) If you omit "x," the instrument performs the operation supposing that x equals 1.0. You can specify "CH," "Z," or a constant only at "x." No function or equation can be specified.	To calculate arc tangent 2 of CH1-1/CH1-2 ATAN2(CH(1,1),CH(1,2))

If a calculation result is overflowing (OVER)

- Values shown at cursor A and B are incorrect.
- When **[Scale]** is set to **[Auto]**, the instrument displays waveforms at the upper and lower ends of the screen, which reminds you that the calculation result is overflowing.
- If an equation you enter includes an error (the frame is filled with red), the calculation result becomes zero.

Calculation result

Example: Absolute value waveform for the waveform acquired across CH1_1
Arithmetic equation $Z1 = \text{ABS}(\text{CH}(1,1))$



8.3 Operators of Waveform Calculation and Calculation Results

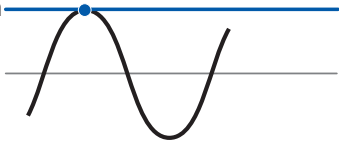
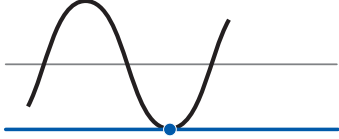
b_i : i th data point of calculation results, d_i : i th data point acquired across the source channel

Waveform calculation type	Description
Four arithmetic operations (+, -, ×, ÷)	Calculates waveforms using operators specified from the four arithmetic operations, which consists of addition (+), subtraction (-), multiplication (×), and division (÷). Multiplication signs (×) and division signs (÷) are represented as asterisks (*) and slashed (/), respectively.
Absolute value (ABS)	$b_i = d_i $ (i = 1, 2, . . . , n)
Exponent (EXP)	$b_i = \exp(d_i)$ (i = 1, 2, . . . , n)
Common logarithm (LOG)	<p>With $d_i > 0$ $b_i = \log_{10} d_i$ With $d_i = 0$ $b_i = -\infty$ (Outputs overflowing values) With $d_i < 0$ $b_i = \log_{10} d_i$ (i = 1, 2, . . . , n)</p> <p>Note The following equations can convert common logarithms into natural logarithms. $\ln X = \log_e X = \log_{10} X / \log_{10} e$ $1 / \log_{10} e \approx 2.30$</p>
Square root	<p>With $d_i \geq 0$ $b_i = \sqrt{d_i}$ With $d_i < 0$ $b_i = -\sqrt{ d_i }$ (i = 1, 2, . . . , n)</p>
Cube root (CBR)	$b_i = \sqrt[3]{d_i}$
Moving average (MOV)	<p>For this function, specify the number of moving points at the second parameter k. When k is an odd number When k is an even number</p> $b_i = \frac{1}{k} \sum_{t=i-\frac{k-1}{2}}^{i+\frac{k-1}{2}} d_t \quad (i=1,2, \dots, n)$ $b_i = \frac{1}{k} \sum_{t=i-\frac{k}{2}+1}^{i+\frac{k}{2}} d_t \quad (i=1,2, \dots, n)$ <p>d_i: ith data point acquired across the source channel k: Number of moving point (1 to 5000)</p> <p>Specify the constant k following a comma. Calculates 100-point moving averages of the Z1 data. MOV(Z1,100) For each k/2 points of data at the beginning and end of the calculation interval, the instrument performs calculations by plugging in zero for data-missing parts</p>
Parallel transition in the time axis direction (SLI)	<p>For this function, specify the number of moving points at the second parameter k. The instrument yields waveforms parallel translated in the time axis direction by the specified number of points. $b_i = d_{i-k}$ (i = 1, 2, . . . , n) k: Number of moving point (-5000 to 5000)</p> <p>Specify the constant k following a comma. Calculates the data Z1 parallel translated in 100 points. SLI(Z1,100)</p> <p>Note When waveforms are parallel translated, the non-data parts at the beginning or end of the calculation interval measure a voltage of 0 V.</p>
Sine (SIN)	<p>$b_i = \sin(d_i)$ (i = 1, 2, . . . , n) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).</p>
Cosine (COS)	<p>$b_i = \cos(d_i)$ (i = 1, 2, . . . , n) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).</p>
Tangent (TAN)	<p>$b_i = \tan(d_i)$ (i = 1, 2, . . . , n) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).</p>

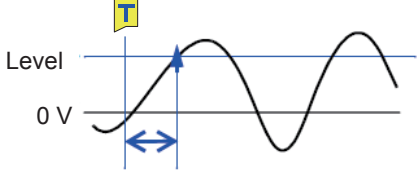
b_i : i th data point of calculation results, d_i : i th data point acquired across the source channel

Waveform calculation type	Description
Arc sine (ASIN)	With $d_i > 1$ $b_i = \pi / 2$ With $-1 \leq d_i \leq 1$ $b_i = \arcsin(d_i)$ With $d_i < -1$ $b_i = -\pi / 2$ ($i = 1, 2, \dots, n$) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).
Arc cosine (ACOS)	With $d_i > 1$ $b_i = 0$ With $-1 \leq d_i \leq 1$ $b_i = \arccos(d_i)$ With $d_i < -1$ $b_i = \pi$ ($i = 1, 2, \dots, n$) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).
Arc tangent (ATAN)	$b_i = \arctan(d_i)$ ($i = 1, 2, \dots, n$) For the trigonometric and inverse trigonometric functions, specify numbers in terms of radians (rad).
Arc tangent 2 (ATAN2(y, x))	Responses arc tangent of (y / x) in the range of $[-\pi, \pi]$. Specify numbers in terms of radians (rad). $ATAN2(y, x) =$ With $x \geq 0$ $ATAN(y / x)$ With $x < 0$ and $y \geq 0$ $ATAN(y / x) + \pi$ With $x < 0$ and $y < 0$ $ATAN(y / x) - \pi$
1st-order differential (DIF) 2nd-order differential (DIF2)	The instrument calculates 1st-order differential and 2nd-order differential using 5th-order Lagrange interpolation formula to obtain 1-point data from 5-point values including before and after the point. The instrument differentiates data d_1 to d_n considering them as the corresponding data for the sampling time t_1 to t_n . Note If the instrument differentiates a waveform that oscillates slowly, calculation results vary significantly. In such a case, raise the second parameter of the function. The following equations hold provided the second parameter equals one. 1st-order differential equation Point t_1 $b_1 = (-25d_1 + 48d_2 - 36d_3 + 16d_4 - 3d_5) / 12h$ Point t_2 $b_2 = (-3d_1 - 10d_2 + 18d_3 - 6d_4 + d_5) / 12h$ Point t_3 $b_3 = (d_1 - 8d_2 + 8d_4 - d_5) / 12h$ ↓ Point t_i $b_i = (d_{i-2} - 8d_{i-1} + 8d_{i+1} - d_{i+2}) / 12h$ ↓ Point t_{n-2} $b_{n-2} = (d_{n-4} - 8d_{n-3} + 8d_{n-1} - d_n) / 12h$ Point t_{n-1} $b_{n-1} = (-d_{n-4} + 6d_{n-3} - 18d_{n-2} + 10d_{n-1} + 3d_n) / 12h$ Point t_n $b_n = (3d_{n-4} - 16d_{n-3} + 36d_{n-2} - 48d_{n-1} + 25d_n) / 12h$ b_1 through b_n : Calculation result data $h = \Delta t$: Sampling interval 2nd-order differential equation Point t_1 $b_1 = (35d_1 - 104d_2 + 114d_3 - 56d_4 + 11d_5) / 12h^2$ Point t_2 $b_2 = (11d_1 - 20d_2 + 6d_3 + 4d_4 - d_5) / 12h^2$ Point t_3 $b_3 = (-d_1 + 16d_2 - 30d_3 + 16d_4 - d_5) / 12h^2$ ↓ Point t_i $b_i = (-d_{i-2} + 16d_{i-1} - 30d_i + 16d_{i+1} - d_{i+2}) / 12h^2$ ↓ Point t_{n-2} $b_{n-2} = (-d_{n-4} + 16d_{n-3} - 30d_{n-2} + 16d_{n-1} - d_n) / 12h^2$ Point t_{n-1} $b_{n-1} = (-d_{n-4} + 4d_{n-3} + 6d_{n-2} - 20d_{n-1} + 11d_n) / 12h^2$ Point t_n $b_n = (11d_{n-4} - 56d_{n-3} + 114d_{n-2} - 104d_{n-1} + 35d_n) / 12h^2$

b_i : i th data point of calculation results, d_i : i th data point acquired across the source channel

Waveform calculation type	Description
<p>1st-order integration (INT) 2nd-order integration (INT2)</p>	<p>To calculate values of 1st-order and 2nd-order integrals, the trapezoidal rule is used. The instrument integrates data d_1 to d_n considering them as the corresponding data for the sampling time t_1 to t_n.</p> <p>1st-order integral equation Point t_1 $I_1 = 0$ Point t_2 $I_2 = (d_1 + d_2) h / 2$ Point t_3 $I_3 = (d_1 + d_2) h / 2 + (d_2 + d_3) h / 2 = I_2 + (d_2 + d_3) h / 2$ ↓ Point t_n $I_n = I_{n-1} + (d_{n-1} + d_n) h / 2$</p> <p>$I_1$ through I_n: Calculation result data $h = \Delta t$: Sampling interval</p> <p>2nd-order integral equation Point t_1 $II_1 = 0$ Point t_2 $II_2 = (I_1 + I_2) h / 2$ Point t_3 $II_3 = (I_1 + I_2) h / 2 + (I_2 + I_3) h / 2 = II_2 + (I_2 + I_3) h / 2$ ↓ Point t_n $II_n = II_{n-1} + (I_{n-1} + I_n) h / 2$</p> <p>$II_1$ through II_n: Calculation result data</p> <p>Note Integration is susceptible to minor deviation of the zero-position. Be sure to execute zero-adjustment before performing a measurement. In addition, zero-point offset correction may be required. Example: To adjust the zero point by 0.124 mV $Z1 = INT (CH1-0.000124)$</p>
<p>Waveform shifting by PLC delay time specified in digital voltmeter module (PLCS)</p>	<p>The instrument shifts a waveform by a frequency (PLC) specified in a digital voltmeter module and a delay time of PLCS. Since digital voltmeter modules calculate averages during periods specified in the NPLC setting, observed waveforms will lag behind waveforms acquired with Model 8966 Analog Unit by a half of the NPLC setting. The PLCS calculation advances the waveforms acquired with the digital voltmeter module by the delay time and thus compensates the results for the lag behind the waveforms acquired with Model 8966.</p> <p>Note If the end of the calculation result contains no data, this part measures a voltage of 0 V.</p>
<p>Average value (PAVE)</p>	<p>Calculates an average value of waveform data to use this numerical calculation result for waveform calculations.</p> $AVE = \frac{1}{n} \sum_{i=1}^n d_i$ <p>AVE: Average n: Number of data points d_i: ith data point acquired across the channel</p>
<p>Maximum value (PMAX)</p>	<p>Calculates the maximum value of waveform data to use this numerical calculation result for waveform calculations.</p> <p>Maximum </p>
<p>Minimum value (PMIN)</p>	<p>Calculates the minimum value of waveform data to use this numerical calculation result for waveform calculations.</p> <p>Minimum </p>

b_i : i th data point of calculation results, d_i : i th data point acquired across the source channel

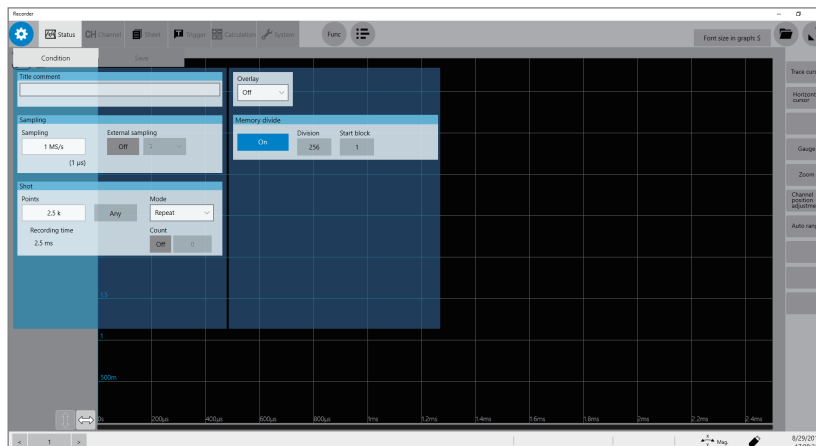
Waveform calculation type	Description
Level at time (PLEVEL)	<p>Calculates a measured value at a time a specified time has elapsed from a trigger point to use this numerical calculation result for waveform calculations.</p> 

9

Memory Dividing Function

You can divide the memory capacity into several blocks, each of which is used to store waveforms.

 > [Status] > [Condition]



Operation available with the memory dividing function

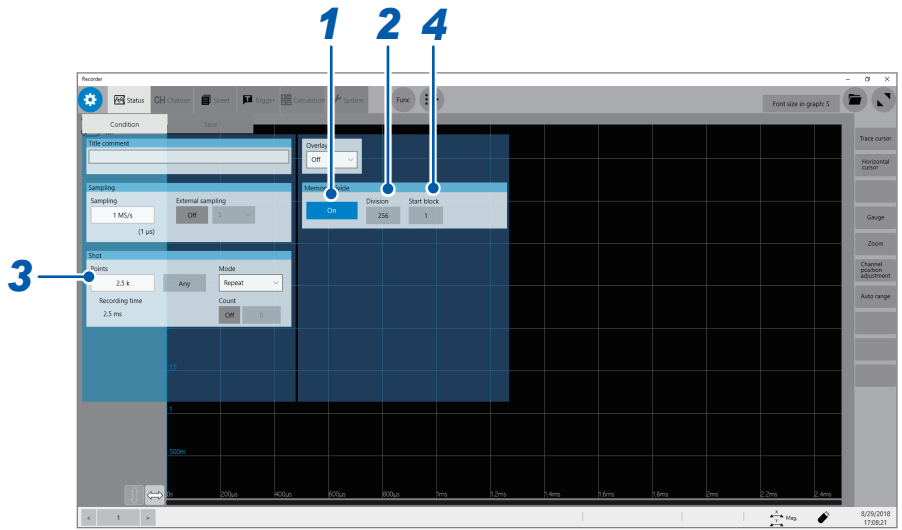
- You can divide the memory capacity into several blocks and save waveforms onto any blocks.
- The maximum division number of blocks varies depending on recording lengths. (Up to 1024)
- When triggered, the instrument starts to acquire waveform data sequentially and store the data onto the block you specified (start block).

When **[Memory divide]** is set to **[On]**, the instrument may irregularly output a low-level signal from the EXT.TRIG terminal under the following conditions:

- Oversampling rate: 20 MS/s to 1 MS/s
- Recording (measuring) length: 5 ms or less

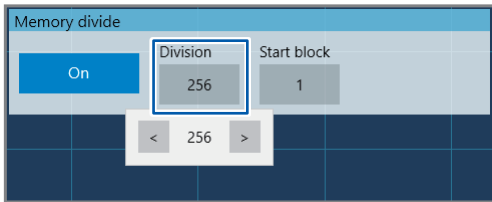
9.1 Specifying the Memory Dividing Settings

 > [Status] > [Condition]



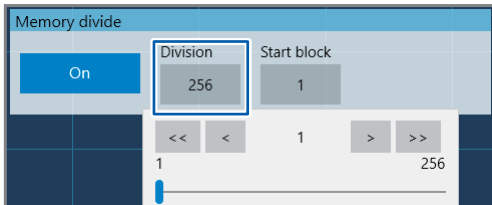
- 1** Set [Memory divide] to [On] or [Off].
- 2** Select a setting of the division number in [Division].

2, 4, 8, 16, 32, 64, 128, 256, 512, 1024



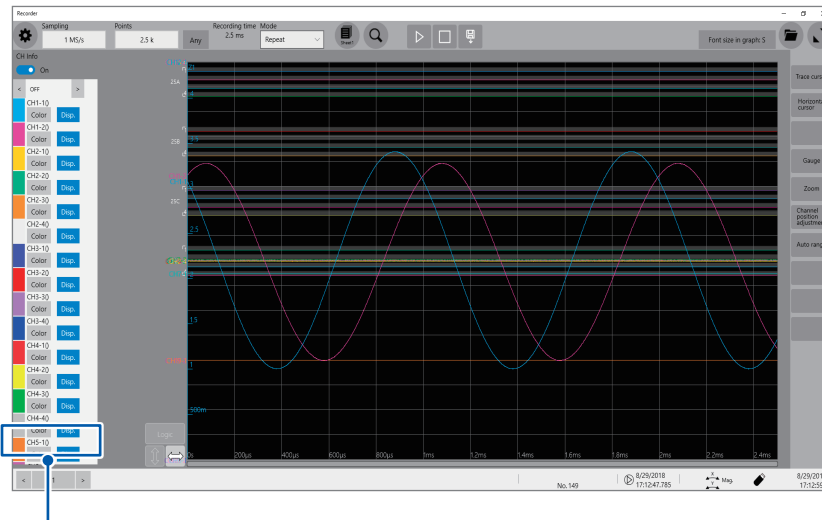
- 3** Enter the recording length in [Shot].
The maximum recording length varies depending on the division number specified in [Division].

- 4** Type the start block number in [Start block].
Specify the number of a block you want to store waveforms in. The instrument stores the waveforms in the block with the number you specified.



9.2 Displaying Waveforms

You can select a block to display waveforms stored in it.



Select a block number you specified.

Waveform calculation with the memory dividing setting

- With the memory dividing enabled, waveforms Z1 through Z16, which are obtained by waveform calculations, remain in the block finally calculated only.
- To observe calculated waveforms stored in other blocks, execute another calculation.

10

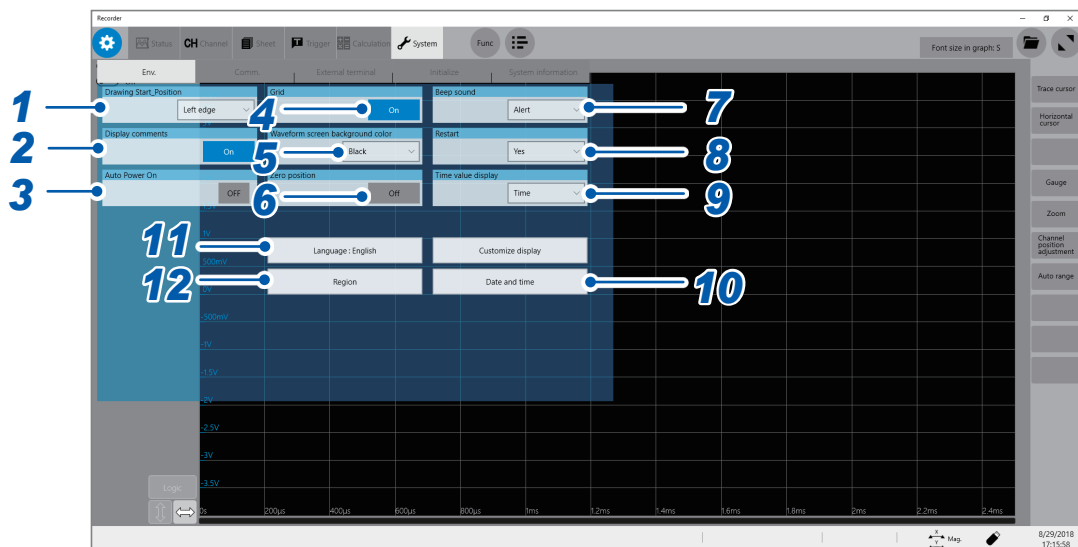
Specifying the System Environment Settings

You can specify the system environment for the instrument.

IMPORTANT

Do not change any Windows® setting unless otherwise indicated in this document. Doing so may cause the system operation to become unstable.

 > [System] > [Env.]



1 Select a drawing start position in [Drawing Start_Position].

Left edge <input checked="" type="checkbox"/>	Starts scrolling through waveforms from the left side of the waveform screen.
Right edge	Starts scrolling through waveforms from the right side of the waveform screen.

2 Select a comment display setting in [Display comments].

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

On <input checked="" type="checkbox"/>	Displays comments.
Off	Does not display any comments.

3 Select an automatic power-on setting in [Auto Power on].

This function enables you to start Windows® and thus to use the instrument for measurements by only throwing a circuit breaker on a power-supply line without pressing the front and rear power buttons (always set the rear power button to on). The instrument does not store the [Auto Power On] setting in any file.

Off <input checked="" type="checkbox"/>	Disables the auto-power-on setting.
On	Enables the auto-power-on setting.

4 Select a grid display setting in **[Grid]**.

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

On <input checked="" type="checkbox"/>	Displays the solid-line grid.
Off	Does not display any grids.

5 Select a waveform screen background color in **[Waveform screen background color]**.

You can choose a background color of the waveform screen.

Some background colors of waveforms may cause waveforms to get difficult to see. Change the waveform colors in such a case.

Black <input checked="" type="checkbox"/>	Sets the background color of the waveform screen to black.
White	Sets the background color of the waveform screen to white.

6 Select a zero-position marker setting in **[Zero position]**.

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

Off <input checked="" type="checkbox"/>	Does not display any markers.
On	Displays markers at the zero position on the right side of the waveform screen.

7 Select a beep sound setting in **[Beep sound]**.

The instrument can beep to remind you of warnings and operating conditions.

Off	Does not allow the instrument to beep.
Alert <input checked="" type="checkbox"/>	Allows the instrument to beep in the following cases: <ul style="list-style-type: none">• If an error message or warning appears• 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 Select a restart setting in **[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 <input checked="" type="checkbox"/>	If a setting is changed during measurement, the instrument confirms the change and restarts the measurement.

9 Select a time value setting in **[Time value display]**.

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

Time <input checked="" type="checkbox"/>	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 absolute date and time when the waveform has been acquired.
Samples	Displays the number of data acquired during the period 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.

10 Specify the **[Date and Time]** settings

Refer to “2.7 Setting the Clock” in Quick Start Manual.

11 Change the display languages.

(1) Click **[Language: English]**.

The setting dialog box will appear.

(2) Select another language.

English , Japanese

(3) Click **[OK]**.

The instrument is turned off.

(4) Press the start button.

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

12 Change the **[Region]** settings (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 . <input type="checkbox"/>	Designates the period (.) as the decimal point.
Comma ,	Designates the comma (,) as the decimal point.

[Separator]

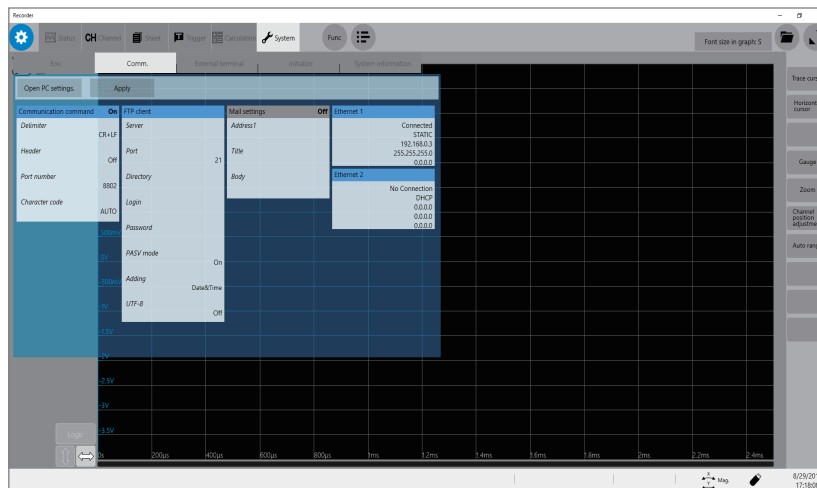
Comma , <input type="checkbox"/>	Designates the comma (,) as the separator.
Space	Designates the space character as the separator.
Tab	Designates the tab character as the separator.
Semicolon ;	Designates the semicolon (;) as the separator.

- Either the decimal point or separator, but not both, can be set to **[Comma ,]**.
- For the **[Comma ,]** setting, the instrument saves files with a CSV extension; for the other separator settings, with a TXT extension.

Familiarize yourself with the section “Before connecting to an external device” in “Operation Precautions” of Quick Start Manual.

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).

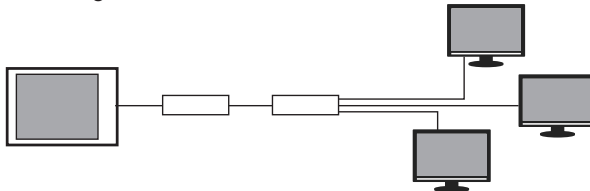
 > [System] > [Comm.]



Operation available on the [Comm.] screen

Specifying the LAN settings and connecting the instrument via LAN (p. 168)

- Connecting the instrument to the PC via the network



- Connecting the instrument to the PC directly



Sending emails (p. 184)

FTP server function (p. 172)

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. 178)

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. 189)

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.

11.1 Specifying the LAN Settings and Connecting to the Network

Specify the LAN settings of the instrument and connect the instrument to your PC with a LAN cable before accessing the instrument with a PC using the FTP or an Internet browser, or using command communication.

Be sure to specify 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 fail to 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 “2.4 Connecting the Instrument with PCs” in Quick Start Manual.

IMPORTANT

Do not change any Windows[®] setting unless otherwise listed in this document. Doing so may cause the system operation to become unstable.

Specifying the LAN settings with the instrument

Items to be checked before specifying 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.

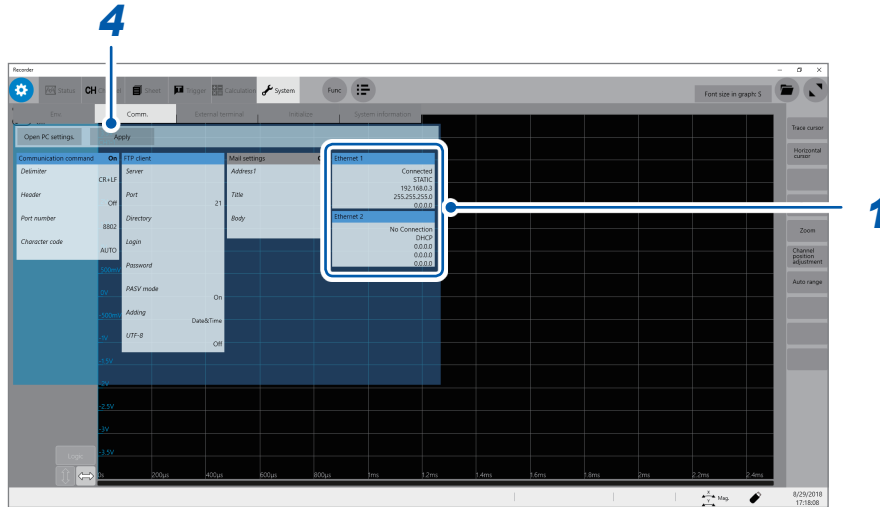
Setting example:

```
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.

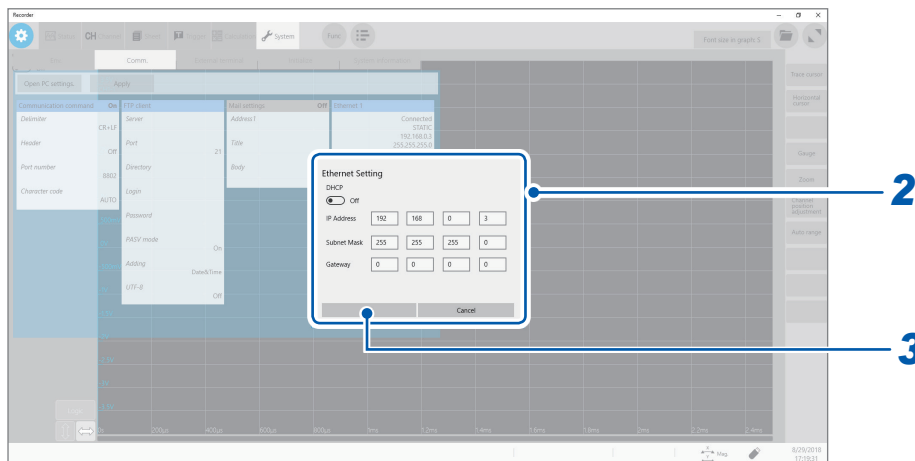
      ↓                ↓
PC name..... Any name (Must be unique)
Subnet mask..... 255.255.255.0
Gateway ..... Off
```

Setting items

 > [System] > [Comm.]



- 1 Click [Ethernet 1] or [Ethernet 2].
The Ethernet settings screen appears.



- 2 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. Specify the subnet mask settings in the same way as those of other devices on the network.
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.

- 3 Click [OK].
- 4 Click [Apply].

Renaming the PC

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

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

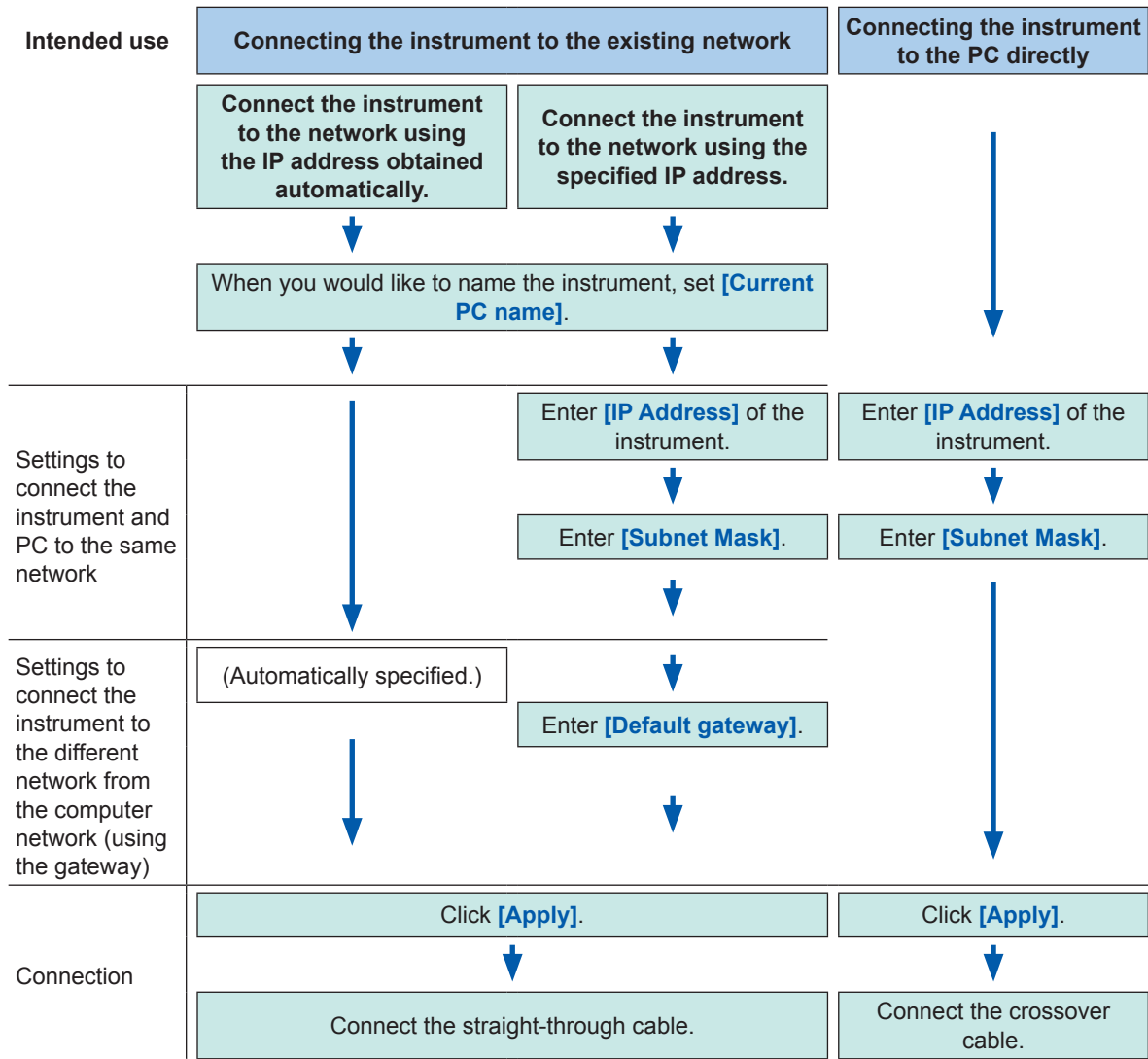
- 1** Click **[Open PC settings.]**.
The Ethernet settings screen appears.
- 2** Click **[Home]**.
The Windows® settings screen appears.
- 3** Click **[System]**.
- 4** Click **[About]** under **System**.
- 5** Click **[Rename PC]** and type another name in **[Current PC name]**.
- 6** Click **[Next]**.
Restarting the instrument is required.
- 7** Click **[Restart now]**.

LAN setting procedure

Follow this procedure in accordance with the intended usage.

For details on each setting, refer to “Setting items” (p. 169).

For details on your network including the IP address, contact your network administrator.



11.2 Managing Data in the Instrument With the FTP Server Function

Specifying the FTP server settings with the instrument

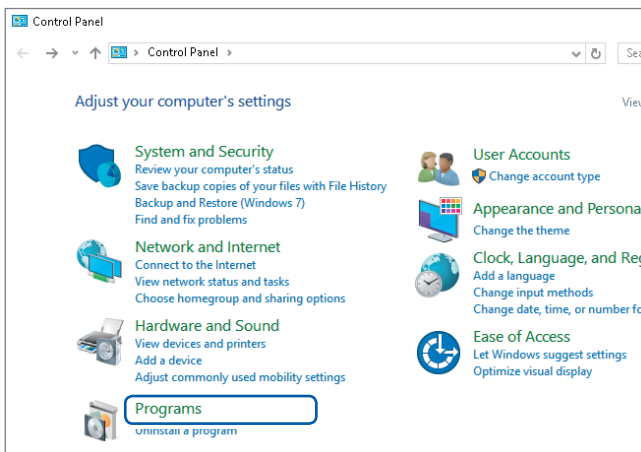
The following example shows how to set the FTP server on Windows 10.

The Microsoft® Windows® Home Edition does not include an FTP server. Use free software such as the FileZilla* Server.

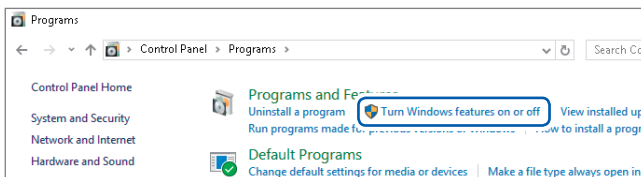
*: Trademark of another company

- Use free software such as the FileZilla Server. 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

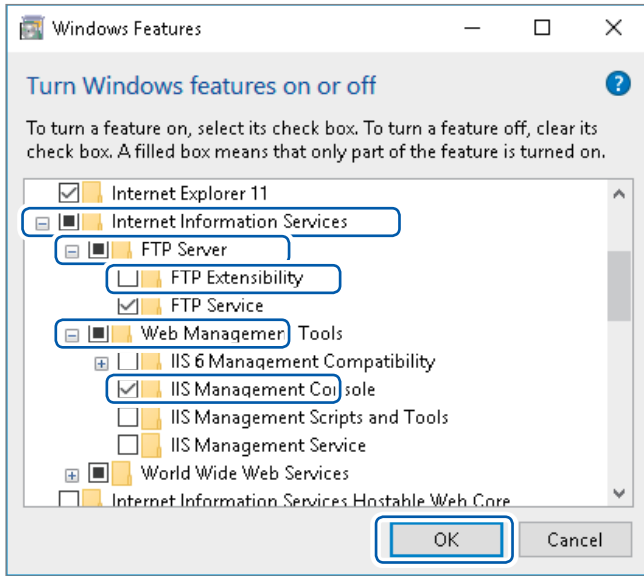


1 Click [Programs] on [Control Panel].



2 Click [Turn Windows features on or off].

The [Windows Features] dialog box appears.



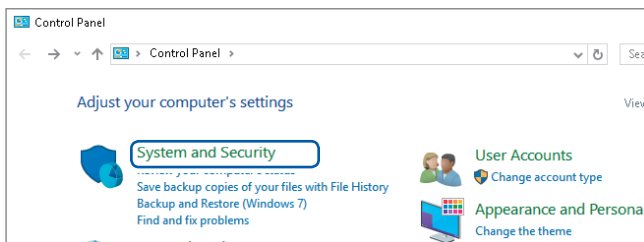
3 Click **[+]** on the left of **[Internet Information Services]** to expand it.

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

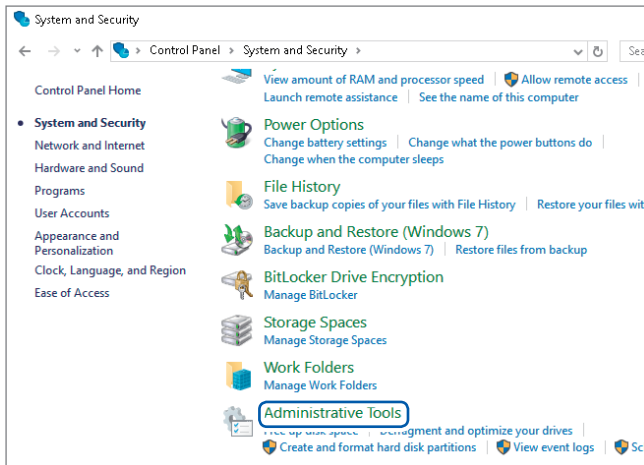
Click **[+]** on the left of **[Web Management Tools]** to expand it, and then select **[IIS Management Console]**.

Click **[OK]**.

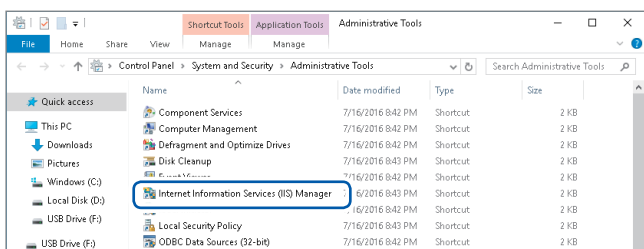
Specifying the FTP settings



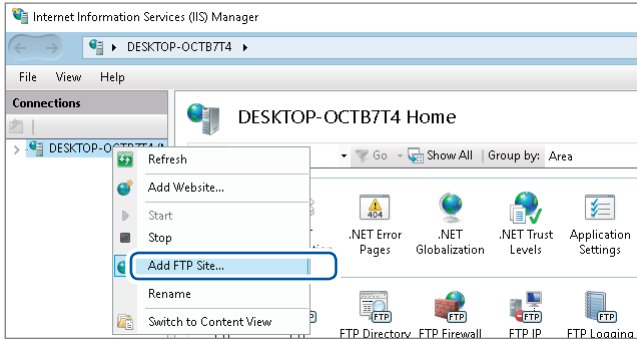
4 Click **[System and Security]** on **[Control Panel]**.



5 Click **[Administrative Tools]**.

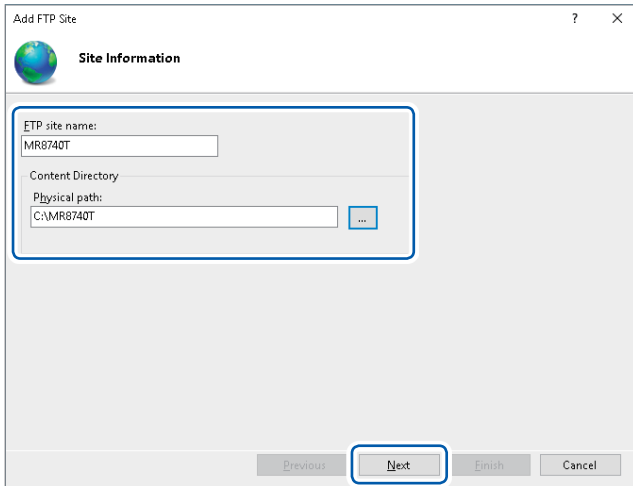


6 Double-click **[Internet Information Services (IIS) Manager]**.



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.

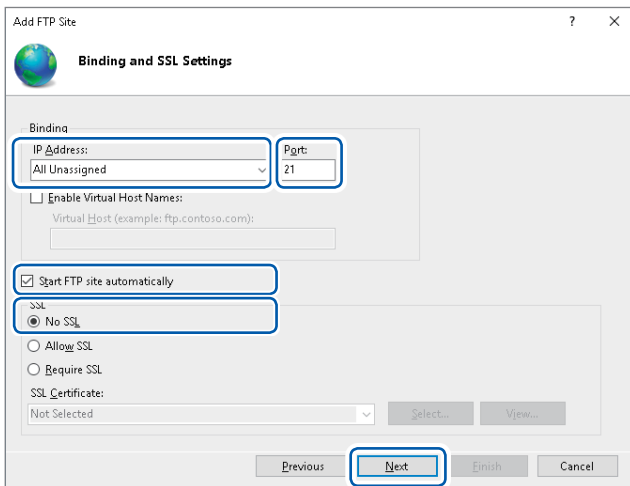
Example:

[FTP site name]: MR8740T

[Content Directory]:

Specify a directory in which data from the FTP client will be saved.

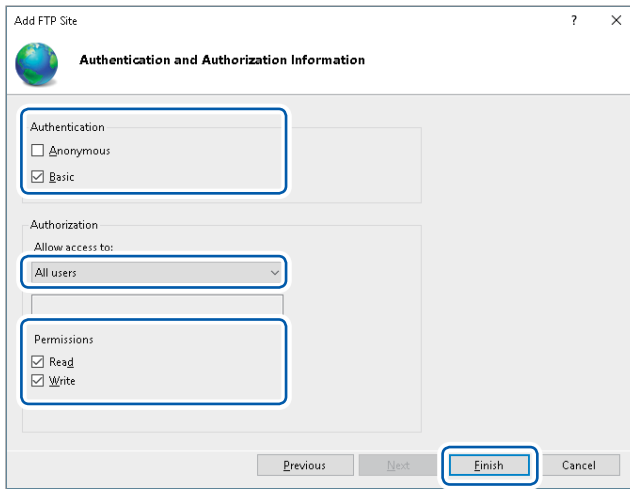
Click **[Next]**.



9 Specify **[Binding]** and **[SSL]** as follows:

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

Click **[Next]**.



10 Specify **[Authentication and Authorization Information]** as follows:

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

Click **[Finish]**.

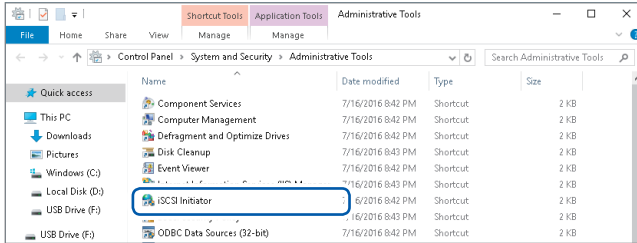
11

Connecting the Instrument to PCs

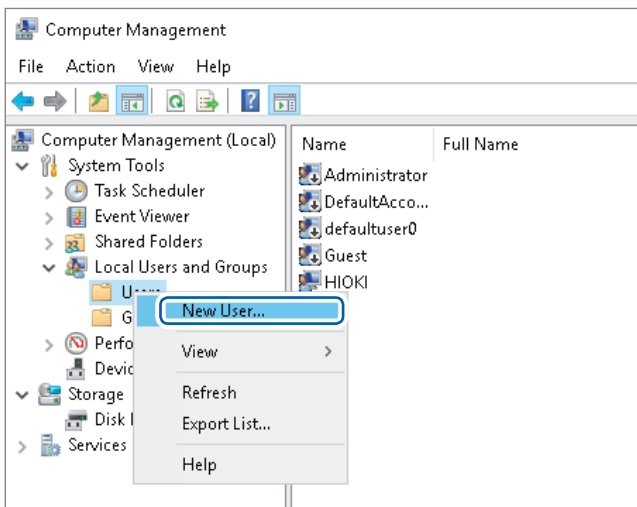
Specifying user access settings

Specify this setting to use the FTP client with the instrument. Refer to step 4 “Type your login name and password in [Login] and [Password], respectively.” on p. 177.

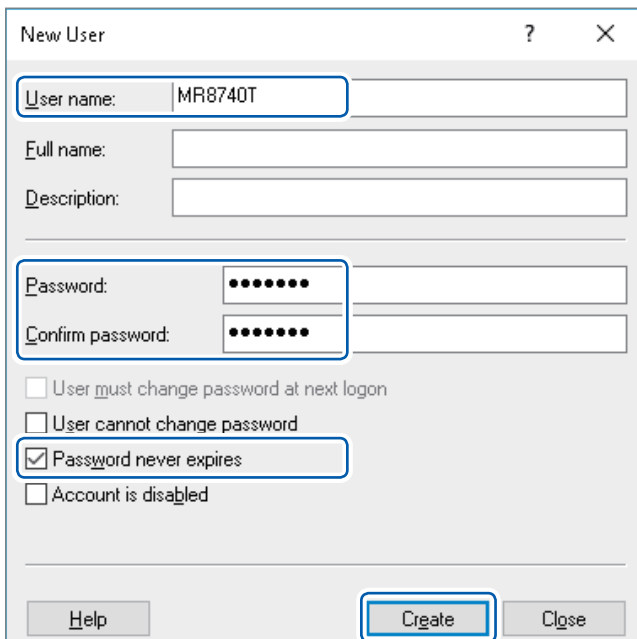
You can use the FTP with a user name and password entered in [User name] and [Password], respectively.



11 Select [Computer Management] in [Administrative Tools] mentioned in step 5 (p. 173).



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



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

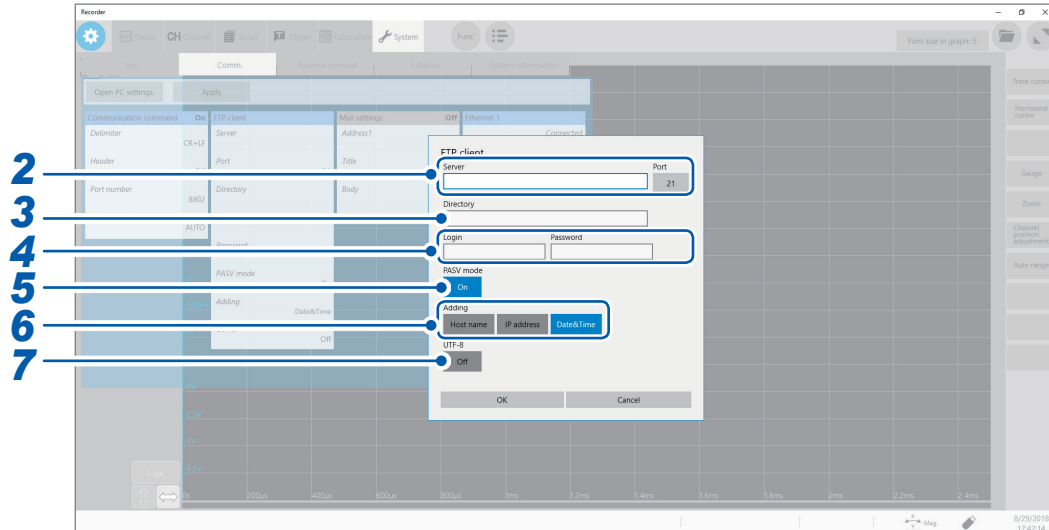
Click [Create].

Specifying the FTP client setting with the instrument

 > [System] > [Comm.]

1 Click [FTP Client].

The setting dialog box will appear.



2 Specify the [Server] and [Port] settings.

Click the boxes to open the touch key or the numeric input dialog box.

Type the PC name or the IP address in [Server]. In [Port], 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 [Directory].

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 [Login] and [Password], respectively.

Type a login name and password used to log in to the FTP server. Enter [User name] and [Password] entered in the FTP server setting.

Refer to “Specifying user access settings” (p. 176).

5 Specify the PASV mode setting in [PASV Mode].

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

6 Specify the file identifier setting under [Adding].

Click the buttons to add identifiers to the file name.

- No identifiers are added when you select a file to be 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 no identifiers are specified under [Adding], 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 now supported.

11.3 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

Auto-save data transmission	Automatically sends the data to be saved on completion of the measurement, according to the auto-save settings. Specify the auto-save settings and specify the save destination to [FTP] .
Transmission with the save icon	When you click the save icon, the data to be saved is automatically sent. In the manually-saving setting, set the save destination to [FTP] .

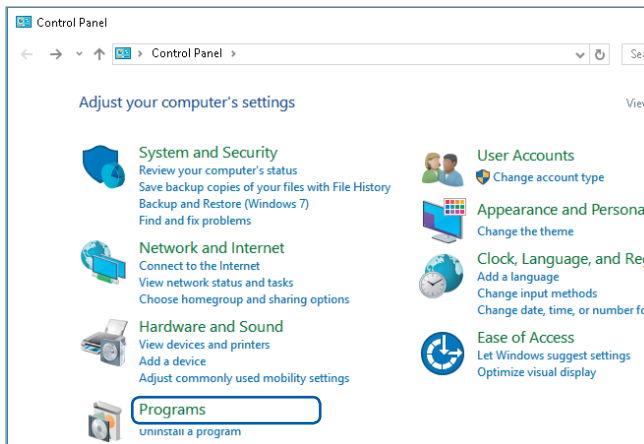
- The date of the file sent to the PC becomes the date the file was sent.
- Transmission to all FTP servers cannot be guaranteed due to differences among servers.
- If a file with the same name exists in the destination, the file is overwritten.

Specifying the FTP server settings on a PC

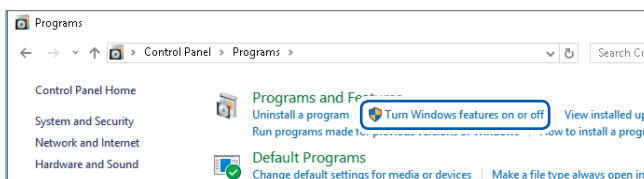
The following example shows how to set the FTP server on Windows 10. The Microsoft® Windows® Home Edition does not include an FTP server. Use free software such as the FileZilla Server.

- The settings may change depending on your 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

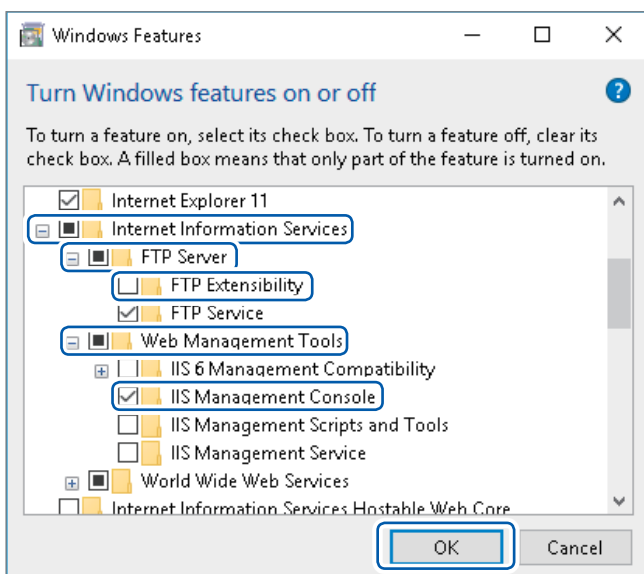


1 Click **[Programs]** on **[Control Panel]**.



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

The **[Windows Features]** dialog box appear.



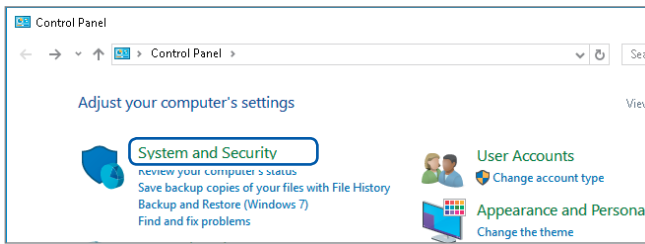
3 Click **[+]** on the left of **[Internet Information Services]** to expand it.

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]**.

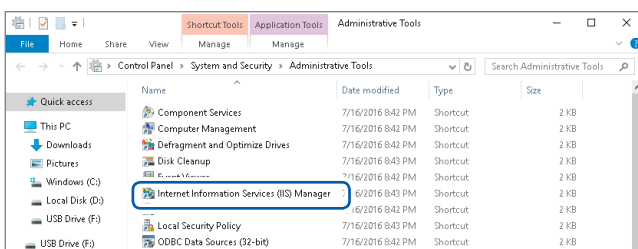
Specifying the FTP settings



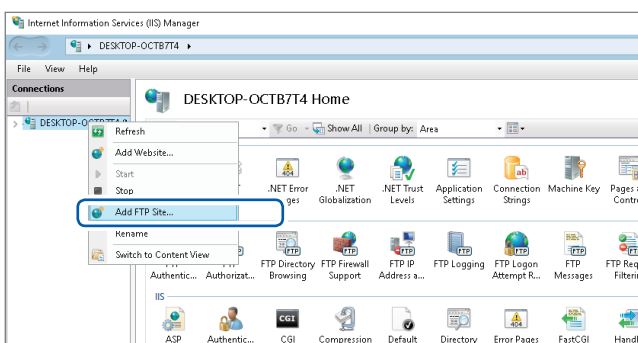
4 Click [System and Security] on [Control Panel].



5 Click [Administrative Tools].

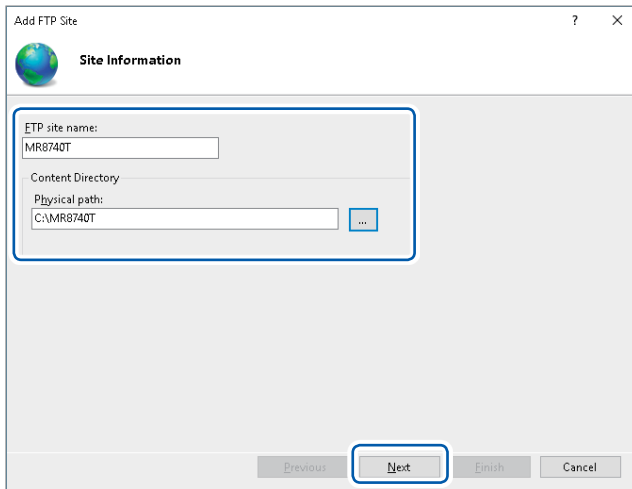


6 Double-click [Internet Information Services (IIS) Manager].



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).



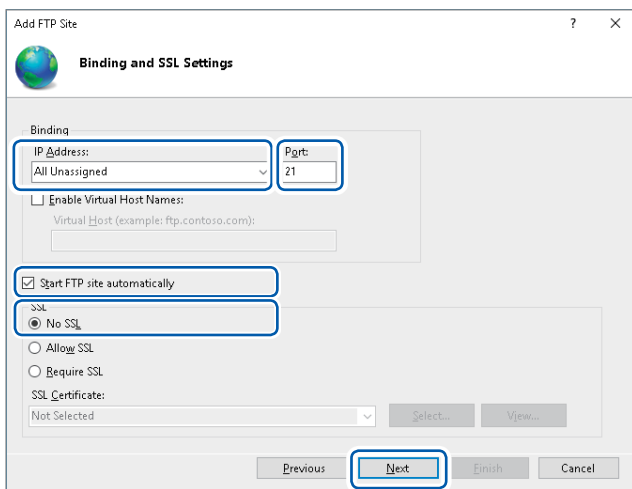
8 Enter the site information.

Example:

[FTP site name]: [MR8740T]
[Content Directory]:

Specify the directory to which data from the FTP client will be saved.

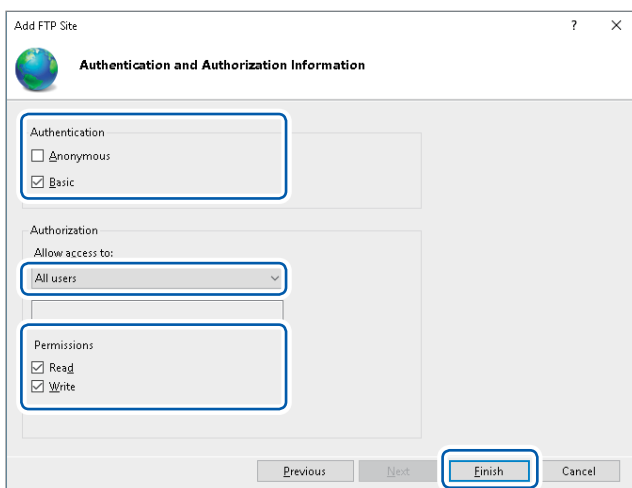
Click **[Next]**.



9 Specify the [Binding] and [SSL] settings as follows:

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

Click **[Next]**.



10 Specify the [Authentication and Authorization Information] settings as follows:

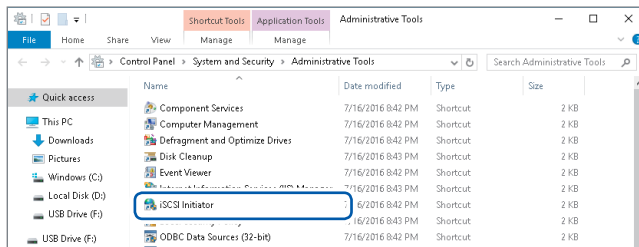
[Authentication]	Select [Basic] .
[Authorization]	[All users]
[Permissions]	Select both [Read] and [Write] .

Click **[Finish]**.

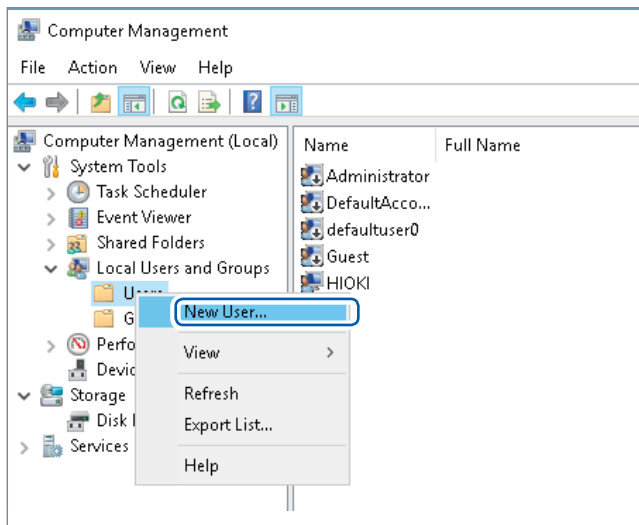
Specifying user access settings

Specify this setting to use the FTP client with the instrument. Refer to p. 183 step 4 “Type your login name and password in [Login] and [Password], respectively.”

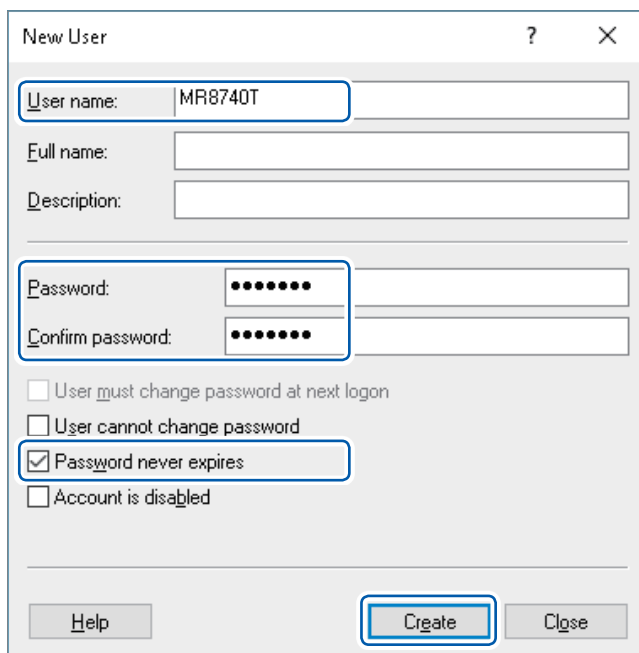
You can use the FTP with entered **[User name]** and **[Password]**.



11 Select **[Computer Management]** in **[Administrative Tools]** mentioned in step **5** (p. 180).



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



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

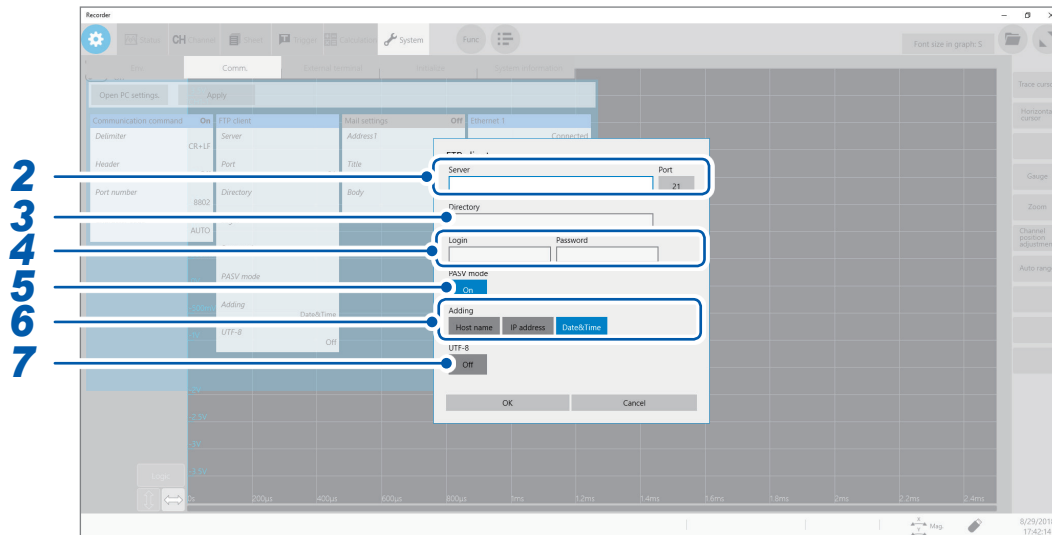
Click **[Create]**.

Specifying the FTP client settings with the instrument

 > [System] > [Comm.]

1 Click [FTP Client].

The setting dialog box will appear.



2 Specify the [Server] and [Port] settings.

Click the boxes to open the touch key or the numeric input dialog box.

Type the PC name or the IP address in [Server]. In [Port], 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 [Directory].

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 [Login] and [Password], 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 “Specifying user access settings” (p. 182).

5 Select a PASV mode in [PASV Mode].

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

6 Specify the identifier preferences under [Adding].

Click 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.

11.4 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. Specify the auto-save setting and set the save destination to [Mail] .
Manual email-sending with the save icon	When you click the save icon, an 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 much 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).

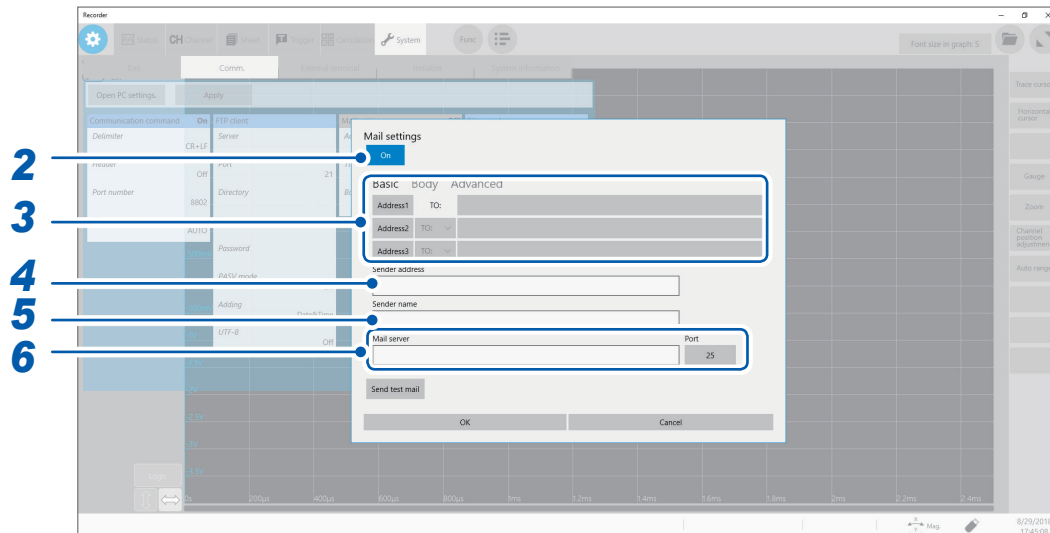
*: Trademark of another company

Specifying the basic setting for sending email

 > [System] > [Comm.]

1 Click [Mail setting].

The setting dialog box will appear.



2 Set [Mail setting] to [On] or [Off].

3 Click [Basic].

Select [Address1] by clicking it, and then type an email address in the blank box.

When emails are to be sent to multiple addresses, type email addresses in [Address2] and [Address3] in the same manner.

Select a recipient type ([To] or [Bcc]) in [Address2] and [Address3].

4 Type a sender address in [Sender address].

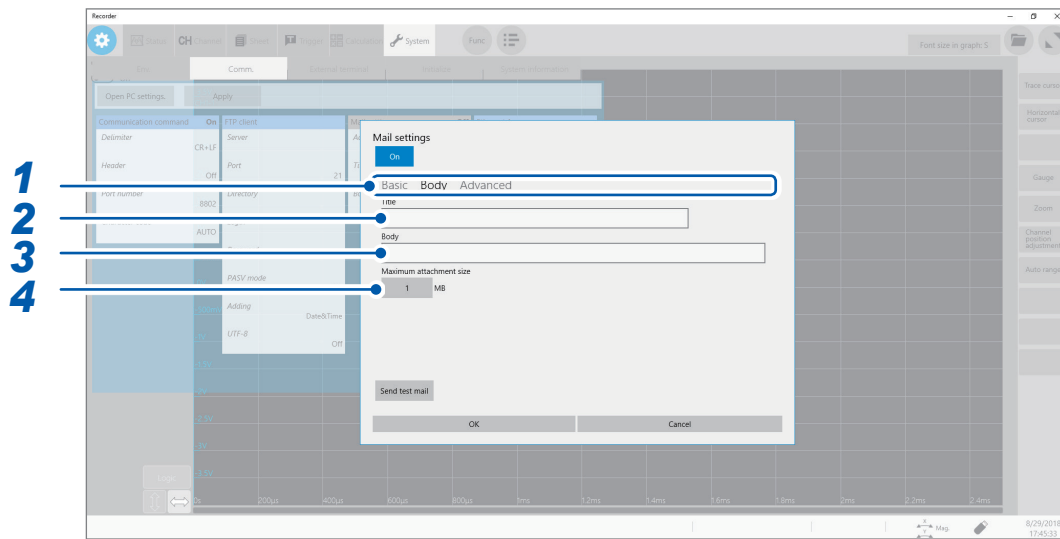
5 Type a sender name in [Sender name].

Type a name so that the recipient identifies emails received from the instrument.

6 Specify the [Mail server] and [Port] settings.

Type the PC name or the IP address in [Mail server]. In [Port], type the port number with which the SMTP server is operating if the number is not the standard number of 25.

Specifying the email content settings



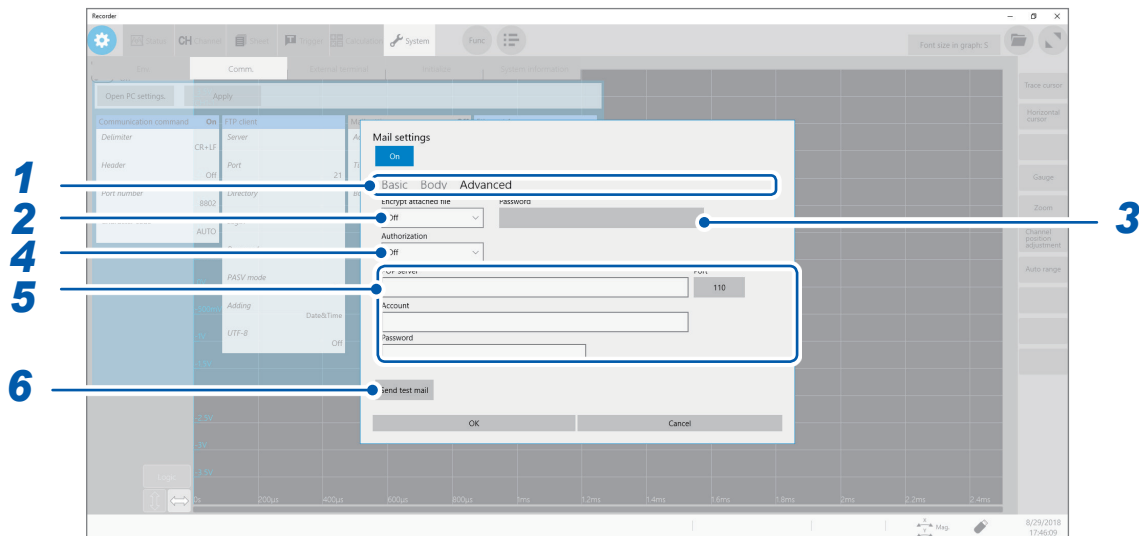
- 1** Click **[Body]**.
- 2** Type a title in **[Title]**.
- 3** Type a body in **[Body]**.
- 4** Enter the maximum size of each attachment file in **[Maximum attachment size]**.

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, and 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.

Specifying the authentication, compression, and encryption settings for emails to be sent



1 Click **[Advanced]**.

2 Specify the **[Encrypt attached file]** setting.

Off <input checked="" type="checkbox"/>	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 **[Password]**.

Number of characters: up to 16

4 (When mail authorization is required) Select an authorization protocol in **[Authorization]**.

Select an authorization protocol.

Off <input checked="" type="checkbox"/>	Does not authorize any emails.
POP	Uses POP (APOP) before SMTP.
SMTP	Uses SMTP (supports CRAM-MD5, PLAIN, and LOGIN).

5 Specify the authorization information.

- When **[POP]** is used
Specify the POP server and port number setting in **[POP server]** and **[Port]**, respectively.
If they are left blank, the mail server address is used for transmission (usually the same).
Type your account and password in **[Account]** and **[Password]**, respectively.
- When **[SMTP]** is used
Specify the SMTP server and port number in **[SMTP Server]** and **[Port]**, respectively.
Type your account and password for authentication in **[Account]** and **[Password]**, respectively.

6 Check if the email can normally be sent.

Click [\[Send test mail\]](#).

A test email that includes the 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 is enabled for the attached file, images in the test email are encrypted.

Be sure to decompress it to check whether the password is correctly set.

11.5 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.

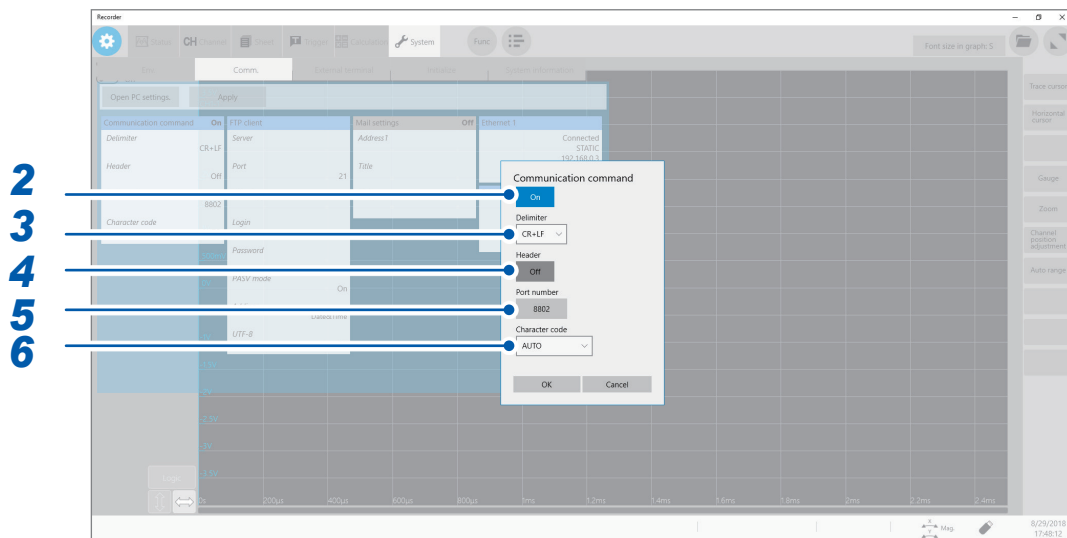
For details, refer to the Communication Command Instruction Manual on the accompanying application disc.

Specify the LAN settings and connect the instrument before using command communications. Refer to “11.1 Specifying the LAN Settings and Connecting to the Network” (p. 168).

 > [System] > [Comm.]

1 Click [Communication command].

The setting dialog box will appear.



2 Set [Mail setting] to [On] or [Off].

3 Select a character code setting in [Delimiter].

Select a character code (line feed code) indicating the data delimiter.

CR+LF <input checked="" type="checkbox"/>	Sends the character codes 0x0d and 0x0a.
LF	Sends the character code 0x0a.

4 Select a header setting in [Header].

Specifies whether to prefix the header to the command response data or not.

Off <input checked="" type="checkbox"/>	Does not prefix any header to response data.
On	Prefixes the header to response data.

5 Specify the port number setting in [Port number].

Specify only the most significant 3 digits of the 4-digit port number. The last digit is fixed to [2].

6 Select a character code setting in [Character code].

AUTO <input checked="" type="checkbox"/>	Automatically specifies a text code depending on the display language. The text code UTF-8 is set for English; SJIS for Japanese.
SJIS	Sets the text code to SJIS.
UTF-8	Sets the text code to UTF-8.

Externally Controlling the Instrument

Familiarize yourself with the section “Before connecting to an external device” in “Operation Precautions” of Quick Start Manual.

Connecting the external control terminals with external devices allows the instrument to start and stop a measurement.

This section describes the procedure and the external control terminals to control the instrument externally.

The terminals are referred to collectively as “external control terminals.”

Refer to “2.3 Connecting the External Control Terminals” in Quick Start Manual for information on how to connect the external control terminals.

12.1 External Input and Output

External input (IN1), (IN2)

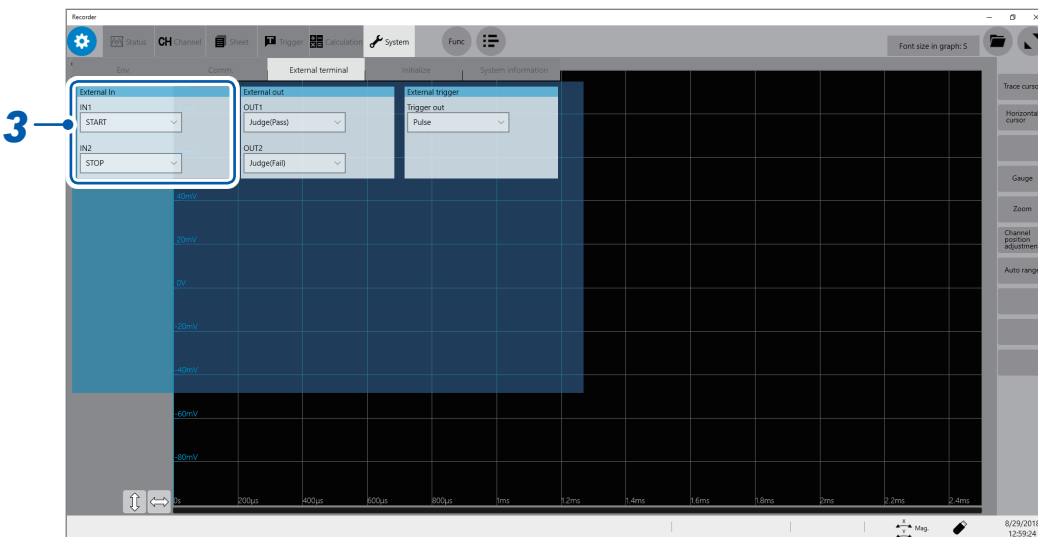
Externally inputting signals can start and stop measurements as well as save the data. In factory default settings, the START signal is assigned to the IN1 terminal, and the STOP signal to the IN2 terminal.

How to input signals

- 1 Connect each of the IN1, IN2, and GND terminals to an external signal-outputting device with wires.

Refer to “2.3 Connecting the External Control Terminals” in Quick Start Manual.

- 2  > [System] > [External terminal]



- 3 Select an external input terminal setting in [External In].

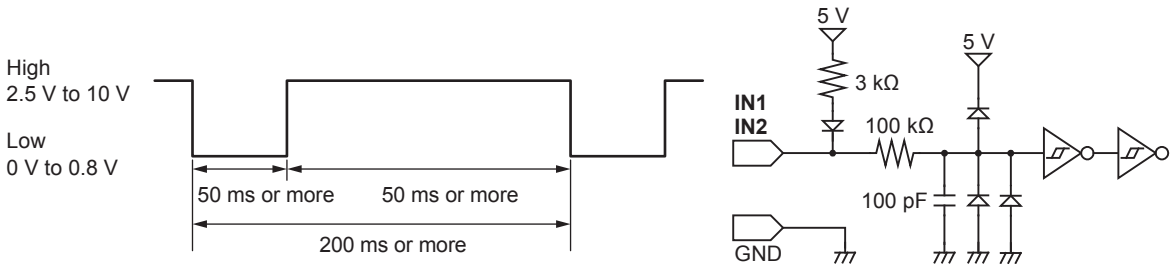
Select any two of the actions to be performed by the instrument in response to the external input signal.

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	[Quick], which is accessible by tracking screens in the following order: [Status] > [Save] > [Save icon operation] > [Quick]
ABORT	Forcefully terminates the measurement. (No post-measurement processes such as numerical calculations or automatic saving are performed. However, the instrument automatically saves a waveform file that contains data acquired until the forcible termination)
EVENT	Puts on an event mark. The event marks are put on the Waveform screen. You can put event marks by clicking the start icon during a measurement.

4 Short-circuit the terminal and GND, or input pulse waves or rectangular waves to the terminal. The signal shall have 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)

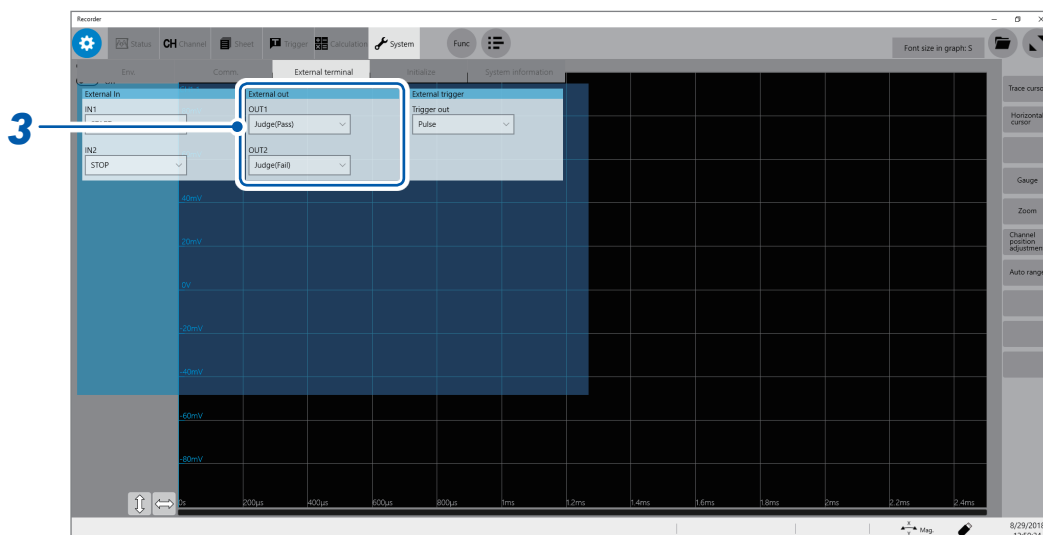
The instrument can output various signals depending on its state.

How to output signals

- 1** Connect each of the OUT1, OUT2, and GND terminals to an external signal-outputting device with wires.

Refer to “2.3 Connecting the External Control Terminals” in Quick Start Manual.

- 2** > [System] > [External terminal]



3 Select an external output terminal setting in [External out].

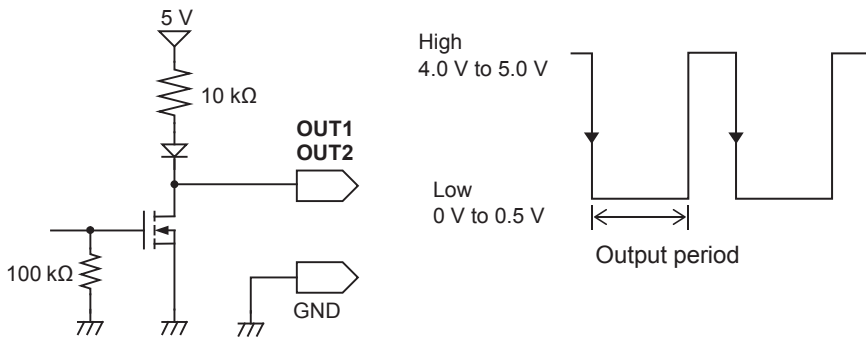
Select any two of the conditions under which the instrument outputs a signal.

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 a 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)

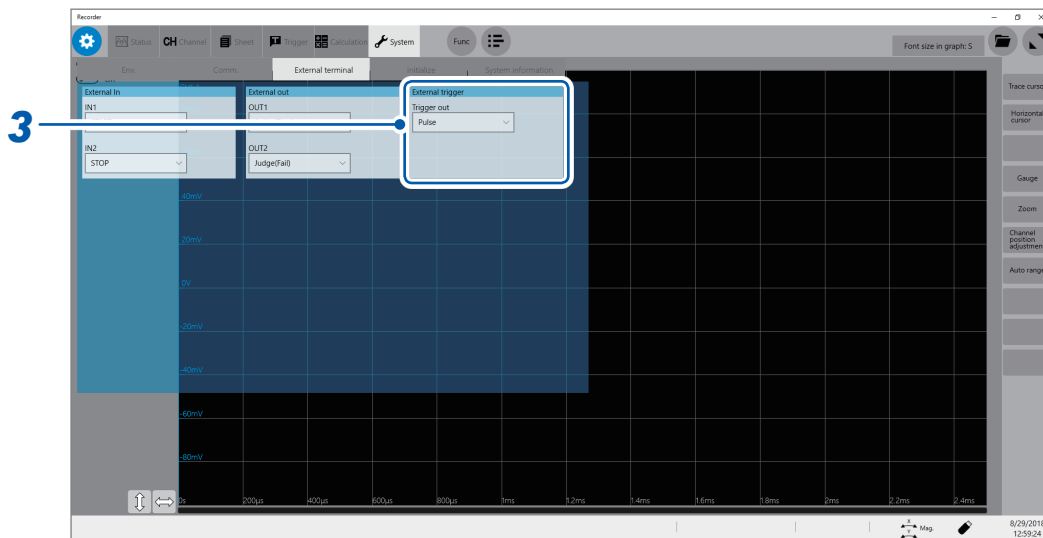
The instrument outputs the signal when it is triggered. This feature allows multiple instruments to be controlled, achieving the synchronous operation.

How to output signals

- 1** Connect each of the TRIG OUT and GND terminals to an external signal-inputting device with wires.

Refer to “2.3 Connecting the External Control Terminals” in Quick Start Manual.

- 2**  > [System] > [External terminal]



- 3** Select a trigger output method in [Trigger out] under [External trigger].

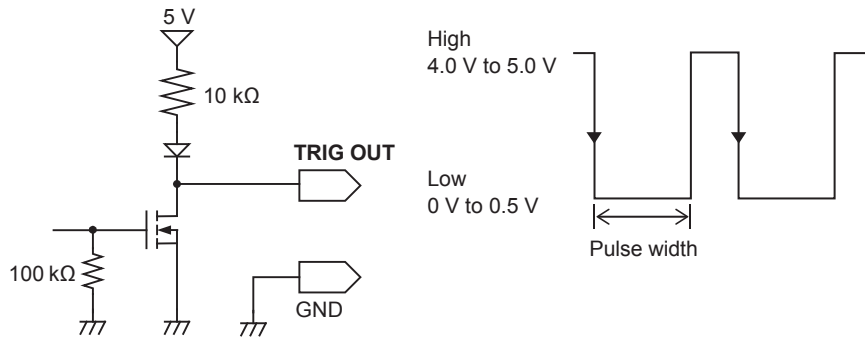
Select an output signal type for the trigger output terminal.

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.




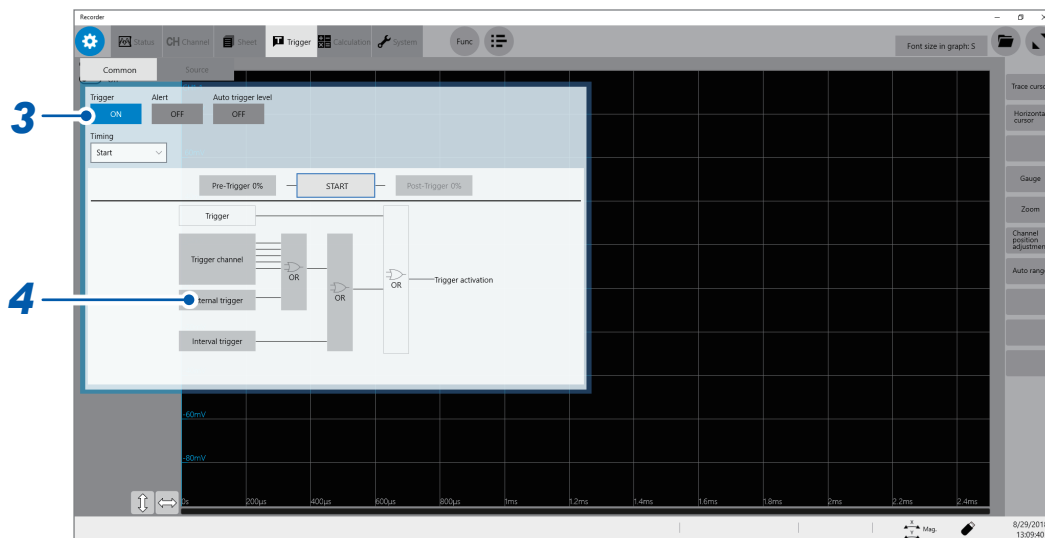
When the auto-range function is used, the instrument is triggered, outputting the TRIG OUT signal. Be careful when performing auto-range measurement while using the TRIG OUT signals.

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.

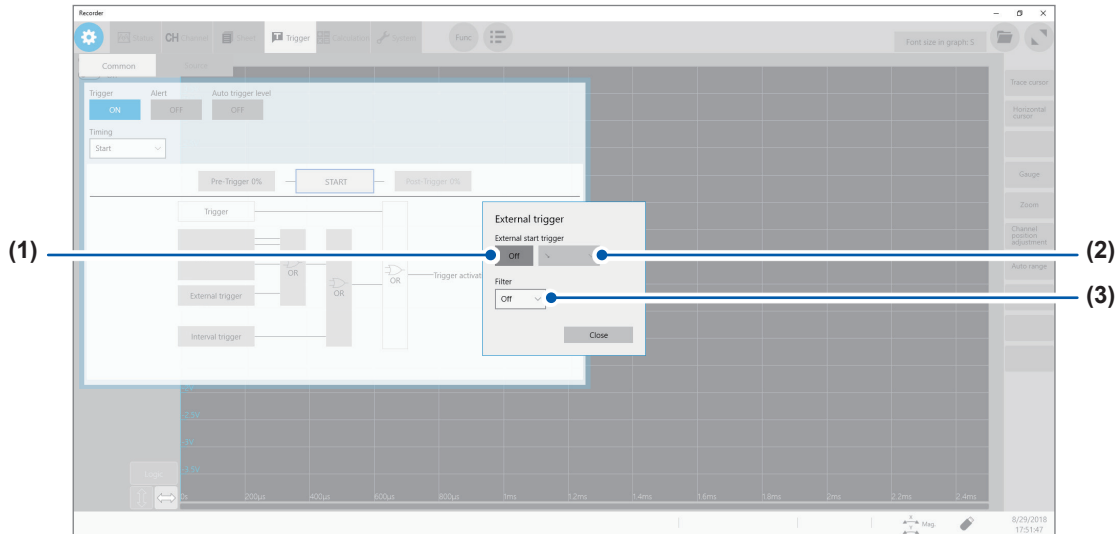
How to output signals

- 1 Connect each of the EXT.TRIG and GND terminals to an external signal-outputting device with wires.
Refer to “2.3 Connecting the External Control Terminals” in Quick Start Manual.
- 2  > [Trigger] > [Common]
- 3 Set [Trigger] to [ON].



4 Click [External trigger].

The setting dialog box will appear.



(1) Set [External start trigger] to [On].

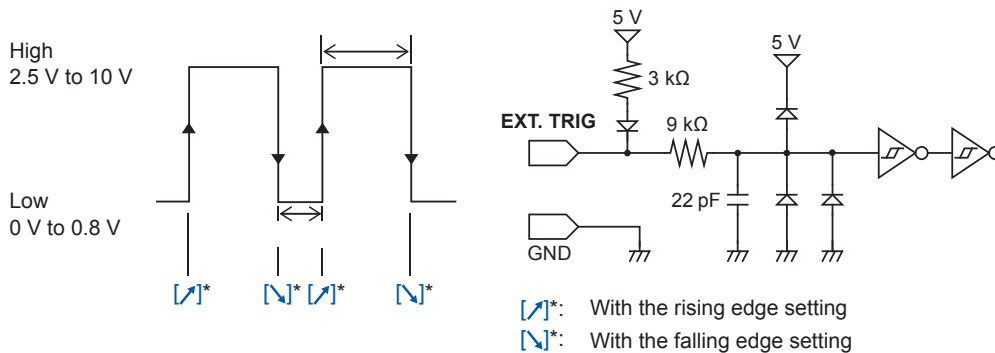
(2) Select whether the instrument accepts the external trigger on the rising edge [↗]* or falling edge [↘]* of the waveform.

(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 have 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] or [LOW] is displayed.

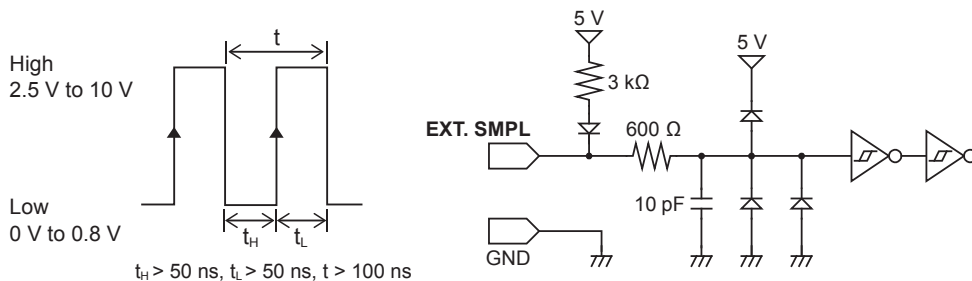
12.2 External Sampling (EXT.SMPL)


Externally inputting the signal can control the sampling rate.

How to output signals

- 1 Connect each of the EXT.SMPL and GND terminals to an external signal-outputting device with wires.
- 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 have 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 tracking in the following order:  > [Channel] > [each Unit]
- When Model U8975 Analog Unit and MR8990 Digital Voltmeter Unit are installed, input a sampling signal that contains at least two times the number of points specified as a recording length; when Model U8991 Digital Voltmeter Unit, at least four times.

13 Appendix

13.1 Information for Reference Purposes

Waveform file size (for reference)

Waveform file size (for reference)

(MEM file size) = (Setting part size) + (Data part size)
 (Setting part size) = 791040 + 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 or U8991) + (Number of logic modules)] + 4 × [(Number of channels of Models MR8990 and U8991) + (Number of real-time calculation channels)]} × (Number of data points)

Recording length (Points)	Number of channels saved					
	4	8	16	32	54	108
2.5 k	815 KB	839 KB	887 KB	983 KB	1.1 MB	2.0 MB
5 k	835 KB	879 KB	967 KB	1.1 MB	1.4 M	3.1 MB
10 k	875 KB	959 KB	1.1 MB	1.5 MB	2.0 MB	5.2 MB
20 k	955 KB	1.1 MB	1.4 MB	2.1 MB	3.0 MB	9.5 MB
50 k	1.2 MB	1.6 MB	2.4 MB	4.0 MB	6.2 MB	22.5 MB
100 k	1.6 MB	2.4 MB	4.0 MB	7.2 MB	11.6 MB	44.1 MB
200 k	2.4 MB	4.0 MB	7.2 MB	13.6 MB	22.4 MB	87.3 MB
500 k	4.8 MB	8.8 MB	16.8 MB	32.8 MB	54.8 MB	216.9 MB
1 M	8.8 MB	16.8 MB	32.8 MB	64.8 MB	108.8 MB	432.9 MB
2 M	16.8 MB	32.8 MB	64.8 MB	128.8 MB	216.8 MB	864.9 MB
5 M	40.8 MB	80.8 MB	160.8 MB	320.8 MB	540.8 MB	2.2 GB
10 M	80.8 MB	160.8 MB	320.8 MB	640.8 MB	1.1 GB	–

- These sizes, which can be used only as a reference, of text files are acquired when analog channels (other than Model MR8990 or Model U8991) are used. Any number of logic channels on one module occupies one channel; one analog channel (Model MR8990 and Model U8991) 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

(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 saved					
	4	8	16	32	54	108
2.5 k	214 KB	354 KB	634 KB	1.2 MB	2.0 MB	3.9 MB
5 k	414 KB	694 KB	1.3 MB	2.4 MB	3.9 MB	7.7 MB
10 k	814 KB	1.4 MB	2.5 MB	4.7 MB	7.8 MB	15.4 MB
20 k	1.6 MB	2.7 MB	5.0 MB	9.5 MB	15.6 MB	30.7 MB
50 k	4.0 MB	6.8 MB	12.4 MB	23.6 MB	39.0 MB	76.8 MB
100 k	8.0 MB	13.6 MB	24.8 MB	47.2 MB	78.0 MB	153.6 MB
200 k	16.0 MB	27.2 MB	50.0 MB	94.4 MB	156.0 MB	307.2 MB
500 k	40.0 MB	68.0 MB	124.0 MB	236.0 MB	390.0 MB	768.0 MB
1 M	80.0 MB	136.0 MB	248.0 MB	472.0 MB	780.0 MB	1.54 GB
2 M	160.0 MB	272.0 MB	496.0 MB	944.0 MB	1.56 GB	3.07 GB
5 M	400.0 MB	680.0 MB	1.24 GB	2.36 GB	3.90 GB	7.68 GB
10 M	800.0 MB	1.36 GB	2.48 GB	4.72 GB	7.80 GB	–

- These sizes, which can be used only as a reference, of text files are acquired when analog channels (other than Model MR8990 or Model U8991) 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.

Scaling method for strain gauges

This section describes how to determine the scaling conversion ratio when measurements are 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: $\text{Stress } (\sigma) = E \times \varepsilon$

When measurements are performed involving temperature compensation with 2 or 4 gauges, position the gauges perpendicularly to each other.

Stress (σ) is multiplied by $1 / (1 + \nu)$ for the 2-gauge method, and $1 / \{2 (1 + \nu)\}$ for the 4-gauge method.

Measuring bending stress: $\text{Stress } (\sigma) = E \times \varepsilon$

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: $\text{Stress } (\sigma) = E / [2 (1 + \nu)] \times \varepsilon$ (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.)

$$\begin{aligned}\sigma &= 73 \times 10^9 \times (\text{Measured value}) \times 10^{-6} \text{ [unit of measured value: } \mu\varepsilon\text{]} \\ &= 73 \times (\text{Measured value}) \text{ [unit: kPa]} \\ &= 7.44^* \times (\text{Measured value}) \text{ [unit: gf/mm}^2\text{]} \\ &*: 1 \text{ Pa} = 1.01971621 \times 10^{-7} \text{ kgf/mm}^2 = 1 \text{ N/m}^2\end{aligned}$$

Conversion ratio: 7.44; unit: gf/mm²

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. 36).

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 file saved

```
"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
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